Prepare for a shock: There’s a new kid on the block in tumour ablation

By Philip Ward

Ever thought of giving your patient an electric shock? The idea may sound like something out of a Frankenstein movie, but more interventional radiologists may soon be doing this if the initial promise of irreversible electroporation, an experimental ablation technique for solid tumours, is supported by further research.

“It’s very much the new kid on the block,” said Prof. Dr. Thomas Helmberger, head of the Institute of Diagnostic and Interventional Radiology and Nuclear Medicine, Klinikum Bogenhausen, Technical University of Munich, Germany. “It has unique features, including preciseness, speed, low collateral damage, and preservation of connective tissue structures.”

At yesterday’s New Horizons Session, ‘Ablation beyond radiofrequency’, he explained that the technique is based on electropermeabilisation, which is a significant increase in the electrical conductivity and permeability of the cell plasma membrane caused by an externally applied electrical field. The method is used in the sterilisation and preprocessing of food, and is a molecular engineering tool for genes, gene delivery in tissue, transdermal delivery of drugs and genes, fusion of cells, introduction of drugs into cells, and electrochemotherapy for treatment of cancer.

The problem, though, is that reliable information about electroporation is limited, and most studies are only Phase II. As of 25 February 2012, there were 159 articles about it on PubMed, only a third of which are clinical. These papers focus on the liver (35), brain (11), kidney (9), lung (6), prostate (5), breast (5), pancreas (3) and bone (3).

“Honestly speaking, there is not much evidence of the technique’s use on a large scale,” noted Helmberger. “We need more studies on the indications, type of procedure setting – percutaneous versus open – optimised protocols, and most importantly of all, long-term efficacy.”

Only one device is commercially available at present: the NanoKnife, from AngioDynamics. The number of pulses ranges from 10 to 100, and the pulse length is 20–100 µs ± 2 µs. The maximum current is 50 A, and there are up to six probe channels, he said.

The technique leads to the loss of vascular smooth muscle cells. The vessel matrix is not compromised, and it has potential in vascular treatment. Unlike thermal ablation, general anaesthesia and cardiac monitoring are essential with electroporation, but there are no immunohistochemical effects, connective tissue is spared, and small vessels are not affected. Only the cell membrane is damaged. Whereas the size of the probe is 14–17G in thermal ablation, it is 16–19G in electroporation, according to Helmberger.

It is important to remember that irreversible electroporation has an electroablative effect and requires a puncture, noted session moderator Prof. José Ignacio Bilbao, professor of radiology at the University of Navarra in Pamplona, Spain, and Congress President of ECR 2013. Conversely, microwave ablation has a thermal effect and necessitates a puncture, high intensity focused ultrasound has a thermo-mechanical effect and needs no puncture, and stereotactic body radiation therapy has an ablative effect and requires no puncture.

Overall, the role of image-guided therapy is to identify the target, to target the target, to select the most appropriate therapy, to monitor the procedure, and to monitor the immediate local effect, he stated.

Percutaneous ablation, either chemical or thermal ablation, is the accepted method of treatment, and involves ethanol, radiofrequency or cryotherapy. The drawbacks are the need for a puncture, unwanted damage to adjacent structures, diminished effects in the vicinity of blood vessels, and ineffectiveness in tumours of less than 3 cm diameter, added Bilbao.
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The wrong diagnosis in acute abdomen may lead to either an unnecessary operation or a delay before a necessary one, so modality choice must be informed and accurate. The pros and cons of ultrasound and CT were spelled out in yesterday’s mini course, which was organised as a face-off between the two modalities.

In the post-talk activities, delegates’ initial votes on the usefulness of CT and ultrasound in the emergency patient revealed that in terms of time and cost-efficiency, they favoured strategies based on the clinical question to be answered, with a preference for ultrasound and optional CT in younger patients.

Co-moderator, Prof. Pablo Ros, chair of the radiology department at Case Western Reserve University, Cleveland, U.S., acted as ‘pro’ by generating a point around this position. A second vote using the handheld devices revealed that while only 13.2% of delegates had opted for the straight ‘ultrasound with optional CT’ during the first vote, the second vote saw only 5.1% voting against ultrasound, the top answers just about maintaining their position.

“The doctor can only be its: the preference and expertise of the radiologist and the emergency doctor on duty plays a role in its decision,” said Prof. Michael Laniado, head of radiology at MCH, The Hague, the Netherlands.

Pneumonia is an easy disease to detect by ultrasound, but if the patient has a fever and the lung looks like liver, according to speaker Dr. Julio Puylaert, head of abdominal radiology at VU University Hospital, Amsterdam, the Netherlands, ultrasound specialists aren’t in the hospital.

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“The program will continue to provide mammographic facilities at no cost to the patient, so that those who are economically unable to pay for mammography, can take advantage of the service,” Salem said.

At her hospital, the approach to abdominal emergencies for adult and non-pregnant patients who are haemodynamically stable is to exclude life-threatening diagnoses such as dissecting aortic aneurysm and perforation and obstruction, and for this CT is the modality of choice, according to Akata.

She pointed to the diagnostic challenge of using ultrasound in complicated or diffuse disease with concurrent and associated pathologies when undertaking gynaecological imaging.

“In a 46-year-old patient with pelvic cramplike pain and vomiting, CT was able to confirm a torsion of a mesenteric cyst from differential diagnoses of acute appendicitis, torsion of ovarian cyst and intestinal obstruction,” she said.

Delegates were shown mammography and ultrasound images of some of the cases of interest, with optional CT, Puylaert listed the advantages of ultrasound. Very much seen as the more cumbersome candidate, given its operator dependency and time required to perform the examination, ultrasound’s superior image resolution if close enough in lean patients, gave it the edge over CT in the hands of an experienced sonographer, Puylaert noted.

This interactive part of the session provided thought-provoking multiple choice questions for delegates to answer, such as whether there are cases where ultrasound and CT don’t compete. Delegates were unanimous that in cases of suspected GI bleeding, mesenteric ischaemia, diverticulitis and trauma, CT should be performed, while appendicitis should be imaged by ultrasound.

Another question asked was whether emergency physicians should be trained in ultrasound. The answers wavered between an outright ‘no’ to limited training in some ultrasound techniques combined with academic education, to more rounded training.

“Emergency doctors should perhaps be at least trained to determine when they should ask for a CT or an ultrasound when diagnosing a patient, pointing to the fact that in the emergency room, there was a tendency to over-request CT scans,” said Puylaert.

“In our hospital, we offer emergency doctors a two month rotation, which is just about enough time for them to learn that they will never master ultrasound. Then they give up,” added Puylaert.

In agreement was challenger Prof. Deniz Akata, an abdominal radiologist at Hacettepe University Hospital, Ankara, Turkey, whose talk covered the advantages of CT in emergency abdomen.

“The radiologist needs to be the person performing emergency imaging and interpretation, whether ultrasound or CT,” she said.

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Maroldi takes ECR delegates on a voyage into head and neck imaging’s future

By Philip Ward

Small is beautiful when it comes to head and neck imaging, particularly because the small structures are so fascinating to explore, according to Prof. Roberto Maroldi, head of radiology at the University of Brescia, Italy.

“These anatomical structures allow you to explore the extreme of human senses like vision, hearing, smell and taste,” he said in yesterday’s Antonio Chiesa Honorary Lecture. “They provide functions like breathing and swallowing, which require perfect coordination. Senses and functions combined, like hearing and voice, permit a sophisticated interaction with other humans. All these functions and senses are provided by miniaturised structures.”

The goal of head and neck imaging is to analyse these structures and functions, as well as to demonstrate abnormalities, plan multidisciplinary treatment strategies, assess response to treatment, and follow-up patients.

Imaging of the ear – or temporal bone imaging, as it used to be called – means examining structures beyond a direct clinical evaluation. This encompasses the sound-waves transmission system, the submersed fluid-waves sensor and its bony box, the data carrier fibre-cable, and the processors that analyse, decode and eventually provide the information as sound, including speed, frequency, loudness, and stereo-location.

Studying the larynx is the next challenge, and involves imaging the submucosal tissues to separate tumour from uninvolved structures. Radiologists must also assess the sub-mucosal muscles, deep fat spaces, supporting cartilages, and ligaments containing membranes and muscles.

Modality choice is likely to be CT (and contrast agent arterial and venous enhancement) or MRI. It depends on tissue contrast resolution, contrast enhancement (arterial and venous), tumour versus oedema discrimination, and high spatial and contrast resolution and 3D capabilities.

The sinuses are the third field of study, and the largest in terms of number of patients and euros, he said. The main aims are to identify or delineate anatomy and variants, to determine tumour versus orbit/skull base/ sinuses and fossa relationship, to assess post-treatment complications and follow-up, and to “orientate surgeons along new corridors.”

Another important task is to teach, to bring difference groups together, and to share and exchange experiences and ideas, Maroldi pointed out. Particular attention must be paid to how to train residents and younger colleagues, and promoting cooperation with ENT and maxillofacial surgeons and oncologists is a critical issue. Setting a minimum number of cases, and how to fully integrate PET/CT, and maybe PET/MRI, are other key issues for the future.

When he was a resident, Maroldi was introduced to the topic by his mentor, Antonio Chiesa, who was President of ECR 2005. “In spite of his illness, he worked tirelessly for European radiology,” noted Maroldi.

Never underestimate teleradiology’s downside, expert warns

By Mélisande Rouger

Teleradiology raises serious questions, especially as the global financial crisis has put healthcare systems under a lot of pressure, ECR delegates were told during Saturday’s session on standards and audits.

Health budgets are tighter, technology is being cut, and things are not likely to change anytime soon, according to Dr. Richard Fitzgerald, a consultant radiologist from Wolverhampton, U.K. “There’s enormous downward pressure on governments and health providers to resource their staff to cope with the issues and challenges posed by demographics and innovation, and teleradiology is just part of a solution,” he said.

The main problem is teleradiology becoming a commodity, and that means commisioners may then go for the lowest bid; he cautioned.

Our winning brings undoubted benefits but its use is accompanied by a number of disadvantages, Fitzgerald pointed out. “Fundamentally teleradiology erodes the local clinico-radiological relationships,” he said.

From the manager or commissioner’s point of view, it can be seen as a cheaper option, since they don’t have to commit to employing someone for decades or make contributions towards pensions, sick pay or study leave. Moreover, for the local radiologist, the commoditisation and competition from teleradiology companies can provide a perverse disincentive to participate in other activities.

There is a perverse incentive to report more masses and faster rather than sit on committee, liaise with commissions, participate in clinical radiological meetings and service development with radiographers, etc. That is a downward spiral to disaster because, unless the local radiologist provides added value, there is nothing to distinguish them from teleradiologists,” he said.

Also money allocated by a local radiology department to a teleradiology company means less money for that department. The consequences for financially fragile institutions can be devastating, as they are less likely to recruit new radiologists.

“It is an utter disaster for both young radiologists and the departments because you need the innovation, the energy and the particular attitude of the new generation to improve services,” Fitzgerald explained.

Retention, provision of pensions, job security, terms of service, hours of work, sick pay, training and research are also being jeopardised. Fitzgerald further remarked that the fact that teleradiologists outside the U.K. do not have to register with the General Medical Council is “an absolute scandal”.

Providing a balance to the session was Dr. Luis Donoso, director of the DiagnostiC Imaging Department, Hospital Clinic of Barcelona, Spain, who outlined the numerous potential benefits offered by teleradiology. These include better workforce mobility within the radiological profession, possible cost advantages, and greater flexibility and fewer skills shortages.

Vienna Hofburg provides glorious setting for Bracco Foundation Concert

By Diana Bracco, Bracco Foundation President

Celebrating scientific events and symposia through classical music is a tradition at Bracco. In 1995, we marked the centenary of the discovery of x-rays with three concerts performed by La Scala Philharmonic in Milan, Rome and Palermo. We also sponsored the annual Lecture. “They provide functions like vision, hearing, smell and taste,” he said in yesterday’s Antonio Chiesa Honorary Lecture. “They provide functions like breathing and swallowing, which require perfect coordination. Senses and functions combined, like hearing and voice, permit a sophisticated interaction with other humans. All these functions and senses are provided by miniaturised structures.”

The concert was performed by the orchestra of the Teatro alla Scala Academy conducted by Pietro Miani, with legendary baritone Renato Bruson, the director of the Singing School, and the young South African soprano Pretty Yende, who completed her studies at the Academy in 2011. It was a way to highlight, symbolically, the encounter between the maestro and a student, between the history of the Academy and its future.

The Bracco Foundation will take an important role in this future. Since the start of this year, our foundation has become a Founding Member and Main Partner of the La Scala Academy, a unique institute in the panorama of European higher education, and is launching a three-year cooperation programme to support the development of young talents in Italy and abroad.

A special evening of Italian opera delighted the audience on Friday night at the Hofburg, Vienna.
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History vital to radiologists

ECR delegates are always looking for the next innovation and breakthrough, but they should also remember their past, say leading members of the International Society for the History of Radiology – ISHRAD, which celebrated its first anniversary and held its annual general meeting yesterday.

“History gives us a sense of meaning and identity. We are not isolated individuals living in the present; we have a future and we also have a past,” said Prof. Adrian Thomas, one of the founders of ISHRAD.

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Answers for life.
Predictive markers for atherosclerosis could unravel paradox of Churchill’s longevity

By Frances Rylands-Monk

Winston Churchill, the former British Prime Minister, smoked heavily and was overweight; yet he lived to the age of 90. Others live healthily and die well before they reach 60. Emerging techniques for diagnosing atherosclerosis promise to explain why this apparent contradiction occurs and make medicine much more patient-specific.

“Now large-scale studies using predictive markers in low, moderate and high risk patients must show which are best and most cost-effective for assessing atherosclerotic risk,” said Dr. Tobias Saam, attending clinical radiologist at Downtown Campus of the Ludwig-Maximilians-University in Munich, pointing to a German study currently in the planning stage that will involve tens of thousands of patients using advanced MR techniques for cardiovascular imaging, to identify optimal imaging and bio-markers.

Atherosclerosis is a chronic disease of the vessel wall, accounting for more than a quarter of ischemic strokes and the majority of myocardial infarctions and cardiac sudden deaths. New methods to image the vessel wall can help radiologists understand the pathophysiology of the disease and identify what makes for increased cardiac- or cerebrovascular risk, moving away from the old concept of only looking at luminal stenosis that often indicated end-stage disease.

“Vessel wall imaging is an exciting field which has entered clinical practice, and its role is set to grow. Luminal stenosis alone is insufficient to predict plaque vulnerability,” said Prof. Maxmeier Reiser, director of clinical radiology at University of Cambridge, U.K., who will be discussing the multitude of different markers for vulnerable atherosclerotic plaque at the Centre of Nuclear Medicine, Münster, Germany, March 4th.

These techniques can also provide a snapshot at various time points to monitor drugs and intervention and demonstrate disease progression and regression.

If methods are optimised, we may be able to detect patients harboring high-risk atherosclerotic plaques that will ultimately cause myocardial infarction or stroke which will significantly impact patient management,” he noted.

Specifically, advanced techniques such as black-blood MRI, intravascular ultrasound (IVUS) and PET/CT are helping to identify risk by providing detailed information on plaque composition, morphology and activity in patients with atherosclerosis. In addition, because atherosclerosis is a chronic disease that starts in a person’s 20s and 30s and develops over decades, with plaque burden increasing by around 2% per year, drugs to decrease plaque load by as much as 10% could be very effective.

“Drugs to slow disease progression could have a huge impact on a patient’s outcome. Data suggests certain drugs may halt progression altogether. In addition, some exciting new preliminary results will be discussed as to whether the disease is reversible with certain treatment,” said Saam, who will be speaking at today’s session about how reversible atherosclerosis currently appears.

Lowered radiation dose means that CT angiography (CTA) has become far more acceptable in intermediate risk patients for assessing the future risk of a major cardiac event, such as myocardial infarction or the need of coronary stenting. CTA used to involve a dose of 10 to 20 milliSieverts, but with the latest scanners, half of patients examined receive less than 1mSv. Even scanners released in the past five years usually involve a dose of only 3–8 mSV. In addition, a recent meta-analysis has shown that the presence of ≥ 1 significant coronary stenosis was associated with an annualised event rate of 11.9%, with a corresponding hazard ratio of 10.74, demonstrating that coronary CTA can be used to identify patients at risk for cardiovascular events.

“Blooming artefacts due to extensive coronary calcifications may hide the extent of stenosis, but this can at least in part be compensated for with thinner slices and faster rotation,” Reiser said.

The predictive value of PET/CT for events is as yet unknown, although ongoing studies in North America may yield results soon. However, it is clear that PET/CT provides information about inflammation in different vascular territories, which is important for establishing the future risk of plaque rupture. Complementing the section on nuclear medicine, Prof. Michael Schlaeger, radiologist at the Centre of Nuclear Medicine, Münster, Germany, will be talking about the role of molecular imaging of atherosclerosis in future clinical practice.

Meanwhile, other techniques are emerging with a capacity to predictively identify risk. High-resolution black-blood MRI shows plaque composition and morphology in the carotid arteries in unprecedented detail. IVUS is an effective technique for determining plaque burden in the coronary arteries, and studies suggest that it can be useful to identify the so-called thin-cap fibrous atheroma, a risky lesion in which the thinner the layer of fibrous tissue covering the lipid/necrotic core, the more prone to rupture and the greater the risk of stroke or infarction. More details about these techniques will be heard in the talk by Prof. Jonathan Gillard, professor of neuroradiology at the University of Cambridge, U.K., who will be discussing non-invasive imaging of the vulnerable atherosclerotic plaque.

One of the main problems with vessel wall techniques is that only the imaging criteria employed to indicate an intervention is the degree of stenosis, regardless of plaque composition. Biological processes such as positive remodelling mean that risky plaques without stenosis may still result in cardiac or cerebral events. In fact, of the ischemic strokes due to atherosclerotic disease, only 10% are watershed infarctions with a high degree of carotid stenosis, whereas 90% of ischemic strokes are caused by thrombosis and distal embolisation due to plaque rupture.

“The higher the stenosis, the more likely the existence of a complicated plaque,” Saam explained. “However, studies have shown that the majority of myocardial infarctions occur in vessels with less than 50% stenosis. Little is known of the prevalence and the impact of complicated plaques in acute stroke patients without carotid stenosis.”

Münch’s carotid plaque imaging study (CAPAS, Carotid Plaque Imaging in Acute Stroke) is using black-blood MRI and conventional ultrasound. It started in February 2011, and is due to end in 2014. It aims to evaluate the prevalence of complicated plaques in non-obstructive carotid disease and to evaluate whether patients with a complicated plaque at baseline have a higher risk of recurrent stroke. Depending on the results, this study may help improve diagnostic decision-making and provide the basis for the planning of targeted interventional studies.

Another research area is the identification of imaging-based plaque factors that accelerate atherosclerotic disease progression or can identify patients at increased risk of cardiovascular events. Some of these markers, such as coronary calcium scoring by CT, are increasingly used in clinical practice. Using these techniques, risk stratification can be substantially improved compared to risk stratification using conventional risk factors alone. But, MRI-based detection of intra-plaque haemorrhage, an indicator of plaque instability, has been identified as being an independent marker of future events. Studies suggest that haemorrhage accelerates atherosclerotic disease progression.

The panel discussion on predictive markers is likely to be lively, as delegates and speakers discuss the multitude of different markers for use with the various modalities.
Musculoskeletal injuries in children, especially those of joints and bones, are very frequent. They differ significantly from those in adults because they occur on a growing skeleton with specific vulnerabilities and because they can lead to growth disturbances.

Musculoskeletal disorders such as developmental dysplasia of the hip (DDH) also need special attention and accurate diagnosis in order to prevent children from experiencing further complications during periods of growth.

Musculoskeletal injuries in children occur mainly during sports or physical activities. The vulnerability of the growing bone and cartilage is increased during periods of rapid growth. Bones and cartilages in children are weaker than muscle and ligaments, which results in specific lesions. The weak points of the child’s musculoskeletal system are also apparent when looking at the most common sports injuries in children: “Acute traumatic lesions are the most frequent, and correspond to the specific fractures of the paediatric age: the epiphyseal separation, the apophyseal avulsions and the patellar dislocation. Chronic overuse injuries, related to repetitive microtraumas, are less frequent and occur in young athletes.” Sports injuries in children can lead to specific complications when the physis is involved, resulting in growth disturbance, with or without an extended follow-up,” explained Dr. Marianne Alison paediatric radiologist at the Robert Debré Hospital in Paris, France.

Diagnosis of bone and joint injuries is challenging in children: the normal appearance of the growing bone must be known and the multiple anatomic variants must be ruled out. The types of lesions encountered are also different according to the age of the child. Knowledge of Salter Harris classification is needed to determine prognosis and management when the physis is involved.

X-rays are the first choice among imaging techniques, but especially in children, the indication should be selected according to clinical findings. Ultrasonography would be the second choice for looking at soft tissue, muscles, tendons and ligaments, while CT is ideally suited to depicting complex fractures. MRI is on the other hand is an excellent tool for the imaging of ligaments, menisci, osteochondral injuries, overuse injuries and also for the assessment of complications such as epiphysiose or osteonecrosis.

Besides joint and bone injuries, congenital musculoskeletal disorders can have major effects on the growth and musculoskeletal system of children. Developmental dysplasia of the hip (DDH) is the most common musculoskeletal disorder in childhood, with a reported prevalence of 1–4% according to the method of ascertainment and definitions used. The disorder is a deformation or misalignment of the hip joint, as Professor Karen Rosendahl from the Department of Paediatric Radiology at the Haukeland University Hospital in Bergen, Norway, explained: “The term DDH refers to a spectrum of pathology, which includes the dislocatable, but normally-shaped newborn hip ascertained by clinical screening (also called neonatal hip instability), the stable, but dysplastic hip identified by ultrasound screening, and the severely dysplastic and dislocated hip presenting clinically in later infancy and early childhood.”

Early diagnosis and treatment with an abduction splint is crucial for the prognosis. Since clinical screening has failed to decrease the number of late cases, ultrasound screening has been introduced worldwide.

High resolution ultrasound enables visualization of neonatal hip stability (NHI), which is strongly associated with acetabular dysplasia, and morphology. A few newborn hips are morphologically normal but dislocatable. The opposite can also be the case, mildly dysplastic hips can be stable. Therefore, both hip stability and morphology should be assessed as part of the newborn US examination. Based on these facts, two different schools of ultrasound imaging have developed. One argues that NHI alone is the major pathology of splinting, the other one credits acetabular shape or morphology as the most important factor. A third method combining the two features has also been proposed and thoroughly validated.

At first, universal ultrasound screening using Graf’s method, based on hip morphology, led to higher treatment and follow-up rates than that based on NHI alone. However, improved examination techniques and a better understanding of the findings have enabled a more tailored approach, and an extensive meta-analysis performed in 2000, including 534 papers, could not find any differences in treatment rates due to different ultrasound techniques.

In Europe, Graf’s ultrasound technique, or a modification of it (i.e. a combined technique including both morphology and stability, Rosendahl) are commonly used in German speaking countries, parts of Scandinavia, the U.K., Italy, France, Hungary and the Netherlands. In other areas a modified Morin’s method (Terjesen) is used, while Harcke’s method, which is quite commonly used in the U.S., is used only occasionally.

Looking at the different schools of ultrasound DDH examination, Prof. Rosendahl has a clear recommendation as to which one to choose in order to get the best results: “The European Society for Paediatric Radiology (ESPR) DDH task force group recommends, based on the available literature, that a combined US technique assessing both acetabular morphology and hip stability be used. Again, although there is a strong association between hip morphology and stability, morphologically normal hips may be unstable and vice versa. Hip morphology should be assessed using Graf’s coronal standard section through the acetabulum, while hip stability may be assessed using different views (coronal, axial).”

The course will conclude with a talk by Dr. Maura Valle from Genoa, Italy, on the imaging of juvenile idiopathic arthritis.

Experts recommend combined ultrasound technique for examination of developmental dysplasia of the hip.
Three decades of HIV/AIDS: what the disease looks like in imaging today

By Mélisande Roquer

The life of an HIV-positive patient in Europe or the U.S. has improved dramatically over the past ten years, thanks mainly to the efficacy of combination antiretroviral therapy (cART).

Life expectancy and quality of life in highly developed countries have improved so much that the human immunodeficiency virus, which continues to kill many people in poorer parts of the world, can now be compared to a chronic manageable disease. As a consequence, some of the most aggressive HIV-associated diseases have almost completely disappeared from clinical practice. Radiologists must be aware of these changes in order to be able to track viral manifestations and therapy-induced effects, experts will explain today during a Special Focus Session at the ECR.

"Opportunistic infections in the brain have significantly decreased in the last ten years. For instance, we don't see brain toxoplasmosis much anymore, whereas in the 1980s, numerous HIV patients presented with that condition," said Maja M. Thurnher, a neuroradiologist at Vienna General Hospital (AKH) as well as an associate professor of radiology at the Medical University of Vienna, Austria.

Rather than opportunistic infections caused by a bacterium, parasite or virus, radiologists now see an increasing number of neurological disorders that are directly related to HIV in the brain.

Doctors mainly deal with deficits in cognitive function, according to Thurnher. She will show how conventional and advanced MR techniques, such as spectroscopy and diffusion imaging, may help to diagnose neuro-AIDS disorders very early, allowing for early treatment.

The efficiency of antiretroviral treatment has been proven convincingly at the periphery; however, the brain remains mostly unaffected by the treatment.

Radiologists are sometimes the first to discover that a patient is HIV-positive. Indicators for this diagnosis are particular signal intensities or abnormalities of the brain, detected by MR. When found, they must be communicated as quickly as possible to both the patient and the referring clinician," she said.

Professor Anne Osborn, a world-renowned neuroradiologist from Salt Lake City, U.S., will talk about new phenomena, in particular immune reconstitution inflammatory syndrome (IRIS), which occurs when restored immunity causes an abnormally robust response to infectious or non-infectious antigens. She will explain to radiologists how to avoid making the mistake of confusing these reactions with disease manifestations.

When therapy works, lesions in the brain may become bigger on the MR scan, usually two months after the start of the treatment. "We have to give the organism a chance to beat it, so we wait another six weeks to two months, then perform another MR scan. Usually the lesions will then be smaller or less numerous," explained Thurnher, who will chair the session.

Radiologists should remember that some brain lesions which they may see on MR are actually the result of immune recovery induced by antiretroviral therapy and not evidence that the disease is progressing in spite of treatment, she insisted.

Another welcome development for HIV sufferers is that cART has significantly reduced the chance of infecting another person, by diminishing the presence of the virus in the blood of an infected person. The reduction of daily medication intake from about 10 pills to just two or three, or even one, has also made it easier for patients to comply with treatment instructions.

But, just when these advances will benefit patients worldwide remains unclear.
Radiology education in Europe will be under the microscope on Sunday morning, in a Refresher Course that will reflect on the current situation throughout the continent. In this likely packed session, Prof. Graciano Paulo, President of the European Federation of Radiographer Societies (ESGR), from the College of Health Technology (UEGF) Coimbra/PT, Portugal, will lead an expert group of speakers through a close examination of the biggest changes and the greatest strengths of radiography education, to learn how these can inform strategies for future improvement.

Although an intrinsic part of radiology, radiography is still a relatively young profession and the major developments in the education systems, which support its work-force, have mainly taken place in the last few decades. Despite vast improvements in many areas, there are still significant differences in the quality of radiography education from one country to the next, as well as a notable divide between the academic and clinical environments.

Prof. Paulo says as a whole is sorely in need of established European frameworks to regulate professional training and to assure quality of patient care. It is very likely that one of the first steps that will be necessary is to improve the harmonisation of basic education. Although the transferal of radiography education to university systems is widely held to have brought massive benefits to many countries, there are still others lagging behind so it is the task of those in the countries that have already made the transition needs to be assessed, explained Paulo.

One of the key changes in education to higher education systems in most of Europe has been the most important change in radiography education to university systems that enable institutions to establish programmes because we definitely need to have the appropriate benefits back. This is an issue that universities and researchers should be including in research programmes because we definitely need to assess and quantify the impact of this educational change on health systems,” Paulo said.

Those European countries with a higher standard of radiography training have generally been providing education through a university system for 30 years or more, others have made the transition in the last decade, and a third group of countries has continued to provide vocational education outside of the university system structure. This means, despite overall satisfactory standards of training, radiography is still an uncomfortable distance from achieving the level of standardisation that is necessary in order to be prepared for the free movement of patients in Europe.

Mandatory continued professional development, regulated at national and European levels, with a regular recertification process for radiographers, is a momentum that is keeping up with the development of their profession, would help to ensure consistent standards of patient care. If universities can be involved in the process of providing that certification it could also help to bridge the gap between the academic and clinical environments, explained Paulo. Building greater connections between clinical practice and the knowledge and concepts being created in universities would greatly facilitate the move toward evidence-based practice, which has become a key priority of the EFRS.

The infrastructure for a harmonised European education system will not be established overnight, but in the meantime, radiography at least benefits from a long tradition in networks that enable institutions, students, researchers, and professionals to cooperate, support and assist each other. One of the main reasons for the existence of these networks is the benefits and opportunities provided by radiography networks, such as the ERASMUS Radiography Group (ERG), which organises 1,200 radiography students the chance to go on three-month study exchanges to institutions that are dedicated to teaching specific topics. This undergraduate exchange system, which places a special emphasis on meeting the specific needs of the student, has undoubtedly helped strengthen radiography in Europe, while also creating important professional connections, as lecturer Jonathan Portelli, a current ERG coordinator and one of its first exchange participants, will testify.

The principle of networking is held dear to the EFRS, whose own educational wing incorporates the Higher Education Network for Radiography in Europe (HREN), which started as an EU co-funded network for national institutions and professional radiography societies. Val Challen, the EFRS Executive Officer for Education, will also take part in the session, examining the political, educational, and professional factors that may be addressed through the presence of European radiography networks.

“The changes we’ve implemented since the early 90s, when the first radiography network – the ERG – started, would not have been possible if we hadn’t developed this network. For me, the networks are the secret to the development of the profession and educational process at European level,” explained Paulo.

Despite the obvious expertise of the speakers, Paulo was keen to stress that this discussion of the state and future of radiography education should be as open and as inclusive as possible, and he invited all attendees to get involved.

“We will focus on debate in this refresher course, so we want people to interact. The three speakers will give an overview of their topics, but what I would like to encourage is a debate with the floor, to get people’s opinions and input because, as President of the EFRS, I am extremely interested in everybody’s thoughts on how we can develop the profession, and ultimately how to protect the patient’s right to the best healthcare possible,” Paulo concluded.

ESGAR: past, present and future of abdominal radiology

By Filipe Castro-Alexes

Subspecialisation is not just a recent trend in radiology education; it has, since the early years of the dedicated abdominal radiologist, had a huge input into the development of specific radiological techniques and, as a result, interpretative skills have been developed and taught all over the world. However, things have changed a lot since then. Objectively, brought about by the ever-evolving cross-sectional techniques of 3D, 4D and functional assessment, acts as a catalyst for doctors to have their own subspecialism. Furthermore, radiology has become a specialty with a logical techniques and, as a result, interpreta-

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In order to provide for the many requirements of subspecialised education in abdominal radiology, ESGAR organises several activities that first come its most visible and important activity, the annual meeting, held in May/June, in different European countries. This meeting is the place to get the full experience of integrated imaging education based on multidisciplinary concepts, with doens of topics, ranging from intermedi-ate to advanced knowledge levels. There are plenty of activities, plenary sessions, dedicated workshops, advanced research sessions and forums for interacting and networking with researchers. Another important aspect of ESGAR is the organisation of a series of workshops during the year, meant for smaller audiences and mostly devoted to promoting interaction through case-based learning. This includes liver and CTC workshops, and also a range of ‘hot topics’ workshops that will take place soon, such as the pulmonary workshop in 2012.

ESGAR is strongly committed to integrating into the European Federation of Gastroenterology (UEGF). ESGAR is one of its 12 affiliated scientific societies, which covers a large GI community of more than 10,000 people, and participates regularly in scientific initiatives. Increased interaction has been planned for the coming years and we will certainly take advantage of new e-learning techniques.

Last but not least, the society is committed to delivering up-to-date scientific material to its members and to the wider radiological community, in the form of consensus statement, clinical practice guidelines, etc., in order to provide up-to-date and evidence-based information on relevant scientific issues.

ESGAR is working proactively on improving quality control in the subspecialisation of abdominal radiology. To this end, the society is ideally positioned, along with the ESR, to certify the best practices within this field. We believe our most important assets are our members, the specialised radiologists who we are proud to represent.

More information on the society can be found at www.esgar.org

By Simon Lee

We have moved on from technically oriented research into the European Federation of Gastroenterology (UEGF). ESGAR is one of its 12 affiliated scientific societies, which covers a large GI community of more than 10,000 people, and participates regularly in scientific initiatives. Increased interaction has been planned for the coming years and we will certainly take advantage of new e-learning techniques.

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Radiologists must get prepared to take centre stage in the emergency room

By Frances Randles-Merk

Trauma is potentially life-threatening until proven otherwise. Experts would claim there is no reliable means other than imaging to evaluate acute trauma patients in the ‘golden hour’ following an event. Specifically, imaging has become of great importance in the evaluation of thoraco-abdominal injuries after blunt trauma, because it provides critical and reliable features useful to the patient management process.

The radiologist is now a real protagonist in the emergency setting and not an executor of orders. My feeling is that technology has gone forward faster than our brains. Now we have to ‘upgrade’ our minds to change our mental attitude, and attitudes,” said Dr. Mariano Scaglione, director of diagnostic imaging at Pineta Grande Medical Centre, Castel Volturno, Italy.

Rapid imaging is vital for the proper management of serious emergencies, and the demand for imaging in the emergency department has risen substantially over the past decade. In tandem with this, multidetector CT (MDCT) technology has changed the rules of the ‘classic’ clinical approach and has significantly reduced the number of preventable deaths of polytraumatised patients.

Rather than providing a ‘classic’ depiction of injury, it is important for radiologists to characterise lesions to give useful information in terms of treatment, according to Scaglione.

“It is no longer acceptable to define a vascular injury as a ‘blush’ as this is an insufficient description. What is important is to differentiate a thoracic injury from an arterial injury and also state if it is contained (see Figure 1) or an actively bleeding lesion (see Figure 2) because these features affect management. Of course, this implies rigorous and specific radiological behaviour: correct patient selection, optimal protocols and interpersonal communication skill,” he said.

In the U.S. between 1996 and 2007, MDCT use in the emergency setting grew by 339%, and these numbers are comparable to those in Europe, remarked Prof. Gerd Schueller, head of emergency radiology at the University Hospital of Vienna. In addition to this, for CT imaging, dedicated organ injury scales that include detailed descriptions of injuries for each abdominal organ help the trauma team to assess whether the patient needs surgery or can be handled with a wait-and-see strategy, he explained.

However, radiologists reporting to remaining problems such as abuse of MDCT technology due to inappropriate patient selection, a lack of guidelines both in the acute setting and in follow-up, and the lack of political focus on emergency medicine. Furthermore, sub-optimal MDCT protocols and a general lack of attention to minimising radiation dose need to be addressed.

Today’s refresher course on polytrauma offers practical up-to-date information on the critical issues radiologists should consider in the evaluation of polytraumatised patients in the emergency setting.

Special attention will be given to vascular emergencies and life-threatening conditions which contribute to the early death of trauma patients. Furthermore, up-to-date MDCT protocols, recommendations, sources of errors, tricks and tips will be provided in detail,” said Scaglione, who will be talking about the relevant features of chest and abdominal trauma. “The vital importance of a dedicated radiologist in the emergency room will be emphasised, as she or he is the only person who has a full understanding of the clinical protocols which can guide towards timely and accurate treatment, when minutes make all the difference.”

Scaglione’s department, contrast-enhanced MDCT is the modality of choice in the evaluation of any ‘high energy’ deceleration injury because it allows for obtaining detailed multiphase images with diagnoses for tailored treatments. MDCT is also favoured in the context of chest pain and acute abdomen, especially when the clinical, lab or screening ultrasound findings are inconclusive or equivocal. However, MDCT cannot be used for every patient.

Ultrasound plays a very important role in the screening of many acute conditions, especially if it is performed in radiologists’ experienced hands. The diagnosis and treatment of these conditions is not just a matter of technology, but needs a skilled team of emergency doctors – including radiologists – working together in dedicated emergency centres’, he said.

At the University Hospital of Vienna, a longstanding cooperation between trauma surgeons, anaesthetists, and radiologists has resulted in a standard operating procedure for polytrauma. CT is the main workhorse, even for severely injured children, Schueller notes. Examinations are mandatory trauma to both adults and children.

“MR imaging is undertaken whenever it is feasible, most of all in cases of spinal trauma. Also, MR is an excellent alternative in modestly injured children when ultrasound can’t provide answers,” he said.

Many conditions may lead to errors in emergency radiology, including, diaphragmatic, pancreatic, intestinal and splenic injuries, according to Scaglione. In such conditions, the diagnosis may be elusive, despite modern technology. Because the initial picture of the injury itself is often subtle and difficult to detect.

Vascular injuries are the first cause of early death in trauma patients. From a clinical viewpoint, these injuries can be easily overlooked, even in cases of a significant injury. Today, MDCT technology – and in selected cases, contrast-enhanced/colour/power Doppler ultrasound – offers a good depiction of such injuries, with optimal correlation to the pathological features. Furthermore, imaging provides details that allow for tailored patient treatment, which is often endovascular rather than surgical.

“Imaging and interventional radiology has significantly reduced the classic surgical approach to polytrauma patients,” Scaglione said.

Focusing on such vascular injuries, at today’s session Schueller will cover torso trauma, including aortic injury, and will discuss imaging techniques as well as therapeutic options. Prof. Ulrich Linsermaier, vice-chair of clinical operations, department of clinical radiology at the Ludwig Maximilians University Hospital, Munich, Germany, will address vascular injuries of the extremities in the context of peripheral trauma.

“Radiologists must be familiar with the imaging findings of major trauma and to what extent these findings are relevant for individual therapy. They must also be thoroughly present in the emergency room at the moment the patient is admitted,” noted Schueller, pointing to the incidence of errors in reporting major trauma when cooperation between radiology and surgery is sub-optimal.

With the advent of MDCT, radiologists are able to report acute life threatening conditions as early as one minute after the initiation of imaging. It is therefore the radiologist’s responsibility to discriminate and report each of the correctable causes of hypovolaemia and hypovolaemia, as well as airway, breathing, and circulatory compromise, he emphasised.
Imaging sports injuries: experts debate the pros and cons of US and MRI

By David Zikra

Sports injuries are often caused by overuse or acute trauma of a body part during athletic activities. In most cases where muscles and tendons are affected, imaging is mandatory in order to find the right diagnosis or to guide the treatment. Muscle imaging is complex and presents unique morphological challenges and the continuing integration of dynamic, physiological, and functional capabilities as imaging technology progresses. Ultrasound and MRI are both excellent imaging techniques which have strengths in different areas and are therefore ideal methods for diagnosing and following up sports injuries.

Ultrasound is excellent for assessing muscle strains and contusion injuries in athletes, correlates well with clinical findings. However, when used at the pitch side, the extent of injury may be underestimated, so it should be used with caution. Within the first six hours of a muscle injury ultrasound can miss the injury. "Sports related injuries can be due to overuse or acute injury, sometimes both together, as is the case in Achilles tendon pathology or spinal injuries. Ultrasound helps to precisely diagnose the amount of tendon damage and helps to better understand aetiology, and by discussing the diagnosis with the patient it can be used to improve training conditions and training regimes," explained Professor Andrea Klauzer from the Department of Radio Diagnostics at the Medical University of Innsbruck, Austria.

In the acute phase of an injury US has nearly the same sensitivity as MR imaging, except during the first few hours when fresh haemorrhage and oedema have similar echoic structures. In addition, ultrasound better defines intratendinous calcifications. And finally, US can be used for looking at neovascularisation of tendons, enhanced ultrasound (CEUS) or Doppler US are used.

MRI, on the other hand, is an excellent tool for assessing muscle injuries and contusion injuries in athletes, providing good correlation with clinical findings, but it can cause the extent of injury to be underestimated. Ultrasound is less sensitive to local oedema or clinical findings, so when ultrasound better defines muscle fibre injury, as some regard MR as exaggerating the extent of disease, as the oedema spreads well beyond the fibre damage.

MRI of the lower leg, showing a stress fracture of the fibula in a marathon runner. (All images provided by Dr. Gina Allen)

MR of the thigh, showing a significant muscle contusion after a direct blow during a professional football match.

MRI imaging is still the preferred method, in particular for the precise assessment of rupture severity and extent, but also in aftercare and guided treatment.

"In this setting Prof. Andrea Klauzer sees US as superior to MR imaging. "There are several benefits when compared to MRI: first of all, US is a dynamic examination, therefore the number of ruptured retracted tendon fibres under forced stressed examination might be better detected. In addition, tendon injuries autologous blood injections to minimise side-effects and maximise efficiency. After looking at the assets and drawbacks of both methods we asked Dr. Allen, if there is a simple answer to the question "US or MRI in sports injuries?" and what congress participants can expect when attending this Refresher Course: "The simple answer is that both techniques are complementary and it depends on the availability of experts as to which of them is used," Dr. Allen stated. "In the Refresher Course we will present current thoughts on both techniques, including up-to-date knowledge from experts who use US and MRI in their everyday practice, and this will hopefully inspire participants to try using these techniques for new clinical indications or try out new approaches within established MRI or US practice."

This course will also feature talks by Prof. Carlo Marton, in the treatment of muscle injuries with US and Dr. Umut Aydingöz in muscle and tendon examination by MRI.

Clinical Corner
Sunday 4 March 2012

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Modality choice poses difficulties in hip joint replacement

By Rebekah Moan

The overriding element, however, appears to be the surgeon’s habits. “Some surgeons say that, for example, if a patient is suffering from hip pain after 10 years and he’s wearing a prosthesis, it just means there is loosening of the prosthesis and they don’t require any examination to just know there is a loosening,” commented Blum. “Someone else will say ‘we have to be sure, we have to be sure there is a loosening, we have to differentiate a septic from an aseptic loosening, we have to look for collections, soft collections, abscesses’, and the surgeon usually asks for a CT scan if the x-rays don’t give the clue.”

Typically, a lot of metal artefacts are involved, but usually the results are good and physicians are able to analyse the bone around the prosthesis and the soft tissue. “We are not right now able to analyse all these aspects with MR … We still have a lot of artefacts,” he remarked. “Another point with a CT scan is that we use it to detect impingement between the acetabular component and the thigh muscle. It’s a very good technique for that because we know exactly how the acetabular component is located beneath the iliosposas muscle.”

At Centre Hospitalier Universitaire, radiologists perform five CT scans of hip prostheses per week and about two or three CT arthrograms per month because the surgeons prefer CT. Blum promises to give ECR delegates tips to determine when a CT scan should be done versus CT arthrography, which combines the advantages of arthrography and CT imaging. “There are some previous studies that show arthrography with subtraction is a good technique to detect some loosening and especially acetabular loosening,” he stated. “If you combine arthrography with CT, you enhance the formation of those techniques.”

He plans to inform attendees about the signs to detect loosening and when they should perform drainage, puncture, or injection of anaesthetic or cortical steroid. Lastly, even though it’s already been discussed in scientific articles, he’ll describe how to perform the CT scan with the best results in order to reduce metal artefacts.

The future for hip arthroplasty will be about new algorithms to reduce metal artefacts, Blum predicts. “I think all manufacturers will come with the new algorithm for the next RSNA congress,” he said. “We are working with Toshiba on that point and consider the fact that in a few months it will really provide new techniques to improve the image quality.”

A different specialty name, but the same challenges for Swedish Society of Radiology

By Peter Leander

After the difficult process of creating a new specialty, there may be changes ahead.

Our specialty

As we reported last year, the new classification of medical specialists in Sweden has resulted in our discipline being renamed ‘Imaging and Functional Medicine’ and our society is now known as the Swedish Society for Functional Imaging (SSFIM). SSFIM is an amalgam of radiology, neuroradiology, nuclear medicine, and clinical physics. The name change is just the first step into establishing training programmes for this new specialty. Once most of the changes are complete, the National Board of Health and Welfare in Sweden will again review these specialties. This overhaul, which was meant to be a minor refinement of the specialty structure, is now opening up for discussion. We do not yet know if there will only be minor changes to the concept of ‘base-specialists,’ and additional ‘branches’ or if a completely new concept will be introduced. In early 2012, the society will take part in hearings, initiated by the National Board. No matter what they decide, radiology will remain one of the most important parts of modern medicine, and radiologists feel an amalgam of the former specialties of radiology and nuclear medicine will be the most appropriate, e.g. PET/CT and functional imaging using multiple contrast phantoms.

In other countries, our new specialty is known as clinical radiology and we continue to support the ECR, which we believe to be the most important European meeting. Most of us are radiologists at heart, even if the badge we wear says something else.

Activities 2011

The SSFIM has once again witnessed the passing of yet another of its ‘Röntgenrekan’ (Radiology weeks). The meeting was held in the city of Umeå, the northernmost University city in Sweden and the European Capital of Culture, 2014. The meeting was held along with the Swedish Society of Radiographers. The national societies for radiation physics, oral diagnostic radiology, and medical secretaries were also invited to participate. Approximately 1,500 delegates visited the congress and the technical exhibition. All professional categories working in radiology met, took part in symposia, listened to lectures and met representatives from vendors at the exhibition. For 2012, we would like to invite you all to Gothenburg, on September 10–14 for ‘Röntgenrekens’ 2012.

Challenges for the future

The continuously increasing number and size of examinations is one of the major challenges for us. It is a tough balancing act, to cope with the daily workload, while at the same time trying to stay at the forefront of new methods. In developing new methods, clinical colleagues have been competing with us, rather than volunteering to help us with our routine workload and we are keen to be in the driving seat of CT and MRI development. Research is another name for development and we must tirelessly work for the good of research. Professors of radiology in Sweden deal with this issue at every meeting. In addition, the society is now discussing the EMF Directive with the Swedish government.

Swedish radiology is a vital part of Swedish healthcare and has experienced the same ups and downs as the rest of Europe, with an increasing number of examinations. We have seen different solutions, but we maintain the resources necessary for research and development.

More information on the society can be found at www.sffim.org.
Diffusion tensor imaging (DTI) is a powerful MRI technique that exploits the anisotropy of direction of dependence of the diffusion of water in the white matter of the brain. As Heidi Johansen-Berg and Timothy Behrens noted in a review, “there is greater hindrance to diffusion across a fibre bundle than along it.” Both the magnitude of the anisotropy and the preferred orientation of the diffusion of water can be quantified to build up a detailed picture of brain structure.1

DTI represents a more complex treatment of the basic principles that also underlie diffusion-weighted MRI.

“Diffusion-weighted MRI is fairly widely used because it is relatively easy to perform and does not take a lot of time,” noted Prof. Marco Essig, from the department of neuroradiology at the University of Erlangen, Germany, adding that the technique is particularly useful in stroke assessment. “It does not need a lot of post-processing.”

DTI encompasses diffusion-weighted MRI. It is possible to extract the diffusion-weighted MRI information out of the DTI data, but the post-processing burden is much higher for DTI than for diffusion-weighted MRI. For DTI, a user needs special software to process the data, according to Essig. Around 3,000 images are generated, in contrast to the 50 or 60 images that are typical for a DW-MRI investigation, and data acquisition also needs to be high quality. “You need high quality magnets, which have good homogeneity and which give you robust image quality at high resolution,” he explained.

DTI is, at this point, still only deployed in academic medical centres and large specialist hospitals. However, because of the fine, micron-scale detail it provides on the brain’s structure and organisation, it is finding increasing application in a number of fields, such as the investigation of brain tumours and the study of neurodegenerative conditions and psychiatric disorders. DTI enables non-invasive tractography or tracing of fibre bundles in the living brain, which opens up new opportunities to study the connectivity between different brain regions.

Essig is speaking this afternoon at a refresher course on diffusion tensor imaging in clinical practice. One of the first clinical applications of the technique has been in the investigation of brain cancers. It is possible to assess whether a tumour is near to a fibre bundle, if it is utilising a fibre bundle or displacing a fibre bundle, he noted. It can guide decision-making on whether or not to operate and, in the case of a decision to proceed, DTI data can assist in pre-operative planning.

The great promise of DTI is that it will offer clinicians early information about a disease, compared to standard imaging methods. The tissue integrity is often disturbed much earlier than is seen on the image, he pointed out. Just because brain infiltration of a tumour is not visible using ordinary means does not mean it has not taken place. This applies to areas outside of brain cancer as well.

“There’s very promising work in neurodegenerative disease,” remarked Essig. “The functional changes in neurodegenerative disease – they come much earlier than any morphological changes.”

By the time gross abnormalities, such as brain shrinkage, become obvious, it is often too late for therapeutic intervention. DTI is also being used in research into post-traumatic stress disorder in war veterans, psychiatric disorders and developmental disorders, such as autism, in which clinical abnormalities are evident even in the apparent absence of structural abnormalities. DTI can support quantitative risk assessment of patients with Alzheimer’s disease. However, further standardisation work on data acquisition and post-processing is required to extend the use of DTI in clinical trials and in clinical management, he cautioned.

Other speakers at the session include Dr. Wim Van Hecke, of the department of physics at the University of Antwerp, in Belgium, who will discuss the physical principles underlying DTI, the acquisition of DTI data-sets and the different post-processing techniques for obtaining quantitative DTI data. Dr. P. Ellen Grant, of the Children’s Hospital, Boston, U.S., will discuss the role of DTI in the diagnosis and management of paediatric brain disorders.

**Clinical Corner**

**Diffusion tensor imaging takes time, but aids navigation of the brain**

By Cormac Sheridan

Diffusion tensor imaging (DTI) is a powerful MRI technique that exploits the anisotropy or directional dependence of the diffusion of water in the white matter of the brain. As Heidi Johansen-Berg and Timothy Behrens noted in a review, “there is greater hindrance to diffusion across a fibre bundle than along it.” Both the magnitude of the anisotropy and the preferred orientation of the diffusion of water can be quantified to build up a detailed picture of brain structure.1

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“Diffusion-weighted MRI is fairly widely used because it is relatively easy to perform and does not take a lot of time,” noted Prof. Marco Essig, from the department of neuroradiology at the University of Erlangen, Germany, adding that the technique is particularly useful in stroke assessment. “It does not need a lot of post-processing.”

DTI encompasses diffusion-weighted MRI. It is possible to extract the diffusion-weighted MRI information out of the DTI data, but the post-processing burden is much higher for DTI than for diffusion-weighted MRI. For DTI, a user needs special software to process the data, according to Essig. Around 3,000 images are generated, in contrast to the 50 or 60 images that are typical for a DW-MRI investigation, and data acquisition also needs to be high quality. “You need high quality magnets, which have good homogeneity and which give you robust image quality at high resolution,” he explained.

DTI is, at this point, still only deployed in academic medical centres and large specialist hospitals. However, because of the fine, micron-scale detail it provides on the brain’s structure and organisation, it is finding increasing application in a number of fields, such as the investigation of brain tumours and the study of neurodegenerative conditions and psychiatric disorders. DTI enables non-invasive tractography or tracing of fibre bundles in the living brain, which opens up new opportunities to study the connectivity between different brain regions.

Essig is speaking this afternoon at a refresher course on diffusion tensor imaging in clinical practice. One of the first clinical applications of the technique has been in the investigation of brain cancers. It is possible to assess whether a tumour is near to a fibre bundle, if it is utilising a fibre bundle or displacing a fibre bundle, he noted. It can guide decision-making on whether or not to operate and, in the case of a decision to proceed, DTI data can assist in pre-operative planning. A small handful of centres are even using the technique during surgery.

The great promise of DTI is that it will offer clinicians early information about a disease, compared to standard imaging methods. The tissue integrity is often disturbed much earlier than is seen on the image, he pointed out. Just because brain infiltration of a tumour is not visible using ordinary means does not mean it has not taken place. This applies to areas outside of brain cancer as well.

“There’s very promising work in neurodegenerative disease,” remarked Essig. “The functional changes in neurodegenerative disease – they come much earlier than any morphological changes.”

By the time gross abnormalities, such as brain shrinkage, become obvious, it is often too late for therapeutic intervention. DTI is also being used in research into post-traumatic stress disorder in war veterans, psychiatric disorders and developmental disorders, such as autism, in which clinical abnormalities are evident even in the apparent absence of structural abnormalities. DTI can support quantitative risk assessment of patients with Alzheimer’s disease. However, further standardisation work on data acquisition and post-processing is required to extend the use of DTI in clinical trials and in clinical management, he cautioned. Other speakers at the session include Dr. Wim Van Hecke, of the department of physics at the University of Antwerp, in Belgium, who will discuss the physical principles underlying DTI, the acquisition of DTI data-sets and the different post-processing techniques for obtaining quantitative DTI data. Dr. P. Ellen Grant, of the Children’s Hospital, Boston, U.S., will discuss the role of DTI in the diagnosis and management of paediatric brain disorders.
**PACS providers innovate to broaden availability of digital images**

By John Bonner

Over the past decade, picture archiving and communication systems have become a vital component in the radiologist's toolbox, but looking beyond the doors of the radiology department, often it is a very different story. Therefore, PACS vendors are working hard to create technologies that allow images to be available hospital-wide and find a way to integrate into the electronic archive all relevant documentation needed to support decisions on patient care.

Saskia Groeneveld, European marketing manager for healthcare IT at Carestream think they have taken a major step towards achieving this goal with the release of Vue Motion. This was on display at ECR 2011 as a work-in-progress, but now appears for the first time as a commercial product. It is reporting its work to 300 sites that print web-based offering that means radiologists are no longer tied to their workstations. Their access images and reports on an Apple iPad or similar tablet computer, as well as on Blackberries, iPhones and other hand held devices with web capabilities, explained Saskia Groeneveld, European marketing manager for healthcare IT at Carestream.

Vue Motion supports the display of clinical data from single or multiple users, providing the referring physician with a single point of access to the entire patient file, including a full report history and relevant prior exams and imaging. According to Carestream. It is also flexible enough to cope with data encoded in a wide range of technical formats, including JPEG, DICOM and XML, as well as non-DICOM image data such as PDF, JPEG, AVI and PNG. It also encourages rapid informal responses because it’s support’s ‘sticky notes communication’, including notification of critical results. With a single click, a physician can send a link to an examination inside an email to a professional colleague for a second opinion or to prove the technology.

Groeneveld notes that there is growing appreciation of the patient’s ownership of their own medical data, and during ECR, the company is demonstrating (as a work-in-progress) a portal that allows patient access to their own electronic medical record. “Ultimately, this will replace the cumbersome process in which data is sent on a CD through the post when a patient wants to seek a second opinion. It will also improve efficiency because there will be no need for the referral hospital to repeat the same radiological exams done at the first clinic. This will improve efficacy, reduce costs and limit the radiation dose that the patient receives,” she commented.

Another leader in the development of improved interconnectivity tools is the California-based company PACS GEAR. It will be demonstrating the first fruits of an ambitious programme to redefine the scope of current PACS, which it is calling PACS 2.0.

“We are developing the technology that allows radiologists to use multiple imaging devices, dermatology camera images, endoscopy videos, etc,” said Ton van den Hoven, vice president for sales and marketing with PACS GEAR. “We are facilitating the integration of those images into an electronic medical record, allowing them to be set it in the right context, the next step is have got the information that you need and develop the workflow around it. Once you have got the information that you need and set it in the right context, the next step is working out exactly what else your customers want to do with that information,” he stated. Helping radiologists communicate better with hospital colleagues is also a theme being addressed on the Siemens Healthcare booth. The company is demonstrating their latest ‘holistic’ solution to increasing radiologists’ productivity.

“The IntelliSpace PACS is a fully functional imaging IT platform designed to optimise radiologist productivity, enhance physician satisfaction, and interoperate with existing departmental (RIS, dictation) and enterprise systems, according to the company.

The IntelliSpace PACS includes a 25% faster level-set algorithm, allowing radiologists to view and report advanced pre-processed images. The ‘syngo.Via’ web viewer is automatically preselected the information and workflow, and provides guidance on disease-specific requirements. Using ‘syngo.Via’ Mobile Applications, physicians and referrers within and outside the hospital can securely access images and reports for viewing in a standard Web browser or on a mobile device.

Improved productivity in the radiology department is also emphasised in Philips latest offering in healthcare IT, the IntelliSpace PACS radlogy 4.4. The product will help to reduce the workflow efficiency with an intuitive user interface and advanced workflow tools that reduce the steps required to view and interpret studies, noted Ian Catt, marketing manager for the company’s Enterprise Imaging Informatics.

“The IntelliSpace PACS is a fully functional workflow solution that includes 2D/3D/4D viewing tools for volumetric data. Customers are then able to purchase dedicated advanced clinical applications from an la carte menu of approximately 40 applications. These include CT Virtual Colonoscopy, CT Brain Perfusion, CT Lung Nodule Assessment, Nuclear Medicine viewer with PET/CT fusion, MR Carriage Assessment ... just to name a few. All of these applications are available today with more being developed as we speak,” he said.

Like its competitors, GE Healthcare has been examining the potential for developing interconnectivity solutions for mobile, web-enabled devices, and the vendor has received approval for using its technology to view CT and MR images on a mobile device. The Centricity Radiology Mobile Access platform has been approved for primary diagnostic use in the U.S. on Apple’s iPad, iPhone and similar devices in situations when a PACS workstation is not available.

This application is one of many features being demonstrated in the ECR technical exhibition hall for the PACS Centricity system, which GE see as a robust, reliable and versatile technology. It offers a proven, scalable imaging IT platform designed to optimise radiologist productivity, enhance physician satisfaction, and interoperate with existing departmental (RIS, dictation) and enterprise systems, according to the company.

"There are a lot of reasons why PACS vendors are working hard to create technologies that allow images to be available hospital-wide and find a way to integrate into the electronic archive all relevant documentation needed to support decisions on patient care," said Carestream’s Saskia Groeneveld.

"Vue Motion allows patients access to their own electronic medical record. We are demonstrating (as a work-in-progress) a portal that allows patient access to their own electronic medical record."
For the 7th consecutive year the CIRSE Foundation is proud to present the programme for training courses in Interventional Radiology. In 2012 the following courses will be available:

**Embollisation**  
April 20-21, 2012  
Amsterdam/NL

**ECIO 2012**  
Third European Conference on Interventional Oncology  
April 25-28, 2012  
Florence/IT  
www.ecio2012.org

**Basic vascular**  
May 11-12, 2012  
Sofia/BG

**Tumour ablation**  
May 25-26, 2012  
Novi Sad/RS

**ICCIR 2012**  
International Conference on Complications in Interventional Radiology  
June 12-14, 2012  
Poertschach/AT  
www.iccir2012.org

**Venous disease**  
June 22-23, 2012  
Winterthur/CH

**CLI & diabetic disease**  
October 5-6, 2012  
Vienna/AT

**Aortic & thoracic stent graft**  
October 12-13, 2012  
Rome/IT

**Radiologia Intervencionista no vascular**  
October 19-20, 2012  
Bilbao/ES

**Biliary Percutaneous interventions**  
October 26-27, 2012  
Prague/CZ

**Liver interventions**  
November 9-10, 2012  
Munich/DE

For more information on upcoming ESIR courses, please refer to  
www.cirse.org

All courses are suitable for preparation for EBIR  
(European Board of Interventional Radiology)
Economic pressure drives evolution of imaging IT

By Theo Ahadome, Stephen Holloway, Carly Reed

The European economic crisis is having a pervasive impact on a wide range of industries. As budget deficits and the need to reduce costs come to the forefront, healthcare is also feeling the pinch, with reduced health-care spending in most European countries. However, in a unique position in that it can be implemented as a cost-saving by improving workflow and operational efficiencies. This potential benefit is being balanced against the initial investment that needs to be made in IT, as well as raising questions on the optimal implementation models needed to achieve cost-savings.

Picterechnique and Communication Systems (PACS) in a range of departments, Radiology Information Systems (RIS) and Cardiovascular Information Systems (CVIS) are all playing an important role in this debate. InMedica’s research reveals that the growing economic uncertainty in Europe is driving an evolution of the traditional IT market.

Market Growth

Overall market growth for PACS, RIS and CVIS is forecast to remain relatively restricted in the short-term as economic pressures reduce total spend on imaging IT across Europe. Strong market growth is projected in 2020 in France, the Nordics and Poland with the Compound Annual Growth Rate (CAGR) from 2010–2015, remaining above 10% in these countries.

Overcoming Economic Pressures

To help overcome economic pressures, a number of key trends are evolving in the imaging IT market. These involve a change in the implementation models for PACS, RIS and CVIS, as well as changes to the business and financial models. Table 1 shows some of the trends emerging being driven by increasing economic pressures on healthcare providers. They are further discussed below.

Enterprise Integration

There is an increasing shift in implementation models towards a hospital-wide focus by integrating departmental systems to a centralised platform. This may be led by a desire to make images accessible from the Electronic Health Record (EHR) or to allow a complete view of the patient’s progress throughout the care continuum. The underlying model is one of patient data being centralised around the patient, rather than on any one department. This allows smoother workflow and information flow between specialists across a wide range of care providers. Better information flow can then reduce overall costs by reducing the costs associated with wrong decisions caused by a lack of sufficient and appropriate information.

Regional/Community Integration

Regional imaging IT projects, where groups of hospitals collectively share a data centre for image access and management, are gaining momentum within Europe. In 2011, regional projects were estimated to account for around 10% of PACS market revenue in Western Europe; by 2015, they are projected to grow to 28%. Regional integration allows for cost sharing between providers, as well as improving patient flow between providers and increasing patient choice. This trend is especially notable in France, the Nordics, Benelux and the United Kingdom.

Business Models

Another trend driven by the underlying economic crisis is the emergence of managed service business models. These involve outsourcing of the management of IT infrastructure to a third-party or vendor. A major influence in the growth of this model is that it allows for a flexible payment model based on an operational expenditure, calculated based on a monthly or annual examination volumes. These models can also involve third-party hosting of patient images or third-party hosting of PACS application. Importantly, managed service models remove much of the risk of IT investment from the hospital to the vendor, a factor that is driving some providers towards its adoption. Subsequently, managed services accounted for 28% of Western European PACS revenues in 2011.

Cardiology Integration

The specialised workflow needs of cardiology have traditionally been managed by non-digital formats or by disparate systems within the department. However, as the amount of imaging procedural volumes and data increases, there is a need for more accessible flow of cardiology and non-cardiology data. Due to the complexities and variations in types of procedures and data generated, cardiology departments usually use a best-of-breed approach, selecting products from different vendors. Subsequently, there is a greater need to tightly integrate these systems to enhance patient flow. Cardiovascular Information Systems (CVIS) provide a central platform to assist in such integration and are increasing moving to the forefront of cardiology purchases. Subsequently, in the imaging IT market, CVIS is forecast with the highest Compound Annual Growth Rate (CAGR) by 2015. These factors are projected to remain post-economic crisis as they are seen to offer improved management of patient data, improve workflow and importantly, reduce costs. What will be left is an evolved market with a focus around enterprise models, regional integration, and flexible business models.

At this year’s ECR, it will be interesting to observe the level of sensitivity to economic factors shown by vendors, and how many of them are offering these or other models to assist customers weather the economic storm.

The authors are market analysts in the medical imaging and healthcare IT research groups at InMedica. InMedica is a leading provider of market research and consultancy in the medical electronics industry (www.in-medica.com).

Table 1. Trends in imaging IT market influenced by economic pressures. Source: InMedica

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Once again a busy and successful year for SIRM

By Antonio Rotondo and Roberto Grassi

The Italian Society of Medical Radiology (SIRM) was founded in 1913 and next year it will celebrate its 100th anniversary, which is considered the oldest and most important and largest scientific societies in Italy. Its governance consists of a President and an Executive Board composed of twelve members elected by SIRM members. The President from 2010 to 2012 is Prof. Antonio Rotondo (Naples) and for 2012–14 it will be Dr. Carlo Faletti (Turin).

SIRM organises a national congress every two years, which was held in Verona, was attended by more than 5,000 members and the 45th Congress will be held in Turin from 1–5 June 2012, with Prof. Giovanni Gandini, presiding as Congress President.

The SIRM journal, La Radiologia Medica, also founded in 1913, is published monthly by Springer Verlag and is distributed free-of-charge to SIRM members. Since 2006, the journal has appeared in both English and Italian. The 2010 impact factor reached 1.618.

SIRM is structured into study sections and regional groups. The study sections are divided according to field of interest, namely clinical issues (abdominal, breast, thoracic, emergency, cardiovascular, head and neck, paediatrics, urogenital, vascular, and interventional radiology), imaging technology (computerised tomography, magnetic resonance imaging, and ultrasound) and other issues (ethics, legislation, management, economics, radiobiology, radioprotection, and contrast materials). Each study section is led by a president and an executive board elected by the members of the section.

SIRM regional groups cover all Italian regions. Each regional group is led by a president and an executive board elected by members of the group.

SIRM places a major emphasis on education. To this end, in 2008 the society acquired a building in the centre of Rome, in Via del Cardellino, which has become its Training and Development Centre. On December 2, 2010, the Italian National Committee for Continuing Medical Education (CME) of the Ministry of Health approved SIRM’s request for professional accreditation, and the society is now an official CME provider.

SIRM organised 46 events in 2011; some were held in the Training and Development Centre in Rome, while some were held in other parts of Italy, and it has granted 20,000 credits to its members. SIRM is also an accredited provider of Distance Learning (DL). The first DL courses became available on December 9, 2011.

In the section of the SIRM website devoted to training and development, two courses are now available on December 9, 2011.

The SIRM Executive Board has decided to issue a call for papers for the period 2011 – 2013 on topics held to be of strategic importance to their role within the field of research applied to clinics. At SIRM we are proud to be members of a European community of radiologists and part of our mission is to ensure that our discipline continues to develop long into the future.

More information on the society can be found at www.sirm.org

Professor Antonio Rotondo from Naples/IT is the President of SIRM and Professor Roberto Grassi from Naples/IT is a SIRM Consigliere.
Hitachi and Aloka: two brands come together to enhance the future of ultrasound

Today, cardiac imaging has evolved into one of the most interesting and rapidly developing subspecialties within radiology. A substantial growth in the radiologist’s involvement in cardiovascular imaging and spectral developments in CT and MRI equipment was evident at the 11th Annual Congress of the European Society of Cardiac Radiology (ESCR). ESCR was founded in 1999 and has grown into a professional organisation of European cardiac radiologists. It is one of the youngest and most successful subspecialty societies within the framework of the European Society of Radiology (ESR).

After a short period of growth and maturation the ESCR has developed into a multifaceted and well-organised society. Its activities are aimed at all major aspects of cardiac radiology, the foremost of which are education and research. Detailed information about the ESCR can be found on its website www.escr.org.

Over the years, the Annual Scientific Meetings of the ESCR are among the major highlights of its activities. In 2011 more than 500 participants from Europe, Asia and the United States attended the ESCR’s Annual Congress in Amsterdam, indicating great interest in cardiac imaging among cardiologists. The congress offered an extensive scientific programme presented by celebrated experts and encompassed all aspects of cardiac imaging. The ESCR’s Annual Congress in Amsterdam (Meeting President Prof. Matthijs Oudkerk) was held in collaboration with the Dutch Society of Cardiac Radiology. The meeting took place in a marvellous venue called Felix Meritis, a historical building in the heart of Amsterdam, dedicated to arts, culture and science.

The ESCR has very good relations with other international societies working in the field of cardiac radiology. The ESCR’s most important partners are NASCI (North American Society of Cardiac Imaging) and ASCI (Asian Society of Cardiovascular Imaging). Joint missions, publications, guidelines and other forms of cooperation between these professional organisations serve to benefit global cardiac radiology and significantly contribute to the success of the ESCR Annual Congresses. Since 2008 the ESCR has been running its Young Abstract Presenter Programme (YAPP). YAPP helps younger doctors to present their abstracts at the ESCR meetings, with support from the society, and provides them with free admission to the meeting.

In some ways, the ESCR Annual Congress in Amsterdam could be regarded as a pivotal event in the history of the society. In addition to traditional educational and scientific content, the Congress presented participants with many important developments and improvements. Among the new features of the ESCR Annual Congress 2011 were the daily sessions, with case presentations from different countries. Congress attendees warmly welcomed this innovation and participated in quizzes and case discussions. The success of the ‘national’ form of case presentations clearly indicates that they should be included (with some improvements) in the programme of future meetings.

Another landmark event of the Annual Congress of 2011 was the launch of another important ESCR project: the European Cardiac CT/MR Registry (www.mrct-registry.org), which was prepared by Prof. Matthias Gerber and his team. The aims of the registry are to document anonymous cardiac CT- and MR-examinations, which have been performed in Europe, to support further education in the emerging techniques of cardiac imaging, recruit teachers, identify potential training centres throughout Europe, and finally document and certify performed Cardiac CT- and MR-examinations for the application of further qualifying procedures (e.g. European Cardiac Diploma).

Thanks to the ESCR’s partnership with the European School of Radiology (ESOR) a cardiac fellowship programme has been created. It allows doctors from Europe to visit and spend time in accredited teaching centres. The programme will continue in 2012 and it is encouraging to see that doctors who have been through this programme are now in positions to help develop cardiac radiology in Europe. Information about the cardiac fellowship programme is available on the ESOR’s website www.myESR.org/ESOR.

It is important to be aware that the ESCR has substantially decreased its membership fee for radiologists who are members of national cardiac societies (20 Euro per year). Of course, ESCR members take active part in the preparation of cardiac radiology sessions for the ECR, in Vienna. Many of the ESCR’s Executive Committee act as members of the ECR’s Cardiac Sub委员会.

The ESCR is very grateful to all its industry partners for their valuable support of the society, annual congresses and other activities. The ESCR is in the process of further improving and refining some of its activities. We are proud to announce that our 11th Annual Scientific Meeting will be held in the magnificent city of Barcelona on October 25–27, 2012. The ESCR 2012 Congress will be held in the Hotel Rey Juan Carlos I, an outstanding hotel located on Barcelona’s main avenue, Avenida Diagonal. The first floor of the hotel has an exceptional meeting facility which should provide a wonderful venue for this meeting. We look forward to seeing you in Barcelona as participants of a successful meeting with a remarkable scientific and social programme.

More information on the society can be found at www.escr.org

By Valentin E. Sinitsyn

Annual Congress of the European Society of Cardiac Radiology: approaching new horizons

We are pleased to announce that on March 3, 2011, Aloka Co. Ltd., Japan, became a subsidiary of Hitachi Medical Corporation, Japan, followed on April 1, 2011, by the launch of their new combined trading name, Hitachi Aloka Medical Ltd. With this step, Hitachi Medical Corporation and Aloka Co. Ltd., which are both based in Japan, combined their strengths in ultrasound, which has lead them to become one of the largest ultrasound companies in the world.

As a result, Hitachi, Medical Systems Europe and Aloka Holding Europe have also joined forces, and are now officially operating as Hitachi Medical Systems Europe Holding AG, since December 1, 2011. This merger has united two leading companies and brands; synergising expertise and talent from both sides, in order to offer our customers an even more attractive range of medical ultrasound solutions.

Aloka has an exceptional history as an innovator in ultrasound and is renowned for high-quality ultrasound systems and support. Combining the Aloka and Hitachi product lines will enable us to broaden our engagement with, and penetration of, this large and diverse market.

Together, we are uniquely positioned to increase our presence in the radiology, surgery, cardiology, internal medicine, obstetrics/gynaecology, urology and veterinary ultrasound markets in Europe, as well as enter new markets by, developing and delivering beneficial breakthrough technologies which improve healthcare, reduce costs and increase efficiency.

What does this mean for our customers? They will benefit from having combined staff expertise, a broader and deeper range of ultrasound systems, the knowledge and resources of the Hitachi Group and a reliable partner, with more than 100 years of experience.

Hitachi Medical Systems Europe is responsible for all marketing, sales, service and clinical application support of both, the Aloka and Hitachi ultrasound systems. In addition, Hitachi Medical Systems Europe, which, apart from ultrasound platforms, also sells a full line of MR and CT systems, will be able to enrich its portfolio and hence offer better options to the medical market while continuing to deliver innovative ultrasound systems.

By Valentin E. Sinitsyn from Moscow/ RU is the current President of ESCR
EIBIR's Joint Initiatives in imaging – ambitious goals, successfully realised

By Eva Haas

In the service of research, the European Institute for Biomedical Imaging Research (EIBIR) opens the door to European collaboration. No matter in which area; networking within working groups creates synergies and broadens horizons.

Within the Joint Initiatives dedicated to biomedical image analysis, chemistry, evidence-based radiology and cancer imaging, the scientists have successfully put into practice a number of activities in order to facilitate exchange and deepen their collaboration and expand their teaching activities.

Biomedical image analysis – key to shaping the future of biomedical imaging Through training, collaborative projects and a roadmap towards improved interoperability of and access to biomedical image analysis tools, EIBIR's Biomedical Imaging Analysis Platform is taking an active role in shaping the future of biomedical imaging research. The mission of representing that field on a European level and furthermore establishing educational activities has resulted in two outstanding features.

The EIBIR Summer School, launched in 2010, holds annual courses in cardiovascular and oncologic diseases in Viladrau, Spain, and a course on imaging in neurology in Dubrovnik, Croatia. Based on the great success of both schools and the clear need for this training, the EIBIR Summer School will be held on a biennial basis (next school: summer 2013, focus: neurology).

The IMAGINE Workshop, presented for the first time at ECR 2011, featured novel technological developments in, among others, diagnosis, therapy planning and therapy guidance. The workshop focused on the development of quantitative imaging biomarkers, computer-aided detection and diagnosis, integrated and interactive visualisation, therapy planning, image-guided interventions and robotics as well as computer-assisted training. At this year's ECR, IMAGINE provides a high-tech specialty exhibition on the latest technological developments in medical imaging analysis and image-guided interventions.

One highlight of 2012 will be the two-day workshop ‘medical image analysis software’ which will discuss issues related to interoperability and access to advanced medical image analysis software (International Symposium on Biomedical Imaging (ISBI), May 2–5, 2012, Singapore/SG).

The platform members are investigating the possibility of European funding for training programmes for researchers in biomedical image analysis.

The Chemistry Platform – European cooperation strengthens the development of novel theranostic agents

The Chemistry Platform devotes special attention to activating initiatives with European level and furthermore establishes educational activities with the scientists having successfully put into practice a number of activities in order to facilitate exchange and deepen their collaboration and expand their teaching activities.

The Action will demonstrate the potential of image-guided therapies in the treatment of diseases with a high social impact and brings together the major European research groups working on the development of novel combined diagnostic, therapeutic, and theranostic agents. The working group is most likely to get a better understanding of crucial aspects of the whole drug delivery process in vivo, in particular regarding the efficiency of drug targeting and release and the relationship with the therapeutic effect.

EuroAIM/Evidence-based radiology: diagnostic and interventional radiology in the spotlight

A year after the introduction of this subject at ECR 2011, evidence-based radiology (EBR) has become a topic of great interest in radiology. Since then, the European Network for the Assessment of Imaging in Medicine (EuroAIM) is mainly working on attracting radiologists to the delayed application of the principles of evidence-based medicine to diagnostic and interventional radiology.

Evidence-based radiology

More than 40 experts including ESR's affiliated subspecialty societies, worked on a systematic literature search for secondary studies concerning diagnostic imaging or interventional radiology published between 2001 and 2010. In total, 3,502 papers were initially screened, 1,931 studies were selected for evaluation, and only 231 (22%) studies had a radiologist or nuclear-medicine physician as author.

The study concludes that indications for diagnostic imaging and interventional procedures are defined by teams mainly composed of other medical specialists, and radiologists are clearly lagging behind.

Multicentre study on preoperative breast MRI

The ‘Preoperative breast MRI multicenter international prospective analysis study’ will be conducted under the supervision of EIBIR, in cooperation with the European Society of Breast Imaging (EUSOBI) and financially supported by Bayer Pharma AG. Two concurrent and consecutive cohorts of diagnosed breast cancer patients defined in terms of receiving or not receiving preoperative breast MRI will be compared by age, breast density. Analytical adjustment will be performed for relevant covariates.

Starting in 2012, approximately 20 high-volume breast imaging centres will be involved in enrolling around 2,600 women from 18 to 80 years who have recently been diagnosed with breast cancer.

Cancer Imaging – Challenges and Partnership in Oncology

Cancer has become the leading cause of death worldwide, and the methodology of imaging will play a crucial role in clinical oncology in the following years. The use of imaging provides the exact location and extent of the tumour, metastases for initial diagnosis, staging, and treatment planning. Thanks to advances in molecular imaging, it will be possible to gain information on the expression and activity of specific molecules as well as on biological processes influencing the behaviour of a tumour.

In response to this, EIBIR’s Joint Initiative, in collaboration with the European Organisation for Research and Treatment of Cancer (EORTC), will organise a joint training workshop on imaging in clinical research for clinical trailists in 2012.

Details: www.eibir.org > Joint Initiatives

All ECR delegates and interested institutions are very welcome to visit the EIBIR Booth at the entrance level of the congress. Here further information on our networking activities is available. For personal discussions, a small EIBIR reception has been organised for today (Room Z, 17:30).

ENCITE Session at ECR 2012

Imaging highlights – Monitoring disease and therapy

Programme

Sunday, March 4, 14:00–15:30, Room Z
Moderator: S. Aime; Torino/IT
14:00–14:15
Get trained on imaging call therapies with probes and procedures developed by ENCITE
S. Aime; Torino/IT
14:15–14:30
Cell Tracking with 19F Magnetic Resonance Imaging
P. Bateni; Malmo, Sweden
14:30–14:45
Imaging of novel therapies in Glialectomas using multiple biomarkers
R. Reichard; Frankfurt/DE
14:45–15:00
Integrated imaging analysis of multi-modal pre-clinical imaging studies
S. Aime; Torino/IT
15:00–15:15
In vivo imaging of immune responses in cancer patients
F. Feder; Herlev/IE
15:15–15:30
Discussion

Euro-BioImaging – Support of translational imaging research by pan-European research infrastructures

Programme

Sunday, March 4, 16:00–17:30, Room Z
Moderator: S. Schlenzig, Viernheim/DE and Mannheim/DE
16:00–16:30
Euro-Biomaging: strategy for access to innovative imaging research in Europe
S. Schlenzig; Euro-Biomaging, Viernheim/DE and Mannheim/DE
16:30–16:40
Infrafrontier: providing large-scale infrastructure for animal models
J. Benet; Barcelona/ES
16:40–17:00
ECRIN: clinical studies involving imaging for outcome-oriented research
J. Barretos; ECRIN, Paris/FI
17:00
Discussion

Audience members are invited to a reception hosted by EIBIR (Sunday, March 4, 17:30, Room Z)

EVENT !
Sun. 4th March
From 10AM to 2PM
Visit us and meet Dr Frank, and discuss his CBCT experience
EXPO B, Booth 201.

A SMARTER WAY FORWARD.

THAT'S DENTAL IMAGING AT YOUR FINGERTIPS. NOW THAT'S SMART.
Selecting regions of interest in breast MRI

By Roberta Fusco

Breast cancer is the most common cancer type among women in the Western world. It is the second leading cause of cancer death in women today (after lung cancer) and is estimated to cause 15% of cancer deaths. Currently the most widespread screening method is DX mammography; however, Dynamic Contrast Enhanced Magnetic Resonance Imaging (DCE-MRI) has demonstrated potential in the screening of high-risk women, staging newly diagnosed breast cancer patients, and assessing therapy effects thanks to its minimal invasiveness and the possibility of visualising functional information not available with conventional imaging. Subsequently, the imaging of the breast before and after the injection of a contrast agent (a commonly used tracer is Gd-DTPA, administered intravenously).

Highly vascularised regions, such as tumours, exhibit typical patterns of signal enhancement versus time as described in the classification by Daniel et al: typically, a quick tracer uptake (III, IV, V), is followed by the tracer washout (VI), normal or benign tissues are characterised by either no enhancement (I) especially in predominantly adipose regions) or slower enhancement with delayed washout (II). By analysing signal intensity-time curves, it is possible to characterise each voxel and detect abnormalities within the breast.

Selection or segmentation of suspicious ROIs is considered to be a preliminary step in tumour evaluation before employing more sophisticated algorithms for tissue malignancy classification. The segmentation is the process of dividing an image into distinct regions that are homogeneous with respect to a given characteristic.

Since the image analysis systems limit their analysis of some regions of the image, the segmentation becomes a critical stage for the precision, accuracy, and quality of the final result which can profoundly affect the subsequent stages.

Computer-Assisted Detection (CAD) systems for the diagnosis of breast cancer analyse DCE-MRI images, and support the radiologist in the research and diagnosis of tumours and lesions.

Since the lesions have different characteristics than the rest of the breast tissue, it is clear that the segmentation techniques used during the search process with the ultimate goal of separating the suspicious regions that might contain the tumour (benign or malignant) from the remaining tissue (parenchyma).

One goal of a CAD system is to assist the physician in identifying the final objects, which are indicated by the authors with the term ‘ROI’. ROIs are suspicious lesions or final, to be submitted as diagnosis: malignant or benign.

During this research phase a process of segmentation typically takes place which employs one or more segmentation techniques with the aim of isolating suspicious lesions from the rest of the tissues.

In most experiments, the lesion or ROI is not detected directly with the final segmentation technique which operate on the entire image, using a comprehensive approach, but by working on smaller and smaller granular- ity regions, using a local approach.

Manual selection of suspicious regions of interest (ROIs), which is the critical first step in lesion detection and evaluation, is operator-dependent and time consuming. Moreover, given the vast quantity and multidimensionality of data to be analysed in a DCE-MRI data set, its possible for diagnostically significant regions of enhancement to be overlooked. Therefore, lesion detection for breast DCE-MRI is a difficult task which should be supported by automatic procedures for identification of suspicious ROIs.

I propose an automatic method for suspicious ROI selection within the breast using dynamic-derived information from DCE-MRI data.

The proposed algorithm includes three steps (Figure 2): (i) breast mask extraction by means of automatic intensity threshold estimation (Otsu Thresholding) on the parametric map obtained through the sum of intensity differences (SOD) calculated pixel by pixel; (ii) hole-filling and leakage repair by means of morphological operators; closing is required to fill the holes on the boundaries of regions, using a local approach. (iii) Manual selection of suspicious regions of interest (ROIs), which is the critical first step in lesion detection and evaluation, is operator-dependent and time consuming.

Figure 1: Types of dynamic signal enhancement curves.

Figure 2: Results of automatic ROI selection versus manual segmentation. A: breast mask selection via Otsu thresholding on SOD; B: breast mask after morphological operators (closing, filling and erosion); C: automatic suspicious ROI selection; D: manual segmentation by expert radiologist.

Planning of radiofrequency ablation: finding the right path quickly

By Sabrina Haas, Christian Reider, Christian Schumann, Philipp Suess, Katrin Tschert, Karl-Heinz Küfer, Tobias Preusser

The success of image-guided, minimally invasive ablative treatments, such as percutaneous radiofrequency ablation (RFA), is heavily dependant on a well-planned treatment strategy prior to the intervention. Typically, this planning procedure is done manually by the radiologist. However, assessing all the criteria that measure the success and the risks of the therapy is a challenging task.

The goal of the planning phase is to define a strategy that leads to the complete destruction of the tumour by means of resistive heating of the tissue through induced electric energy. This includes considering the heat sink effects caused by nearby vascular structures, as can be seen in Figure 1, for an RFA in the liver. In addition, the planned path has to be safe in terms of critical structure protection and last but not least, the strategy should be implementable in the given clinical setting.

Taking into account all these aspects not only requires substantial interventional experience, but, depending on the given case, it can also require a considerable amount of time to plan the necessary care, particularly if a simple strategy is not possible. Therefore, researchers at the Fraunhofer Institutes in Bremen and Kaiserslautern have been developing a workflow oriented software platform for planning, intervention support and assessment of image-guided RFA.

Although the main goal has been the realisation of an integrated, easy to use workflow platform, the software allows for the segmentation of tumours and vascular structures in a semi-automatic fashion with a minimum amount of interaction. Furthermore, common applicator types from various vendors have been modelled and can be placed interactively by the radiologist to test various intervention strategies. The probes including the corresponding ablation zones are superimposed onto the 2D-slice views that covers all aspects of this now widely used intervention, special attention has been paid to the planning of the procedure. As a pre-requisite for the planning, the software allows for identification of suspicious ROIs, which is the critical first step in lesion detection and evaluation, is operator-dependent and time consuming.

In most experiments, the lesion or ROI is not detected directly with the final segmentation techniques which operate on the entire image, using a comprehensive approach, but by working on smaller and smaller granular- ity regions, using a local approach.

Manual selection of suspicious regions of interest (ROIs), which is the critical first step in lesion detection and evaluation, is operator-dependent and time consuming.

Figure 3: Three dimensional illustration of a possible outcome of an RFA. Three probes (grey), a simulated coagulation area (red), the tumour (blue) and all relevant vessels (yellow) are depicted. Since the tumour lies in the vicinity of large vessels, the tumour cannot be completely destroyed due to the cooling effects of the vessels (taken from Patient-Specific Planning for Radio-Frequency Ablation of Tumors in the Presence of Uncertainty, Tobias Preusser and Heinz-Otto Peitgen. It-technology 52(5), 265-271, 2010 © 2010 Oldenbourg Wissenschaftsverlag GmbH.)
Hunting down vulnerable plaques: new developments in phase-contrast imaging

By Tobias Saam, Julia Herzen, Franz Pfeiffer, Fabian Bamberg

Complications resulting from cardiovascular disease are the most common cause of death in the world. Despite major advances in the treatment of cardiovascular disease, a large percentage of individuals with the disease die without prior symptoms. Pathological examinations of human lesions have found plaque rupture as the cause in the majority of acute coronary events. Therefore, the challenge for screening and diagnostic methods is to identify patients at risk who have lesions that are likely to rupture, so-called high-risk or vulnerable plaques, before the event occurs. However, no method currently in clinical use is able to accurately predict the likelihood of a plaque rupturing.

In order to identify plaques that are likely to rupture, imaging methods are needed which are able to detect all the features of vulnerable plaques, such as a large lipid/necrotic core, a thin or ruptured fibrous cap, inflammation, haemorrhage, and thrombus. However, the non-invasive imaging methods currently in use all have inherent limitations: black-blood magnetic resonance imaging has excellent soft tissue contrast but is limited to relatively large, stationary vessels such as the carotid arteries; multi-detector CT is able to quantify the atherosclerotic plaque burden but has difficulty differentiating between fibrofatty, haemorrhagic, and lipid tissue and is unable to depict the fibrous cap; ultrasound has difficulties differentiating between fibrous, haemorrhagic, and lipid tissue and is limited to superficial arteries, such as the carotid or femoral arteries; PET/CT is able to quantify plaque inflammation but has similar limitations to conventional CT in differentiating between the different plaque components. These advances in existing imaging technology or novel techniques are needed which would enable the detection of all the features of vulnerable plaque non-invasively and with excellent temporal and spatial resolution.

X-ray phase-contrast imaging (PCI) is a recently developed imaging technology that takes advantage of the phase-shift that occurs when x-ray waves pass through different tissue components. This phase shift is used to generate contrast differences in the image. Phase-contrast imaging has been successfully used to enhance contrast in medical samples and has created improved and complementary images to standard x-ray absorption methods. Standard x-ray imaging of biological soft tissue is often limited due to the weak absorption contrast of the tissues of interest. Thus, phase-contrast imaging represents a promising alternative. Since phase-contrast technology requires higher photon energy than absorption contrast imaging, phase-contrast imaging has the potential to enhance image quality at a lower radiation dose, but with the same spatial resolution. Until recently, however, all phase-contrast modalities relied on highly brilliant synchrotron radiation sources, and thus could not be considered for clinical application.

Given that a high potential for gb-PCI for the characterisation of soft-tissue components, we are studying the feasibility of this technique for atherosclerotic plaque characterisation. The initial results of this proof-of-concept study demonstrate that gb-PCI, using a synchrotron radiation source, is able to quantify the atherosclerotic plaque burden while correlating well with histopathology. Furthermore, gb-PCI was able to image human carotid artery specimens with unprecedented detail (Figure 1). The technique has a high potential for atherosclerosis imaging and further studies are underway to test whether gb-PCI of atherosclerosis can be translated into conventional x-ray tubes. It is our hypothesis that gb-PCI has the potential to detect structural differences pertaining to high-risk atherosclerotic lesions that are beyond the capability of established imaging techniques.

gb-PCI also provides a dark-field signal. This signal has recently been reported to yield information about the local texture of a specimen and holds great potential for visualising changes, for example, in the vascular wall at different stages of inflammation. The Institute for Clinical Radiology at Ludwig Maximilian University in Munich, Germany (Head: Professor Maximilian Reiser) and the Physics Department E17 of the Technical University of Munich (Head: Professor Franz Pfeiffer) both within the Munich Centre for Advanced Photonics (MCAP), a Cluster of Excellence, are investigating the potential of PCI in various tissues, including atherosclerotic plaque, cancerous breast, cartilage, and lung.

Given the great potential of gb-PCI for the characterisation of soft-tissue components, we are studying the feasibility of this technique for atherosclerotic plaque characterisation. The initial results of this proof-of-concept study demonstrate that gb-PCI, using a synchrotron radiation source, is able to quantify the atherosclerotic plaque burden while correlating well with histopathology. Furthermore, gb-PCI was able to image human carotid artery specimens with unprecedented detail (Figure 1). The technique has a high potential for atherosclerosis imaging and further studies are underway to test whether gb-PCI of atherosclerosis can be translated into conventional x-ray tubes. It is our hypothesis that gb-PCI has the potential to detect structural differences pertaining to high-risk atherosclerotic lesions that are beyond the capability of established imaging techniques.

Tobias Saam and Fabian Bamberg are from the Institute of Clinical Radiology at the Ludwig-Maximilian-University, Munich/DE. Julia Herzen and Franz Pfeiffer are from the Physics Department E17 at the Technical University of Munich/DE.

Figure 2: During path selection for therapy planning of radiofrequency ablation in the liver multiple criteria have to be considered. An optimal trade-off between a short path length (left), a comfortable distance to critical structures, a complete coverage of the tumour (right) and several other constraints has to be determined.
New ultra-fast level-set algorithm may bring more intelligent segmentation tools to the clinic

By Chunliang Wang

Medical image segmentation, especially three-dimensional image segmentation is the foundation of quantitative image interpretation and evaluation. It has been widely used in oncological imaging, CT/MR angiography and surgery planning. But are doctors satisfied with the tools they have? Do they always get what they need to segment during various tasks? The answers may be controversial as they depend upon: the user's experience, the tasks which they face, and image quality. One common observation is that the clinically available tools are usually not intelligent enough, or in a sense 'stupid'. Many commercial systems use region-growing methods which allow users to segment an object by using one or several seed points. The software then repeatedly adds neighbouring voxels with similar intensity values to the region.

However, in a clinical environment, it does not always work as well as it does in the vendor's demo videos. It is common for marked organs to leak from one organ to another through a narrow gap or grow a long band instead of the whole image, and Whitaker who later extended narrowband level-set to the sparse field level-set (where the narrowband is only one pixel wide) has already made noticeable difference to the conventional level-set algorithm. The research tool MiaLite has been developed for image segmentation based on this algorithm (http://www.cmiv.liu.se/output/software). An intuitive user interface was provided to enable the user to define seed regions, prevent propagation into neighbouring organs and adjust key parameters. MiaLite is free to use, and supports multiple platforms (Mac, Windows and Linux).

Many researchers have contributed to improving the performance of level-sets, for example Sethian who invented the narrowband method (the computation is limited to a band a few pixels wide instead of the whole image), and Whitaker who later extended narrowband level-set to the sparse field level-set (where the narrowband is only one pixel wide). The current work thus adds to progress that has already been made.

The accompanying poster to this presentation is published in EPOS™ and can be accessed online at myESR.org/EPOS. The poster (C-0456) is titled ‘Interactive Image Segmentation Software based on Coherent-propagating Level-set Method’.

Chunliang Wang works at the Center for Medical Image Science and Visualization at Linköping University in Linköping/SE.

Examples of organ segmentation using MiaLite

By Chunliang Wang

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A special anniversary brochure was created to celebrate the fifth anniversary of the European School of Radiology (ESOR). A number of key people involved with ESOR were interviewed about its effect on the past, present and future of radiological education.

After five successful years of uninterrupted growth and investment in radiological education in Europe and beyond, we took the opportunity to bring together the founder and the pioneering members who established ESOR to one table and talk to them about their past experiences and their hopes for the future of the programme.

We spoke to the educational director of ESOR and former EAR, ESR and ECR President, Professor Borut Marinček, co-opted ESOR member and current ESR President, Professor András Palkó, and co-opted ESOR member and current ECR 2010 Congress President, Professor Małgorzata Szczerbo-Trojanowska, who have all supported ESOR with great dedication from the very beginning.

This is the first part of the round table discussion; the second part will be published in Monday’s issue of ECR Today.

What did radiological education throughout Europe look like at the time ESOR was founded?

Nicholas Gourdyssianis: One way to find out what was missing in the past is to recognise and identify the new features that have been introduced and provided by ESOR since it was founded to improve radiological education in Europe, and there are many.

ESOR raised the scientific profile of radiological education, by introducing structured and accredited modular training programmes, promoting enrolment at free reference training centres, establishing visiting scholarships and exchange programmes, and by offering a great number of educational grants.

ESOR has promoted interest in the specialisations throughout Europe, by offering organ-oriented subspecialty training programmes in European countries where subspecialisation was and still is evolving. ESOR introduced fellowships for education in Europe, by facilitating subspecialty mini-fellowship grants.

ESOR has assisted thousands of luminaries among residents in Europe, by offering interactive training through visiting schools. ESOR became, in a short period of time, an international provider of education on behalf of the ESR, by offering annual tailored programmes across the globe, including Asia, the Middle East, and South America.

András Palkó: Radiology specialty training, the rules of which were and are defined on a national level both inside and outside of the European Union, has always varied greatly from one country to another in terms of concept, structure and duration. There has never been a real chance so far to correct this situation on a political level. Therefore the European Association of Radiology (one of the predecessor organisations to the ESR) decided to tackle this issue on a professional level by preparing the first version of the European Training Curriculum, which was later adopted and has since been maintained by the ESR. Thus, we had the content to distribute but did not have the proper tool to do so until ESOR was established.

What has ESOR achieved?

András Palkó: There was and there still is an imbalance in radiological education between the various European countries. Given the constant changes in the practice of medicine there was (and there still is) an inadequate relationship with other clinical specialties which prevents us from providing patients with the best medical care. Radiologists should learn to practice their profession in a more service-oriented fashion.

Małgorzata Szczerbo-Trojanowska: Before the foundation of the European School of Radiology, European radiological education did not have any organised structure. Most education was provided on a local basis by radiological departments. It was supplemented by courses and educational/scientific meet-tings which were mainly organised by national radiological societies and radiological subspecialties. Additional training was provided by companies and commercial institutions but they were often seen as being biased. European radiological education suffered from substantial differences in the level and content of knowledge acquired during training from country to country and even within countries.

What were the motives that led to the founding of ESOR?

Nicholas Gourdyssianis: At the time of the creation of ESR, radiological education in Europe was still characterised by great diversity. It resembled a patchwork of noticeable differences in texture, content, duration, delivery, and regulatory processes. With the exception of the ECR, organised forums or assigned efforts to assist the harmonisation or improvement of radiological training were lacking.

The need for a strong educational pillar at a European level within the newly established European Society of Radiology – mascots. The need for a strong educational pillar at a European level within the newly established European Society of Radiology.

András Palkó: In response to this changing situation the newly established European Society of Radiology created ESOR in 2006.

One of the main aims was the harmonisa-
tion and unification of radiological training in all European countries by offering high level specialist courses in various areas of radiology. Courses were made available to radiological communities in all countries.

A carefully selected faculty of leaders in the field was selected to teach junior radiologists. From the beginning, ESOR prepared many very attractive and diverse educational programmes adjusted to the specific needs of its public.

ESOR pioneers discuss the past, present and future of the European School of Radiology (Part I)
Distinguished thoracic radiologist to deliver honorary lecture at ECR

In recognition of his tremendous contribution to radiology, especially intensive care imaging and imaging of adult respiratory distress syndrome and pulmonary thromboembolic disease, Professor Lawrence R. Goodman from Milwaukee, United States, has been invited to present the Wilhelm Conrad Röntgen Honorary Lecture ‘In search of venous thromboembolism: the first 2,912 years’ at ECR 2012.

Lawrence R. Goodman, MD, FACR, is a pioneering chest radiologist, whose work has greatly advanced the development of the sub-specialty and imaging as a whole. He is Chief of Thoracic Imaging at the Medical College of Wisconsin in Milwaukee, U.S., a role he took on almost three decades ago. He has been Professor of Pulmonary Medicine & Intensive Care at the same institution since 1996.

A former member of the faculty of Hahne- mann Medical College in Philadelphia and George Washington University in Washing- ton DC, Professor Goodman received his MD from the State University of New York in Brooklyn.

In 1973, after one-year fellowship in pulmonary radiology at the University of California, he moved to Wisconsin. As a medical student, I was impressed by what radiologists could derive from simple x-rays. Two particular teachers, Dr. Lucy Squires and Dr. Harry Mellers were particularly influential and encouraging. Reading Felton's 'Principles of Chest Roentgenology' really got me interested in pulmonary disease. At the same time, an elective on pulmonary medicine with Dr. Harold Lyons, an eminent pulmonologist, got me interested in pulmonary disease and this rest followed from there. Radiology is always a challenge. The number of modalities has blossomed, and the understanding of disease with each modality continues to progress. Having medical students, residents, and fellows at the workstations every day adds to the stimulation and fun. Working with Dr. Paul Stein et al on the Prospective Investigation of Pulmonary Embolism (PIOPED II and III) for the last twelve years has been an incredible experience,” he said.

His contribution to radiology translated into numerous appointments within prestigious institutions, some of which he helped shape from the beginning. Professor Goodman was one of the original members of the Society of Thoracic Radiology, where he served on the Organizing Committee in 1982 and as President in 1985–86. His commitment to the development of the society earned him a Gold Medal Award for lifetime achievement in 2008. He has also been very active within the Fleischner Society, where he served on the Programme Committee and as Programme Chairman, Treasurer and President. He is currently on the society’s Strategic Planning Committee.

While at the Medical College of Wiscon- sin, he started a fellowship programme, in the name of Gerry Scanlon, his predecessor as Head of the Chest Imaging section. Professor Goodman has trained many fellows from North America and around the world, stressing his interest in mentoring younger generations.

A fellow of the American College of Radi- ology, he has also carried out numerous functions within the Radiological Society of North America (RSNA), and is a member of the American Roentgen Ray Society and the Association of University Radiolo- gists. He is also the editor of the second and third edition of ‘Felton’s Principals of Chest Roentgenology’.

He has published almost 150 influential papers, mainly focusing on intensive care imaging, imaging of adult respiratory distress syndrome and imaging of pulmonary thromboembolic disease. His paper ‘Detection of pulmonary embolism in patients with unresolved clinical and scintigraphic diagnosis: Helical CT vs angiography’ was the 18th most-cited article in the American Journal of Radiology over the last century.

Sunday, March 4, 12:15–12:45, Room A
Wilhelm Conrad Röntgen Honorary Lecture
‘In search of venous thromboembolism: the first 2,912 years’

Lawrence R. Goodman, Milwaukee, WI/US

Despite the financially trying times in which we find ourselves, it is a testament to the professionalism of radiologists throughout Ireland that the highest standards of clini- cal radiology are not only provided, but are transparently measured, and rigorously assessed for excellence.

From May 2011 it became a legal require- ment for all doctors in Ireland to engage in professional competence. The principal role of the faculty is to provide a pathway whereby fellows can safely record their activities. It is in the professional interests of all fellows that we are able to measure and report on the performance of doctors and patients that the highest possible standards of clinical practice are applied.

It is evident that our radiological activity is becoming increasingly complex. Metrics to measure the diversity and complexity of our workload are challenging. In March 2011, a significant document ‘Measuring Clinical and Radiological Workload in Ire- land: National Methodology and Results from a National Survey’ was published by the Faculty. In the context of other jurisdictions, the results confirmed the onerous workload of radiologists through- out the country, and with the metrics sub- sequently having been accepted by the Health Service Executive, it is hoped that this and future iterations will provide an algorithm to redress the shortfall in radi- ologist numbers.

In order to maintain the status of the Irish Faculty of Radiologists as a recognised train- ing body, our programmes must be approved and accredited by the Irish Medical Council. The continued existence of the faculty as a postgraduate training body depends on its successful achievement of accreditation by the Irish Medical Council. The Faculty of Radiologists, both diagnostic and radia- tion oncology arms, underwent the Medical Council’s accreditation process in November 2011. Collation of the requisite informa- tion was achieved using a consensus Delphi model from colleagues throughout the country.

Last year also marked the 50th anniversary of the founding of the Faculty of Radiolo- gists. To mark this occasion, an extended Annual Scientific Meeting was held in Sep- tember. In addition to a State-of-the-Art Scientific Session, the meeting included significant elements of historical material, and reflections on our achievements to date. At the meeting, Honorary Fellowship of the Faculty was conferred on Dr. András Palkó (President, European Society of Radiology), Dr. Jane Barrett (President, Royal College of Radiologists) and Dr. Burton P. Drayer (President, Radiological Society of North America). The Faculty was also privileged to have the presence of several former deans

at the meeting. Some of them are shown in the photograph.

The faculty, despite testing economic waters at its half-century, remains buoyant and committed to clinical excellence in all of its endeavours.

More information on the society can be found at www.radiology.ie

Dr. Barry Kelly is Honorary Secretary of The Royal College of Surgeons, Ireland – Faculty of Radiologists.

Irish radiologists remain committed to clinical excellence in their endeavours

By Barry Kelly

Thromboembolism will also be the sub- ject of his lecture during ECR 2012. “It has taken medicine a long time to get to our current level of understanding of venous thromboembolism (pulmonary embolism and deep venous thrombosis). Fortunately, we have learned a lot, unfortunately, this new knowledge has raised many new questions. This lecture will emphasise much of the work of the last half century and then focus on areas of controversy or work still to be done,” he explained.
European Radiology – Highlights 2011

In order to highlight for you, our readers and ECR participants, some of the most exciting articles published in European Radiology during 2011, we asked our section editors for their expert opinion by selecting what they believe to be the most groundbreaking developments in their field.

Luis Martí-Bonmatí is Professor and Head of Radiology at the Hospital Quirón in Barcelona, Spain, and European Radiology section editor for magnetic resonance. For ECR Today he chose the abstract below and briefly explains his reasons for doing so.

This cross-sectional and institutional multi-centred research article focuses on 4D flow-sensitive MR imaging (4D-PC-MRI) biomarkers and on the evaluation of frictional secondary aortic flow patterns in normal subjects. By using streamline lines and time-resolved 3D particle traces, they showed that, aortic arch geometry, and size have an influence on secondary flow patterns. Helical flow was less common with altered shapes and increasing age, while the number of detected vortices increased with aortic diameter and age.

The influence of flow dynamics and vessel wall shear forces seem quite relevant to the diagnosis of and therapeutic decision process for cardiovascular disorders. 4D-PC-MRI parameterisation will surely play an important role as a non-invasive technique. Knowledge of pathophysiological variants should limit evaluation bias.

Interdependencies of aortic arch secondary flow patterns, geometry, and age analysed by 4-dimensional phase contrast magnetic resonance imaging at 3 Tesla


Abstract: Objective: It was the aim to analyse the impact of age, aortic arch geometry, and size on secondary flow patterns such as helix and vortex flow derived from flow-sensitive magnetic resonance imaging (4D-PC-MRI).

Methods: 62 subjects (age range 20–80 years) without circumscribed pathologies of the thoracic aorta (ascending aortic (A) diameter: 3.2±0.6 cm [range 2.2–5.1]) were examined by 4D-PC-MRI after IRB-approval and written informed consent. Blood flow visualisation based on streamline and time-resolved 3D particle traces was performed. Aortic arch shape (gothic, crook-shaped, cubic), angle, and age were correlated with existence and extent of secondary flow patterns (helix, vortex); statistical modelling was performed.

Results: Helical flow was the typical pattern in standard crook-shaped aortic arches. With altered shapes and increasing age, helicity was less common. A/Ao diameter and age had the highest correlation (r = 0.69 and 0.68, respectively) with number of detected vortices. None of the other arch geometric or demographic variables (for all, P > 0.177) improved statistical modelling.

Conclusion: Substantially different secondary flow patterns can be observed in the normal thoracic aorta. Age and the A/Ao diameter were the parameters correlating best with presence and amount of vortices. Findings underline the importance of age- and diameter-matched control groups for haemodynamic studies.

Key Points:
- Secondary blood flow patterns (helix, vortex) are commonly observed in the aorta
- Secondary flow patterns predominantly depend on patient age and aortic diameter
- Geometric factors show a lesser impact on blood flow patterns than age and diameter
- Future studies on flow patterns should incorporate age- and diameter dependencies

Eric de Kerviler is Professor of Radiology at Hospital St. Louis in Paris, France, and European Radiology section editor for oncology. For ECR Today he chose the abstract below and briefly explains his reasons for doing so.

With the development of multidisciplinary chemotherapies and targeted therapies for solid tumours, RECIST criteria exhibit some limitations. We are therefore looking for new indicators for response to treatment. In this field, molecular imaging should play an important role in the future. Lambregts et al have clearly demonstrated, with a series of recent cancer patients, that ROI size, drawing, and positioning all have a considerable influence on tumour ADC values and interobserver variability (see Figure). This is even worse after chemoradiation due to the irregular aspect and ill-defined borders of the residual area. New biomarkers such as ADC are therefore very promising, even though standardisation of the acquisition technique and measurements are needed.

Tumour ADC measurements in rectal cancer: effect of ROI methods on ADC values and interobserver variability


Abstract: Objectives: To assess the influence of region of interest (ROI) size and positioning on tumour ADC measurements and interobserver variability in patients with locally advanced rectal cancer (LARC). Methods: Forty-six LARC patients were retrospectively included. Patients underwent MRI including DWI (b5000,10000) before and 4–6 weeks after chemoradiation (CRT). Two readers measured mean tumour ADCs (pre- and post-CRT) according to three ROI protocols: whole-volume, single-slice, or small solid samples. The three protocols were compared for differences in ADC, SD and interobserver variability (measured as the intraclass correlation coefficient, ICC). Results: ICC for the whole-volume ROIs was excellent (0.91) pre-CRT versus good (0.66) post-CRT. ICCs were 0.53 and 0.42 for the single-slice ROIs versus 0.60 and 0.65 for the sample ROIs. Pre-CRT ADCs for the sample ROIs were significantly lower than for the whole-volume and single-slice ROIs. Post-CRT there were no significant differences between the whole-volume ROIs and the single-slice or sample ROIs, respectively. The SDs for the whole-volume and single-slice ROIs were significantly larger than for the sample ROIs. Conclusions: ROI size and positioning have a considerable influence on tumour ADC values and interobserver variability. Interobserver variability is worse after CRT. ADCs obtained from the whole tumour volume provide the most reproducible results.

Key Points:
- ROI size and positioning influence tumour ADC measurements in rectal cancer
- ROI size and positioning influence interobserver variability of tumour ADC measurements
- ADC measurements of the whole tumour volume provide the most reproducible results
- Tumour ADC measurements are more reproducible before, rather than after, chemoradiation treatment
- Variations caused by ROI size and positioning should be taken into account when using ADC as a biomarker for tumour response


Typical secondary flow patterns depicted by streamline visualisation in a systolic time frame (A, B = left anterior oblique view of A and particle traces in an early diastolic time frame (C = magnification detail of D), D, Helicity, as shown for the ascending aorta in A and B, was recognised as the overall corkscrew-like bulk motion of blood. Vortices, as depicted in C and D, resembled recirculating areas within the vessel.

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Community News
News from the Association of Radiology of Bosnia and Herzegovina

By Zulejha Merhemić

Radiologists in Bosnia and Herzegovina (BiH) are represented by the Association of Radiology of BiH. Today the association has approximately 130 members, made up of radiologists from all over the country. The association is an active member of the ESR. Since its very beginning it has been the educational and scientific organisation for BiH radiologists, developing radiology in Bosnia and Herzegovina through the exchange of information along with scientific and educational programmes.

Over the last fifteen years the association has organised four congresses with international participation, all in an effort to develop radiology in our country. The most important national radiological event of 2011 was the 4th Congress of Radiology of BiH, which took place in Sarajevo at the end of September.

The association is actively involved in the continuing education of young radiologists as well as professional radiologists. We have five clinical centres around the country serving as tertiary centres of medical care and teaching, which are involved in the day-to-day training of radiologists. We are trying to adapt our curriculum of specialisation in radiology to meet European standards, and over the last few years our training system has improved.

Today, our young radiologists are involved, as active members, in the Radiology Trainees Forum of the ECR, and we have been encouraging them to take the new European Diploma in Radiology.

As in the rest of Europe, we are debating the issue of subspecialties, but the situation in BiH is difficult because only one subspecialty, angiology, is officially recognised by the government. We are trying to encourage the Ministry of Health to recognise at least a few other subspecialties like interventional radiology, paediatric radiology and neuroradiology.

As radiology is one of the most expensive fields of medicine, we are trying to keep up to date with modern technology, so over the past several years our Ministry of Health has made significant efforts to obtain the latest generation of equipment as well as to modernise existing equipment, in order to meet modern standards.

In the clinical centres we have the latest MRI units, like 3.0T and 1.5T, as well the latest generation of 64-slice CT scanners. Next year the clinical centre in Sarajevo is going to receive a new PET-CT scanner, which will be the first of its kind in our country. All of our centres are also making enormous efforts to introduce PACS; four of the clinics have already implemented it.

Another important goal of the association, for the future, is to establish interventional radiology as part of the regular and daily routine. Over the past few years we have had problems with the implementation of interventional procedures, mainly because of their high cost. The main current professional activity of our society is supporting attempts to improve the financing of radiological procedures by the National Health Fund. Many radiological procedures are poorly financed, and we aim to improve this situation as much as possible. We have, so far, managed to acquire a modern angiography suite for each of our five clinical centres, among which are two with 3D and DynaCT capabilities. We are also making significant efforts to improve the education of our specialists in interventional procedures. Our goal is to establish at least two referral centres, where all interventional procedures can be performed, and where our patients can get full treatment.

In the future we hope that, besides all this, we will be able to raise the standards of Bosnian-Herzegovinian radiology to those of the rest of Europe.

Further information can be found on the society’s website www.radiologija.ba or via e-mail: info@radiologija.ba

Assist. Professor Zulejha Merhemić from Sarajevo/BiH is President of the Association of Radiology of Bosnia and Herzegovina.
Spotlight on radiology in Germany
Radiologists launch information campaign

By Florian Schneider

Radiologists enjoy an outstanding reputation in Germany; however not many people actually know about their wide range of services. This is the result of a survey conducted by the Deutsche Röntgengesellschaft (German Radiological Society – DRG) in autumn 2010, together with the Society of Nuclear Medicine and Radiation Therapy. Only 37% of the interviewees identified radiology as a radiological service. Procedures like computer tomography or magnetic resonance imaging were associated with radiologists by only 13% of the people interviewed, although these services are established tasks of numerous radiological institutions. Against this background the DRG and its partner societies have launched an information campaign aimed at patients and the general public.

The website www.medizin-mit-durchblick.de features and explains the examination methods and treatment procedures of radiology, nuclear medicine and radiation therapy as well as background technical information. A further key aspect is raising awareness in cancer patients according to which inform people about the work of radiologists and several imaging methods. A poster series presents the uses of radiological images and highlights radiologists’ diagnostic skills, for example when they have to react fast in the case of a stroke or a hypertensive disease.

Radiology: a key discipline
“Radiology is a key discipline in terms of patient care,” says Professor Michael Forsting, President of the DRG and radiologist at the University Hospital Essen. Radiology is about more than just fractures; about 80% of all serious diseases are diagnosed through medical imaging. Radiologists are important partners when it comes to diagnosis and therapy control of cancer or vascular problems like heart attack or apoplectic stroke,” adds Forsting.

With x-rays against cancer
The above-mentioned website also informs people about nuclear medicine and its diagnostic and therapeutic possibilities. “Our survey shows that 46% of the interviewees have no idea what nuclear medicine is about,” says Professor Jörg Kotzerke, President of the Deutsche Gesellschaft für Nuklearmedizin (German Society of Nuclear Medicine). “With the help of the website and the waiting room campaign we aim to inform our patients about our medical service, which includes diagnosis of thyroid diseases and local and conservative cancer therapy with radioscopes,” says the nuclear medicine specialist from Dresden.

Our project aims to reduce patients’ anxiety about radiation used for medical purposes,” explained Prof. Jürgen Dunst, President of the Deutsche Gesellschaft für Radiologie (German Society of Radiation Oncology), who teaches at the University of Munich. “The fact that over half of severe diseases are curable nowadays is also due to the contribution of radiation therapy. In contrast to surgical methods, radiation therapy tackles cancer with the utmost precision and causes only minimal tissue damage. Additionally, radiation is used for the therapy of benign diseases like arthritis, another fact our patients can learn about during the information campaign.”

Further information on the society can be found at www.drg.de

Florian Schneider is the DRG press officer and can be contacted via schneider@drg.de

New means of cooperation for the Radiological Society of Serbia

By Milos A. Lucic

The Radiological Society of Serbia (RSS) is an association which represents radiology specialists, radiologists in training, and other professionals working in the field of diagnostic and interventional radiology and also in diagnostic medical and functional-molecular imaging in the Republic of Serbia.

The RSS has its roots in the Radiological Association of Yugoslavia, which was founded in 1994, but with the political changes and restructuring of state institutions, it was renamed the Radiological Association of Serbia and Montenegro in 2002. Finally, in 2006 it was changed to its present name, the Radiological Society of Serbia.

The goals of the RSS are as follows: to promote professional, scientific, and educational activities in the field of radiology and diagnostic imaging, coordinate work in all subfields of radiology through the standardization of national radiological and medical imaging sectors, coordinate the collaboration between radiologists and other specialists in scientific and professional disciplines, develop educational activities in all fields of radiology, increase information in order to create, enforce and implement laws and regulations related to radiology and medical imaging, represent radiologists in terms of their professional and academic interests, and finally, develop institutional cooperation with other radiological societies and medical fields as well as European and international associations of radiologists in order to exchange and disseminate knowledge along with professional and scientific experience.

In order to achieve these goals, the RSS works towards the continuous development of radiological, diagnostic, and functional-molecular imaging by organising the Serbian Congress of Radiology in cooperation with the Radiological Diagnostics Section of the Serbian Medical Doctors Society. It also arranges scientific and professional seminars, assemblies, consultations, courses, and exhibitions of education in the field of radiology, either alone or in cooperation with the Radiological Diagnostics Section of the Serbian Medical Doctors Society or other professional organisations. To this end it also publishes books, CD-ROMs, and other radiological and diagnostic imaging publications and coordinates activities in radiology on a national level. The RSS works with universities, faculties, schools and other educational organisations around the country, as well as with other international and European organisations, dedicated to radiology and diagnostic imaging.

Currently, the RSS is an institutional member of the European Society of Radiology (ESR) and the International Society of Radiology (ISR).

Closer cooperation with the Radiological Diagnostics Section of the Serbian Medical Doctors Society was formally confirmed last year by the signing of the Collaboration Agreement by the Chairman of the Radiological Society of Serbia, Prof. Milos A. Lucic and the Chairman of the Radiological Diagnostics Section of the Serbian Medical Doctors Society, Prof. Viktor Till, at the first joint Congress of Radiology in cooperation with the Nuclear Medicine Society of Serbia held at Zlatibor on November 13–16, 2011, and attracted a huge number of radiologists; the largest number so far.

Numerous programme themes, which were defined by the Joint Scientific Committee and presented at the Congress, started a new chapter in the activities of the Radiological Society of Serbia and the Radiological Diagnostics Section of the Serbian Medical Doctors Society, which was a united effort to improve the quality of the scientific programme. Important contributions came not only from the outstanding foreign lecturers, but also from the quality educational programme contributed by the Radiology Trainers Forum (RTF), ‘Basics of Radiology and Diagnostic Imaging’, which created a huge interest in sessions in this particular field. Some of these courses were enriched by role-playing sessions, for example the ‘24 hours in Emergency Centre’, which was organised by a team of doctors from the Clinical Centre of Vojvodina, Novi Sad, demonstrated in an original and almost theatrical manner that learning important and serious facts in radiology can also be very amusing. In addition, the Joint RSS/NMSS Interuniversity Session on Hybrid Imaging in cooperation with the Nuclear Medicine Society of Serbia was held for the first time, presenting the current capabilities of SPECT/CT, PET/CT and PET/CT/MRI diagnostics to the radiological community.

A quiz for radiologists in training was also organised for the first time, enabling the assessment of knowledge as well as the chance to gain new and valuable information. Under the direct sponsorship of the RSS numerous educational courses are held and organised every year; the most prominent of which are the Thomas Jefferson School of US and Belgrade and the Breast Imaging and Performing MRI Schools in Sremska Kamenica. The Radiological Diagnostics Section of the Serbian Medical Doctors Society also sponsors a Permanent CT School in Novi Sad, a Digestive Radiology School in association with DAGIRS (Društvo digestivnih radiologa Srbije), and a School of Neuroradiology in Belgrade in association with the Serbian Society of Neuroradiology, as well as many other educational courses.

In addition, the RSS organises many other multi-disciplinary courses in collaboration with numerous professional organisations, last year’s course on Functional Anatomical Diagnostics of Cardiological Diseases, organised in association with the Cardiological Society of Serbia and the Serbian Nuclear Medicine Society. As a result, a wide spectrum of possibilities within various subfields of radiology has been created enabling the performance of many new diagnostic procedures, including some of the most state-of-the-art and, technically demanding radiology examinations.

Professor Milos A. Lucic from Stenska Kamenica/RSS is Chairman of the Radiological Society of Serbia.
A very special treat: discover Vienna’s unusual museums

By Michael Crean

Vienna is known as a city of culture; opera, classical music, the Waltz and coffeehouse culture are just some of the cultural features commonly associated with the city. These are all characteristics which its inhabitants have come to love and which tourists come to discover. Perhaps less well-known is that there are also features which can take pride in an impressive range of museums, which are not only dedicated to the visual arts and music, but also to historical preservation and some rather more obscure, but nonetheless fascinating themes.

Most major cities around the world, certainly capital cities, have museums of fine arts, natural history, design and military history. But in Vienna visitors have the chance to discover the rather morbid history of the undertaker’s profession, learn about the development of cartography, view the furniture and household utensils of the Habsburgs and explore the development of medicine. This makes Vienna the ideal destination for history buffs and those who want to see something besides Klimts and Schieles.

Remains from every discipline within medicine will surely be intrigued by the collection of the Museum of Medical History, which is part of the Medical University in Vienna’s ninth district. The museum building was originally commissioned by Emperor Franz Joseph II as a medical and surgical academy and became known as the Josephinum. The museum’s most impressive feature is its collection of anatomical and obstetric wax models which were made by the anatomist Paolo Mascagni between 1874 and 1878. The museum also has exhibits containing documents, pictures and instruments spanning three centuries of medical development. The museum should be on the itinerary of every visiting medical professional.

Do you sometimes feel like you make the world go round? Well pay a visit to Vienna’s Globe Museum and you can do just that, albeit on a smaller scale. This museum is the only one of its kind in the world and has a collection of 570 celestial, terrestrial, lunar and extraterrestrial globes. The museum is located in Vienna’s first district, in the Palais Mollard and is part of the Austrian National Library. The museum also has the oldest globe in Austria, dating back to around 1536, which is currently on loan from a private collection. This museum is a must for the intrepid globe enthusiast which has seen everything, except a museum dedicated to globes.

In 1950, a single undertaker service was established in Vienna, the Bestattung Wien. Before then, funerals were big business in imperial Vienna and many Viennese people were willing to pay big money to ensure they would have the most elaborate and glamorous send-off. During the early 1900s there were eight private undertakers in Vienna and 52 graveyards, which all add up to ensure an impressive collection at Vienna’s Undertaker Museum. The museum is located in Vienna’s fourth district, near the Belvedere Palace, and here visitors can discover the elaborate rituals of Viennese funerals. This museum houses some truly unique curiosities such as a reusable coffin, introduced in 1784 to save wood, a ‘Rettungswecker’, a bell with which the prematurely buried could alert those above ground, as well as a variety of hearses and other funeral related paraphernalia. This museum is something really unique to Vienna and allows visitors to gain an insight into the peculiar Viennese attitude and superstitions towards death.

Have you ever wondered what life was like before IKEA? The Hofmobiliendepot (Court Furniture Depository) located in Vienna’s sixth district, just off the bustling high street of Mariahilferstraße, is just the place to glimpse the items which furnished the many residences of the Habsburgs, as well as those of the less illustrious middle classes of the past. This is not just any collection of furniture, but in fact the largest collection in the world. In 1747, Empress Maria Theresa founded the Court Furniture Depository in order to keep account of the Habsburgs burgeoning collection of furniture. The logistics of keeping track of all these items across many royal residences were staggering, which is evidenced by the fact that the museum’s warehouse now holds almost 160,000 items. Visitors to the museum can view the progression of interior design and the changes in décor over the years and take with them a sense of how the design of furniture has evolved. Currently there is a special exhibition; Sixties Design, which focuses on the designs of this seminal decade. This vast and fascinating museum is a place where one can spend hours admiring everything from cabinets to bathtubs from many different periods. But don’t worry, if you get tired there is no shortage of chairs.

It is probably safe to say that there is something for everyone in this unique city. Where else could you find a museum dedicated to funeral arrangement? Or a museum devoted solely to globes? These are by no means the only museums worth visiting in Vienna, visitors can find many other peculiar and unique museums around the city and exploring them is one way to make their visit to Vienna a unique and unforgettable one.

\[\text{For more details and information on Vienna’s museums visit the Arts & Culture Booth in the entrance hall to pick up your personal copy of the Arts & Culture Brochure or search the dedicated website www.myESR.org/arts_culture/}\]
What’s on today in Vienna?

**Theatre & Dance**

Please note that all performances, except at Vienna’s English Theatre, are in German!

- **Akademietheater**
  - Location: 1030 Vienna, Luitpoldstraße 1
  - Phone: +43 1 51444 4145
  - Website: www.burgtheater.at
  - Time: 18:00
  - Play: Platonov by Anton Chekhov

- **Burgtheater**
  - Location: 1010 Vienna, Dr. Karl-Lueger-Ring 2
  - Phone: +43 1 51444 4145
  - Website: www.burgtheater.at
  - Time: 17:00
  - Play: Eine Mittsommerachts-Sex-Komödie by Woody Allen

- **Museumsquartier – Halle E+G**
  - Location: 1070 Vienna, Museumsplatz 1
  - Website: www.halleneg.at
  - Time: 19:00
  - Play: The Bar at Buena Vista

- **Rabenhof**
  - Location: 1030 Vienna, Rabengasse 3
  - Phone: +43 1 712 82 82
  - Website: www.rabenhof.at
  - Time: 20:00
  - Event: Feier.Abend

- **stadtTheater walfischgasse**
  - Location: 1010 Vienna, Walfischgasse 4
  - Phone: +43 1 512 42 00
  - Website: www.stadttheater.org
  - Time: 20:00
  - Play: Revanche by Anthony Shaffer

- **Theater in der Josefstadt**
  - Location: 1080 Vienna, Josefstädter Straße 26
  - Phone: +43 1 42700 300
  - Website: www.josefstadt.org
  - Time: 15:00
  - Performance: Amadeus by Peter Shaffer

- **Volksoper**
  - Location: 1090 Vienna, Währingerstraße 78
  - Website: www.volksoper.at
  - Time: 19:00
  - Performance: Die Fledermaus

- **Wiener Staatsoper – Vienna State Opera**
  - Location: 1010 Vienna, Opernring 2
  - Website: www.wiener-staatsoper.at
  - Time: 19:00
  - Performance: Così fan tutte by Wolfgang Amadeus Mozart

**Concerts & Sounds**

- **Konzerthaus (Classical Music)**
  - Location: 1010 Vienna, Littenweg 12
  - Website: www.konzerthaus.at
  - Time: 19:30
  - Performance: Quatuor Mosaïques, string quartet

- **Musikverein (Classical Music)**
  - Location: 1010 Vienna, Residenzplatz 12
  - Website: www.musikverein.at
  - Time: 16:00
  - Performance: Tonkünstler-Orchester Niederösterreich, conductor Michael Junek, Alexander Markovich, piano

- **Porgy & Bess (Jazz)**
  - Location: 1010 Vienna, Muttergasse 11
  - Website: www.porgy.at
  - Time: 20:30
  - Performance: Kenny Garrett ‘Seeds from the Underground’

- **Gasometer**
  - Location: 1110 Vienna, Guglgasse 8
  - Website: www.planet-s1.at
  - Time: 20:00
  - Performance: Melissa Etheridge

- **Szene Wien (Alternative Music)**
  - Location: 1110 Vienna, Hackbrücke 26
  - Website: www.szenewien.com
  - Time: 20:00
  - Performance: Black Stone Cherry

**Opera & Musical Theatre**

- **Volkstheater**
  - Location: 1070 Vienna, Neustiftgasse 1
  - Phone: 43 1 521 11 40
  - Website: www.volkstheater.at
  - Time: 15:00
  - Performance: Die Dreigroschenoper by Bertolt Brecht & Kurt Weill

- **Raimundtheater**
  - Location: 1060 Vienna, Wallgasse 18–20
  - Website: www.musicalvienna.at
  - Time: 18:00
  - Performance: Ich war noch niemals in New York

- **Ronacher**
  - Location: 1010 Vienna, Seilerstätte 9
  - Website: www.musicalvienna.at
  - Time: 18:00
  - Performance: Sister Act