SIEMENS Healthineers

SOMATOM Sessions

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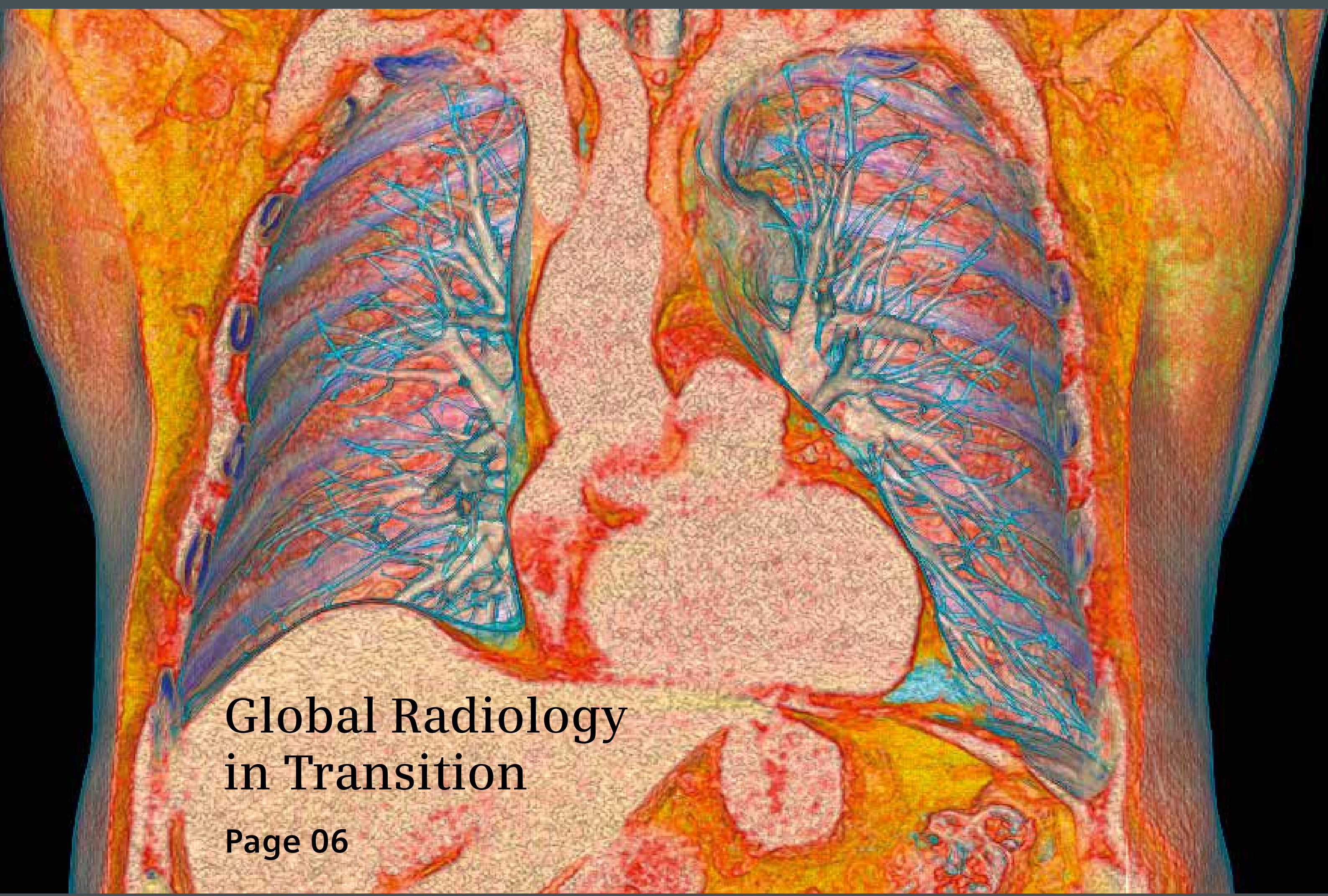

Global Radiology in Transition

Page 06

"Keeping costs in check while at the same time delivering cutting-edge medical service poses a challenge for the needs of both patients and healthcare suppliers today."

Professor Michael Uder, MD,
Head of the Institute of Radiology, University Hospital Erlangen, Germany

Cover page:
A native CT scan of the thorax was acquired on SOMATOM go.Up. Multiple small pulmonary nodules (< 3 mm) can be seen bilaterally on the VRT image.
Courtesy of University Hospital Erlangen, Germany

Dear reader,

Certainly, you will have noticed that this issue of *SOMATOM Sessions* features our new logo marking our transformation from Siemens Healthcare to Siemens Healthineers. We have a long and valued commitment to helping healthcare providers to offer high-quality and efficient healthcare services. As Siemens Healthineers, we are now building on and further developing this strong foundation of expertise and dedication. We want to enable you to deliver better outcomes at lower cost. Our goal is to expand our portfolio of tailored customer solutions that support healthcare providers at all levels of operational and clinical need, while also keeping the patient firmly in focus and at the same time lowering costs.

As a company, we recognize that we can only achieve these goals by increasing our engagement jointly with providers around the world to better understand their specific needs and identify today's greatest challenges. By collaborating closely with physicians and clinical staff in various CT imaging settings, we have learned that the most pressing issues currently concern profitability, excellent patient care based on the latest and best standards, and a patient-centered approach. Our cover story looks at how these insights helped to create SOMATOM go.[1] – an entirely new CT platform (page 6).

SOMATOM Sessions offers room for clinical specialists to share their experiences and begin valuable conversations with one another. Professor Marilyn Siegel describes in the article "Dual Energy CT Lung Perfusion Imaging in Children" how DECT enables her team to evaluate pulmonary arteries and lung perfusion from just one contrast-enhanced examination with radiation exposure equal to – or in some cases even lower than – a conventional single energy CT scan (page 74). In "Reconstructing the Heart to Save Childrens Life" Catherine Owens, MD, and Martin Kostolny, MD, from London explain how 3D reconstructions produced by faster imaging can help plan surgical interventions for children with congenital heart disease, and communicate complex information about the conditions to patients and their parents (page 20). Keeping radiation dose as low as possible in CT scans while maintaining uncompromising image quality is a major concern for Professor Helmut Ringl from Vienna. In "Extending the Range of Diagnostic Possibilities", he tells how this balancing act is successfully managed in his radiology department with SOMATOM Drive (page 28). As an innovative and established company, Siemens Healthineers will also be keeping its finger on the pulse with advances in high-performance technologies developed from the latest scientific findings. Our article "Photon-counting Detectors[2] in Clinical Computed Tomography" (page 71), for instance, explores whether and to what extent the future of detector technology lies in photon-counting detectors. The fascinating report "On the Virtual Anatomy of the Living – From Papier-Mâché to 3D Model" introducing two young, ambitious scientists from the Museum of Medicine in Brussels looks at how medical teaching methods from the early 19^{th} century can be combined with state-of-the-art 3D imaging technology in a meaningful and educational way (page 16).

These are just some of the inspiring stories featured in this issue of *SOMATOM Sessions*. You will, moreover, find a wide range of clinical cases, many news, and various interesting educational topics.

Enjoy reading this issue.

Christiane Bernhardt,
Vice President
CT Marketing and Sales

[1] The product is pending 510(k) clearance, and is not yet commercially available in the U.S.
[2] The product is still under development and not commercially available yet. Its future availability cannot be guaranteed.

December 2016

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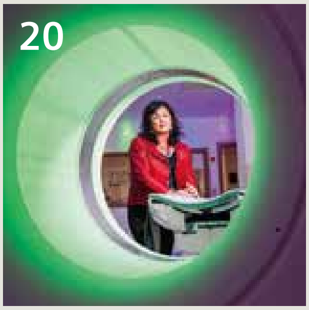
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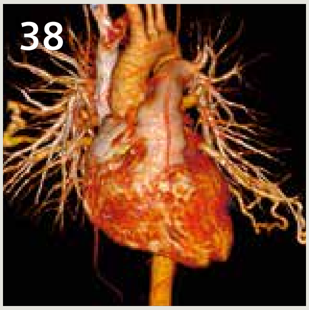
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Global Radiology in Transition

All over the world, radiological departments are facing an uphill struggle. Patient numbers are on the rise, and so are expectations of both patients and payers, putting physicians and clinical staff under pressure. Yet, eroding healthcare finances make investments in imaging equipment more difficult than ever. Furthermore, qualified experts and well-trained assistants are increasingly hard to come by. What does all that mean for imaging technology? Are CT systems, for example, really addressing these challenges properly?

Text: **Philipp Grätzel von Grätz, Swati Prasad**
Photos: **Anna Schroll, Arush Mayank**

Professor Michael Uder, MD (right) and PD Matthias May, MD from the University Hospital Erlangen, Germany are true general practitioners.

The figures are fairly unequivocal: According to the World Health Organization (WHO), total health expenditure worldwide has risen from 8% of GDP in 1995 to around 10% today. This is true of industrialized economies and many emerging market economies alike: In Germany, total health expenditure increased from 9.4% to 11.3%. In China, it went up from 3.5% to 5.5%. And in the U.S. it shot up from 13.1% to 17.1%.

National healthcare systems increasingly struggle to keep costs in check. Some try to centralize; others do the opposite. Some create artificial price limits on drugs or exclude certain imaging modalities from reimbursement. Others introduce new reimbursement models that reward patient satisfaction or medical outcome rather than the number of interventions or examinations. In the U.S., for example, Medicare will soon base 2% of its reimbursement on outcome and patient satisfaction.

How to keep up with investments needs?

Whatever the national policy is, for healthcare institutions the challenges look remarkably similar all over the globe. While keeping an eye on costs and reimbursements, many have to invest heavily in modern medical equipment in order to cope with rising numbers of patients or provide access to cutting-edge care.

In India, for example, with a demography that is skewed toward the young, hospitals will have to provide up to 700,000 additional beds over the next five to six years, according to projections by the India Brand Equity Foundation, a government trust established by the Indian Ministry of Commerce and Industry. This translates into estimated additional investments of 25 to 30 billion U.S. dollars. In Germany, the number of hospital beds is shrinking while the population ages. There, too, hospitals have to invest to maintain the high standards that patients expect. The German Hospital Federation (abbreviated in German to DKG) estimates that the investment gap in the hospital sector amounts to 12 billion euro, rising by 2.5 billion euro annually.

Radiology at the epicenter

As a discipline that requires significant investments and a high degree of expert knowledge, radiology is at the epicenter of the seismic shifts that are reshaping modern healthcare. To address the shortage of qualified labor, new players are emerging, and teleradiology is on the rise. Take India, for example: Imaging centers in the metropolitan areas are mushrooming. They regularly produce CT reports for hospitals in smaller cities now where trained radiologists and radiology assistants are in short supply.

On a different level, we find a comparable picture in highly developed economies. Integrated Delivery Networks (IDNs) have established themselves as a new model of diagnostic imaging in the U.S., with a hub in the center that provides most of the manpower and expertise for cooperating institutions at the periphery. In a very similar approach, German university hospitals increasingly cover radiological services for small- and medium-sized hospitals in the vicinity.

Working together for a better outcome

Given this background, the question arises as to whether currently available CT systems are suitable for the new realities. Is high-quality computed tomography affordable enough to satisfy the needs of, say, an IDN in the U.S., a regional hospital in Germany or a rural medical center in India? Is the usability of the machines such that they can easily be operated by specialists and non-specialists alike?

Siemens has asked those who are in the know. About 500 radiologists, radiology assistants, chief financial officers, patients, and referring doctors from various countries were interviewed. Of these, 32 even worked together with Siemens representatives over a period of two weeks in a co-creation space on better workflows and improved device features using Styrofoam models brought to life by human creativity. The result is a new CT platform that provides high quality standards but also takes into account the challenges of radiologists all over the world. Hear from some of these people in the following.

2 p.m. (CET), Erlangen, Germany

Radiologists at University Hospital Erlangen are struggling to meet the growing expectations of colleagues, patients, and hospital management simultaneously. Yet, compromising on quality or radiation dose is not an option.

It is an average day for Professor Michael Uder of University Hospital Erlangen, Germany. The head of the Institute of Radiology attended a major interdisciplinary tumor board in the morning in which he discussed cancer patients with colleagues from surgery, oncology, and other disciplines. Later on, there were two interventional therapies planned. In between this, he looked at recent images, cleared dozens of reports, and dropped in on two other interdisciplinary rounds, before taking the time for our brief interview: "Colleagues really expect us to be present these days. In a modern hospital, radiologists are the only true general practitioners. This is what makes us so important."

Radiologists at University Hospital Erlangen want their patients to be satisfied with their hospital stay so that they return. They may even post favorable reviews online that could boost the reputation of the institution.

Importance has its price, however: Rounds and boards are time-consuming: "All in all, we are talking about more than 30 interdisciplinary meetings per week," says Uder. A steep increase in interventional therapies has added to the workload in recent years. And the number of diagnostic patients has not decreased either: "Today, we care for twice as many patients as we did a decade ago." Most need simple examinations, for example head CT scans to exclude bleedings. Others require more complex types of imaging, such as cardiac CT examinations, CT angiographies.

Patient satisfaction: It's all about radiology

Radiologists have to meet not only the expectations of their colleagues, but also those of hospital management and, most importantly, patients. "In certain areas, patients are beginning to handpick their radiologists, for example in urology and gynecology. Some even suggest examinations themselves," says Uder. Patients are also becoming more willing to share their experiences – for better or worse. In Germany, reimbursement does not actually depend on patient satisfaction, but in reality it does. If a patient is not satisfied with his hospital stay, he may not come back, and he might even write an unfavorable review online that damages the reputation of the institution.

Although patient satisfaction is not just about radiology, the radiology experience is an important part of the puzzle: "A patient who has to wait for three hours for a CT scan will always feel that his hospital stay was negative." So how can we make patients feel better? Waiting times, obviously, need to be addressed: "We need to know exactly in advance what examination is needed. More workflow automation would be extremely helpful, too, and also more automatic quality checks to avoid errors."

"We need to know exactly in advance what examination is needed. More workflow automation would be extremely helpful, too, and also more automatic quality checks to avoid errors."

Professor Michael Uder, MD,
University Hospital Erlangen, Germany

Matthias May, MD, a colleague of Uder's in Erlangen, points out another aspect: "When patients get a CT examination today, they often have the impression that the radiologist or the radiology assistant is hiding from them. The reason is that staff has to go back and forth between control room and examination room in order to run the examination." May is convinced that a modern, mobile operational concept could address this issue: "If a patient feels that someone is close by, it is perceived as better care. It is hard to measure, but it will make a difference."

Attractive conditions, durable equipment

Hospital management is interested not only in patient satisfaction but also in costs. Radiology, after all, is one of the largest cost factors in a modern hospital. According to Uder, the cost pressure on radiology has risen quite significantly: "Most of it comes not from hospital management but rather from the heads of the clinical departments. Thanks to internal cost allocation, they have to pay us for our service, and we are regularly their highest expense factor."

The Erlangen radiologists see several options to make the total costs of CT systems for a hospital more affordable and more predictable. One important factor, according to May, is durability: "Obviously, maintaining a CT scanner is expensive. But also whenever a CT scanner needs to be repaired, we cannot use it. If we had a CT system with durable components and less downtime, we would benefit twofold – from lower running costs and reduced downtime. And I am also convinced that nowadays there are certainly ways to monitor the scanners to identify potential future issues or even to perform software upgrades remotely."

Different service models might also help to better calculate costs. Uder likes the idea of having longer guarantees with as many years of service included in the initial payment as possible: "In Germany at least, there are still ways to find funding for necessary investments. But I cannot source any money for follow-up costs. I have to pass these down directly to my customers. Having less follow-up costs would make life easier for us."

Maximum flexibility

Another cost factor that is often overlooked is investments in rooms and buildings. Uder recalls the purchase of a CT system some years ago that came along with construction costs of almost 400,000 euros. For small- and medium-sized institutions, building costs such as these can be an insurmountable obstacle. University Hospital Erlangen performs radiology services for five smaller hospitals in the vicinity. Uder would prefer to run a CT scanner on site. "But we haven't been able to find a suitable room that would allow us to install a CT system at reasonable costs." Conventional CT platforms are not adaptable enough to different architectural realities, Uder emphasizes: "I'd love to be far more flexible with my machines. I want to be able to put them where I need them and not where the building requires me to put them."

One imaginable scenario that could be very helpful for Uder and May, in particular in the satellite hospitals of hub-and-spoke imaging networks, is a standard X-ray-like CT setup: "If there were a remote control for the scanner, and all necessary technology, including basic postprocessing capabilities, were integrated, we would no longer need two or three rooms for a CT scanner. A lead glass niche within the scanner room to protect staff from radiation would be enough," says May.

No compromise on quality or low radiation dose

Uder and May have various ideas that could help to keep costs of new CT machines in check for radiology departments. What both radiologists would not accept, however, is low image quality or higher-than-necessary radiation dose: "We would not want to compromise either on quality or on low radiation dose. It is obvious that we cannot expect the same tube capabilities in a smaller CT scanner as in a high-end scanner. But we can expect a highly reliable tube, and we

Easy-to-use, standardized workflows make daily routines in hospitals more efficient.

"To provide low-dose imaging, we would want to have the option to individualize the X-ray spectra. We need tube current modulation, low kV imaging, and we need tin filters for spectral shaping."

Matthias May, MD,
University Hospital Erlangen, Germany

certainly expect the dose reduction technologies that have been introduced in recent years," emphasizes Michael Uder.

Matthias May agrees absolutely. Up-to-date iterative reconstruction capabilities to reduce radiation dose is among the first things that come to mind: "We would not want to do without this. Even a small scanner can easily be furnished with it. To provide low-dose imaging, we would also want to have the option to individualize the X-ray spectra. We need tube current modulation, low kV imaging, and we need tin filters for spectral shaping."

Workflow automation to manage complexity

Perhaps the most pressing issue in modern CT radiology is its increasing complexity: "Handling a CT is almost as complex as handling an MRI these days," says May. What is needed, he argues, is a design turnaround that puts workflows back into the focus of developers. "This is a real issue even at an university hospital. We have radiological assistants who refuse to work with certain kinds of scanners because they consider them too complicated." Over-boarding complexity might be no more than a nuisance in university hospitals. In small- and medium-sized hospitals, in hub-and-spoke scenarios, and in integrated (tele)radiology delivery networks, it is intolerable. If a shift has to be staffed with someone less experienced, they might not get the protocol right. The result is suboptimal image quality or a higher-than-necessary radiation dose, or both.

May's wish list for a modern scanner thus features a high degree of workflow automation, including clinical intelligence to recognize mistakes and issue an alert if a patient is not suitable for the standardized workflow: "For the vast majority of examinations, standard protocols can be used, and postprocessing can be automatized, including low-dose examinations such as lung cancer screening. These protocols should be available with a click or two. But it must still be possible to go deeper if necessary. Ideally, we have two layers of operation: a simple user-interface, for example on a tablet PC, plus a conventional access that allows us to modulate the standards if necessary."

Ultimately, the patient benefits

Easy-to-use, standardized workflows make daily routines more efficient. They facilitate disseminated care scenarios, reduce the need of training and make a radiological department less dependent on highly skilled individuals. But ultimately, it is the patient who benefits most from automation and clinical intelligence, says Uder. His example is that of a nightshift examination, when contrast media is often injected by some doctor on duty, who does that only occasionally. There might also be a radiological assistant without enough experience to recognize when contrast media doesn't flow properly. In the worst case, the mistake is only noticed once the images are ready, and the examination has to be repeated. "In such a case, I would want to have a red warning light so that the protocol can be stopped early."

Philipp Grätzel von Grätz is a medical doctor turned freelance writer and book author based in Berlin, Germany. His focus is on biomedicine, medical technology, health IT, and health policy.

2 a.m. (IST), Madurai, India

K. G. Srinivasan, MD, Managing Director of KGS Scan Centre in Madurai, has overcome many challenges that confront radiology centers worldwide with his unique model of focusing on volumes and working round-the-clock.

Thanks to K.G. Srinivasan, MD, the KGS Scan Center in Madurai has become a one-stop shop for diagnostics in the region.

It is 2 a.m., and Madurai is buzzing with activity. No wonder they call it "Thoonga Nagaram" – Tamil for a city that never sleeps. K.G. Srinivasan, 48, managing director of the immensely popular KGS Scan Center, has emulated this quality of Madurai.

Srinivasan, however, prefers to be known as senior radiologist. "God is the owner of KGS, not me," he says. Some kind of divine intervention seems to be at play here at this scan center, which is just four kilometers away from the famous Meenakshi Amman Temple. For, it takes on the extraordinary task of working every single day of the year.

You will find Srinivasan here, from 10 a.m. to 2 a.m., at his desk – examining scans sent seamlessly to

"No one is so poor that they should not receive world-class imaging and diagnosis."

K.G. Srinivasan,
KGS Scan Center, Madurai, India

The penetration of health insurance is low in India. All patients who come to the KGS center pay out of pocket. For the poor, the center also does scans for free.

his computer screen from four centers – two in Madurai, one in Ramnad (113 km from Madurai) and another in Arupukkottai (50 km from Madurai). Simultaneously, he is on the phone, speaking to clinicians spread across a 150 km radius around Madurai discussing the scans, even as patients and their relatives surround him, waiting for him to pronounce his diagnosis.

"We are a one-stop shop for diagnostics," says Srinivasan, whose centers have X-ray, CT, MR, and ultrasound facilities. For the sake of proper diagnosis, his team often scans other parts of a patient's body if the recommended scan provides inconclusive results. All this, at no extra cost.

Leveraging volumes to overcome challenges

The challenges Srinivasan's scan centers face are no different from those faced by radiology departments across the world. Yet, he has found a mechanism to cope with most of them.

Since the center's inception in 2002, Srinivasan has focused on volumes to recover the steep investments in equipment – the Madurai centers perform 120 CT and 120 MR scans in a day. On peak days, CT scan numbers can even go up to 170, as they did six months back.

Srinivasan manages the high maintenance cost of machines by opting for a comprehensive warranty scheme. Equipment downtime is kept to a bare minimum as a supplier's engineer is stationed at the Madurai center to repair breakdowns.

Similarly, the challenge of postprocessing is taken care of by sending senior technicians to centers in Ramnad and Arupukkottai. "Our core team has remained the same for 15 years," he adds. It comprises of five radiologists, ten technicians, and four senior nurses. The experience the team has gained over the years is unmatched.

The center has addressed the challenge of radiation dose by choosing Siemens' CARE (Combined Applications to Reduce Exposure) package. And since the quality of power supplied by the government is poor, an uninterrupted power supply (UPS) system, coupled with a generator, ensures the equipment works seamlessly.

Offering better quality at the same price

Volumes have also helped Srinivasan keep the prices unchanged for the last decade. And that's important since the penetration of health insurance is abysmally low in India. According to the World Bank, out of pocket expenses for India stood at 86% in 2012. All patients who come to the KGS center pay out of pocket. For the poor, the center also does scans for free.

Thanks to volumes, Srinivasan is also able to upgrade the equipment every three to five years. These periodic upgrades have led to better quality scans. For CT imaging, the Madurai centers currently have a 128-slice and a 16-slice scanner, while Ramnad has a 32-slice scanner and Arupukkottai has a 16-slice.

Recruiting new radiologists has been problematic as not enough of them are able to undertake complex CT protocols. Therefore, Srinivasan takes them on himself, after midnight.

The real issue, however, continues to be accessibility. It is difficult to find radiologists in rural India. Srinivasan is addressing this through technology. Experienced technicians are sent to Ramnad and Arupukkottai, who message or email images to radiologists in Madurai for diagnosis.

Over the next six months, Srinivasan plans to open another center in Sivakasi – a town 78 km away from Madurai, known for its fire-cracker and match industries. It is also his birth town.

Replicating the KGS model

Srinivasan is part of an industry that is growing at over 17% per year.[1] Yet, approximately one million Indians die each year due to inadequate healthcare facilities.[1] Therefore, the scope of replicating the KGS model is tremendous.

For instance, the center has a unique workflow strategy whereby they line up three patients to reduce the time in between patients. When one patient is inside the gantry, the second is waiting outside, while the third is being prepared – a strategy other centers could easily replicate.

In August this year, KGS organized a conference on mini musculoskeletal review, which was attended by radiologists from across India. Several radiologists were keen to understand Srinivasan's model. Since then, a scan center in Amritsar has even managed to increase throughput.

When it comes to the KGS Scan Center, Srinivasan does not want to spread himself too thin. "In two years, I will be 50. I am not sure if I can continue to work such long hours," he says. He has the support of his team and family, however, who help him out with accounts and management, it is unrealistic to look for radiologists that match his passion for diagnosis. Therefore, a new CT platform that can address the challenges faced by the radiology industry worldwide is vital. ■

The challenges KGS face are no different than those faced by radiology departments across the world.

Swati Prasad is a freelance business journalist based in Delhi. She reports from India for several publications overseas and has worked as a correspondent and editor for *The Economic Times*, *Business Standard*, *The Indian Express*, and *Business Today*.

Reference

[1] India Brand Equity Foundation, http://www.ibef.org

Facts & Figures

The SOMATOM go. platform enables advanced workflows and supports comprehensive clinical insights.

The new SOMATOM go. platform[1]

Go for high performance with trendsetting workflows

- The mobile workflow is a completely new way of operating the scanner that allows clinical staff to stay with patients for longer.
- A line-up of innovative solutions – tablet, remote control, camera, and a new workplace design bring an unparalleled level of flexibility and mobility to daily CT routines.
- GO technologies is an holistic set of features to support users in workflows beyond the scan itself. They include Scan&GO, an advanced tablet app which allows control of scans from wherever the user is.

Go for visible growth with profound clinical results

- The Stellar detector lowers image noise in every scan, while advanced iterative reconstruction from SAFIRE delivers excellent image quality at very low doses.
- Tin Filter technology plays a key role in keeping dose levels exceptionally low, for example in lung imaging and lung cancer screening.
- High Power 80 (high mA values in 80 kV imaging) allows scanning at 80 kV for enhanced iodine contrast.

Go for financial certainty with an all-in-one solution

- Healthineers Connect Plan[2] is an embedded multi-year remote service package that redefines access to seamless support.
- The embedded service package also includes a new training concept. Users get free access to a blended learning program that combines self-study training material, face-to-face training, and online learning via the PEPconnect[2] platform.
- Thanks to gantry-integrated computers, investment in a separate control room is no longer needed. Valuable space can be saved by having scanner and workstation in one single room.

[1] The product is pending 510(k) clearance, and is not yet commercially available in the U.S.

[2] Powered by Siemens Remote Service. Healthineers Connect Plan is subject to regional adaptions/restrictions. PEPconnect is subject to country-specific availability.

Coronary Stenosis – Optimized Treatment Decision at a Low Dose

By Ralf Grötker, MD, PhD

Dynamic myocardial perfusion imaging might aid in the assessment of the hemodynamic relevance of coronary stenosis. Two new videos show tips and tricks for an effective examination.

To get tips and tricks by Koen Nieman, MD, PhD, scan the QR code and watch the video.

Scan the QR code to watch the video with Francesca Pugliese, MD.

Koen Nieman, MD, PhD, and Francesca Pugliese, MD, illustrate not only the clinical indications and benefits in their videos, but also the tips and tricks for a successful dynamic myocardial perfusion test.

Although technically demanding, myocardial perfusion imaging follows a straightforward five-step procedure. Color-coded perfusion maps are produced from the imaging datasets showing the different parameters of myocardial perfusion. The videos explain the procedure in detail.

At Bart's Heart Centre, London, coronary CT angiography is a widely employed method used to diagnose patients with chest pain. "Sometimes the results of a CTA don't allow us to anticipate whether or not patients whose arteria display moderate lesions would profit from revascularization," explains Francesca Pugliese, MD, radiologist at Bart's. To identify these patients, she uses dynamic myocardial perfusion imaging with the help of a SOMATOM Definition Flash scanner. "At first sight, perfusion imaging might seem a complex process, but with a well-prepared team it is absolutely feasible in clinical practice," says Pugliese. One important benefit: Dynamic – as opposed to static – myocardial perfusion also offers the possibility of obtaining quantitative values. The case she presents is that of a 76-year-old woman whose CTA displays calcified plaques and therefore indicates a risk of stenosis. "Results of the perfusion imaging confirmed the suspicion from the CT angiogram," concludes Pugliese, while scrolling through the images from the basal left ventricle down to the apex, indicating the blue areas of reduced flow. The patient was treated with coronary angioplasty through the LAD.

Koen Nieman, MD, PhD, cardiologist and Head of the Cardiovascular Imaging Group and Medical Director of the Intensive Care Unit at Erasmus Medical Center, Rotterdam, has had a similar experience. Nieman's team works with a SOMATOM Force, allowing for especially fast rotation and endsystolic triggering. In the case he presents, imaging helps to identify the optimal coronary artery for revascularization. With dynamic myocardial perfusion imaging, Nieman points out, "it becomes possible to access both anatomical and functional information at once, which allows for better planning of revascularization." Perfusion imaging is both comfortable and safe for the patient: "The duration of the whole process is less than thirty minutes, and the burden of radiation can be as low as five millisievert," explains Nieman. ■

Ralf Grötker, Dr. Phil., works as a science writer for research organizations, foundations, and companies as well as for various print and online media. He possesses expertise in Bioethics, STS, and Sustainability.

Diagnostic Confidence Despite Metal Artifacts

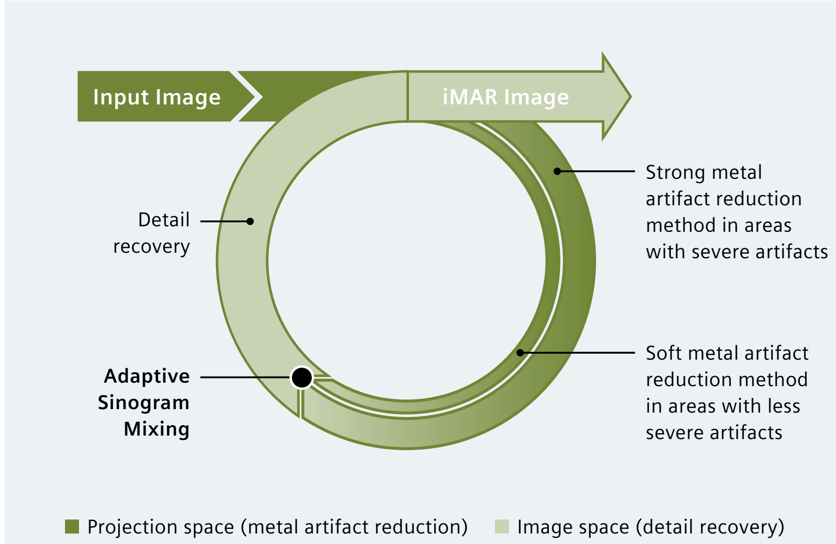
By Ricarda Grund, *Siemens Healthineers, Germany*

In CT imaging, it is often vital to reduce metal artifacts in order to diagnose particular clinical cases with confidence. A smart iterative metal artifact reduction algorithm helps to handle challenging cases smoothly.

iMAR* is a metal artifact reduction algorithm based on Adaptive Sinogram Mixing. Adaptive Sinogram Mixing combines a strong metal artifact reduction method in areas with severe artifacts and soft correction in areas with less severe artifacts.

The user interface of iMAR is simple. In addition to the typical reconstruction parameters, the desired artifact correction algorithm must be selected from a drop-down menu. iMAR can even be combined with an iterative reconstruction algorithm or dual energy scanning.

The result is improved image quality with clearly reduced metal artifacts while valuable information is retained. This is especially helpful in supporting diagnosis in complex cases such as patients with spine implants, pacemakers, dental fillings, bi-lateral hip prosthesis, or neuro coils. ■



Functionality of the iMAR algorithm

*iMAR is Siemens' iterative reconstruction software designed to reduce metal artifacts in CT images. It is a user-selected option to be used with conventional reconstruction methods (WFBP or iterative reconstruction) on Siemens CT systems. The amount of metal artifact reduction and corresponding improvement in image quality depends on a number of factors including composition and size of the metal object, patient size, anatomical location and clinical practice. It is recommended to perform reconstructions with iMAR enabled in addition to conventional reconstruction without iMAR.

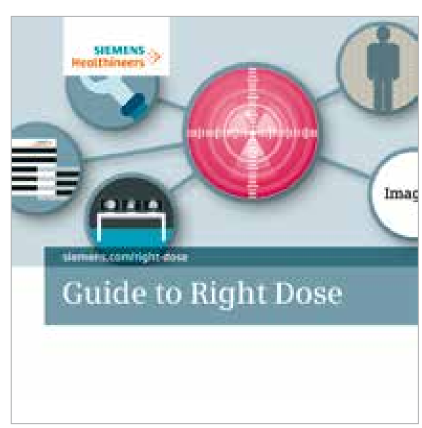
Step by Step to the Right Dose

By Ricarda Grund, *Siemens Healthineers, Germany*

In the highly practical 'Guide to the Right Dose', Siemens Healthineers offers support to healthcare professionals in their daily decisions on dose application while also helping them to explain medical imaging procedures more clearly to patients.

Radiation dose, radiation dose management, and dose reduction top the list of sensitive topics in medical imaging today. The need to reduce patient anxiety about dose is putting medical professionals under increased pressure to justify performing imaging procedures. Open debates on the question of dose can be heard around the world. Instead of adding to uncertainty among patients by concealing hard facts – however discomforting they may be – a culture of transparency is developing characterized by open communication and sound reasoning. In this context, experts have recently voiced an opinion that brings a new focus to the discussion: Radiation exposure should always be minimized but without compromising image quality or diagnostic performance.

The new 'Guide to the Right Dose' can be downloaded as a PDF or ordered in print free-of-charge: www.siemens.com/order-guide-to-low-dose. ■



Siemens' new 'Guide to the Right Dose' offers practical advice for patients and practitioners.

On the Virtual Anatomy of the Living – From Papier-Mâché to 3D Model

Louis Auzoux made one of the first highly detailed anatomical models at the beginning of the nineteenth century: a papier-mâché corpse for educational purposes. Today, innovative cinematic rendering and 3D-printing techniques, developed within Siemens' Research platform *syngo*.via Frontier, take just a few minutes to show the inner composition of a human being. Undoubtedly, these technologies are a quantum leap for the future of healthcare.

Text: **Erika Claessens,** Photos: **Ezequiel Scangetti**

A curious museum visitor comes face to face with the highly accurate anatomical model produced by Louis Auzoux in the mid 1800s.

It must have been quite unusual to see a group of people walking through the Erasmus Hospital in Brussels with a two-hundred-year-old anatomical model on a stretcher, but for Lara de Merode, scientific coordinator, and Anne-Sophie Hanse, art restorer and collections coordinator at the Museum of Medicine in Brussels, Belgium, it was amazing reality. "The most remarkable item in our museum, the first anatomical corpse developed by Auzoux, reached the height of its fame and glory when it was chosen by the Brussels Museum Council to feature as a major piece in its annual campaign. Beginning in April 2015, the Auzoux model had been carefully restored by art restoration experts Hanse and her colleague Marion Gouriveau. To celebrate these two events, the Museum of Medicine collaborated with Siemens to use its innovative 3D-imaging technology to display the plaster corpse in the museum in a brand new setting," says de Merode. The freshly restored masterpiece was brought to a scanner at the nearby Erasmus hospital and a series of radiographic images were taken. De Merode and her colleagues were more than happy with the results.

Scientific coordinator Lara de Merode (left) and art restoration expert Anne-Sophie Hanse (right) enjoy a close-up view of the Auzoux anatomical model.

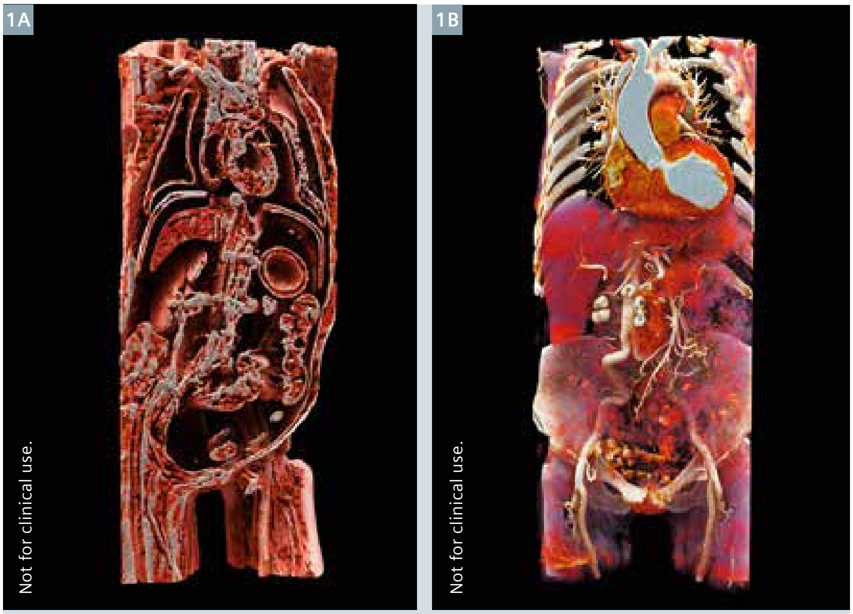
"After applying the cinematic rendering technique, a 3D view of the nineteenth century corpse was developed, showing its metallic structure and revealing all the stages of its manufacture," she states proudly.

Scientific aspirations in papier-mâché

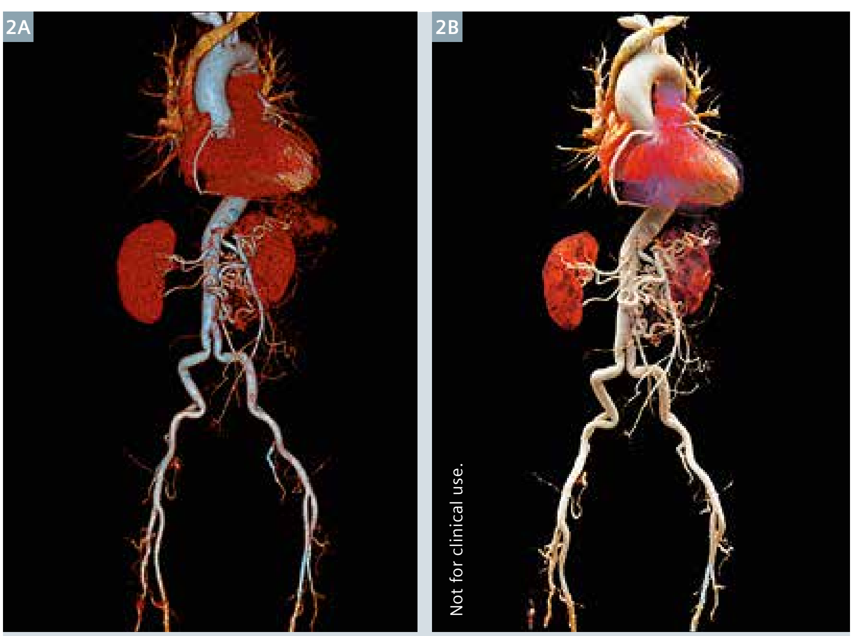
Louis Auzoux was born in 1797 in Upper Normandy, France, to a family of agricultural landowners. His father taught him how to work with wood and metal, but at age 18, Auzoux decided to study medicine. His particular interest in anatomy made him reflect on the emergence of human dissection as a primary tool for teaching and learning about the inner human. He was firmly convinced that cadaver dissections were indispensable to ensure safe and efficient clinical practice. And so he decided to rely on his woodworking skills and produce anatomical models in papier-mâché to serve the training needs. "The medical student came up with a papier-mâché anatomy model that was made of a mixture of cork, ropes of hemp and metal fibers, clay, paper, and wheat glue." Anne-Sophie Hanse explains: "What made it even more interesting is that his models could be taken apart piece by piece and, compared to the previously used wax models, were less expensive." Auzoux founded a factory for producing anatomical models and, after a few years, the models became a commercial success and were widely used for educational purposes.

"After applying the cinematic rendering technique, a 3D view of the 19th century corpse was developed, showing its metallic structure and revealing all the stages of its manufacture."

Lara de Merode, scientific coordinator at the Museum of Medicine in Brussels, Belgium



1 A comparison of the 3D reconstruction of the papier-mâché model using cVRT with imaging of a real human being highlights the accuracy of the model created by Auzoux back in the 19th century:
Coronal cut from a cVRT reconstruction of a CT scan of the Auzoux model performed on a SOMATOM Force (0.75 mm slices, Fig. 1A). Coronal cut from a cVRT reconstruction of a contrast-enhanced CT scan of a human being performed on SOMATOM Definition Flash (Fig. 1B).
Courtesy of Erasmus Medical Center, Rotterdam, the Netherlands, and University Hospital Erlangen, Erlangen, Germany



2 Comparison of a traditional volumetric rendering technique (VRT) reconstruction with the cinematic (cVRT) reconstruction of a CT angiography for the same patient demonstrates the benefits of cVRT. With cVRT, the depth perception in the shading creates a more realistic depiction and enables a better understanding of the human anatomy. This supports surgical planning, for instance: VRT (Fig. 2A) and cVRT reconstruction (Fig. 2B) of a CTA performed on SOMATOM Definition Flash.
Courtesy of University Hospital Erlangen, Erlangen, Germany

Holy Grail of photorealistic rendering

The Cinematic Volume Rendering Technique[1] (cVRT) used for displaying the Auzoux model was one of the first research prototypes available in *syngo*.via Frontier,[2] and will soon be available with the release of *syngo*.via VB20.[3,4] cVRT is based on the latest developments in the gaming and animation industries. It is a visual technology that takes 3D depictions of the human body to the next level of image quality. cVRT describes a physical rendering algorithm that simulates the complex interaction between photons and the scanned anatomical image to obtain photorealistic images. Both CT or MRI images can be rendered using cVRT. The algorithm takes the data from the scan procedure and calculates not only how the light reflects on the surface of the tissue or bones, but also how the light penetrates the material and is scattered in it. Considered by many as the "Holy Grail of photorealistic rendering", the algorithm moves from purely geometric optics to a quantum optic simulation.

Seeing is believing

Whereas traditional volume rendering techniques (VRT) simply apply a preset of colors, opacities, and brightness, cVRT enables the depiction of certain visual effects, like shading. Shading means, for instance, that a spherical panorama is captured using a reflective sphere. This records the current light environment that is then applied to all the synthetic elements that are added. So cVRT operates as a virtual camera. Moreover, the program makes it possible to hide or show soft tissue, muscles, blood vessels, and bone for a clear view of the desired anatomies and a completely novel insight into the human body. Seeing is believing and in this case it means that anatomical evidence can be viewed easily and often, leading to a better understanding of the human body.

An open platform for translational research

To support the model-creation process, Siemens harnessed the potential of *syngo*.via Frontier. This platform provides easy access to postprocessing prototypes for evaluation and publication purposes and seamlessly integrates them with the clinical routine *syngo*.via environment. The dedicated *syngo*.via Frontier Prototype Store is continuously enriched with new contributions from Siemens Healthineers R&D, other Frontier users, and external partners.

For instance, the 3D-printing prototype available for research in *syngo*.via Frontier, automatically recognizes the organ segmentations from various *syngo*.via applications and prepares them for 3D printing. The potential of this area is huge. In clinical practice, 3D technology is receiving more and more attention. Its main benefit will be improving both the planning of surgeries, as well as communication between physicians, and dialog with patients.

Like Auzoux's anatomical models, cinematic rendering and 3D printing also open up new dimensions in education: understanding and perceiving human anatomy. They allow visualization of the anatomy of a living patient, showing all structures present. If Auzoux were still alive, he would most likely be an early adopter and proud to have been part of the future in healthcare. ■

The Museum of Medicine in Belgium applied Siemens' innovative 3D cVRT to recreate a 19th century papier-mâché anatomical model.

For more than 25 years, journalist and editor **Erika Claessens** has contributed to numerous print and online publications in both Belgium and the Netherlands. Her principal topics are entrepreneurial innovation and sustainability. She works in Antwerp, Belgium.

The statements by Siemens' customers described herein are based on results that were achieved in the customer's unique setting. Since there is no "typical" hospital and many variables exist (e.g., hospital size, case mix, level of IT adoption), there can be no guarantee that other customers will achieve the same results.

[1] Cinematic VRT is not intended for diagnostic reading.
[2] *syngo*.via Frontier is a research platform and not intended for clinical use.
[3] The product is pending 510(k) clearance, and is not yet commercially available in the U.S.
[4] *syngo*.via can be used as a standalone device or together with a variety of *syngo*.via-based software options, which are medical devices in their own right. *syngo*.via and the *syngo*.via based software options are not commercially available in all countries. Due to regulatory reasons its future availability cannot be guaranteed. Please contact your local Siemens organization for further details.

"As a medical student, Auzoux came up with a papier-mâché anatomy model that was made of a mixture of cork, ropes of hemp and metal fibers, clay, paper, and wheat glue."

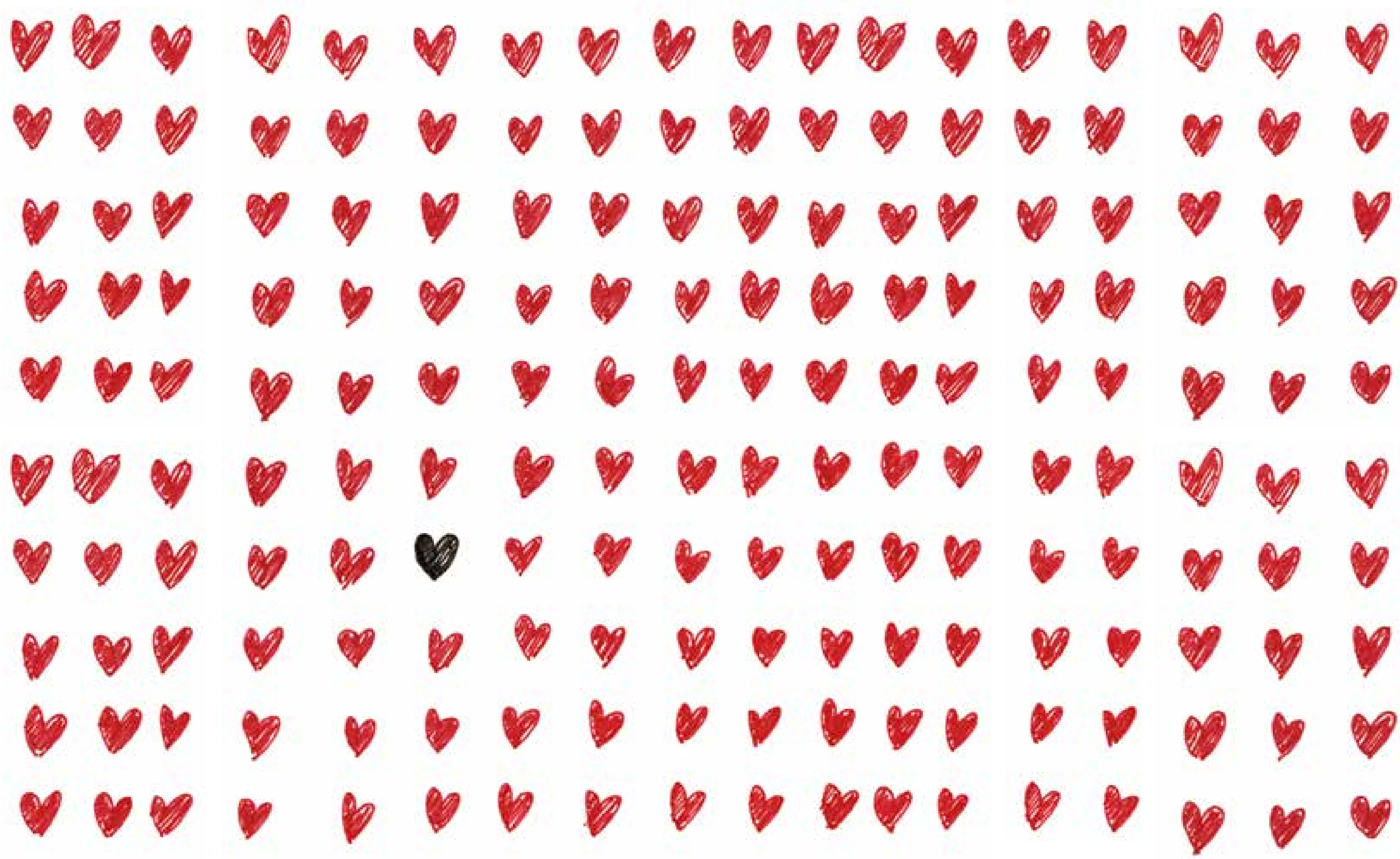
Anne-Sophie Hanse, art restorer and collections coordinator at the Museum of Medicine in Brussels, Belgium

Siemens Healthcare Business Rebranded

By Monika Demuth, *PhD,*
Siemens Healthineers, Germany

SIEMENS Healthineers

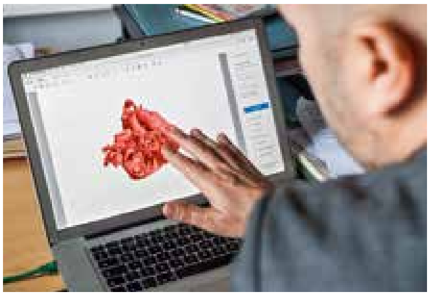
Siemens Healthcare has changed its name to Siemens Healthineers. The new name embodies Siemens' pioneering spirit and engineering expertise in the healthcare industry. Siemens Healthineers wants to enable healthcare providers to deliver even better outcomes at lower cost to support them at all levels of operational and clinical need, while also keeping the patient firmly in focus. The new brand defines the organization and its employees - people who are dedicated to their customers, who support and inspire them, and who stand for outstanding solutions and products. ■



Reconstructing the Heart to Save Children's Lives

Cardiac surgeons and radiologists at Great Ormond Street Hospital for Children (GOSH), London, collaborate in the treatment of children with congenital heart disease (CHD). Faster imaging produces 3D reconstructions and models to be used as planning tools for surgery and in communication with patients and their parents. Consultant radiologist Catherine Owens, MD, and consultant surgeon Martin Kostolny, MD, spoke to *SOMATOM Sessions* about their work at GOSH.

Text: **Linda Brookes, MSc,** Photos: **Andrea Artz**



Martin Kostolny, MD, is the lead in neonatal cardiac surgery, performing between 200 and 240 operations annually.

"What is important for me as a surgeon is to get an understanding of a 3D image."

Martin Kostolny, MD, GOSH, London, UK

One in every 180 babies in the UK is born with congenital heart disease (CHD) – a structural malformation of the heart or major blood vessels.[1] CHD is the most common congenital anomaly and causes more deaths in the first year of life than any other birth defect. Twenty to thirty years ago, only 15% of babies in the UK with the most complex CHD survived beyond 18 years, but since then deaths from CHD in childhood have fallen by 83% so that over 90% of these children now survive into adulthood.[1] This improvement has been attributed to better imaging and improved understanding of the anatomy of a child's heart. In addition, new, often highly complex surgical techniques have been developed, and use of sophisticated cardiac catheters for minimally invasive interventional procedures to correct the defects avoids the need for more risky open-heart surgery.

Most cases of CHD require surgery or interventional procedures to restore the heart's normal function. Great Ormond Street Hospital for Children (GOSH) in London is the largest pediatric center for cardiac surgery in the UK. Between 2012 and 2015, surgeons at GOSH carried out 2,995 major pediatric CHD procedures, with a 30-day survival rate, (the benchmark used to judge outcomes) of 99% – the highest in the country.[2]

At GOSH, the type of heart defect a child has is usually identified initially by a pediatric cardiologist using an echocardiogram. This information is limited, however, so a multidisciplinary team of cardiologists, surgeons, intensivists, imagers, and nurses then meet in a 'joint cardiology conference' to discuss the symptoms and decide on the type of additional imaging that will provide the surgeon with the optimal tools for planning the necessary operative procedures or medical interventions.

Individualized 3D models

Martin Kostolny, MD, has been a consultant cardiothoracic surgeon at GOSH since 2006.

He is the lead in neonatal cardiac surgery, performing between 200 and 240 operations annually. For more common defects, such as transposition of the great arteries, where surgical intervention is needed within the first two weeks of life, "the only information I need is in the form of an echocardiogram," Martin Kostolny explains. "For the more complex heart defects, we usually need a combination of imaging modalities to help the team reach the right decision. What is important for me as a surgeon is that you can combine these imaging modalities to get an understanding of a 3D image," he stresses.

A recently introduced application of the 3D datasets from CT and MRI imaging is the production of individualized models of patient's hearts built by deploying a 3D printer using a technique known as "rapid prototyping." These models provide surgeons with a valuable clinical planning tool and can be used to help parents and patients understand the complex anatomy of congenital heart defects. They are also used in teaching. "Not everyone can visualize a 3D image in their heads, so this is a very important development," explains Kostolny.

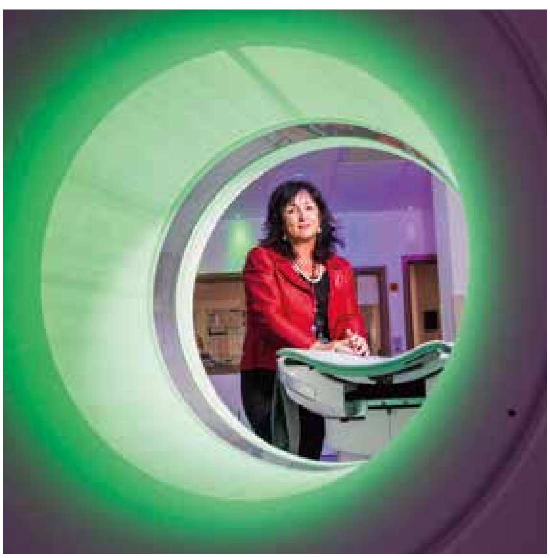
The department of radiology at GOSH provides diagnostic imaging and interventional radiology services for children from newborns to 16 years of age. Among their equipment is a CT scanner, a Siemens SOMATOM Force, installed in 2015. Up to that time, the department was using a SOMATOM Definition for CT scanning, which lacked the high-speed Turbo Flash scan mode.

State-of-the-art CT scanner

"We went straight from a first-generation dual source CT scanner to a state-of-the-art third-generation device, notes Catherine Owens, MD, consultant radiologist at GOSH. "We were very happy with the previous scanner," she stresses. "We spent a lot of time modifying it to get to a place where our radiation doses were very low. Our images were good and diagnostic, but they were nowhere near the diagnostic quality of the images we are getting now, with significantly reduced radiation dose compared with the previous scanner," she says. "The new scanner has a number of new technologies, but the Turbo Flash mode (increasing scan speed to 737 mm/s), rapid acquisition (0.25 s compared with 0.33 s per rotation on the previous scanner), and hence high temporal resolution (66 ms compared with 83 ms) have all made a huge difference for us." In the year since the SOMATOM Force scanner was installed, there has been a marked increase in the number of cardiothoracic CT examinations performed at GOSH, rising from around 800 in the previous year with the previous scanner to almost 1000 in 2015.

"The average time taken for a CT scan is less than five seconds – the actual time of the scan is tiny compared with the average time of an MR, which is about half an hour," Owens explains.

Martin Kostolny appreciates the advantage of being able to run a fast CT in cases such as hypoplastic left heart syndrome, one of the most complex cardiac defects seen in the newborn and probably the most challenging to manage; without treatment, the syndrome is always fatal, often within the first hours or days of life. "I do an operation called a Norwood-type procedure in which I reconstruct the aortic arch and provide a source of pulmonary blood flow," Kostolny explains. "The echocardiogram can tell me everything about the function of the valves inside the heart, but can only give limited information about the shape and size of the aortic arch. So if there are any doubts about the clinical picture, then I can ask for a CT. The patient is fed, swaddled, put into the CT scanner, and we have the image in two seconds, with no concern about radiation," he says.



In the year since the SOMATOM Force scanner was installed, there has been a marked increase in the number of cardiothoracic CT examinations performed at GOSH.

"Since the installation of the SOMATOM Force scanner, we've reduced our doses radically."

Catherine Owens, MD, GOSH, London, UK

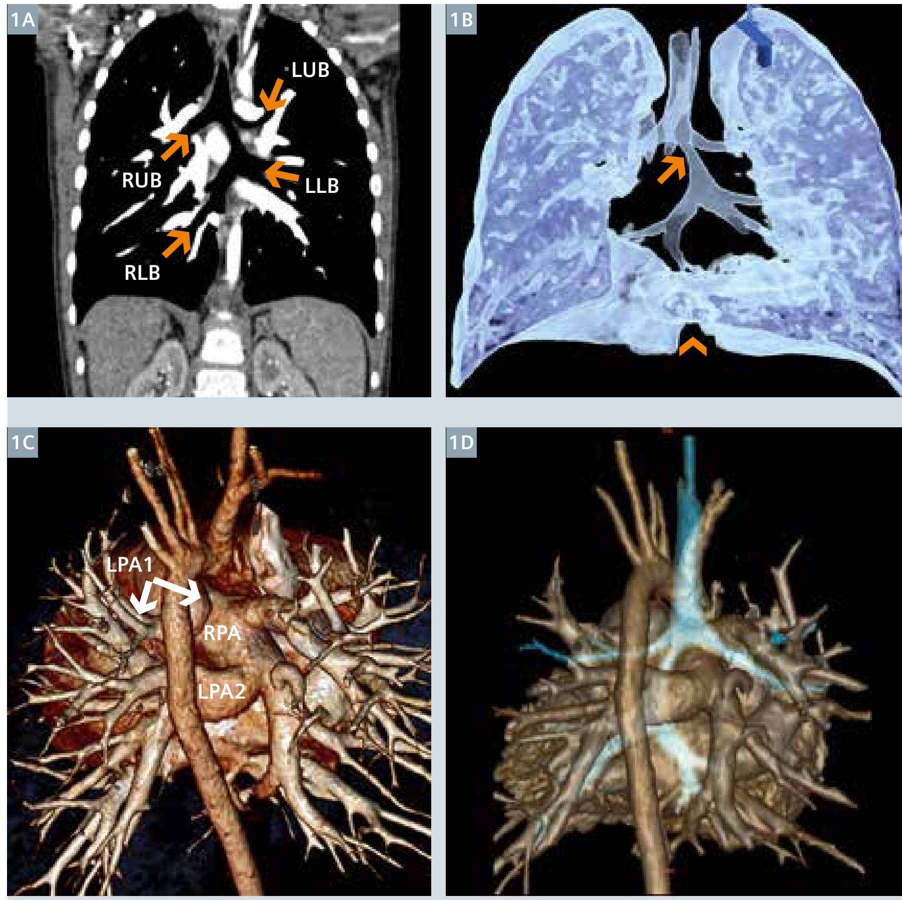
The ultimate test

"Children really are the ultimate test of a good CT machine," Owens admits. "They are small – many of the hearts operated on are about the size of a walnut – and the rapid heart rates and faster breathing in children cause motion artifacts; and older children may be uncooperative. In a child, it is not uncommon to see a heart rate of 150–180 bpm," she says. However, the extended coverage of SOMATOM Force means an entire heart can be covered in approximately 150 ms.

Radiation remains a concern in pediatric CT imaging, "and rightly so," Owens acknowledges, although "the data associating radiation in diagnostic use with cancer risk are very sparse and the potential risks probably very low," she adds. As current President of the European Society of Paediatric Radiology, Catherine Owens is involved in a number of initiatives for radiation safety in medical imaging, including EuroSafe, the European Society of Radiology's campaign for medical radiation protection.

Reduced doses

In the UK, requests for an examination using radiation must be clinically 'justified' by the referring clinician. Owens explains that before performing a CT scan, a risk-benefit analysis is carried out that involves asking whether an examination is really necessary and if so, whether another form of imaging that does not involve ionizing radiation, such as MR, could be used instead. After justification, the CT scanner will be optimized to provide the best quality image that is 'fit for purpose,' that is, clear enough to see any abnormality at the lowest possible diagnostic radiation dose. "Since the installation of the SOMATOM Force scanner, we've reduced our doses radically" Owens notes. "The test of our work is with patients and the clinicians," she says. "We have a very close-knit multidisciplinary team and through regular meetings we help plan patients' therapy and educate clinicians about imaging and the tools that are valuable for each potential diagnosis. The bottom line is that you justify your examination; you do it for a reason that will benefit the patient, and you perform the scan to the best of your ability, working with your scanner." ■



1 A coronal MPR (Fig. 1A) and three VRT (Figs.1B–1D) images show a "Christmas tree" pattern of a trachea-bronchial system, and a left pulmonary artery (LPA) sling with duplication. The coronal views (Figs. 1A and 1B) demonstrate the right-upper bronchi (RUB), left-upper bronchi (LUB), right-lower bronchi (RLB) and left-lower bronchi (LLB) connected via a narrowed tracheal segment (Fig. 1B, arrow), and a horseshoe lung segment (Fig. 1B, arrowhead). The posterior views (Figs. 1C and 1D) illustrate the duplicated LPA originating from the right pulmonary artery (RPA) (Fig. 1C), and the relationship of the airway to the vessels (Fig. 1D).
Courtesy of Great Ormond Street Hospital, London, UK

Linda Brookes is a freelance medical writer and editor who divides her time between London and New York, working for a variety of clients in the healthcare and pharmaceutical fields.

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Meeting Market Challenges in Regional Switzerland

Since the introduction of the invoicing-process DRG in 2012, public hospitals in Switzerland are under constant cost pressure. The Division of Radiology and Nuclear Medicine at Kantonsspital St. Gallen has adjusted to the new market situation by centralizing its services within the region and by investing in high-end diagnostic technology.

Text: **Irène Dietschi,** Photos: **Daniel Auf der Mauer**

Professor Sebastian Leschka, MD (left) and Professor Simon Wildermuth, MD (right) explain that the radiology department at KSSG has largely streamlined its imaging equipment. They included systems mainly from Siemens to be as consistent as possible.

When Switzerland passed a new law on hospital funding in 2012, the government introduced a DRG system similar to the system established across the border in Germany. Cost effectiveness became a crucial term for the management boards, and many of the roughly 200 public Swiss hospitals invested in their equipment in order to position themselves favorably among their competitors. Four years into the new system, and cost pressure is the most commonly criticized aspect.

Such was the situation when Kantonsspital St. Gallen (KSSG) in the eastern part of Switzerland had to replace one of their two high-end computed tomography (CT) scanners in 2014. "We needed a CT scanner that covered all the needs of a large hospital, and – along with our business strategy – we wanted the best machine on the market," says Professor Simon Wildermuth, MD, Head of Radiology and member of KSSG's board of directors. Colleague Professor Sebastian Leschka, MD, senior lead radiologist explains: "There were, of course, a number of financial considerations to be made, but crucial to our choice were the clinical criteria."

Kantonsspital St. Gallen is the main regional hospital in the Swiss canton of St. Gallen, fully integrating two other regional hospitals – Rorschach and Flawil – in its organizational structure. Moreover, KSSG serves as the hub for several smaller clinics scattered across the canton and its neighboring regions. While claiming university level for many of its medical procedures, the hospital itself has no medical faculty. Radiology is the only completely centralized department at KSSG: Its network includes a total of twelve CT scanners allotted to ten hospitals. Two of them are high-end systems at KSSG: one in radiology, the other one in the emergency room. This is a USP that none of the private competitors in the area can claim. Routine CT imaging is often carried out locally by KSSG radiologists or via teleradiology, but complex or rare examinations are performed exclusively at St. Gallen. The imaging archive system is also centralized.

Streamlined imaging equipment

In view of these organizational structures, the radiology department at KSSG has largely streamlined its imaging equipment to include mainly systems from Siemens. Chief radiologist Simon Wildermuth comments: "It has been our policy to be as consistent as possible in the acquisition of our machines, for the sake of our staff and their daily challenges as well as for the validity of our protocols." Both these aspects – the networked structure of the hospital and brand consistency in scanner purchases – spoke strongly in favor of a Siemens high-end CT scanner from the start. Nevertheless, the department compiled a business case to justify the system before they bought it. Fabian Dorner, the department's analyst, calculated that the system would break even with a daily throughput of 35 patients. "It was a cautious assessment," he recounts, "but we wanted to be on the safe side." So in the end, KSSG opted for a SOMATOM Force from Siemens. The hospital executives decided that the scanner would ideally meet their clinical requirements, and that it could be run profitably despite high cost pressure.

Since the installation of the SOMATOM Force in October 2014, there has not even been a need to evaluate the return on investment. According to Fabian Dorner: "We see considerably more than 35 patients on a daily basis, mostly between 40 and 50, sometimes even up to 60." So the system is proving to be profitable. In the words of Simon Wildermuth:

Since KSSG covers all medical disciplines except heart surgery, the SOMATOM Force is used for a wide variety of applications.

"Many examinations which used to be within the realm of conventional X-ray have given way to computed tomography, and many specialized imaging systems have ceased to exist."

Professor Simon Wildermuth, MD,
KSSG, Switzerland

"After not quite two years of clinical routine, the Force has clearly paid off."

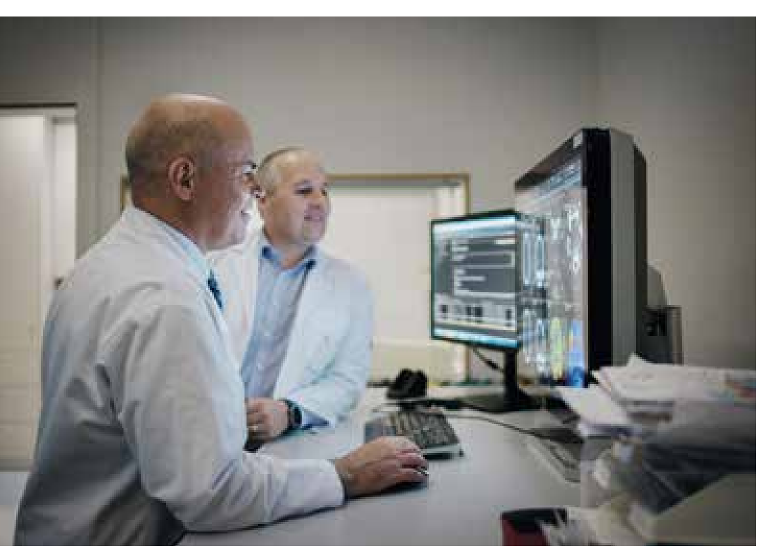
Low doses and minimal contrast agent

The investment has not only proven its worth in financial terms: Most important to the radiologists at St. Gallen are the clinical benefits the SOMATOM Force delivers, especially with regard to the vast dose reductions and the minimal need for contrast agent. Sebastian Leschka explains: "What used to be our ultra-low-dose examination five years ago is now the standard dose." Since KSSG covers all medical disciplines except heart surgery, the scanner is used for a wide variety of applications including oncological and surgical topics; neurological problems such as aneurysm or stroke; dynamic perfusion examinations for various organs such as pancreas, abdomen, kidneys, and the liver; imaging of blood vessels in the abdomen or at the extremities, lung scans; and many more.

Cardiac CT

One feature the KSSG radiologists particularly appreciate is cardiac CT, especially for the exclusion of coronary heart disease. It is an exam that they perform exclusively in their unit at St. Gallen, given the need for the diagnostic precision that only a high-end CT scanner can provide. "It's fantastic," says Leschka: "Ten years ago, when we did a cardiac CT we had to work hard to obtain decent images – nowadays, the Force does it almost all by itself." He recalls how he used to give specific instructions to the technical assistant for every single cardiac CT – a procedure that has become standard. This also benefits the patient, it must be said: Cardiac scans along with all other exams are performed with standardized protocols that Siemens provides at delivery and which the clinicians can adapt according to their needs.

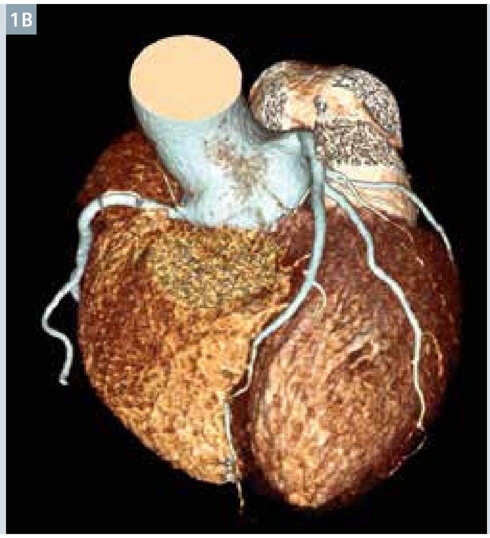
The reliability of the cardiac protocol has also helped solve a common issue that has long since led to tension between radiologists and cardiologists – not only in Switzerland: The latter would not accept that cardiac CT angiography could be used to assess the chances of coronary heart disease in a patient with certain risk factors. "After years of discussions, we have now achieved coexistence characterized by mutual respect and clinical relevance," says Wildermuth. Cardiac CT angiography for coronary heart disease, according to the Swiss Medical Board, is meant as a rule-out exam for patients with uncertain pretest probability, whereas



Statistics for Kantonsspital St. Gallen: CT examinations increased from 2014 to 2015

(including the hospitals in Rorschach and Flawil)

	2014	2015
Computed tomography (CT) in total	23,854	25,132
Neck / thorax / abdomen / pelvis	10,358	10,741
Head / spine	5,842	5,991
CT angiography	4,517	4,966
Extremities	1,225	1,262
CT interventions	1,410	1,433
Heart	369	455
Others	133	284



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A curved MPR (Fig. 1A) and a VRT (Fig. 1B) image showed a myocardial bridge in the mid LAD.
Courtesy of Kantonsspital St. Gallen, Switzerland

patients presenting indisputable risk symptoms are directly referred for catheter examination.

Nevertheless, the demand for cardiac CT is constantly growing, mirroring a general trend toward increased CT imaging at KSSG (see table). "Generally speaking, many examinations which used to be within the realm of conventional X-ray have given way to computed tomography, and many specialized imaging systems have ceased to exist," says Wildermuth. "For example, we used to do very complicated illuminations of the intestines or imaging of the urinary tract and the kidneys, such as intravenous urography. All this has been replaced by CT, which is much simpler, safer, and more effective. SOMATOM Force is of course not the only scanner accountable for this development, but with its many technological virtues it has certainly made a significant contribution."

Sebastian Leschka adds: "Since radiation dose is under control and the procedure is so fast, CT has become standard for almost any indication – polytrauma, acute abdominal pain, appendicitis, you name it. The threshold for a CT scan has certainly dropped, and its use is now firmly established." This is not just clinically relevant, it is also important in terms of costs within the DRG system that the Swiss are bound to: The more accurate the diagnostics, the lower the risk that patients have to be rehospitalized after treatment.

"What used to be our ultra-low-dose examination five years ago is now the standard dose."

Professor Sebastian Leschka, MD,
KSSG, Switzerland

However, there are also downsides to the trend of increasing CT scans: Issues of patient management and scan evaluation are much more time-consuming and often more challenging than the scanning process itself. Wildermuth and Leschka both agree: "We offer better services to our colleagues, no doubt. But this also calls for improved organization and more resources on our part."

Numerous supporting studies

Due to the highly advanced technology in their SOMATOM Force in particular, KSSG radiologists are able to pursue research interests with accelerated zeal. They have, for example, published a substantial number of studies over the past two years. Several publications are dedicated to cardiac CT angiography; another study evaluated the image quality and sensitivity of ultra-low-dose CT for the detection of pulmonary nodules; and in yet another they studied advanced modeled iterative reconstruction for abdominal CT. In a particularly interesting study, researchers explored dual energy CT imaging of cocaine and heroin in drug smugglers. They discovered that it was possible to distinguish whether body bags contained cocaine or heroin using different dual energy indexes.

To conclude: KSSG executives are very satisfied with the acquisition of their SOMATOM Force. Its many benefits have eased clinical processes and enabled a greater range of examinations such as cardiac CT. Both staff and patients now take this improved situation for granted. Still, Simon Wildermuth is sometimes in awe of this evolution: "We used to spend hundreds of hours obtaining good pictures of the heart, and nowadays you can achieve the same quality as standard routine and with a minimal dose," he comments. "When I first realized this, it was an extraordinary moment." ■

Irène Dietschi is an award-winning science and medical journalist based in Olten, Switzerland.

Extending the Range
of Diagnostic Possibilities

CT examinations are not always feasible: Radiation dose remains an issue, as does contrast media toxicity. Technology, however, continues to evolve. Radiologists at the Medical University of Vienna feel much more confident about performing a CT scan these days, even in patients who are normally not considered very suitable candidates. Here is why.

Text: **Philipp Grätzel von Grätz,**
Photos: **Reiner Riedler**

"We are now able to reduce the radiation dose drastically compared to what we had before."

Professor Helmut Ringl, MD,
AKH, Vienna, Austria

Computed tomography is the modality of choice for answers on a vast variety of clinical questions. Still, some drawbacks remain that limit its use in situations in which a CT examination would be desirable in principle: “Radiation dose always has to be considered. And in renal patients, contrast media can deteriorate kidney function. With conventional CT machines, we often have to withhold CT examinations from children. And we will regularly abstain from contrast-enhanced CT examinations in renal patients, even if there are good reasons to perform them,” says Professor Helmut Ringl, MD, deputy head of the Clinical Department of General Radiology and Pediatric Radiology of Vienna General Hospital (AKH) and Medical University of Vienna.

Improved CT: Significant dose reduction is possible

Radiology at AKH in Vienna is a large-scale enterprise. AKH is among the largest university hospitals in Europe. There are five different CT scanners available and 80 radiologists who perform between 6,000 and 8,000 CT examinations per machine per year. It is the prototype of a tertiary care hospital, as the reference institution not only for Vienna, but also for large parts of eastern Austria, in particular Lower and Upper Austria. “Doctors who send their patients here expect us to come up with answers. Not being able to perform a CT scan on a patient can be a real problem,” says Ringl. Luckily, medical technology is increasingly providing solutions that will enable access to CT examinations for more patients than before. Radiation dose can be reduced considerably, for example, by using modern detectors, a low kV X-ray generation system, modern algorithms for iterative reconstruction, and sophisticated filters. This is particularly important for children: “Compared to adults, they have a higher risk of radiation-associated complications because they live longer and their rate of cell division is higher,” says Ringl. Another group of patients who benefit disproportionately from lower doses are women. “They, too, have a higher risk of radiation-associated damage. This is especially true when they are younger, but also in their later years.”

Radiologists at AKH have proven in recent months that a dose reduction of a relevant magnitude is no longer merely theoretical, but can actually be achieved in daily routine. At the beginning of March 2016, a new SOMATOM Drive CT scanner was installed – the first of its kind in clinical routine used worldwide. Asked about its most important advantages, Ringl doesn’t hesitate for a second: “Most important is dose reduction. Overall, we are now able to reduce the radiation dose drastically compared to what we had before with the previous machine.” Dose reduction doesn’t help, however, if image quality goes off the mark. But this is not the case, according to Ringl: “The relation between dose and image quality is really good. We have less dose now, but the image quality is better than before. This is a huge step forward.”

The case of the woman with a lung nodule

Apart from children, which patients benefit most from dose-limiting technologies? “A typical adult patient who benefits a lot would be a 35-year-old female in need of follow-up examinations after the detection of a lung nodule,” says Ringl. The follow-up CT scans in such a patient are not about characterizing the nodule, but about comparing its size to earlier examinations. This can be done with unenhanced CT, but repeated scans in young women is something doctors have striven to avoid until now. “What SOMATOM Drive can do is to push radiation dose down to levels that make serial CT scans an excellent option. We are able now to get a complete CT dataset with a very good image quality and a dose exposure equivalent to between one and two plain films,” says Ringl.

Among the technologies that make this possible are a new generation of powerful detectors and also improved algorithms for iterative reconstruction. “We didn’t use the old algorithms much, and if so then only at low strength,” Ringl admits. “With the new ones, this is different: We are very satisfied with the image quality they provide, and so we use them in almost all protocols at strength three,

Radiologists at AKH have proven in recent months that a dose reduction of a relevant magnitude is no longer merely theoretical.

Facts and Figures

of the CT department at AKH Wien

5 CT scanners

80 radiologists

6,000 – 8,000
examinations per machine/year

resulting in much lower radiation dose."

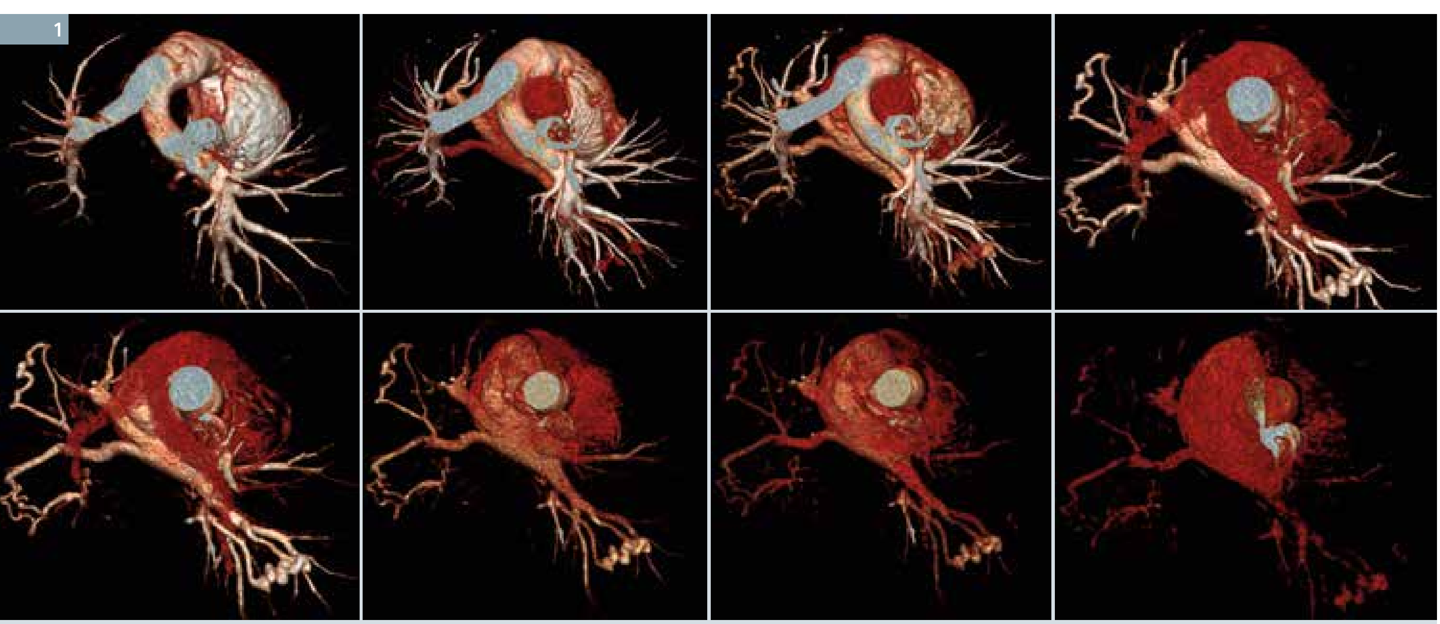
The Tin Filter is a key technology used in the SOMATOM Drive scanner to reduce radiation dose without compromising image quality. What the Tin Filter does is to separate the low energy photons in the X-ray spectrum of the tube from the diagnostic part of the spectrum, explains Ringl. Low energy photons that would never reach the detectors, or that do not contribute much to image quality, are absorbed before they enter the patient. "In the end, this means that we have an X-ray beam that is tailored to diagnostic use. We don't apply any dose to the patient that is not necessary."

However, the Tin Filter is not suitable in every kind of examination. In contrast media-enhanced examinations, for example, low energy photons are needed to make the contrast agent visible. This is not the case in unenhanced CT scans: "If we only need an unenhanced CT, we use the Tin Filter quite often," says Ringl. Another potential beneficiary that comes to mind is a patient with an unclear finding on a chest X-ray. In this patient, a lung CT is necessary to rule out malignant lung pathologies. "With the Tin Filter, we can rule out a pathology at the dose of a chest X-ray," says Ringl.

The case of the cardiovascular patient

Patients with cardiovascular diseases are a further group of patients for whom Ringl finds the dual source scanner to be particularly suitable. "With the SOMATOM Drive, we can perform very fast low-dose examinations, which makes it an excellent machine for 4D imaging in cardiovascular patients." In fact, only two days after the installation in March, the Vienna radiologists used the CT for a 8-phasic 4D CTA of the pulmonary vessels in a young woman with suspected arteriovenous fistulae. It transpired that they were only pulmonary venous varices. (Read the full case report on page 38)

Previously, an 8-phasic 4D CTA would have meant very high radiation exposure, and as such it would not have been the diagnostic method of choice at all in many cases. "Four months ago,



1 VRT images acquired from eight different phases (early arterial to late venous) of a dynamic 4D CTA scan demonstrate clearly bilateral pulmonary venous varices and rule out suspected arteriovenous fistulae.
Courtesy of General Hospital of Vienna (AKH), Medical University of Vienna, Vienna, Austria

we would certainly not have thought of something like this in a young woman for dose reasons. We would have done an invasive angiography or a MRA instead. But with SOMATOM Drive, we were able to perform the 8-phasic CTA at about the same dose as a single-phase CTA previously."

Radiology at AKH in Vienna is a large-scale enterprise and among the biggest university hospitals in Europe. Professor Ringl, MD, was one of the first SOMATOM Drive users.

Low kV imaging: ready for prime-time

Dose reduction with SOMATOM Drive is achieved using advanced detectors, the Tin Filter, and iterative reconstruction. Similarly important for dose reduction is the ability of the CT scanner to perform low kV imaging while maintaining a high image quality. In Vienna, the radiologists decided to use automatic selection of kV ("auto kV") as the default option. "We thought that we will get the best possible dose reduction if we use auto kV all the time. This is similar to an anti-collision system in a car: You would not switch it off only because you felt highly concentrated." With auto kV, the system chooses for itself which voltage to use to achieve a sufficiently high tube current. In lean patients, 70 or 80 kV will be sufficient most of the time. In more obese patients, the software will go for a higher kV value.

"Low kV imaging is only possible with a powerful tube that is able to provide a high tube current at low voltage. With other CT scanners, 70 kV or indeed 80 kV is often not feasible because we don't get enough photons from the tube, resulting in an image that is too noisy." With SOMATOM Drive, this is no longer an issue anymore, says Ringl: "We are in the low kV range now for the vast majority of patients. We have almost completely moved away from 120 kV. It is highly unlikely that 120 kV is selected by the device, and the image quality we get proves that the device is right."

The case of the renal patient

Low kV imaging is not just about dose, it is also about contrast media. Iodine contrast agents absorb photons produced by a 70 kV system much more readily than photons produced by a 100 kV or even 120 kV system. So low kV imaging leads to a reduction in the amount of contrast agent needed to perform a contrast-enhanced CT. And this is not merely theoretical, says Ringl: "What we have seen in the last three months in daily routine is a significant reduction in the contrast media we use." This is especially good news for patients with renal failure, because less contrast agent means less damage to the kidneys.

At Vienna General Hospital the word is out that Ringl and his colleagues can now offer CT examinations for patients who would not have been suitable in the past: "Our referring physicians are very happy to hear that we have a new CT with a much lower dose. And they are very satisfied with the image quality we provide. We even have a handful of doctors who explicitly ask us from time to time to scan their patient with the new system." ■

Philipp Grätzel von Grätz is a medical doctor turned freelance writer and book author based in Berlin, Germany. His focus is on biomedicine, medical technology, health IT, and health policy.

Dose Performance Made Transparent

At "Krankenhaus der Augustinerinnen" in Cologne, Germany, dose standardization and optimization are key. As a result, dose management is becoming increasingly important. Frank Schellhammer, MD, Chief of Radiology, describes how the hospital is keeping X-ray doses as low as reasonably achievable.

Text: **Wiebke Kathmann, PhD,** Photos: **Sandra Stein**

The "Krankenhaus der Augustinerinnen" in Cologne enjoys a good reputation offering a broad spectrum of medical examinations.

As a Catholic hospital whose values are shaped by the rules of St. Augustine, "Krankenhaus der Augustinerinnen" focuses on the human being as a whole. Optimal medical and pastoral care of the patient are a top priority, and the hospital enjoys a good reputation offering a broad spectrum of medical examinations. Even though it is a regional clinic with just 300 beds, it is known for its convincing performance in surgery, internal medicine, as well as in gynecology, oncology, orthopedic surgery, and radiology. The department of radiology takes great pains to adhere to the ALARA principle that states X-ray doses should be "as low as reasonably achievable."

Frank Schellhammer, MD, Chief of Radiology and a neuroradiologist by training, is proud that his department is able to offer a broad radiological portfolio. He and his team perform oncological imaging, including tumor staging before and after chemotherapy, as well as image-guided tumor interventions such as liver embolization, thorax, and orthopedic or gynecological exams. For Schellhammer, a key goal is dose optimization over the complete radiology portfolio. And teamplay from Siemens provides a tool to support him and his team in reaching this dose management goal by offering clear and intuitive dose performance graphics.

Intuitive graphical user interface

Schellhammer considers teamplay a valuable add-on which he has come to rely on to quickly evaluate the dose performance of all CT scans in his department. He has developed a habit of looking over the past weeks' images before leaving his office on a Friday night. With teamplay, it only takes him a couple of seconds. The first screen gives a graphical representation of where he stands regarding dose. It tells him what percentage of the CT scans are within the dose limits of the national reference values. More important for Frank Schellhammer, however, are the dose limits he has defined for his institution. These institutional reference values are lower than the German national reference values and therefore have a better impact on patient care. "One glance tells me whether or not I need to be nervous." Going one step further, he finds the information on when and why the scan was performed. He quickly finds all the data needed to evaluate a particular scan (organ, type of examination, individual scan, indication) and the answer as to why a specific scan required more radiation than normal.

Data transparency

Schellhammer uses teamplay in two ways: First, to rapidly identify any dose outliers and then retrieve specific exams for closer inspection. In the case of a retrieval, he can connect his PACS (picture archiving and communication system) via teamplay with the so-called PACS call-up functionality. With teamplay Dose, the right patient data is automatically detected and opened in PACS. This allows for factors such as patient shape and image quality to be checked and adjusted if necessary. "As we have a reputation for HIV-associated issues of lung function and we advertise low-dose CT scans of the thorax, I regularly use teamplay to check whether we are where we want to be in regard to the results of our low-dose protocols. teamplay lets me know how I perform in any given CT exam. It gives substance to my feeling about the performance based on true data filed from PACS and converts it into a graphic that is easy to grasp." As Schellhammer points out, teamplay's data-mining function is especially helpful as it uses real data from the modality itself. "It isn't calculated data and is therefore very reliable," he says.

"I regularly use teamplay to check whether we are where we want to be in regard to the results of our low-dose protocols."

Frank Schellhammer, MD,
"Krankenhaus der Augustinerinnen",
Cologne, Germany

For Frank Schellhammer, MD, the dose limits he has defined for his institution are crucial. These institutional reference values are lower than the German national reference values.

teamplay Images is designed to offer a secure environment for clinical image exchange among peers for research and education.

"Quality management is now vivid and accessible, depicted in a graph representing information that has real substance and one that I can base meaningful decisions on."

Frank Schellhammer, MD,
"Krankenhaus der Augustinerinnen",
Cologne, Germany

In terms of quality management, Schellhammer sees an immense advantage for patients in teamplay Dose. "We have a tool that objectifies our work. Quality management is no longer a report on a pile of paper archived in some folder. It is vivid and accessible, depicted in a graph representing information that has real substance and that I can base meaningful decisions on."

Of the various apps that teamplay offers, the radiology team in Cologne currently uses mainly 'Dose' and 'Usage'. Given that dose monitoring is essential for Frank Schellhammer, he uses teamplay Dose regularly and finds teamplay Usage especially valuable for larger institutions with more scanners as it then can be used for efficiency management. In general, teamplay Usage provides an overview of whether there are times during the day or week when the scanner is hardly used and thereby helps to organize usage more efficiently – critical in times of enormous budget pressures.

As the teamplay platform is constantly expanding, Frank Schellhammer is looking forward to using the latest 'Images' app.[1] teamplay Images is designed to offer a secure environment for clinical image exchange among peers for research and education. "At the moment, I can see a potential advantage in making it easier to share clinical images with colleagues at my institution and beyond," Schellhammer comments.

Clinical cases

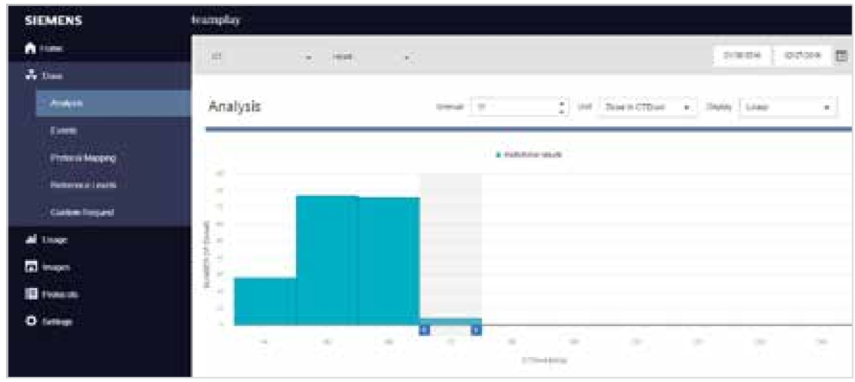
Schellhammer illustrates three cases of teamplay as used in clinical routine in Cologne:

Case 1
This case describes backtracking an outlier: "While the national reference value[2] for a head CT scan in Germany is $CTDI_{vol}$ 60 mGy, our examination used $CTDI_{vol}$ 108 mGy," Schellhammer explains. "To justify this value, we need

to find the root cause," he continues. "When checking the clinical data, I saw that we actually did three scans (a native CT scan, a CT angiogram, and another scan post-contrast) to clarify the clinical situation. I can go deeper into the issue and double-check the indication. The issue here was impaired perfusion of the brainstem in a patient not suitable for MRI. Therefore, we fulfilled the goal of the CT scans to exclude relevant ischemia or vessel occlusion. Considering there were three examinations, we did well regarding dose."

Case 2

"Last week we performed a head CT scan on someone who had been involved in a fight. As we are located in the center of town with bars all around, we see quite a few emergency cases. In this instance, the patient was agitated and moved around quite a bit. Motion artifacts can be recognized during the helical scan and the double contour signs. Therefore, we had to rescan the patient several times in order to exclude a hematoma of the brain. In the end, he had three scans instead of one. The only other options would have been not to put him into the CT scanner and have him rest for two hours or to administer sedation, which was not really an alternative. We needed to make a clinical decision. Taking this into account, the dose outlier needed no further analysis."



teamplay Dose provides easy access to current data and allows further analysis e.g., by modality and body part for continuous dose management.

Case 3

"The national reference level[2] for a general CT scan of the thorax in Germany is $CTDI_{vol}$ 10 mGy, regardless of the examination. It comes as no surprise that we were over the reference value when performing a biopsy of a conspicuous structure in the lung, a circular lung focus. Such an intervention can only be partially calculated: A further rotation may be needed to access the structure. Therefore, we were fine with an increase in dose in this case. It was more important to hit the structure and confirm the pathology than to comply with dose hygiene."

Today, teamplay is an extremely welcome and valuable tool in Schellhammer's daily routine. So far, he is not being compelled to undertake dose management to the extent he currently does. Most likely this will change in the near future. Yet, Schellhammer considers his responsibilities for dose standardization and optimization as part of his professional ethics – and does this gladly. ■

"At the moment, with teamplay Images I can see a potential advantage in making it easier to share clinical images with colleagues at my institution and beyond."

Frank Schellhammer, MD,
"Krankenhaus der Augustinerinnen",
Cologne, Germany

1 Performing a lung biopsy assisted by CT imaging necessitated a further rotation to access the structure (case 3).

Wiebke Kathmann, PhD, is a frequent contributor to medical magazines. She holds a Master in Biology and a PhD in Theoretical Medicine and was employed as an editor in chief for many years before turning freelance in 1999. She is based in Karlsruhe and Munich, Germany.

[1] Preliminary information. This product is not yet released for diagnostic use.

[2] Bundesamt für Strahlenschutz (Bekanntmachung der aktualisierten diagnostischen Referenzwerte für diagnotische und interventionelle Röntgenuntersuchungen), https://www.bfs.de

Clinical Imaging Out and About

A flood. The hospital is inundated. Demand for the computed tomograph is urgent, but the scanner is not working. Staff will have to find a way of reorganizing the entire clinical workflow. This is just one of the scenarios in which Alliance Medical and its wide range of mobile clinical devices could be of help.

By **Monika Demuth, PhD,** *Siemens Healthineers, Germany,* Photos: **Benjamin Rösner**

Alliance Medical is active in multiple European countries, which all differ widely in terms of the prevailing conditions and local healthcare systems. For mobile use, computer tomographs need to fit into trailers and containers. Offering a mobile kit is also essential.

Over a decade of expertise

Alliance Medical is a leading provider of imaging services in Europe with more than a decade of expertise in the mobile medical equipment sector. Trucks carrying its diagnostic devices are a permanent fixture on Europe's roads. The company's mobile fleet includes CT scanners, a mobile heart cath lab, PET/CT scanners, MRI scanners, X-ray systems, DEXA, mammography, and ESWL units. "Customers of Alliance include the NHS in the UK, private and public hospitals, as well as private imaging centers," says Bastian Berkel, Sales Manager Europe at Alliance Medical Northern Europe. "We operate mobile units Europe-wide," he adds.

Mobile imaging safeguards patient care

Floods are not the only type of event that result in physicians having to seek out flexible solutions. For instance, a medical facility may have ordered a new, more advanced CT scanner to replace its previous model. To cover the time it takes to dismantle the old device, renovate the room, and install the new scanner, they can opt for a mobile solution. After all, if a diagnostic device like a CT scanner is out of action, staff have to reschedule appointments, send patients to other centers, and explain delays to referring physicians. Doctors cannot afford such heavy limitations on their workflows today, so a temporary solution makes good sense. Alliance Medical's mobile devices remain on site for anything from a week to several years. "It depends entirely on the individual circumstances," says Christopher Barfuß, Sales Manager at

Alliance Medical. "For instance, one of our scanners has been at a facility in Ireland for several years now. They're so happy with it that they don't want it to go." But this is an exception – devices are normally only deployed for a limited period of time. Some customers use them to bridge the gap until their new device is up and running. Others have more patients during certain periods than they can handle with their existing equipment. "In these cases, an extra, temporary device eases the bottleneck. Once the numbers drop again, things go back to normal," says Barfuß.

Diverse challenges

Current events in Europe have created an acute need for mobile X-ray scanners to screen the high numbers of refugees arriving from the Middle East and Africa. Screening every refugee for tuberculosis, for example, to safeguard public health is an immense challenge. Setting up mobile X-ray scanners close to refugee centers can offer a temporary solution. In this scenario, the diagnostic device comes to those who need it, rather than the other way around. This greatly eases the logistical burden for the on-site clinical staff who make these large-scale projects possible. Mobile solutions are also sometimes required for sporting events such as city marathons and transalpine races.

Alliance Medical is active in multiple European countries, which all differ widely in terms of the prevailing conditions and local healthcare systems. The company deals with this by offering flexible contract options. "In Italy and the UK, for instance, some hospitals and practices outsource all of their radiology services," says Berkel. In those cases, a temporary solution is not just about the device and clinical staff – it also involves collaborating with labs and physicians to provide full the range of diagnostic tools.

The ideal CT: compact, flexible, and powerful

To equip its latest mobile CT trailers, Alliance Medical chose to collaborate with Siemens. "SOMATOM Scope is the ideal scanner for our purposes," says Barfuß. "As well as offering a mobile kit, which is essential for operating in trailers and containers, it also fits perfectly into our trailers." This makes it easy to transport the scanners and avoids the need to drive at night with a police escort – which is the EU rule for transporting loads that are over 2.8 m wide. Alliance Medical can therefore handle customer requirements on a very individual basis, and can set up temporary scanning solutions very quickly. "If permanent systems fail, we ideally aim to provide a mobile solution within two days," says Berkel. If the medical facility knows where it wants the scanner and can provide a 125 A or 400 V high-voltage electricity connection (CEE) that is not more than 50 meters from the trailer, Alliance Medical can install the system within two hours. Hospitals using the mobile solution have been able to perform up to 30 patient scans per day.

Reliable cooperation and support

Obviously, this requires a high level of acceptance and motivation on the part of clinical staff. Moving a scanner outside of the building means adapting workflows and sometimes getting used to a new system, as well. "We work with Siemens to provide staff with extensive training on the SOMATOM Scope scanner and the *syngo* user interface. The sessions are thorough and needs-based, so transitioning to the new system doesn't take long," says Barfuß. Once employees have adjusted to the somewhat snug interior of the trailer, the whole process runs smoothly – especially since the trailers can be extended sideways to provide more space around the device once they are at the location. A major advantage for emergency patients is that the gurney can be wheeled directly out of the ambulance, onto the trailer platform, and then positioned next to the scanner table. This means there is no need to transfer trauma patients from the ambulance stretcher onto a transport stretcher.

The service packages always include fast, on-site response if any problems arise. "We collaborate with Siemens service teams and react immediately if something stops working the way it is supposed to," says Berkel.

Alliance Medical Sales Managers Bastian Berkel (above) and Christopher Barfuß (below) support hospitals in maintaining high clinical and operational standards even in challenging situations.

Smooth return to clinical routine

When the container or trailer is picked up at the end of the agreed period, the clinical staff are obviously glad to return to normal CT operations inside. However, the time spent working with the temporary scanner and its software can often actually ease the transition to the new CT scanner. "If a medical facility has already worked with the same software and a similar device in a temporary context, it makes it easier to get to grips with the new scanner," says Barfuß. When Alliance Medical customers look back on their time with the interim mobile solution, most describe it as a really interesting experience. One radiology technical assistant said it was "a bit like clinical camping in style."

To support hospitals in maintaining high standards even in challenging situations, Alliance Medical remains dedicated to providing customers with flexible tailored solutions and to getting mobile medical devices out and about. ■

Case 1

Multiple, Enlarged and Tortuous Pulmonary Vessels – a Straightforward Diagnosis?

By Professor Helmut Ringl, MD;[1] Paul Apfaltrer, MD,[1] and Maria Schoder, MD[2]

[1] Division of General and Pediatric Radiology; [2] Division of Cardiovascular and Interventional Radiology, Department of Biomedical Imaging and Image guided Therapy, General Hospital of Vienna (AKH), Medical University of Vienna, Vienna, Austria

History

A 31-year-old female patient with a history of Crohn's disease presented herself with an abnormal finding on a plain film due to a recent pneumonia. CT of the chest was required for further evaluation.

Diagnosis

Adaptive 4D Spiral CTA images revealed atresia of several segmental pulmonary veins in both lower lobes with consecutive pulmonary varices, i.e. large venous collaterals that allowed venous drainage through adjacent segmental pulmonary veins.

The primary exam, a standard computed tomography pulmonary angiography (CTPA) showed multiple, tortuous and enlarged vessels in the periphery of both lower lobes. Even though the segmental atresia of several veins was recognized, the suspicion of coincidental pulmonary arteriovenous malformations (PAVMs) was raised due to similar contrasting of both arteries and veins. In addition, several small segmental arteries were shown in close vicinity of the enlarged tortuous vessels.

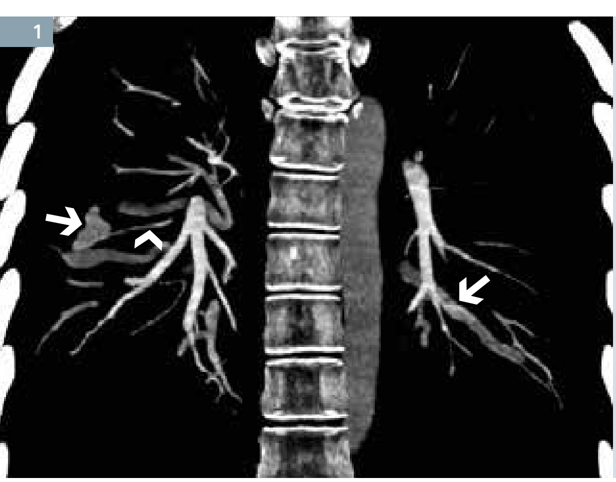
Comments

High-quality imaging is critical for a successful assessment and potential treatment of vascular malformations. Dependent upon their size, PAVMs are treated with embolotherapy to avoid complications, such as paradox embolism, whereas pulmonary varices usually require no treatment. Several imaging methods such as 4D-CTA, MRA and conventional angiography are used to assess the hemodynamic features of vascular lesions. In order to accurately identify the potential feeding arteries and draining veins of the suspected vascular malformation, an Adaptive 4D Spiral CTA mode was performed to generate detailed multiplanar images of the pulmonary vessels, as well as to allow accurate separation of the arterial and venous enhancement.

The scan range was planned to include both hilar and lower lobes. A test bolus was applied to acquire the time-to-density curve, which helped to determine the number of necessary scans. Informed consent was obtained from the patient prior to the Adaptive 4D Spiral CTA examination. Eight dynamic phases were acquired using 35 mL of contrast agent (Iomeron 400 mg) followed by saline chaser.

CTA images provided sufficient spatial and temporal resolution to completely separate pulmonary arterial and venous enhancement. The resulting images offered two arterial phases, three mixed phases and three venous phases. PAVMs were confidently ruled out since no venous enhancement was seen in the two arterial phases. Homogenous slow diffuse venous contrast filling was visible in the later phases. The high spatial resolution of the SOMATOM Drive allowed easy depiction of the segmental venous atresia and the pathway of venous varices without segmentation. The Adaptive 4D Spiral CTA images contributed to a final distinct diagnosis for the patient at the dose of a standard CTPA of earlier days. ■

1



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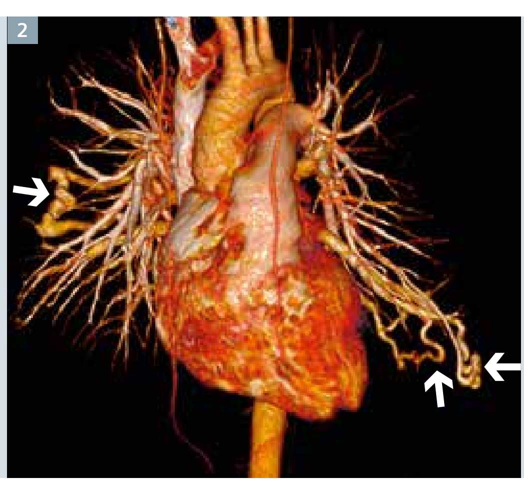

1 Coronal thin MIP of a standard CTA of the pulmonary arteries: It shows several large tortuous vessels in the periphery of both lower lobes (arrows) and suspected arterial feeder vessels (arrowhead).

2 Coronal VRT of a standard CTA of the pulmonary arteries: Several tortuous large vessels in the periphery of both lower lobes are depicted (arrows).

3A Thin MIP image from the first phase of the 8 phases performed with Adaptive 4D CTA mode shows contrast only in the pulmonary arteries of the right lower lobe.

3B Thin MIP image from the second phase shows high contrast in the pulmonary arteries only and a hint of diffuse enhancement in the pulmonary veins (arrow).

3C Thick MIP image from phase 7 shows high contrast in the pulmonary veins only, providing a clear image of the origin (arrowhead) and the extent (arrow) of the enlarged vessels. No segmentation was performed. Visualization is solely based on thin MIPs and a narrow contrast window.

4 Thin MIP of a late venous phase with high contrast in the pulmonary veins of the left lower lobe only, provides a view on the segmental vein atresia (arrow heads) and the varices (arrows) of the left lower lobe. Note that the pulmonary arteries are not visible on this image due to the high temporal resolution of the scan, the saline chaser and the use of a narrow contrast window.

Examination Protocol

Scanner	SOMATOM Drive
Scan area	Thorax, lower lobes
Scan mode	Adaptive 4D Spiral
Scan length	147 mm
Scan direction	Cranio-caudal-cranial
Scan time	10.3 s
Tube voltage	80 kV
Tube current	110 mAs
$CTDI_{vol}$	22.37 mGy
DLP	346 mGy cm
Effective dose	4.8 mSv
Rotation time	0.28 s
Slice collimation	128 × 0.6 mm
Slice width	1.5 mm
Reconstruction increment	1.5 mm
Reconstruction kernel	B20f
Contrast	400 mg/mL
Volume	35mL
Flow rate	4 mL/s
Start delay	7 s

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Case 2

Revealing a Myocardial Perfusion Defect, unseen on MRI, using Adenosine-stress Dual Energy CT

By Ralf W. Bauer, MD,[1] and Jan-Erik Scholtz, MD[2,3]

[1] Clinic of Radiology and Nuclear Medicine, Cantonal Hospital St. Gallen, Switzerland
[2] Goethe University, Frankfurt am Main, Germany
[3] Cardiac MR PET CT Program, Massachusetts General Hospital, Harvard Medical School, Boston, USA

History

A 68-year-old male patient, with a known history of coronary artery disease, was referred to our hospital due to unclear chest pain. Previously the patient had undergone percutaneous coronary angioplasty with stent placement. An adenosine-stress myocardial perfusion MRI was performed revealing no perfusion defect. Thereafter, the patient was referred for a coronary CT angiography with adenosine-stress myocardial perfusion using Dual Energy CT (DECT) mode.

Diagnosis

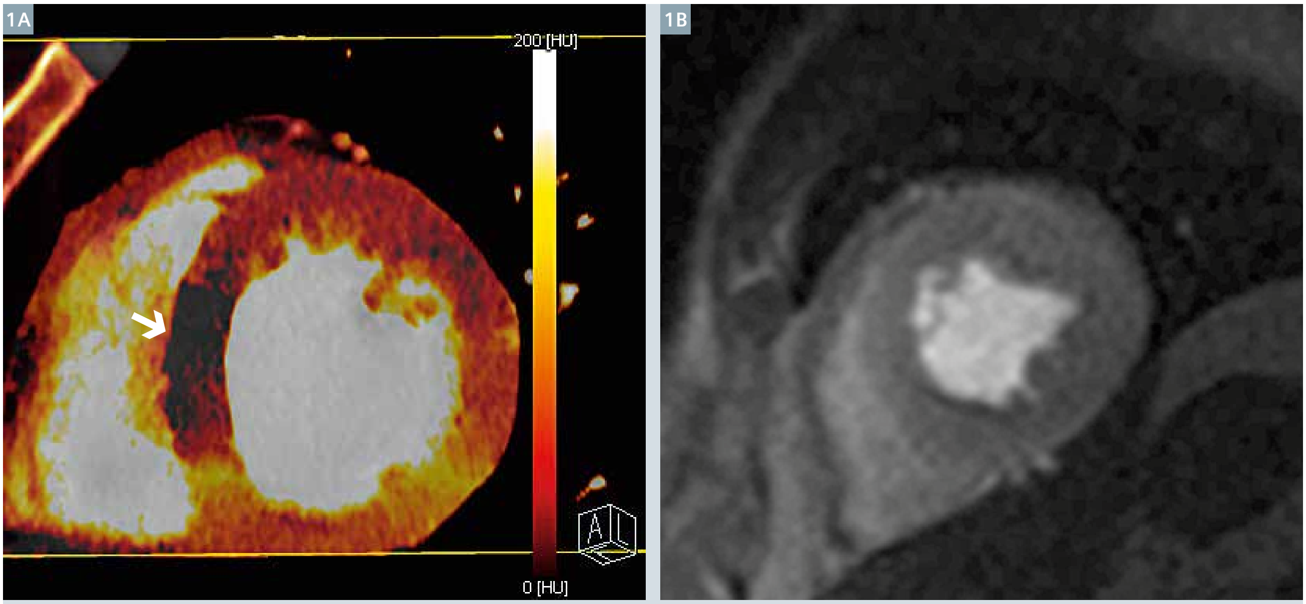
CT was carried out directly under stress conditions after an i.v. infusion of adenosine (140 µg per kg body weight per minute) and no rest phase. CT angiography with systolic reconstruction revealed a moderate stenosis in the mid-left anterior descending coronary artery (LAD) caused by a non-calcified plaque. Myocardial iodine distribution maps, as a surrogate for myocardial perfusion generated using *syngo*.CT DE Heart PBV, showed a large perfusion defect in the mid-septum with normal wall motion and no late enhancement (not shown). Invasive coronary angiography confirmed the LAD stenosis with a pathological fractional flow reserve (FFR) of 0.68 and was therefore stented. An additional high-grade septal branch stenosis was seen but not treated due to its small vessel caliber.

Comments

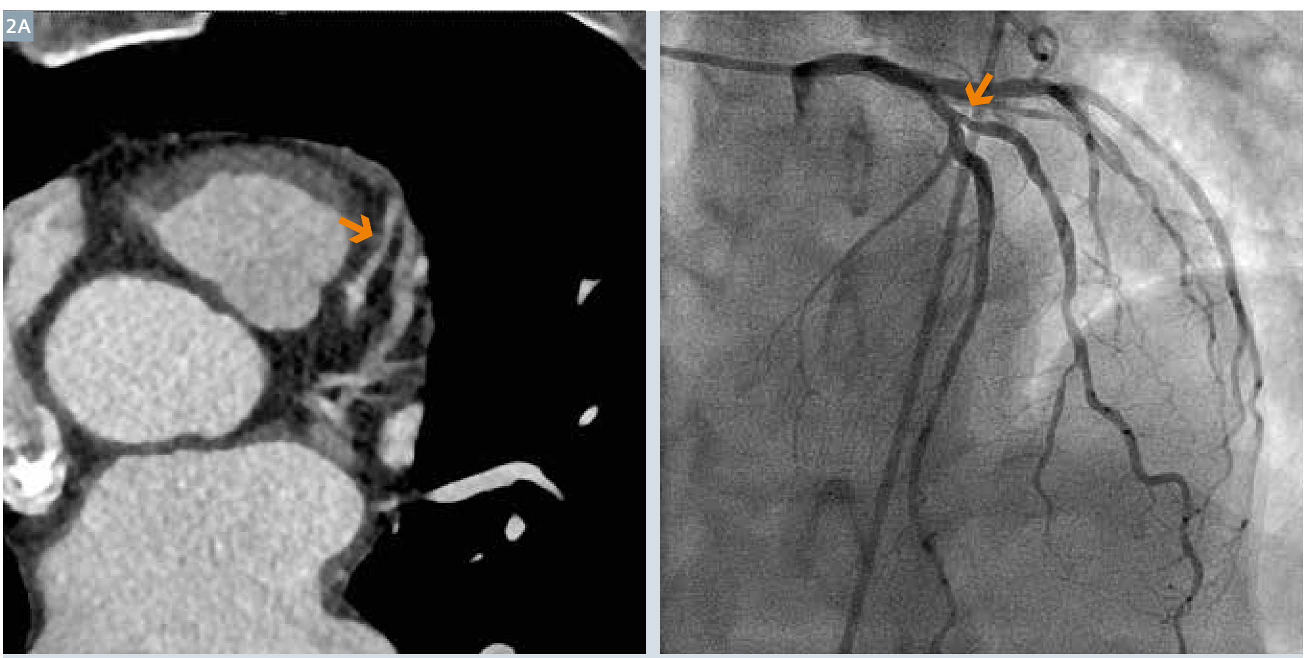
The contradicting results of two "gold standard" tests, i.e. adenosine-stress MRI and invasive FFR, makes this case interesting. While MRI, as the preferred non-invasive imaging test in this clinical scenario, is negative whereas a still novel and non established method, i.e. adenosine-stress DECT, delivers both information on a moderate LAD stenosis and its impact on myocardial perfusion with an obvious perfusion defect of the septum in agreement with invasive coronary angiography and FFR measurement. This case highlights the necessity of deepening research and widening clinical implication of myocardial perfusion imaging with DECT as it can provide both morphological and functional information from one scan. Compared to time-resolved myo-

Examination Protocol

Scanner	SOMATOM Force		
Scan area	Heart	Pitch	0.28
Scan length	97 mm	Slice collimation	128 × 0.6 mm
Scan direction	Cranio-caudal	Slice width	1.5 mm
Scan time	2.3 s	Reconstruction increment	1 mm
Tube voltage	90 / Sn150 kV	Reconstruction kernel	Qr40 ADMIRE 2
Tube current	130 / 102 mAs	Heart rate	68 – 83 bpm
Dose modulation	CARE Dose4D	**Contrast**	400 mg/mL
$CTDI_{vol}$	20.75 mGy	Volume	50 mL
DLP	266.3 mGy cm	Flow rate	5 mL/s
Effective dose	3.7 mSv	Start delay	Test bolus
Rotation time	0.25 s		



1 Mid-ventricular short axis view of iodine distribution maps of stress DECT (Fig. 1A, arrow) reveals a large septal perfusion defect which is not seen in the stress myocardial perfusion MRI (Fig. 1B).



2 CT angiography with systolic reconstruction shows a moderate stenosis of the LAD (Fig. 2A, arrow). An invasive coronary angiography (Fig. 2B, arrow) confirms CTA results with pathological FFR of the LAD stenosis of 0.68 indicating an ischemia.

cardial imaging approaches, such as dynamic perfusion CT or MRI, DECT images are acquired in just one single breath-hold within typically 8–10 seconds shortly after peak aortic enhancement. In our opinion, this makes the dual energy approach to myocardial perfusion imaging an attractive method with enormous potential for clinical use. ■

Case 3

Runoff CT Angiography for Peripheral Arterial Disease

By Aarthi Govindarajan, MD; Prasanna Vignesh, MD; Arun Kumar, MD, and Raj Kumar, MD

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History

A 72-year-old male patient presented himself due to suspected peripheral vascular disease. A runoff peripheral CT angiography (CTA) was performed to evaluate the lower limb vessels.

Diagnosis

CT images demonstrated extensive atherosclerotic soft mural and calcified plaques, involving the abdominal aorta, the major lower limb arteries and its branches thus resulting in an irregular luminal narrowing. A small eccentric mural plaque involving the proximal superior mesenteric artery (SMA), immediately after the origin and resulting in a 50% stenosis, was visualized. An extended soft plaque involving the left external iliac artery (EIA), 17 mm from the bifurcation and 12 mm in length, resulting in a 90% stenosis, was also detected. A complete thrombotic occlusion, measuring 6.2 cm in the left superficial femoral artery (SFA), with reformation in the adductor canal through collaterals, was shown as well. Compared to the posterior tibial artery (PTA), the caliber of the anterior tibial artery (ATA) and the CPA (central peroneal artery) appeared narrow on both sides throughout their entire course. The right common femoral, the superficial femoral, the profunda femoris and the popliteal arteries appeared normal. Flow was noted in the dorsalis pedis artery on both sides.

Comments

Peripheral CTA is valuable in imaging workup and helps in establishing a quick diagnosis. In this case, the excellent image quality enabled a clear visualization of the vascular structures with a homogeneous contrast within the entire runoff range. Dose modulation CARE Dose4D and iterative reconstruction were both applied to achieve an effective dose as low as 2.27 mSv. ■

Examination Protocol

Scanner	SOMATOM Scope		
Scan area	Runoff	Rotation time	0.8 s
Scan length	1258 mm	Pitch	1.5
Scan direction	Cranio-caudal	Slice collimation	16 × 1.2 mm
Scan time	35 s	Slice width	1.5 mm
Tube voltage	110 kV	Reconstruction increment	1 mm
Tube current	48 mAs	Reconstruction kernel	I31s
Dose modulation	CARE Dose4D	**Contrast**	
$CTDI_{vol}$	3.14 mGy	Volume	100 mL + 40 mL saline
DLP	409.87 mGy cm	Flow rate	4 mL/s
Effective dose	2.27 mSv	Start delay	Bolus tracking

1

A VRT image shows an overview of the complete range of the runoff CTA.

2

A sagittal MPR image shows a small eccentric mural plaque resulting in a 50% stenosis in the proximal SMA.

3

A coronal MPR image shows an extended soft plaque resulting in a 90% stenosis in the left EIA.

4

A MIP image shows a complete thrombotic occlusion in the left SFA with reformation through collaterals.

Case 4

Anomalous Left Main Coronary Artery: Exclusion of a Malignant Variant using Coronary CT Angiography

By M. Goeller, MD; M. Marwan, MD; M. Hell, MD; A. Schuhbaeck, MD; M. Troebs, MD, and S. Achenbach, MD

Department of Internal Medicine 2, Cardiology, University Hospital Erlangen-Nuremberg, Erlangen, Germany

History

A 62-year-old female patient suffering from hypertension and obesity (body mass index 31.6 kg/m²) was referred to a nearby hospital for exclusion of coronary artery disease (CAD) by invasive coronary angiography. The patient suffered from exertional dyspnea, chest discomfort and palpitations in recent weeks. Her physical examination was unremarkable and the electrocardiogram as well as the transthoracic echocardiography were normal. Invasive coronary angiography revealed mild atherosclerosis without hemodynamic relevant stenosis. Furthermore the left main coronary artery (LM) showed an anomalous course and the patient was referred to our department for coronary CT angiography (CTA) to further clarify the course of the LM in relation to the adjacent large vessels to rule out malignant coronary anomalies.

Diagnosis

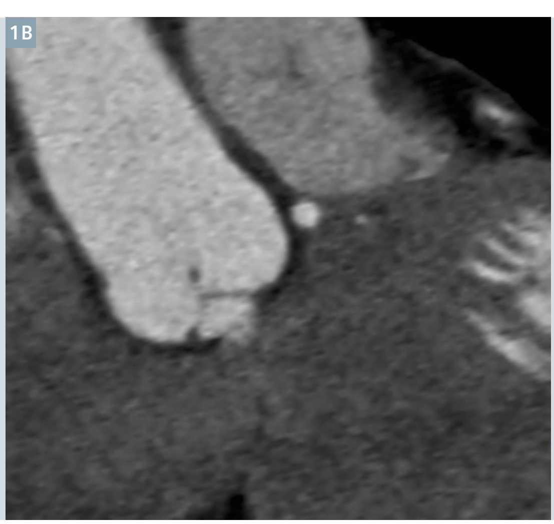
Coronary CT angiography demonstrated an anomalous origin of the LM arising from the proximal segment of the right coronary artery (RCA) (Fig. 1A). The anomalous LM then followed a sub-pulmonic course (Fig. 1B) and subsequently bifurcated into a left anterior descending artery (LAD) and left circumflex artery (LCx), with a normal course (Figs. 2, 3, and 4). The LAD and LCx showed no evidence of coronary plaques or stenosis. The RCA showed non-calcified plaque without stenosis.

Comments

Precise characterization of congenital coronary artery anomalies is essential due to their potential association with myocardial ischemia and sudden death. Coronary anomalies are a rare occurrence with a reported incidence of 0.3–1.3%.[1,2] The incidence of an anomalous origin of the LM from the right sinus of Valsalva or from the RCA is approximately 0.1% in patients undergoing coronary angiography.[3,4]

Among these patients, an inter-arterial course of the LM between the aorta and the pulmonary artery can be found in up to 75% of cases.[3,4] This inter-arterial course can lead to stretching of the intramural segment, an acute angle of the artery from the aortic ostium or compression of the LM during systole resulting in myocardial ischemia or sudden cardiac death (> 50%), particularly during or shortly after exercise.[5]

In the case of our 62-year-old female patient, an acute angulation near the ostium or malignant inter-arterial course directly between the aorta and pulmonary artery was excluded by coronary CT angiography, the method



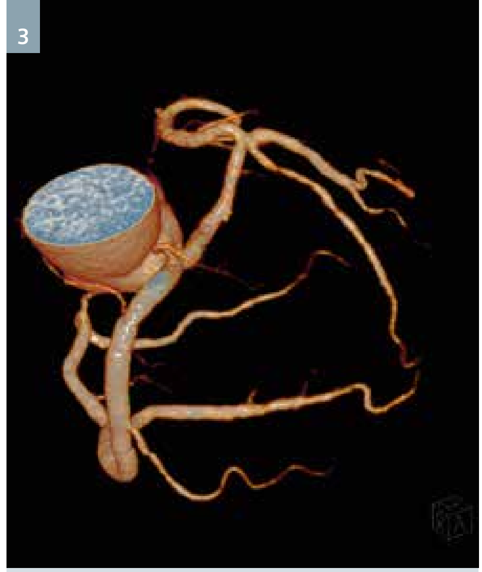
1A

Curved MPR image shows LM which arises from the proximal RCA and non-calcified plaque without stenosis in the RCA.

1B

MPR image shows the sub-pulmonic course of the LM.

2 VRT shows the pathway of LM, LAD, RCA and LCx and excludes an inter-arterial course.



3 VRT of coronary tree shows anomaly of the LM and the course of LCA, LAD, RCA and LCx.

4 VRT of coronary tree shows the sub-pulmonic course of the LM.

of choice for the evaluation of coronary anomalies. In comparison to conventional coronary angiography, coronary CT angiography provides true volumetric visualization of the coronary arteries with better definition of their origin, course, and relation to adjacent cardiac structures. No further follow-up examinations were necessary and the patient could be discharged directly after coronary CT angiography. ■

References

[1] Roberts WC. Major anomalies of coronary arterial origin seen in adulthood. Am Heart J 1986; 111:941-963.

[2] Yamanaka O, Hobbs RE. Coronary artery anomalies in 125,595 patients undergoing coronary angiography. Cathet Cardiovasc Diagn 1990; 21:28-40.

[3] Donaldson RM, Raphael M, Radley-Smith R, et al. Angiographic identification of primary coronary anomalies causing impaired myocardial perfusion. Cathet Cardiovasc Diagn 1983; 9: 237-249.

[4] Kimbiris D, Abdulmassih SI, Segal BL, et al. Anomalous aortic origin of coronary arteries. Circulation 1978; 58: 606-615.

[5] Kim SY, Seo JB, Do KH, et al. Coronary artery anomalies: classification and ECG-gated multi-detector row CT findings with angiographic correlation. Radiographics. 2006; 26(2):317-33.

Examination Protocol

Scanner	SOMATOM Definition Flash
Scan area	Heart
Scan mode	Prospective ECG-triggered sequential scan
Scan length	138 mm
Scan direction	Cranio-caudal
Scan time	6.3 s
Tube voltage	120 kV
Tube current	400 mAs / rot.
Dose modulation	ECG pulsing
$CTDI_{vol}$	14.35 mGy
DLP	198 mGy cm
Effective dose	2.8 mSv
Rotation time	0.28 s
Slice collimation	128 × 0.6 mm
Slice width	0.6 mm
Reconstruction increment	0.6 mm
Reconstruction kernel	Bv40 (ADMIRE)
Heart rate	58 bpm
Contrast	350 mg/mL
Volume	65 mL + 50 mL saline
Flow rate	6.5 mL/s
Start delay	Test bolus + 2s

Case 5

Diabetic Foot Syndrome Complicated by an Arteriovenous Fistula

By Gang Wang, MD; Haocheng Zhang, MD, and Xi Zhao, MD*

Department of Radiology, Baotou City No. 8 Hospital, Baotou, IM, P.R. China
*Siemens Healthineers, P.R. China

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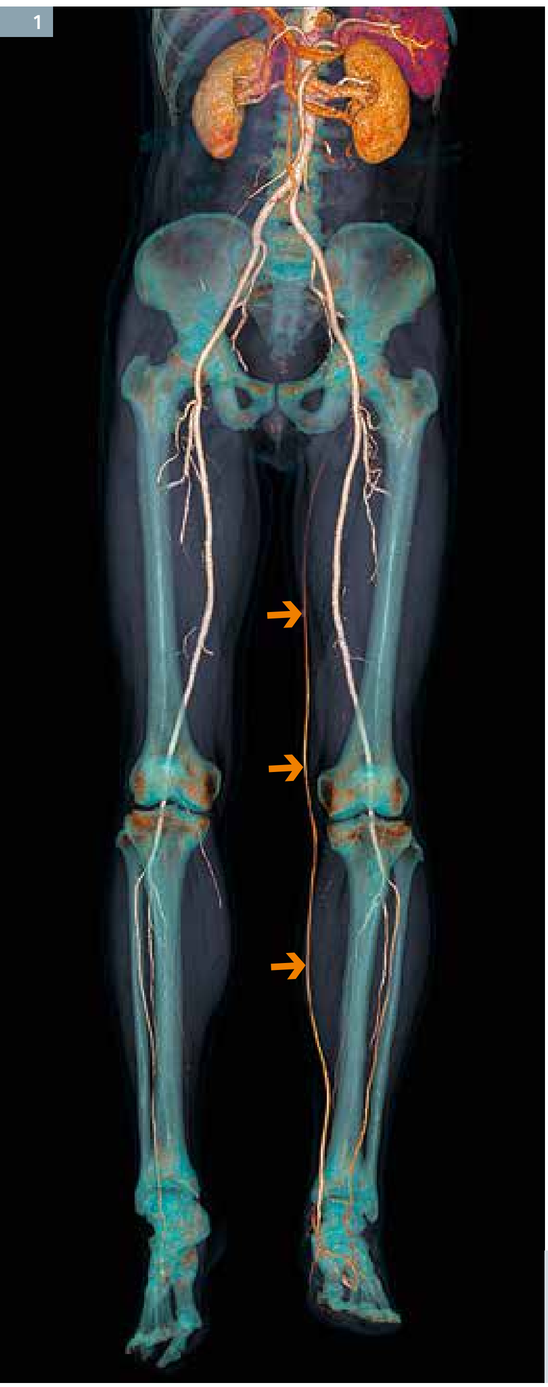


History

A 64-year-old male patient with a known history of diabetes mellitus (DM) was feeling systemically unwell and noted problems with his left foot. He was presented for a CT angiography (CTA) evaluation.

Diagnosis

CTA images showed an early venous return of the left great saphenous vein (Fig. 1) and a fistula between the peripheral anterior tibial artery and the great saphenous vein (Fig. 2). Signs of osteoclasia in the first proximal phalanges, involving interphalangeal joint destruction and osseous fragments, as well as accompanying soft tissue swelling and skin ulcer were observed. No signs of soft tissue gas were noted.The abdominal aortic artery and its other branches were unremarkable.

Comments

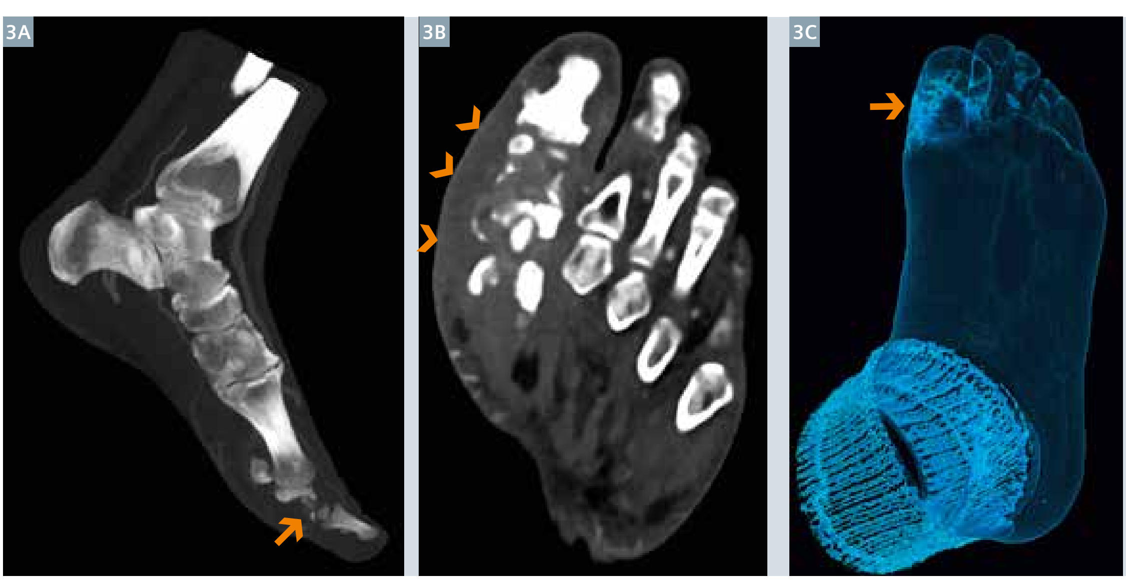
DM is mainly a neurovascular disease that particularly affects the musculoskeletal system, especially the foot. The presence of several characteristic diabetic foot pathologies such as infection, diabetic foot ulcer, and neuropathic osteoarthropathy, is called diabetic foot syndrome. An early diagnosis and prompt treatment are essential to avoid amputation. In the imaging of diabetes-related foot complications, CT has certain advantages: generation of images with high tissue contrast, as well as aiding in the identification of cortical erosions, small sequestra, soft tissue gas and calcifications. The three-dimensional nature of CT makes it a useful tool for the analysis of compartmental anatomy. In this case, 70 kV was applied which contributed both to the improvement of contrast enhancement and to the reduction of radiation dose. A runoff CTA showing great peripheral vascular details was completed using only 50 mL of contrast medium. In combination with other advanced dose reduction techniques such as CARE Dose4D (real-time anatomic exposure control) and ADMIRE (sinogram affirmed iterative reconstruction) a total effective dose of 1.58 mSv was achieved. ■

1 A VRT image shows an overview of the runoff CTA and an early venous return of the left great saphenous vein (arrows).

2 VRT images demonstrate a fistula (dashed arrow) between the peripheral anterior tibial artery (arrowheads) and the great saphenous vein (arrows).

Examination Protocol

Scanner	SOMATOM Force
Scan area	Supra-renal to toes
Scan length	1242.5 mm
Scan direction	Cranio-caudal
Scan time	17.7 s
Tube voltage	70 kV
Tube current	192 mAs
Dose modulation	CARE Dose4D
$CTDI_{vol}$	2.26 mGy
DLP	285.4 mGy cm
Effective dose	1.58 mSv
Rotation time	0.5 s
Pitch	0.6
Slice collimation	192 × 0.6 mm
Slice width	1.0 mm
Reconstruction increment	0.7 mm
Reconstruction kernel	Bv36, ADMIRE 3
Contrast	370 mg/mL
Volume + Flow rate	30 mL at 5 mL/s + 20 mL at 3 mL/s + 30 mL saline at 3 mL/s
Start delay	Bolus tracking in the popliteal artery with a threshold of 100 HU and an additional delay of 7 s



3 MIP (Fig. 3A), MPR (Fig. 3B) and VRT (Fig. 3C) images show signs of osteoclasia in the first proximal phalanges (3A, arrow) involving interphalangeal joint destruction, osseous fragments, soft tissue swelling (3B, arrowheads) and skin ulcer (3C, arrow).

Case 6

A Comprehensive Cardiac CT Examination – CT Angiography, CT Stress Perfusion and CT Delayed Enhancement

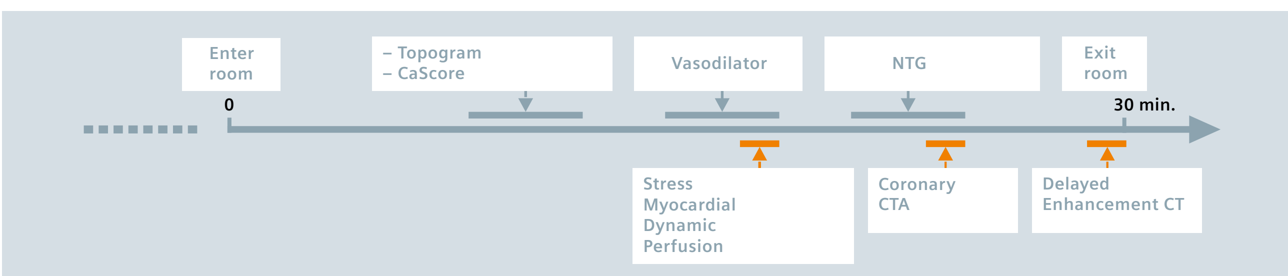
By Satoshi Nakamura, MD; Kakuya Kitagawa, MD; Nagasawa Naoki, RT, and Hajime Sakuma, MD

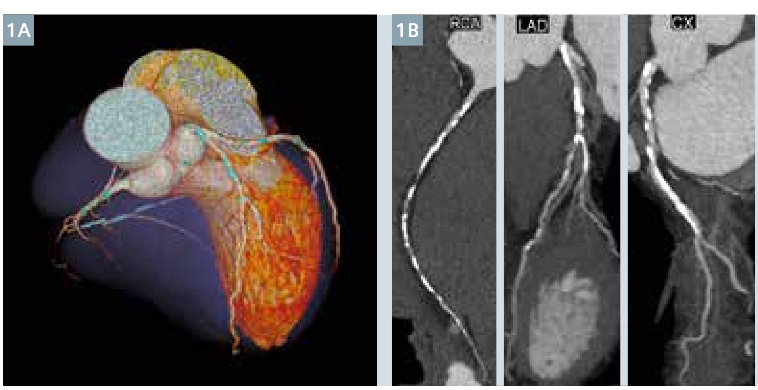
Department of Radiology, Mie University Hospital, Tsu, Japan

History

A 79-year-old male patient was referred to our hospital for a follow-up of his coronary heart disease. He was on medication for hypertension and was asymptotic. The referring physician reported that the patient was diagnosed with multiple significant stenoses (#1 90%, #2 99%, #5 50%, #7 50% and #13 75%) by invasive coronary angiography in 2001, but had refused to undergo invasive revascularization. In 2010, the referring physician convinced the patient to undergo cardiac MR for follow-up. A sub-endocardial myocardial infarction with ischemia in the inferior wall was revealed. The patient again preferred not to be treated by invasive angiography. Although multiple coronary stenoses were known, the main concern was whether the myocardial infarction or ischemia had worsened. This time, cardiac CT was indicated and an integrated cardiac CT examination

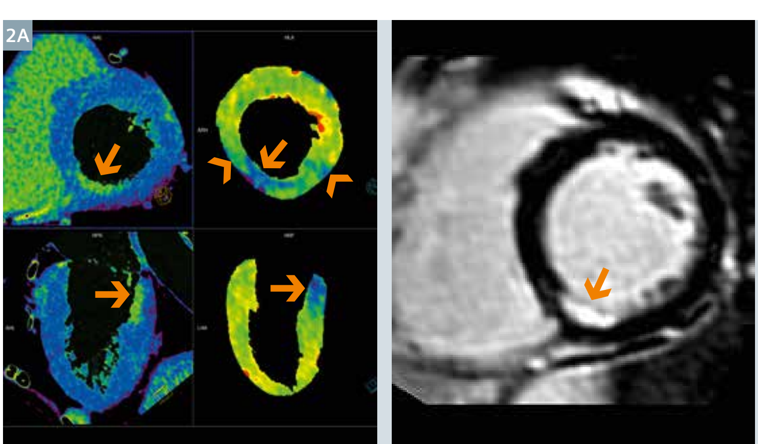
Table 1: Scheme of a comprehensive cardiac CT study





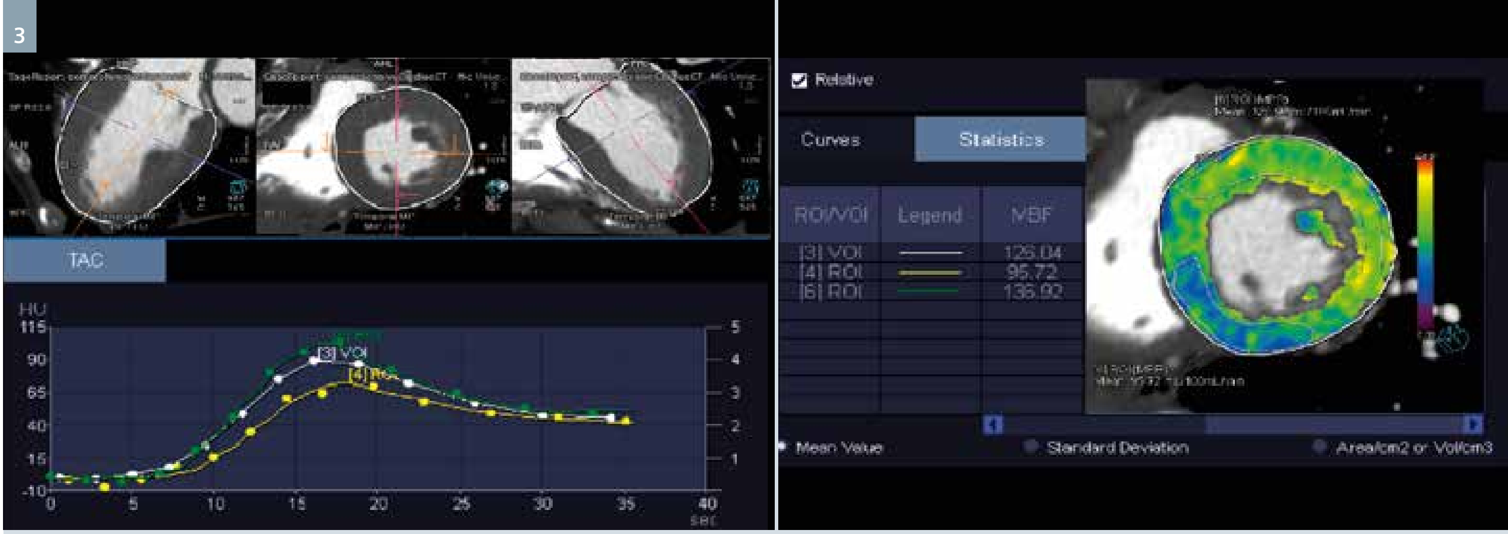
1

VRT (Fig. 1A) and curved MPR (Fig. 1B) images show coronary arteries with extensive calcifications.



2

A small area of severe perfusion deficit (arrows) within a larger one of moderate ischemia (arrowheads) in the inferior wall is shown in the MBF map (Fig. 2A, right, see also Fig. 3). This corresponds to a small subendocardial lesion (arrows) in the CT delayed enhancement scan (Fig. 2A, left). The left ventricle blood pool is suppressed by fusion with an end-systolic cCTA reconstruction. There is no significant change in comparison to the MR image acquired in 2010 (Fig. 2B).



3 MBF evaluation reveals a moderate ischemic area (ROI#4, in yellow, 96 mL/100 mL/min) in comparison to the normal myocardium in the same slice (ROI#6, in green, 137 mL/100 mL/min) and the whole myocardium (VOI#3, in white, 126 mL/100 mL/min).

was performed to assess the coronary arteries as well as the condition of the myocardium.

Diagnosis

Coronary CT angiography (cCTA) revealed extensive calcifications in the coronary arteries (Fig. 1); the right coronary artery (RCA) appeared to be affected most severely. Moderate ischemia was seen in the inferior wall in the myocardial blood flow (MBF) maps of the CT stress perfusion examination (Fig. 3). This RCA territorial ischemia included a severe perfusion deficit in the MBF maps at the same location of a small endocardial lesion in CT delayed enhancement scan, corresponding to a small infarction area (Fig. 2A). The sub-endocardial lesion was unchanged compared to the finding on cardiac MR 5 years earlier (Fig. 2B). As the patient was asymptomatic and did not wish invasive treatment, he was discharged to continue optimal medical therapy at home.

Comments

In cases of severely calcified coronary arteries, a direct evaluation of stenoses is difficult. However myocardial infarction and ischemia can be evaluated regardless of the condition of the arteries, as in this case. The 79-year-old patient was reluctant to undergo an invasive examination, a comprehensive CT evaluation including cCTA, myocardial stress perfusion and late enhancement, enabled by Dual Source CT, was helpful to analyze his situation. ■

Examination Protocol

Scanner	SOMATOM Force		
Scan area		Heart	
Scan mode	Stress myocardial perfusion	cCTA (Seq.)	Delayed enhancement
Scan length	101 mm	134 mm	103 mm
Scan direction	shuttle	Cranio-caudal	shuttle
Scan time	34 s (13 phases)	4.75 s	7 s (3 phases)
Tube voltage	80 kV	80 kV	80 kV
Tube current	88 mAs/rot.	130 mAs/rot.	190 mAs/rot.
$CTDI_{vol}$	22.6 mGy	6.7 mGy	11.2 mGy
DLP	239 mGy cm	239 mGy cm	118.6 mGy
Effective dose	3.3 mSv	1.27 mSv	1.66 mSv
Rotation time	0.25 s	0.25 s	0.25 s
Slice collimation	48 × 1.2 mm	168 × 0.6 mm	192 × 0.6 mm
Slice width	3 mm	0.6 mm	1 mm
Reconstruction increment	1 mm	0.3 mm	1 mm
Reconstruction kernel	Qr36	Bv40 ADMIRE 3	Qr36
Heart rate	53 – 115 bpm	48 – 51 bpm	48 – 51 bpm
Contrast		370 mg/mL	
Volume	40 mL	43 mL	–
Flow rate	5 mL/s	3.5 mL/s	–
Start delay	4 s	17 s	7 minutes after cCTA
Scan timing	ATP infusion start ↓ 3 min scan	ATP infusion release ↓ 3 min Nitro ↓ 7 min scan	coronary CTA ↓ 5 min scan

The outcomes by Siemens' customers described herein are based on results that were achieved in the customer's unique setting. Since there is no "typical" hospital and many variables exist (e.g., hospital size, case mix, level of IT adoption), there can be no guarantee that other customers will achieve the same results.

Case 7

Dual Energy Perfusion Maps Reveal the Extent of Perfusion Deficits from Multiple Peripheral Pulmonary Emboli

By Andreas M. Bucher, MD, and Ralf W. Bauer, MD

Institute for Diagnostic and Interventional Radiology, University Hospital Frankfurt am Main, Frankfurt am Main, Germany

History

A 58-year-old female patient presented to the emergency department complaining of shortness of breath and acute chest pain. History revealed an extended immobility due to long-distance travel and further risk factors such as smoking and female gender. Risk of pulmonary embolism according to the Wells' score was elevated, as was the D-dimer level, while the arterial O_2-saturation level was low during monitoring. CT imaging was ordered to rule out pulmonary embolism. A pulmonary CT angiography (CTA) was performed in dual energy mode.

Diagnosis

CTA images revealed a multitude of bilateral segmental and subsegmental pulmonary emboli. Branching filling defects caused by thrombus formation were seen in both upper lobes. The central pulmonary arteries were free of embolic formation and there was no total occlusion at the segmental level. Enlargement of the right atrium and ventricle, along with arching of the interventricular septum towards the left ventricle, were observed.

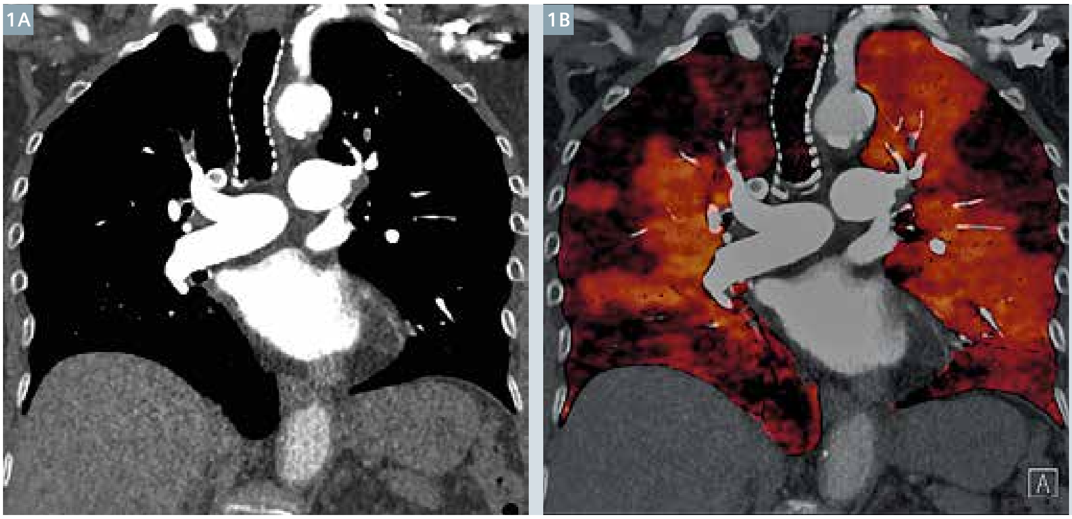
Pulmonary perfusion maps revealed an extended bilateral decrease in pulmonary blood volume. Perfusion defects were dominant on the right side affecting the apical and lateral right-upper lobe, the lateral middle lobe, the peripheral regions of the right-lower lobe, the apicolateral left-upper lobe and the ventral left-lower lobe with several smaller peripheral defects. There was a typical wedge shape to these perfusion defects. None of the pulmonary segments showed a complete perfusion defect.

Comments

Diagnostic information on the presence of pulmonary emboli and the accompanying perfusion impairment can be simultaneously obtained using dual energy pulmonary CTA. Pulmonary blood-volume maps, utilizing iodine quantification, add valuable information on pulmonary perfusion deficits from total or subtotal occlusions of the subsegmental pulmonary arteries. These emboli are very small and can be potentially missed if relying on single energy pulmonary CTA alone. In case of multiple peripheral emboli, perfused blood volume imaging allows a visual correlate for severe pulmonary perfusion deficit. ■

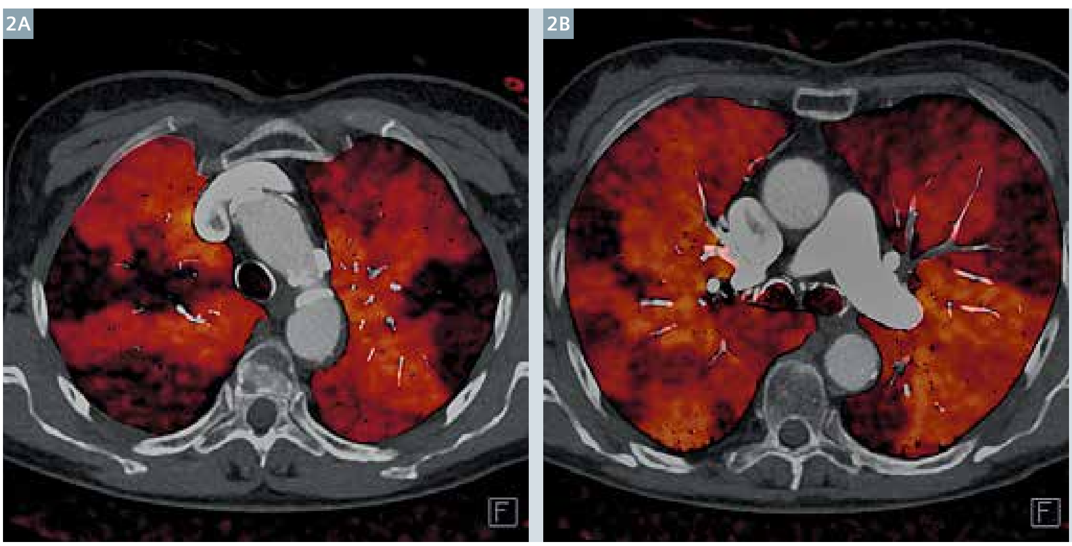
Examination Protocol

Scanner	SOMATOM Force		
Scan area	Thorax	Rotation time	0.25 s
Scan length	252 mm	Pitch	0.55
Scan direction	Caudo-cranial	Slice collimation	192 × 0.6 mm
Scan time	1.9 s	Slice width	1.0 mm
Tube voltage	90 / Sn150 kV	Reconstruction increment	0.5 mm
Tube current	43 / 32 mAs	Reconstruction kernel	Qr40, ADMIRE 3
Dose modulation	CARE Dose4D	**Contrast**	400 mg/mL
$CTDI_{vol}$	2.19 mGy	Volume	50 mL
DLP	63.3 mGy cm	Flow rate	4 mL/s
Effective dose	0.89 mSv	Start delay	Bolus triggering, 140 HU in the pulmonary trunk



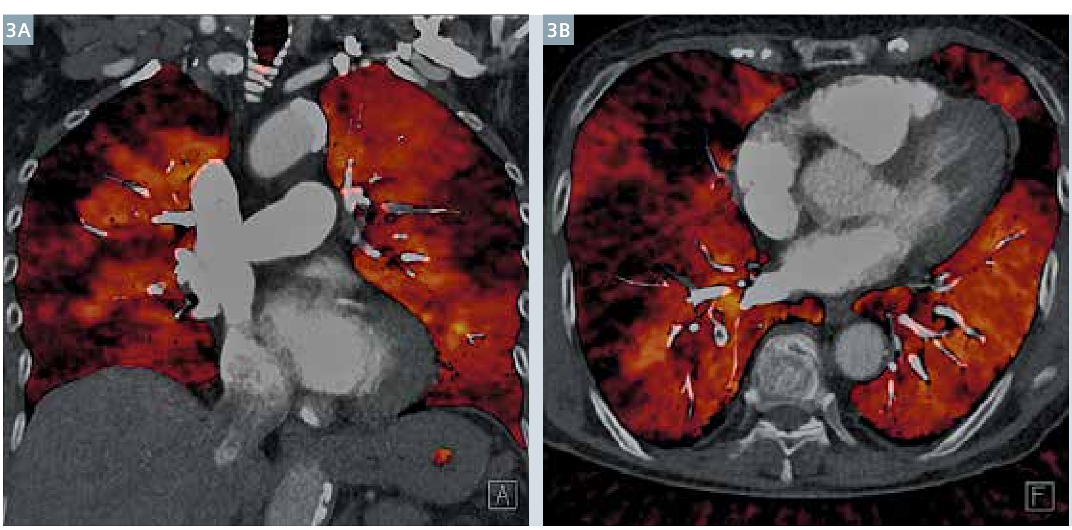
1

A coronal MPR (Fig. 1A, 5 mm) and a pulmonary perfusion map fused with a coronal MIP image (Fig. 1B, 10 mm) demonstrate filling defects in the right pulmonary artery A1 with subsegmental occlusion. Perfusion defects are visible bilaterally in the apicolateral upper lobes, as well as the basal lower lobes.



2

A pulmonary perfusion map fused with an axial MIP image (10 mm) reveals typical wedge shaped apical perfusion defects tapering towards the pulmonary hili (Fig. 2A), branching filling defects in the segmental pulmonary artery A3 with consequent subsegmental perfusion defect (Fig. 2B) and a subsegmental perfusion defect of the left apical lower lobe, corresponding to the distally occluded pulmonary artery branch.



3

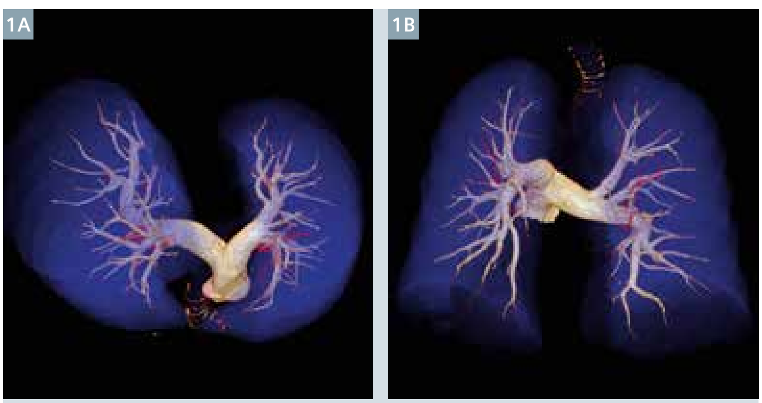
A pulmonary perfusion map fused with a coronal MIP image (Fig. 3A, 10 mm) shows filling defect in the left A3 artery with peripheral contrast filling suggesting a subtotal occlusion. The corresponding subsegmental perfusion defect is seen distally to this artery. A pulmonary perfusion map fused with an axial MIP image (Fig. 3B, 10 mm) shows a central filling defect in the right-lower lobe artery with corresponding perfusion deficits in the right anterobasal lower lobe.

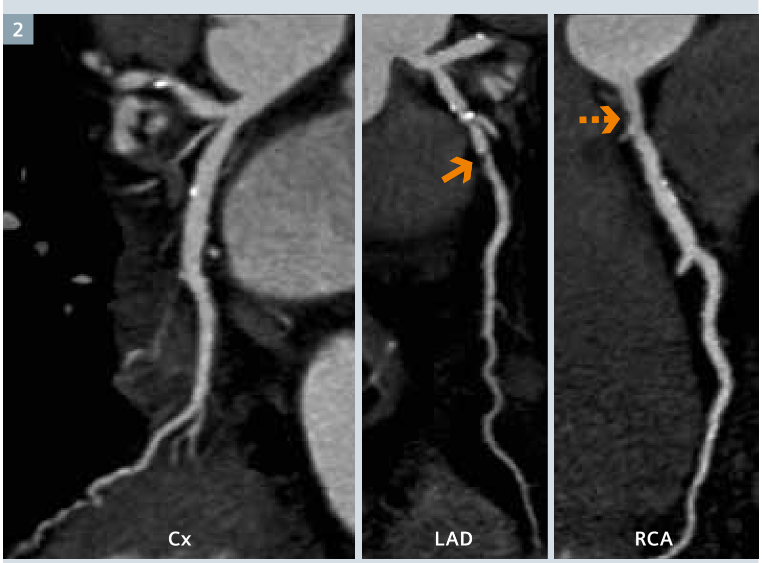
Case 8

Double Flash Scan with Single Contrast Bolus for Triple Rule Out

By Adriano Camargo de Castro Carneiro, MD;[1] Tiago Augusto Magalhães, PhD, MD;[1] Valéria de Melo Moreira, MD;[1] Mariana Macedo Lamacié, MSc, MD;[1] Helder Jorge de Andrade Gomes, MD;[1] Paulo César Ferraz Dias Filho, MD;[1] Matheus de Souza Freitas, MD;[1] Fábio Vieira Fernandes, MD;[1] Bernardo Noya Alves de Abreu, MD;[1] Juliana Hiromi Silva Matsumoto Bello, MD;[1] Carlos Eduardo Elias dos Prazeres, MD;[1] Saulo de Tarso Oliveira Cantoni, MD;[2] Hilton Muniz Leão Filho, MD;[2] Caroline Bastida de Paula, BD;[3] Dany Jasinowodolinski, MD,[2] and Carlos Eduardo Rochitte, PhD, MD[1]

[1] Department of Cardiovascular CT and MRI of the Heart Hospital (HCor), São Paulo, Brazil;
[2] Department of Radiology of the Heart Hospital (HCor), São Paulo, Brazil;
[3] Siemens Healthineers, Brazil





1 VRT images show the normal pulmonary arteries.

2 Curved MPR images show a moderate stenosis in the proximal LAD (arrow), a mild stenosis in the proximal RCA (dashed arrow), and multiple calcified plaques in all three coronary arteries.

History

A 76-year-old male patient, with a known history of hypertension and dyslipidemia, was presented to the emergency department complaining of acute retrosternal chest pressure. The pressure began three hours previously, radiated to the back, was accompanied by dyspnea, nausea and profuse perspiration and lasted for 20 minutes. The initial electrocardiogram and biomarkers were normal. A CT examination was requested to rule out coronary artery disease, pulmonary embolism and/or aortic dissection (triple rule out).

Diagnosis

The images acquired from the initial Flash scan showed contrast enhancement solely in the pulmonary arteries with no signs of pulmonary embolism (Fig. 1). The coronary CT angiography (cCTA) images, acquired from the second Flash scan, showed a moderate stenosis in the left anterior descending artery (LAD) and a mild stenosis in the proximal right coronary artery (RCA) (Figs. 2 and 3). No stenosis was seen in the left main coronary artery (LM) nor in the left circumflex artery (Cx). An Agatston calcium score of 154 was calculated. There were no signs of aortic dissection (Fig. 4).

The patient was diagnosed with unstable angina and was referred for an interventional coronary arteriogram which confirmed the moderate stenosis

Examination Protocol

Scanner	SOMATOM Definition Flash	
Scan area	Thorax (pulmonary arteries)	Thorax (heart and aorta)
Scan length	329.2 mm	329.2 mm
Scan direction	Cranio-caudal	Caudo-cranial
Scan time	0.72 s	0.72 s
Tube voltage	100 kV	120 kV
Tube current	370 mAs	400 mAs
Dose modulation	CARE Dose4D	CARE Dose4D
$CTDI_{vol}$	3.59 mGy	6.48 mGy
DLP	140 mGy cm	254 mGy cm
Effective dose	1.95 mSv	3.55 mSv
Rotation time	0.28 s	0.28 s
Pitch	3.4	3.4
Slice collimation	128 × 0.6 mm	128 × 0.6 mm
Slice width	0.6 mm	0.6 mm
Reconstruction increment	0.4 mm	0.4 mm
Reconstruction kernel	B26f, I26f	B26f, I26f
Heart rate	55–61 bpm	50–61 bpm
Contrast		
Volume	60 mL	
Flow rate	5 mL/s	
Start delay	Test bolus (pulmonary trunk) + 4 s	
Test bolus	(ascending aorta) + 4 s	

3 VRT images show a moderate stenosis in the proximal LAD (Fig. 3A, arrow), a mild stenosis in the proximal RCA (Figs. 3B and 3C, dashed arrow).

4 VRT images reveal a normal aorta.

in the LAD. A drug-eluting stent was implanted and the patient recovered uneventfully.

Comments

cCTA has become a reliable, non-invasive imaging method for ruling out suspected coronary stenosis. However, in the emergency department, a triple-rule-out protocol for simultaneous evaluation of life-threatening conditions such as acute coronary syndromes, acute aortic syndromes and pulmonary embolism has unclear indications in the present guidelines. Multiple CT examinations require more contrast volume and result in higher radiation exposure and in compromised image quality.

In this case, a double Flash scan protocol was introduced to reduce the scan time (0.72 s), the radiation dose (5.5 mSv) and the volume of contrast agent used (60 mL). An initial test bolus with 10 mL of contrast was used to determine the peak enhancement in the pulmonary trunk and in the ascending aorta. Four seconds were added to the peak enhancement time so as to determine the start delay time. A double Flash scan of the thorax was then performed using only 60 mL of contrast. The first scan (cranio-caudal) was aimed at acquiring images with contrast enhancement only in the pulmonary arteries, whereas the second scan (caudo-cranial) was to acquire images with contrast enhancement in the coronary arteries and the aorta. Taking into consideration that the patient had a moderate calcium score, a higher kV was applied in the second Flash scan to avoid potential beam hardening artifacts caused by calcified plaques in the coronary arteries.

All three vascular systems were successfully evaluated, which reduced the patient's time to diagnosis, time to stay and, in the long run, the costs to the emergency department. ■

Case 9

D-Transposition of the Great Arteries – CT Evaluation of a Newborn

By Pannee Visrutaratna, MD, and Wai Leng, Chin*

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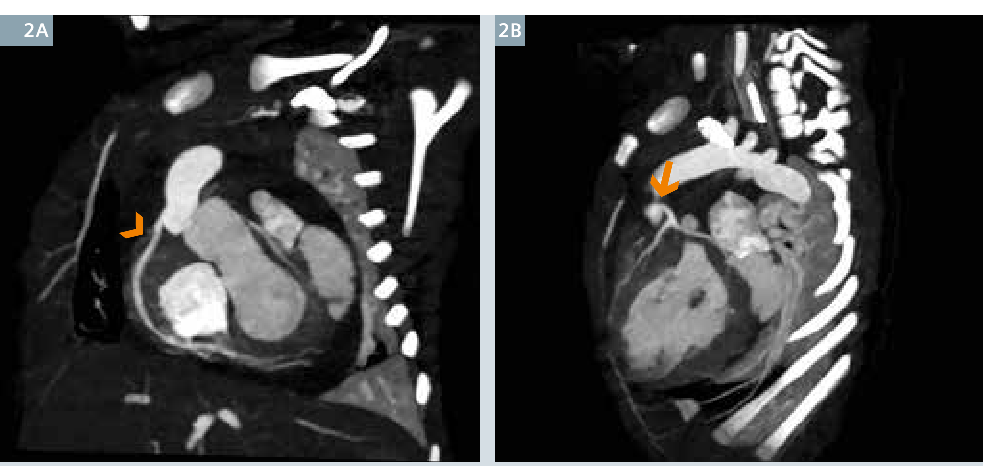
History

A 13-day-old female newborn suffering from desaturation was scheduled for a surgical operation on an arterial switch. A cardiac CT scan was ordered to evaluate the anatomy of the heart, the great vessels and the coronary arteries prior to the operation.

1 VRT images show a d-TGA with the aorta originating from the RV, and the pulmonary trunk from the LV. Coronary arteries are with normal pattern.



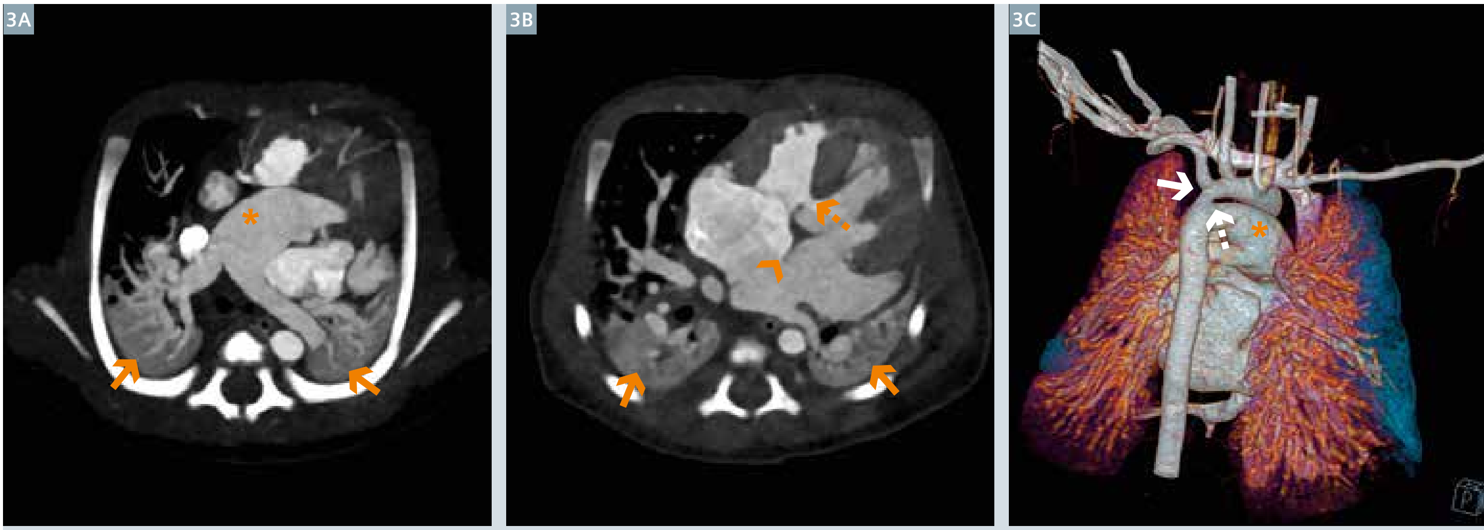
2 MIP images (Fig. 2A, 5 mm; Fig. 2B, 8 mm) show the right coronary artery (Fig. 2A, arrowhead) and the left main coronary artery (Fig. 2B, arrow) branching into the left anterior descending and left circumflex arteries.

Diagnosis

CT images showed a dextro-transposition of the great arteries (d-TGA) with a usual type of the coronary arteries. The aorta, originating from the right ventricle (RV), was anterior and to the right of the pulmonary trunk which originated from the left ventricle (LV) and was enlarged. A cardiomegaly with an atrial septal defect (ASD), a ventricular septal defect (VSD) and a patent ductus arteriosus (PDA) were seen along with a juxta-ductal type coarction of the aorta with hypoplastic aortic arch. Bilateral hyperattenuation in the posterior lung sections was present, suggesting pulmonary edema.

Comments

Cardiac CT scan on a newborn is always challenging due to a higher heart rate and difficulties in breathhold. In this case, an ultrafast scan mode, the Turbo Flash mode with a scan speed of 737 mm/s, was performed, enabling an acquisition of 98 mm in 0.13 s. The newborn was free-breathing during the scan. A fast true temporal resolution of 66 ms provided by dual source CT allowed an ECG-triggering in the systolic phase (at 35% RR) and maintained an excellent image quality to depict all three coronary arteries despite the infant's higher heart rate (142 bpm). The 70 kV, selected automatically by CARE kV (automated dose-optimized selection of X-ray tube voltage), allowed for an excellent enhancement with only 6 mL of contrast agent. The combination of all these advanced techniques contributed to a confident diagnosis with a very low radiation dose (0.72 mSv). ■



3

MIP (Figs. 3A and 3B) and VRT (Fig. 3C) images show that the ascending aorta is anterior and to the right of the enlarged pulmonary trunk (asterisk). An ASD (arrowhead), a VSD (dashed arrow), aortic coarctation (white arrow) with a PDA (white dashed arrow), and hyper-attenuation in both posterior lungs (arrows) are present.

4

VRT (Fig. 4A) and MinIP (Fig. 4B) images show a normal bronchial tree with limited volume of inflated lungs.

Examination Protocol

Scanner	SOMATOM Force		
Scan area	Thorax to upper abdomen	Pitch	3.2
Scan length	97.5 mm	Table speed	737 mm/s
Scan direction	Cranio-caudal	Slice collimation	192 × 0.6 mm
Scan time	0.13 s	Slice width	0.6 mm
Tube voltage	70 kV	Reconstruction increment	0.3 mm
Tube current	160 mAs/rot.	Reconstruction kernel	Bv40
Dose modulation	CARE Dose4D	Heart rate	142 bpm
$CTDI_{vol}$	0.45 mGy	**Contrast**	
DLP	6.9 mGy cm	Volume	6 mL
Estimated Dose	0.72 mSv	Flow rate	0.7 mL/s
Rotation time	0.25 s	Start delay	CARE Bolus

Case 10

Sub-millisievert Assessment of Thoracic Vascular Ring in an Infant

By Frandics P. Chan, MD, PhD

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History

A 13-day-old infant boy, born with Trisomy 21, presented with poor feeding, weight loss, and stridor. A postnatal echocardiography had shown a right-sided aortic arch and a diverticulum of Kommerell, suspicious for a vascular ring that may constrict the trachea and the esophagus. CTA was performed to evaluate the vascular anatomy, its relationship with the trachea and the patency of the airways.

Diagnosis

CTA confirmed a right-sided aortic arch and a diverticulum of Kommerell which form the right and posterior borders of a vascular ring (Figs. 1 and 2). The anterior border consisted of the ascending aorta, the right pulmonary artery and the pulmonary trunk. A ligamentum arteriosum, a remnant of the closed patent ductus arteriosus, connecting the pulmonary trunk to the diverticulum was depicted. This ligamentum itself was not visible on the CTA, due to the lack of contrast material; however its presence was suggested by the "beaks" at the pulmonary trunk and the diverticulum which marked the two ends of the ligament forming the left border of the vascular ring. The ring surrounded the trachea and the esophagus, however both structures were patent without any seen obstruction.

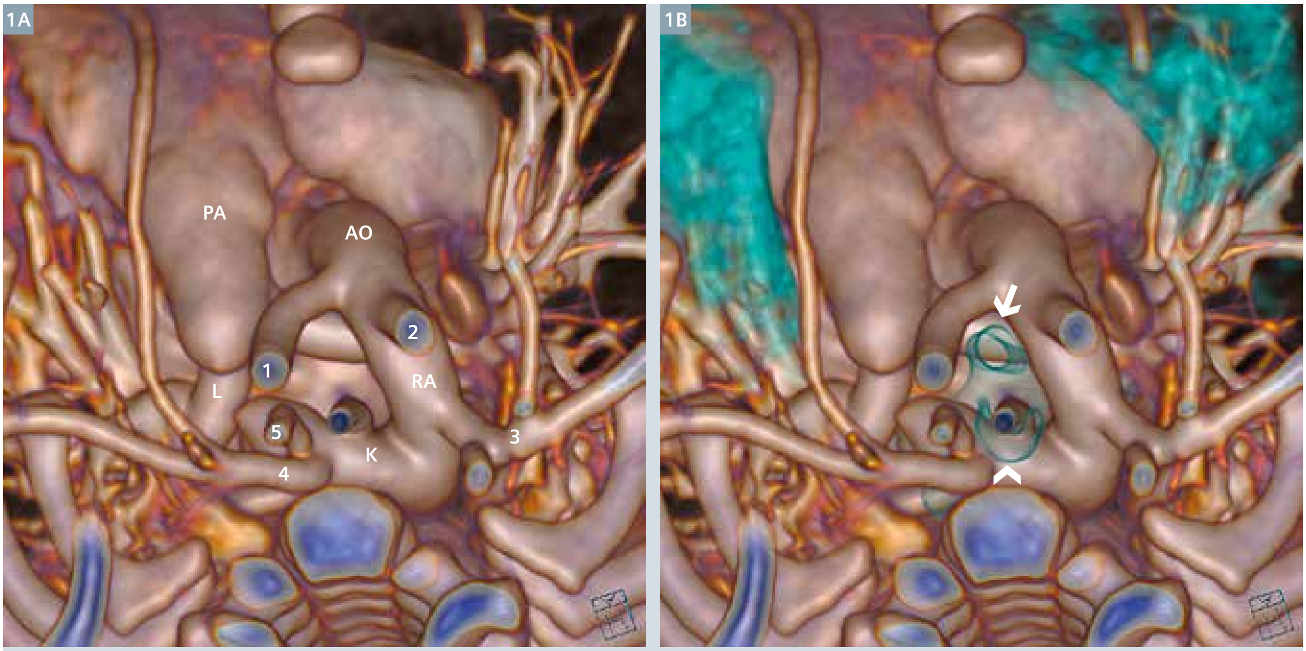
Comments

The traditional imaging for vascular rings is a fluoroscopic esophagram, in which abnormal indentations in the barium column suggest compressing vascular structures. Today, the preferred imaging test to directly evaluate the airways and the vascular structures is CT angiography. Using Flash mode, the scan time for an infant chest CTA is less than half a second, rendering breath-hold unnecessary. Although not strictly necessary, the use of sedation may help ease the discomfort from intravenous catheter puncture and contrast injection and helps immobilize the patient during the scan. Vascular rings that constrict the trachea come in many forms. The most constrictive one is a double aortic arch.

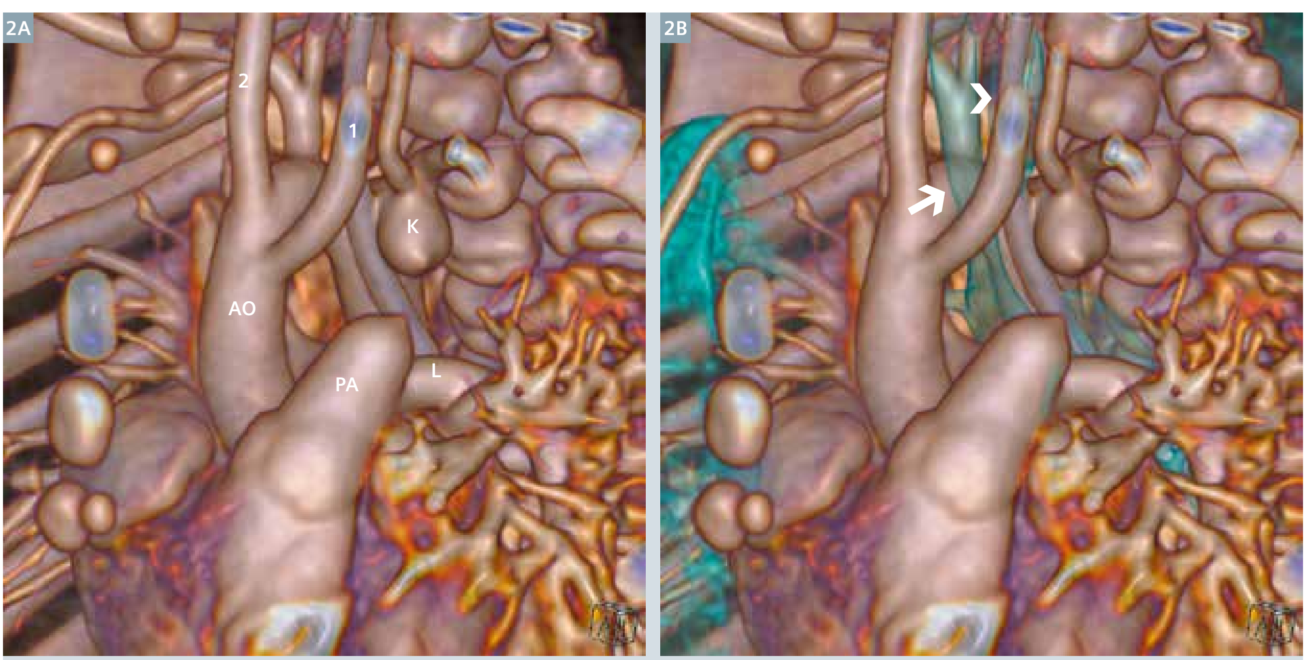
In this case, the vascular ring formed by a right arch and a diverticulum of Kommerell is typically more relaxed and may not require treatment. The severity of symptoms in this patient ultimately drove the decision to surgically divide the ligamentum arteriosum, to translocate the left subclavian artery and the left vertebral artery to the left common carotid artery and to remove the diverticulum. ■

Examination Protocol

Scanner	SOMATOM Definition Flash
Scan area	Thorax
Scan length	82 mm
Scan direction	Cranio-caudal
Scan time	0.2 s
Tube voltage	70 kV
Tube current	70 mAs
Dose modulation	CARE Dose4D
$CTDI_{vol}$	0.68 mGy
DLP	10 mGy cm
Effective dose	0.94 mSv
Rotation time	0.28 s
Pitch	3
Slice collimation	128 × 0.6 mm
Slice width	1 mm
Reconstruction increment	0.5 mm
Reconstruction kernel	B26f
Heart rate	NA
Contrast	350 mg / mL
Volume	15 mL (60%) + 10 mL saline
Flow rate	1 mL/s
Start delay	Bolus tracking



1 Volume rendering images of the upper chest viewed from the top show the vascular structures (Fig. 1A) and the airways (Fig. 1B). A ring is formed around the trachea (arrow) and the esophagus (arrowhead). There is a feeding tube within the esophagus. The anterior border of the ring consists of the pulmonary trunk (PA), the right pulmonary artery (hidden), and the ascending aorta (AO). The right border consists of the right-sided aortic arch (RA); the posterior border consists of the diverticulum of Kommerell (K) and the left border consists of the left pulmonary artery (L) and the ligamentum arteriosum. The ligamentum arteriosum is invisible but its two ends are marked by the "beaks" from the pulmonary trunk and the diverticulum of Kommerell. The branch arteries to the neck are left common carotid artery (1), right common carotid artery (2), right subclavian artery (3), left subclavian artery (4), and left vertebral artery (5).



2 Volume rendering images of the upper chest viewed from the left-anterior position show the vascular structures (Fig. 2A) and the airways (Fig. 2B). The trachea (arrow) and the esophagus (arrowhead) are surrounded by various vascular structures explained in Fig. 1. Labels are the same as in Fig. 1. The invisible ligamentum arteriosum is suggested by the two "beaks" from the pulmonary trunk (PA) and the diverticulum of Kommerell (K).

Case 11

Diagnosis of Bone Marrow Edema Associated with Metastases from SCLC using Dual Energy CT

By Moritz Kaup, MD; Julian L. Wichmann, MD; Thomas J. Vogl, MD, and Ralf W. Bauer, MD

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History

A 73-year-old male patient, with palliatively treated small cell lung cancer of the right lung, presented for an oncological re-staging CT. To date, there were no known bone metastases. The patient had a history of chronic back pain with slight aggravation during the weeks prior to the planned CT scan. The clinical examination revealed slightly diffuse pain over the middle thoracic spine with no neurological deficits.

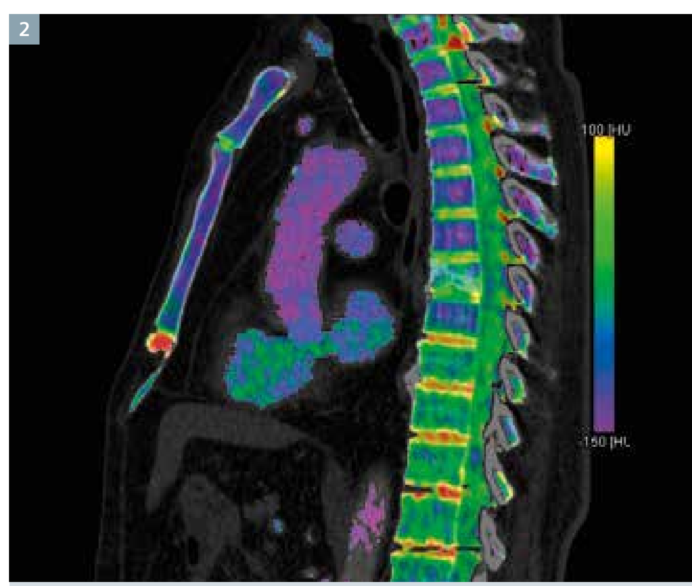
Diagnosis

A contrast-enhanced CT scan of the chest was performed on a SOMATOM Definition Flash operated in dual energy (DE) mode. Standard linear blended sagittal reformations demonstrated a diffusely hypersclerotic seventh thoracic vertebra (Th7) with deformation of the ground plate (Fig. 1). The adjacent vertebrae showed typical osteoporotic texture, with fatty replacement of the bone marrow, aggravated by prior radiation and chemotherapy. After a DE-based calcium subtraction, a diffuse signal increase of the bone marrow of Th7, consistent with edema, was visible (Fig. 2). The bone marrow edema was confirmed in MRI on TIRM (Fig. 3A) and native T1 TSE (Fig. 3B). The contrast-enhanced T1w series showed strong gadolinium uptake (Fig. 3C) indicating an active tumor process.

Comments

Standard single energy CT is primarily performed for imaging of a compression fracture of the vertebra. However, it falls short in the differentiation between an old fracture and a new one. This is due to the fact that a bone marrow edema, feature of a fresh fracture,

1 Standard line ablended sagittal CT reconstruction shows a compression fracture of the seventh thoracic vertbra with suspect osteolytic and sclerotic areas.

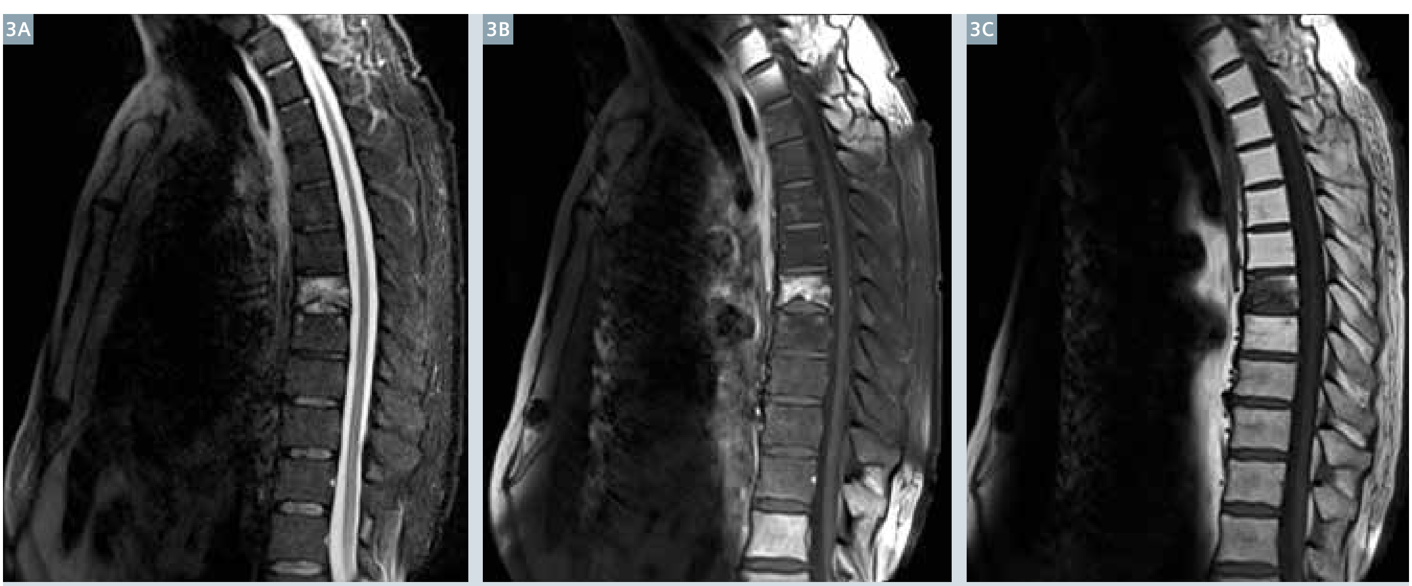


2 A sagittal bone marrow image reveals a clear visualization of the bone marrow edema of the fractured vertebra.

may be masked by underlying high-density structures such as a calcium deposit. Contrast-enhanced MRI as well as nuclear medicine (NM), with a standard bone scan or PET, are normally the suitable methods to differentiate these structures. While NM bases the diagnosis on tumor metabolism, MRI uses the features of signal alterations, in T1- and T2-weighted as well as Gd-enhanced T1-weighted sequences, hereby showing active metastases. This usually results in a low signal in native T1 and a high signal, consistent with edema, in T2 FS with markedly increased contrast uptake. DECT, with the possibility of suppressing calcium information, may provide information on water retention in tissues similar to MRI. ■

Examination Protocol

Scanner	SOMATOM Definition Flash
Scan area	Thorax
Scan length	320 mm
Scan direction	Cranio-caudal
Scan time	17 s
Tube voltage	80 / Sn140 kV
Tube current	153 / 61 mAs
Dose modulation	CARE Dose4D
$CTDI_{vol}$	6.02 mGy
DLP	207 mGy cm
Effective dose	2.9 mSv
Rotation time	0.5 s
Pitch	0.6
Slice collimation	32 × 0.6 mm
Slice width	3 mm
Reconstruction increment	3 mm
Reconstruction kernel	D34f / B70f
Contrast	
Volume	60 mL
Flow rate	2 mL/s
Start delay	50 s



3 Correlating MR TIRM (Fig. 3A) and T1 TSE (Fig. 3B) sagittal images confirm the bone marrow edema. Diffuse contrast enhancement of the vertebra confirms pathologic genesis (Fig. 3C).

Case 12

Stromal Tumor Causing Intestinal Bleeding – a Diagnostic Workup using CT

By Mei Jiang, MD; Shuipei Xue; Xi Zhao, MD,* and Prof. Bixian Shen, MD

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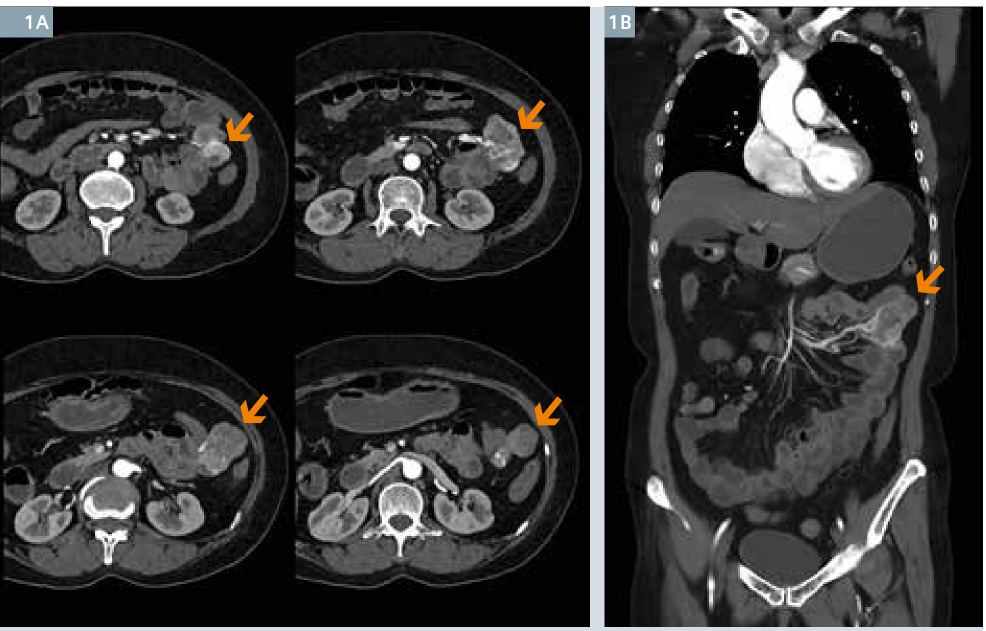
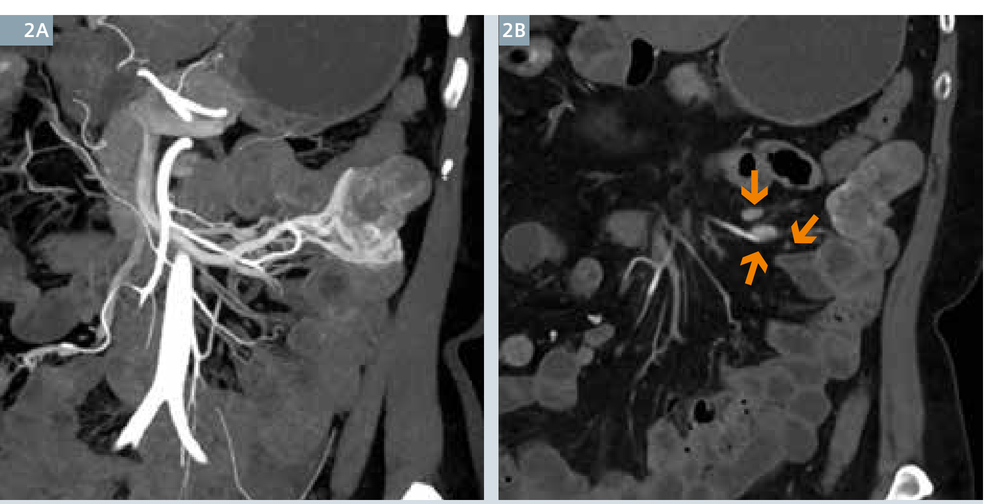
* Siemens Healthineers, P.R. China



1 Axial (Fig. 1A) and coronal (Fig. 1B) images acquired from arterial phase show an exophytic heterogeneous enhancing mass (arrows) arising from the jejunal loops, causing a partial obstruction of the jejunum.



2 A MIP (Fig. 2A) image shows a hyper-perfused lesion with a strong arterial feeder derived from the segmental artery of the SMA and drained by the SMV. A coronal MPR image (Fig. 2B) reveals three enhanced lymph nodes in the adjacent omentum (arrows).

History

A 57-year-old female patient, complaining of three episodes of sudden chest distress with sweating and one onset of short syncope within the past ten hours, was admitted for clarification. Cardiac workups excluded a cardiac event. Due to the fact that the patient had tarry stool in the past three days along with recent weight loss, chronic gastricism and anemia, gastrointestinal track bleeding was suspected. A colonoscopy performed was unsuspicious and an added upper endoscopy was also unable to locate the site of bleeding. An abdominal CT examination was then requested for further investigation.

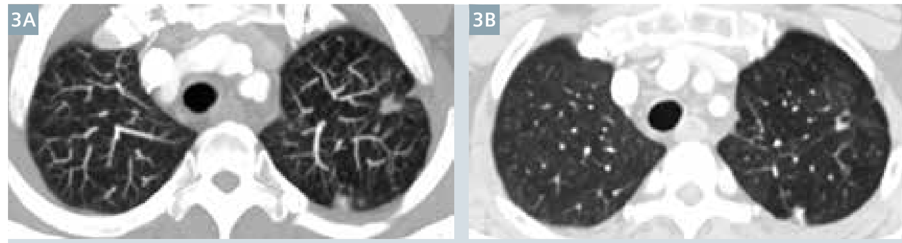
Diagnosis

Double-phase contrast CT images showed an exophytic heterogeneous enhancing mass, measuring 5 × 3.5 cm in size, arising from the jejunal loops. The lesion was hyper-perfused with a strong arterial feeder derived from the segmental artery of the superior mesenteric artery (SMA) and drained by the superior mesenteric vein (SMV). The jejunum was partially obstructed by this mass. Additionally, local lymph nodes (maximum 1.3 × 0.6 cm in size) were present in the adjacent omentum and were rated as suspicious. This was due to their contrast enhancement and their increased number when compared to other sections of the lymphatic drainage within the omentum. To conclude, a stromal tumor was suspected along with a local lymph node involvement.

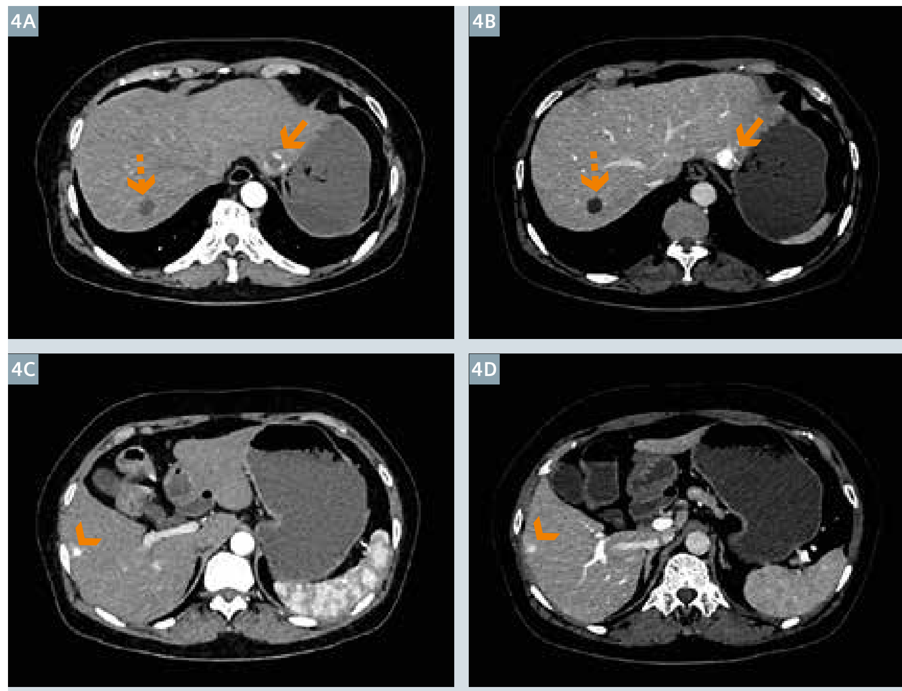
In further staging, two small lesions in the left-upper lobe of the left lung were revealed.

The configuration of the lesions was rated non-tumorous. Furthermore, three small lesions were seen in the liver – the one in the left lobe was characterized as a hemangioma, another one in the right lobe was rated as a cyst and the smallest one, in the periphery of the right lobe, was non-conclusive after two scans and required further investigation. No evidence of bone metastases was seen.

The patient underwent abdominal surgery and pathology confirmed an intestinal stromal tumor.



3 An axial MIP (Fig. 3A) and a MPR (Fig. 3B) image show two small lesions in the left-upper lobe of the left lung which were rated as scar tissue due to their configuration and missing contrast media enhancement.



4 Axial images acquired from arterial (Figs. 4A and 4C) and venous (Figs. 4B and 4D) phases (slice thickness 1 mm) reveal three small lesions in the liver – the one in the left lobe (arrow) is characterized as a hemangioma, another one in the right lobe (dashed arrow) is rated as a cyst and the smallest one in the periphery of the right lobe (arrowhead) is non-conclusive with the two phase scan exam performed and requires further investigation.

Comments

A confident CT diagnosis and staging in oncology require not only excellent image quality but also fast scan speed. Since double phases or multiple phases contrast scans over a longer scan range are often required for differential diagnosis and staging, such as in this case, exact timing of each phase can only be achieved with fast scan speed. This also helps to reduce artifacts caused by bowel movement. ■

Examination Protocol

Scanner	SOMATOM Definition Edge		
Scan area	Chest abdomen pelvis*	Rotation time	0.5 s
Scan length	594 mm	Pitch	1.2
Scan direction	Cranio-caudal	Slice collimation	128 x 0.6 mm
Scan time	6.5 s	Slice width	1 mm
Tube voltage	100 kV	Reconstruction increment	0.7 mm
Tube current	204 mAs	Reconstruction kernel	I31s SAFIRE 3
Dose modulation	CARE Dose4D	**Contrast**	
$CTDI_{vol}$	8.07 mGy	Volume	80 mL + saline
DLP	506 mGy cm	Flow rate	4.0 mL/s
Effective dose	7.6 mSv	Start delay	Bolus triggering in the ascending aorta with a threshold of 100 HU and an additional delay of 7 s

*For arterial phase. Venous phase applied the same scan protocol for abdomen and pelvis. The patient was asked to drink water before the examination. No bowel relaxants were applied.

Case 13

CT-Guided Interventional Vertebral Kyphoplasty Palliative Treatment

By Rodrigo Gobbo Garcia, MD;[1] Eduardo Noda Kihara Filhom, MD;[1] Fernanda Marques Abatepaulo, BM;[1] Laercio Rosemberg, MD;[1] Arthur Werner Poetscher, MD,[2] and Caroline Bastida de Paula, BD*

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History

A 74-year-old female patient was admitted to the hospital due to a growing mass in the left posterior thoracic region associated with local and lower back pain. MRI and PET/CT examinations revealed a soft tissue lesion with multiple secondary lesions in the liver and the spine. A biopsy of the thoracic lesion was performed and a histopathological diagnosis of melanoma was confirmed. After two weeks of oncological treatment and pain control, the back pain remained (8 out of 10 in pain scale) despite optimization in pain relief. An interventional kyphoplasty palliative treatment was indicated and requested.

Diagnosis

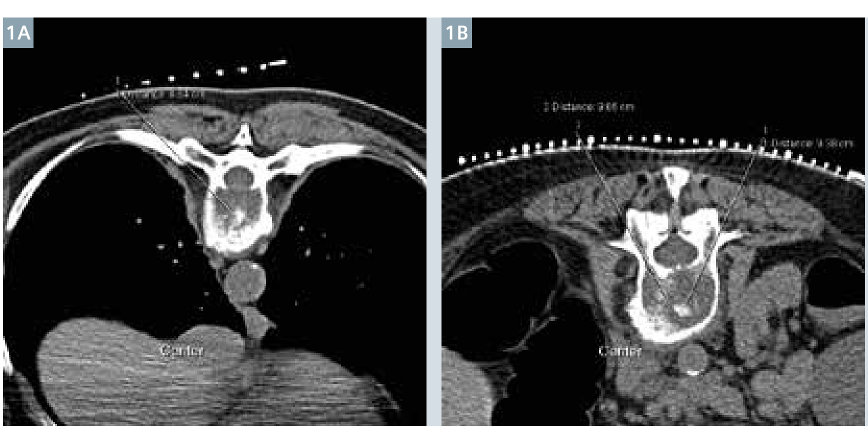
CT images showed metastatic destructions in the 9th thoracic (T9) and the 2nd lumbar vertebral body (L2). CT-guided intervention was performed uneventfully, with consequent gain in height in the fractured vertebral bodies and significant improvement in pain relief (2 out of 10 in pain scale). The patient was released to continue treatment in home care.

Comments

The patient was suffering from intense pain and kyphoplasty was seen as the best option. However, there were great concerns about central canal safety and placing the needles to target – the vertebral body height loss was significant and the posterior wall was clearly disrupted. CT guidance allows great accuracy and the fluoroscopy gives the necessary confidence while injecting the cement. We achieved satisfactory vertebral restoration and significant pain relief, without any neurological involvement. ■

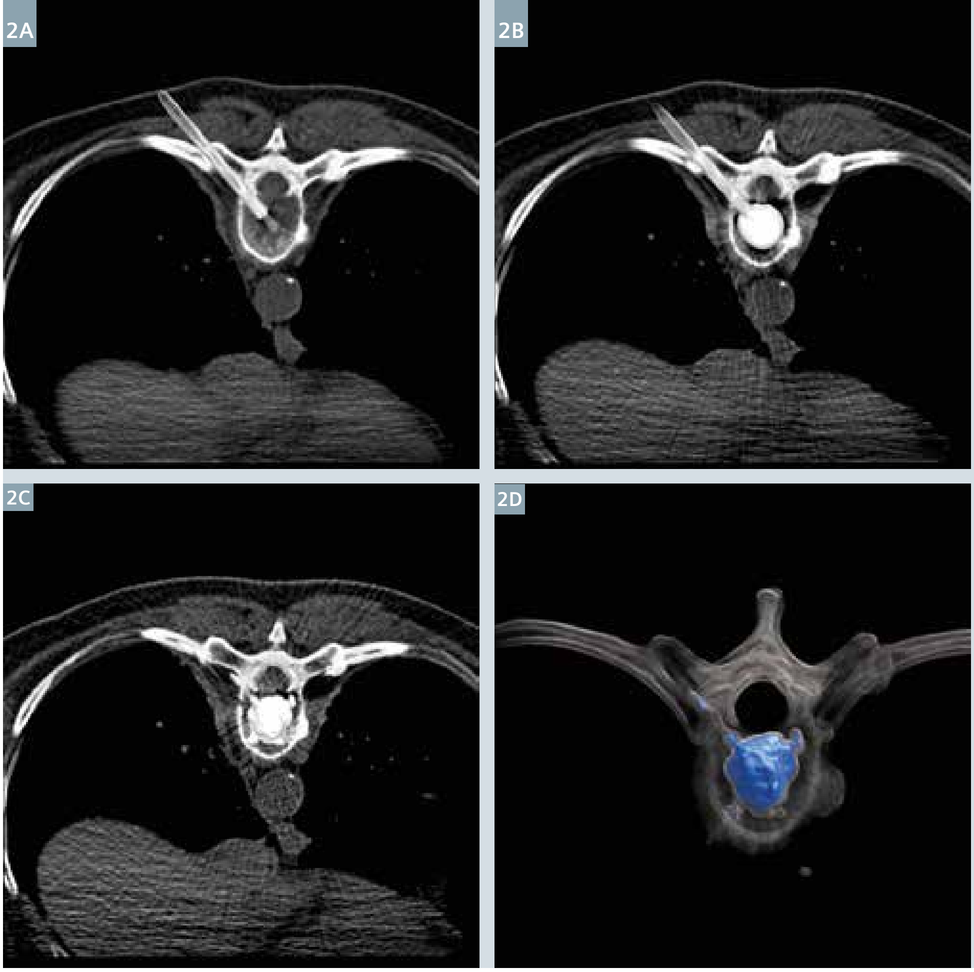
Examination Protocol

Scanner	SOMATOM Definition AS+	
Scan area	T9	L2
Scan mode	i-spiral	i-spiral
Scan length	24 mm	42 mm
Scan direction	Cranio-caudal	Cranio-caudal
Scan time	0.75 s	1.3 s
Tube voltage	100 kV	100 kV
Tube current	50 mAs	50 mAs
Dose modulation	–	–
$CTDI_{vol}$	30 mGy	6.47 mGy
DLP	208 mGy cm	39 mGy cm
Effective dose	1.7 mSv	0.58 mSv
Rotation time	0.5 s	0.5 s
Pitch	0.8	0.8
Slice collimation	16 × 1.2 mm	16 × 1.2 mm
Slice width	3 mm	3 mm
Reconstruction increment	3 mm	3 mm
Reconstruction kernel	B30f	B30f



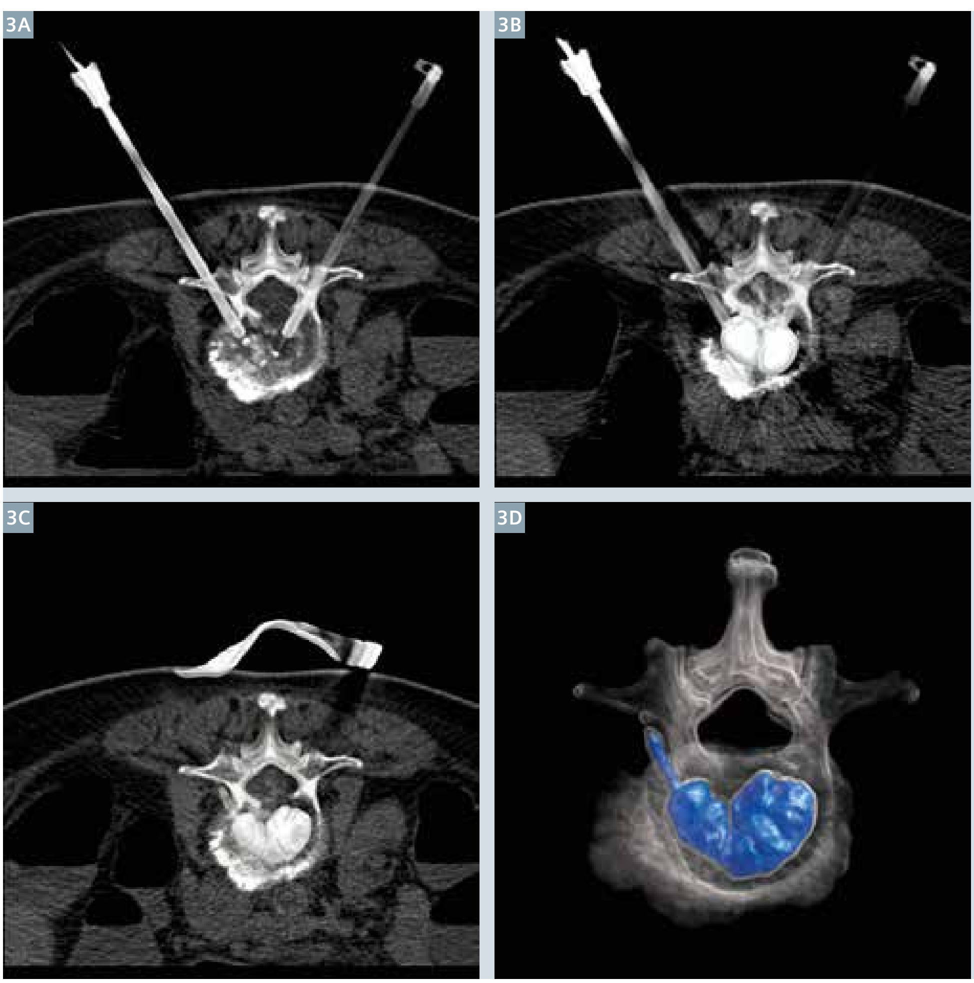
1

Axial images show the distance measurements before the needle positioning at T9 (Fig. 1A) and L2 (Fig. 1B).



2

Fused axial and VRT images show the needle positioning (Fig. 2A), the injection (Fig. 2B), and the post procedure control (Figs. 2C and 2D) at T9.



3

Fused axial and VRT images show the needle positioning (Fig. 3A), the injection (Fig. 3B), and the post procedure control (Figs. 3C and 3D) at L2.

Case 14

Pre-operative Detection of an Isoattenuating Pancreatic Insulinoma in Volume Perfusion CT

By Hua-dan Xue, MD; Liang Zhu, MD; Ping Li, MS; Xi Zhao, MD,* and Zheng Yu Jin, MD

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*Siemens Healthineers, P.R. China

History

A 23-year-old female patient, suffering from frequent hypoglycemic attacks, was referred to our institution for suspected hyper-functioning pancreatic endocrine tumor. Clinical and laboratory tests suggested endogenous hyper-insulinemic hypoglycemia. Because previous imaging was unable to localize the tumor, Volume Perfusion CT (VPCT) of the pancreas was ordered by the clinician for insulinoma localization.

Diagnosis

Images acquired by Adaptive 4D Spiral scans were reconstructed in multiple series. Dynamic scans captured the transient hyper-enhancement of the tumor – a hyperenhancing nodule with clear margin in the early arterial phase, washing out quickly and becoming isoenhancing compared to the pancreatic parenchyma in the standard pancreatic arterial phase. The hypervascular nature of the tumor was also reflected by its significantly increased perfusion. On the pseudo-colored perfusion maps, the tumor was shown as a "hot spot", standing out from the background parenchyma.

Comments

Insulinoma is the most common hyper-functioning pancreatic endocrine tumor. Its characteristic manifestation leads to clinical diagnosis. The role of imaging is to detect and to indicate the precise location of the tumor. Since most insulinomas are small, and the changes of pancreatic contour are subtle or absent, tumor localization greatly relies on the enhancement pattern.[1,2] Although insulinomas typically manifest as a hyperenhancing nodule, isoattenuating tumors can be encountered in up to 25% of the cases,[3] which limits the sensitivity of standard biphasic enhanced CT.[4]

VPCT of the pancreas allows for fast, dynamic scans of the pancreas, which are useful in capturing the transient hypervascular flush of the tumors. Since isoattenuating tumors show significant increased blood flow compared to the normal pancreatic parenchyma, VPCT may increase the sensitivity for insulinoma detections. ■

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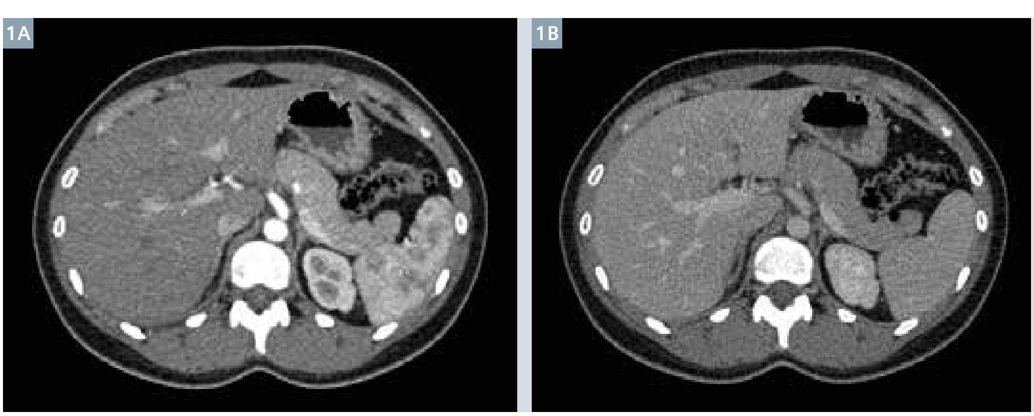
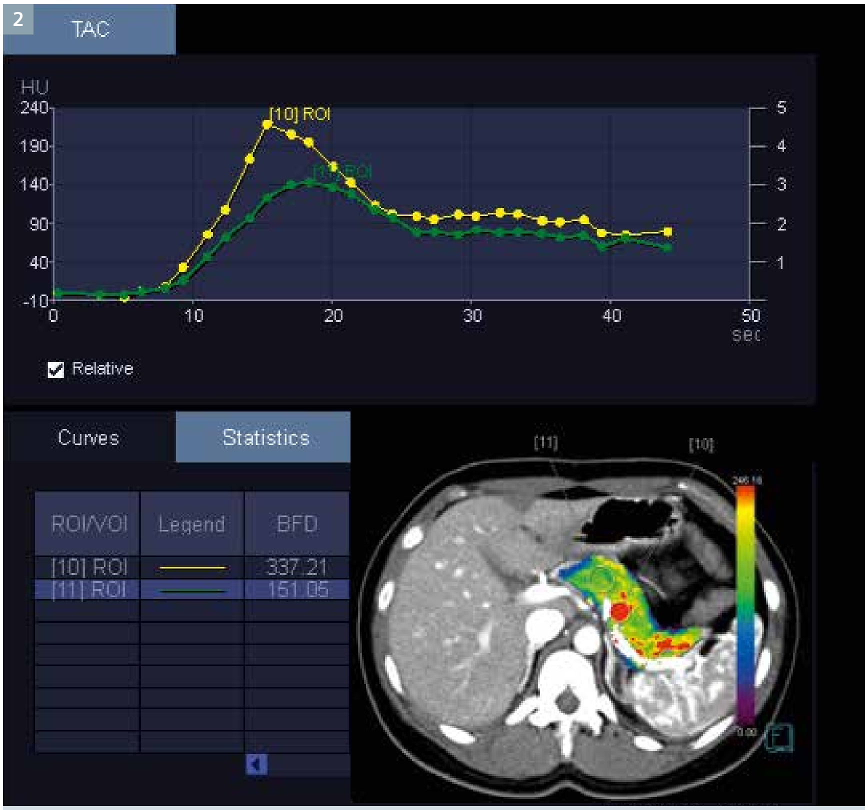


1

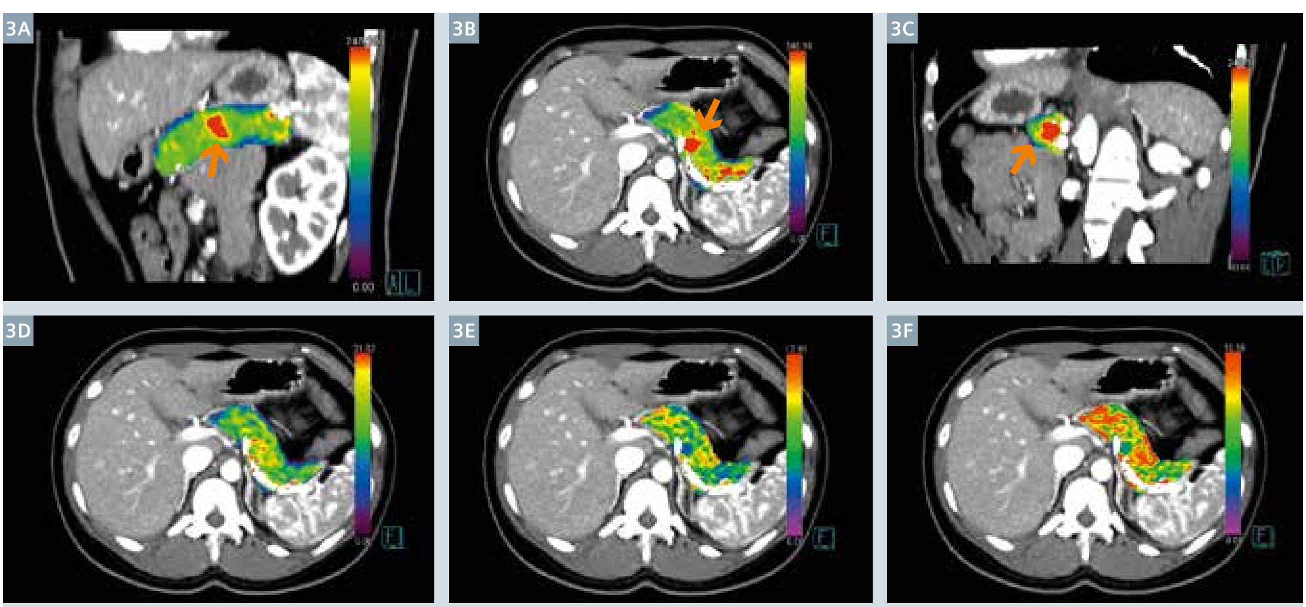
Arterial (Fig. 1A) and portal venous (Fig. 1B) phases of previous CT revealed negative result.



2 The tumor-harbouring area (ROI#10) shows more than doubled blood flow than that of the tumor-free area (ROI#11).

Examination Protocol

Scanner	SOMATOM Force
Scan area	Upper abdomen
Scan mode	Adaptive 4D Spiral
Scan length	176 mm
Scan direction	Bi-directional
Scan time	43.5 s
Tube voltage	80 kV
Effective mAs	55 mAs
$CTDI_{vol}$	30.3 mGy
DLP	577 mGy cm
Effective dose	8.7 mSv
Rotation time	0.325 s
Slice collimation	48 × 1.2 mm
Slice width	3 mm
Reconstruction increment	2 mm
Reconstruction kernel	Br36
Contrast	370 mg/mL
Volume	48 mL + 20 mL saline
Flow rate	5 mL/s
Start delay	6 s



3 Perfusion maps show a higher blood flow (BF, arrows, Fig. 3A – long axis, Fig. 3B – axial, Fig. 3C – short axis), an inconspicuous blood volume (BV, Fig. 3D), a shorter mean transit time (MTT, Fig. 3E) and a shorter Tmax* (Fig. 3F).

*Time needed by a theoretical unit of contrast media to reach the maximum concentration in one specific voxel. Mathematically defined as Tmax = TTS + MTT/2. It reflects the transit time to the center of the IRF (ideal impulsive bolus response function) at the voxel location. Tmax is the sum of the arteries' bolus delay and the tissue transit time to the center of the voxel.

Case 15

Diagnosis of Gout using Dual Spiral Dual Energy CT

By Heraldo O. Mello Neto, MD; Guilherme J. Morgan, MD; Rafael Olivo da Luz, MD, and Caroline Bastida de Paula, BD*

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*Siemens Healthineers, Brazil

History

A 56-year-old male patient, with history of podagra, was complaining of intense pain in the first left metatarsophalangeal joint for the past three days. The serum uric acid test results were normal. Dual Energy (DE) CT was requested for further evaluation.

Diagnosis

DECT, using material decomposition, revealed multiple major uric acid gouty tophi formations in the first left metatarsophalangeal joint, around the right medial cuneiform and in front of the right tibia. Smaller lesions were also seen in the rest of the left metatarsophalangeal joints and in the 1st and the 4th metatarsophalangeal joints.

Examination Protocol

Scanner	SOMATOM Perspective
Scan area	Ankles and feet
Scan length	169 mm
Scan direction	Cranio-caudal, Caudo-cranial
Scan time	5.7 / 5.7 s
Tube voltage	80 / Sn130 kV
Tube current	114 / 40 mAs
Dose modulation	CARE Dose4D
$CTDI_{vol}$	3.2 / 4.4 mGy
DLP	69.93 / 95.83 mGy cm
Effective dose	0.06 / 0.08 mSv
Rotation time	1 s
Pitch	0.75
Slice collimation	64 × 0.6 mm
Slice width	0.75 mm
Reconstruction increment	0.5 mm
Reconstruction kernel	D30s

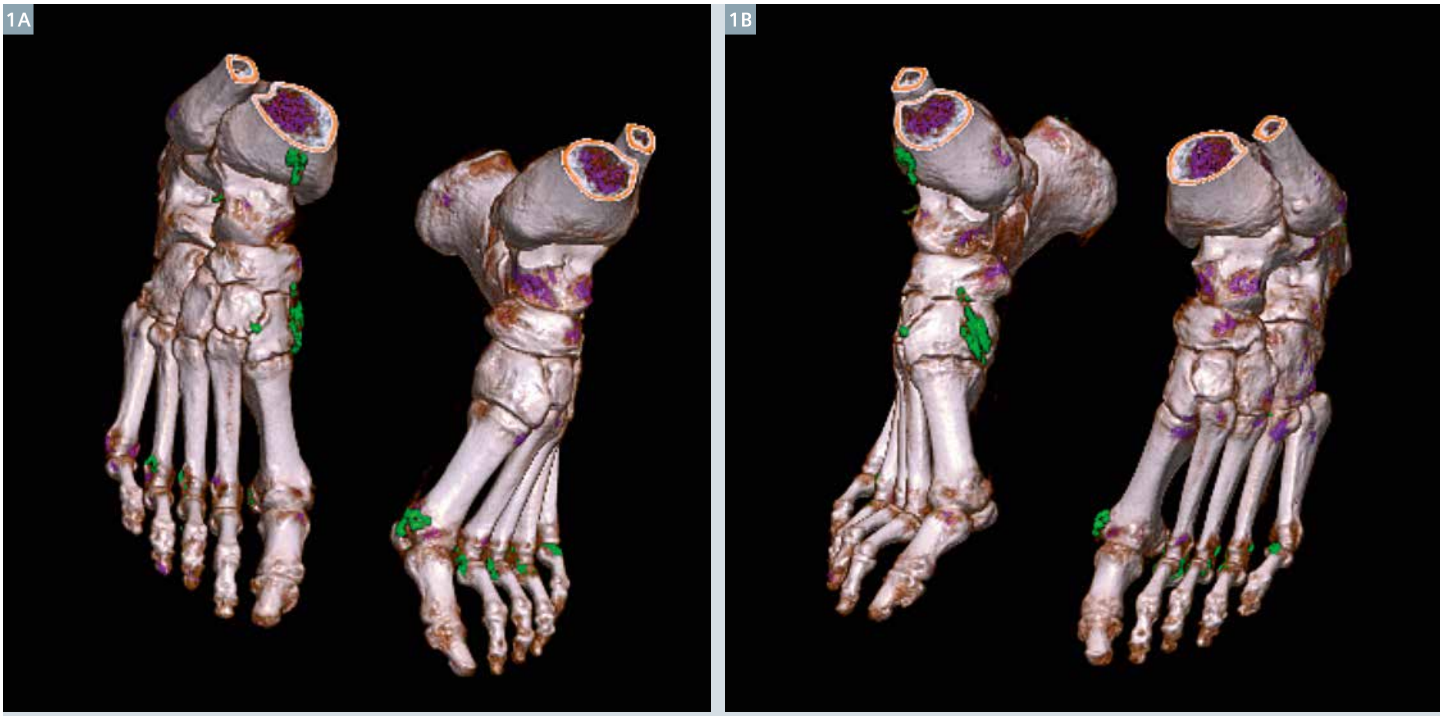
Comments

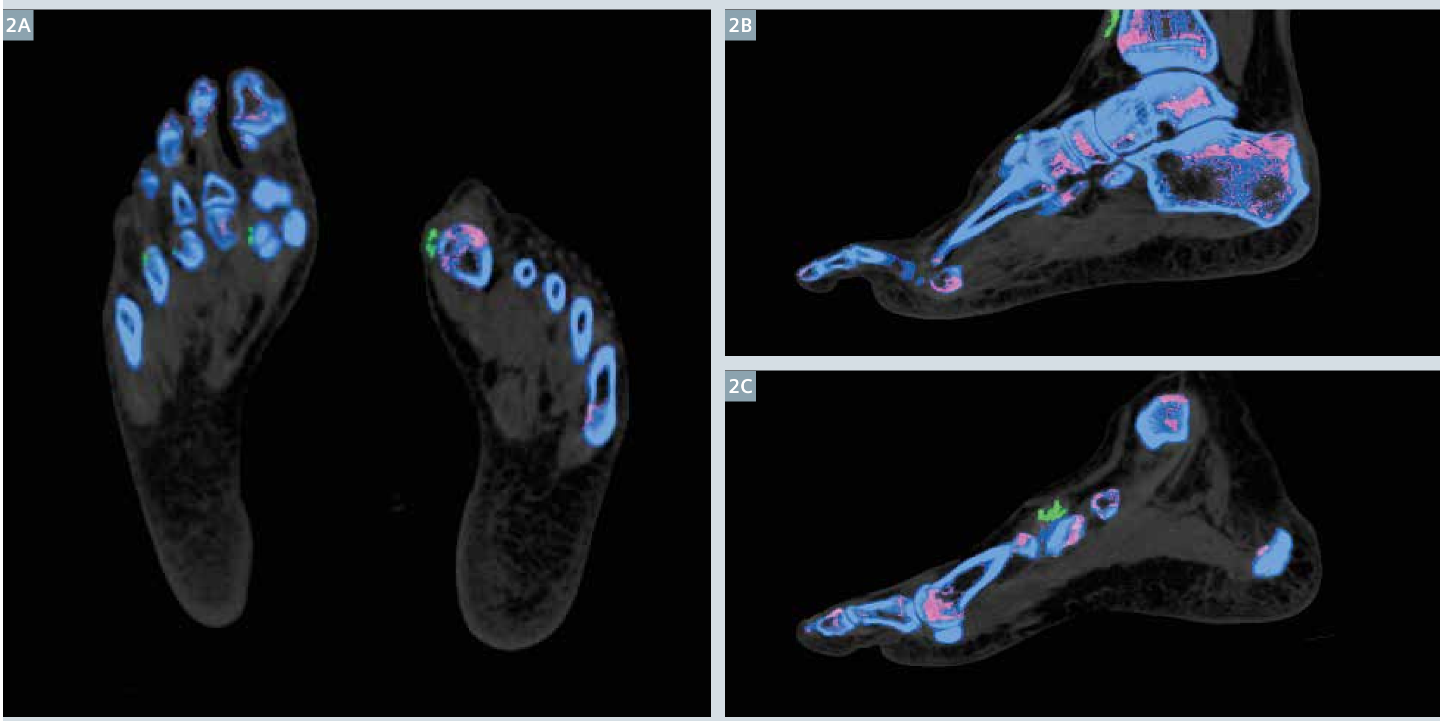
The incidence of gout has tripled over recent decades and now represents the most common form of inflammatory arthritis in men and women. The only certain way to diagnose gout is through the identification of monosodium urate (MSU) crystals in synovial fluid (SF). Unfortunately, the high dependency on microscopic analysis of bio specimens involves problems such as obtaining adequate specimens from small joints or periarticular structures. This can be difficult especially within primary care setting. The reliability of polarising microscopy is also wanting.

Since a diagnosis of gout arthritis typically results in therapeutic steps that are distinctly different from those used to address other types of inflammatory arthritis, the failure to detect MSU deposition can result in exposure to unnecessary and ineffective treatment strategies.

There are studies that confirm the good overall accuracy of DECT in diagnosing patients with gout. Moreover, DECT can provide important diagnostic information when the current routine diagnosis approach has failed to confirm the presence of MSU crystals. DECT also enables the detection of MSU deposition in anatomic structures that cannot be easily aspirated. The DECT sensitivity and sensibility is approximately 95%.[1,2,3]

DECT may be used to correlate crystal deposition with osseous changes. Classic osseous radiographic findings include well-defined "punched out" periarticular erosions with overhanging edges, normal mineralization, relative preservation of the joint spaces and asymmetric distribution that eventually becomes polyarticular. After an acute attack, classic osseous findings take several years to manifest, so if these findings are seen with no urate crystal deposition they may be due to remote, currently inactive gout and alternative causes for an acute-onset of arthropathy may be pursued. ■





1,2 DECT VRT (Fig. 1) and MPR (Fig. 2) images reveal multiple major uric acid gouty tophi formations (in green) in the first left metatarsophalangeal joint, around the right medial cuneiform and in front of the right tibia. Smaller lesions are also seen in the rest of the left metatarsophalangeal joints and in the 1st and the 4th metatarsophalangeal joints.

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Drive Dose Control: The Technology in Literature Review

Computed tomography is always striving to lower the required radiation dose. Key technical features that help to achieve this include high power reserves at low kV, additional tin filters to optimize the shape of the X-ray spectra, and 10 kV steps for tube voltage.

By Sebastian Faby, PhD, Siemens Healthineers, Germany

A constant challenge in computed tomography (CT) is to achieve the optimal dose for a confident diagnosis – no more nor less than required. Committed to the "Right Dose", Siemens Healthineers continuously improve technology to enable lower dose in CT imaging. Typical dose reduction techniques include automatic tube current modulation (with CARE Dose4D™) and iterative reconstruction algorithms, such as SAFIRE and ADMIRE. The top-line dual source scanner SOMATOM Force introduced previously unseen technical features that support even lower dose values.

Launched at the 2016 European Congress of Radiology (ECR) in Vienna under the slogan "Drive precision for all", Siemens Healthineers' new dual source scanner SOMATOM Drive is based on the gantry architecture of the SOMATOM Definition Flash with key technical features of SOMATOM Force. The performance strengths of SOMATOM Definition Flash have been reported in over 600 peer-reviewed publications and SOMATOM Force with its new core features has been evaluated in over 70 publications so far. Key issues include iterative reconstruction, new scan modes, tin filtered spectra, dual energy, cardiac and low kV imaging.

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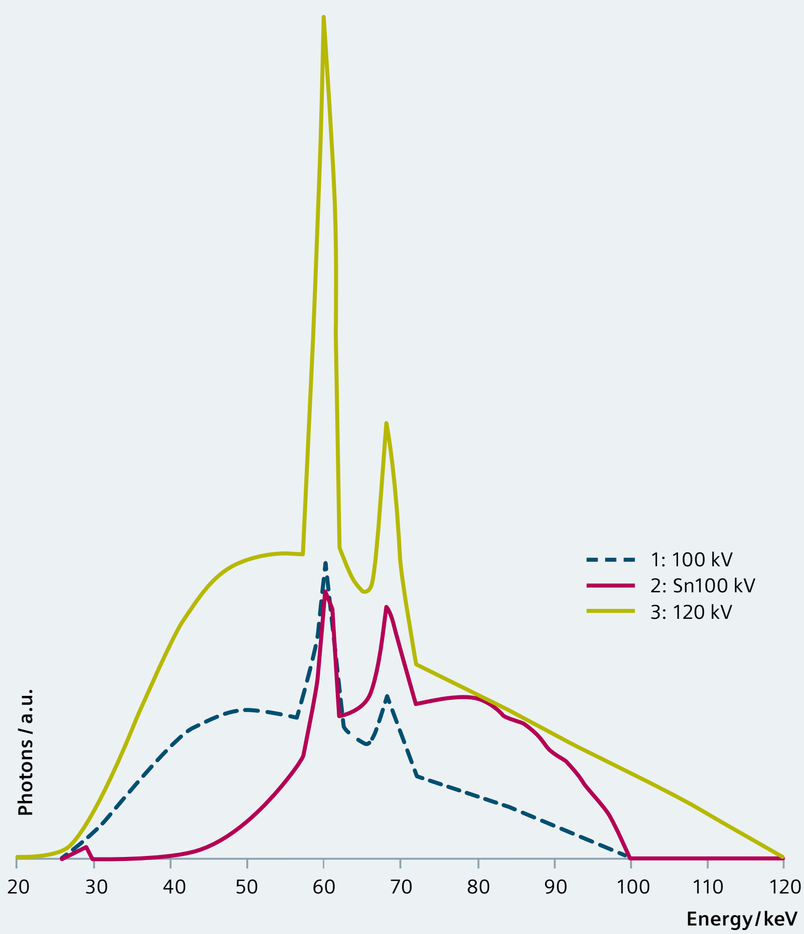

1 Tube output X-ray spectra of the Straton MX Sigma

Spectral shaping with tin filters

Additional tin filters on the two X-ray sources help to optimize the shape and dose efficiency of the X-ray spectra as illustrated in Figure 1. The tin filter removes low-energy photons from the X-ray spectrum typically absorbed in the patient. Comparing spectrum 1 with 2 shows how the tin filter shapes the spectrum, shifting its mean energy toward higher energies and at the same time rendering the spectrum narrower. This results in increased dose efficiency from the Sn100 kV spectrum and fewer beam hardening artifacts. A tin-filtered spectrum is best for high-contrast examinations, for example for lung cancer screening or paranasal sinus imaging, but not suitable for studies with contrast agent.

The dual source scanners SOMATOM Force and SOMATOM Drive feature tin filters on both tubes. In high-pitch Flash mode, scans deliver high in-plane temporal resolution and have the potential to avoid breath-hold and sedation. Several publications confirm the effectiveness of SOMATOM Force's spectral shaping technique and the benefits of tin filters in chest CT imaging, [1-6] e.g., for ultra-low dose lung cancer screening. When combined with iterative reconstruction (e.g., ADMIRE), the radiation dose may approach that of a conventional chest radiograph. Studies using the tin filter for imaging of the paranasal sinus region [7,8] report dose values as low as 0.03 mSv for preoperative planning. With SOMATOM Drive, the advantages of the tin filters will be studied in relation to other regions, such as CT colonoscopy, calcium scoring, and extremity examinations. SOMATOM Force was included in a feasibility study for calcium scoring at Sn100 kV using phantoms [9] and showed a good Agatston score agreement. The study compared a high-pitch Sn100 kV Turbo Flash scan (pitch = 3.2) with a 120 kV sequence mode, and also a 120 kV Turbo Flash scan. Dose values were 0.37 mGy for the 120 kV sequence, 0.17 mGy for the 120 kV Turbo Flash, and 0.03 mGy for Sn100 kV Turbo Flash.

Table 1

kV	Max. mA
70	650
80	750
90	750
100	800
110	800
120	800
130	769
140	714

2 Overview of the maximum available mA at different kV settings with 10 kV steps for SOMATOM Drive

Straton MX Sigma tube and Sigma generator

SOMATOM Drive features the new Sigma generator and Straton MX Sigma tube. The Sigma generator delivers a precise kV output with one percent accuracy typically and 10 kV steps from 70 to 140 kV. Tube voltage can, therefore, be better adapted to individual patients and anatomy. Introduced with SOMATOM Force, the benefits of 10 kV steps are reported in several studies.[10-15] One study [15] noted an average dose of 9.5 mSv when using 10 kV steps and CARE kV at 180 reference mAs, compared to an average dose of 12.0 mSv at 120 kV and 180 reference mAs on a SOMATOM Sensation 64.

In addition to excellent kV accuracy, the Straton MX Sigma and Sigma generator have been designed to enable high tube current at low kV. In studies with contrast agent, low kV imaging has the potential to save radiation dose and/or contrast agent. [16] However, this requires high power reserves, especially for larger patients. Improved power modules with reduced losses in the Sigma generator enable higher tube currents and thus higher output power at low kV (see Table 1). SOMATOM Drive with dual source technology features a hardware-based temporal resolution of 75 ms. For an image reconstructed from the combined data of the two detectors collected over a quarter rotation, it can deliver up to 93 mAs at 70 kV by running the two tubes at 650 mA. In a comparable single source acquisition, while the tube would have to deliver the same current of 650 mA over half a rotation to achieve the same 93 mAs for an image, the temporal resolution would be 142 ms rather than 75 ms. Although 142 ms is a good value, this is the difference between enabling (75 ms) or impairing (142 ms) end-systolic cardiac acquisitions – especially advantageous at high heart rates. At present, the only available tube able to deliver a current of over 650 mA at 70 kV is SOMATOM Force's Vectron tube (max. 1,300 mA at 70 kV).

Dual energy imaging with two tubes and high mA at low kV mean that the 80 kV / Sn140 kV combination can potentially be used more often instead of having to resort to 100 kV / Sn140 kV, benefitting thus from a better spectral separation. A new scan mode designed for CT angiography, called Dual Power mode, operates the two tubes at the same time at conventional pitch values (pitch = 1.2) to double the tube power (e.g., 2 × 650 mA = 1,300 mA at 70 kV). ■

In clinical practice, the use of ADMIRE and SAFIRE may reduce CT patient dose depending on the clinical task, patient size, anatomical location, and clinical practice. A consultation with a radiologist and a physicist should be made to determine the appropriate dose to obtain diagnostic image quality for the particular clinical task.

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Photon-counting Detectors in Clinical Computed Tomography

The detector system is arguably *the* key component in a computed tomography scanner. Its task is to convert the incoming X-rays into an electrical signal that can then be fed into the image reconstruction chain. Decisive properties are high quantum efficiency (X-ray stopping power), large dynamic range, and fast signal decay (low afterglow) combined with excellent signal stability.

By Stefan Ulzheimer, PhD, and Steffen Kappler, PhD, Siemens Healthineers, Germany

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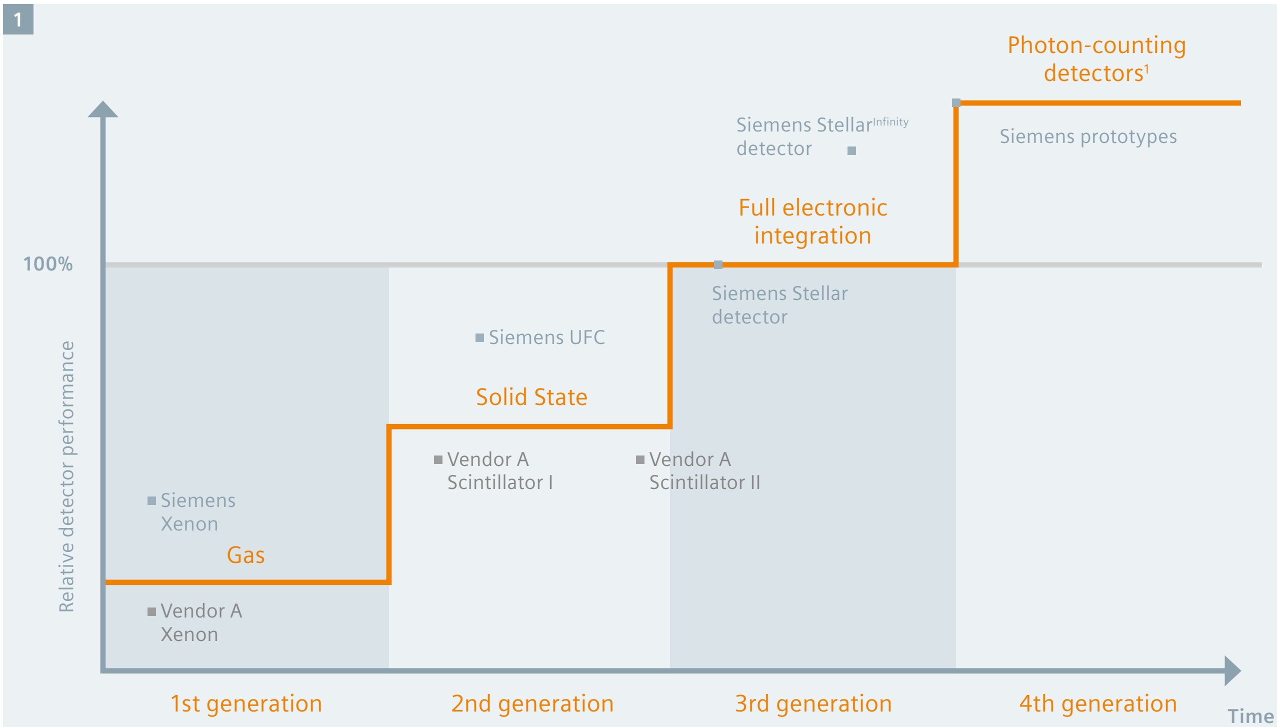


1 First-generation detectors still used Xenon gas under high pressure to convert the incoming X-rays into electric current. Second-generation detectors use solid-state ceramic scintillators to convert X-rays into light, photodiodes to convert light into current, and analog-to-digital converters (ADC) to digitize the signal. The Stellar detector is the first third-generation detector that combines the photodiode and the ADC in one application-specific integrated circuit (ASIC), dramatically reducing electronic noise, power consumption, and heat dissipation. Photon-counting detectors[1] have the potential to revolutionize CT imaging.

CT detectors – permanently enhanced

CT detectors have undergone many development steps from the very early gas detectors – sometimes radical, sometimes merely incremental. Based on its proprietary scintillator material UFC™, Siemens continuously sets new standards in CT detector design.[1] The latest innovation is the fully integrated Stellar^Infinity detector that Siemens uses in today's high-end CT systems (Fig. 1), first introduced with SOMATOM Force. Due to its unprecedented level of electronic integration, the Stellar^Infinity detector delivers exceptionally low levels of electronic noise and high signal dynamics. This makes it the optimal tool to exploit current and future iterative reconstruction possibilities.

Today's solid-state detectors use a two-step process to convert the incoming X-ray intensity into an electronic signal. First, the X-rays are converted into visible light in a scintillator layer. Below, the figure shows a photodiode array that converts the emitted light into an electric current that is digitized in dedicated ASICs. The scintillator layer is made of a ceramic material that is mechanically structured into pixels. Septa of finite width separate the individual pixels in order to suppress optical cross-talk (Fig. 2A).

The next step: photon-counting detectors[1]

Semiconductor materials such as cadmium telluride (CdTe) are able to convert X-rays directly into electric signal pulses. Each incoming X-ray quantum generates clouds of free charge carriers with the amount of free charges being proportional to the energy of the incident X-ray beam. A strong electrical field inside the detector material transports the charge clouds to anode pixels (Fig. 2B) in which an electrical current is induced. Highly integrated circuits transform these charge pulses into voltage pulses of a few nanoseconds duration that can be counted digitally.

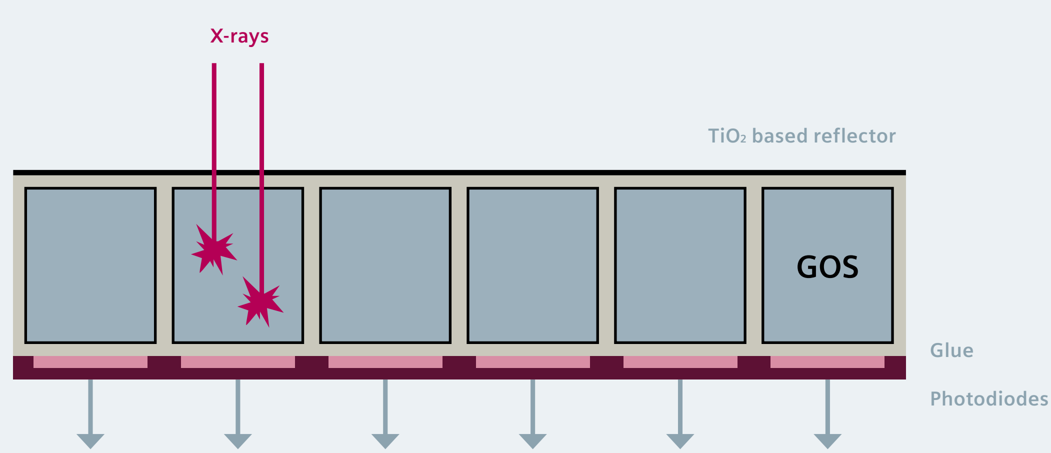
So far, CdTe has not been used in commercially available clinical CT scanner detectors for the following reasons:

- The goal of photon-counting detectors is to register each X-ray individually. Due to the large diameter of the scanned patient in a clinical setting, a relatively large number of X-ray beams is required to reach the detector in a very short time. In clinical whole body CT imaging – even with the low dose levels used today – the time between two X-rays that arrive at an individual pixel can be as short as a couple of nanoseconds. Therefore, the detector electronics have to be extremely fast and precise.
- Signal stability in CT scans is of the utmost importance. Even the slightest stability variations in the detector signal can lead to visible ring artifacts in the CT images. Production of crystalline materials with the purity and excellent signal stability required to achieve diagnostic image quality in a whole body CT scanner has not yet been possible.

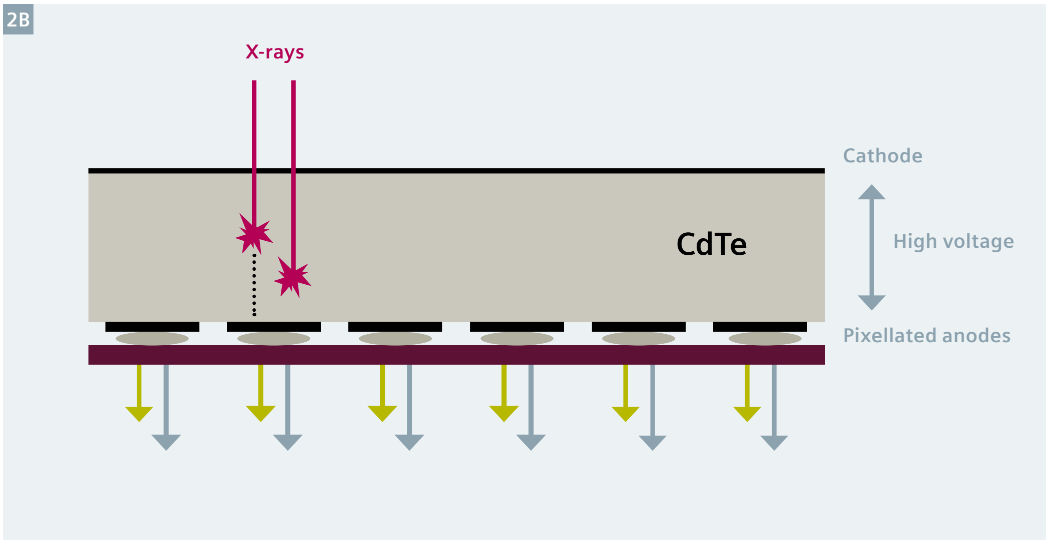
Multi-energy information

If such detectors, however, do become available, they will offer tremendous advantages. It would not only be possible to register or count each individual photon but also to measure the energy from each individual photon. Without any other technical prerequisites, multi-energy CT could become possible.
In principle, as a next step following on from dual energy CT, an arbitrary number of energies is achievable. Still, in order to limit the amount of data delivered by the detector, it is more practical to put the registered photons within certain energy ranges or "energy bins" and only read the data for these bins. Today's dual energy CT is sufficient for the materials present in the human body and for iodine contrast. More "bins" would not add more information here. Should new contrast materials become available in the future, however, such as gold nanoparticles with additional absorption peaks in the used X-ray energy range,[2] three, four, or even more, bins might be beneficial (k-edge imaging).

2A



2A Energy-integrating detectors convert X-rays into an electrical signal in a two-step process: First, a scintillator layer (GOS) converts X-rays into visible light. Photodiodes then convert light into an electrical current.



2B

Certain materials (e.g., CdTe) can directly convert X-rays into an electrical current. Each photon can be detected individually and its energy can be measured.

Lower dose and higher spatial resolution

Since only signal pulses above a certain threshold are registered in photon-counting CT scanning, such detectors completely eliminate electronic noise that is produced in every electronic component until a signal is digitized. The Stellar^{Infinity} detector set a new standard with exceptionally low electronic noise due to its complete integration of photodiodes and analog-digital convertors in one single chip. There are clear advantages in clinical scenarios of using extremely low doses [3] or when having to deal with low signals such as in obese patients. Photon-counting detectors will take this to a new level. In addition, photon-counting detectors are able to weigh low-energy photons higher than high-energy photons. This allows even further optimization of the contrast-to-noise ratio (CNR) in contrast-enhanced applications. Initial studies show that an additional dose reduction of 32% will be possible.[4]

In today's scintillators, the pixels have to be mechanically structured and therefore cannot be infinitely small. With decreasing pixel size, the geometrical dose efficiency drops because the relative area of the septa between the pixels increases. In photon-counting detectors, a mechanical separation of the pixels is not necessary. Pixels can be structured in a photolithographic process as already established for silicon chips. In principle, pixels can be made very small. Of course, an optimized value must also be found here that delivers practical additional clinical value. Recent publications in the field of computed tomography indicate that the pixel pitch in photon-counting detectors for clinical scanners might be reduced by a factor of three to four relative to today's solid-state detectors.

Prototype installations

Siemens is the first medical equipment company to be able to demonstrate the potential of high-flux capable photon-counting technology in two near-clinical prototype installations. [5,6] The prototypes are based on SOMATOM Definition Flash hardware in which the second detector system was replaced with a photon-counting detector. For the first time, clinical equivalence comparable to existing technology was demonstrated in human subjects. In the next five years, Siemens will collaborate with its network of partners to optimize the technology and to identify new clinical potentials. ■

[1] The product is still under development and not commercially available yet. Its future availability cannot be guaranteed.

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Dual Energy CT Lung Perfusion Imaging in Children

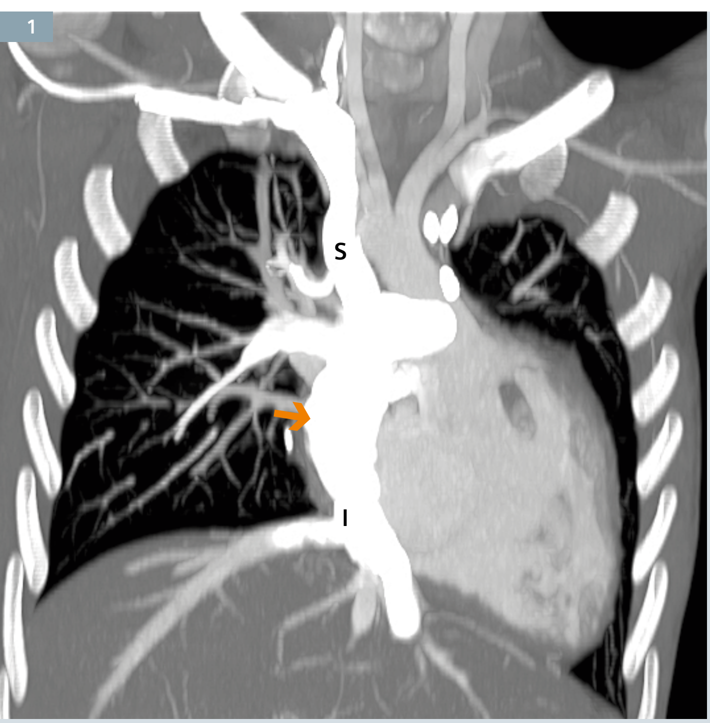
We use Dual Energy CT (DECT) for pulmonary CT angiography in children which enables the evaluation of the pulmonary arteries and lung perfusion from a single contrast-enhanced CT examination. Based upon our experience, in all types of pediatric contrast-enhanced DECT protocols (chest, abdomen, and pelvis) radiation exposure is similar to, or at times even lower than, those of conventional single-energy CT.[1]

By Professor Marilyn J. Siegel, MD

For this article, our general DECT angiography protocol is discussed followed by a specific case report focusing on the use of DECT-based lung perfusion image analysis.

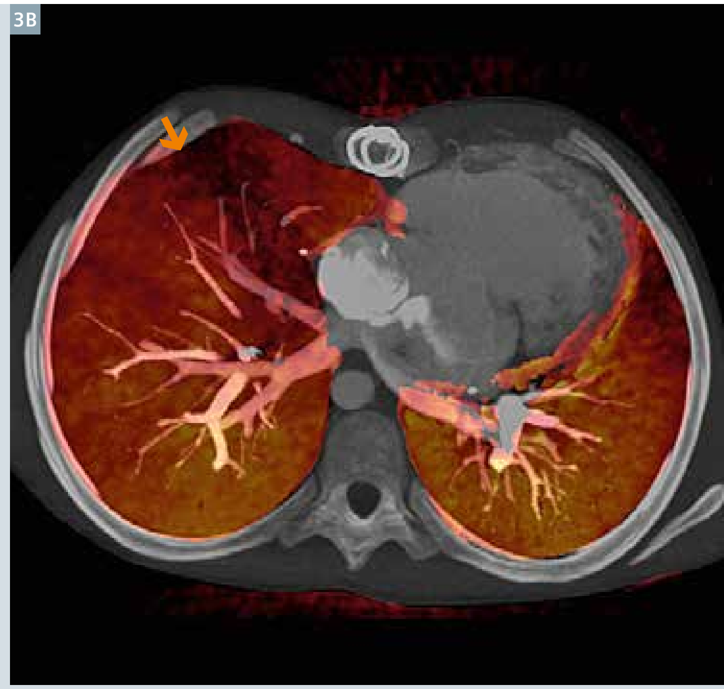
CT techniques

Our DECT examinations are performed on a SOMATOM Definition Flash, operating at 80/Sn140 kV, where Sn indicates tin prefiltration of the high-energy tube. Real-time anatomic exposure control (CARE Dose4D™) and sinogram affirmed iterative reconstruction (SAFIRE) techniques are used to facilitate dose reduction. Fixed acquisition parameters include: rotation time of 0.33 seconds, detector collimation of 128 × 0.6 mm, and pitch of 1.2. The use of a higher pitch is of critical importance in pediatric patients to decrease motion artifacts, differing from DECT in adults where a lower pitch is commonly used. In pediatric CT, unlike adult CT, tube power issues (e.g., mAs limits because of faster scan speeds) are not as relevant



1 Coronal MIP image shows the Fontan connection (arrow) joining the superior vena cava (S) and inferior vena cava (I) at the confluence of the pulmonary arteries.
Courtesy of Washington University School of Medicine, St. Louis, Missouri, USA

2 Axial MIP image shows a single atrioventricular valve (arrow), a large atrial septal defect (asterisk) and a large ventricular septal defect (double asterisk).
Courtesy of Washington University School of Medicine, St. Louis, Missouri, USA



3 Coronal (Fig. 3A) and axial (Fig. 3B) PBV images reveal areas of diminished perfusion to the right-upper lobe and right-middle lobes (arrows). *Courtesy of Washington University School of Medicine, St. Louis, Missouri, USA*

due to the smaller patient habitus. Similarly, with the exception of very large patients (e.g., some adolescents), pediatric patients will always completely fit within the scan field of view (e.g., 33 cm) of the second tube of the Dual Source CT scanner.

A non-ionic contrast medium (320 mg/mL) is administered with a volume of 2 mL/kg, not to exceed a total of 100 mL. A power injector is used if the catheter is in an antecubital position. The flow rate selected varies according to the catheter size. Contrast medium is injected by hand if the catheter is not located in the antecubital region.

In daily routine, we use bolus tracking for timing the injection, with the region of interest (ROI) placed in the pulmonary trunk. The scan is automatically triggered once the contrast level reaches 100 HU. A default is set at 15 seconds in case the scan does not trigger. In congenital anomalies with absent or hypoplastic pulmonary arteries, the ROI is placed over the proximal descending aorta since the pulmonary arteries will fill with the systemic arterial bolus.

A test bolus and saline flush are not routinely used in pediatric CTA.

Image postprocessing and interpretation

To illustrate image generation and review in DECT-based perfusion imaging of the lungs, the following case is presented: A 12-year-old boy with a history of right dominant unbalanced atrial-ventricular (AV) canal, transposition of the great vessels, absent main pulmonary artery, and Fontan palliation, had worsening congestive heart failure and was a candidate for heart transplant. A pre-operative CTA of the chest was performed to assess the pulmonary vascular anatomy and lung perfusion prior to surgery.

Following parameters were used: 80 kV, 140 kV, linear blended images at a ratio of 0.7, monoenergetic plus reconstructions at 50 keV, as well as coronal and sagittal multiplanar reformat at the console. Only the axial blended images, axial monoenergetic images, and multiplanar reformats are sent to PACS for the radiologist to interpret. The new software VA48 allows reconstruction of PACS-ready monoenergetic plus images directly at the CT console. Monoenergetic plus reconstructions at 50 keV, generated at the console or with *syngo*.via, are preferred over the 80 kV images since they provide better contrast.

Additionally, maximum intensity projection (MIP) images are done to optimize visualization of the pulmonary arteries in patients with congenital abnormalities of the pulmonary arteries. To further improve the iodine contrast, we use the 50 keV monoenergetic plus images to generate the MIP images. In this patient, the coronal 50 keV MIP image showed the Fontan connection (arrow) joining the superior vena cava (S) and inferior vena cava (I) at the confluence of the pulmonary arteries (Fig. 1). The main pulmonary artery was absent. Flow appeared normal in the peripheral blood arteries. Axial 50 keV MIP image showed a single atrioventricular valve (arrow), a large atrial

septal defect (asterisk) and a large ventricular septal defect (double asterisk) (Fig. 2). Peripheral pulmonary blood flow again appeared normal.

Furthermore, we used *syngo* DE Lung PBV to create pulmonary blood-volume maps to assess the flow to the lungs. In this patient, the coronal (Fig. 3A) and axial (Fig. 3B) PBV images suggested areas of diminished perfusion to the right-upper lobe and right-middle lobes, respectively (arrows). However, overall the lungs appeared well perfused and no acute intervention was needed. By enabling a comprehensive evaluation of vessels and parenchyma, DECT has the potential to obviate additional imaging that involves radiation, such as catheter angiography. ■

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References

[1] Siegel MJ, Curtis WA. Ramirez-Giraldo JC Effects of Dual-Energy Technique on Radiation Exposure and Image Quality in Pediatric Body CT AJR 2016 Oct; 207:1–10

Examination Protocol

Scanner	SOMATOM Definition Flash		
Scan area	Thorax	Rotation time	0.33 s
Scan length	330 mm	Pitch	1.2
Scan direction	Cranio-caudal	Slice collimation	128 × 0.6 mm
Scan time	2.4 s	Slice width	3 mm
Tube voltage	80 / Sn140 kV	Reconstruction increment	2 mm
Tube current	39 / 20 mAs	Reconstruction kernel	Q30f SAFIRE 3
Dose modulation	CARE Dose4D	**Contrast**	320 mg/mL
$CTDI_{vol}$	1.53 mGy	Volume	100 mL
DLP	62.1 mGy cm	Flow rate	2 mL/s
Effective dose	1.85 mSv	Start delay	Bolus tracking

A New Approach To Personalized Education

By Robert Dittrich, *Siemens Healthineers, Germany*

Every professional role requires specialist knowledge. How this knowledge is best acquired depends on each individual. Siemens Healthineers, therefore, offers a dynamic, comprehensive online experience to Siemens' customers that seamlessly delivers quality educational content – anywhere, anytime, from any device. This online experience can be combined with face-to-face training on installing a new computer tomograph.

The industry's first personalized education and performance experience for the healthcare professional, PEPconnect, is designed to increase staff competency, efficiency, and productivity for the overall healthcare environment, creating smarter connections of people to knowledge. PEPconnect focuses on increasing the knowledge, skills, and abilities of each individual user of Siemens equipment, with on-demand access to individual and competency-based activities, webinars, and performance support, such as videos and jobs aids. With features such as event management, registration, and transcript, PEPconnect provides a single space for the individual to effectively and continuously enhance job-relevant and competency-based knowledge.

PEPconnect allows you to:
- Access education and real-time performance support, anytime, anywhere, on any device
- Construct your personalized learning experience
- Share and connect your learning experience with others
- View individual training paths enabling maximum training transparency for users and managers
- Manage all classroom and virtual instructor led events easily*

After installation, the customer is supported via remote assist and can be trained during the lifecycle on manageable topics via remote training. The flexible approach means that study packs can be designed individually to suit learning preferences. With the blended learning approach, these tailored learning pathways can be generated for each staff member in accordance with personal goals and needs. ■

* Features and languages depend on county availability.

PEPconnect offers a blended learning approach supporting individual learning preferences to achieve optimal training results.

Tips & Tricks: Automatic Creation for Lung CAD and Dual Energy Results

By Patricia Jacob, *Siemens Healthineers, Germany*

Rapid Results Technology (RRT) triggers automatic calculation directly at the scanner and archives the evaluation results, for example Lung CAD in the MM Oncology workflow or Monoenergetic Images in CT Dual Energy. This saves time when reading cases since RRT creates just the right amount of information required – standardized and reproducible. Moreover, there is **no need to open the workflow in *syngo*.via**[1] since the calculated results are automatically transferred to the PACS with *syngo*.via functioning as a node.

Rapid Results in Lung CAD (MM Oncology)

syngo.CT LungCAD is a computer-aided detection (CAD) tool designed to assist radiologists in detecting pulmonary nodules when assessing chest scans. It is intended to function as a second reader after the radiologist has completed the initial read.

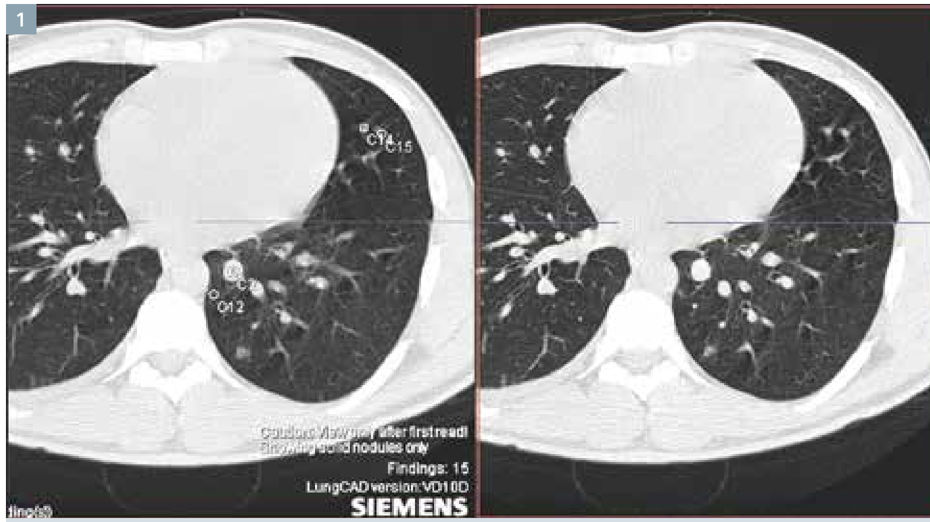
With RRT, users can calculate CAD results directly at the scanner using the Scan Protocol Assistant. Results are generated as an additional DICOM series with the corresponding Siemens disclaimer on the screen (see Fig. 1) and are transferred to the PACS automatically.

In the PACS, the original series can be compared with the result series. In the result series, only slices with Lung CAD findings are displayed. The PACS synchronizes the original image stack with the Lung CAD image stack using the slice position to locate the Lung CAD findings in the original series for clinical review.

Rapid Results with Dual Energy

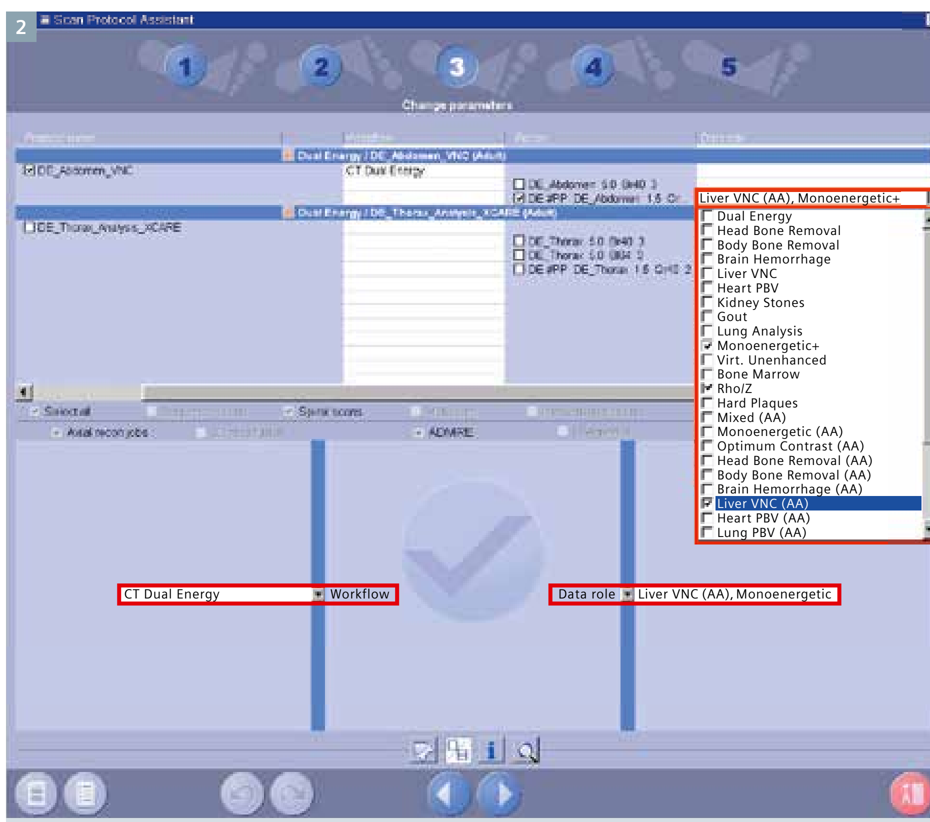
Dual Energy in combination with Rapid Results Technology enables the automatic creation of dual energy results without any user interaction in *syngo*.via. Results are transferred to the PACS system automatically as part of preprocessing.

1



1 *syngo*.via enables automated Lung CAD results to be created directly at the scanner.

2



2 Assigning data roles allows the Dual Energy workflow to calculate and create results directly at the scanner.

Assign data roles for automatic archiving via the Scan Protocol Assistant

If a scanner supports data role mapping and is connected to *syngo*.via, the Scan Protocol Assistant can be used to modify a scan protocol by assigning data roles to a series before the data are imported into *syngo*.via. This is how it works:
Open the Scan Protocol Assistant: Options > Configuration > Scan Protocol Assistant > Scan Protocols > *syngo*.via > Select protocol > Change parameter tab

Corresponding data roles need to be selected for those series to be used for Rapid Results (Fig. 2). The calculation will run for the series marked with the corresponding data roles (AA) in the Scan Protocol Assistant. ■

Available data roles for Dual Energy (*syngo*.via VB10)*:

- Mixed (AA)
- Monoenergetic (AA)
- Optimum Contrast (AA)
- Head Bone Removal (AA)
- Body Bone Removal (AA)
- Brain Hemorrhage incl. VNC & Iodine Map (AA)
- Liver VNC incl. VNC & Iodine Map (AA)
- Heart PBV incl. VNC & Iodine Map (AA)
- Lung PBV incl. VNC & Iodine Map (AA)
- Monoenergetic+ (AA)
- Virt. Unenhanced incl. VNC & Iodine Map (AA)
- Bone Marrow (AA)
- Rho/Z (Electron Density & Atomic Number) (AA)

[1] *syngo*.via can be used as a standalone device or together with a variety of *syngo*.via-based software options, which are medical devices in their own right. *syngo*.via and the *syngo*.via based software options are not commercially available in all countries. Due to regulatory reasons its future availability cannot be guaranteed. Please contact your local Siemens organization for further details.

*Automatically archived volumes will be labeled as such by the postfix "(Auto)" in the series description. Additionally, "Automatic Result" is displayed as an image comment.

Available on the latest Siemens CT scanners (SOMATOM Definition family with software version *syngo* CT 2011A or later) and from *syngo*.via VB10.

Dual Energy Clinical Workshop

By Axel Lorz, *Siemens Healthineers, Germany*

In keeping with tradition, Siemens Healthineers CT is maintaining a focus on continued clinical education in 2016. A specialist Dual Energy (DE) Workshop led by Ralph Bauer, MD, Professor of Radiology at the Kantonsspital St. Gallen, Switzerland, was held at the Siemens Healthineers headquarters in Forchheim/Erlangen in May. Over two days, experts from the R&D department explained the physical principles of single source and dual source dual energy imaging. A talk on parameter optimization in clinical scan protocols explained the influence of the voltage combination of both X-ray tubes, reconstruction kernels or the pitch. The advantages of the dose modulation program CARE Dose4D™ were also highlighted along with routine workflow issues, such as automatic transfer of DE data to PACS. Professor Bauer concluded the day with a scientific and clinical presentation of leading publications on dual energy. A welcome change to the intensive teaching sessions was provided by a tour of Siemens' computed tomography factory to show first-hand how CT systems and detectors are manufactured.

During his Dual Energy Workshop Professor Ralph Bauer, MD, Professor of Radiology at the Kantonsspital St. Gallen, Switzerland, focuses on DE applications in clinical routine.

On the second day, the focus was on interactive case readings of clinical datasets at *syngo*.via workstations. The impact of all the relevant DE applications, such as *syngo*.CT DE Lung Analysis, *syngo*.CT DE Virtual Unenhanced, *syngo*.CT DE Gout and *syngo*.CT DE Direct Angio was discussed in detail and participants were invited to explore the datasets independently. Thanks to the vast experience of Professor Bauer and the help of Siemens application specialists, participants were able to improve clinical practice skills while obtaining valuable insights into current and future developments. The workshop atmosphere was extremely open, relaxed, and constructive prompting lively discussions. ■

Upcoming Events & Congresses 2016/2017

Short Description	Date	Location	Title	Contact
Radiological Society of North America	November 27–December 2, 2016	Chicago, USA	RSNA	www.rsna.org
Arab Health	January 30 – February 2, 2017	Dubai, UAE	Arab Health	www.arabhealthonline.com
European Society of Radiology	March 1–5, 2017	Vienna, Austria	ECR	www.myesr.org
European Conference on Interventional Oncology	April 23–26, 2017	Bilbao, Spain	ECIO	www.ecio.org
Annual Meeting of the Association for European Pediatric and Congenital Cardiology	March 29–April 1, 2017	Lyon, France	AEPC	www.aepc2017.org
European Society for Radiotherapy & Oncology	May 5–9, 2017	Vienna, Austria	ESTRO	www.estro.org
Particle Therapy Co-Operative Group	May 8–13, 2017	Yokohama/Chiba, Japan	PTCOG	www.ptcog.ch
European Stroke Conference	May 24–26, 2017	Berlin, Germany	esc	www.eurostroke.eu
European Society of Pediatric Radiology	May 30–June 3, 2017	Davos, Switzerland	IPR	www.espr.org
American Society of Clinical Oncology	June 2–6, 2017	Chicago, USA	ASCO	www.am.asco.org
International Society for Computed Tomography	June 4–7, 2017	San Francisco, USA	ISCT	www.isct.org
Jahrestagung der Deutschen Gesellschaft für Radioonkologie	June 15–18, 2017	Berlin, Germany	DEGRO	www.degro.org
European Society of Thoracic Imaging	June 18–21, 2017	Boston, Massachusetts	ESTI	www.myesti.org
European Society of Gastrointestinal and Abdominal Radiology	June 20–23, 2017	Athens, Greece	ESGAR	www.esgar.org
Society of Cardiovascular Computed Tomography	July 6–9, 2017	Washington, USA	SCCT	www.scct.org
The American Association of Physicists in Medicine	July 30–August 3, 2017	Denver, USA	AAPM	www.aapm.org
European Society of Cardiology	August 26–30, 2017	Barcelona, Spain	ESC	www.escardio.org
European Society for Medical Oncology	September 8–12, 2017	Madrid, Spain	ESMO	www.esmo.org
American Society for Radiation Oncology	September 24–27, 2017	Boston, USA	ASTRO	www.astro.org
Annual Meeting of the Japanese Society for Therapeutic Radiology and Oncology	November 17–19, 2017	Tokyo, Japan	JASTRO	www.jastro.or.jp
Radiological Society of North America	November 26–December 1, 2017	Chicago, USA	RSNA	www.rsna.org

Clinical Workshops 2017

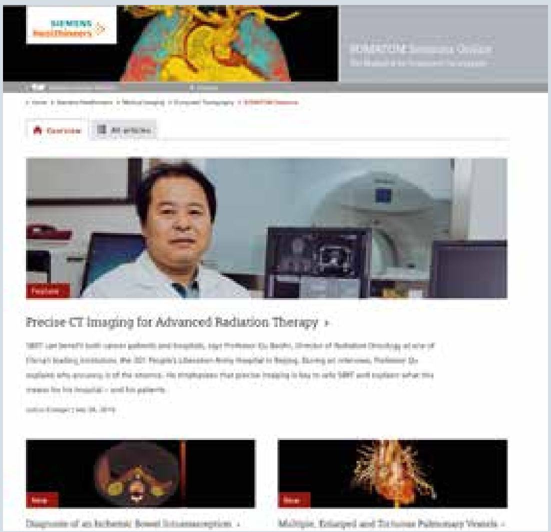
As a cooperation partner of many renowned hospitals, Siemens Healthineers offers continuing CT training programs. In a wide range of workshops, clinical experts share the latest experience and options in clinical CT imaging.

Workshop Title / Special Interest	Date	Location	Course Language	Organizer – Course Director	Link
Hands-on at the ESGAR Workshop / Colonography	December 14–16, 2016	Barcelona, Spain	English	ESGAR Professor Andrea Laghi, MD	www.esgar.org
Advanced Cardiovascular CT	May 23–26, 2017	Frimley, UK	English	Ed Nicol, MD Simon Padley, MD Sujal Desai, MD	www.imperial.ac.uk
Hands-on at the ESGAR Workshop / Colonography	May 10–12, 2017	Turin, Italy	English	ESGAR Daniele Regge, MD	www.esgar.org
Workshop on Dual Energy	May 18–19, 2017	Forchheim, Germany	English	Siemens Healthineers – Professor Ralf Bauer, MD	www.siemens.com/ SOMATOMEducate
Hands-on at the ESGAR Congress / Colonography	June 20–23, 2017	Athens, Greece	English	ESGAR	www.esgar.org
Hands-on at the ESC congress 2017	August 26–30, 2017	Barcelona, Spain	English	Siemens Healthineers	www.siemens.com/ESC
Hands-on at the ESGAR Workshop / Colonography	September 27–29, 2017	London, UK	English	ESGAR: S.A. Taylor, S. Halligan, A. Plumb	www.esgar.org
Workshop for Physicists	October 17–18, 2017	Forchheim, Germany	English	Siemens Healthineers	www.siemens.com/ SOMATOMEducate
Coronary CTA Interpretation Workshop	November 23–24, 2017	Erlangen, Germany	English	Siemens Healthineers – Professor Stephan Achenbach, MD	www.siemens.com/ SOMATOMEducate

In addition, you can always find the latest CT courses offered by Siemens Healthineers at
www.siemens.com/SOMATOMEducate

Siemens Healthineers Publications

Our publications offer the latest information and background for every healthcare field. From the hospital director to the radiological assistant – here, you can quickly find information relevant to your needs.



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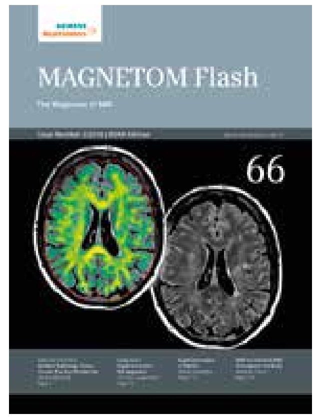

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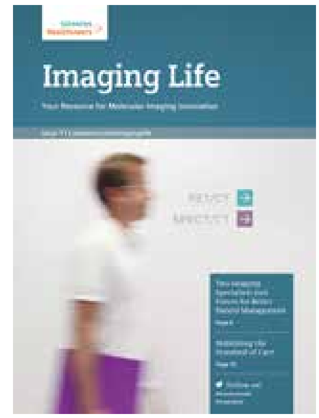
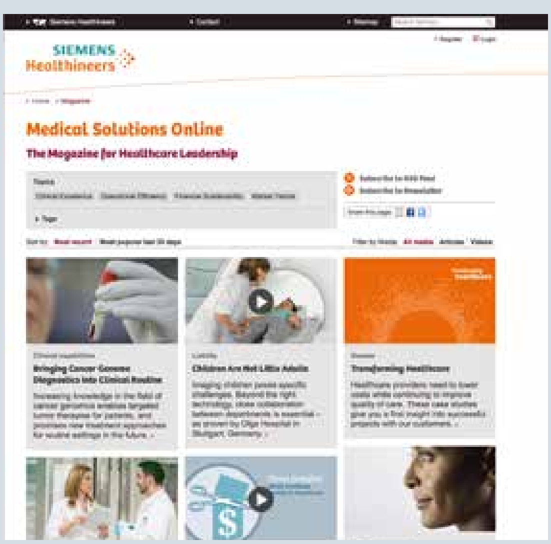
Everything from the world of magnetic resonance imaging.



Imaging Life
Everything from the world of molecular imaging innovations.



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