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EH@ECR 2008

THE EUROPEAN HOSPITAL SPECIAL ISSUE FOR THE EUROPEAN CONGRESS OF RADIOLOGY

The 2008 ECR promises to be international, controversial, inspiring, as well as a meeting in which new insights for inter-professional relationships and working practices are sought. The programme is impressive indeed. We asked **Professor Maximilian F Reiser**, this year's Congress President, about the highlights, newly introduced themes and other pressing issues that impact on radiologists throughout Europe and beyond

The high profile agenda of Europe's biggest radiology congress

'RADIOLOGISTS MUST STEP OUT OF THE SHADOW OF THEIR MACHINES'

This year the guest countries at ECR are Germany, Israel and India. Why were they chosen?

Maximilian Reiser: ECR's primary task is to present advances in radiology, and the selected guest countries are interesting for several reasons: Israel is an important location that generates many exciting drives and developments. India has established itself at an international level and we would like to draw attention to the country's medical and radiological developments. We will focus on India's diagnostics and therapy for tuberculosis, a disease of global significance that increasingly re-appears in the West. The German contributions highlight the potential of computer-aided diagnosis (CAD) in clinical applications. CAD will play an increasingly important role in radiology and we look forward to many interesting presentations that will show not only its advantages but also the drawbacks.

The ECR Meets Partner Disciplines is a new event on the agenda. What is this?

MR: It's an entirely new and exciting format that aims to strengthen interdisciplinary co-operation. We invited colleagues from different countries, this year general practitioners (GPs) with whom we will discuss coronary heart diseases and peripheral arterial obstructive diseases in the context of atherosclerosis, for example: Where do these two areas converge? What does the GP have to know about diagnosis and treatment? How can radiology help?

We want to overcome communication barriers in order to improve exchange and cooperation. After all, as a radiologist, you have two types of customers: patients and referring physicians.

This issue also has a certain professional-political dimension because, in my opinion, in many countries the profession 'radiologist' is misunderstood. They are perceived as people who sit somewhere behind huge machines, whereas, in reality, radiologists are clinical physicians. Therefore, no matter how different European healthcare systems may be, radiologists have to step out of the shadow of their machines and present themselves as clinical physicians who play a crucial role in patient care.

We do not want to start a discussion on international healthcare systems, but ECR prides itself in being a particularly innovative congress – our programme bears testimony to that.

Which criteria do you apply when selecting a paper for the congress?

The ECR offers a wide range of scientific sessions and professional seminars that deal with issues central to our work: How can we ensure that a diagnosis is as precise as possible? How do we most effectively control the success of the therapy? Here we not only choose presentations that provide the most knowledge, but we also aim at optimising the learning process by using interactive elements. A case in point: our 'audience response system', which is becoming increasingly important in events targeted at radiologists in training. This system allows the speaker to integrate the audience in his or her presentation, for example by soliciting opinions on radiation exposure. On a pad, the participant can chose between several alternative answers. This kind of interaction significantly increases motivation. The system can also be applied to check whether participants understood and retained the material under discussion. This is something particularly appreciated by our younger colleagues.

Unfortunately, we must decline many submitted abstracts — this year almost two third of all entries. However, this is by no means negative, because it shows that we have high scientific expectations and that we follow through on those expectations. A 'no' may be frustrating for the researcher, but we strive for utmost objectivity in our selection.

What are this year's ECR highlights?

There are many highly differentiated presentations on radiation exposure. Frequently this issue is being dealt with in quite a biased manner, that is, the focus lies on the risks and how to minimise them. But when we talk about radiation exposure we must always talk about the risks and benefits of a radiological examination. That's what we want to emphasise in our events.

Professor Maximilian F Reiser

In the context of one of our Special Focus Sessions we will also address the issue of the ageing society – the 'demographical tsunami'. We must find answers to questions such as 'What does a sustainable healthcare system look like and how will this impact radiology?' There are some highly interesting cross-disciplinary approaches, such as the use of telemedicine for stroke diagnostics. A further example is mobile diagnostic systems, because they are already used in Norway, where

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CT: Overuse in emergencies, but top value for trauma cases

The high profile agenda of Europe's biggest radiology congress

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a patient does not go to a radiologist for X-rays, but the X-ray equipment goes to the patient. This is particularly beneficial for older patients because they no longer have to leave their familiar environment.

A further interdisciplinary session will deal with myomae, focusing on myoma embolisation with presentations by a gynaecologist, radiologist and a patient. This is very exciting, because the patient will describe her hospital experience in detail. She will present her records and show, very impressively, how her quality of life was impeded by the myoma and how much it improved after embolisation. The patient had learnt about this organ-saving therapy only after long research - and after four gynaecologists had recommended hysterectomy. Myoma embolisation is an acute problem, since this radiological intervention is not widely accepted, particularly in Germany. Moreover, myomae can be treated with focused ultrasound – another option that will be discussed.

Why has the Women in Radiology theme been introduced?

Women are still discriminated against in radiology. It is unacceptable that the females earn less and in general have worse working conditions. It is unacceptable that the careers of women suffer because they have children. Nevertheless, that's the reality and it's a reality that women will discuss at this event. The presentations emphasise the social responsibility of radiology and they suggest solutions to these problems. We will also address possible political steps – for example the fact that we need more day-care for children. In some countries, such as France, childcare outside the family is well organised. In other countries this is still a huge problem.

However, there are solutions to all these problems and ECR, as the biggest European radiology congress, will contribute its share. I'm confident that all participants will welcome this year's high-profile agenda and that, once again, ECR will be a huge success

By **Professor Moshe Graif MD**

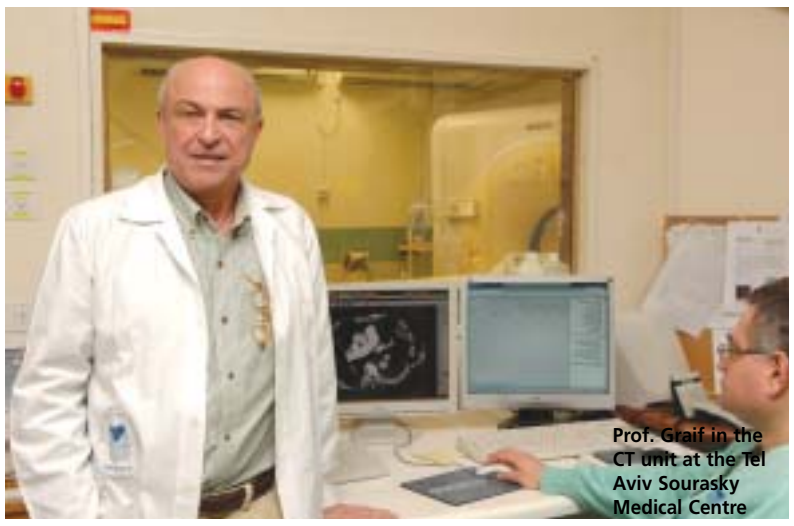
Over the last three decades CT has become a premier diagnostic tool for the evaluation of the acute patient.

Over the past ten years in Israel, we have seen an overwhelming increase in the volume of CT examinations in the emergency department (ED). Data from the USA and Germany appear to yield similar results. A comparison of the number of CT studies performed per 1000 ED visits showed a five-fold increase over one decade! Particularly dramatic was the increased use of CT studies during the night shift. A particular increase in body CT studies in the ED (Renal Colic, appendicitis, acute abdomen, bowel obstruction) over neurological CT was also noted.

Surprisingly, the massive CT utilisation patterns had no significant impact on the consumption of other imaging services (such as X-rays). Expectations that examinations — such as acute abdominal series (AAS) which have limited clinical value in patients in whom CT or ultrasound is considered — will decrease, were not met. The five views skull radiographs so far appear to be the only example of an 'extinct species'.

The 'Golden Hour' (Dg & treatment within 60 minutes) rule, which nowadays dictates the management of the trauma patient, favours CT, as a 'one stop shop', over the combination of several modalities. It also appears that clinicians may still feel more comfortable with CT images than with ultrasound. Emergency doctors prefer to use CT as the gold standard for imaging abdominal trauma and to reserve FAST (focused abdominal sonography for trauma) for unstable patients.

These trends boost healthcare costs. They also affect patients due to increased radiation exposure and more incidental findings that lead to further investigation (not always justified). They create queues of patients waiting for a CT examination (prolonging the average investigation time for each patient, particularly the clinically



Prof. Graif in the CT unit at the Tel Aviv Sourasky Medical Centre

more justified cases).

Regarding radiation exposure, the 2007 report of the National Council on Radiation Protection & Measurements (NCRP) revealed that the collective annual population medical radiation dose increased between 1980 and 2006 by 7.5-fold. The number of CT scans performed in the USA has grown from 18.3 million in 1993 to 62 million scans in 2006.

As for the cost, a recent study has shown, for example, that cervical spine CT use shot up by more than 400% and the number of admissions rose by only 13%, while severity of injury and illness changed little. A cost analysis yielded an expenditure of US$ 8,509 for each positive study.

It has also impacted on radiology teams. Over half of Emergency CT studies are performed during the shift hours, involving smaller and less experienced teams. Those teams are also subjected to the effect of prolonged, continuous working hours and accumulated fatigue. While the technical time per CT examination has decreased (Spiral CT exam time is shorter by 2.3-10 factor) which induces increased throughput, the radiologist reading time is prolonged because there are more images to read (69% more images per MDCT study on average), more reconstructions to perform, and change in procedure mix (more complicated studies such as CTA, abdominal studies, CT guided interventions).

A particular aspect of Emergency CT is related to its role in mass casualties events (MCE).

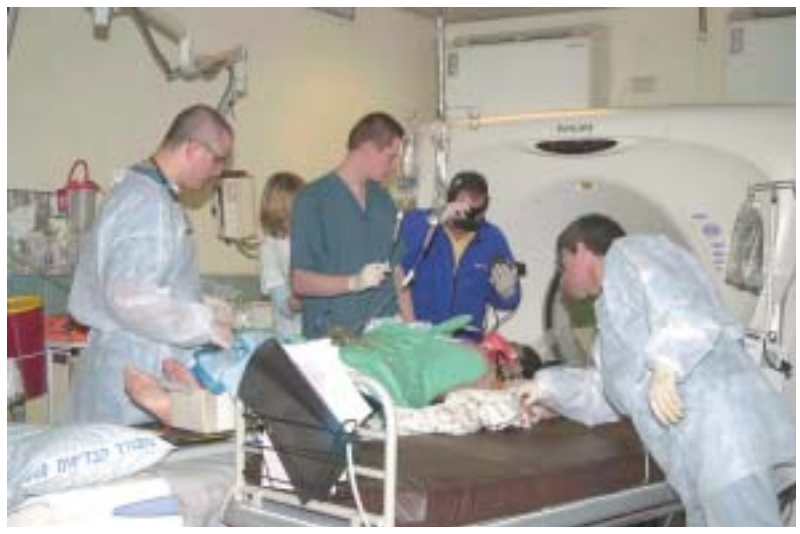
It appears that hospitals situated near to such events play a major role in trauma patient care. More than 50% of patients are evacuated to the nearest hospital within 5-20 minutes. This creates an immediately overwhelming overload on all hospital medical resources, including CT; it is therefore mandatory to have a hospital preparedness plan to be able to deal effectively with the situation. Generally two phases can be observed. The Initial Phase – when casualties are flowing in and chaos is at maximum. In this phase, the main objective is to identify the critically injured patients, who need to be treated first. From a radiological point of view it usually requires the use of abdominal ultrasound and chest X-rays. The definitive phase occurs when casualties are no longer arriving. At this point, the main objective is to provide optimal care, which involves more skeletal X-Rays, CT work up and angiographies.

The clinical nature of the cases that involve blast and/or shrapnel injuries requires special CT protocols. This includes whole body scans to identify foreign bodies missed on a radiography and triple contrast regime (via naso-gastric tube, intravenous injection and rectal contrast administration). There is also a routine use of CT angiography and 3-D reconstructions in every case of a penetrating object and/or suspicion of vascular involvement.

In those situations, CT now offers a quick mode to evaluate the extent of injury, shrapnel localisation and the detection of unsuspected injuries. The rapidity of the modality makes patient co-operation less necessary. The availability of PACS, and heavy duty workstations, enables simultaneous evaluation of a complex injury by several specialist teams.

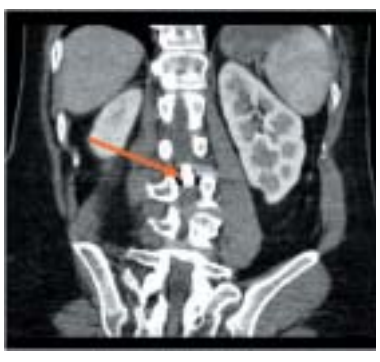
The velocity of execution and accuracy make CT an ideal tool for emergency use, and is replacing traditional radiological studies. Utilisation is likely to increase. The development of techniques designed to reduce radiation are constantly under intensive consideration.

Careful use of the guidelines may help to reduce the unnecessary studies. In the future, more radiologists and technicians will be needed, and residency programme planning measures should be taken at national level to ensure the proper future availability of a professional workforce.



Multi-disciplinary team with patient in the CT suite during MCE

CT surview image showing 2 metallic ballistic objects distant from each other (arrows)



Coronal CT image of one of the metallic objects located in the spine (arrow)

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Radiation dose reduction

US launches a national initiative

By **Cynthia E Keen**

4,000,000 paediatric CT scans were performed in 2006 in the USA, a number that has tripled since 2001. Concerns about the adverse effects of cumulative radiation dose in a generation of children where CT imaging and other radiation intensive procedures will be the norm has led to the launch of a national campaign to establish low dose radiation protocols designed specifically for variously aged children.

The 'Image Gently' campaign was launched in January 2008 by the founding members of the Alliance for Radiation Safety in Paediatric Imaging (ARSPI). The Society of Paediatric Imaging proposed this campaign in 2006, and formed the Alliance in 2007 with the American College of Radiology, the American Society of Radiologic Technologists and the American Association of Physicists in Medicine. An additional six major professional organisations have become affiliate members, representing a total of more than 500,000 medical professionals working in Canada and the United States. GE Healthcare provided a large unrestricted educational grant to fund the project.

The campaign aims to significantly reduce the amount of radiation used when performing paediatric CT scans. It emphasises that children should be scanned only when absolutely necessary, that radiation dose should be reduced using protocols and scanning techniques created specifically for paediatric imaging, and that alternative imaging procedures with less or no radiation should be used when possible. (As an example, the newly published results [*Radiology* online January 14, 2008] of a study performed at the University Hospital in Bologna reported that contrast-enhanced ultrasound is almost as accurate as contrast-enhanced CT for diagnosing solid organ injuries in children following blunt abdominal trauma.) Medical physicists are also encouraged to become more involved and actively monitor paediatric CT techniques.

The *www.imagegently.org* website includes a library of protocols for imaging children. In its first week of operation, over 2,600 providers downloaded protocols. The website also contains research and educational materials.

Marilyn Goske MD, chair of ARSPI and a leading paediatric radiologist at the Cincinnati Children's Hospital Medical Centre in Ohio, said, 'We hope to change the way all children are imaged, using kid-size, not adult-size radiation doses.' In an interview with *European Hospital*, she said that it will take decades to learn if paediatric CT scans are detrimental to the long term health of children who receive them. With the exception of paediatric cancer patients receiving radiation therapy, no records are being kept of the cumulative radiation doses that children receive, which, Dr Goske said, is an issue of discussion by the Society of Paediatric Radiology, as an electronic registry interacting with electronic patient records is technologically achievable.

The fourth bi-annual ALARA (as low as reasonably achievable) Concept in Paediatric Imaging conference was held in February in Orlando, Florida, and was attended by paediatric radiologists, emergency physicians, medical physicists and hospital administrators. Its theme was *Building bridges between radiologists and emergency medical providers* and focused on improving imaging safety and quality for children presenting in an emergency department. The conference objectives were to discuss the challenges that emergency physicians and radiologists face in overcrowded hospital emergency departments and to identify methods of improving communication, as well as establish better protocols for procedure ordering and imaging of children with the least amount of radiation.

The combination of the threat of litigation with malpractice lawsuits and the fact that many uninsured families use emergency departments as sources for primary care has created an environment in many US hospitals in which an excessive number or inappropriate diagnostic imaging procedures are ordered. This is done to make rapid accurate diagnoses, provide treatment quickly, and deal effective with a higher volume of patients than an emergency department can support.

The 2008 ALARA conference chairs, paediatric radiologist Donald P Frush MD and paediatric emergency medicine specialist Karen S Frush MD, both at Duke University Medical Centre, Durham, North Carolina, said that they hope the meeting will provide a foundation upon which methods of working more effectively together as a team will be initiated. "The majority of children receive emergency treatment at hospitals that primarily treat adults. We think that recommendations for protocols of treatment developed jointly by paediatric emergency specialists and paediatric imaging specialists can provide a safer and better quality of care.'

Dr Goske added that European hospitals have developed impressive initiatives in keeping paediatric radiation dose to a minimum.

'Choose, prioritise, compromise and juggle'

Professor Rémy-Jardin MD PhD heads the Department of Radiology and is Chairman of the Department of Thoracic Imaging at the Calmette Hospital, University Centre of Lille. She is also Professor of Radiology in Lille University's Medical Faculty.

The Calmette Hospital specialises in thoracic and respiratory medicine. In her department, Prof. Rémy-Jardin oversees five senior doctors and seven interns. Her international reputation and the quality of the department's research attract radiologists from all over the world – the present senior staff includes doctors from South Africa, Canada and Italy, all at Lille to improve their knowledge in high-resolution computer tomography of diffuse infiltrative and vascular lung diseases; interventional vascular procedures; cardiac and pulmonary functional imaging, and reduction in radiation dose – the professor's areas of expertise. Additionally, much of her published research is in spiral CT imaging, especially technical developments; post-processing; CT angiography and multi-detector CT, including dual energy.

Her university thoracic imagers and scanning research programme is based on a longstanding collaboration with Siemens: the centre serves as a reference site for the company, providing it with access to clinical activities through which clinical research can be undertaken. This research is then channelled into publication in international journals and/or presented at major conferences. It is also used for Siemens' technological investigations. In return, the radiology department can propose the use of the latest scanners and imagers to patients — technology that most public hospitals only dream of buying.

In her private life, Prof. Rémy-Jardin is a wife and mother. During a *European Hospital* interview we asked about her career as well as its effects on her private life:

What do you consider your major professional achievements among the many we can only briefly outline here?

R-J: To have become the Head of a Radiology Department in which it is possible to combine high-quality diagnostic activities, teaching and clinical research activities. This has been possible through the constant collaboration with the previous head of this department, Professor Rémy. Because he was nearing retirement age, he handed over the Radiology Department to concentrate on university research interests. Perhaps, due to my close personal involvement with him, I feel very keenly the challenge of keeping not only the same level of quality but also the overall vision for the department's future.


Prof Rémy-Jardin

How do you manage family time? Has being a mother compromised your career?

True, my work doesn't leave me much free time, but I have a little boy who is my most important personal achievement. One has to make choices in life. I chose to commit time to bringing up my son. He is still only 10 years old.

I've been extraordinarily lucky in my professional life, because my husband is in the same profession, the same specialty and the same department — very lucky! There is probably only one thing I might have done differently if I'd been a man, or not had a family, and that is to have been more involved in the organisation and politics of our profession — another important aspect of radiology. Unfortunately, this isn't something one can do without full-time commitment and it would involve a lot of time and travel. So my choice has been my son rather than professional politics. I don't really have any regrets. I sometimes think about it, but if I can't do something with 100% commitment I'd rather not do it. My son is far more important to me than this 'missed' opportunity.

Is it more difficult for women to be radiologists than men?

No, I think medicine is a pretty equal profession for both. I don't think medicine itself makes differences; it is society and perhaps even nature. It is women who commit to the family, who make that extra time and, to do this, they must prioritise, compromise, juggle and eventually decide which the best path is for them. Again, my personal experience is probably very different from that of most women. I had my son late, at 41. My career was already established and, because I'm Head of Department, I can organise my working day without having to ask my boss's permission. That's not something someone 10 years more junior could do. I can arrange to leave early and work at home, so that when my son comes home from school we have time together. However, I'm often at the hospital at weekends, much to my son's displeasure! If I employed someone to look after him, I could organise my day differently but that's not what I want.

The same goes for choosing radiology; if you love it you should do it. As a specialty there are plenty of options. The hospital career path is probably the most challenging to balance with a family but, in a private radiology centre, a woman can happily work part time, fitting her professional life around her family.

What advice would you offer women in medicine or, specifically, radiology?

Women, particularly those in senior positions, have to impose some rules. Although we are just as efficient as men (if not more so) our time is more limited. So, if a half-hour meeting is scheduled for mid-day, it starts at mid-day; if people turn up at 12.15, it becomes a 15 minute meeting. Obviously, over time, I've become very diplomatic in the way I say this, but it is important. The time we have for work has to be used effectively. Women must be efficient and flexible with the time at their disposal and our male colleagues must learn to understand and respect this. We are not only doctors but also have other important commitments: husbands and children.

Roles in radiology, research, plus a private life? What could be better?

Professor Maria Cova is one of the two women Board Members of the Italian Society of Radiology (SIRM), of which she was Vice President from 2004-2006.

Apart from spending a year at Johns Hopkins University Hospital, Baltimore, USA, the professor has never worked anywhere other than at the Radiology Department at the University Hospital of Cattinara Hospital, Trieste, of which she is Chairman.

***Daniela Zimmermann* asked her about what women can achieve in this field, as well as the professor's own multifarious roles and research activities.**

DZ: ***What does your role as a Board Member of the Italian Society of Radiology entail?***

MC: The Society is subdivided in many scientific sections, subspecialties such as neuroradiology vascular and interventional radiology, and so on. My function is to co-ordinate the presidents of these subspecialties, mainly with the aim of attracting more young scientists.

How many women do you support in this way?

MC: Actually, very few. The Board has only two. The problem is that, although there are a lot of female radiology residents and a lot of women actually work as radiologists, only very few reach top positions. So far there are few, but I hope in the future more and more women will be motivated to work harder to reach top positions in radiology.

Are they held up because they marry or change professions?

No, they stay in the profession, but it's very tough for them to co-ordinate and manage everything.

How did you achieve this?

First, I really like my job – that's very important. Second, I am ambitious — to succeed, you need to be. Third, you also need to be feminine. Also, I've always done my best to reach where I wanted to reach and then, I have to add, you must be lucky. In my case, things always went right. I chose Trieste, did my exams here, went to America and returned here with my post doctorate. I became Assistant Professor, then Associated Professor and, in 2004, full Professor. That sounds easy, but it was hard work and women must sometimes even work a bit harder. You must always combine the job with your private life. I'm not married and have no children, but I do have a very active private life – which naturally I don't want to miss. So I've always done my best for work, but what I've borne in mind that I wanted to preserve my inner self. I am very proud to say this attitude has worked, so far. Of course I'm diplomatic, but I would never change myself only to find a compromise. The most important thing for me is to keep myself balanced.

What about your work at the hospital?

I'm Chairman of the Radiology Department at the University Hospital, so I not only manage the department, the patients and so on, but also have various teaching functions. It's really what I like most! I would never give it up. I am also Director of the postgraduate School of Radiology and Director of the Radiographer's Degree Course in Trieste. And, I carry out research, with a focus on MRI and, within that, muscular-skeletal research, particularly on articular cartilage. Using MRI you can get morphological information as well as biochemical information. So the aim is to use MRI to see the changes that cannot be seen by changing morphology — biochemical changes. You can do it today. I'm also working on the technical aspect of MRI, just optimising the technique. In this field I work with physicists and with the Department of Biochemistry, so there's a very good, dedicated team. We are aiming to get with the right technical sequence, in a short time, both the morphological and biochemical data.

Using contrast media and molecular imaging would be the greatest tool to obtain this result.

Have you already reached the professional level you want?

At the moment, I'm very happy with my position because there are still challenges and managing a department means you have to learn something new every day. And, I'm not a one-man-show: I strongly believe in teamwork and I work with a wonderful team. In a team everyone has the chance to give his or her best and every single person has a special quality that can lead to perfect results.

Of course I'm always open for opportunities that may arrive, but I'm totally satisfied with all that I must deal with every day. I cannot imagine anything better, from the point of view of a 47-year-old woman who loves radiology.

PET/CT AND CHILDREN

Study shows higher sensitivity, specificity and accuracy than conventional imaging

PET/CT imaging exhibits significantly higher sensitivity, specificity and accuracy than conventional imaging when it comes to detecting malignant tumours in children, according to research published in the Journal of Nuclear Medicine (12/07). 'PET/CT is useful in finding small tumours in small children and is a promising imaging tool in evaluating paediatric malignancies,' concludes Richard L Wahl MD, the 'Henry N Wagner Jr. MD Professor of Nuclear Medicine' at Johns Hopkins Medical Institutions in Baltimore, Maryland, who has pioneered the use of PET with FDG and fusion imaging in a wide range of common adult cancers. 'In our study, we found that PET/CT can detect small lymph node lesions diagnosed as negative with conventional (or anatomical) imaging and deny the presence of active disease in soft-tissue masses post-treatment — especially in children with a wide range of malignant cancers. Using PET/CT could help spare children from overtreatment while fighting their disease.'

There are few findings about the use of PET/CT imaging compared with conventional imaging in paediatrics, he points out. The investigators retrospectively reviewed cases to evaluate the efficacy of PET/CT compared with other imaging methods. This involved 151 FDG PET/CT examinations performed on 55 children with non–central nervous system malignancies (30 had lymphoma).

PET with CT imaging — using the radio-tracer fluorodeoxyglucose (FDG) — enables collection of biological and anatomical information during just one examination — PET picks up metabolic signals of body cells and tissues; CT provides a detailed map of internal anatomy. 'PET/CT showed its broad applicability and utility by providing additional information, in over a third of the children's exams, that could be used by doctors to more appropriately manage or treat the disease in children,' adds Dr Wahl. 'When there were discrepancies between PET/CT and conventional anatomical imaging in analyzing cancer lesions, PET/CT was diagnostically accurate 90% of the time.'

Dr Wahl adds that additional studies with specific childhood cancers are warranted.

*** Co-authors of '18F-FDG PET/CT in Evaluating Non-CNS Paediatric Malignancies': Mitsuaki Tatsumi, of the Nuclear Medicine Division, and John H. Miller, Paediatric Radiology, both at the Radiology Department of the Johns Hopkins Medical Institutions, Baltimore, Md.**

The new IMPAX Solution Suite

Agfa Healthcare's new IMPAX solution suites offer PACS and RIS to cover hospital data handling and cardiovascular, cardiology, orthopaedics, mammography and radiology data. The firm's Enterprise Suite, for example, was designed for the multi-site hospital and Integrated Healthcare Delivery Networks operating in multi-patient ID domains. The system is driven by Agfa's Data Centre, a multi-media archive for medical images and diagnostic results. Other applications in the new IMPAX series include:

Virtual Colonoscopy: This non-invasive CT colonoscopy clinical application produces a complete (supine and prone) CT colonoscopy data set in about 20 seconds. No user interaction is needed before diagnosis begins. Lesion detection takes place in a clinically relevant, user dependent, pre-defined layout. Automation ensures maximum productivity and streamlines results sharing.

Registration and Fusion: Easy-to-use automated tools and single mouse click make the comparison of high-res images effortless. The application supports the comparison of images from the same image types (for example CT to CT and / or MR to MR for follow-up studies) as well as in multi modality cases (e.g. CT to MR). Besides supporting X-ray images, the software also supports nuclear medicine by means of the registration and fusion of PET with CT and/or PET with MR.

OrthoGon: Agfa reports that this advanced measurement tool, for orthopaedic (Orthopaedic) and paediatric (paediatric) specialists, eliminates the need to perform manual measurements because it has an intelligent wizard. This 'guides the physician through complex measurement schemes and compares results with normative values. Results can be saved as images and proprietary records in PACS, printed as reports, or exported for further processing'.

X-ray Angio Analysis: Diagnosing peripheral arteries and angiograms requires dedicated image processing and analyses. The application provides a comprehensive package for reviewing vendor independent DICOM X-ray Angio (XA) CR and RF diagnostic images in the radiology domain. The application key functionalities are Digital Subtraction Angio (DSA) and quantitative analysis of lesions and morphologies. The package offers three types of analyses: Straight, Bifurcation and Ostial. The creation of reports for hospital-wide distribution is supported.

IMPAX RDS: Agfa reports that the application enables radiologists, and other specialists, to access the world's most comprehensive radiology database of diagnoses, case examples and images. Integration with the IMPAX system allows automatic results filtering based on anatomical region, improving both speed and diagnostic confidence.

Sectra launches a new PACS system

The new Sectra PACS

Sectra's wide portfolio on show at the ECR this year includes a new PACS workstation, a photon-counting MicroDose Mammography system, pre-operative solutions for orthopaedic surgery and the company's full range of Enterprise Control solutions

PACS - The IDS7/dx, the latest model in Sectra's PACS workstations, is being launched in Europe for the first time. This comprehensive, high-end diagnostic workstation features a patent pending technology that solves the problem of data explosion, Sectra explains: 'The system enables radiologists to retrieve, display and process image data of extreme sizes with ease – problems encountered in working with large datasets do no longer occur.' The PACS can distribute images for readings in multiple clinics. Even over high-latency networks, the streaming technology distributes datasets in network quality, regardless of size and variations.

Photon-counting - Sectra reports that its MicroDose Mammography L30 is currently the only commercially available photon-counting mammography system on the market. 'The unique photon-counting full-field digital mammography system maximises image quality and increases throughput at the lowest radiation dose on the market. At our booth, we demonstrate a totally integrated solution for mammography screening, including Sectra Screening RIS, Sectra MicroDose Mammography, and Sectra Breast Imaging PACS, all designed to efficiently streamline mammography workflow.'

Orthopaedics - Sectra offers a solution to optimise productivity through advanced image processing capabilities. A comprehensive set of guides for pre-operative planning of hip and knee surgery includes approximately 33,000 views of digital templates, from 18 implant manufacturers, bringing full functionality to plan and template even complex trauma cases.

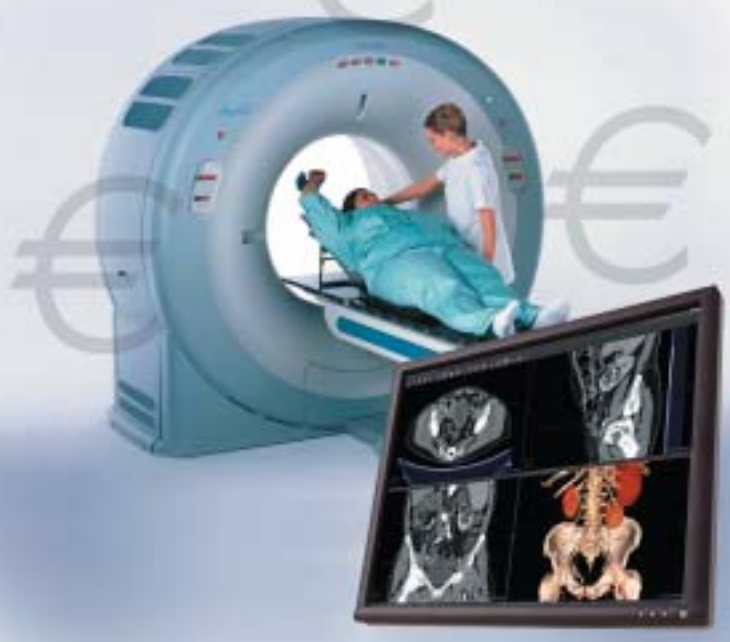
The company will also showcase PACS-Guard. Control Tower software generates reports, monitors the daily status of a radiology department, reveals long-term production trends in RIS and PACS and identifies potential bottlenecks early.

PRESENTED AND ORGANISED BY THE EUROPEAN CONGRESS OF RADIOLOGY AND EUROPEAN HOSPITAL

THE HOSPITAL MANAGEMENT SYMPOSIUM AT ECR 2008

Expert advice on management, IT and finance

08.30-13.30
8 March 2008
The Austria Centre, Vienna



Speakers and abstracts

SESSION 1 Management

The Management of Innovation and Efficiency
How to inspire creativity while assuming productivity

Britta Fünfstück graduated in engineering physics in Linz, Austria. For the past ten years she has worked in management consulting and healthcare, in Germany and the USA, where she worked with the Boston Consulting Group from 1998-2000. She then joined Siemens Healthcare, where she has managed business development projects, led product definition teams in healthcare IT, and has been responsible for product planning, global marketing and sales of MR systems. At the beginning of 2008 she was appointed to lead the team as Head of Business Development/Strategy

Globally, many healthcare providers face a dilemma: They not only need to be innovative to provide high quality care but also must reduce the costs of that care. Is this really a contradiction? No. In fact one effort can be directly connected to the other – by increasing workflow efficiency.

How increased efficiency leads to high productivity, as well as to exceeding quality, can be demonstrated by looking at high-tech industry – e.g. the medical engineering industry. Strong process orientation is a common and important factor in reaching and maintaining excellence and best-in-class quality. This is reflected by not only measuring criteria, incentive structures, and productivity programmes, but also by the motivation of the people involved. Yet, at the same time competitive advantage requires innovations that exactly match the market's needs. Such innovations in products and solutions are the key to success. Innovation management has therefore developed as a discipline and core competence.

These management experiences and insights of driving innovation and at the same time cost efficiency can and often need to be transferred to different markets and businesses – and also to healthcare providers.

During the symposium, examples of innovation and efficiency in healthcare will be demonstrated as well as examples of how industry experience could be applied to hospital management or the management of radiology departments. We will also see how a close collaboration between healthcare providers and the industry can drive innovations in technology and workflow – to shape the future of medicine together.

The importance of strategic partnerships

Harald W Bachleitner *studied law at Ludwig-Maximilians University, Munich, and for the bar at Zweite Juristische Staatsprüfung. Further training included Public Management as well as studies to qualify as an assessor, at the European Foundation for Quality.*

After a period as a civil servant for the city of Munich, he joined the München-Schwabing Hospital, first as Deputy Administrative Director and Head of Finances, then rising to become the hospital's Administrative Director.

In 2005 he was appointed Managing Director of SRH Zentralklinikum Suhl gGmbH and, in 2007, became a healthcare consultant and Managing Director of bachleitner contract Gmbh and Bachleitner Beteiligungs GmbH.

In January this year, he was appointed Managing Director of Initiative Gesundheitswirtschaft, Berlin.

The healthcare system is in a phase of transition – from planned economy to free market economy. Competition is becoming a challenge. Only entrepreneurs and enterprises that develop creative strategies will stay on top – or make it to the top.

Establishing and maintaining strategic partnerships is a crucial component of any viable strategy for future business.

Although the healthcare market may not be a loud and noisy one, it nonetheless deserves close attention as more and more information about medical services is available on the internet or in quality reports.

Patients have an increasingly clear idea about their interests and know how to look after their own interests. They spend a lot of time and energy on finding the right partner for their particular health issues.

Oversupply leads to competition for the client – the patient.

Incomes stagnate and require cost-saving measures such as product standardisation.

The competition and the market are rather problematic: Services offered are difficult to compare; the service providers offer no clearly differentiated products and prices bear little relation to quality; volumes and product ranges are strictly regulated; approvals and in general tight state regulations are market barriers that are difficult to overcome.

In many countries, healthcare is the biggest industry – as well as among the few that are growing! This means healthcare is a highly dynamic market.

The current situation nevertheless has enormous potential for service providers that manage to sharpen their profiles on this dynamic market by offering products with unique selling points or at least points that differentiate their products from those of other companies.

Strategic partnerships are long-term co-operations between owners of complementary know-how and joint corporate objectives – both factors ensure a level of quality that cannot be reached by one of the partners alone and they offer optimised cost efficiency. Moreover, strategic partnerships enable the parties to enter into large projects and they open perspectives and create visions.

In the high-tech medical technology sector **strategic partnerships** help to secure funding to cover increasing investment costs. If, for example, manufacturers of CT or MRI equipment offer their customers – i.e. the users – provision of the required know-how to operate their equipment, implementation and operating costs remain affordable. Consequently, the use of the equipment is efficient in the long run.

Furthermore, the manufacturers' corporate co-responsibility ensures product development that is based on actual need in the field.

The result is a win-win situation for all players: the patient receives verifiable quality and profits from the realisation of technological potential. The user also realises his potential and at the same time minimises risks; he incurs less implementation and operating costs, increases customer loyalty, number of cases, efficiency and employee satisfaction. Additionally, the manufacturer has satisfied customers and generates demand by offering his customers an added-value.

In short: A **strategic partnership** gives you an edge over the competition. It's worth the effort!

Medical management in the Russian healthcare system

Professor Shlyakhto Eugene Vladimirovich MD *studied medicine at the Pavlov Medical State University, St. Petersburg; he also gained a doctorate in science, and worked as Vice Rector for research at the university from 1994-2001.*

In 1993 he was appointed Professor in the Department of Internal Medicine, of which he has been head since 1997, when he also became Director of the Cardiovascular Institute in the university.

Prof. Vladimirovich also has been Director of Almazov Federal Heart, Blood and Endocrinology Centre since 2001.

In 2004, he was a corresponding member of the Russian Academy of Medical Sciences, and is a member of various Russian medical societies and associations; among these he is Vice President of the St Petersburg Branch of the Russian Medical Association.

The professor is Editor in Chief of Arterial Hypertension *(Russ.) and Vice Editor in Chief of Scientific notes (Russ.) publications. Since 1992, his monographs/books and scientific manuscripts have been many, covering his fields of interest: Arterial hypertension, heart failure, unstable angina, clinical pharmacology of antihypertensive drugs, cardioprotections and molecular cardiology.*

In addition, he has participated in numerous clinical trials

Healthcare in Russia is currently undergoing a comprehensive reform process. In the early 1990s, a new source of funding for the public health system was established: mandatory medical insurance and general practitioners' offices as well as private medical practice. Thus, 'the rules of the game' changed whilst the total financial burden to be carried by the state did not increase. Soon, a paradox emerged: physicians had to go through years of education before being allowed to treat a patient while a healthcare manager was appointed to lead a huge hospital for thousands of

Radiology process redesign, the theory of constraints and the twenty-nine million dollar revenue opportunity

After gaining a degree in Nursing and a qualification as Nurse Practitioner, ***Martin Bledsoe MSPH*** *worked in Kentucky, USA, for 11 years. He then attended the University of North Carolina, gaining an MSc in Public Health, and joined Johns Hopkins Medicine. His roles there included various top administrative roles prior to his current appointment as Chief Administrator for the Russell H Morgan Department of Radiology and Radiological Science at Johns Hopkins Medicine. In this role he manages about 1,000 employees.*

He has been actively involved in the leadership and programme development for the Association of Administrators of Academic Radiology, of which he is currently President-elect. He is a consultant and published author of articles on imaging business operations

In almost all US hospitals, inpatient radiology examinations are not scheduled. Instead, they are performed when equipment and patients are simultaneously and serendipitously available. While this flexibility may optimise patient flow for radiology under current conditions, it introduces variability and inefficiency into broader hospital operations, which may result in increased length of stay. In an environment with fixed reimbursement per admission, a decrease in length of stay of even a few hours over an entire hospitalisation can create tens of millions of dollars of revenue opportunity if the newly created capacity can be utilised.

This presentation shows how the Johns Hopkins Department of Radiology analyzed its in-patient workflows with the intention of redesigning them before moving into its portion of a new 1.6 million square foot in-patient facility. The presentation includes a brief review of a management concept concerning throughput known as the theory of constraints. Some of this concept's principles are then applied to the process of an in-patient hospitalisation, which leads to the conclusion that to maximise throughput, hospitals must deploy new systems for patient tracking, universal scheduling, and real time systems performance monitoring. These systems have been widely deployed in other industries but for the most part specific applications for healthcare have not been developed.

One key principle of the theory of constraints is that maximising the throughput of a microsystem often slows throughput of the macrosystem. In the context of an in-patient hospitalisation, radiology can be regarded as a microsystem and given hospitalisation itself the macrosystem. Because throughput has always been important in radiology due to large capital investment in equipment, it is a logical place for early proof of concept work in designing the new healthcare applications. However, as a next step in developing and testing these new applications it will be necessary to perform simultaneous pilot work across all hospital microsystems, including other diagnostic areas, treatment areas, and in-patient nursing care, in order to capture throughput efficiencies at the macrosystem level. Only then can hospital management create the revenue opportunity provided by a length of stay shortened by a few hours.

patients without having had any special training.

Experienced physicians were 'demoted' to mere team leaders and we lost many good clinicians only to receive poor managers. The situation became even more difficult when the market economy hit Russia. Private medical clinics were actively organised by former dentists, gynaecologists and surgeons, who were bravely diving into the depth of the free market knowing almost nothing about business laws and regulations. Consequently, training programmes on healthcare management soon appeared in Russia.

An important component of such training is financial management, because the Russian healthcare system has three funding sources: state and municipal budgets, statutory medical insurance and patient's direct payments.

A national top-priority project on healthcare is making high-tech medical technologies widely available in Russia - three of fourteen federal medical centres (Astrakhan, Penza and Tcheboksary) were launched recently. These centres are fully equipped with up-to-date medical technologies and they require profound postgraduate training for their staff, including healthcare managers.

SESSION 2 IT & Telemedicine

Outsourcing as part of hospital IT optimisation Doing it the right way

*Medical doctor **Thomas Geisinger** studied hospital business administration (VWA) at Mainz University, Germany. Today, he is Global Manager for E-Health integration with Agfa HealthCare.*

After being head of medical management at Frankfurt/Main University Hospital for three years, in 2003 he became a hospital business advisor and director for DRG Product Management at GWI in Bonn — which was acquired by Agfa HealthCare. He then joined a specialist-team to build up the international rollout of the Agfa HIS/CIS business, with a focus on market evaluation and strategy

The trend towards consolidation of healthcare services across a hospital, and across hospital groups, leads to the segmentation between core competences and those services that may be handled more efficiently by a third party. This analysis will uncover opportunities for more efficiency even with improved service levels. However, the execution should be carefully planned and prepared.

The presentation will show the opportunities and challenges that such segmentation offers. It will cover how to best select the right competences, how to prepare and execute the change and how to manage the providers.

The model shown will begin with a classification of all Diagnostic activities (such as DRGs). It includes the procedures for medical documentation and the cost measurements based on the activities performed. The available DRG models will be shown that could be used to perform such activity/cost correlations.

The second part will focus on the execution: What the parameters are to manage the vendor and what available definitions there are for the service levels.

Using a single HIS/PACS platform for patient medical data sharing between healthcare providers

***Dr Peeter Ross** studied medicine in Tartu University, Estonia, and in Helsinki University, Finland (1985-91). In 1996, following his residency in radiology at Tartu University, he undertook further studies in radiology at Oulu University, Finland, and in Armed Forces Institute of Pathology, Washington DC, USA. He took on further studies in healthcare management at INSEAD, France.*

Dr Ross has participated in the EU funded eHealth projects InterregPacs, Baltic eHealth and R-Bay.

In 2004, he was appointed to his current position as Director of Research and Development in East-Tallinn Central Hospital, Estonia. He is also acting president of Estonian Society of Radiology and a member of the supervisory board of Estonian Health Insurance Fund and Estonian eHealth Foundation

The presentation will provide an overview of patient medical data sharing and distribution between the hospital, general practitioners (GP) and patient, using recent developments in Hospital Information System (HIS) and Picture Archiving and Communication System (PACS). The effective use of digital medical data requires workflow re-engineering and use of modern data transfer technology.

Using the latest HIS/PACS technology, the radiology department at the East Tallinn Central Hospital (ETCH) has completely re-engineered radiology workflow management during the last four years.

The hospital started to use PACS with limited diagnostic workstations and web user licenses. By the end of 2007 the hospital became 'filmless', with an annual volume of 170,000 radiology examinations. The case mix includes all imaging modalities and radiologists also provide reporting services for external facilities.

Our web-based PACS with streaming technology allow archiving of all kinds of images, including non-DICOM and non-radiology images. The PACS is integrated with the web-based HIS, so the radiologist or referring physician can open images using the HIS and simultaneously view other patient data. The same possibility is available for general practitioners (GPs) outside ETCH. This kind of holistic patient approach achieved by HIS-PACS integration minimises the risk of having inadequate patient history or referral letters before imaging or during reporting.

Inspired by successful digital image sharing with other health care providers, ETHC has opened the entire electronic patient record for authorised GPs and even more – a patient can access his/her medical data in HIS. The security of delicate patient data is guaranteed by using a personal ID-card.

Classic hospital or department workflow is linear, meaning that almost all patient data resides with the individual patient or physician and can't be accessed from different locations.

Digital processing of patient data opens new dimensions for patient care management. Now, if needed, patient data can be used any time and any place.

From this point of view, the implementation of PACS is allowing radiologists to achieve workflow optimisation. The radiologist can report not only the images made in the department or radiologist's location, but also the images that have been taken in other locations. Reporting can be done on the basis of the anatomic region, modality, urgency, department, etc. The successful and secure radiology data sharing can be taken as a good example for implementing similar solutions for other medical information distribution.

From the outset of HIS/PACS planning, it is essential that HIS/RIS and PACS should be integrated.

Managed services in patient data archiving The impact on IT, finance and physicians

*Following graduation Institut National Polytechnique Grenoble (INPG), **Pierre-Yves Nectoux** has benefited from over 20 years experience in telecommunications, IT and medical IT.*

From 1985 to 1998, he was employed by firms such as IBM, Schneider Electric and Digital Equipment Corporation (now Hewlett Packard) in Product Management roles, and has overseen the design of several telecommunication products as well as developed partnerships with big European telecommunication players such as Ericsson, Nokia and Alcatel.

In 1999, he joined StorageTek – now SUN - Solution Business Group (SBG) as programme manager for telecom and e-commerce and, in particular, he developed hosted managed services. This role led him in to European eHealth initiatives.

In 2003, he became responsible for Europe, the Middle East and Africa business for Kodak Healthcare IT Information Management solutions. Four years later, he joined Carestream Health and its eHealth Managed Service Business Unit to launch eMS offer in Europe. Now, as eHealth Managed Services Business Manager for Carestream Health, his role covers Europe, the Middle East and Africa

Storing, archiving and sharing patient information in an intelligent and controlled manner is one of the 'hot topics' for healthcare organisations. It can become a real nightmare, as the volume of information explodes, technology change rate increases, and the different stakeholders of patient care become more demanding.

Questions are immediately raised:

- Should I keep information in-house?
- How can I give ubiquitous access, but in a controlled way?
- How can I ensure legal requirements are fulfilled?
- What will be the costs in the long run?

Managed services can provide part of the answer.

The presentation will explain new architectures, often grid based, and delivery models for archiving and sharing patient data. It will detail the impacts of the model on IT, finance and the physician.

It also will provide practical examples from Europe and USA, highlighting the lessons learned. Finally, the presentation will identify how the model can smoothly integrate within global eHealth strategies

Countrywide Data and Resource Sharing
Finland's National Patient Data Repository

Dr Tech Hanna Kaarina Pohjonen *gained her MSc in Engineering at the Helsinki University of Technology (thesis: 3-D analysis and visualisation of medical images), then her Licentiate of Technology (thesis: Registration and visualisation of multimodal medical images). In 1997 she gained her doctorate (thesis: Image fusion in open-architecture quality-oriented nuclear medicine and radiology departments), and in 2002 became Associate Professor at the same institute (docent in healthcare informatics, post-doctoral merit). In 2008 Dr. Pohjonen became Associate professor at the Tallinn University of Technology.*

She has carried out research at the Clinical Perfusion Laboratory of the Papworth Hospital, UK; the Department of Human Anatomy and Cell Biology; the Muscle Research Group, University of Liverpool, UK and at the Dept. of Technical Physics in the Laboratory of Biomedical Engineering, Helsinki University of Technology.

As a clinical engineer she was employed at the Medical Engineering Centre of Helsinki University Central Hospital, working on the registration of multimodal images for neurological cases (computer algorithms & clinical marker designs); 3-D-modelling of medical objects, segmentation, and quality assurance concepts in radiology. At the same centre, she was a network engineer working on healthcare IT procurement; telecommunication networks and had responsibility for RIS/PACS pilots and teleradiology

In 1997, Dr Pohjonen was an evaluator of the European Union Telematics Programme. In that year she also became

Project Manager at the National Technology Agency (Tekes) under the Ministry of Trade and Industry, until 2000, when she began full-time consultancy in healthcare information systems and networks, founding her own company ***Rosalieco Oy****, which has held consultations in 20 countries. 'About 90 % of our turnover is from abroad,' Dr Pohjonen points out.*

The company has specialised in large national and regional eHealth programmes throughout Europe (e.g. consultation for almost all the largest PACS installations in Europe, including the NHS Connecting for Health). Consultation also includes healthcare information systems, networks, data privacy and security issues as well as eHealth applications. Typical customers: governments, hospital districts, private healthcare chains, EU, global IT companies, small innovative eHealth companies, investors, big consultancy companies

Dr Pohjonen is also a reviewer in European Radiology *and Correspondent for* Imaging Management

The EU eHealth initiative and action plan is the driver for patient information sharing and the networking of expertise across different institutions and countries. Launched in 2004, it will be applied in its current form till 2010. Besides organisational eHealth, this initiative encourages eHealth to national-level; simultaneously the focus is being shifted from in-border health to more integrated healthcare provision across the Union.

Sharing of patient data is changing dramatically: from 'point-to-point' to 'many-to-many'. The recent IHE XDS and XDS-I profiles for cross-enterprise document and image sharing are being applied in several eHealth projects in Europe and Canada. In this architecture, IT systems like PACS act as sources and consumers for information. The data are stored in a repository and published in the metadata registry: this is how we separate IT systems from data and data from metadata. Consolidation of patient-centric data in a common archiving solution is a growing trend in the healthcare IT market. The new solutions allow any type of fixed content data, including images, laboratory results, EPR summaries etc to be stored in one architecture.

The traditional images-only archives are being replaced by new generation enterprise archives that are configured as network-attached systems and they allow a set of standard interfaces and protocols – not just DICOM. The future repositories will form a GRID linked together via nation-wide registries; the European Health Insurance Card (EHIC) will be used to access this GRID data in the coming years.

The archives are changing from separate IT system attached silos to common shared architectures, but at the same time to eHealth platforms: the core is still archiving, but there are also data privacy and security services, messaging services, patient's informed consent, coding services etc. Additionally, the same platform can be used for teaching and research.

In the talk, an example of such a project in Finland will be described.

SESSION 3 Finance

Hospitals must be governed by business rules

Jürgen Abshoff *studied economy, law and social sciences (Diplom-Volkswirt) at the University of Cologne.*

His early professional experience includes consultancy for planning government approved hospitals for the North-Rhine-Westphalia Hospital Federation; employment by a leading German insurance firm, and a four-year focus on hospital finance and human resources at the German Hospital Federation. He has also been a finance committee member for the European Hospital Federation; advisor to the health committee of Germany's National Parliament (Bundestag), and executive vice manager for the North Rhine-Westphalia Hospital Federation.

From 1984 to 2007, he was Managing Director of the Hamburg Hospital Federation, and was founder and member of the steering committee of the Co-operative for Quality Management in Hamburg Hospitals (EQS). Last year, be became President.

Following membership of various committees of the German Hospital Federation, last year he became a hospitals consultant.

Since 2006, he has also worked with quant GmbH, a service institution for quality management in healthcare, which organises the public German database for quality data in hospital care.

He is also a member of the advisory council (Beirat) for the German health industry congress, and a member of the committee for Northern Germany of WIBERA / PWC (PriceWaterHouse Coopers)

In those European countries where citizens are entitled to comprehensive healthcare financing the healthcare systems are becoming increasingly daunting tasks. Whilst in some isolated cases medical progress may indeed lead to certain cost reductions, overall this inflates costs. Moreover, with extended life expectancy the number of care-intensive patients will mount, thus contributing to rising healthcare costs.

Although these developments are obvious, politicians in Germany and other countries feed the illusion that in the future everyone will be able to obtain any state-of-the-art medical treatment. This is entirely unrealistic - at least in the current system of statutory health insurance. Today, the 'pension lie' – the often repeated affirmation that public pensions will continue to rise and cover the needs of pensioners – is complemented by a 'health lie'. The DRG system, introduced in Germany as a pricing system, is used as a budget system. Combined with strict budget capping, this has deeply changed the hospital environment. Recent political healthcare reform has exacerbated this trend in the entire health system. Above all, this reform rang the death knell for the well-tried and successful administrative autonomy of the healthcare system. Health insurers were deprived of their independence and control over their income. If the planned health fund becomes reality, politics will control the income of health insurers and will – mere election tactics – tighten the health insurers' financial flexibility even more. Additionally, to add insult to injury, politicians will hold the insurers and health providers responsible for their disastrous policies.

In 2009, following the so-called convergence, Germany will witness a further fundamental change in hospital financing. This coming reform aims to abolish, or at least entirely change, the principles of German hospital financing emplaced since 1971: planning, dual-source funding, pricing system.

Most importantly, the dual-source funding system, which means that capital investments are being funded by the state while operating costs are being paid for by the statutory health insurers, is to be replaced by overall financing schemes based on fixed, maximum or recommended (DRG) prices.

In Germany, the dual-source funding scheme has failed and, after a long transitional period, will be entirely discontinued. With tight public budgets the funds provided by the German Länder to finance capital investments by the hospital have shrunk. Consequently, there is an enormous investments backlog in many hospitals. Estimates show that over Euro 40 billion is urgently needed for necessary improvements.

Nevertheless, due to increasing competition and cost pressure, hospitals are forced to invest. They must create the precondition to implement more efficient workflows. To attract patients, hey must also offer modern equipment and effective medical care.

Where will they find the money for these investments? The answer to this crucial question depends to a large extent on whether we are looking at public/municipal, independent/not-for-profit or private hospitals.

Conventional loan financing will gain importance. But the hospitals' financial and legal framework places tight restrictions on this option.

Therefore, to off-set the lack of public funding and complement often difficult loan financing, new and innovative funding schemes are needed. Such new schemes must take into account the current legal framework. Above all, it will not suffice to present old financing concepts dressed up with cool names.

In view of tighter budgets, hospitals should invest in a clearly targeted manner. The must also ensure their investments yield a reasonable return, including refinancing. However, this will not be enough! In recent months, medical employees have increasingly demanded the end of pure commercialisation of medicine and healthcare. However, they fail to say exactly what they mean. Before the reforms they sometimes threatened to pile dead patients on the hospital manager's desk if certain equipment was not purchased.

Today, physicians understand that business rules also reign over hospitals. Put simply: Money spent for one item will not be available for another. Although this may sound banal, many physicians only learn that principle when they must handle their own budgets. It teaches them to become good money managers pretty quickly.

Launching a brand new hospital? Here's how…

The Director General of Torrevieja Salud UTE, ***Luis Barcia Albacar*** *holds degrees in law and as well as Healthcare Management and International Commerce.*

Among the various healthcare projects he has managed in Spain, was the foundation of the Valencia Institute of Oncology (1989-1998).

Following this, he became Financial Director, also responsible for the human resources and logistics departments, of the Hospital de la Ribera, Spain's first Private Finance Initiative (PFI) contract.

A newly constructed 220-bed hospital, with 11 operating theatres, an entirely new IT infrastructure and with 1,200 employees, all fully operational and able to provide a comprehensive range of clinical services from day one – impossible? Not if you look at Hospital de Torrevieja (www.torrevieja-salud.com) which opened near Valencia, Spain just over a year ago. Its launch was flawless.

In addition, the Torrevieja has set one record after another. In the first 12 months, 15,000 surgical interventions were performed; the average Accident & Emergency (A&E) waiting time was 40 minutes and average in-patient stay 4.1 days (Spain's lowest). Above all, the patients rated their satisfaction at 9.1 on a scale of 1 to 10.

In addition, the hospital, which is located in an immensely popular holiday area, coolly sailed through its baptism of fire: the tourist season, when the population it serves sky-rockets in numbers.

This impressive performance is no happy accident; it results from meticulous planning, hard work, sound financial management and dedicated players. Hospital de Torrevieja is a public-private endeavour — initiated by Valencia's public health authority but privately managed. The hospital ethos is shared by everyone: to be patient-centred, provide top quality medical care, use resources efficiently, and be motivated professionally – all supported by a comprehensive, stable and affordable IT infrastructure.

To ensure the result, every aspect of the institution was integrated into the planning process. Going far beyond the spatial layout, it encompassed clinical workflow, whether primary, emergency or intensive care, as well as administrative workflow, IT architecture, equipment, staff recruitment and training.

A tightly controlled construction schedule helped the project to stay on track. And last but not least sound financial planning and ongoing financial management and controlling ensure that public funds are used efficiently.

How to afford state-of-the-art technology – and not go bust!

Eric-Jan Rutten *was Business Development Manager at Oldelft/Delft Instruments before gaining his Masters Degree in Business Administration at Rijks University Groningen in 1997. That same year, he was appointed by Philips Medical Systems as the company's Commercial Manager for the Netherlands region. Four years later he became its Business Development Manager for the EMEA region, for which he became Director of Financial Services in 2003.*

In 2006, he began his present role as General Manager of Professional Healthcare Solutions, Philips Healthcare International, in Eindhoven, the Netherlands.

When Philips Healthcare looked at today's crucial cost containment challenges that hospitals face, we decided to support them by taking more operational responsibility and sharing some of their business risks. As a result, we don't just ask '*Which technology would you like to buy?*' We look at underlying challenges, such as '*How can we optimise the total cost of ownership and workflow for this disease?*' and '*Which partnership models can help us to meet this need?*' We're trying to understand the business issues of our customers by listening to them to find out what they really need. And what they need is not just money, but also more flexible, predictable, customised and reliable solution.

In our *Pay per Use* model, for example, we offer to share the risk associated with patient examinations or patient volume with our customers. In this case, Philips offers a new financing approach, for example, for a CT device, built on success-oriented financing. In practice this means that if a radiologist examines fewer patients than planned, they pay less. If they perform very well and examine more patients than planned then we also share in those productivity gains.

Pay per Use models are currently popular in Germany, whereas in the UK our customers ask for financing in the context of public-private partnerships. Our solutions vary depending on the scope of the partnership. Sometimes construction work is required, such as a completely new hospital wing or radiology room, and sometimes other operational activities are involved, which the hospital likes to outsource. We do not perform all those tasks – we work with the appropriate partners, in a consortium. Philips Healthcare takes care of the technology – our core business – and our partners contribute other skills. In some cases, we handle everything from air conditioning to medical instruments and lighting systems. The duration of these contracts can vary: In the UK our partners enter into contracts for 10, 15 or 25 years, whereas in Italy they look for short-term agreements for six or seven years.

The *Technology Leap Lease* or *Managed Service* solution: As well as providing financing, Philips can also include a commitment to keep the technology up-to-date over a fixed period. Thus, when a customer signs a Technology Leap Lease for six years we can include fixed upgrades, or options for replacements, for predefined budgets. On a larger scale Philips can also provide a managed service for longer terms when the company provides multiple systems; as technology progresses it will upgrade and replace the systems within the agreed budget. In this way Philips ensures that the customer is always working with state-of-the-art technology over a defined period, for a pre-agreed budget. In such partnerships we typically also agree on the performance levels of the systems, such as uptime and response times.

In addition to these financing and service approaches it is important for Philips to provide customers with a 'full scope' of technology solutions. That's why we established Philips' turn-key solutions. The company acts as a main contractor and integrator for all technologies when a hospital is planning a new wing or modernisation of an existing facility. As an integrator, the company plans and evaluates the purchase of all medical devices, from beds to lamps. The company takes care of the programme management, specifications, procurement, project management, installation, testing, and point-of-care management – all for a fixed price.

Responding to these new demands requires flexibility. Approaches as well as technologies and performances change over time, therefore, we also have to design our contracts with the utmost flexibility and on a good working relation – for the benefit of Philips customers and our partners. Long term partnerships need to be predictable for customers from a performance and financial point of view. This is what Philips provides: flexible, predictable, customised and reliable solutions.

XPCi

New technique enables transfer of X-ray phase contrast imaging to clinical practice

X-ray phase contrast imaging (XPCi) is a novel imaging technique with the potential to revolutionise the field of diagnostic radiology. It can do this because it is based on a different physical effect, namely refraction/interference instead of absorption. Studies carried out with synchrotron radiation have demonstrated that the exploitation of such effects leads to a substantial increase of the contrast of all details in an image, as well as to the detection of details classically considered invisible. These studies have shown impressive advantages especially in those fields where small absorption differences are the main factor limiting image quality, such as mammography – where most tumours are characterised by X-ray absorption characteristics very similar to the ones of the surrounding healthy tissue. After preliminary investigations based on ex-vivo studies, which demonstrated substantial improvements both in terms of sensitivity and specificity, the first station for in vivo XPCi mammography with synchrotron radiation is currently in operation in Trieste, Italy. Alongside mammography, substantial benefits in many other radiology fields were demonstrated by means of ex-vivo or animal studies. These include:

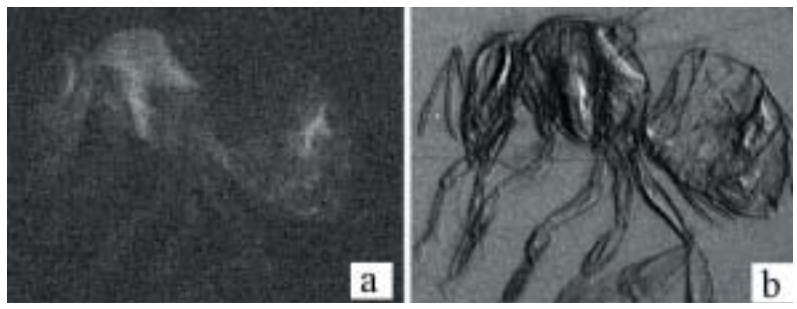
By **Professor Robert D Speller**, Head of the Radiation Physics Group, University College London, and **Dr Alessandro Olivo**, of the Medical Physics & Bioengineering Dept. University College London

- lung imaging, in which the technique showed the potential to spot small lesions with conventional planar imaging without having to rely on expensive (both in terms of cost and patient dose) CT scans
- vascular imaging/coronary angiography, in which the potential to image blood vessels without contrast agents was demonstrated
- bone imaging, where minimal details on the bone trabecular structure are easily and effectively depicted due to the substantially increased sensitivity
- and many others, to include improved resolution and lesion detectability in liver imaging, kidney imaging, etc. Moreover, refraction/interference effects are less subject to decreasing with increasing X-ray energy that absorption effects: as a consequence, images could be acquired at higher X-ray energies, which could translate into dose reductions also of one order of magnitude.

Despite being probably the ideal X-ray imaging technique, the problem so far with XPCi was that its use seemed to be restricted to synchrotron radiation environments. All early implementations of the technique seemed in fact to require levels of spatial coherence (i.e. small focal spot plus large source-to-sample distance) and monochromaticity not available with state-of-the-art clinical sources. Although pilot experiments with synchrotron radiation like the one on mammography currently underway in Trieste have a high scientific significance, a real world-scale impact would be achieved only by developing a relatively small-sized, cost effective prototype. This clearly requires taking XPCi out of synchrotron environments and into laboratory practice.

Researchers at University College London, after having demonstrated that polychromatic radiation can provide the same level of phase contrast image quality of its monochromatic counterpart, have developed a new technique based on the use of coded apertures, which makes all advantages of XPCi achievable with conventional sources.

Unlike other techniques based on perfect crystals, grating interferometers, etc, the coded apertures approach allows for the first time the use of divergent, polychromatic X-ray beams like those produced by conventional clinical sources. Moreover, the combined effect of two sets of apertures strongly relaxes the requirements on the source coherence, and it was demonstrated that levels of phase contrast signals comparable to the ones obtained with synchrotron radiation can now be achieved with source sizes as big as 100 ηm – i.e. fully compatible with current mammography sources. This technique has therefore the potential to allow for the first time an effective transfer of XPCi into clinical practice, and a consequently widespread diffusion of the technique.



The impressive image improvements provided by XPCi (b) compared to the standard image quality of conventional X-ray absorption imaging (a). This sort of improvement, up to now accessible only to synchrotron radiation scientists, could soon be available in clinical environments

The new technique was fully modelled through a computer simulation, a small imaging prototype was realised, and the pilot experiments carried out provided results perfectly matching the simulated ones. Such experimentation confirmed beyond doubt that the advantages of XPCi demonstrated by synchrotron radiation studies can now be achieved by means of conventional X-ray sources.

A system based on the new technique would therefore be based around conventional, state-of-the-art sources and detectors. As a consequence, its cost would not differ substantially from radiography units currently in use.

The main difference would lay in the introduction of the coded-aperture arrays, which consist of extremely thin (20-30mm) gold layers deposited on graphite substrates. The cost of such a device is currently in the range of a few thousand Euros, but could be reduced by at least one order of magnitude if the devices were mass-produced. Alignment stages to achieve the correct positioning of such devices would be the only further addition to the system, meaning that its practical realisation would thus be very cost-effective.

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4-D imaging and Bio-System-Radiology

The Virtual Physiological Human

By **Hans-Ulrich Kauczor MD PhD**, (left) Director and Chairman of Radiology at Heidleburg University Clinic, and radiologists **Frederik Giesel MD MBA** and **Hendrik von Tengg-Kobligk MD** of the German Cancer Research Centre in Heidleburg, Germany

Today, biomedical research faces many challenges for which the traditional approach, based on the subdivision of biological systems, is inadequate. These artificial subdivisions are generally along dimensional scales (body, organ, tissue, cell, molecule), scientific disciplines (biology, physiology, medicine, bioengineering), or topographic anatomy (cardiovascular, musculoskeletal, gastrointestinal, etc.). They make it impossible to unravel the systemic nature that governs physical disease manifestations.

Thus, it is necessary to complement this traditional approach with an integrative approach to combine observations, theories and predictions across the temporal and dimensional scales, the scientific disciplines, and anatomy. This realisation, shared by the vast majority of experts in biomedical research, has given rise to a number of initiatives such as integrative biology, system biology, physiome, etc.

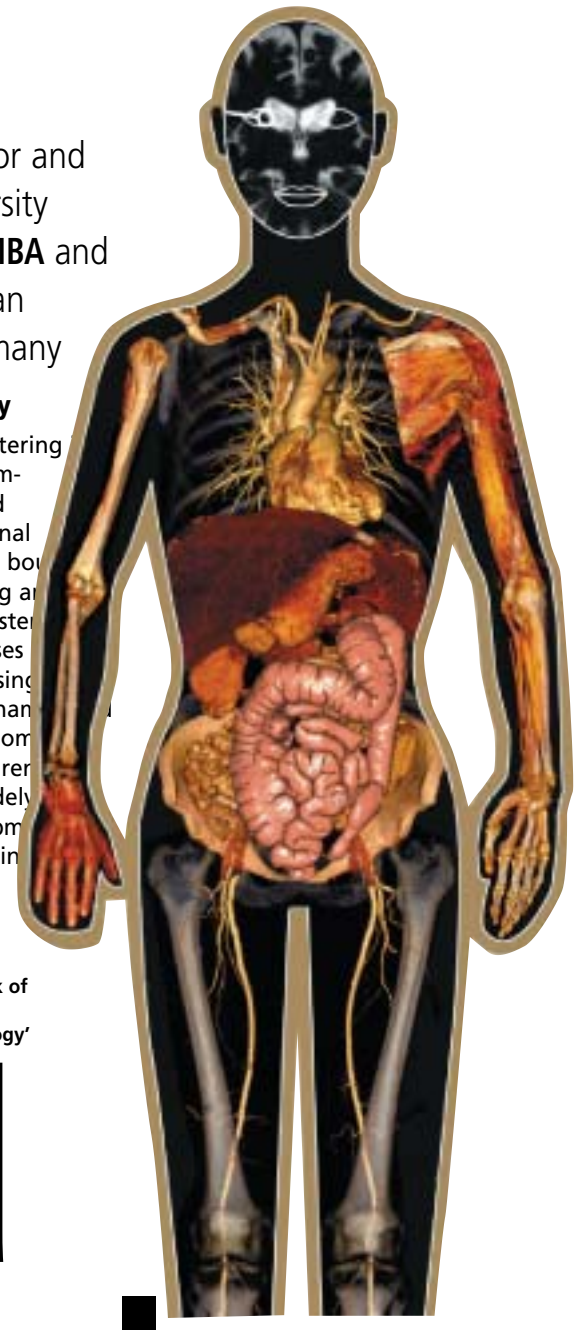
However, most of these are still highly focused and require a general framework allowing experts from a variety of disciplines to work collaboratively to analyse their observations and develop systemic hypotheses. The Virtual Physiological Human (VPH) has been proposed as a methodological and technological framework to serve these needs. The VPH might be a way to share observations ('description'), to derive predictive hypotheses from them ('prediction'), and to integrate them into a constantly improving understanding of human physiology/pathology ('integration'), by regarding it as a single system.

What is the role of Radiology?

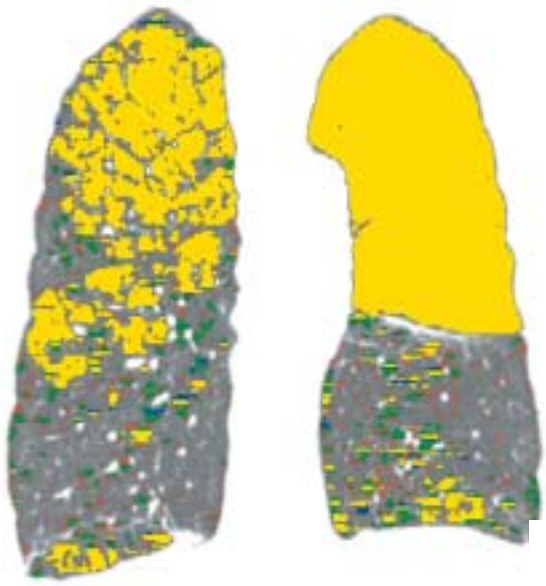
Radiology should play a major role in this integrative approach of the VPH, as imaging provides non-invasive insights into structure and function of human tissues and organs. With revolutionary technological developments during the last decade, radiology has grown far beyond visualisation of 2-D structures. Multi-slice CT and MRI, especially when using parallel imaging and higher field strength, record volumetric data at isotropic submillimetre spatial and subsecond temporal resolution. Together with the assessment of function, such as molecular imaging e.g. by PET, diffusion-weighted MRI or dual energy CT, multidimensional, so-called 4-D imaging has become reality. With 4-D imaging dynamic processes are observed and analysed, e.g. dynamic cine imaging of the beating heart or the breathing lung and also the moving liver during respiration and the subsequent deformation. When using contrast agents and imaging with high temporal resolution, tissue and organ perfusion are easily addressed. Another major advantage of radiology is its capability to provide all these data of individual patients looking at different scales: cells (molecular imaging), tissue, organ and whole body.

Bio-System-Radiology

As such, radiology is entering a new field – 'bio-system-radiology'. Image-based geometries and functional assessments are used as bou conditions for modelling a simulation of human syste its physiological processes pathological changes using computational fluid dynan other methodologies. Com from the non-medical aren modelling has been widely in research and developm in the car or aerospace in



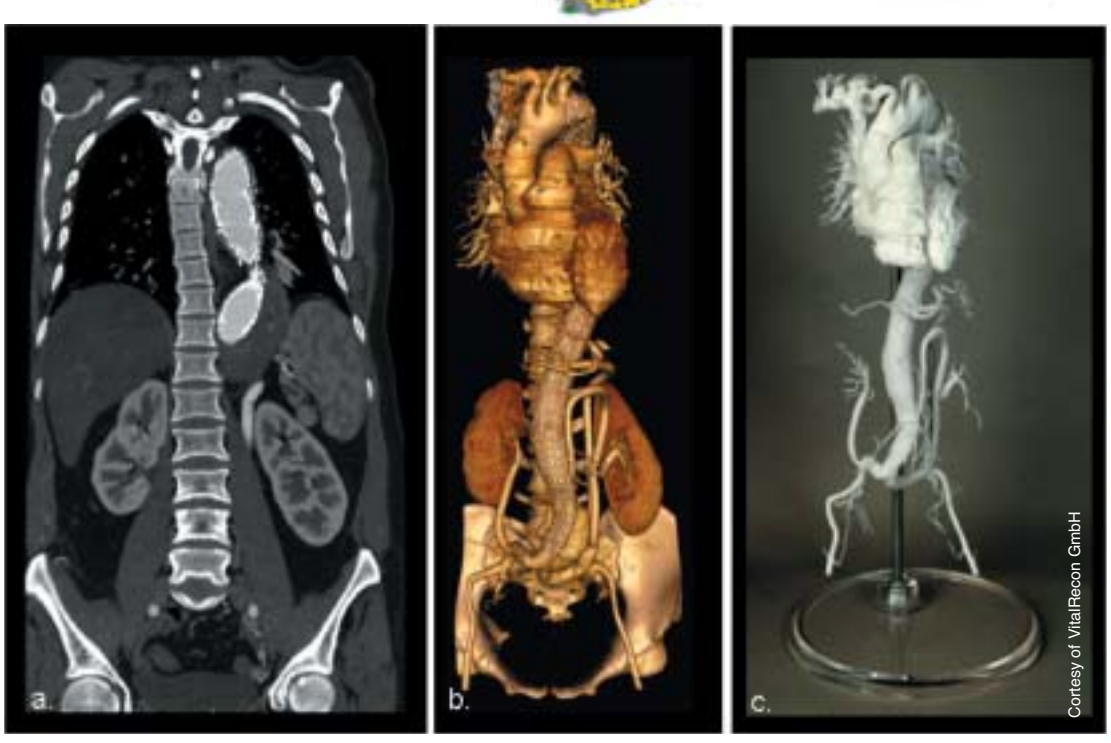
Right: Contribution of Radiology to an integrative approach in biomedical research and the framework of the Virtual Physiological Human: 'Bio-System-Radiology'



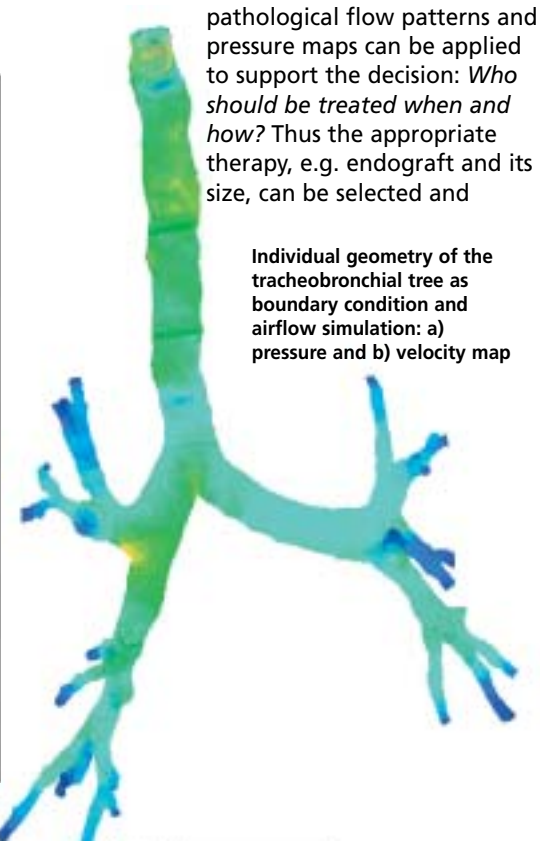
Quantitative CT and cluster analysis of emphysema with left upper lobe predilection as input for 'Bio-System-Radiology'

Aiming at improvements of drug and device design, modelling is currently entering the medical arena, e.g. system-biology in oncology or simulation of blood flow in cardiovascular disease. The great advantage of system modelling includes the development of novel dedicated treatment options, which can even be tailored to the individual patient in the context of 'personalised medicine'. In clinical practice, dynamic imaging of e.g. aortic diseases and simulation of pathological flow patterns and pressure maps can be applied to support the decision: *Who should be treated when and how?* Thus the appropriate therapy, e.g. endograft and its size, can be selected and accurately targeted. This knowledge will also foster the development of new, dedicated stent designs. Radiology has even more to offer. We can use image data together with rapid prototyping technology to produce reproductions of living structures or organs representing the actual structure in 3-D, the so-called '3-D print'.

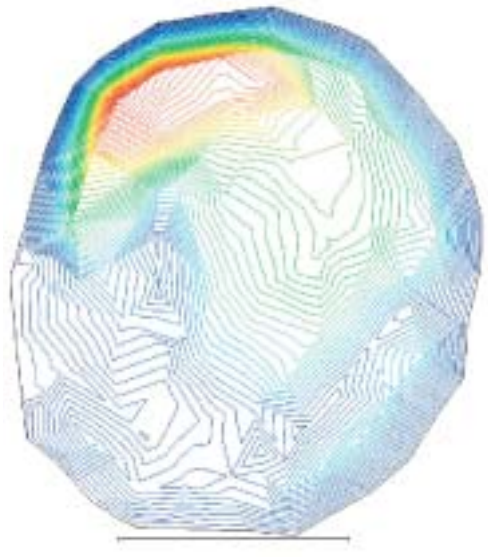
Novel integrative approaches in biomedical research and their translation into the clinical arena will profit substantially from multidimensional radiological imaging. Radiology should seize the chance to expand into the new field of 'Bio-System-Radiology' so that patients can benefit from innovations driven by bioengineering and systembiology.



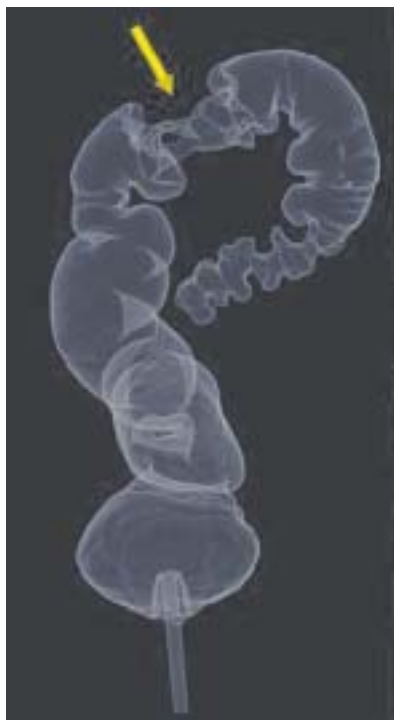
MSCT of the aorta, segmentation of individual geometry and 3-D print generated by rapid prototyping technology

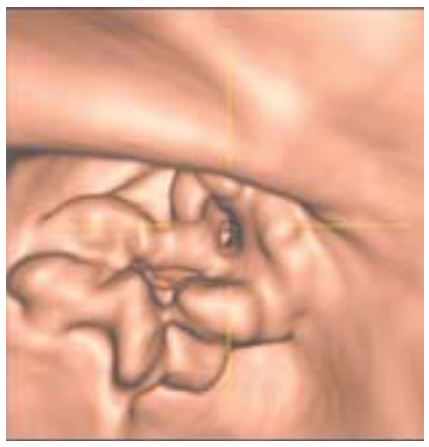


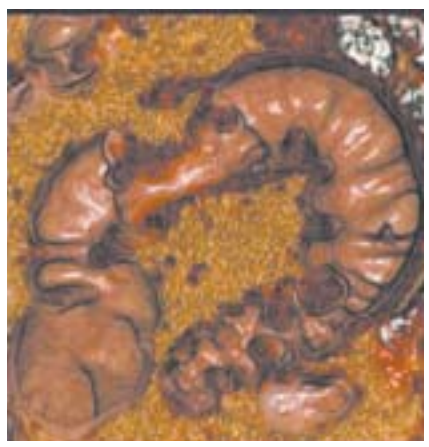
Individual geometry of the tracheobronchial tree as boundary condition and airflow simulation: a) pressure and b) velocity map



Clinical trial validates CT virtual colonoscopy







When the International Agency for Research in Cancer (IARC) 2007 statistics report, showed that 429,000 new cases were reported in Europe in 2006, Director Peter Boyle recommended that colorectal cancer screening programmes be implemented throughout Europe.

This disease is not fatal – if diagnosed in its earliest stages. Adults should have a colorectal

By **Cynthia E Keen**

screening examination from aged 50 and then every three to 10 years, based on their level of cancer risk. The barium enema and optical colonoscopy — traditional tests to identify polyps — are resource-intensive and time consuming. Traditional optical colonoscopy is invasive, usually requiring sedation and incurring a 1-in-1,500 risk of colon perforation.

Patients find both processes unpleasant, and many avoid screening. In the USA, for example, although there were over 112,300 new cases of colon cancer and over 52,000 deaths from this disease in 2007, the US Centers for Disease Control and Prevention reports that only 44% of individuals eligible for screening (about 70,000,000 people) had a screening examination.

From a hospital resource perspective, non-invasive CT colonoscopy, or virtual colonoscopy (VC), is a far more efficient alternative, as long as there are physicians qualified to interpret the procedure. With the proliferation of multi-detector CT scanners in hospitals and clinics, the ability to offer this procedure, by medical facilities throughout Europe, has increased significantly.

Two barriers have prevented widespread implementation: procedure cost and validation to show that VC has equivalent detection sensitivity. The publication in 2007 results from major clinical trials conducted in Europe and the USA have validated VC's accuracy and effectiveness. In September last year, the preliminary results were announced from the National CT Colonography Trial, sponsored by the American College of Radiology Imaging Network (ACRIN) and funded by the US National Institutes of Health. ACRIN reported that VC procedures performed on 2,531 asymptomatic patients in 15 US academic hospitals and private practice imaging centres yielded a 90% per patient sensitivity for adenomatous colorectal lesions 1 cm or larger in diameter. This level of sensitivity was comparable with that of optical colonoscopy.

Presenting those results, C Daniel Johnson MD, Professor of Radiology at the Mayo Medical School, Rochester, MN, emphasised that rigorous reader training was an important component for the results. All interpreting physicians had to read 500 cases, or attend a 1.5 day training course, and also pass a certified examination consisting of 50 cases of mixed levels of difficulty.

The results of the Munich Colorectal Cancer Prevention Trial,

continued on page 14

Computed tomography versus magnetic

COMPETITIVE OR COMPLEMENTARY?

By **Florian Schwarz BS**, **Balazs Ruzsics MD PhD** and **U. Joseph Schoepf MD**, of the Radiology and Medicine Departments, at the Medical University of South Carolina, Charleston, USA.

The rapid pace of technological developments both in cardiac Magnetic Resonance Imaging (MRI) and cardiac Multi Detector-Row Computed Tomography (MDCT) keeps revolutionising the field of cardiac imaging. In this contribution we intend to give a brief overview over the specific imaging capabilities of cardiac MDCT versus cardiac MRI and highlight some typical differential indications.

Multidetector computed tomography of the heart

In the last decade, the majority of clinical studies on cardiac MDCT focused on coronary artery disease (CAD), both in the acute and preventive setting.

Traditionally, the first approach in the evaluation of CAD with MDCT is the quantification of coronary artery calcification. The correlation between the extent of coronary artery disease and coronary calcification is supported by substantial clinical evidence. Various ways of reporting the calcium burden have been established (Agatston-Score, Calcium Mass, Calcium Volume). It has been shown that the extent of calcification has a high predictive value for subsequent coronary events, so that Calcium Scoring has been established as a tool for risk stratification in a preventive setting.

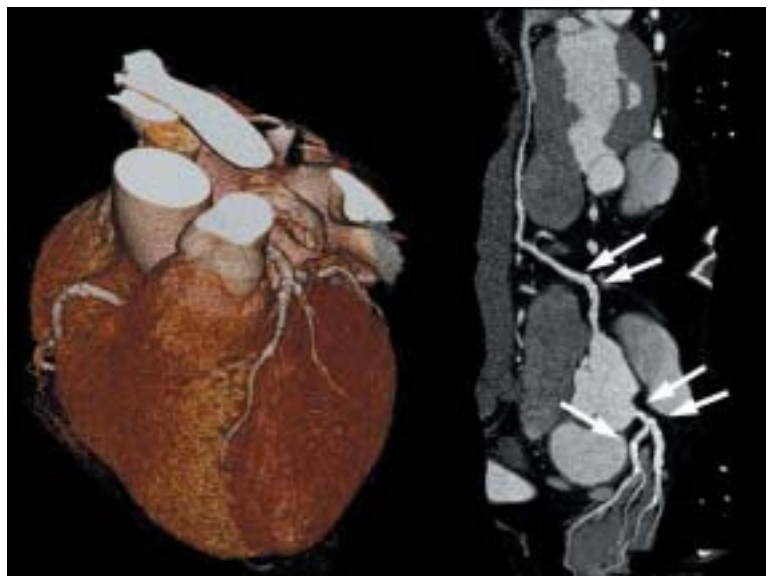
As there is no one-on-one relationship between coronary artery calcium and coronary artery stenosis, the detection of obstructive coronary artery disease requires assessment of the arterial lumen. This analysis has been traditionally performed invasively with coronary artery catheterisation. Recently, however, the value of CT Coronary Angiography (CTA) has been recognised, particularly owing to its high negative predictive value for non-invasively ruling out significant stenosis in patients with atypical chest pain or prior equivocal or non-diagnostic test results. Compared with conventional coronary artery catheterisation, recent clinical trials of CTA with 64-slice CT or later generation scanners report sensitivities approaching 100% and specificities of over 95% in the diagnosis of obstructive coronary artery disease. It has also been shown that CTA is a valuable tool for the assessment of coronary artery anomalies and coronary bypass patency.

With the advent of faster scanner generations, CTA is increasingly extended to detect coronary artery disease, pulmonary embolism, acute aortic syndromes, and other thoracic pathology with a single, ECG-synchronized contrast enhanced CTA study of the entire chest. This paradigm has been dubbed the 'triple rule out' scan and has been demonstrated in initial studies to be both, time- and cost-effective in the assessment of acute chest pain.

The combination of speed and spatial resolution provided by CTA is unprecedented, making it the premier non-invasive tool for the assessment of coronary artery lumen integrity. Increased research interest is currently directed at deriving information on myocardial perfusion and viability with advanced MDCT techniques. Similarly, since

Table: Typical Indications for CT versus MR of the Heart

	Cardiac MDCT	Cardiac MRI
Differential Indications	Elective evaluation of coronary arteries - atypical chest pain - intermediate pre-test probability of CAD AND - ECG uninterpretable or unable to exercise or prior stress test equivocal	Detection of myocardial scar and viability - post myocardial infarction - prior to revascularisation
	Evaluation of acute chest pain: - intermediate pre-test probability of CAD AND - no ECG changes, serial enzymes negative	Evaluation of LV function: following myocardial infarction or in heart failure
	Prior to invasive procedures: - before placement of biventricular pacemaker - prior to repeat cardiac surgical revascularisation	Characterisation of native and prosthetic cardiac valves: Quantification of flow volumes
	Evaluation of suspected coronary anomaly	Evaluation of specific cardiomyopathies
		Evaluation of myocarditis or myocardial infarction with normal coronary arteries
Shared Indications Choice of modality depends on clinical situation and local expertise	Evaluation of suspected aortic dissection	
	Evaluation of pericardial conditions	
	Evaluation of cardiac masses (tumour or thrombus)	
	Prior to radiofrequency ablation	
	Assessment of complex congenital heart disease	



Retrospectively ECG-gated, contrast enhanced Coronary CTA of a 77-year-old male patient, presenting with chest pain syndrome, reconstructed as 3-D volume rendered image (left) and curved multiplanar reconstruction (right) of the coronary arteries illustrating atherosclerotic changes in coronary vessels with calcified plaques (arrows).

Contrast enhanced cardiac MRI scan in a representative short axis plane of a 57-year-old patient with history of myocardial infarct. Delayed enhancement pattern can be seen in the phase sensitive inversion recovery (PSIR) sequence (left) as well as in the corresponding magnitude image (right). Hyperenhanced endocardial region (hyperintense endocardium) shows the location of non-viable, infarcted area with myocardial thinning (arrows).

Clinical trial validates CT virtual colonoscopy

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first reported at the 2007 International Symposium on Virtual Colonoscopy (ISVC) held in Boston, Mass. in October, yielded 100% per patient sensitivity in identifying lesions 10 mm and larger. Sensitivity for polyps between 6-10 mm was 93.4% and 76.9% for lesions smaller than 6 mm. The 300 asymptomatic patients were given both optical colonoscopies and VCs using a 64-detector row Siemens Sensation CT scanner. The same radiologist read both studies, using a computer assisted detection (CAD) program with the CT scans. Dr Anna Graser, radiologist at the Grosshadern campus, University of Munich and principal investigator of this study, stated that the VC images enabled radiologists to identify clinically significant polyps nearly as accurately as optical colonoscopy. However, she cautioned that flat lesions were difficult to detect, as is the case with optical colonoscopy.

A clinical trial conducted at 12 medical centres in Italy, sponsored by the Societa Italiana di Radiologica Medical (SIRM), performed both optical and VC procedures on 934 asymptomatic subjects. Principal investigator Daniele Regge MD, radiologist at the Institute for Cancer Research and Treatment (IRCC) in Candiolo, a private, non-profit institution founded and supported by the Fondazione Piemontese per la Ricerca sul Cancro-Onlus, also presented preliminary results at the ISVC meeting. The research team determined that accuracy of VC ranged from excellent to acceptable.

This comparative trial assessed the sensitivity and specificity of VC in a population at increased risk for colorectal cancer. 40% of the participants had a family history of colorectal cancer or polyps, 36% had had a polypectomy, and 24% had a positive faecal occult blood test result. The 341 postpolypectomy patients represented one of the largest VC surveillance populations studied to date.

10 centres acquired images on 16-slice CT scans and two centres used 4-slice CT scanners. Of the 25 radiologists and gastroenterologists who participated, only five had read more than 500 VC examinations; 11 had read 50-100 and nine had read 100-500.

Dr Sarah Jane La'Porte, radiologist at Northwick Park & St. Mark's Hospitals in Chesham, UK, presented at RSNA 2007 the experiences of her hospital's conversion from barium enemas to VC for symptomatic and high risk patients. Over a nine-month period, she said, the 287 VC procedures were of adequate quality for interpretation. Detected cancers underwent immediate CT staging and these patients had an optical colonoscopy.

A study conducted at the University of Wisconsin Medical School in Madison, compared the results of VC screening of 3,120 consecutive adults with optical colonoscopy screening of a different group of 3,163 adults. Both groups were from the same general screening population and geographic region. The results (Pub: 4/10/07. *New England Journal of Medicine*) also found comparable results between the two types of procedures.

Cost-effectiveness - VC is still very open to evaluation. Radiologists at the Pitié-Salpêtrière Hospital, Paris, used simulation modelling over a 10-year period to assess the cost of faecal occult blood tests, optical colonoscopy, and VC for a virtual asymptomatic French population aged over 50.

Dr Medhi Cadi, who presented the results at RSNA 2007, said the team had presumed that 50% of the eligible population would present for screening. Assumptions were made that the optical/VC procedures would be repeated at 10-year intervals if negative, and after 3-5 years if positive with adenomas. The faecal occult blood tests would be repeated every two years.

Medical costs were based on 2007 French rates. The cost per individual over a 10-year period averaged €885 for an optical colonoscopy, €543 for a CT VC, and €459 for faecal occult blood tests.

A cost-effectiveness simulation on

resonance imaging of the heart

functional information is obtained with every retrospectively ECG-gated CTA scan, this ancillary information is ordinarily exploited to also assess cardiac function and segmental wall motion. For the latter applications, however, CTA is in strong competition with other imaging modalities, primarily nuclear medicine techniques, which have been traditionally used for the assessment of cardiac perfusion, echocardiography as the most commonly used tool for the evaluation of cardiac function, and MRI, which currently still exceeds the temporal resolution of CT for the assessment of cardiac function, enables the spatially resolved evaluation of myocardial perfusion and does not expose the patient to ionising radiation.

Cardiac MRI

Because of the limitations of other clinical methods (e.g. poor acoustic windows at echocardiography, limited spatial resolution and specificity of nuclear medicine myocardial perfusion scans), cardiac MRI is shaping up as the new reference standard for the assessment of myocardial function, perfusion and viability. Compared to MDCT, MRI has significantly better contrast resolution and, seen in isolation, in theory has better temporal and spatial resolution. Currently available cardiac MRI scanners and sequences, however, are unable to combine spatial and temporal resolution to match cardiac MDCT for the detailed assessment of the coronary artery lumen.

Our routine cardiac MRI protocol is designed to yield comprehensive information on cardiac morphology, function, perfusion and viability within a 40 min time-frame. For the routine MRI workup of the heart, contrast agent is administered to study two phenomena: First-pass kinetics (= perfusion imaging) and delayed enhancement of the myocardium. The perfusion scan is typically performed twice, after application of pharmacologic stress and at rest.

In 4-5 representative sections of the heart the wash-in of the contrast agent is recorded in real-time. This allows for the reconstruction of a detailed perfusion map. Thus, rather than evaluating for obstructive coronary artery disease directly, such as with MDCT, the presence of significant coronary artery stenosis is indirectly deduced from the presence of perfusion deficits within the dependent myocardium.

A milestone in the field of cardiac-MRI in the '90s has been the discovery of the effect of delayed enhancement (DE). DE Imaging makes use of the fact that hyper-enhancement on DE Images (performed 10-12 minutes after contrast administration) represents irreversibly injured myocardium (due to any kind of heart disease). This way, important information on the likely success of revascularisation (e.g. via bypass grafts) can be objectively established.

Conclusion

For the responsible clinician it is important to recognise that both tomographic imaging modalities of the heart have their unique strengths and weaknesses which are currently intrinsic to the physical underlying principles and limitations, which will not be overcome in the near future. The primary strength of MDCT clearly is the morphological assessment of the coronary arteries, whereas ischemic sequelae and their effect on cardiac function, perfusion and viability are preferably evaluated with cardiac MRI. Therefore, pending future developments, we have come to discourage the notion of the often proposed "one-stop-shop" in cardiac imaging with a single modality. Both techniques are important, evaluate different manifestations of coronary artery disease and thus complement each other. It is our responsibility as physicians to judiciously choose the appropriate imaging modality for each patient and for each clinical scenario.

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a virtual population of 100,000 Italians was conducted at the Gastroenterology and Digestive Endoscopy Unit of Nuovo Regina Margherita Hospital in Rome: Lead author: Cesare Hassan MD. Based on 2006 Italian rates, all types of screenings were shown to save medical expenses, with the CT VC saving most, at €48 per person compared with €11 for an optical colonoscopy and €17 for a flexible sigmoidoscopy.

The technology of CT colonoscopy, interpretation techniques, 2-D/3-D software and CAD for polyp detection is evolving rapidly. Hospital decisions to offer VC need determination by many factors. However, the good news is that, in 2007, important clinical trials have proved that VC provides another method to help reduce unnecessary death from colon cancer.

Breast tomosynthesis

A promising mammography screening technology

By **Andrew Smith PhD**, principal scientist at Hologic, Inc. in Bedford, Mass, is involved in research and development of digital imaging systems

Mammography is an effective imaging tool to detect early breast cancer, and is the only screening modality proven to reduce mortality from breast cancer. Mammography is a very technically demanding radiographic procedure because it simultaneously requires high spatial resolution and good dose performance. High resolution is needed because some objects that must be depicted are very small microcalcifications, which can be visualised when they are as small as 200 microns. Dose performance is a requirement, because mammography is a screening modality and patient X-ray dose must be kept as low as reasonably acceptable.

The presence of overlapping tissue poses a significant obstacle in interpretation with conventional screening mammography. When screening mammography demonstrates questionable findings, follow-up diagnostic mammograms and other tests, such as ultrasound or MRI, or biopsy, ultimately determine whether the finding is significant. This process creates an anxiety for patients and induces additional healthcare costs for findings that frequently are found to be benign.

As evidence accumulates from clinical trials in the United States and Europe, breast tomosynthesis is on track to provide a superior alternative to the analogue and digital screenings available today. The industry has been talking about tomosynthesis for years. Now, finally, commercial systems are expected to be available soon.

Efforts to use tomosynthesis techniques for breast imaging were pioneered at Massachusetts General Hospital in the U.S. in the mid-1990s before the first digital mammography systems were commercialised. The early trials were promising, but limitations were apparent. Advances in image receptors, computer processing power, and digital mammography system designs have now made the application of breast tomosynthesis practical.

The principle of tomosynthesis is simple. During tomosynthesis acquisition, the breast is held stationary, and images are acquired at a number of different X-ray source angles. The dose of each image is kept low so that the total dose of all the images is similar to that of a conventional single breast mammogram. These images, known as projections, are then converted into 3-D cross-sectional slices through mathematical algorithms similar to CT reconstruction methods. The resultant 3-D image sets can be viewed on a computer workstation. These images are superior to digital mammograms because of the reduction of noise from breast tissue at different heights in the breast.

Tomosynthesis systems look much like digital mammography machines, and the breast is compressed in a standard way. Similarly to conventional mammography, the breast is imaged in the medio-lateral oblique (MLO) or the cranio-caudal (CC) orientation, although the tomosynthesis system should support the ability to acquire images in any desired view.

A high quality digital detector with rapid readout and minimal image distortion is important for breast tomosynthesis. Current digital mammography technology fulfils this requirement. Detector technology can be cesium iodide crystals on an amorphous silicon thin film transistor (TFT) array, or selenium on silicon TFT arrays. Selenium is an especially good material due to its high dose efficiency, i.e., its greater than 95% X-ray absorption at mammographic energies.

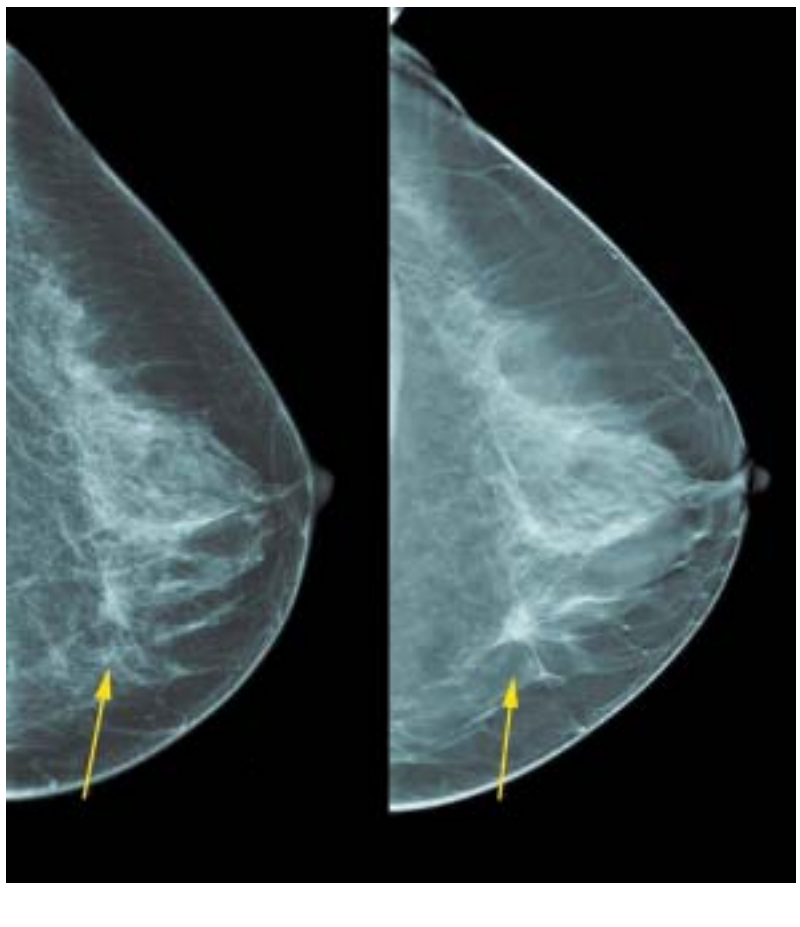
Another consideration in the design of tomosynthesis systems is the motion of the X-ray source during acquisition. The X-ray tube can move in a continuous or step-and-shoot motion. If the tube rotates continuously, short X-ray pulses are used to avoid blurring the image due to focal spot motion during each exposure. If step-and-shoot motion is employed, the gantry must come to a complete stop at each angular location before turning on the X-rays, otherwise vibration will blur the image. With continuous motion, scan speed must be slow enough, or each X-ray exposure short enough, to avoid image blurring due to focal spot motion. The angular range and number of exposures acquired during the scan are additional variables that need to be optimised. Minimising the total scan time is important, because patient motion will degrade the visibility of small objects in the breast.

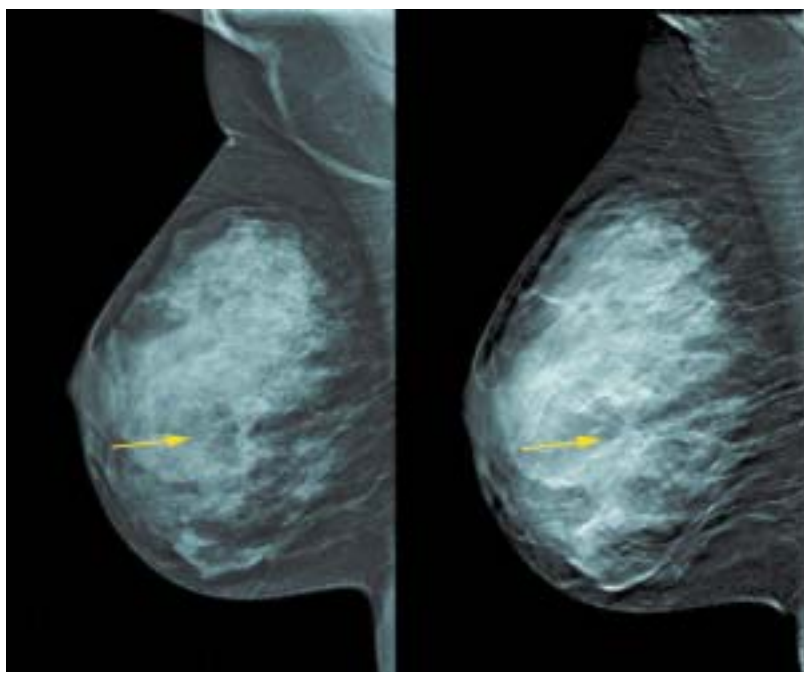
In general, more exposures will allow reconstructions with fewer artifacts. This must be balanced against the fact that for a given total examination dose, more exposures will mean smaller signals for each of the individual shots. For sufficiently small exposures, imager receptor noise will dominate the image and degrade reconstructed image quality. More exposures can also increase the scan time, which degrades the image through patient motion.

In regards to angular range, a larger angular range gives superior reconstructed slice separation, where smaller angular ranges keep more structures in focus in a given slice. Increased separation might be desired for resolving two closely lying structures, but could impair the appreciation of a cluster of microcalcifications by having individual calcifications appear in different slices. A large lesion might have some of its spicules appear less sharp in any given slice if those spicules are far from the displayed slice. A larger angular range can also be a disadvantage if it requires a longer scan time.

Some commercial units like Hologic's Selenia Dimensions now working its way through the FDA approval process, have dual functionality to perform both 2-D digital mammogram and breast tomosynthesis with the same unit. Therefore, it has all advantages of 2-D digital mammography, and in addition the ability to perform 3-D imaging. While the exact performance of 3-D imaging is still under investigation, it is likely that 2-D imaging will be a required operation mode for some time, such as to support magnification imaging.

A spiculated cancer with microcalcifications (arrowed) is better appreciated in the tomosynthesis slice (right image) than on the digital mammography image (left)





Architectural distortion and associated microcalcifications (arrowed) are better appreciated in the tomosynthesis slice (right) than on the digital mammography image (left)

Potential clinical benefits

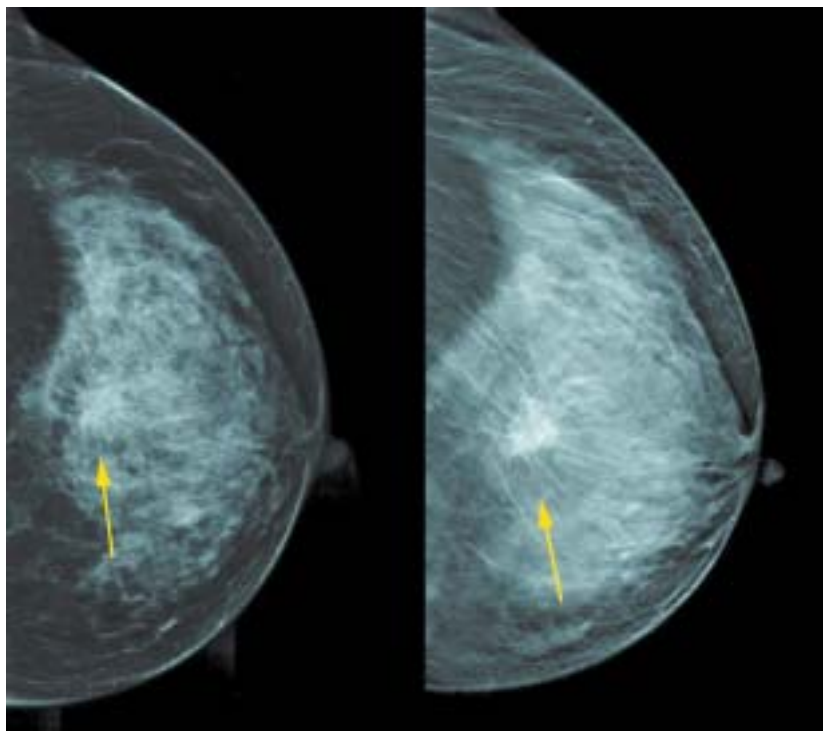
Tomosynthesis should resolve many of the tissue overlap reading problems that are a major source of recalls and additional imaging in 2-D mammography exams. The biopsy rate should also decrease through improved visualisation of suspect objects. Some pathologies that are mammographically occult will be discernable through the elimination of structure noise. Finally, tomosynthesis may allow for improved detection of cancers in women with denser breasts that are currently not well served by 2-D mammography.

Tissue localisation

Because the location of a lesion in a tomosynthesis slice completely determines its true 3-D coordinate within the breast, needle localisation and biopsy tissue sampling methods can easily be done using the tomosynthesis-generated coordinates.

Faster review time

As the images are presented with reduced tissue overlap and structure noise, objects are expected to be visualised with improved clarity. This will likely lead to faster case review and more confident readings. Computer-aided detection (CAD) algorithms might also have improved accuracy.



A spiculated cancer (arrowed) is better appreciated in the tomosynthesis slice image (right) than on the digital mammography image (left)

Mammography in Russia


Prof Georgy Manikhas

Breast cancer morbidity has been the leading oncology disease (21.8%) in Russia since 1996 – and since 1981 in St. Petersburg. In Moscow, the morbidity has increased 52.4% in last 14 years.

Almost 13% of all diagnosed cases are neglected. The low success of treatments is due to unsatisfactory early diagnoses – even though worldwide experience has confirmed the high effectiveness of diagnosis from mammography screening. Some attempts are being made in Russian to realise such programmes.

Professor Georgy Manikhas, Head physician at the St. Petersburg Oncology Centre reports: 'The level of breast cancer morbidity in St. Petersburg was always the same as in Scandinavian countries. However, following the introduction of a screening programme in Finland, in 1996 our colleagues there published data that showed a 20% decrease in the country's mortality rate. Their expert recommendations became the basis for the creation of a similar programme in St. Petersburg. With funds from the City Government, we bought 40 ALFA III (Finland) mammography machines and installed them in St. Petersburg's out-patient clinics. The plan was to examine women aged between 40 and 69 years. Unfortunately, this the project was stopped because there were no funds for patient screening and mammography machines were only used as diagnostic devices, not for screening.

Today, the country's only mammography screening programme is in Moscow. The recommended number of mammograms per one million women is 12; the real number in Russia is 3.7. As is known, expenses for the examination of one breast cancer case is between US$2-5,000, which was too high a sum for the Russian Public Health Service until recently. The Moscow screening programme began in 2004, after 85 mammography machines were installed in Moscow's out-patient clinics.

This year, St. Petersburg oncologists asked the City Government to reach concrete decisions to realise a screening programme, and the modernisation of existing city mammography machines was decided. In the next four years, we plan to digitise mammography equipment and connect the mammograms to the shared city computer network. With the main framework in our clinic, the network will hold all the city's morbidity images and provide flexible management. Unclear or debatable screening results will be evaluated by an expert committee in our clinic. We have only found a similar programme in Tartu, Estonia, but Tartu is, of course, a small town compared with the megalopolis of St. Petersburg.'

Professor Vladimir Semiglazov, Director of Petrov's Federal Cancer Research Institute, adds: 'The key concept behind screening is very early stage cancer discovery, so that treatment can change the prognosis and the natural clinical course of the disease. However, breast cancer is a heterogeneous, multi-faceted disease that may influence screening efficacy. To screen the healthy population, test specificity is vital because it means a minimum amount of false-positive results that lead to unjustified biopsies and sometimes to surgery. Cancer progression is a long process and not all stages are irreversible. Possibly, in the future, screening methods will lead to recognition of early molecular-genetic changes, and then more complete screening techniques will be needed. For now, mammography serves as the main element of screening.'

Reduced compression pressure

In conventional mammography, breasts are highly compressed so as to reduce tissue overlap. High compression pressure is not needed for tomosynthesis imaging. Just enough breast compression to pull tissues out of the chest wall and keep motion at a minimum is adequate. Therefore, there is the possibility of less painful compression using tomosynthesis. If reduced breast compression is used, the X-ray energies may need to be raised so as to penetrate the thicker breasts more efficiently. In this case, it is important that the image receptor maintain its high quantum efficiency at the higher energies.

Contrast-enhanced imaging

Researchers have studied mammography using IV administered iodinated contrast agents. Using either dual energy or pre- and post-contrast imaging, they have observed enhancement of otherwise occult cancers and differentiation of benign from malignant tumours. While this research is still in its infancy, contrast- enhanced tomosynthesis images might allow for even greater malignant tumour to background contrast and visibility over that observed with 2-D contrast imaging, and could conceivably supplant MRI gadolinium breast imaging.

TRENDS IN IMAGE-GUIDED THERAPY

NEW...

We are pleased to introduce...

a new series organised by **Prof. Stefan Schönberg** of the Institute of Clinical Radiology and Nuclear Medicine (IKRN), University Hospital Mannheim, Medical Faculty Mannheim, University of Heidelberg.
For the first article in his series, Prof. Schönberg invited colleagues at Mannheim and partners at Ohio State University, USA, for a roundtable discussion on:

PET-CT for radiation therapy planning: A step towards personalised radiation medicine

Meet the experts

N.A. Mayr[1], F. Wenz[2], S. O. Schönberg[3], J. Boda-Heggemann[2], W.T.C. Yuh[4], F. Lohr[2], C. Fink[3], S.S. Lo[1], J.C. Grecula[1], S. Sammet[4], M.V. Knopp[4]
(Underline = chairs)

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N.A. Mayr


F. Wenz


S. O. Schönberg


M.V. Knopp

For individualised radiotherapy, high-precision delineation and characterisation of the tumour is critical. If highest radiation doses are delivered in a targeted fashion, the chance of tumour cell kill increases and tumour control probability is enhanced. Precise delineation of the target in its anatomical/geometric and functional/biological aspects has long been a great dilemma for radiation oncologists. Traditionally, large margins were added to the tumour volume to account for uncertainties of tumour visualisation and target delineation. This results in a high risk of 'collateral damage' to healthy tissues – and in return the radiation dose to the tumour must be lowered, compromising the chance of tumour control.

Technological progress has enabled advances in cross-sectional imaging, molecular imaging, and 3-D reconstruction. Introduction of CT was the first key development towards modern 3-D radiotherapy planning. Additional information from other imaging modalities such as magnetic resonance (MR) imaging, MR spectroscopy, or PET, has further improved the target volume definition process by providing better soft tissue contrast or physiologic information. Parallel innovations in radiation therapy technologies enable millimetre-precision with the introduction of stereotactic techniques and online 3-D image-guided radiation therapy (IGRT) based on linac-mounted Cone Beam CT systems. These parallel innovations have brought the fields of radiation oncology and radiology, which had drifted apart in the past decades, together on a novel level. Today, radiation oncologists are able not only to see the tumour but also *treat* the tumour with highest precision for each individual patient.

However, despite 3-D CT-based planning, the definition of target volumes has still remained a highly subjective process, as shown by several 'inter-user' target volume definition studies. This is likely related to inherent uncertainties in tumour margin definition by anatomical imaging modalities that frequently do not adequately delineate the biologic/physiologic tumour target.

PET as a functional imaging modality adds critically to the existing panel of imaging methods. PET provides physiological information of tissue and tumour metabolism. Increased FDG uptake indicates areas of higher glucose metabolism, which is characteristic of uncontrolled growth of tumour cells. However, PET alone lacks correlative anatomical information. Conversely, CT lacks this physiological information but provides superior definition of anatomical detail, tumour localisation and tissue density. The 'marriage' of the two modalities as a PET/CT provides combined imaging acquired at the same time without patient motion and is superior to either PET or CT imaging alone.

This allows incorporation of biological, molecular, and pathophysiological parameters directly into the radiation therapy algorithms. Incorporating these principles has several aspects for the therapy algorithm, that all build on each other: Proper staging, anatomical and molecular target delineation for radiation therapy planning and image-guided treatment, treatment adaptation, and outcome prediction, and treatment adaptation based on outcome predictions during or after therapy (Fig. 1).

Ample evidence has now accumulated that lung tumour delineation can be significantly refined by the use of PET/CT compared to CT alone, and impact treatment planning in half of patients. Improved delineation of the target volume by PET CT *reduces the target volume* in approximately one fourth of patients, especially for lesions masked by non-cancerous tissue (fibrosis or atelectasis), that is very challenging to differentiate from tumour by standard imaging. Reducing the target volume permits a decrease in the radiation dose to dose-limiting normal tissues (lung, spinal cord, oesophagus), and provides the opportunity to escalate the radiation dose for better tumour control. Conversely, an *increase in the target volume* based on PET/CT occurs in about one fourth of cases, where PET/CT identifies tumour involvement that is not evident by CT alone.

Integrating PET-CT into the radiation therapy planning process has the potential to reduce risk for inadequate coverage of the tumour within the radiation ports ('geographic misses'), and reduces inter-user variability in target definition. The higher precision in delineating tumour extent, and excluding non-cancerous tissues, open the door to *dose escalation* to the tumour while omitting large margins or 'elective' target volumes. Radiobiologic modelling studies of such dose escalation in stage N2-3 lung cancer have estimated an increase in tumour control probability by 13-18% - surpassing the gains achievable by many adjuvant therapies.

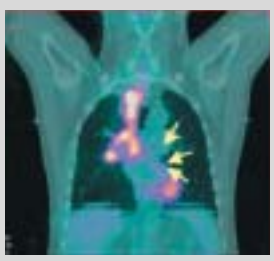
Similarly, in head and neck cancer, target delineation through PET/CT fusion has shown benefit. Initially used to assess tumour response and guide management of involved cervical lymph nodes after radiation therapy, the technique of co-registration has evolved to *PET/CT-guided intensity-modulated radiation* (IMRT). This enables selective intensification of the radiation dose ('*dose painting*') in tumour sub-regions that are most metabolically active or in hypoxic areas using ^{18}F-MISO PET/CT as a hypoxia tracer.

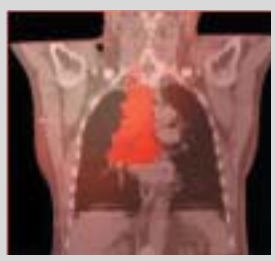
Now that PET/CT planning is becoming established in lung, head and neck cancer, other tumours, such as gastrointestinal, anal carcinoma, prostate carcinoma, lymphoma and gynaecologic tumours are also being studied. For example, at initial diagnosis of anal carcinoma, 15-39% of the inguinal lymph nodes are involved. In the future, PET may be used as a decision tool whether to include the inguinal nodes to the target volume or not (Fig. 2)

However, the use of this new paradigm is not without challenge. Not all metabolically active areas within malignant lesions represent tumour. Inflammation and radiation-induced reactive changes can represent challenges. Although PET/CT has reduced inter-observer variability in tumour delineation and has further refined how we 'see' tumours in anatomical and metabolic aspects, the optimal use and the proper integration of this relative expensive technique into cancer therapy has to be further defined and long-term follow-up studies to assess the impact on ultimate therapy outcome have yet to be completed. This novel approach holds the promise to improve cancer care in many malignancies. Its effective implementation will bring us closer to a *Personalised Radiation Medicine* approach in cancer therapy.

For more details on this topic see our upcoming Symposium:
www.mr-pet-ct.com

Integration of PET/CT into the radiation therapy planning process





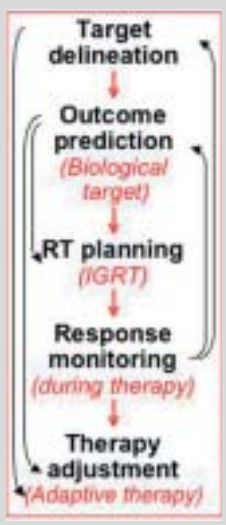


Fig. 1: Combined Anatomical and Molecular/Biological Tumour Targeting
Anatomical imaging alone by radiation planning CT (left, arrows) shows indistinct contours of the lung tumour. The PET fusion in treatment position shows the metabolically active tumour and lymph nodes (yellow/purple). The target volume (shown in red) for the radiation therapy plan is based on the combined anatomical (CT) and molecular/biological (PET) information (centre).
In addition to tumour targeting for initial radiation therapy planning, molecular imaging is being explored for outcome prediction. Repeat imaging during or after radiation therapy can be used for image-guided therapy adjustment, and to guide further therapy (right).

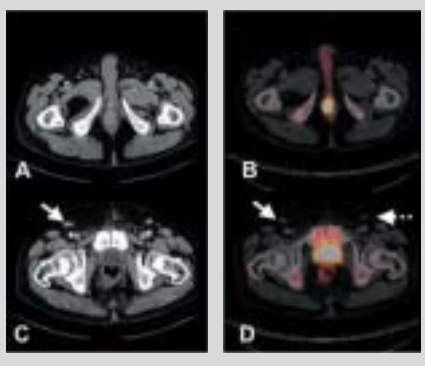


Fig. 2: Contrast-enhanced CT (A, C) and F18-FDG-PET/CT (B, D) of a male patient with anal carcinoma vividly demonstrating the added value of PET-CT for target volume definition. Conventional CT shows a questionable mass in the anal canal; however the exact extent of the tumour cannot be differentiated from the sphincter muscle (A, arrow). PET/CT (B) clearly identifies the tumour by visualising the increased glucose metabolism. Similarly, a right inguinal lymph node, which appears within normal shape and size ranges in contrast enhanced CT (C), can be identified as malignant node by increased glucose metabolism in PET/CT (D) and can be differentiated from a normal contralateral inguinal node (dashed arrow)

MR contrast agents: A step up from compartmental to targeted imaging

Andrea Martini and **Joerg Larsen**, of the Institute for Roentgendiagnostics, Braunschweig Teaching Hospitals, Germany, discuss nanotechnology, hybrid imaging and the quest for a personalised medicine

Gadolinium is dominating current clinical applications for contrast media in MRI. Nonetheless, recent developments somehow follow the evolution of approaches in Nuclear Medicine over two decades ago: Specifically, the attempt to image a physiological environment and pathological processes in vivo is what unites new approaches to modulate image contrast and with the additional advantage of ever increasing spatial resolution. This article aims briefly to review current MRI contrast media usage, the variety of creative approaches to new exogenous media and the state of their development, highlighting particularly interesting or promising concepts.

The issue of image contrast is inherent to MRI. The natural desire to differentiate structures and reflect function has previously been explored in Roentgen applications. However, owing to the particulars of ionising radiation physics, k-edge characteristics of only a few agents could be exploited, namely iodinated, Barium sulphate-, Gadolinium- and other heavy metal-based compounds as well as gases. These have been applied to what are essentially compartment-based approaches that may be used to image the vascular system, gastrointestinal tract or other body cavities. However, in MRI, contrast agent development has been more diverse and can only be considered as a market issue today. With current use quoted for between 20 and 40% of MRI scans, depending on body area, the development of Gadolinium compounds in the 1980s was a particular success story and the largely intravascular use of MRI contrast media were originally used to make unspecific lesion detection easier, i.e. to contrast focal pathological processes, such as inflammation or tumours, against normal tissue background. Lesion characterisation also became possible through repeated scanning following contrast medium administration and was advanced with the introduction of hepatic agents. As hard- and software capabilities improved, fast imaging became a reality and today we routinely image and analyse the first pass of a contrast agent in perfusion studies. Beyond a need for acceptable tolerability, there are no set requirements new agents must fulfil. Quite the contrary, with developments in image acquisition, more specific clinical questions allow for more specific contrast media.

Para- and superparamagnetic properties have traditionally been exploited in MRI contrast agents: Unpaired extranuclear electrons act as strong magnetic dipoles and affect hydrogen nuclei in their vicinity. Gadolinium (Gd) with seven, manganese (Mn) with five and iron with three such unpaired electrons, all shorten both the T_1- and T_2-values respectively. However, the T_1-effect is greater and results in a rise in signal intensity in areas of contrast media uptake on T_1-weighted images. Compounds based on these materials have therefore been called positive agents. In contrast, very small particles of iron are too small to be ferromagnetic but they may be magnetised, a state that renders them superparamagnetic. The resulting susceptibility leads to a signal intensity decrease on T_2*-weighted images and a negative image contrast, an effect that can exceed that of Gd by well over an order of magnitude [Jensen]. Gd-compounds are available as soluble agents while the ferumoxides come in colloidal solutions (superparamagnetic iron oxide, SPIO).

While Gd-based agents will primarily increase the contrast between normal and pathological tissues when there is an increased vascular permeability, such as in breakdown of the blood-brain-barrier, the site of iron-induced MR relaxation depends on particle size: Larger SPIO will accumulate in the reticuloendothelial system and permit detection and characterisation of focal hepatic or splenic lesions, while smaller particles have a much prolonged intravascular residence and can be used as blood-pool agents. New approaches focus on even smaller, ultra-small USPIOs, enabling cell tracking and the labelling of macromolecules, specifically, antibodies.

In addition, there has been renewed interest in manganese as a cofactor in several critical biological functions where it may serve as a surrogate marker of calcium influx in cerebral or

continued on page 20

continued from page 19

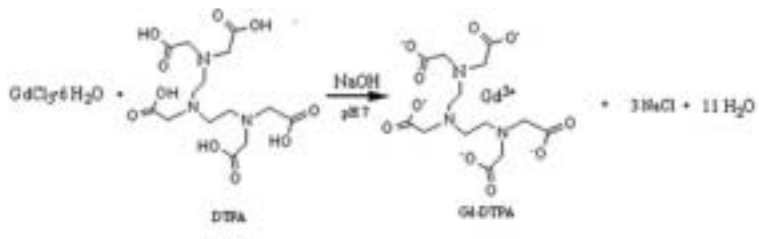
cardiac applications, e.g. to assess tissue viability. Manganese may also bind to particular intracellular sites, giving rise to a unique tissue contrast, which has been used to distinguish neuronal cell layers, e.g. in the amygdala and hippocampus [Koretsky and Silva]. Finally, intracellular manganese can be tracked as it is passed on between neurons and neuronal connections may thus be traced in this way. However, certain states of manganese are toxic and some of the above experiments have been conducted in rodents at doses which are not suitable for the use in humans.

In the late 1990s, a new chapter has opened in MR contrast agent research. Proof of concept was provided for yet another class of agents, however, utilising very different

mechanisms: Nanotechnology in targeted or molecular imaging aims to provide specific and sensitive detection of molecular targets that are far too small to be considered with conventional MRI techniques. This approach is analogous to immunohistochemistry, in situ hybridisation, and some scintigraphic methods and positron-emission-tomography [Wickline and Lanza]. While there is considerable experience with issues surrounding the selective binding to target epitopes, the development of agents that provide a sufficient contrast-to-noise ratio to visualise even a single cell constitutes the actual challenge. Nonetheless, this has been realised for some applications in standard clinical MRI settings although mechanisms explored and potential clinical applications are too diverse to attempt to describe the current state of all developments and try to evaluate their future roles.

Nonetheless, a few specific agents from cardiovascular, rheumatologic, neurological, oncological and endocrine research shall be referred to briefly to illustrate the variety of possibilities: Tang has used USPIO particles to detect and characterise the degree of inflammation in atherosclerotic carotid artery plaque, which is today considered the culprit process in plaque instability and subsequent stroke illness. Macrophage activity has been equally assessed in an experimental arthritis to consider MR-based monitoring of disease progression and the effect of therapies [Simon]. Equally, iron oxide accumulation has been shown in spinal nerve roots in a rat model of autoimmune neuritis when uptake interestingly occurred already at a preclinical stage [Stoll]. In a rat-model of transient cardiac ischaemia, French has demonstrated enhancement in hypoxic but later re-perfused muscle using an iron oxide-labelled monoclonal antibody against endothelial cell adhesion molecule PE-CAM 1 at 4.7 Tesla. This could thus serve as a memory agent for ischaemic events. Spuentrup has shown that fibrin clots implicated in acute pulmonary and cardiac thrombo-embolic events can be visualised in swine models at 1.5 T using a prototype Gd-peptide which specifically binds to fibrin. A very high accuracy in focal solid pancreatic lesion detection has been reported for the commercially available Mn-compound Mangafodipir, although the differentiation between inflammatory and neoplastic lesions was poor in that study [Zanello]. Also using Mn-enhancement, beta-cell activation could be visualised in cell culture experiments, perhaps allowing a non-invasive assessment of beta-cell mass and functionality in future [Gimi].

Particular efforts have also been directed at the labelling of stem cells to allow their tracking during therapeutic uses when confirmation of 'delivery' and early cell migration are of crucial interest. Iron oxide nanoparticles have been favoured for this purpose, since approaches using radioactive materials have suffered from short-lived tracer activity. Drug delivery may similarly be visualised in this way.



A further field looms: the labelling of gene constructs to ascertain the site and expression of certain genes in the context of gene therapy. These developments must be realised in an environment of optimised image acquisition, post-processing and mathematical analysis, a fertile cocktail of opportunities to further exploit biological specificity as outlined by Roberts PL et al. [Eur J Radiol 2000;34:166-].

What evolves from within the mist of this array of new molecular diagnostic agents may be what has been called *personalised imaging*, the attempt to tailor investigation and therapy to the way a particular illness expresses itself in an individual. However, while embracing these exciting developments, we must not forget that contrast agents are drugs and the fact that it took over 20 years to recognise nephrogenic systemic fibrosis as one of the most harmful side effects of Gadolinium compounds is a sad reminder of this simple truth. Appropriate licensing procedures are therefore mandatory, although the process of development of new contrast media is primarily a technological innovation that leads from the idea of a technical possibility through the conception of a usable compound to finding an application as an imaging tool and market development. This relies on co-operation between academic researchers and industry but priorities on patents may dominate developments as emphasised by de Haen [TMRI 2001;12:221-]. In all this, there is yet another crucial point to consider: As has been pointed out by Rinck, contrast agents require hardware to image them and developments in these markets have not always been synergic [www.emrf.org]. The basic fact that soft tissue contrast and the physical properties of MR contrast agents change and change independent of one another with rising field strengths [Rohrer M et al. Invest Radiol 2005;40:715-] is only the most obvious reason why the career of a novel contrast drug may be unpredictable. Given current bureaucratic obligations in the licensing process and patent-related legal implications, it can take years before a new compound reaches the market and, suddenly, a new hard- or software development comes along and renders the new agent obsolete. We note, for example, that the first work-in-progress PET-MRI-System was presented last year, using next-generation detector technology and featuring acceptable scan parameters such as a spatial resolution of 3 mm, currently sufficient for brain imaging. While the developers and many others primarily see the introduction of further hybrid-modality imaging technology as a commercial development, it will allow new ways to study cerebrovascular and degenerative brain diseases in particular.

Conclusion

New approaches to modulate tissue contrast in MRI are plentiful and diverse and almost all are very much in their developing stages. Evolving methods are faced with a patent-driven market in which only large-scale applications may advance into the latter stages of clinical trials. These include common uses such as occlusive vascular or tumourous diseases. Many invariably cost-ineffective but intriguing concepts in MR contrast media research may therefore require a certain amount of protection or fostering to succeed. Such policies have long been considered for rare medical diseases [Hughes DA et al., Q J Med 2005;98:829-] and may be needed to allow for a small but medically required research and specialist applications market. Irrespectively, the search for contrast in MRI applications is likely to take us to a more facetted picture than may have been imaginable in the early days of the technique.

Full article and reference details: j.larsen@klinikum-braunschweig.de

A novel PET tracer for early detection of Alzheimer's

Amyloidβ, (Aβ) plaque formation is a hallmark of Alzheimer's disease (AD) and precedes the onset of dementia. In a recent issue of *The Lancet Neurology*, Australian researchers reported the first data on the validity in humans of a new PET tracer binding to Aβ. Their data suggest that ^{18}F-BAY94-9172 of Bayer Schering Pharma AG can reliably detect Aβ deposition and thereby aid early diagnosis, differential diagnosis, and therapeutic monitoring in AD.

At present, Alzheimer's disease can only be diagnosed at an advanced stage, i.e. when the patient is already suffering from distinct cognitive impairments. Moreover, the development of novel, improved therapies for Alzheimer's will greatly benefit from in-vivo imaging procedures that can track the pathology of the disease at very early stages.

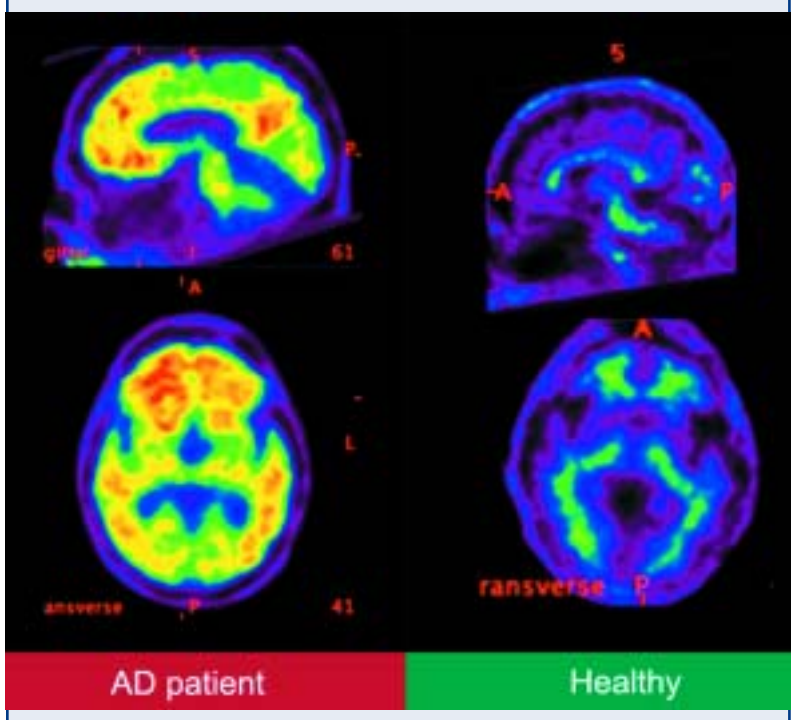
Bayer Schering Pharma AG researches and develops new, innovative diagnostic agents – not only for CT and MRI, but also for molecular imaging. Research in this field is focused on the development of tracers for the early diagnosis of tumours and follow-up cancer treatment, as well as neurodegenerative disorders like Alzheimer's.

'We are very happy that early clinical research studies with our most advanced PET tracer have been successful,' said **Dr Ludger Dinkelborg**, Head of PET Research at Bayer Schering Pharma. ^{18}F-BAY94-9172 was studied in 15 patients with mild AD, 15 healthy controls, and five patients with a non-amyloid degenerative dementia (frontotemporal lobar degeneration, FTLD). The novel PET tracer was shown to be able to discriminate between AD, FTLD and healthy controls. Moreover, binding of ^{18}F-BAY94-9172 matched the reported post-mortem distribution of Aβ plaques. The detection of beta-amyloid in the brain would enable physicians to exclude Alzheimer's in case of negative scans, or to establish the diagnosis in case of positive scans.'

Based on these results, the company will start the clinical development of ^{18}F-BAY94-9172 this year.

'Thanks to molecular imaging, an early and precise diagnosis of, for example, Alzheimer's or certain forms of cancer, is becoming very likely. We are hopeful that it will become a routine hospital procedure in less than 10 years,' Dr Dinkelborg said. The development of molecular imaging tracers is a complex iterative process that requires close co-operation between interdisciplinary preclinical and clinical teams. 'Bayer Schering Pharma is therefore collaborating with a worldwide network of partners from the biotech field, academia, pharmaceutical companies and manufacturers of imaging devices,' he added. 'Most recently, for example, with four other partners from German industry and the German government, we announced a joint investment of €900 million in molecular imaging research. This *Innovation Alliance on Molecular Imaging* will provide funding for joint projects involving the research and industry sectors. The aim is to develop new tracers, devices and software.'

www.bayerscheringpharma.de



Personalised medicine? It's on the move!

Integration has become a keyword when discussing present and future challenges in healthcare worldwide. Companies such as Siemens have already begun to change business concepts by offering services that cross departmental boundaries. However, the basis of full integration is a good IT network and compatible technologies. *Daniela Zimmermann,* of European Hospital, asked Tom Miller, CEO of Workflow and Solutions, Siemens Healthcare, and Dr Bernd Montag, CEO of the Imaging and IT Division of Siemens Healthcare, about the huge challenge they face.

In addition, in the article '*Diagnostics: Uniting the lab and radiology*' (Laboratory section of European Hospital — page 10) Jackie McDowell, Head of Integrated Diagnostics and Market Development at Siemens, presents further reasons behind the Siemens Healthcare acquisitions of DPC, Bayer Diagnostics and Dade Behring.

DZ: ***How will integration benefit healthcare?***
Dr Bernd Montag: Progress in medical imaging – working closely with laboratory diagnostics by using sophisticated information technology – will lead to an earlier and more reliable diagnosis and localisation of diseases, for example cancer or cardiovascular diseases. Already many examples, such as the diagnosis of breast cancer, show that the combination of in vitro and in vivo diagnostics increases the quality of care significantly. If, for example, the existence of a tumour can be verified using a lab test, then it can be localised and typified by using innovative imaging methods, such as mammography, ultrasound or magnetic resonance tomography.

On the other hand, medical imaging plays an important role in the field of acute care, (e.g., when trauma patients must be examined quickly). The University Hospital Erlangen recently installed our brand new CT system, the SOMATOM Definition AS, directly in their trauma centre. Now, patients can be examined from head to toe within seconds.

We should also note the enormous potential of such innovative systems in the field of functional imaging. Here, trendsetting technologies, such as ultra-high-field magnetic resonance imaging, allow an unprecedented view into the human body. This, for example, dramatically increases our understanding of the causes of many neurological diseases, such as Alzheimer's or Parkinson's. This understanding of the genesis of diseases is the prerequisite to develop new and even more individualised therapies for people all around the world, as well as to discover new possibilities in preventing diseases.

DZ: ***Although everyone is discussing the full integration of medical workflow, no-one seems to have a clear idea what it really entails. So, first, who is involved in any kind of integration?***
Tom Miller: The answer is simple: Everybody! Looking at the near future, most very forward thinking healthcare providers are looking at care teams, instead of single clinicians, because the likelihood that a single individual could assess all the medical knowledge necessary to handle the complexity of care that our aging population requires is increasingly low. The real problem for hospitals will become patients with three or four conditions. For example, to exaggerate that, it could be a HIV-positive, diabetic, schizophrenic patient with chest pain. Therefore, it's not a single clinician who will treat that patient, but a whole team. In this scenario, a question arises: How can we co-ordinate all the data and how do we ensure the team works efficiently? So every clinician would be frustrated by the lack of holistic information surrounding the patient.

Another example, if a patient has shown up for a radiology examination, and the radiologist does not know what to image, that is a worse case scenario of inefficiency – and it's not that rare. An analogue problem occurs looking at treatment options: How does knowledge arrive today? Most often through epidemiology — in other words, we must wait ten years, see what happens to the patient, and then change the standard of care. Again, the problem is due to a lack of available information.

Tom Miller: 'How do you treat the HIV-positive, diabetic, schizophrenic patient presenting with chest pain? By making the necessary information available for personalised medicine'

So, in terms of integration, this not only means creating teams but, more importantly, also creating networks of knowledge – through IT. This can be used to bring epidemiological data together, by collecting relevant data from all over the world. So information about treatment options can be obtained in six months instead of ten years.

Another example: Only ten years ago the breast cancer death rate was significantly higher and it was seen as only one disease. Now we know there are different forms and these may be diagnosed through digital mammography followed by biopsy, which then leads to a blood test to evaluate HER-2/neu serum levels that show a special protein. Its presence can lead to a Herceptin regimen, which is only effective in a certain type of breast cancer, and contra indicates for certain chemotherapy agents that are given at the same time, and can cause congestive heart failure. So, cardiac enzymes must also be tested.

That example describes a very personalised treatment for a particular breast cancer, which is only possible with the ability to bring all the pieces of information together – via a personal exchange as well as a technological exchange.

Are these future scenarios, or are they happening already?
TM: The availability of information and a clinical workflow based on IT is already happening with our Soarian system. To continue the example of breast cancer, we can take women from screening to biopsy, testing, guided chemotherapy, surgery, through to radiation therapy with all the data from her pre-existing therapies, which are necessary to understand each single step along the treatment of that disease.

Of course this is a very ambitious approach, but we are already very successful with it; Soarian already runs in seven hospitals in Europe with 57 automated workflows. Some university hospitals, such as the University Hospital Eppendorf in Hamburg, Germany, are very forward thinking. They plan to implement Soarian and, from the CEO down, only speak of the optimisation of care processes throughout the enterprise.

The advantage of our Soarian is that we have designed the system to take into account the fact that information comes from many different places. It is the only service-oriented architecture that can manage and process data from other sources and treat it as if it were integrated – a single source. This is the only way such a data process can work, because there are hardly any hospitals working with homogenous IT and technologies across all departments.

How does Siemens deal with its own internal integration of different business units?
TM: It's a huge change. Siemens established a new organisational structure and created the Workflow and Solutions division to co-ordinate all our business units: cardiology, women's health or oncology, aiming to figure out how best to take this incredibly rich set of technological resources and apply it efficiently to these disease settings. It's also an absolutely new approach – applying a disease-centric focus, rather than a technological focus to solutions. It's a huge opportunity that will provide us with the tools to manage future healthcare challenges

Cardiovascular molecular imaging
Is it ready for internal medicine diagnostics?

Imaging in Internal Medicine is among the main topics for *114th Congress of the German Society of Internal Medicine* (March. Wiesbaden). Specialists in internal medicine, radiologists, and nuclear medicine have developed a programme that will not only provide an overview of the values of modern imaging procedures but also tackle controversial subjects.

Professor Wolfgang Bauer MD (Würzburg) specialist in molecular imaging and with special expertise in the cardiovascular field, writes: 'The objective of molecular imaging is to capture physiological and pathophysiological processes on a molecular to cellular level, not only to gain new insights but also to be able to use appropriate therapy strategies at an early stage. Optical technologies, ultrasound, nuclear medical procedures and magnetic resonance imaging (MRI) are all suitable imaging procedures. The latter two procedures have particular potential for clinical use. Two topics are especially relevant for cardiovascular medicine: arteriosclerosis in the coronary vessels as the cause of heart attacks and healing of the heart after the occurrence of heart attacks.

The motivation for the first topic is that the cause of a heart attack is a tear in an unstable arteriosclerotic plaque. A thrombus then forms on this tear which, in turn, blocks the coronary vessel and therefore interrupts the blood supply to the heart muscle. The problem is the non-invasive identification of this unstable plaque as it normally doesn't much restrict the coronary vessel, and therefore does not produce any symptoms. The plaque is also not characterised by an excessive calcification so that CT, for instance, is of no help here. However, molecular imaging should be able to capture and show the appropriate cell structures known to us from cellular and molecular biology. It is known, for instance, that active macrophages are located in the unstable plaque. These can be shown, for example, through unspecific absorption of ferrous nanoparticles (Jaffer, Libby et al. 2006), or through MR contrast media that specifically bind to surface markers of these cells (Amirbekian, Lipinski et al. 2007). It is also possible to identify early forms of arteriosclerosis. Here we make use of our knowledge that, even in the beginnings of arteriosclerosis, there are so-called adhesion molecules that line the inner walls of the vessels to which we can bind specific magneto-optical contrast media (Nahrendorf, Jaffer et al. 2006). These methods are invaluable for fundamental research. However, use on a patient will require more time because, aside from contrast media development, non-invasive imaging of coronary vessels also still requires significant improvements.

The particular relevance of myocardial healing for imaging results from the observation that, in many patients, the pumping capacity after major attacks declines continuously. Therefore it is important to promote myocardial healing in the best possible way straight after the occurrence of a

Professor Wolfgang Bauer

heart attack. For regenerative therapies, hope rests on the administration of pre-stem cells. It is already possible to capture the cell distribution in a patient's heart muscle using nuclear medical technologies (Hofmann, Wollert et al. 2005). But, we must emphasise that this is still an experimental procedure. In other areas there are approaches, for example to make scars as firm as possible through the modulation of wound healing factors, such as factor XIII. Verifying the efficiency via imaging is crucial and has already been achieved with nuclear medical procedures in animal experiments (Nahrendorf, Hu et al. 2006). The lack of spatial resolution was compensated by using fusion imaging via MRI (Sosnovik, Nahrendorf et al. 2007). Further strategies have tried to impact on programmed cell death (apoptosis) which is an important factor for the development of heart insufficiency after the occurrence of heart attacks. In animal experiments it has been possible to achieve apoptosis imaging with MRI (Hiller, Waller et al. 2006) and optical contrast media (Sosnovik, Schellenberger et al. 2005), which bind to surface molecules specifically present in apoptotic cells.

In conclusion, molecular imaging offers fascinating opportunities for fundamental, medical research to study processes in a largely non-invasive manner and to derive and verify the according therapy concepts. Molecular imaging is still in its beginnings with regards to direct use on patients. Ideally, we would be able to obtain optimum levels of information by combining highly sensitive, nuclear medical procedures and morphologically functional, high resolution MRI in the sense of fusion imaging.'

MR probes for molecular imaging

By **Silvio Aime**, of the Department of Chemistry & Molecular Imaging Centre, University of Torino, Italy

Silvio Aime

Molecular imaging aims at the in vivo quantitative visualisation of molecules and molecular events that occur at cellular level. The potential towards clinical translation is huge, because the same modalities used in medical imaging are used in molecular imaging investigations.

Traditionally, medical imaging was a tool for non-invasive mapping of anatomy and for the detection and localisation of a disease process. The advent of molecular imaging-based protocols will allow the detection of the onset of diseases at an early stage, well before the biochemical abnormalities result in change in the anatomical structures. Moreover, it will offer efficient methods to monitor the effect of therapeutic treatments.

Molecular imaging agents provide the crucial link between the specificity of the target and the quantitative visualisation of its *in vivo* distribution.

The possibility of carrying out molecular imaging protocols by means of MRI is very attractive for the superb anatomical resolution that is attainable by this technique. However, MRI suffers from an intrinsic insensitivity with respect to the competing imaging modalities that has to be overcome by designing suitable amplification procedures based on the development of reporting units endowed with an enhanced sensitivity and on the identification of efficient routes of accumulation of the imaging probes at the sites of interest. MRI definitively suffers when compared with nuclear medicine and optical molecular imaging techniques for the set-up of molecular imaging protocols, as its low sensitivity implies the use of 10^7-10^9 imaging reporting units per cell, when few are necessary for the latter modalities. Now, the need to target molecules that are present at very low concentration requires the development of novel classes of contrast agents, characterised by enhanced contrasting ability and improved targeting capabilities. Efficient targeting procedures for cellular labelling and recognition of epitopes characterising important pathologies are therefore as important as the task of developing more efficient image contrasting units.

The possibility of delivering a high number of imaging agents to the target of interest appears the solution of choice, to overcome the drawback associated with the low sensitivity of the MRI approach. The use of metal-based particles entered the armoury of MRI contrast agents very early, with the Superparamagnetic Iron Oxides' family, which are still among the most sensitive systems. Currently, much attention is devoted to the design and use of self-assembled systems based on lipophilic molecules, where the imaging reporters are invariably represented by highly stable paramagnetic lanthanide (III) complexes. In general, whatever the paramagnetic lanthanide (III) ion is, the particles act as T2-susceptibility agents whose contrasting abilities increase by increasing the magnetic field strength. In the case of Gd(III) complexes, the systems act mainly as T1-relaxation agents whose efficiency is eventually enhanced by the long re-orientation time of supramolecular aggregates. In addition, to tackle sensitivity issues, such systems may also be designed in order to become responsive to a specific physical or bio-chemical parameter of the micro-environment in which they distribute. Moreover, nano-sized carriers for Gd-complexes based on naturally occurring systems (e.g. lipoproteins) have also been considered for targeting specific epitopes on diseased cells.

Finally, the structure of liposomes has been exploited to generate a novel class of CEST agents (CEST= Chemical Exchange Saturation Transfer) dubbed LipoCEST. Such systems are characterised by containing a shifted resonance for the water molecules entrapped in the liposomial cavity, which can be selectively irradiated in order to transfer saturated magnetisation to the 'bulk' water signal. In this way, one deals with frequency-encoded MRI contrast agents that open the interesting perspective of detecting more than one agent in the same anatomical region. All together, the achievements made in the use of these nano-carriers in MRI applications also represent the basis for the development of the field of imaging of drug delivery processes. The superb anatomical resolution provided by MR images, together with the availability of targeting and responsive agents, will allow the clinician to pursue the task of visualising the delivery of drugs at the diseased region and, even more important, to monitor the therapeutic output in real time.

Finally, much is expected from the use of hyperpolarised molecules, because it has been shown that hyperpolarised C13-pyruvate can act as an efficient metabolic reporter for cancer cells in prostate tumour bearing mice.

By **Rudolf Schwarz** and **Andreas Krüll**, of the Section of Radiation Oncology Department, Ambulanzzentrum GmbH of the University Medical Center Hamburg-Epprndorf

Designed in the 1990s, the TomoTherapy HiArt treatment system looks like a CT scanner, allowing efficient 3-D-CT imaging to be used to ensure daily treatment accuracy for all patients (Fig. 1). It was designed to combine industry standard imaging and helical radiation delivery (Fig. 2). The accelerator, with an energy of six Megavolts in the gantry, is used for CT scanning and irradiation. It delivers intensity modulated radiotherapy (IMRT) that uses tens of thousands of narrow beamlets, producing the most precise conformal radiotherapy available. HiArt delivers radiation from all angles around the patients. The beam is rotated around the body, while the treatment couch simultaneously moves into the machine. The system ensures accurate delivery of precise helical IMRT plans via 3-D image-guided radiotherapy (IGRT), based on daily pre-treatment megavoltage CTs in treatment position for higher accuracy and precision. Necessary adjustments in patient positioning can easily be made using registered planning and daily CT images for references (Fig. 3).

With every treatment fraction, one can see where the anatomy is, compared with where it should be. An overlay of planned dose

NEW . . .

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RadiologySearch.NET

at the ECR

RadiologySearch, developed by the non-profit organisation EduRad in collaboration with radiologists at the Cleveland Clinic in Ohio, USA, is a free next-generation search engine that provides peer-reviewed contents and websites. The engine also combines features such as word and literature searches in radiology journals and scientific articles, or a case file, image and video search.

Dr Roland Talanow, resident radiologist at the Cleveland Clinic, launched the search engine at RSNA 2007 and it will be demonstrated at *ECR 2008*.

The programme is already implemented as a search engine on several websites and in software applications. A further hope is that this fast uncluttered access to radiology data will be used on the websites of radiology societies.
Website:
www.RadiologySearch.net

Helical tomotherapy

offers further assurance that the prescription dose level will cover targeted anatomy. Imaging dose with 1-3cGy is consistently low. The system allows for organ movements. Radiation exposure to healthy tissue and organs is minimised. The system integrates tools for optimised, individualised treatment planning, quality assurance, imaging technology, helical IMRT, recording and verification. Delivery Quality Assurance (DQA) is integrated in the planning software, allowing seamless calculation of the dose with the patient's plan applied to a phantom.

The DQA plan can be selected and delivered from the Operator Station, and compared with point dose and planar film dose measurements. This ensures the prescription will be carried out according to plan.

On average, the full procedure takes about 20 minutes from patients' arrival in the treatment room until they leave. This includes about five minutes for performance of the daily CT and another five to ten minutes for treatment delivery.

The TomoTherapy HiArt-System was installed at our institution in autumn 2006, and up to December 2007, we had irradiated over 120 patients. Comparison of treatment planning showed that helical tomotherapy brings better dose conformality to the tumour and better sparing of normal tissues than 3-D-conformal radiotherapy and intensity-modulated radiotherapy with the step-and-shoot technique.

Many patients with tumours such head-and-neck, brain, upper abdomen, and prostate cancer, benefit from tomotherapy.

It can be used to re-treat patients who had been irradiated and have a local recurrence. It can be dangerous to re-irradiate, because one can risk complications. So it is important to reduce doses to critical, pre-irradiated structures. Tomotherapy can offer this.

Helical tomotherapy can be done for curative as well as in palliative purposes.

Dose escalation over 80 Gy is essential for the primary treatment of prostate cancer. The limiting factor for this dose escalation can be proctitis. Tomotherapy is a safe tool to reduce the rectal dose and minimise the incidence of proctitis. The higher accuracy and precision brings further benefit by reducing the security margins around the targets. Integration of simultaneous boost with higher doses per fraction presents another treatment option (Fig. 4).

The Tomotherapy system allows delivery of a conformal dose or multiple dose levels to complex targets in the head and neck (Fig. 5). With cancers of the tongue, throat, and larynx, often all the lymph nodes must be irradiated, along with the primary tumour. This usually results in permanent damage to the salivary glands with a life-long dry mouth — xerostomia. With tomotherapy doses to radiosensitive structures (e.g. spinal and parotid glands) can be kept low.

Brain tumours: Tomotherapy can treat multiple tumours, such as brain metastases and large or complex shaped primary brain tumours. For brain metastases it is possible to treat the whole brain to a moderate dose and to escalate the dose to metastases by integration of a boost at the time. Another option is to irradiate recurrent brain metastases after previous whole brain irradiation. Tomotherapy brings substantial benefit for the treatment of the neurocranium and the neuroaxis in one treatment plan and process (Fig. 6).

Tomotherapy in a stereotactic mode can also treat lung cancer. Smaller tumours can be irradiated with hypofractionation at the same time, with low doses to the spinal cord and the lung.

Multiple targets especially multiple metastases can be irradiated simultaneously in one treatment plan.

It is important to evaluate every patient's cancer to determine which form of radiation therapy is appropriate. 3-D-conformal radiotherapy, IMRT with step-and-shoot or dynamic leaf or stereotactic radiotherapy, are other methods of irradiation and can be beneficial for special cases.

Fig. 1 Tomotherapy system at the Medical Centre's Department of Radiation Oncology © TomoTherapy Corp.

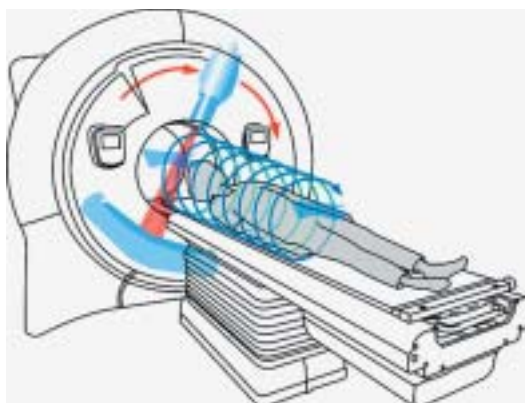


Fig. 2 Tomotherapy HiArt: During imaging or irradiation, the 6MV linear accelerator gantry rotates around the patient as the couch simultaneously moves through

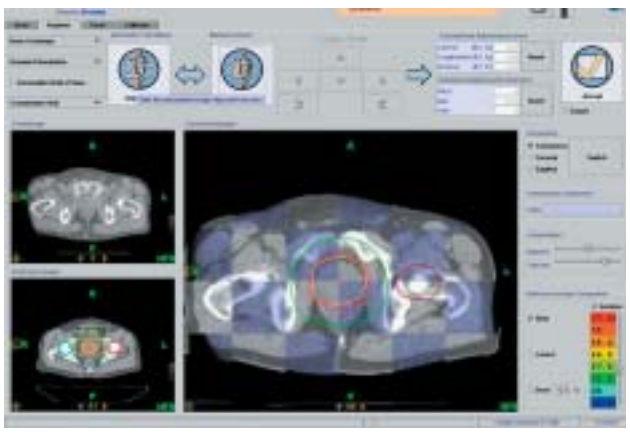


Fig. 3 Adjustments in patient positioning are easily made, matching registered planning and daily CT images

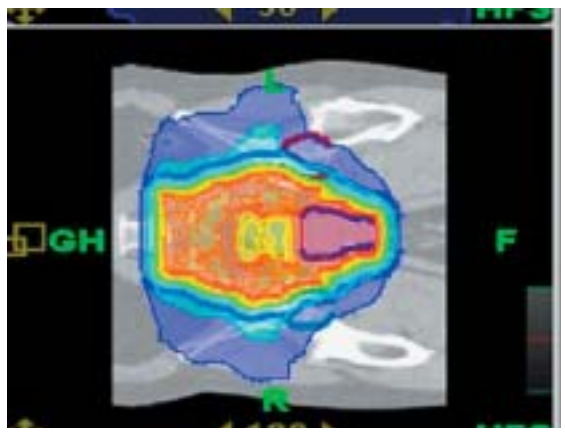


Fig. 4 Integration of simultaneous boost with higher doses per fraction in the treatment of prostate cancer

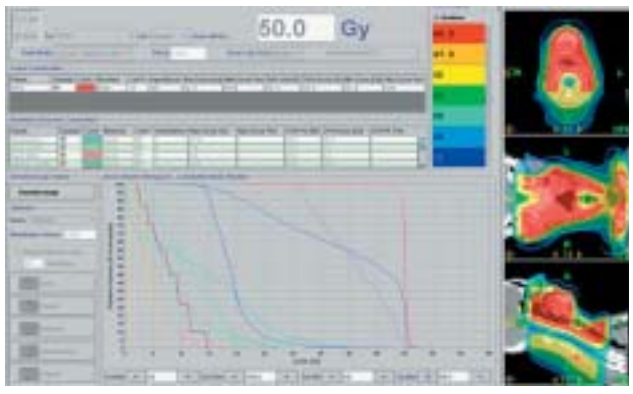


Fig. 5 Tomotherapy of complex target volumes with selective dose reduction for normal tissues, such as the spinal cord

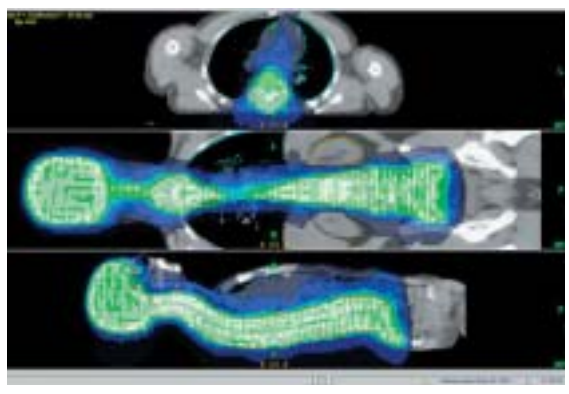


Fig. 6 Tomotherapy of neurocranium and neuroaxis in one volume and treatment process

SAFIRE: THE WORLD'S FIRST DIRECT-CONVERSION R/F-FPD

The 52-bed, acute care Hachiya Orthopaedic Hospital conducts 330 surgical operations annually, including minimally invasive artificial joint surgery and endoscopic surgery. In 1996, the hospital digitised ordering; in 1998, imaging was digitised; in 2004, a urology department was added. **Dr Hiroyasu Yano** reports on the effective use of tomosynthesis in orthopaedic surgery

During orthopaedic surgery, metal implants, plates, and screws are commonly employed. These frequently cause problems with metal artefacts during CT or MRI examinations of bone union and in post-surgical follow-up observations. This is a report on the use of tomosynthesis to restrict metal artifacts in images.

Current tomosynthesis status: Since introducing the flat-panel detector (FPD) in 2005, we have conducted tomosynthesis examinations on 35 artificial joint cases (20 hip, 10 knee, 5 elbow), 8 spondylodesis cases, 3 arthrodesis cases, and 4 osteosynthesis cases.

Evaluation as clinical images: Tomosynthesis images created by the shift-and-add method and filtered back projection (FBP) method were compared with CT images. For this we used the Shimadzu Sonialvision Safire* R/F system with Tomosynthesis Workstation option and the MSCT: Company A, 6-slice CT.

Evaluation of the bone union of the grafted bone is based on the continuity between the grafted bone and original bone, and on the reduction in radiolucent lines. As doctors found evaluation difficult due to the strong enhancement of the FBP image in Fig.3 d), subsequently the shift-and-add method image in Fig.3 c1) was used. The shift-and-add method image in Fig.3 c2) was taken 14 months after surgery. It shows that bone union is almost complete.

Conclusions

Fig.4 compares CT and tomosynthesis images. For a CT examination in which radiography is conducted while rotating the body axis, the significant metal artifacts centred on the metal, and the beam hardening occurring between metals, affect the raw images. Blurring occurs along the path of the X-ray tube during tomography. However, as the images are two-dimensional, the effects of the artifacts are less than with CT. Low-artifact images can be achieved by selecting shift-and-add method images or FBP images according to the aim of the examination.

CT is superior in some aspects, as it allows flexible image reconstruction and produces 3-D images. However, due to concerns about X-ray exposure from radiodiagnosis since the publication of a paper in the Lancet in 2004 (A Berrington de Gozaiez, S Darby: *Risk of cancer from diagnostic X-rays: estimates for the UK and 14 other countries*. Lancet 363: 345-351, 2004), CT examinations have been classified in the highest exposure class of all radiodiagnostic techniques, with a tissue- absorbed dose between 10 and 100 mGy (T Ishiguchi: Risk *Management in Radiology*, Nichi-Doku Iryo, Vol. 31 - 3849, 2004).

As tomosynthesis requires fewer images than CT, the exposure dose should be lower.

Examining these topics and efficiently applying digital image technologies to take even better images in the future should make tomosynthesis an effective means of post-operative follow-up.

** Safire = Shimadzu Advanced Flat Imaging Receptor*

		Radiography	Artifact effects	Artifact generated	Flexble image reconstruction and 3D images	Exposure (thorax)	No. of Images
CT		360 deg. around body axis	Large	Metal artifact Beam hardening	Possible	10 to 20 mGy	200 to 300 average
TomoSynthesis	Shift & add	Linear path, max. 40 deg. With respect radiography position	small	Blurring	Change tomographic plane and slice thickness 3D images not possible	4 to 5 mGy	67 images in 1 direction
	FBP		less than CT	Metal artifact			

Fig. 4

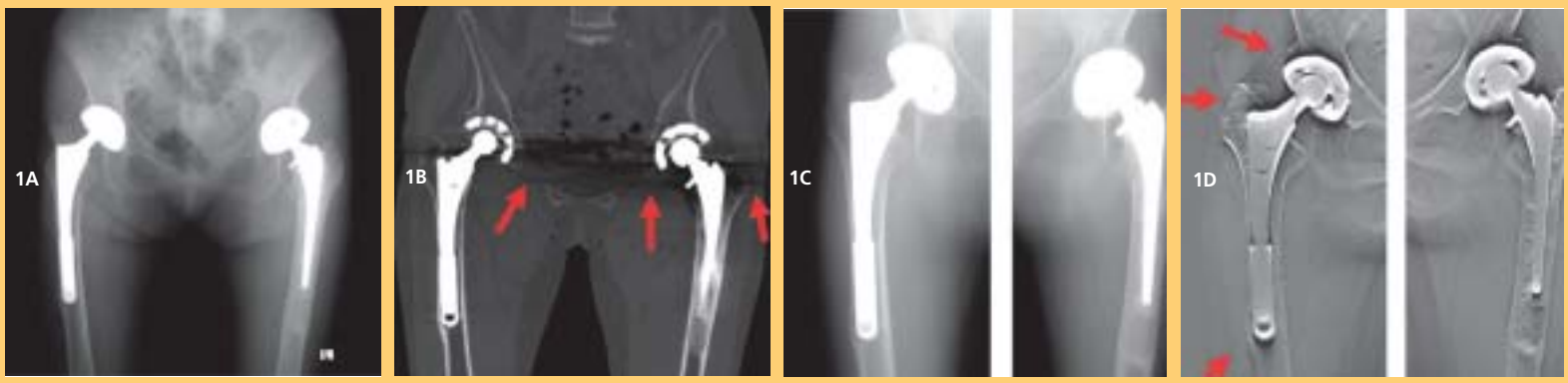


Fig. 1: Post-surgical images of bilateral total hip replacement
Due to looseness of the stem, 11 years after bilateral total hip replacement surgery the left joint was replaced in a 73-year-old female.
The bilateral hip replacement post-surgical CT image in Fig.1 b) includes significant artifacts due to the implant between the acetabulum and trochanter. The shift-and-add method image in Fig.1 c) exhibits no effects of artifacts, whereas the FBP image in Fig.1 d) exhibits artifacts in the tube-shift direction and at the boundary of the implant.

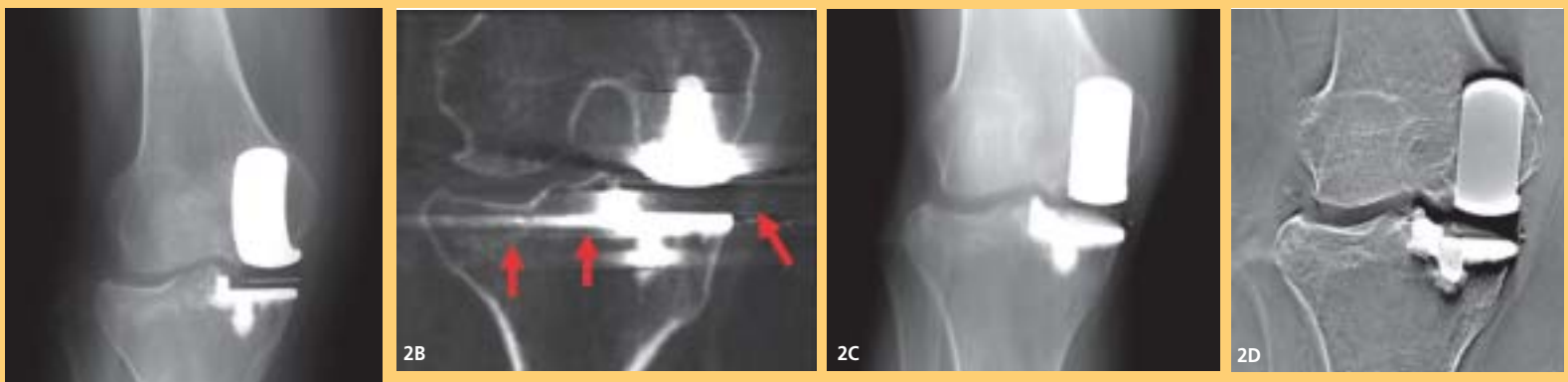


Fig. 2: Fracture after knee replacement
A 59-year-old female, who had undergone knee replacement surgery due to osteo-arthritis, fractured the lateral tibial plateau in a fall. The CT image in Fig.2 b) exhibits effects of the implant artifacts to the lateral side of the tibia. However, these effects do not extend to the lateral side in the shift and add method image or the FBP image (Fig.2 c, 2 d).

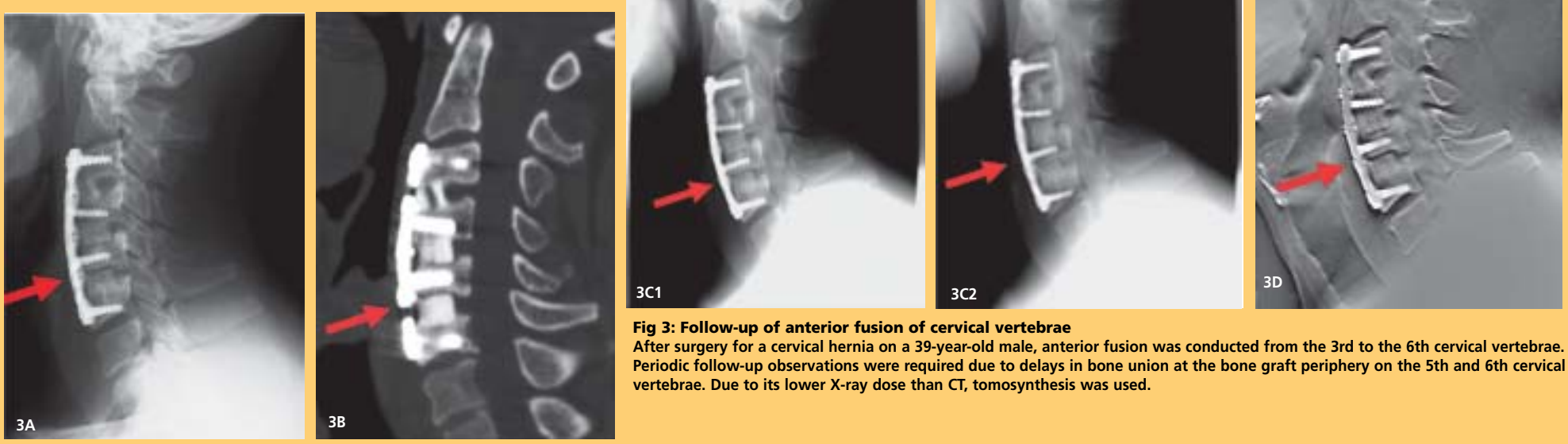


Fig 3: Follow-up of anterior fusion of cervical vertebrae
After surgery for a cervical hernia on a 39-year-old male, anterior fusion was conducted from the 3rd to the 6th cervical vertebrae. Periodic follow-up observations were required due to delays in bone union at the bone graft periphery on the 5th and 6th cervical vertebrae. Due to its lower X-ray dose than CT, tomosynthesis was used.

MR diffusion and perfusion

Can they replace PET?

Marco Essig MD, Professor of Radiology at the German Cancer Research Centre, outlines relevant presentations at the ECR

Prof Marco Essig

While, in the past, MRI was praised mainly for its superb anatomic display and tissue contrast, a number of advanced, non-enhanced and contrast enhanced MR imaging techniques have been developed within the past years that provide new insights into the physiology of tissues and the pathophysiology e.g. of tumours. These techniques include MR-spectroscopy, perfusion MR imaging, dynamic contrast enhanced MRI and diffusion tensor MR.

At the ECR, in a new horizon session, on Friday morning, perfusion and diffusion MRI and their potential in oncological imaging will be described and the provocative question of whether they can replace PET will be discussed on the basis of the latest results from PET and PET-CT, presented by Professor Steinert from Zürich.

Today, the combined PET-CT acquisition is becoming the standard to assess focal and systemic cancer. PET-CT provides an excellent combination of morphological and metabolic imaging and, for example, can identify metastases that are 5 mm in diameter or larger, thanks to metabolic uptake of fluorine-18 FDG. The addition of anatomical information from CT then allows practitioners to precisely locate those metastases. However, lesions that are smaller than 5 mm cannot be detected reliably. This is one area where MRI could perhaps aim to compete. However, whilst FDG-PET is the standard tracer method in most cancer types, alternative tracers with a more specific uptake are being investigated and may enable better imaging of anti-tumour effects involving angiogenesis, apoptosis and reporter gene expression.

Should we see the modalities as rivals and how can they stimulate each other? What can functional MRI learn from PET and vice versa? Another key question for the radiological community, for the panel discussion, is how and when to use MRI instead of PET.

Prof. Herneth (Vienna) will present his results on diffusion weighted imaging in the assessment of lymph node metastases. DTI is a promising new methodology that allows insight into the integrity of tissue, not only of the brain. Lymph node imaging and prostate cancer are good examples to prove the potential use of this method in the description of tumour infiltration. Later in the session Dr. Berger (Munich) will explain how perfusion MRI may assess treatment monitoring in anti-cancer therapy. As at initiation, tumours in a pre-vascular phase are supplied by oxygen and nutrients that diffuse from pre-existing normal vessels, ischemia leads to the secretion of angiogenic factors when the tumour reaches a critical size. These factors, such as vascular endothelial growth factor (VEGF), recruit and maintain tumour vessels that exhibit increased blood volume and permeability compared with normal vessels. MR-based techniques, such as dynamic susceptibility weighted (DSC) MRI or dynamic contrast enhanced (DCE) MRI can be used to measure the blood volume, the vascularity, size of the vascular space within designated areas, and behaviour of contrast within those vessels. DCE-MRI has been investigated for a range of clinical oncologic applications including cancer detection, diagnosis, staging and assessment of treatment response. Tumour microvascular measurements by DCE and DSC-MRI have been found to correlate with prognostic factors such as tumour grade, microvessel density (MVD), and vascular endothelial growth factor expression (VEGF) and with recurrence and survival outcomes (Figure 1).

In addition, changes of DCE-MRI in follow-up studies during therapeutic intervention have been shown to correlate with outcome, suggesting a role for DCE-MRI as a predictive marker. The Munich researchers are trying to find out whether perfusion MRI can monitor the efficacy of anti-angiogenic treatment in kidney cancer. This type of cancer has been shown to respond particularly well to anti-angiogenic drugs. Functional measurements related to the tumour blood supply should provide a surrogate marker of whether the treatment strategy is working. This may not necessarily be obvious from measurements of the tumour size or morphology.

Work to standardise and quantify diffusion and perfusion MRI procedures is just beginning. This will be most essential if multi-centre trials are to be conducted. Dr. Stieltjes (Heidelberg), an expert in quantification strategies for structural and functional MRI techniques, will give a brief overview of how MRI data can be reliably quantified to allow them to be used for follow-up assessments and in clinical trials. Both, DTI and PWI require specifically tuned sequences and extensive post-processing. In his presentation he will illustrate the importance of both sequence development and post-processing, by going through this process for DTI (Fig. 2). The availability of different measurement techniques and their applications will be addressed. Also, he will highlight common pitfalls in DTI quantification and potential approaches to overcome these issues.

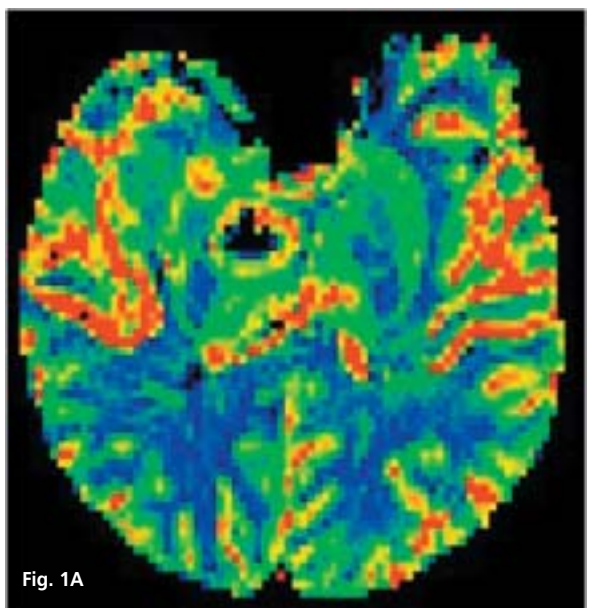


Fig. 1A

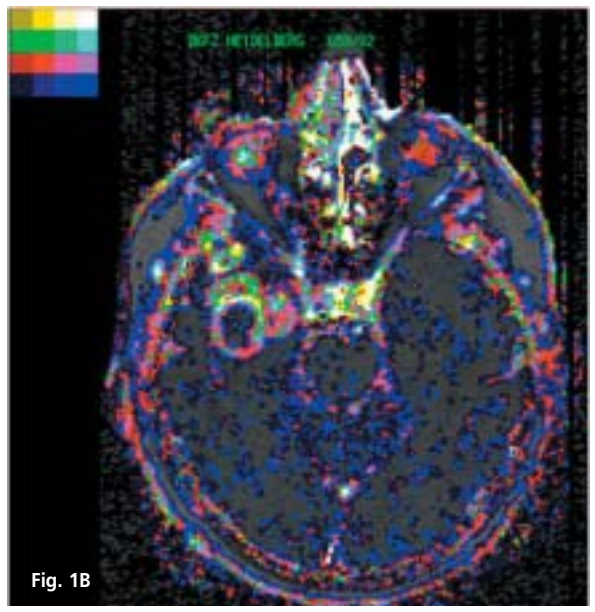


Fig. 1B

Fig. 1. DSC (A) and DCE (B) MRI presenting the heterogeneity of malignant glial brain tumours. DSC acquires a series of EPI images after a bolus injection ofcontrast media and using the indicator dilution theory for quantification of blood flow and volume. DCE MRI acquires a series of GRE images after slow contrast media infusion for quantification of tumour vascularity and vessel permeability. Histology proved the presence of low grade and high grade areas with different vascularity and molecular vascular profiling within the same tumour and in good correlation to the imaging findings

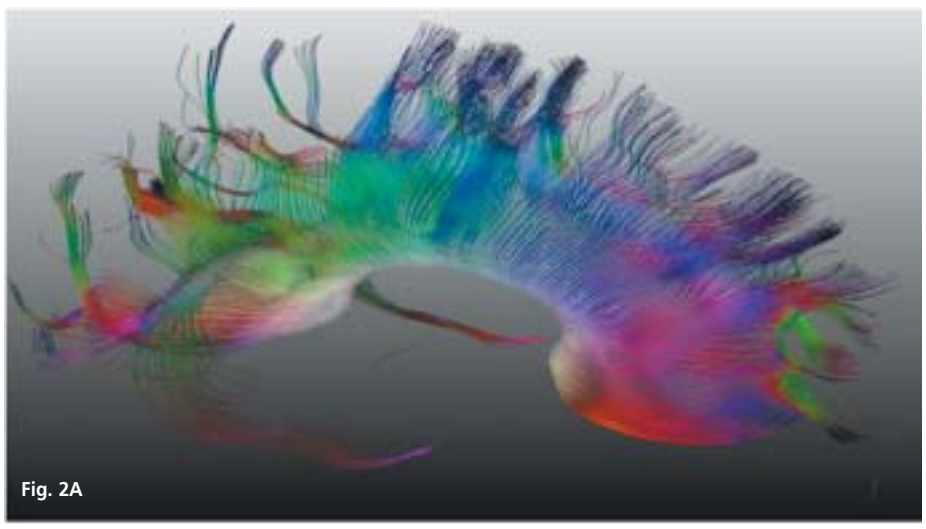


Fig. 2A

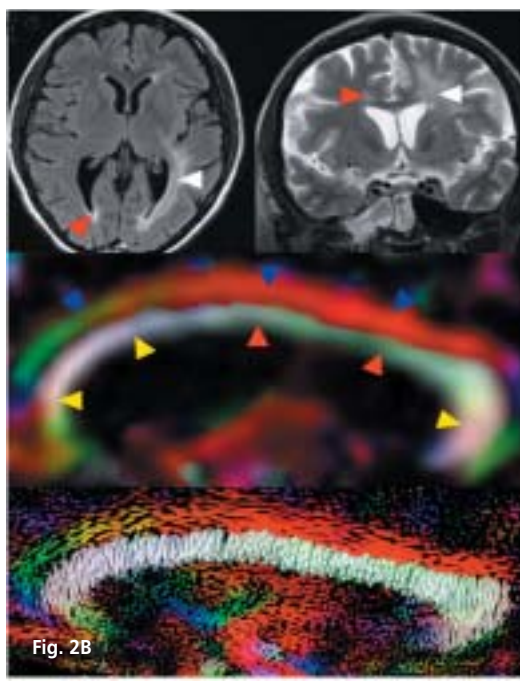


Fig. 2B

Fig. 2: Tractography (A) and quantitative FA mapping in a patient with glioma. FA mapping allows the display of infiltration not visible on conventional T2 and FLAIR imaging

Open High-field MRI

Microtherapeutic interventions under radiological image control

The open high-field MRI in use. Prof. Jens Ricke injects a patient with a slipped disc an analgesic under MRI control

As part of a research and development project, doctors at the University Hospital Magdeburg, Germany, are treating oncology patients with local minimally invasive surgery (MIS) which, for the first time, can be carried out under radiological image control using high-field magnetic resonance imaging (MRI). The system offers excellent image quality under extremely favourable, radiation-free conditions.

Due to the closed, tube-shaped construction of magnetic resonance tomographs, minimally invasive interventions have so far been controlled with the help of ultrasound or CT. However, both procedures have their disadvantages — either the image quality is not ideal or a patient is exposed to additional radiation.

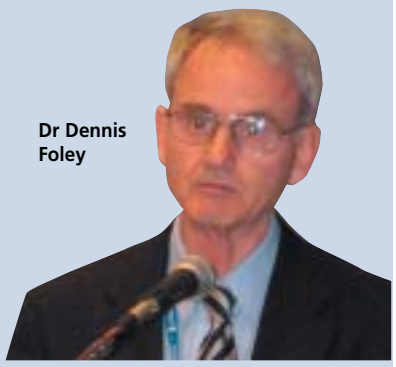
Open high-field MRI can significantly improve micro-surgical procedures. 'This equipment is a milestone for microtherapy: Due to its open construction it offers us doctors the important, free access to the patient which we need for these procedures,' explained Prof. Jens Ricke, Director of the Clinic for Radiology and Nuclear Medicine at the University Hospital Magdeburg. 'Moreover, the new system shows soft tissues with excellent image quality and works without ionising radiation.'

The open version of MRI enables the implementation of microsurgical procedures near tumours, under permanent image control. First studies indicate that minimally invasive procedures, such as image-guided brachytherapy or thermal radiofrequency ablation combined with conventional surgical or chemotherapeutical treatment, can achieve better therapy success with lower follow-up costs.

As part of the project, which the university hospital started with Philips Healthcare, the development of new procedures, such as those against chronic pain, is also to be promoted. There is to be particular emphasis on interdisciplinary co-operation. 'Microtherapeutic interventions are always part of a whole, interdisciplinary concept. The University Hospital Magdeburg develops an individual treatment plan for every patient and puts it into practice, with close cooperation of all specialised areas of medicine involved in the delivery of oncological therapy,' Philips pointed out.

GE high-definition CT technology

High definition CT (HDCT) technology developed by GE Healthcare promises to revolutionise image acquisition for CT scanning. **Dr Dennis Foley**, Director of Imaging at Milwaukee's Froedtert Lutheran Medical Center and the Medical College of Wisconsin was the first to utilise a number of HDCT technologies. Here, for *European Hospital* readers, Dr Foley reports his experiences.



Dr Dennis Foley

HDCT technologies are a portfolio of developments that improve the hardware, software and electronics of the system. From the hardware, GE designed a new scintillator, which should perform dual energy with almost simultaneous acquisition of the projection data at different beam energies. Due to rapid beam energy switching and electronic readout within 8ms, almost identical projection angle data at the two different beam energies can be obtained. This is much faster than a system that is fundamentally mechanical in approach and has two X-ray tubes inside the gantry, which results in a 83ms delay in obtaining the same projection angle at different beam energies.

Potentially, the new scintillator can enable subtraction imaging of coronary artery calcification – a major breakthrough. Today, the challenges in coronary CT are improved temporal and spatial resolution, in addition to the removal of artifacts. Artifacts relate largely to coronary calcification. When performing selective coronary arteriography, subtraction imaging is an integral part of the cardiologists process. If CT can emulate selective coronary catheterisation by removing calcification, this would be a major advance.

Prospective gating for cardiac CT has already been implemented for GE Healthcare's LightSpeed system. This technique which is fundamentally a step-and-shoot technique, and is applied in patients with regular heart rate, produces images equivalent to those obtained with retrospective gating, but with significant reduction in radiation dose. Radiation dose is reduced as data is obtained only at a predefined point in each R-R interval, compared with retrospective gating in which the X-ray tube is on continuously, throughout the cardiac cycle. Prospective gating reduces radiation dose to approximately one half of that obtained with retrospective gating, even with EKG gated tube current modulation. Prospective gating requires a system with adequate beam width and appropriate software.

A new approach to CT image formation is iterative reconstruction. This is a relatively software intensive approach in which images that are smooth, and have good sharp anatomic outlines, are obtained at about one half the radiation dose utilised for conventional CT scanning.

Volume dual energy techniques for cardiac and non-cardiac imaging and iterative reconstruction remain in clinical developmental phases and implementation depends on software engineering and initial clinical applications. However, I am optimistic that these technologies will come into clinical practice within the next 12 months.

DYNAMIC

By **Georg Bohner MD**, of the Department of Neuroradiology, Charité University of Medicine Berlin, Germany

Professor Eberhard Siebert (left) and Dr. med. Georg Bohner (right) (Department of Neuroradiology)

A 320-row CT scanner (Aquilion One, Toshiba Medical Systems Co., Tokyo, Japan) was installed for the first time in Europe, at the Charité University Hospital, Berlin, Germany, in November 2007. Its capability to cover the whole brain in a single rotation means this new type of scanner has the potential to impact strongly on the field of neuro-imaging.

Due to the limited detector width available in conventional multislice CT scanners dynamic imaging used for perfusions studies, or time-resolved angiography, was limited to partial organ coverage only (20 to 40 mm scan length). To overcome this limitation, repeated scanning in an adjunct region or table movement during examination was necessary, which limited time resolution in dynamic imaging studies.

For the first time, this limitation has been overcome by volumetric, time-resolved whole-brain imaging using the 320-row scanner with its high-resolution coverage of 160 mm during a single rotation.

Simultaneously morphological as well as functional image data are collected.

The dynamic volume CT uses a detector module arranged in a 320 x 0.5 mm configuration. There are 896 detector rows x 320 elements, with an element size of approximately 1 x 1 mm, which corresponds to a 0.5 mm (transverse) x 0.5-mm (longitudinal) beam width at the centre of rotation. The fastest gantry rotation time is 0.35 seconds and the data sampling rate is 2,572 views per second.

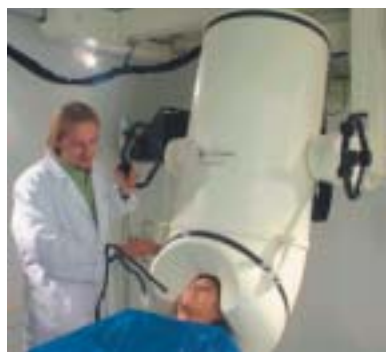
Within the first weeks of usage the following acquisition techniques were applied at the Charité for neuro-imaging studies using the dynamic volume CT: Single rotation cranial CT (SR-CCT), incremental cervicocranial CT-Angiography (3-D-CTA), time resolved intracranial CT-Angiography (4-D-CTA) and a combined whole brain 4-D-CTA and CT perfusion protocol (4-D-CTA/CTP).

Mental health and

The Uliazpi Foundation in Spain, which studies and cares for severely mentally retarded patients, carried out an interesting study to identify bone mineral density values in a group of its patients, compare these with the general population and investigate the possible influence on these values on certain clinical variables and therapeutic regimens.

The bone mineral density value of 192 male/female patients was obtained via digital densitometry, using a compact desktop system with dual X-ray absorption measurement technology. The data obtained was contrasted with sex, age, degree of mobility and anti-epilepsy or sedative medication.

Mugica et al, found that the patients' bone mineral density was significantly lower than that of the general population: 25% presented osteopenia and 22% osteoporosis. The latter is frequent among severely mentally retarded patients. The greatest risk is associated with insufficient mobility, Down's syndrome and regular doses of Phenobarbital. The authors concluded that digital densitometry is a simple procedure that may be useful to identify the true dimension of this problem and the efficacy of the various preventive or curative procedures presented.



Neuro-imaging in Psychiatry (US)

The new 'omics' technologies (genomics, proteomics and metabolomics) heralded a new era of biomedical discovery that is affecting every field of medicine. With the rapid growth of the older population worldwide, there is great interest in applying these technologies not only to diagnose and prevent disease, but also to enhance brain longevity and mental wellness. Nearly two-thirds of the c. 30,000 genes in the human genome are related to brain function, and up to half of the variance in age-related changes in cognition, brain volume, and neuronal function appears to be genetically determined. Neuro-imaging is being employed to study the effects of genes and how neurogenetics may affect future radiology research and practice (Petrella et al, Department of Radiology, Duke University Medical Centre. Pub: 2008).

Mood disorders

Clinical research in mood disorders increasingly involves advanced neuro-imaging techniques.

VOLUME CT

The impact on neuro-imaging

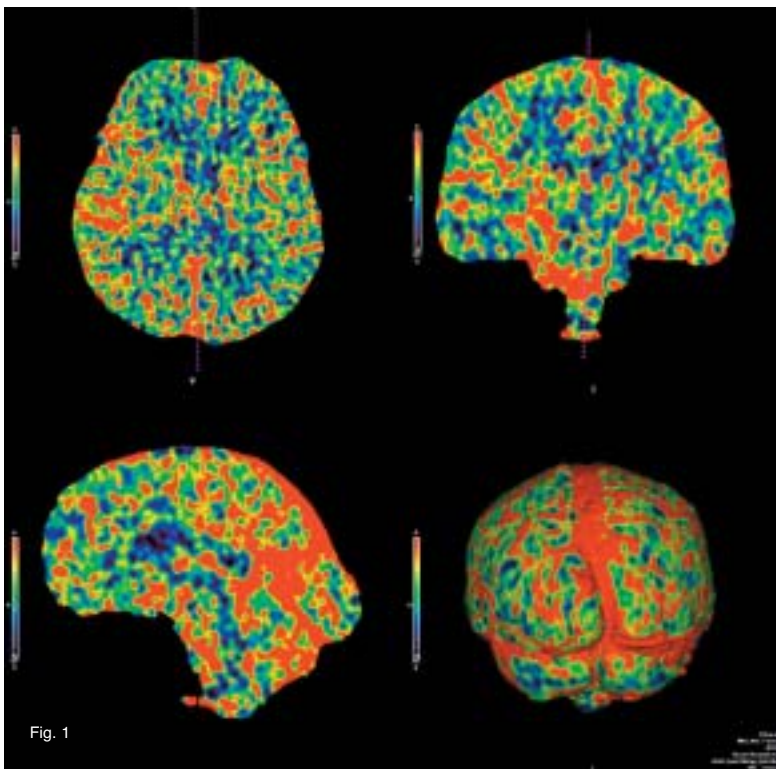


Fig. 1

Following the scan protocol for the combined angiography and perfusion scan will be addressed briefly. For the 4-D-CTA/CTP protocol we use a combination of intermittent and continuous scanning for a total examination time of 50 seconds, after having performed a test bolus scan to determine the circulation time. After injection of 50ml iodinated contrast agent, scanning is performed using an 80kV protocol that results in a dose length product of 2355,4 mGy x cm. Multiplied with the ICRP-factor (k=0.0023 mSv x mGy^{-1} x cm^{-1} for the head) this would result in a calculated effective dose of 5,4 mSv. This is in line with manufacturer's phantom measurements where radiation exposure for the dynamic whole brain 4-D-CTA/CTP combination results in 6.4 mSv.

Indications for dynamic volume CT comprised, amongst others, trauma, acute stroke, chronic ischemia due to arteriosclerosis of cervicocranial vasculature as well as veno-occlusive disease.

Based on our initial experiences the scan speed of SR-CCT and 3-D-CTA protocols are the main advantages over conventional multislice CT scanners, with the potential to reduce motion artefacts in uncooperative patients.

In stroke imaging, it is likely that the sensitivity of CT perfusion imaging will increase, especially with respect to infratentorial ischemic lesions, or lesions within the semioval centre and the frontoparietal cortex, although the clinical impact of such findings is still a matter of discussion. As illustrated here (Fig. 1), volumetric perfusion imaging enables whole brain coverage and calculation of high resolution parameter maps with 0.5 mm voxel size along the z-axis.

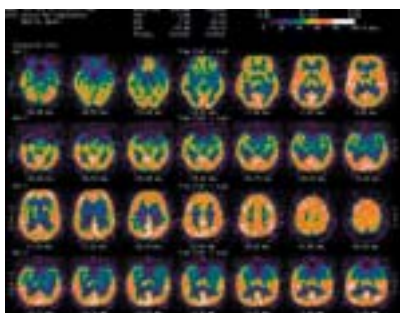
Especially when altered haemodynamics are suspected, the time resolution combined with the complete brain coverage provided by the 4-D-CTA and the combined 4-D-CTA/CTP protocols are interesting new scanner features. Up to now, no dynamic whole-brain angiography was available based on CT technology; thus assessment of circulation time changes in shunting vascular disorders, venous arterialisation or prolongation of venous outflow in the setting of veno-occlusive disease, especially in cortical vein thrombosis, remained limited using CT. All these neuroradiologically important issues can now be addressed directly and dynamically by whole brain 4-D-CTA.

However, with the new technique of dynamic volume CT not only the quality of information increases but also the quantity, as for a complete stroke examination, together with the postprocessed images, a total amount of up to 18,000 images can result. Not only high-end workstations for image reconstruction are needed to limit the time of data postprocessing, which can take up to 15 minutes only to calculate the parameter maps in stroke evaluation, but also high speed network connections and a powerful PACS system are needed to cope with the large amount of data.

radiology

Eduardo de la Sota MD reports on the increasing use of radiology and neuro-imaging in psychiatry

Advances in neuro-imaging technology have refined models of disease pathophysiology in mood disorders and the mechanistic basis of antidepressant action. Magnetic resonance (MR) approaches provide information on white and gray matter pathology (segmentation), cellular metabolism (MRS), oxygen consumption (BOLD), and neurocircuitry (DTI). Radionuclide-based neuro-imaging methodologies provide quantitative estimates of brain glucose metabolism, regional blood flow, and ligand-receptor/transporter binding.



Clinical implications of neuro-imaging methodologies are widely recognised (Konarski et al. Canada).

Bipolar disorder

Strakowsky et al (2004) reviewed existing structural and functional neuro-imaging studies of patients with bipolar disorder and discussed how these investigations enhance our understanding of the neurophysiology of this illness. Findings from structural magnetic resonance imaging (MRI) studies suggest that some abnormalities, such as those in prefrontal cortical areas (SGPFC), striatum and amygdala exist early in the course of illness and, therefore, potentially, predate illness onset. In contrast, other abnormalities, such as those found in the cerebellar vermis, lateral ventricles and other prefrontal regions (e.g. left inferior), appear to develop with repeated affective episodes, and may represent the effects of illness progression and associated factors. Magnetic resonance spectroscopy investigations have revealed abnormalities of membrane and second messenger metabolism, as well as bioenergetics, in striatum and prefrontal cortex. Functional imaging studies report activation differences between bipolar and healthy controls in these same anterior limbic regions. Together, these studies support a model of bipolar disorder that involves dysfunction within subcortical (striatal–thalamic)–prefrontal networks and the associated limbic modulating regions (amygdala, midline cerebellum). These studies suggest that, in bipolar disorder, there may be diminished prefrontal modulation of subcortical and medial temporal structures within the anterior limbic network (e.g. amygdala, anterior striatum and thalamus) that results in dysregulation of mood. Future prospective and longitudinal studies focusing on these specific relationships are necessary to clarify the functional neuro-anatomy of bipolar disorder.

Brain scanning (Australia)

Nevertheless, CT has its limitations according to some researchers. Agzarian et al (2006) published research on the use of routine CT brain scanning of psychiatry patients in Australia. Their aim was to evaluate the usefulness of CT of the brain in patients presenting a psychiatric condition without focal neurological signs. The reports of 397 consecutive CT brain scans of patients at two acute tertiary hospital psychiatric services over a two-year period were assessed retrospectively. 377 (95%) of the CT scans showed no abnormality; specific abnormalities were described in 20 (5%). Three scans showed non-specific minor abnormalities, which, when followed up by MRI, showed no relevant abnormality. All the abnormalities shown on CT were considered clinically unrelated to the patient's psychiatric condition. In conclusion, the pretest probability of finding a space-occupying lesion or other pertinent abnormality in the patients with psychiatric illnesses in this study appears not to be greater than that of the general population.

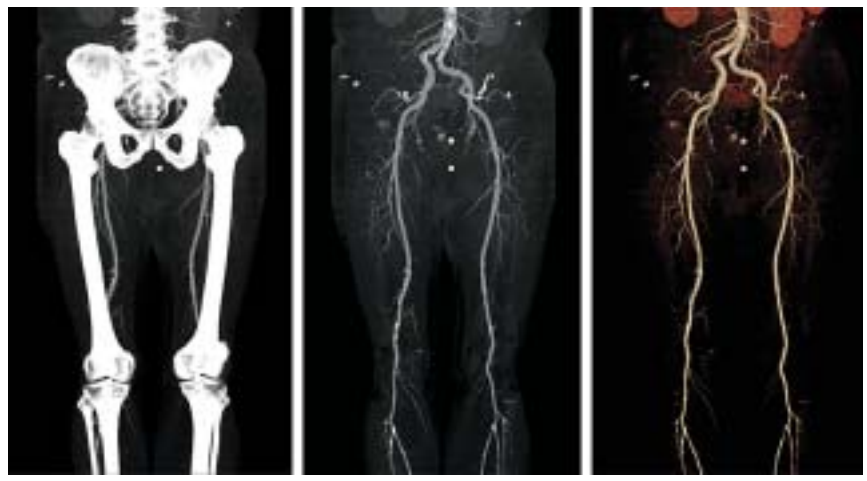
FMRI (Japan)

Functional magnetic resonance imaging (FMRI) has become the most widely used method for imaging normal brain function in a relatively short period of time. Its use in clinically related research has been much slower. However, FMRI is becoming a valuable tool in the study of many neurological and psychiatric disorders (Professor Matsuda. Japan).

Thin client products aim to 'unleash the potential of scanner technologies'

The Visage Thin Client product range on show at the ECR provides a fully-integrated system with advanced tools for 2-D, 3-D, and 4-D image review and interpretation, post-processing, data management, and image distribution.

The thin client-enabled PACS solution produced by Visage Imaging (a subsidiary of Mercury Computer Systems Inc.) has new features for use in radiology, cardiology, neurology, oncology, surgery and other subspecialties. These include application-specific display and post-processing protocols, saving and sharing of annotations as well as post-processing results, volume analysis of lesions and structures in 3-D, improved automatic bone removal, sharing of roaming sessions, easy switching of layouts and viewers, etc.



Visage CS Thin Client/Server includes tools to access CT and MR angiography images from any location. All from the same study: 3-D MIP of a contrast-enhanced CT study, with bone included (left). 3-D MIP with bone removed automatically by Visage CS (centre). Volume rendered image with bone removed (right)

The latest version of the Visage CS Cardiac Analysis is also on show. Assets: new tools and optimisations such as calcium scoring, improved reporting, and efficient manual editing, the company points out. 'This makes Visage Cardiac Analysis the only comprehensive and fully integrated cardiac analysis application on a thin-client-server platform. With Visage's CS client-server technology the image data as well as the applications within the Visage platform are not bound to specific workstations and become instantly accessible anywhere, anytime within the PACS workflow. The Visage Thin Client platform allows sharing data and applications across radiology and cardiology departments, and helps to unleash the true potential of the latest scanner technologies and diagnostic tools.'

The web and thin-client technologies make it easy to deploy this integrated solution across an entire hospital.

New injectors from ulrich

ulrich medical has added a number of new products to the firm's wide range of injectors and accessories for computer and magnetic resonance tomography.

The new MRI injector tennessee is accumulator free and ready for use at any time, ulrich points out. 'It avoids permanent time-consuming charging and handling of heavy accumulators. The tennessee is throughout flexible, comfortable and safe and simplifies daily workflow.'

The new passive temperature preservation for contrast agent system preserves the temperature of a contrast agent up to four hours without any need of power supply. The new ceiling suspension for CT injectors, a space-saving alternative that should prove particularly worthwhile for small examination rooms, ensures fast, comfortable positioning of the injector, the firm reports, adding: 'The fully internal cabling establishes a secure and convenient examination environment for patient and user.'

ulrich injectors are known internationally for high quality "made in Germany", economical performance, smooth and comfortable workflow and meet the requirements of modern imaging technology.

** ulrich medical, of Germany, has manufactured contrast agent injectors for 25 years. Today, they are available in about 40 countries.*