SOMATOM Sessions

The Magazine for Computed Tomography

The Radiology Conundrum – And How To Handle It

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SIEMENS Healthineers

"We literally work from head to toe, and we are using modern scanning technology for a lot of things we didn't before."

Lena Gordon-Murkes, MD,
Astrid Lindgren Children's Hospital,
Stockholm, Sweden

Dear reader,

Radiology is currently facing a greater number of challenges than ever before. When talking to you, our customers, we are acutely aware of the increasing significance of standardization and automization in delivering effective and efficient care along the entire patient journey. Moreover, there is a growing expectation that therapy will be personalized when possible along with a demand for improved patient experience. In order to achieve these goals, physicians rely on precise diagnostic image quality, and healthcare providers strive to satisfy the needs of both patients and medical personnel.

We embrace these challenges equally as our own. In ongoing dialogue with you, our customers, we listen to your needs so that we can best equip you for the future and jointly face what lies ahead. Our cover story, for example, deals with the difficult question of how to overcome the hurdles that exist in radiology today (page 6, Cover Story).

One particularly satisfying result of our collaboration with you was the development of our new SOMATOM go. platform last year. This success story continues. Discover in this issue how the SOMATOM go.Up and SOMATOM go. Now CT scanners are delivering results in daily clinical routine (page 18).

Our SOMATOM Sessions magazine continues to offer a platform for you to share experience and best practices with other colleagues. Read on page 22 how the Academic Medical Center in Amsterdam, Netherlands, took the patient perspective and put it at the heart of a novel room design for their polytrauma emergency center – bringing care to the patient and not the other way round.

An innovative concept at Astrid Lindgren Children's Hospital in Stockholm, Sweden, focuses on creating a stress-free environment for their little patients. Modern technologies and original animations are combined to make pediatric examinations easier for both children and their parents (page 26).

True Dual Energy CT offers a high level of diagnostic support. Processing the increased volume of data that this involves, however, presents a serious problem but one that can be successfully solved as the Duke University Medical Center in North Carolina shows (page 30).

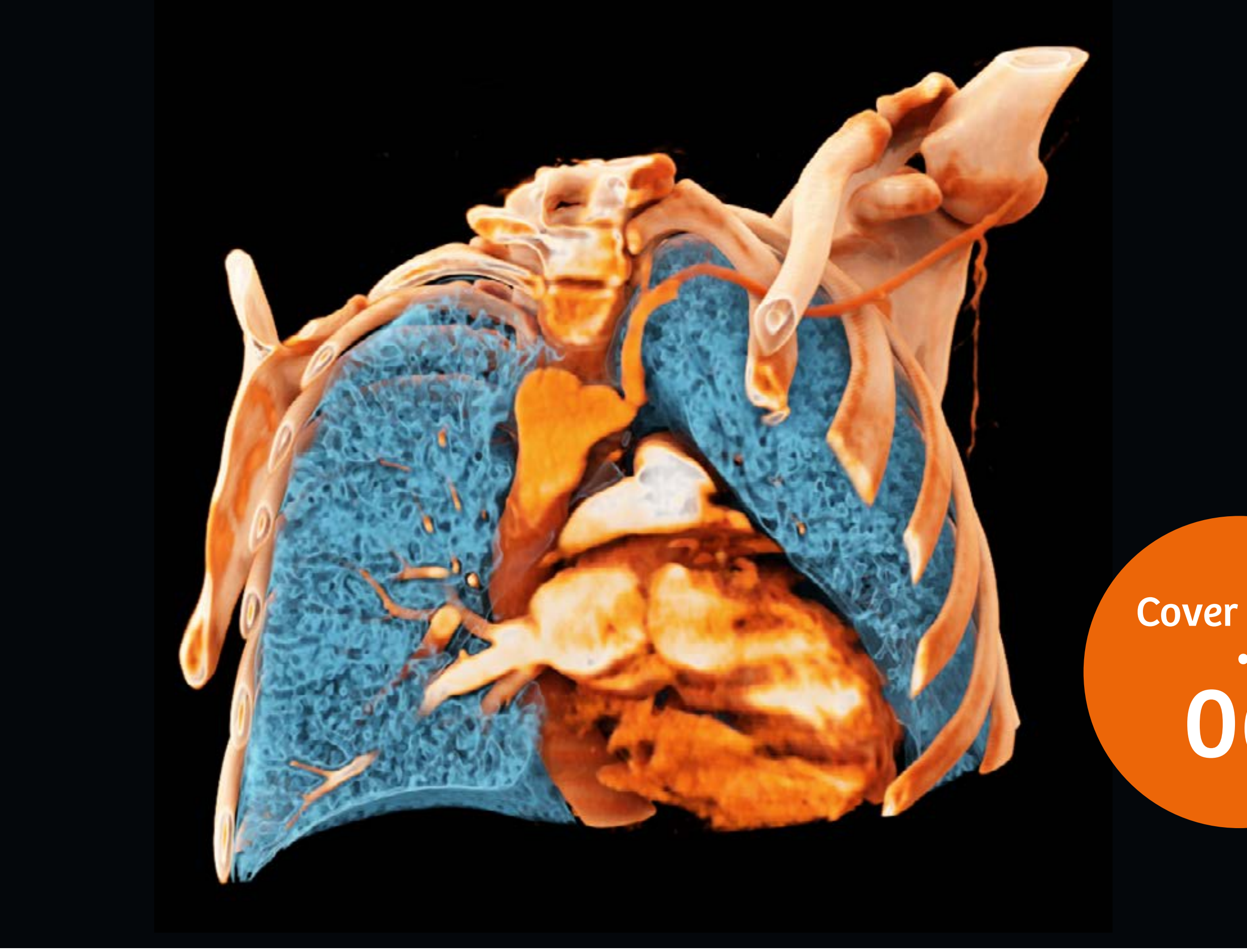
Hospitals in different surroundings have different needs. We report on page 34 how the very same concept can be implemented to meet the varying needs of two hospitals in Switzerland.

Dip into this latest issue of SOMATOM Sessions to learn more about these topics as well as other interesting developments, for instance how cinematic rendering is increasingly used as a tool for teaching and communication, news from teamplay, plus a variety of clinical cases.

Enjoy reading!

Christiane Bernhardt,
Vice President CT Marketing and Sales

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.



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A cinematic rendering image created on *syngo*.via Frontier shows a right-sided aortic arch with aberrant left subclavian artery from Kommerell's diverticulum. Read more on page 54.
Courtesy of KGS Advanced MR and CT Scan, Madurai, Tamil Nadu, India

The Radiology Conundrum – And How To Handle It

It is no secret: To tackle the countless challenges that modern radiology is facing, daily routines and processes along the whole radiological patient journey have to be far more standardized and automated than they currently are. The reward will be better image quality, higher patient and staff satisfaction, lower radiation doses, and more efficiency. So what steps are necessary to transform vision into reality? The technology is there. Just ask the radiologists what they need.

Text: Philipp Grätzel von Grätz | Photos: Siemens Healthineers

While countries and their healthcare systems may differ, the demands that radiologists are facing all over the world are strikingly similar. For instance, radiologists and technicians have to diagnose more and more patients. In Europe and the US, this is a result of higher imaging demand plus consolidation processes in times of tighter budgets. And in growing economies like, for example, India, it is the overall patient numbers that are driving the increased workload on radiologists and technicians.

Workloads on the rise, expectations, too

Statistics and scientific analyses support this point. According to OECD data, between 2005 and 2014–2016, the average number of CT examinations per 1,000 inhabitants per year has risen in the US from 195 to 254.[1] In Denmark, it went up from 56 to 162, in Germany from 90 to 144, and in Canada from 102 to 157. This was not accompanied by a proportional rise in the number of radiologists. On the contrary, it is becoming increasingly difficult to find qualified doctors and technicians.

Research from the US suggests that the number of individual images that a radiologist, in theory, has to look at per minute has risen more than fivefold from 3 to 16 since the turn of the century.[2] It's no wonder, then, that a survey conducted in the New England region of the US found that a staggering one third of radiology residents reported feelings of burnout. In fact, the radiology department of Brigham and Women's Hospital in Boston has already created a wellness committee to lessen the risk of burnout and depression among staff.[3,4]

The challenges that modern radiology faces are not limited to increasing workload and the shortage of qualified labor. There is also a growing demand to keep up with quality standards and to document proper performance. Pressure is built up through reimbursement or legislation, or both. Two examples: In the US, there are serious efforts, for example with Medicare's Value-Based Payment Program, to shift the healthcare system from volume-based towards value-based reimbursement. And in Germany, a new radiation protection law came into effect in June 2017. It features, for the first time, a reporting obligation for radiological institutions when certain dose limits are exceeded.[5]

A case of cognitive dissonance

Digitization is a challenge for radiology, too. Although experts agree that artificial intelligence (AI) and big data analytics will not replace radiologists any time soon, there is some concern. In a recent interview at the European Congress of Radiology 2017, former ESR president Lluís Donoso of Hospital Clinic Barcelona recommended opening up radiological departments in the face of digitization.[6] "Radiologists," he said, "should become more active in multidisciplinary teams and more visible on clinical wards." This echoes the European Action Plan for Medical Imaging that the ESR published three years ago. It not only calls for better quality and safety, but also for more interaction with other medical providers – and with the patients.[7]

Most radiologists would probably agree with what Donoso and the ESR recommend. But the reality is different. For organizational and financial reasons, radiological departments are having difficulties shifting their discipline towards patient-centered care. A recent survey showed this very clearly. The researchers diagnose a severe disconnect between what radiology leadership espouses and what radiological departments currently practice. So here is the radiology conundrum: On the one hand, radiologists are acutely aware of how radiology should evolve to keep its position at the center of care. On the other hand, the actual efforts to get there are somewhat limited. Radiology, to give a diagnosis, seems to be suffering from cognitive dissonance.[8]

What radiologists want

Is that inevitable? No. If you ask radiologists and technicians, they know what to do. In essence, it's all about workflows and standards. Radiologists won't – or rather cannot – compromise on quality and safety. So they will explain that they want tools and processes to ensure high diagnostic quality and high degree of safety for every patient, the lean and the obese, the old and the young, the relaxed and the agitated. They want quality and safety to be constant

Stay close to the patient without interruptions to the workflow with touch panel tablets.

New Mobile Workflow – A whole new way to operate the scanner

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- Keep a close eye on the patient with the integrated camera[1]
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in every situation, during the week, when experienced staff are available, as well as at the weekend, when younger doctors or less experienced technicians are on duty.

Radiologists also want fast and efficient workflows in order to avoid unnecessary delays to patient care. This will improve patient satisfaction and satisfy hospital management. At the same time, it will give the imaging centers more time to address the challenges they are confronted with. In Madurai, India, the radiologist K.G. Srinivasan has gained time by switching to a new CT platform, and he is investing that time in teleradiology and CT-guided invasive procedures.

Step one: Improve patient preparation

The good news is: The deficits in CT workflows that need to be addressed to increase efficiency, to make CT imaging more independent of the individual technicians' skill level, to reduce radiation dose, and to provide less fluctuations in image quality, are all well known. Let us start with patient preparation: It takes too long, in general, and it can be fairly cumbersome, since the technician has to go into the examination room, position the patient, then go back to the control room, select the program, and then sometimes reposition the patient. If a patient needs a series of examinations over a certain period of time, all positioning and programming has to be done again, and again, and again.

In an age of mobile communication and real-time surveillance, this could be much easier. A technician could be next to the patient and use a mobile device or a touch panel to

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

FAST Integrated Workflow[1]

- Automated patient positioning workflow powered by world's first FAST 3D Camera[1]
- Unique technology with smart algorithms bring a high-end workflow to high-end scanners
- The new FAST Integrated Workflow[1] is a seamless combination of FAST 3D Camera,[1] touch panels, and advanced applications
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Always keep the patient in view with the ceiling-mounted FAST 3D Camera.[1]

choose programs and adjust the settings. This would save time and increase patient satisfaction. Much of the positioning and parameter settings could be automated, which would allow less experienced technicians to take responsibility earlier and may reduce the likelihood of imaging errors due to lack of experience.

Automation could be based on the examination type, of course, but also on individual patient characteristics. It would be ideal if there was a tool that could be used to check the patient's position and measure individual body shape, including the abdominal height, to select optimal protocol settings and the correct scan range. This is not only about convenience: Research has shown that up to 95% of patients are not positioned accurately in the gantry isocenter.[9]

Step two: Optimize image acquisition

Next: Image acquisition. A lot can go wrong here. The amount of contrast media could be too high or too low; the radiation dose could be inappropriate; motion artifacts might occur; or image quality may not be sufficient. Whatever the problem, the result is unpleasant: An image might have to be retaken; results could be inconsistent in serial examinations; radiation dose statistics might be spoiled; or examinations turn out to be unexpectedly long.

None of this is inevitable. If examination protocols could become more standardised, not just in routine examinations but also in more advanced procedures such as cardiac imaging, this could limit the likelihood of operator-dependent imaging errors. Automated selection of tools like special filters and low kV tuning tools could help achieve optimal dosing, especially when a system is used that is technically prepared to enable a high number of dose permutations. (Read more on page 70)

Connectivity, too, comes into play here: If scanners and workstations are properly connected, it is possible to transfer proven and tested protocols between systems and thus standardize quality and dose across different scanners or scanning units. Not rocket science, again, but not every CT solution out there features this kind of connectivity. In CT imaging, single-scanner islands remain the standard geography in many places. (Read more on page 12)

Step three: Streamline postprocessing

Finally, image processing. Lengthy and cumbersome image processing is among the most important causes of reduced efficiency in radiology. Fast and reliable postprocessing tools can reduce the time a patient is on the system, and thus increase the number of patients diagnosed. A common user interface reduces the risk of error and, again, the time to operate. Dual Energy CT imaging is an area where much can be achieved through better postprocessing. Without remote workstations and with direct reporting, Dual Energy imaging would be less restricted to research scenarios and far more accessible for routine care.

So, here's the bottom line, or the finish: Yes, CT imaging can be standardized even more. And it should be – if consistent quality, low radiation dose, high throughput, and improved patient experience are the goals to aim for. Implementing workflow features like the ones above is not impossible, but so far it has not been done as widely as it could be. The reason is probably that progress in CT imaging has been driven by technological leaps forward in recent years. But important as the technology is – the patient perspective and the user perspective should not be forgotten. ●

GO technologies

- **Comprehensive workflow automation to fully focus on patients**
- **Guidance through all procedures and zero-click postprocessing**
- **Dose-neutral Dual Energy[1] imaging integrated in clinical routine with automated, ready-to-read postprocessed results**
- **Check&GO helps to optimize coverage and achieve the right contrast distribution and timing**

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

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[1] The product is pending 510(k) clearance, and is not yet commercially available in the U.S.
syngo.via Frontier is a research platform and not intended for clinical use.

Simplifying the Protocol Management Process

Optimized CT protocols are essential to achieving high image quality at low doses. Protocol setting errors can lead to unnecessarily high doses or even to damage from radiation. Scan protocols should therefore be standardized where possible and constantly reviewed. This is textbook knowledge for any radiologist – but monitoring and managing CT protocols, especially at a large institution or IDN, can be an extremely unwieldy task.

By Philipp Braune

Consider the following: Every CT scanner has about 150 preinstalled protocols. A protocol can easily consist of three to four scans. Each scan usually includes at least three reconstruction jobs: Thin and thick slices, bone and a soft-tissue window reconstruction, with numerous auto-transfer rules. This quickly adds up to 1,000 different scan and recon definitions or more for every scanner – as experienced CT users well know. Multiply this by the number of scanners at an institution and you will quickly grasp the complexity of protocol settings. Now, add all the individual variations established by the users over time.[1] The result is a highly confusing jungle of protocol variations with a thick, almost impenetrable undergrowth of altered settings that makes protocol management difficult and time-consuming. Still, this job is essential and recent studies have shown that greater standardization of protocols is urgently needed.[2]

Manual, local, uncommented?

Protocol standardization is especially frustrating when attempted without the right equipment to support the necessary workflow steps: Maintaining an accurate set of master protocols, retrieving protocols from the scanners, comparing scanner protocols with master protocols, reviewing the differences between the scanner and master protocols, and, finally, updating the scanner protocols and perhaps also the master protocols. If all this needs to be done manually, the process is extremely labor-intensive. Add to this the unproductive hours spent travelling from site to site if standardization cannot be managed remotely. Manual protocol standardization is not just labor-intensive and costly, however; it is also error-prone and can result in decreased image quality or increased dose if inadvertent or unauthorized protocol changes are overlooked or not

"teamplay Protocols provides centralized access to my scanner protocols, virtually anytime and anywhere. It also reduces my travel time, which I can invest in protocol standardization."

Alexander Klemm, PhD
radprax Gesellschaft für Medizinische Versorgungszentren mbH, Wuppertal, Germany

correctly reviewed. Yet another problem is the lack of documentation: There is typically no record of what exactly has been changed, by whom, and why.

Streamlining standardization

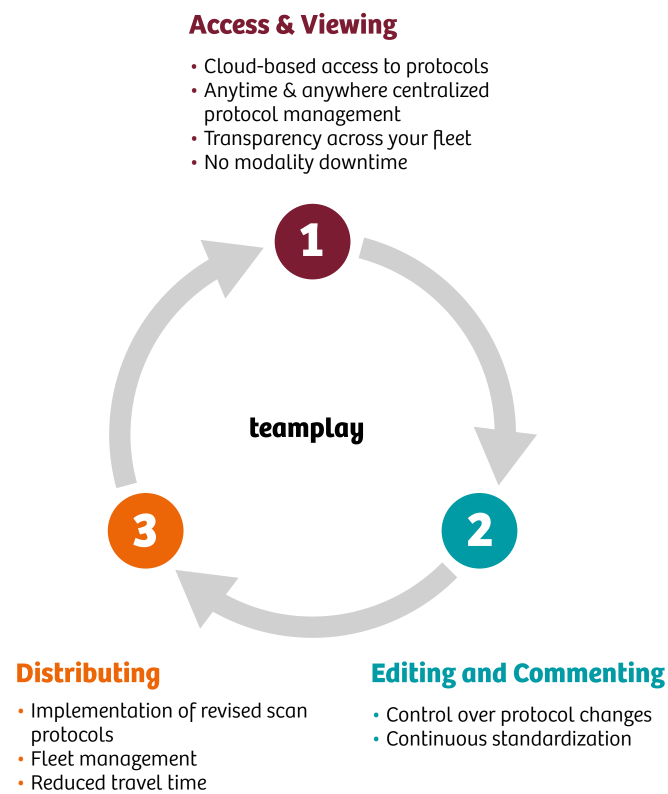
A protocol management system that automatically keeps a close eye on all protocols across a practice, clinic, or even group of institutions can minimize both the hassle and the potential for dangerous mistakes. With teamplay Protocols,[1] Siemens Healthineers introduces a solution that helps simplify the CT protocol process as part of the cloud-based teamplay network. This application automatically retrieves protocols from all connected scanners[2] within an institution and allows all protocols to be viewed in one place and analyzed in detail. This facilitates the comparison and alignment of protocols and – since teamplay Dose also automatically reports unusually high dose values – the underlying protocols of dose outliers can even be scrutinized for errors. Did the high dose originate in a special scan situation – for example, due to exceptional patient size – or was it caused by a flawed protocol? Changes to protocols are also recorded in the version history, which makes it easy to keep track of recent protocol improvements and to reverse inadvertent changes.

teamplay Protocols[1] allows master protocols to be installed remotely throughout an institution on all compatible scanners.[2] Entire protocol trees can be distributed remotely to ensure that scanners perform identically. It is also possible to add comments to protocols for later reference, and distribute master protocols with accompanying notes from a central workstation.

Fast track to optimized protocols

The advantages of systematic protocol management are immediately apparent: Consistent results, lower dose levels, and cost-saving processes. All of these are especially important for clinics, hospital groups, and integrated delivery networks. Moreover, individual practices and their patients will also see significant benefits from the implementation of optimized protocols. In short, teamplay Protocols helps improve image quality, reduce dose, and increase diagnostic confidence.[2] Looking forward, an exciting possibility for the future may be a protocol exchange across institutions that will allow radiologists to share protocols with colleagues and compare their settings and values with benchmark protocols from all over the world. The journey toward optimized protocol management with teamplay continues.

Protocol management cycle with teamplay



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[1] A recent study focusing exclusively on abdomen and pelvis protocols detected 309 modified protocols on two scanners within a 24-week trial period. About one-quarter of these modified protocols were determined to contain erroneous protocol parameter modifications (Grimes J, Leng S, Zhang Y, Vrieze T, McCollough C. J Appl Clin Med Phys. 2016; 17: 523-533.

[2] Guite et al. found that up to 50 percent of the abdomen protocols in the U.S. do not follow the criteria defined by the American College of Radiology (Guite K M et al. J Am Coll Radiol. 2011; 11: 756-61). Boland, Duszak, and Kalra identified that protocols for the same kind of scan also often vary significantly between different departments in the same clinic. These protocol variations result in dose levels that can exceed the standard dose by 200 to 300 percent (Boland G W, Duszak R Jr, MD, Kalra M. J Am Coll Radiol. 2014; 11: 440-441).

[1] teamplay Protocols supports selected Siemens scanners. Please contact a Siemens representative for details.

[2] Sharing protocols is only possible between scanners of the same type. Software versions of the distributing and receiving scanners must be identical. Otherwise, the receiving scanner needs to have a more recent software version installed.

Cinematic Rendering in Medical Imaging

Cinematic rendering is an innovative visualization technique that brings 3D depth to medical imaging. Photorealistic depictions make communication with patients and procedural planning or follow-up much easier.

By Lisa Hyna and Jesús Fernández León, Siemens Healthineers, Germany

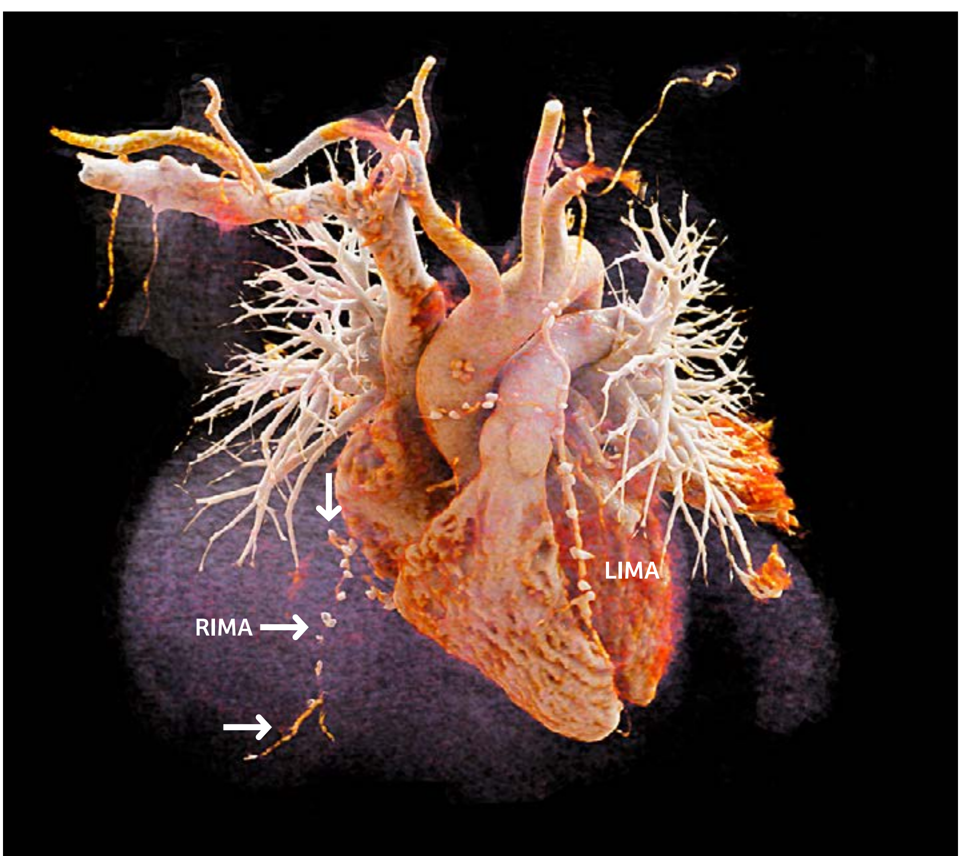


Figure 1: Three-dimensional cinematic rendering shows patent reverse right internal mammary artery (RIMA)/right coronary artery (RCA) graft (see arrows). Left internal mammary artery (LIMA)/left anterior descending (LAD), and vein to diagonal (Dg) graft were patent.

The novel cinematic rendering technique improved the 3D plasticity aspect of small vessels and bypass grafts. This aided both surgical procedure planning along with postoperative control and visualization of graft patency.
Courtesy of the Medical University of Innsbruck, Austria

A recent white paper presents a novel visualization technique known as "cinematic rendering". Authors Gudrun Feuchtner, MD (Department of Radiology, Innsbruck Medical University, Austria), Hatem Alkadhi, MD (Institute of Diagnostic and Interventional Radiology, University Hospital Zurich, Switzerland), Stéphane Rusek, PhD (Cardio-Thoracic Center of Monaco, Monaco) together with Siemens Healthineers provide technological background and review the visualization benefits in several applications and body regions. The cases presented show how cinematic rendering can be useful for planning cardiac, vascular, and trauma surgery or follow-ups. The new imaging technique can also be used to provide referrers with more detailed 3D insights into the topography of more complex fractures.

Hollywood-inspired imaging adds 3D depth

Traditional volume rendering is a standard technique used for preoperative planning and follow-up imaging. It is based on geometrical modelling of the light to give an artificial impression of the anatomies depicted. Inspired by the movie industry, Siemens Healthineers has developed the new physically based volume rendering method to create highly realistic images. For the first time, photorealistic visualizations of the anatomy can be generated based on CT as well as MRI scans – in real time and with minimal user interaction. Compared with conventional volume renderings, cinematic rendering offers improved spatial resolution and image quality by mimicking the electromagnetic nature of light and its interaction with objects. As a result, shadows, shapes, and depth can be visualized making the images easier to grasp for the viewer. Cinematic rendering is optionally available on *syngo*.via VB20.

Photorealistic anatomical views

Both cases from the white paper show that high-contrast structures and soft tissue can be depicted with high quality using cinematic rendering. This helps not only radiologists and referrers but also patients to better understand anatomy and disease based on the photorealistic images. It also avoids the need for the physician to give a full verbal description of anatomy, specific organs, and disease etiology.

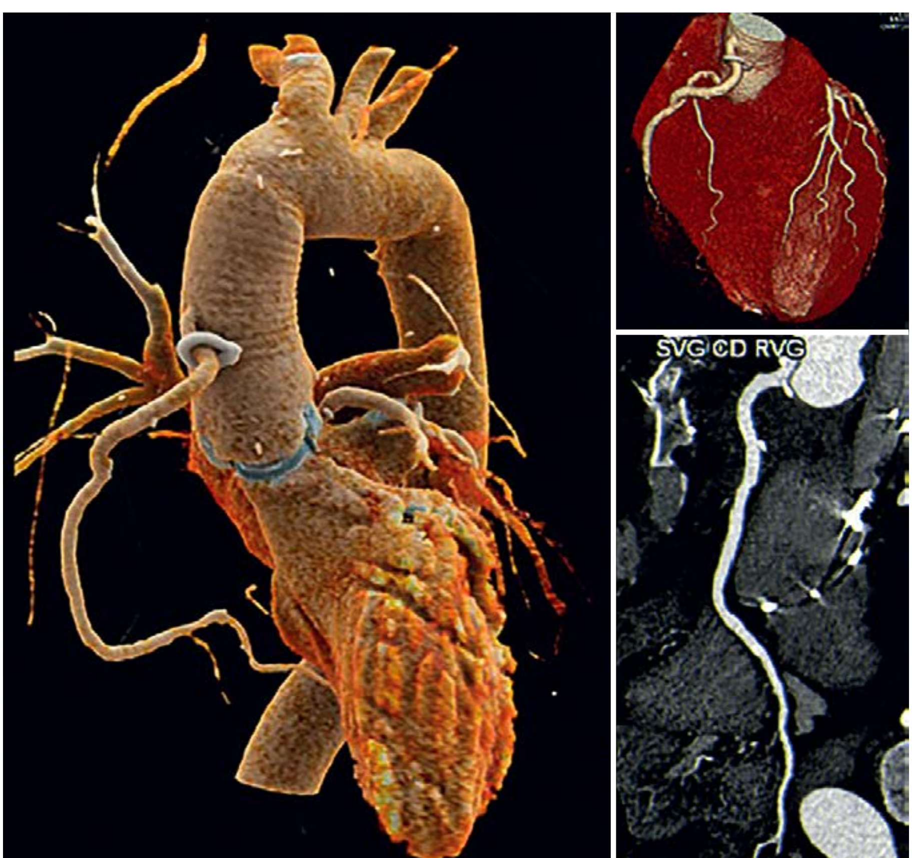


Figure 2: Cinematic rendering shows replacement of the aortic root with implantation of the coronary ostia and an aortic valvular replacement with a bioprosthesis.

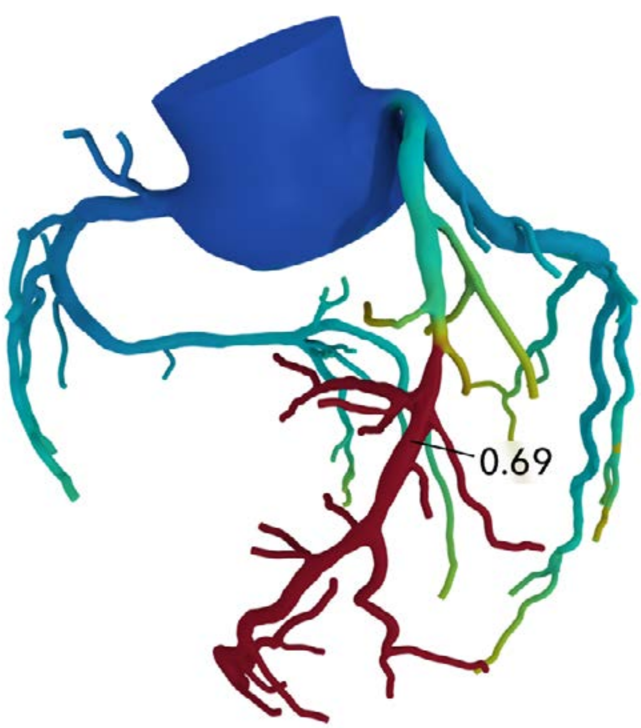
The novel visualization technique improved the natural 3D aspect of the anatomy, e.g., by visualizing the aorta or other vessels with the shadows that other surrounding structures cast. This gives a better understanding of the depth and relation between these vessels and the surrounding tissue than previously possible using traditional volume rendering techniques.
Courtesy of Monaco Cardio-Thoracic Center of Monaco, Monaco

Further Information
siemens.com/syngo.via-applications

Improving Clinical Decision-making in Coronary Artery Disease

Until now there have been two imaging gold standards for evaluating the functional relevance of coronary lesions – invasive measurement of FFR and cardiac MRI. A third method is on its way into the clinical setting – noninvasive FFR based on cCTA.

By Wiebke Kathmann, PhD



A HeartFlow FFR_{CT} showing reduced coronary blood flow in the LAD caused by a stenosis. The system offers a virtual FFR number that has a proven correlation with invasive, catheter-based FFR. (Courtesy of HeartFlow)

The optimal test for patients with suspected stable coronary artery disease (CAD) would not only be noninvasive but it would also be able to describe both the coronary anatomy and the functional impact of focal lesions. Coronary CT angiography (cCTA) in combination with a noninvasive cCTA-derived fractional flow reserve (FFR_{CT}) does just that. When applied to patients with an intermediate pretest likelihood of an intermediate lesion, this approach has a better diagnostic performance in defining or excluding lesions that cause ischemia, than cCTA alone or other noninvasive or invasive tests.

The clinical value of a noninvasive determination of FFR from high quality cCTA is generally acknowledged, as it applies virtual blood flow simulation to an existing cCTA dataset. Its accuracy – when performed with the only commercially available method, HeartFlow FFR_{CT} Analysis – has been proven in several clinical studies.[1–3] They demonstrated a high diagnostic accuracy of FFR_{CT} in more than 600 patients with suspected CAD, all of them undergoing cCTA, invasive coronary angiography (ICA), invasive FFR measurement, and FFR_{CT}. Hemodynamically significant stenoses could be discriminated with a high per-vessel sensitivity and specificity versus the current gold standard of invasive FFR. Additionally, the diagnostic accuracy and discrimination of ischemia was improved compared with cCTA alone.

Impact on patient triaging

As shown recently in a multicenter prospective setting, using an FFR$_{CT}$-guided strategy greatly reduces unnecessary invasive angiograms, compared with the standard approach. It helps clinicians to direct patients to the treatment most appropriate for them.[4] In the cohort of patients with planned invasive coronary angiograms (ICA), applying an FFR$_{CT}$- guided strategy helped to appropriately identify patients who would benefit from revascularization. ICAs showing no obstructive CAD were reduced by 83 percent. In 61 percent of cases, the invasive angiograms were no longer deemed necessary. Furthermore, there were no adverse clinical events in the subsequent year indicating long-term reliability. Finally, the number of revascularizations was similar when compared with the standard approach.[4]

Moreover, in a real world setting including patients with suspected CAD and low to intermediate pretest risk of significant coronary stenosis, frontline cCTA with selective FFR$_{CT}$ testing lead to a high rate of safe cancellations of planned ICAs, when using a high-end scanner, in this case SOMATOM Definition Flash or SOMATOM Force.[5]

Importance of high image quality

Since the early days of the HeartFlow FFR$_{CT}$ Analysis, emphasis has been placed on high quality imaging [6] as the coronary tree has to be segmented from the cCTA dataset. The higher the image precision, the better the flow simulation in the area of a lesion.

The requirements are in accordance with those of the Society of Coronary Computed Tomography (SCCT) and the National Institute for Health and Care Excellence (NICE) in the United Kingdom (UK) regarding the cCTA acquisition performance.[7]

Advantage in daily practice

Overall, there are good arguments for using an FFR$_{CT}$-guided strategy in stable, recent onset chest pain patients. This noninvasive approach has the potential to reduce the number of other noninvasive functional and imaging tests. It spares patients unnecessary ICAs and radiation. As for the physician, it improves clinical decision-making regarding revascularization and has the potential to reduce cost of care by avoiding inconclusive or inaccurate diagnostic tests, unnecessary ICAs, and by reducing the need for high-cost invasive procedure suites with low patient turnaround.[7]

Siemens Healthineers cardiac CT – excellent image quality for FFR$_{CT}$

- Unprecedented native temporal resolution
- Reduced cardiac motion even for high and irregular heart rates
- High spatial resolution for enhancement of coronary vessel delineation
- Image quality that leads to early high acceptance rates of FFR$_{CT}$

Integrated solution for optimized workflow

Today, Siemens Healthineers and HeartFlow Inc. are working together to bring industry-leading high-end CT technology from Siemens Healthineers and HeartFlow's noninvasive FFR assessment platform to patients and clinicians across the world. The goal is to provide customers with easy access, thereby supporting healthcare providers in developing integrated, noninvasive care solutions for improved management of CAD patients. Although the U.S. is the initial commercial focus of this collaboration, both companies plan to expand their efforts to other markets in the future. ●

Wiebke Kathmann, PhD, is a frequent contributor to medical magazines. She holds a Master's degree in Biology and a PhD in Theoretical Medicine. She is based in Karlsruhe, Germany.

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Challenges Addressed in India and Portugal

Radiological departments all over the world are struggling to meet demands for better quality, lower dose, more interdisciplinary engagement, and closer patient contact. In theory, all this is more than welcomed by radiologists, but it can be hard to make ends meet when patient numbers are rising and qualified staff are difficult to find.

Text: Philipp Grätzel von Grätz, Swati Prasad, Manuel Meyer | Photos: Arush Mayank and João Pedro Marnoto

Two radiologists. Two medical institutions some 9,000 kilometers apart. Two totally different sets of challenges. Isabel Ramos, Head of Radiology at Centro Hospitalar São João in Porto in Northern Portugal, is trying to cope with the legacy of the financial crisis that has hit Portugal – and its healthcare system – more profoundly than other places in aging Europe. Far away, in Madurai, India, K.G. Srinivasan, Managing Director of KGS Scan Centre, is trying to keep pace with the imaging needs of a fast-growing country with a demography that is heavily skewed toward the young, and with a rapidly-expanding healthcare system. According to projections by the India Brand Equity Foundation, the Indian healthcare system will need about 700,000 new hospital beds within the next few years.[1]

Interestingly enough, different as India and Portugal might be on the macro level, differences tend to diminish on the micro level of a radiological department. In Portugal, where healthcare expenditure per capita according to OECD figures has barely risen between 2005 and 2014,[2] it has become very difficult for department heads like Isabel Ramos to find qualified technicians and radiologists to take care of the patients. Patient numbers might not be rising overall but, thanks to austerity politics, they are rising for individual institutions. In India, with its massively increasing patient numbers, radiologists and technicians are available, but they tend to cluster in the metropolises. Colleagues like K.G. Srinivasan in Madurai, which is a Tier II city, on the other hand, struggle to cope with their patient load.

Both institutions needed equipment to help them do their jobs. And they found it. These days, Centro Hospitalar São João in Porto can do up to 50 instead of ten to 12 examinations per day. And KGS Scan Centre in Madurai is now completing eight to ten cases an hour, nearly twice as many than before. While K.G. Srinivasan is investing the time gained into expanding his business with more teleradiology and more CT-guided interventions for instance, the hospital-based radiologists in Porto are happy to have more time for interdisciplinary work and to save contrast agent and radiation dose. In short: Challenges are being addressed.

Philipp Grätzel von Grätz,
medical writer based in Berlin, Germany

The KGS Scan Centre led by K.G. Srinivasan, MD (left), in Madurai is open nearly 16 hours a day and provides scans for over 200 patients.

Scanning India

With the advent of faster and more efficient diagnostic methods, imaging centers in India are playing a crucial role in both diagnosis and treatment.

It's midnight in Madurai, a bustling city in South India. Just as K.G. Srinivasan, MD, and managing director of the renowned KGS Scan Centre, warms up for our interview, a 35-year woman is brought into the imaging room. Given the heavy demand, emergency patients prefer to come in late. The two KGS centers in Madurai are open nearly 16 hours a day and provide scans for over 200 patients.

Srinivasan excuses himself to attend to the patient, suspected to be suffering from pyelonephritis, a condition where the kidney is inflamed due to a bacterial infection. The scan shows enlargement around the kidneys. Srinivasan diagnoses lobar nephronia, an intermediate stage between acute pyelonephritis and renal abscess, and the patient is put on antibiotics by her urologist.

As Srinivasan gets back to the interview, he explains the changing role of radiology: "Due to the advent of advanced systems, radiology centers have become the new emergency rooms," he says.

Burgeoning patient load

For its population of over 1.3 billion, India lags behind in primary healthcare. As a result, most people in rural India come to cities for diagnosis and treatment. Furthermore, India faces challenges like a low doctor-patient ratio. According to the Medical Council of India (MCI), India has a doctor-patient ratio of 1:1,674 against the WHO norm of 1:1,000.[1]

To make matters worse, health insurance covers only around 30 percent of India's population.[3] And in 2014, India had 0.5 beds per 1,000 population – amongst the lowest in the world.[4] The corresponding figures for China, the U.S., and Germany were 3.6, 2.8 and 8.2 respectively.

Rising incomes and changing lifestyles are increasing the incidence of lifestyle diseases like diabetes, heart diseases, and cancer. Speedier, more affordable, and accurate diagnosis has therefore become vital in saving precious lives.

The scan center in Madurai was amongst the first in the world to purchase a SOMATOM go.Now 32-slice CT scanner. "This new system scans a lot faster," says Srinivasan. Since it enables a mobile workflow via tablet, the staff do not have to shuttle between the control room and the scanner, and can stay with the patient. The shorter gantry may help to reduce claustrophobia, while the advanced iterative reconstruction delivers good image quality at very low doses.

Faster scans, faster workflow

Since the new workhorse at KGS is nearly 30 percent faster than its predecessor, Srinivasan has more time at hand, which he devotes to teleradiology and CT-guided interventions.

"In one hour, we are able to complete eight to ten cases, as against five to six cases previously," says Srinivasan.

Since there is a shortage of trained staff, the automated postprocessing function helps a great deal. "You get the same quality, irrespective of who is doing the scan," explains Srinivasan.

Using CT for guided interventions

While people from all economic classes come to KGS, around 90 percent of patients pay out-of-pocket. Given this scenario, a minimally invasive CT image-guided intervention by radiologists comes as a blessing. The patient saves the expense of stay and surgery at a hospital, and gets treated in a single day.

Today, nearly 100 doctors spread across Madurai refer their patients to Srinivasan for biopsies and guided interventions. The latter often involve areas around vital organs, and Srinivasan is amongst the few radiologists in India who attempt such interventions.

While CT-guided interventions of this nature are yet to catch on, Srinivasan feels advanced machines have changed the very role of a radiologist. "Today, many medical students want to take up radiology," he adds. ●

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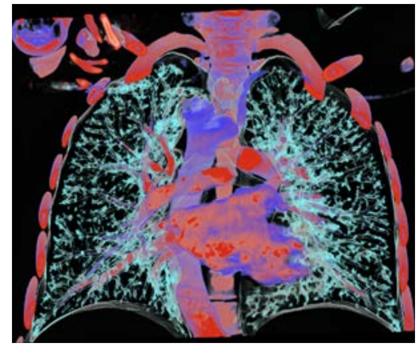


A VRT image shows a right-sided aortic arch with the thoracic aorta descending along the right side of the spine, and an aberrant left subclavian artery rising from the Kommerell's diverticulum – please read the details in the case report on page 54. *Courtesy of KGS Advanced CT and MRI Scan Centre, Madurai, Tamil Nadu, India*

A Sure Way out of the Crisis in Portugal

Even after the economic crisis, Portugal's hospitals continue to struggle with budget cuts and staff shortages. Still, the radiology unit at São João University Hospital has managed to improve the quality of the medical care it provides.

The radiology team of Centro Hospitalar São João loves their SOMATOM go.Up as it helped them to gain access to high-performance technology.

Carla Pinto goes toward the waiting room of the radiology unit Centro Hospitalar São João in Porto. The name of the next patient appears automatically on the X-ray technician's tablet, which is networked with the CT scanner.

There's hardly a free seat left in the waiting room. The university hospital in the north of Portugal is one of the best-known medical establishments in the whole country. But in recent years that has become a problem. Portugal is recovering from the severe economic downturn only slowly. And its healthcare system still bears the scars left by the crisis and the government's radical austerity measures.

The university hospital's radiology unit has had to save money, too. Its scanning equipment was last renewed in 2005. There's also a lack of radiologists, says Isabel Ramos, head of department. But patients don't really notice this shortage.

CT radiographer Carla Pinto explains why: "Our new scanner platform does image postprocessing with Recon&GO automatically. This gives me time to prepare for the next patient's examination without having to rush."

Faster, simpler, and more efficient

She says she gains a huge amount of time this way: "Postprocessing used to take me up to fifteen minutes. With the new system the workflows are much quicker, more automated, and straightforward. While I used to get through 12 examinations a day, now I can scan up to 50 patients," says Pinto.

Accelerated, more efficient workflows were precisely what the radiology unit was hoping for when it acquired the innovative SOMATOM go.Up CT scanner at the end of 2016. Isabel Ramos explains: "Our patient numbers are increasing by ten percent a year. Last year alone we did 370,000 examinations. With the old equipment and limited personnel, that was almost impossible to manage without a detrimental effect on the comfort of staff and patients."

Safe, economical, and high quality

The new scanner platform has also enabled the radiology unit to boost quality in medical terms. "The diagnostic quality of the new CT scanner is fantastic," says radiologist Rui Cunha. Another advantage: "The new platform saves us radiologists a huge amount of time. Because the automated scan protocol includes all scan areas as standard, we no longer have to explain to the technicians in advance precisely what images we're going to need."

Thanks to fast image post-processing with Recon&GO, Carla Pinto can now scan more patients.

Radiologist Antonio Madureira adds: "With the new scanner's Stellar detector, low tube voltages, and Tin Filters, we can work at very low doses and still get high-quality images. As well as boosting the medical quality and the safety of patients and staff, this saves us costs as we use less contrast medium."

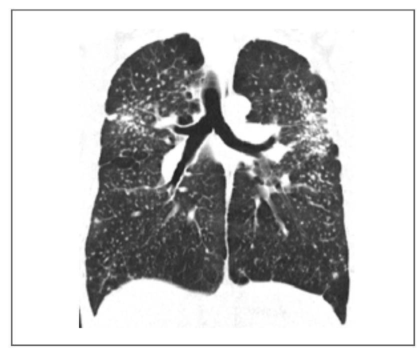
Close to patients

Carla Pinto emphasizes the completely new way of working that is made possible thanks to the new technology, saying that this benefits patients in particular. What impresses her most besides the innovative single room concept is the system's tablet control.

"I used to be permanently flitting between the scanner and control rooms. Now that I can carry the tablet with me to access scan functions, I move around much more freely and spend more time with the patient," explains Pinto. She says this is particularly important with children and others who are anxious.

"The fact that I'm right there with them is comforting for patients. They feel more at ease, which means they don't move around as much and the images turn out better." ●

Manuel Meyer reports from Spain and Portugal for the German medical newspaper ÄrzteZeitung.



A coronal MPR image in lung window depicts the predominance of nodules in the upper and posterior zones of lungs, coalescing to form masses – read more in the case report on page 52.
Courtesy of Centro Hospitalar de S. João, Porto, Portugal

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[2] https://www.oecd.org/els/health-systems/Health-at-a-Glance-Europe-2016-CHARTSET.pdf

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Ludo F. M. Beenen, MD, (left) and Jan S. K. Luitse, MD, (right) behind the sliding gantry CT that can move between two rooms.

Bringing Healthcare to the Patient

The Academic Medical Center (AMC) in Amsterdam, the Netherlands, is one of the highest performing and most prominent polytrauma emergency centers in the world. The emergency department is designed entirely from the patient's perspective. It is a novel approach where care is brought to the patient, not the other way around.

Text: Erika Claessens | Photos: Michel De Groot

The Academic Medical Center (AMC) in the South-East quarter of Amsterdam feels like an indoor mini city. There are all kind of shops, several restaurants offering healthy food and beverages, a conference space, and comfortable lounges within reach. In the Emergency Department (ED), the colors, texture and art pieces covering entire walls are unusual as well. "This design and architecture confirms our growing belief that patient care is entirely determined by the patient's perspective," states Jan S. K. Luitse, MD, recently retired trauma surgeon and Head of the ED. "This part of the hospital building has been completely restructured and we only re-opened it half a year ago. It's the final phase in a long and breathtaking process of changes to bring healthcare to the patient."

From trauma bay to imaging

"It all started back in 2000, when the hospital was officially designated a Level One Trauma Center," Luitse continues. "Up until then, the AMC had been functioning the same way for over twenty years: Our radiology department and CT scanner were housed on the first floor while the hospital's ED was situated in the basement of the hospital. A regular discussion point was that continually moving emergency patients from one department to another is very bad for their health. It was also time-consuming and inefficient in terms of workflow. Moving a patient from the trauma bay to the radiology department and back took about 30 minutes and involved eight employees passing from one floor to another – often struggling with the gurney, pushing it into the elevator, and meeting all kinds of obstacles on the way."

Ludo F. M. Beenen, MD, emergency radiologist, confirms the situation: "You can see that the circumstances were not ideal. Intensive care patients were scanned with the same imaging machine as used for emergency patients. Inpatients and outpatients all went through one of the two CT scanners on the first floor. Unfortunately, we were always waiting for one of them to be free. We needed to change our process efficiency, but it was not easy to determine the needs or find the right equipment."

Life-saving efficiency

For Luitse, the main focus was to configure an imaging situation where patients could remain on the trauma table. This would minimize transportation and maximize process efficiency, helping save as many lives as possible. But having a dedicated CT scanner in the trauma bay would also be inefficient. It would also need to be available for use on other acute and regular patients as well.

"In 2001, we heard about a Siemens CT imaging system in the operating room of a Japanese hospital that could move three meters forward. We agreed this cutting-edge invention could offer us a solution." They started brainstorming over how they could scan trauma patients better, while also integrating other emergency and intensive care unit patients.

The AMC was the first hospital in the world to possess a two-room emergency setup with sliding gantry CT.

The Academic Medical Center

The Academic Medical Center (AMC) is one of the most prominent research institutions in the Netherlands and is one of its largest hospitals. It employs over 7,000 people, providing integrated patient care, fundamental and clinical scientific research, as well as teaching. The AMC complex houses the university hospital and the UvA faculty of medicine along with the Emma Children's Hospital, the Netherlands Institute for Neuroscience, the Spinoza Center for Neuroimaging, the medical department of the Royal Tropical Institute and the Amsterdam Institute for Global Health and Development. Numerous biotech companies and AMC spin-offs are also located on the site.

As such, the AMC is a breeding ground for fruitful scientific collaboration. But with its 45 clinical and non-clinical departments, it is equally a medical center for all the existing medical specializations, providing outstanding patient services of all kinds, including a high percentage of high-quality referral care. About 26,000 patients are admitted to AMC wards each year, whilst the outpatient clinics see around 350,000 people annually. Day care – an intermediate form of care – is becoming increasingly popular: About 30,000 patients a year receive such care. In addition, the AMC is one of the Netherlands' eleven trauma centers.

A group of dedicated people from the radiology department, trauma surgery, emergency department, and anesthesiology unit all met up and discussed their specific needs.

"To perform fully, we needed a CT that could move at least five meters backwards and forwards," explains Luitse. "Our preference was for it to be set up in the middle of two rooms, sliding on rails from one to the other. The patients would remain on the table in their room, and as such we would bring healthcare to the patient. It was key that the functional design met the specific requirements of the polytrauma patient, not the standards of the medical staff or the hospital. The two-room emergency setup ensures that there is always one room free when an ambulance arrives. Much to our surprise, Siemens confirmed that they were ready to develop a CT-on-rails prototype for the AMC. The CT Sliding Gantry was born. From that moment on, the AMC was the first hospital in the world to possess a two-room emergency setup with sliding gantry CT."

A pit stop for all patients

Beenen compares the evaluation and treatment of an emergency patient to a pit stop in Formula 1 racing, "One of the benefits of the sliding gantry is that speed is in the patient's favor. Because when evaluating a trauma patient, time is critical, Time = Life," Beenen states. "As in motor racing, evaluating a trauma patient is a team activity. Precise timing and perfect choreography of all the medical disciplinary teams involved is vital to saving lives. The more we work together, the faster we get, the better our chances of a good outcome. The CT-on-rails helped us develop this speed.

Feet first

In the dual room, Beenen is eager to illustrate the setup from a patient's perspective. "In a dual-room solution you can adapt at any time to the changing circumstances.

Whenever a trauma CT is required, the gantry is slid across to the respective room. And when the trauma team is finished, the gantry is simply returned to the other room without further delay for the next patient. The patient is placed feet first towards the CT scanner, which makes it easier for the anesthesiologist to control airway, tubes, and other vital patient functions. The patient remains on the table during the scan, with the gantry moving over him or her – the flat rail system enables movement of the scanner at 120 mm/s with the same accuracy as regular CT scanners. All supporting devices, including conventional radiography, are ceiling-mounted. The first practical setup of the dual room back in 2003 had one routine CT room and one trauma room, with the CT scanner located primarily in the routine CT room. This first CT scanner was a SOMATOM Sensation 4 model, which was progressively upgraded to a 64-slice configuration in 2008. Following last year's redesign of the ED, a brand new mirrored configuration with a 128-slice SOMATOM Definition AS+ system was installed. This provides complete flexibility, as both rooms can now receive all kinds of emergency and regular patients in a completely symmetrical two-room solution. Next to the trauma rooms, we also installed a Dual Source CT, a SOMATOM Force."

No time to waste

Luitse points to a life support trolley and explains that it stays with the patient from his or her arrival until the end of treatment, eliminating several disconnection and reconnection times. "As the volume of patients increased, the more there was the need for speed," the surgeon continues. "So we decided to connect the different tubes to the life support trolley. This reduces the overall trauma team by three people but gains us eight minutes. Our workflow is now very well developed, enabling us to provide therapy in less than 30 minutes."

Beenen continues: "For example, in acute ischemic stroke cases, every minute counts. Because of the direct availability of the sliding gantry CT the patient can be scanned within six minutes of arrival, resulting in a door-to-needle time of less than 30 minutes for most patients. This leads to significantly better patient outcomes. Now, being even more ambitious, we generally achieve times of less than 20 minutes. Once you realize that during a stroke, two million neurons are lost every minute, it becomes obvious how valuable it is to save time with the CT on rails."

A twin emergency room

As Luitse explains, "Although of course it doesn't happen all the time, in the most urgent cases we can scan two critical patients almost simultaneously, just one minute apart from each other. Whatever side the patient enters, the equipment is duplicated in each room with every single tool located in exactly the same place. Secondly, we made an investment in terms of electricity. It is equally important that both rooms have independent electricity networks."

This has meant that the entire trauma bay had to be restructured to meet the requirements of the new CT setup. Luitse concludes: "From a patient's perspective, the two-room solution is one of the best things we've ever had."

The view onto the twin emergency room and its sliding gantry CT from the control room.

Conclusion

This CT pit stop on rails, first imagined by Jan S. K. Luitse, MD, and his team back in 2000, was built and elaborated upon over several years. It has become the ultimate example of a new patient philosophy. It has made the Academic Medical Center (AMC) in Amsterdam, the Netherlands, one of the highest performing and most prominent polytrauma emergency centers in the world. Every day, medical staff and researchers from all over the world visit the hospital to see for themselves and learn more about its novel patient concept. More importantly, the two-room sliding gantry concept provides an interdisciplinary, multifunctional, and cost-effective patient approach, allowing the simultaneous treatment of different patients at the same time. There is a bright future ahead.

Erika Claessens has contributed as a journalist and editor to numerous print and online publications in Belgium and the Netherlands. Her principal topics are entrepreneurial innovation and technology. She works from Antwerp, Belgium.

An Environment for Children's Care

An entertaining cartoon is projected onto the SOMATOM Force. Distraction from the images helps the little patients stay calm. Together with the latest in scanning technology, this helps to get good images in pediatric cases.

At Astrid Lindgren Children's Hospital in Stockholm, Sweden, the child always comes first. In 2016, they opened a new scanning center designed to ease the stress of diagnostic scans for children. Doctors, radiologists, videographers, and engineers came together to create a relaxing environment with the most modern scanning technology.

Text: Nils Lindstrand | Photos: Lasse Burell

A sick and nervous child accompanied by worried parents is always a tough challenge for doctors and nurses. When the task is to correctly diagnose what might be a severe illness, you can't always rely on established hospital routines. But if you combine a bit of modern magic, a group of committed and creative professionals, and the latest in scanning technology, the challenge can be turned into a major success. This is what has been accomplished over the last few months at Astrid Lindgren Children's Hospital in Stockholm, Sweden.

The toughest challenges

The patients at the scanning center at Astrid Lindgren Children's Hospital are often very small, some of them just babies, and they are often scared or extremely anxious. Sometimes, however, they are not nervous at all, but happy and lively and won't keep still. Some patients also have mental or social issues. What they do, however, all have in common is that they are not adults that can be just told to lie still during a medical examination or a scan. They move, they refuse to lie down on the scanning table, or simply won't go near this impressive but somewhat scary piece of technology.

"When we moved Astrid Lindgren Children's Hospital to the new complex where we are today, we realized we wanted to do something drastic to convert the scanning room into a friendly environment for children," says Lena Gordon-Murkes, MD. "It was clear that the latest in scanning technology gave us a chance to get good images even with children as patients, but we still needed to get them to cooperate and to be calm for a few minutes."

Creating a new environment

Lena Gordon-Murkes, knew of a company in Sweden that is developing audiovisual technology for commercial and educational use.[1] Cartoons, light effects, sound, and video films are projected onto walls or backgrounds, using very powerful projectors and loudspeakers.

The Astrid Lindgren's Children Hospital, established in 1998 through the merger of three existing children's hospitals in the Stockholm area, provides care for the most severely ill children from all over Sweden. The motto of the hospital is 'The child always comes first'.

"I phoned them up, and we started collaborating to create a scanning room that would be welcoming and calm children and parents instead of scaring them," Gordon-Murkes says.

And it worked. It really, really worked. The rest of the room is dark, and the scanner is covered with images of stars, rainforest backgrounds or simply dreamlike flickering lights. For small children, popular cartoons are screened onto the ceiling.

Lena Gordon-Murkes, MD (middle) discussing a cardiac case with her colleagues Patrik Nowik (medical physicist) and Marika Lidegran, MD (pediatric and cardiac radiologist).

"If we show them one episode of a popular cartoon, they want to watch all the episodes before they have to go home..."

Lena Gordon-Murkes, MD,
Astrid Lindgren Children's Hospital,
Stockholm, Sweden

"We had one boy of about ten years who was autistic. He got very anxious when he was about to lie down on the scanning table, and got quite aggressive in his agitated state. But when we tested the popular small children cartoon 'Babblarna®', a concept originally created to aid language development for small children with or without special needs, this young man became quite calm, totally focused on the story played out in the cartoon."

A positive effect

The new scanning room design really worked, and not only for the children. "We saw the positive effect it had on the parents", says Lena Gordon-Murkes. "They came in, obviously being very anxious about what the scanning would show, and nervous about the procedure as well. The audiovisual display gives them another focus, and something beside the health issues to talk about. This provided a much more calm and positive situation all together."

Gordon-Murkes says, smiling, that the old challenge of getting the children to lie still during the scanning procedure has been replaced by the problem of making them leave. "If we show them one episode of a popular cartoon, they want to watch all the episodes before they have to go home..." So, the situation and mood during the scanning of small children has become much more calm and positive. But this is obviously not enough.

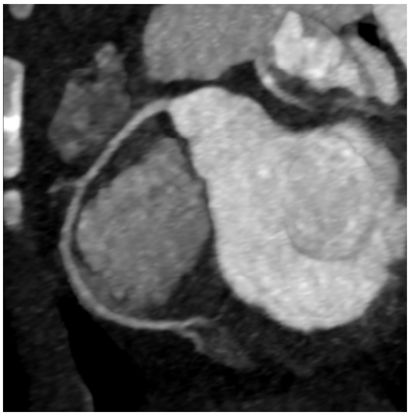
The purpose of the whole operation is to get images from the scanning procedure to achieve sound diagnosis of health issues, involving such delicate parts of the body as the heart, the spine or individual blood vessels. This task is certainly not made easier by the fact that these details in pediatric imaging are extremely small. The demand for good quality in the scanning images is therefore very high; at the same time, the small bodies involved means you have to keep the radiation doses at a minimum.

High quality scans at lower dose

The group working at Astrid Lindgren Children's Hospital have made it all work – with doctors, nurses, and physicists dedicated enough to go the extra mile. They also had access to the advanced scanning equipment that made it possible to succeed.

Dual Source is the fundamental technology in Siemens Healthineers premium CT imaging technology. It enables extremely short scan times of about half a second, with excellent results, and very low radiation doses. The powerful tube makes it possible to use low levels of contrast agent. With the unique Tin Filter, high quality images can be produced even at very low doses of radiation.

"The equipment has done what Siemens Healthineers said it would do, and has done so from day one," says Gordon-Murkes. "This is not



Left: An MIP image shows the right coronary artery (RCA) of a 2-month-old baby with a heart rate of 133 bpm. Images were acquired with 1.16 mGy at 70 kV using CARE Child technology.
Courtesy of Astrid Lindgren Children's Hospital, Stockholm, Sweden

Right: A MinIP image shows a foreign body in the proximal left main bronchus of an 18-month-old baby. A 25 cm scan range was acquired in 0.3 s with 0.02 mGy at Sn100 kV, using Turbo Flash mode and Tin Filter technology.
Courtesy of Astrid Lindgren Children's Hospital, Stockholm, Sweden

always the case when you buy healthcare equipment, but this is extremely important." At the same time, the technology continues to develop in collaboration between the hospital staff and Siemens Healthineers.

"Our physicist, Patrik Nowik, has been instrumental in the applications and further development of the scanning features, similarly the colleagues from Siemens Healthineers have been integral to the creation of this process," says Gordon-Murkes with a smile. "It has been very important for the successful use of this new technology that all of those working with it at the hospital have been able and willing to work together as members of one single team, whether they are doctors, nurses, physicists or engineers." ●

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Nils Lindstrand is an independent business and technology writer based in Stockholm, Sweden.

Gentle examinations for the smallest patients

"We literally work from head to toe, and we are using modern scanning technology for a lot of things we didn't before," says Lena Gordon-Murkes. "Using Siemens Healthineers' SOMATOM Force as a dedicated pediatric scanner has given us advantages in a number of areas."

Here are some examples: The parents of a baby operated on for congenital hip dislocation (CHD) were worried that the hip might not be in place. This was checked with a follow-up scan at a very low dose. "The child was happy and constantly kicking his feet", says Gordon-Murkes. "But with the scan we got useful images anyway, despite the extremely low dose and the kicking feet. The hip was in place and the child is doing fine today."

Another baby was suffering from cardiomyopathy and had a pulse of 133 bpm. The baby was referred to Astrid Lindgren Children's Hospital to rule out any coronary anomalies. Despite the extreme pulse, a very low effective dose scan gave very precise images of the child's coronaries (see image above).

Gordon-Murkes and her team have also established new clinical pathways with Siemens Healthineers' unique Tin Filter technology. CT scanning has become a standard procedure when they get children in with foreign bodies in their airways. "Beside lung imaging and orthopedics, another possible area is the check up of shunt catheters in a whole body acquisition. While in the past this was done with several X-rays from different angles, which is time-consuming and cumbersome, one single ultra-low dose CT scan can now fulfill the diagnostic task. Using CT technology makes it much easier for the doctors on call to establish what the situation is and what they need to do, compared to previously used techniques," says Gordon-Murkes.

It has also been possible to use CT imaging for all neck exams, due to the low radiation doses, instead of applying it only in special cases where it was considered absolutely necessary. "The toughest challenge of them all," according to Gordon-Murkes, may be to visualize the spinal arteries in small children. With the SOMATOM Force images being so exact, the doctors at Astrid Lindgren Children's Hospital were able to successfully operate on a child with a tumor adjacent to the artery of Adamkievicz.

The team at Astrid Lindgren Children's Hospital has also used images from the SOMATOM Force to produce a 3D model for preoperative planning in a case of complex dysplasia (see image above).

Lena Gordon-Murkes, MD, is convinced of the advantages of the SOMATOM Force in the pediatric field.

The doctor said after the operation that the 3D model had totally changed their line of approach to the operation that wouldn't have been the case without it.

Minimizing Time and Chances of Errors

With more information comes more complexity. That is why radiologist Daniele Marin, MD, at Duke University Medical Center welcomes any support that can make CT scanning easier, faster, and more reliable.

Text: Martin Suter | Photos: D.L. Anderson

"Sapienza" is Italian for wisdom. It is also the name of the world-famous university in Rome where Daniele Marin, MD, took the first steps in his academic career. His quest for medical wisdom led Marin to Duke University Medical Center, where today he is Associate Professor of Radiology. Located in Durham, North Carolina, Duke University is one of the cornerstones of the famed "Research Triangle". Its clinics offer top-notch medical treatment and medical research in all relevant fields.

"Duke offered exactly the research opportunities I was looking for," says Marin, who came here from Italy ten years ago. On the sprawling campus of the Medical Center, new research and treatment facilities are being built regularly. The 50 faculty members of Duke's Radiology Department oversee roughly 20 computer tomography platforms, "Clinically we are a very busy department."

Duke University Medical Center offers top-notch medical treatment and medical research in all relevant fields.

Radiology is based on perception

For Daniele Marin this translates to a large number of case readings every day. "Of course we have residents and fellows, so it's not like it's only me sitting at a workstation," he says. "Five team members are in the room. Each has three to four patients, and I hop from place to place. Usually I read between 50 and 70 cases a day." However, the radiologist is never overwhelmed, "I love anatomy," he says. "It has always been my passion to see into the patient, to see structures and organs. That's why I fell in love with radiology."

As Director of the Multi-Dimensional Image Processing Lab Marin finds the capabilities of Dual Energy CT uniquely productive and has realized some of the benefits of this sophisticated technology. The lab is located at the Hock

Daniele Marin, MD, welcomes any support that makes CT scanning easier, faster, and more reliable.

Plaza Building in the western side of the campus and employs more than half a dozen highly specialized technologists. In subdued lighting, they do sophisticated image postprocessing work at workstations, each equipped with three flat-screen monitors.

Acquiring experience is indispensable for Marin's professional growth. "My ultimate goal is to advance CT imaging," he says, "Radiology is very subjective, based on a perception of the radiologist. And a lot of the decision-making is based on this perception. My goal is that in the future we can provide more meaningful, more quantitative, more measurable metrics of patient response to therapies, including predictions of outcomes."

Full spectrum of details

At Duke, Dual Energy CT scans are routinely done in four areas: Neural scans help to map brain hemorrhages; chest scans are used to locate pulmonary embolisms and create perfusion maps; musculoskeletal scans visualize uric acid crystals that my indicate gout and pathologies of bone marrow. Daniele Marin is most interested in the abdominal area, where dual energy is very powerful in analyzing lesions of the liver and kidney.

As an example, Marin shows the dual energy image of a kidney. "A lower monoenergetic level is better for visualizing lesions, for example diffuse tumors, because it enhances the attenuation and therefore its conspicuity," he explains. The radiologist points to a very small bright spot. With dual energy I have the full spectrum of energies at hand. I can choose the level that best visualizes what I need. For instance, a high monoenergetic level is very useful in reducing metal artifacts. Moreover, iodine uptake and a virtual noncontrast scan are also calculated, which helps characterize and measure a lesion very accurately.

Marin remembers a case when dual energy was crucial in a time-critical situation. A patient in the emergency department was suffering from intestinal bleeding. Before we had implemented dual energy routinely, the technologist was supposed to do a CT scan without and then with contrast media, but he forgot the first round. Luckily the scan was done with dual energy and the radiologist was still able to calculate a virtual noncontrast and differentiate low density material from high density materials, which may be a sign of bleeding in the bowel. "We were able to rule out a source of the bleeding," Marin says. "Dual energy can help a lot avoiding such mistakes."

Automation is cost-effective

Dual Energy CT is also cost-effective. For example, a patient comes into an emergency room with bowel inflammation. The physicians suspect diverticulitis and perform an abdominal CT scan. On the images they don't see diverticulitis, but rather a lesion in the kidney. The scan was performed with dual energy thus the images allow for a preliminary diagnosis. Immediate follow-up scans are unnecessary. For Daniele Marin, this hypothetical case illustrates one of the benefits of Dual

"I think it's critical to make information available to more of the people who need to see it."

Daniele Marin, MD
Duke University Medical Center,
Durham, North Carolina, USA

Dual energy is becoming a large proportion of the work that Daniele Marin, MD, and his team do at Duke. He estimates that the department conducts between 500 and 1,000 dual energy scans per month.

Energy CT; it can reveal more incidental findings. "It has the potential to decrease the overall financial burden for the health system."

Duke's radiologists fully embrace the concept. Accordingly, "dual energy is becoming a large proportion of what we are doing," says Marin. He estimates that the department conducts up to 500 dual energy scans per month. But even a top-of-the-line research institution, such as Duke, sometimes struggles with the complexity and additional time requirements that come with this process. "Workflow is one of the most important challenges," Marin says. At Duke we were typically performing two reconstructions for single energy scans in the abdominal field-one on the axial plane, and one coronal. "With dual energy, there is the opportunity to reconstruct a lot of additional series, with the subsequent extra information. We move to five, eight different datasets for the same scan."

For medical staff at Duke University, the level of trust is very important.

Without a fitting workflow solution, the increase in time required is substantial. Radiologists report that the reconstruction of a dual energy scan takes 20 minutes as opposed to 5 minutes for single energy. If technologists do all the extra postprocessing work at the CT console, the number of reconstruction mistakes could increase. Marin estimates a 5-10 percent chance of error.

These drawbacks largely disappear with Siemens Healthineers' Rapid Results Technology. In its new iteration, this software solution enabled by the *syngo*.via reading and reporting platform automates all of the complicated postscanning calculations. "The original datasets are sent to the *syngo*.via server," Marin explains, "This computer automatically reconstructs all the different series I need. You minimize the time at the CT console, and you minimize the chance of reconstruction mistakes. You are automating the process."

Providing a faster workflow

Siemens Healthineers' most advanced dual energy capable scanner, SOMATOM Force, is located in the newly erected Oncology Center.

The scanning process itself does not take longer when done with dual energy. "Acquiring the images pretty much requires the same amount of time as with single energy," says Daniele Marin. After the patient passes through the scanner gantry, which is now glowing in pleasant colors, the technologist at the console finishes the image acquisition and the data is automatically sent to be processed. Within a few minutes he is ready to accept the next patient.

While the new patient is positioned on the scanning table, the off-site computers generate preprogrammed datasets and format the resulting images to be evaluated by the radiologist in the PACS system. "It is very important that all of these series are available on PACS," Marin says, "since it is everybody's natural reading environment." In this way, Rapid Results Technology makes information available to more of the people who need to see it. "I think it's critical."

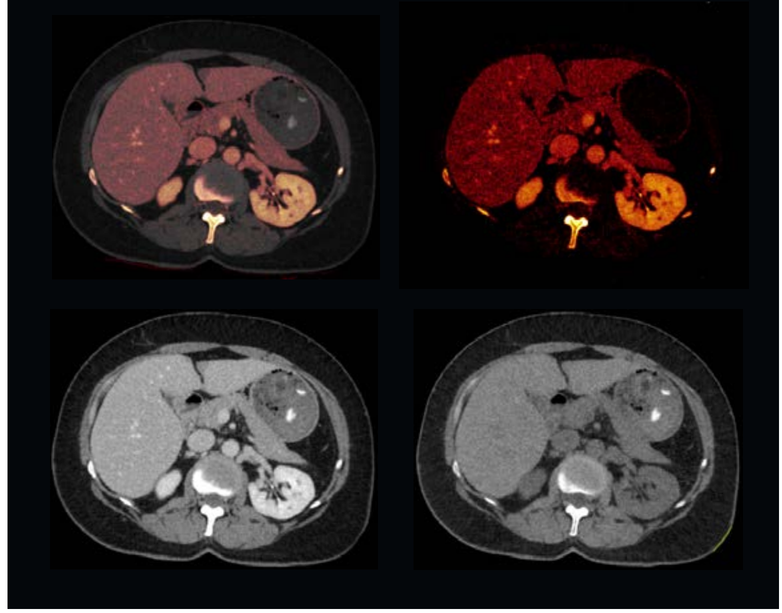
Information can be streamlined

Experience tells the radiologists that automation tools will not hide information that a manual process would reveal. "I don't really see any downside from a clinical standpoint," Daniele Marin concludes. The technologists working on his team agree. "It helps a lot, sending automated results from *syngo*.via to the PACS or whatever reading platform you are using," says Susan Whitney, team leader at the Multi-D Lab. "The doctors read a lot, so we are constantly trying to keep up, doing it faster, faster, faster. With any improvement in workflow – transfer or postprocessing – we can examine more patients."

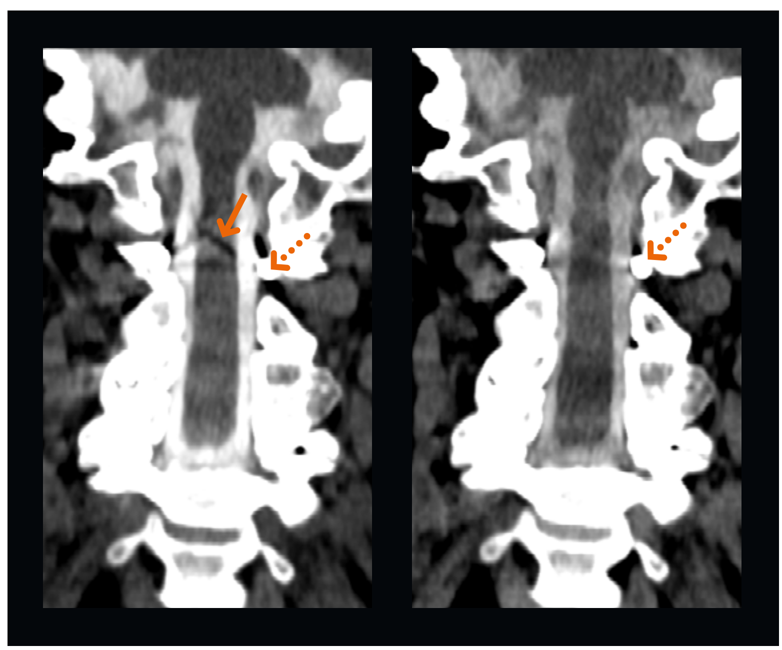
Increased data aids diagnosis

In Daniele Marin's view all these difficulties pale in comparison to the benefits. He considers dual energy scanning with Rapid Results Technology to be a breakthrough. It allows him to expect a future where computers can be even more capable problem-saving tools. "I would like to get to a point where artificial intelligence can learn from all this extra information and support us with diagnosis even further."

Might increased automation eventually make even the job of a radiologist redundant? "There is always a risk," Marin concedes. "But if you build trust with your referring physician, I don't see that as a problem. That level of trust is too important." ●



Dual Energy CT imaging of a 62-year-old female patient, with clinical history of intermittent gastrointestinal bleed, reveal multiple small foci of high density within the gastric lumen in the mixed image (lower left) possibly indicating active contrast material extravasation. This is ruled out by the absence of iodine material on the color-coded iodine map (upper right) and fused image (upper left), as well as baseline increased attenuation on the virtual noncontrast image (lower right). Note the incidental low attenuation lesion in the left hepatic lobe, which can be confidently characterized as an area of focal fat deposition by the lack of iodine content on the color-coded iodine map.
Courtesy of Duke University Medical Center, Durham, North Carolina, USA



Coronal MPR images of a cervical CT myelogram in a 65-year-old female patient show a severe artifact (left, arrow) caused by a metal bar (dashed arrows). The artifact is significantly reduced using Dual Energy Monoenergetic Plus imaging (right).
Courtesy of Duke University Medical Center, Durham, North Carolina, USA

Martin Suter, based in New York City since 1993, is a correspondent for the Swiss Sunday newspaper, *Sonntags-Zeitung* and has written for a variety of major European publications on topics ranging from politics and technology to business and healthcare.

Different Needs, One Approach

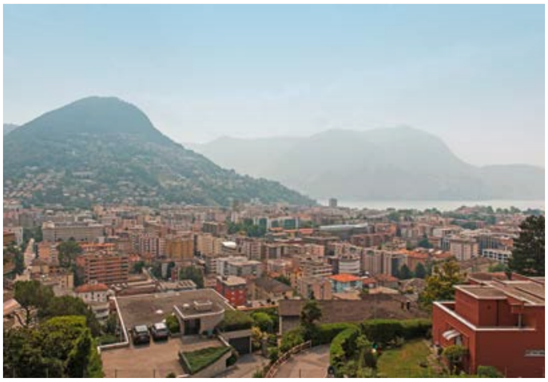
Two hospitals in Ticino, Switzerland, one serving an urban area of 100,000 people, the other a town of about 15,000, confront the demands of an aging population, increasing patient loads, and disruptions in patient scheduling when emergencies arise. Can a new approach make them increasingly efficient and attractive?

Text: Claudia Flisi | Photos: Mattia Vacca

Filippo Del Grande, MD (left), Ermidio Rezzonico (middle), and Matteo Merli, CAT scan technician (right), Ospedale Regionale di Lugano, regularly share ideas on how to manage processes to maximize efficiency, remain competitive with other hospitals in their market, and solidify a good reputation to attract patients and staff.

Nestled among alpine trees in a green valley by Lake Lugano is the Ospedale Regionale di Lugano – Civico e Italiano (Lugano Regional Hospital). It is part of the EOC, the Ente Ospedaliero Cantonale of Ticino, Switzerland, and epitomizes the crisp modern efficiency of Switzerland's medical system, one of the world's best, operating in one of the world's wealthiest countries. Lugano's patients are sophisticated – and older than the patients of an average regional hospital: Swiss men are the longest living in the world, according to the OECD, and Lugano is located in Ticino, with the country's oldest population.

Kidney disease, gout, stroke, heart attacks, and other cardiovascular ailments are common in such aging populations. So the hospital is particularly attentive to these diseases.



The hospitals in Lugano and Locarno in Switzerland confront the demands of an aging population, increasing patient loads, and disruptions in patient scheduling when emergencies arise.

When a patient comes in with suspected kidney stones, for example, the standard procedure has been to ask him or her to filter his urine and “catch” a stone. The stone is analyzed and a therapy prescribed, based on the composition.

A similar situation confronts a smaller regional hospital in northern Ticino, Ospedale Regionale di Locarno. It is a linear, grey 200-bed general hospital located in a town near the northern nose of Lake Maggiore, and serves a local community of 15,000. “We have a little of everything,” explains Jürgen Heinkel, MD, Chief Radiologist in Locarno. He oversees a radiologist and two technicians specializing in CT exams.

By contrast, Lugano’s Civico has 300 beds, hosting patients with major medical problems such as trauma, neurology, stroke, vascular issues, and abdominal surgery.

Both Lugano and Locarno are part of EOC – the others being Ospedale Regionale di Bellinzona e Valli, Ospedale Regionale di Mendrisio, Clinica riabilitazione di Novaggio, Istituto Oncologico della Svizzera Italiana, and Neurocentro della Svizzera Italiana.

Two hospitals, similar needs

The two regional hospitals have differences and similarities in terms of several common needs: Managing processes to maximize efficiency, remaining competitive with other hospitals in their market, and solidifying a good reputation to attract patients and staff. Like all Swiss hospitals, both facilities adhere to strict national rules regarding standardized medical protocols and low radiation doses, so acquisitions must facilitate adherence.

The right equipment purchases can help address these needs and specifications. Lugano has had a top-of-the-line imaging device since 2010 with the SOMATOM Definition Flash, frequently used for cardiology patients. The exams of cardiac patients are performed in collaboration with cardiologists of the close located Cardiocentro Ticino who report the cardiac part of the exams. Problems arose when the needs of scheduled patients conflicted with emergency cases, and so the hospital decided to supplement existing equipment to minimize such disruptions. It planned to locate this new addition by the emergency room, but expected to use it for kidney, gout, and vascular patients, and others as well.

Locarno was looking to replace an older imaging device with something newer and faster, and planned to redesign the physical layout of its radiology department to accommodate its increasing patient loads. It had one changing room; it wanted to add a second – provided the equipment which fast enough to handle the load.

Since older patients have more metal prosthetics, such as artificial limbs or teeth, both hospitals shopped for imaging equipment that would not be compromised by metal artifacts.

Improved appointment process and patient flow

Between 2016 and 2017, EOC decided to purchase a Siemens SOMATOM Definition Edge CT, equipped with TwinBeam Dual Energy (TBDE), for each of the two hospitals. Lugano already had a SOMATOM Definition Flash and bought the SOMATOM Definition Edge to replace an older Siemens model.

Locarno had seen the advantages of dual energy in Lugano and foresaw a mixed use: Emergencies and also scheduled appointments.

Lugano was familiar with the technology and its advantages: Sharp contrast images, minimal doses, metal artifact reduction, and versatility with a variety of optional applications. The purchase was made with emergency radiology (ER) use in mind, and has dramatically improved patient handling, according to Filippo Del Grande, MD, Chief Radiologist. His Head of Medical Technicians, Ermidio Rezzonico, seconds his observation: "With the Edge we improved our appointment process and our overall management of patient flow. The impact has been very positive."

While the SOMATOM Definition Flash would continue to be used for cardiology patients and scheduled exams, the SOMATOM Definition Edge was installed near the emergency room. The idea was to use it in the ER so that patients would not suffer scheduling disruptions when emergencies happened. The result has been a significant improvement in patient flow.

Locarno had seen the advantages of dual energy in Lugano and foresaw a mixed use: Emergencies and also programmed visits for – among other applications – gout, kidney stones, pulmonary embolisms, and cardiovascular pathologies. Patient satisfaction was a key reason for this acquisition. "The patient is our center of attention. So any new equipment we purchase must have a benefit for the patient," explains Heinkel. "It was clear from the introduction of dual energy that it offered something more for the patient from a diagnostic point of view."

Diagnostic applications for gout and kidney stones

Two of the most outstanding benefits are the dual energy postprocessing applications for gout and kidney stones, which can be applied in conjunction with TBDE technology. Gout is characterized by crystal deposits of urine acid. The TBDE technique is an important and popular problem-solving technique for the referring physician to directly visualize uric acid crystals that may indicate gout in and around the joints. The information from the TBDE CT scan will help clinicians to choose the optimal treatment for the patient.

The impact on kidney stone diagnosis is more dramatic. Ninety percent of kidney stones are composed of calcium oxalate, ten percent are uric acid; the prescribed therapy varies, depending on composition. Oxalate calls for breaking down the stones internally, acid calls for medicinal treatment. A TBDE scan enables a spectral analysis that identifies this chemical composition. "Clinically this is important," says Heinkel. "Before TBDE, we had to wait for the stone to be expelled, then do a chemical analysis in the lab. For the patient this was very inconvenient; you had to try to catch the stone during urination. We used to do an X-ray, then ultrasound, then a CT scan. Now we start with the TBDE scan, and it is often the only exam needed. We can locate the stone precisely and see the damage it is causing."

Further applications

Another important application is to reduce artifacts when imaging patients with metal implant such as knee and hip arthroplasty and metal implants after surgical fracture correction. This

A cinematic rendering image shows the posterior view of the abdominal aorta and its branches, with a renal aneurysm present on the right –read more in the case report on page 42.
Courtesy of Locarno Regional Hospital Charity, Locarno, Switzerland

DECT images reveal small discrete uric acid deposits next to the 1st, 2nd and 3rd metatarsophalangeal joints – read more in the case report on page 60.
Courtesy of Lugano Regional Hospital, Public Cantonal Hospital Corporation, Lugano, Switzerland

With their modern equipment, it is easy for Alberto Manara and Jürgen Heinkel, MD, to maintain higher dose standards than the national minimums.

is an interesting clinical application in continuously growing population.

Dual energy minimizes interference from metal prosthetics, common in an older population. Older patients also have more need for vascular exams, and the elaboration of such data is reconstructed easily and precisely with the SOMATOM Definition Edge, according to Manara.

The SOMATOM Definition Edge is also much faster than the previous CT scanner thanks to the fast pitch of 1.7. "We have gone from 17 seconds down to 7 seconds per scan," reports Alberto Manara, the technician responsible for CT exams in Locarno.

Benefits of standardized protocols

The SOMATOM Definition Edge in Ticino has improved services for staff as well as patients. "Having the same machines allows us to be more cost efficient, and standardize procedures from one facility to another," notes Del Grande. Like all Swiss hospitals, the facilities in Lugano and Locarno adhere to strict national rules regarding standardized medical protocols and low radiation doses, so acquisitions must facilitate adherence.

Similar equipment facilitates the Swiss approach, because protocols can be more easily standardized. The same is true for training technicians. Staff can be more easily rotated among hospitals. Both Rezzonico and his colleague Matteo Merli, CAT scan technician, Ospedale Regionale di Lugano note that learning TBDE and the corresponding dual energy applications with the SOMATOM Definition Edge was easy because of Lugano's experience with the SOMATOM Definition Flash. "We have always worked with Siemens equipment, so the same user interface, same applications and protocols speed up and facilitate the learning phase," says Rezzonico.

Lower radiation doses than required by law

The Swiss passion for protocol is rivalled by their focus on dosage. Ticino hospitals maintain higher standards than the national minimums because they easily meet the minimum requirement. "What is important is to provide optimal images with low radiation doses," notes Heinkel. After more than a year of working with the SOMATOM Definition Edge, he says that his department is using considerably less dose than with previous equipment. "This is significant for cancer patients who sometimes have to undergo several exams every year," he points out.

CT scans doubled over the last 10 years in Lugano, from 8,400 in 2006 to 17,000 in 2016. "Speed, improved workflows, new applications, reliable machines and the possibility to have the same CT technology in the radiology department helped dramatically to face efficiently and effectively the important increasing workload in the last years." concludes Dr. Filippo Del Grande.

Based in Italy, **Claudia Flisi** has written about the intersections of science and technology for the International New York Times and many other publications.

A winning combination

Swiss law requires competitive bidding for hospital equipment costing more than 200,000 Swiss francs (about 184,000 Euro). Price represents a certain part of the bid. The other factors are technical features, such as the power of the tube, the presence of dual energy, and the number of slices, as well as after-sales service, taking into consideration the experience, reliability, and availability of technicians in Ticino. Siemens shines in this category, as it has four technicians on call 24/7 and 365 days a year in the canton, one entirely dedicated to CT scanners. "We almost never have to call them but it is reassuring to know that we can," says Filippo Del Grande, MD, Chief Radiologist at Ospedale Civico Regionale di Lugano in Ticino, Switzerland.

Coronary CT Angiography – an Appealing Alternative for Coronary Stent Evaluation?

By Guihan Lin, MD; Chunmiao Chen, MD; Chenying Lu, MD; Xianghua Hu, MD,
and Jiansong Ji, PhD Department of Radiology, Lishui Central Hospital,
The No. 5 Affiliated Hospital of Wenzhou Medical College, Lishui, Zhejiang, P. R. China

History

A 57-year-old male patient, who had suffered from a left coronary artery stenosis and undergone a percutaneous coronary intervention (PCI) 3 years ago, came for a routine follow-up. A coronary CT angiography (cCTA) was requested for evaluation.

Diagnosis

cCTA images showed a patent stent in the middle segment of the left anterior descending artery (LAD) and a moderate stenosis, caused by a non-calcified plaque, proximal to the stent. No signs of an in-stent restenosis or thrombosis were seen. A small calcified plaque and some wall irregularities were shown in the right coronary artery (RCA), as well as a mild stenosis in the proximal circumflex (Cx) caused by a non-calcified plaque.

Comments

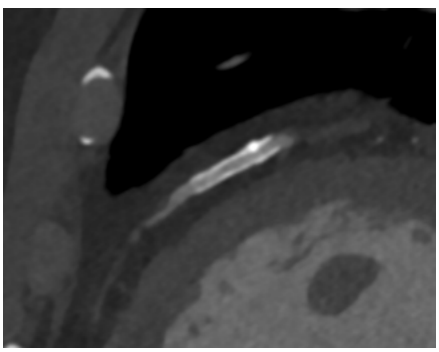
Coronary artery stenting has become the most important nonsurgical treatment for symptomatic coronary artery disease. Conventional coronary angiography has until now been considered the gold standard for assessing stent patency.[1] However, this invasive procedure comes along with associated morbidity and mortality risks.[2] A noninvasive and less costly technique for detecting in-stent restenosis would be of great interest and use for follow-up examinations.[3] In this case, the latest generation of Dual Source CT scanners was used, which offers a temporal resolution of 66 ms and an isotropic resolution of 0.3 mm. The images were reconstructed using standard parameters (0.75 mm, kernel Bv40) and are excellent for diagnosis. The in-stent resolution can be further improved using thinner slices (0.5 mm) and a sharper kernel (Bv44) reconstruction. The whole acquisition was completed in 0.18 seconds with only 32 mL of contrast agent. It was not

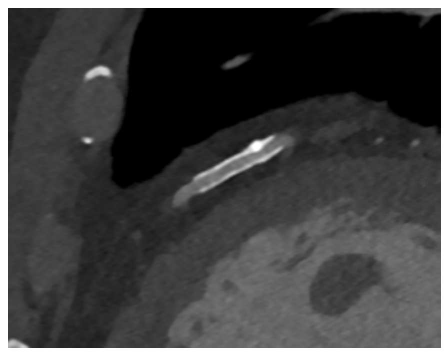
Examination Protocol

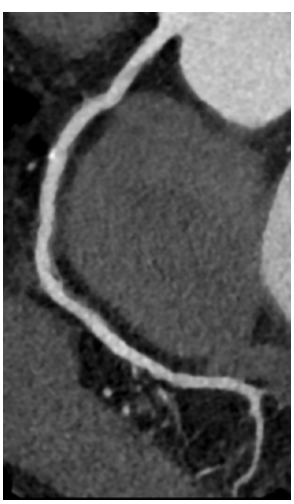
Scanner	SOMATOM Force		
Scan area	Heart	**Rotation time**	0.25 s
Scan mode	Turbo Flash Spiral	**Pitch**	3.2
Scan length	129.3 mm	**Slice collimation**	192 × 0.6 mm
Scan direction	Cranio-caudal	**Slice width**	0.75/0.5 mm
Scan time	0.18 s	**Reconstruction increment**	0.5/0.3 mm
Tube voltage	100 kV	**Reconstruction kernel**	Bv40/Bv44
Effective mAs	500 mAs	**Heart rate**	57 bpm
Dose modulation	CARE Dose4D™	**Contrast**	320 mg/mL
$CTDI_{vol}$	4.95 mGy	**Volume**	32 mL+ saline 40 mL
DLP	84.2 mGy cm	**Flow rate**	4 mL/s
Effective dose	1.2 mSv	**Start delay**	100 HU at the aortic arch +5 s

1a


1b


1c


1d


2a


2b


2c


1 Curved MPR (Figs. 1a and 1b) and oblique MPR (Figs. 1c and 1d) images demonstrate the difference between stent images reconstructed at 0.75 mm with a standard kernel of Bv40 (Figs. 1a and 1c) and at 0.5 mm with a sharper kernel of Bv44 (Figs. 1b and 1d). The in-stent resolution is significantly improved with thinner slice and sharper kernel reconstruction.

2 Curved MPR images show a small calcified plaque and some wall irregularities in the RCA (Fig. 2a), as well as a patent stent in the LAD (Fig. 2b). Non-calcified plaques (arrows) are seen proximal to the stent and in the Cx (Fig. 2c) causing no significant stenosis.

necessary for the patient to hold his breath during scanning. The same image dataset can also be used for assessing the condition of the whole coronary tree.[4] This makes coronary CT angiography an appealing alternative for coronary stent evaluation. ●

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Diagnosis of Reversible Myocardial Ischemia using Dynamic CT Perfusion: Confirmation by ^{15}O-labelled Water PET/CT

By Kakuya Kitagawa, MD;
Yasutaka Ichikawa, MD;
Masaki Ishida, MD;
Naoki Nagasawa, PhD;
Yoshitaka Goto, MD,
and Hajime Sakuma, MD
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Mie University School
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History

A 72-year-old male patient, suffering from diabetes mellitus and elevated triglyceride levels, was admitted for surgical resection of an adrenal tumor. Echocardiography was performed for preoperative cardiovascular assessment. This revealed a regional hypokinesis in the posterior wall of the left ventricle. A cardiac CT and a ^{15}O-labelled water PET/CT were requested for further evaluation.

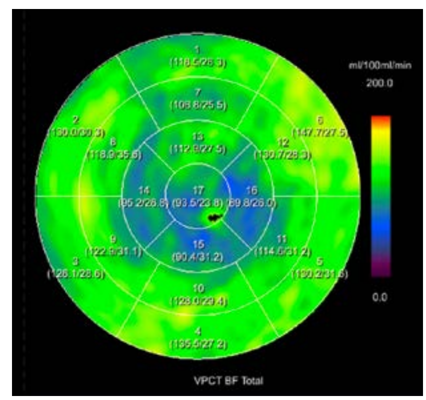
Diagnosis

Coronary CT angiography images depicted a high grade stenosis caused by non-calcified plaques in the proximal left anterior descending artery (LAD, Fig. 1a), and a mild stenosis caused by calcified plaques in the proximal right coronary artery (RCA, Fig. 1b). The circumflex artery (Cx) was hypoplastic, and no plaques were seen in the left-main coronary artery (LM).

1a

1b

2a



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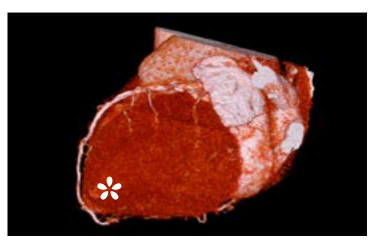
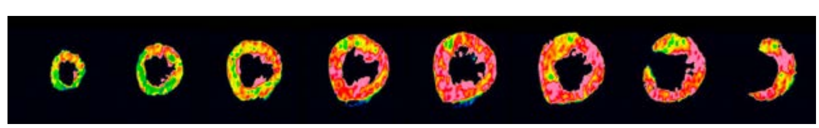


2c

3a



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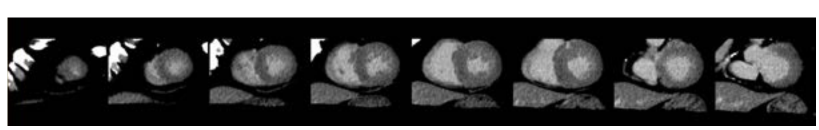


1 Curved MPR images of the LAD (Fig. 1a) and the RCA (Fig. 1b) show a high-grade stenosis in the proximal LAD (Fig. 1a, arrow) and a mild stenosis in the proximal RCA (Fig. 1b, dashed arrow).

2 A polar map of myocardial blood flow derived from dynamic CT perfusion shows reduced perfusion in the anterior and apical segments (Fig. 2a). Volume rendering images (Figs. 2b and 2c) show LAD wrapping around the apex (asteriks).

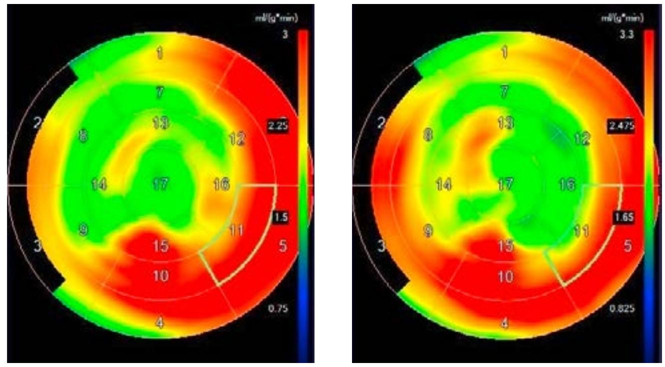
3 Short axis images of myocardial blood flow map (Fig. 3a) and delayed enhancement CT (Fig. 3b) show no evidence of infarction in the area with reduced perfusion.

Myocardial blood flow maps, derived from dynamic CT perfusion, revealed a significant reduction of blood flow in the area subtended to the LAD (Figs. 2a and 3a).

Delayed enhancement CT showed no abnormal enhancement and no evidence of infarction in the area with reduced perfusion (Fig. 3b).

Quantitative polar maps of myocardial perfusion obtained from ^{15}O-labelled water PET/CT also demonstrated reduced myocardial blood flow under stress and myocardial perfusion reserve in the LAD territory (Fig. 4).

4a



4b

4 Polar maps of myocardial blood flow (Fig. 4a) and myocardial perfusion reserve (Fig. 4b) obtained from ^{15}O-labelled water PET/CT demonstrate reduced perfusion in the anterior and apical segments showing good agreement with the CT-derived polar map (Fig. 2a).

Comments

Cardiac CT has evolved from the morphological assessment of coronary arteries to the assessment of myocardial perfusion and viability. As exemplified above, a comprehensive cardiac CT examination can provide almost all needed information to guide patient management and develop therapeutic strategies. Dynamic CT perfusion, which had been limited by relatively high radiation and insufficient z-axis coverage, has broadened its clinical applicability since the introduction of SOMATOM Force. This new system allows higher tube current at lower tube voltage and has a 96-row detector covering 10.5 cm in the cardiac shuttle mode.

^{15}O-labelled water PET/CT imaging is considered the gold standard for the quantitative assessment of myocardial perfusion because ^{15}O-labelled water is a freely diffusible agent and the extraction fraction is not affected by flow rates or the metabolic state of the myocardium. However, despite promising results in the research context, its availability is extremely limited. As shown here, dynamic CT perfusion can provide quantitative parametric maps that agree well with ^{15}O-labelled water PET/CT.

Examination Protocol

Scanner	**SOMATOM Force**		
Scan area	Left ventricle	Heart	Left ventricle
Scan mode	Stress myocardial perfusion	cCTA (Seq.)	Delayed enhancement CT
Scan length	105 mm	120 mm	105 mm
Scan direction	shuttle	Cranio-caudal	shuttle
Scan time	32 s	5 s	8 s
Tube voltage	70 kV	80 kV	80 kV
Tube current	182 mAs/rot.	247 mAs/rot.	278 mAs/rot.
Dose modulation	CARE Dose4D™	CARE Dose4D™	CARE Dose4D™
$CTDI_{vol}$	24.2 mGy	10.4 mGy	15.8 mGy
DLP	255.8 mGy cm	128.1 mGy cm	167.2 mGy cm
Effective dose	3.6 mSv	1.8 mSv	2.3 mSv
Contrast			
Volume	40 mL	60 mL	–
Flow rate	5 mL/s	4.7 mL/s	–
Start delay	4 s	Bolus tracking	–
Scan timing	Adenosine infusion start ↓ 3 min scan	Adenosine infusion release ↓ Nitro ↓ 5 min scan	cCTA ↓ 3 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.

Renal Artery Aneurysm

By Juergen Heinkel, MD
Department of Radiology, Locarno Regional Hospital Charity, Locarno, Switzerland

History

A 69-year-old female patient suffering from nausea and weight loss of 5 kg within the past 2 months was referred for a CT examination. TwinBeam Dual Energy (TBDE) CT was performed to rule out any abdominal disorders.

Diagnosis

CT images showed a saccular, wide-necked, contrast-filled outpouching arising from the bifurcation of the right renal artery, suggesting an extra-parenchymal aneurysm. The maximum diameter was 2.8 cm. Kidney perfusion and excretion appeared to be symmetrical. Calcified plaques were seen at the origin of the celiac artery and of the left renal artery as well as in the abdominal aorta and bilateral iliac arteries, all causing no significant stenosis.

Comments

A renal artery aneurysm (RAA) is defined as a dilated segment of the renal artery that exceeds twice the diameter of a normal renal artery.[1] It is usually asymptomatic but can be complicated by conditions such as rupture, thrombosis, distal embolism, obstructive uropathy, hypertension of renovascular etiology, and arterio-venous communications.[2] Treatment of an RAA depends upon the size and location of the aneurysm, and also whether it is symptomatic or not. Prior to surgical repair or endovascular interventions, CT or MR examinations are usually required to evaluate the exact location, size, and structure of the aneurysm as well as its relation to the nearby organs. Increasingly higher speed and improved spatial resolution make CT a first-line imaging modality. Three-dimensional image reconstructions demonstrate the aneurysm in an illustrative way and provide us with its detailed anatomy. This is of particular value when planning surgery. In this case, an innovative Dual Energy approach, TBDE, was performed. It allows simultaneous acquisition of high and low kV datasets in a single scan. The datasets are processed in *syngo*.CT DE Direct Angio, which accurately highlights bone structures and removes them in an automated workflow.

1a

1b

1 Cinematic rendering images show a saccular aneurysm arising from the bifurcation of the right renal artery.

References

[1] Coleman DM, Stanley JC. Renal artery aneurysms. J Vasc Surg. 2015 Sep. 62 (3):779-85.

[2] I. Anastasiou, I. Katafigiotis, C. Pournaras, E. Fragkiadis, I. Leotsakos, and D. Mitropoulos, "A cough deteriorating gross hematuria: a clinical sign of a forthcoming life-threatening rupture of an intraparenchymal aneurysm of renal artery (Wunderlich's Syndrome)," Case Reports in Vascular Medicine, vol. 2013, Article ID 452317, 3 pages, 2013

2a

2b

2c

2d

2 Cinematic rendering images, using different presets, show the anterior (Figs. 2a and 2b) and posterior (Figs. 2c and 2d) views of the abdominal aorta and its branches, before (Fig. 2a) and after (Figs. 2b–2d) bone removal using *syngo*.CT DE Direct Angio. Kidney perfusion appears symmetrical.

Examination Protocol

Scanner	SOMATOM Definition Edge				
Scan area	Abdomen	Dose modulation	CARE Dose4D™	Slice width	0.75 mm
Scan mode	TwinBeam Dual Energy	CTDI$_{vol}$	7.83 mGy	Reconstruction increment	0.5 mm
Scan length	406 mm	DLP	332 mGy cm	Reconstruction kernel	Q30f
Scan direction	Caudo-cranial	Effective dose	4.98 mSv	Contrast	400 mg/mL
Scan time	7.7 s	Rotation time	0.33 s	Volume	120 mL + 40 mL saline
Tube voltage	AuSn 120 kV	Pitch	0.45	Flow rate	4 mL/s
Effective mAs	365 mAs	Slice collimation	64 × 0.6 mm	Start delay	Bolus tracking

Giant Arteriovenous Malformation of the Anterior Abdominal Wall

By Neeraj Wadhwa, MD, and Sunil Kumar Puri, MD
Department of Radiology, GB Pant Institute of Postgraduate Medical Education and Research (GIPMER), New Delhi, India

History

A 20-year-old male patient, suffering from a painless, progressive, pulsatile swelling in the left paramidline anterior abdomen for the past 10 years, was presented to the hospital. A vascular malformation was suspected and a CT angiography (CTA) was ordered to assess the vascular supply and the extent of the lesion prior to surgical resection.

Diagnosis

CTA images revealed a left paramidline soft tissue mass, measuring 8 × 15 × 18 cm in size, in the left rectus abdominis with gross vascularity suggestive of an arteriovenous malformation (AVM). Arterial feeders were visible, superiorly from the prominent left internal mammary artery via the left superior epigastric artery and inferiorly through the left inferior epigastric artery originating from the left external iliac artery. No signs of a major draining vein or an arterial-venous (A-V) shunt could be identified in either arterial or venous phase. The histological result derived from an operative resection confirmed the diagnosis of an AVM.

Comments

An AVM is a disorder in which the blood shunts directly from the arteries to the veins, bypassing the capillaries. The channels between the artery and

1a

1b

1 Right (Fig. 1a) and left (Fig. 1b) oblique views of cinematic rendering images, acquired in the arterial phase, depict an AVM of the anterior abdominal wall along with its arterial feeders, superiorly from the prominent left internal mammary artery via the left superior epigastric artery and inferiorly through the left inferior epigastric artery originating from the left external iliac artery.

vein are termed the "nidus". The nidus can consist of a smaller number of large arteriovenous shunts, which was not seen here, or a vast number of tiny shunts, which can only be confirmed by histopathology at the microscopic level, such as in this case. Although MRI and ultrasound are preferable for acquiring hemodynamic information, CTA is widely available and accessible to provide the necessary information concerning vascular anatomy, enhancement, thrombosis, calcification, and involvement of adjacent structures. With the development of advanced technologies, significant reductions in radiation dose and contrast agent have been made possible, which promote the applications of CTA in clinical routine. In this case, a 100 kV setting was applied, combined with CARE Dose4D™ (Real-time Anatomic Exposure Control), to achieve a complete acquisition of the trunk at a $CTDI_{vol}$ of only 3.3 mGy. Three-dimensional images aid the physicians for clear communication and demonstration.

Examination Protocol

Scanner	**SOMATOM Definition Flash**				
Scan area	Thorax – Abdomen	**Dose modulation**	CARE Dose4D™	**Slice width**	0.75 mm
Scan mode	Spiral	**$CTDI_{vol}$**	3.31 mGy	**Reconstruction increment**	0.5 mm
Scan length	567.5 mm	**DLP**	211 mGy cm	**Reconstruction kernel**	B26f
Scan direction	Cranio-caudal	**Effective dose**	3.2 mSv	**Contrast**	350 mg/mL
Scan time	6.2 s	**Rotation time**	0.5 s	**Volume**	70 mL+ 20 mL saline
Tube voltage	100 kV	**Pitch**	1.2	**Flow rate**	3.5 mL/s
Effective mAs	80 mAs	**Slice collimation**	128 × 0.6 mm	**Start delay**	Bolus tracking + 5s

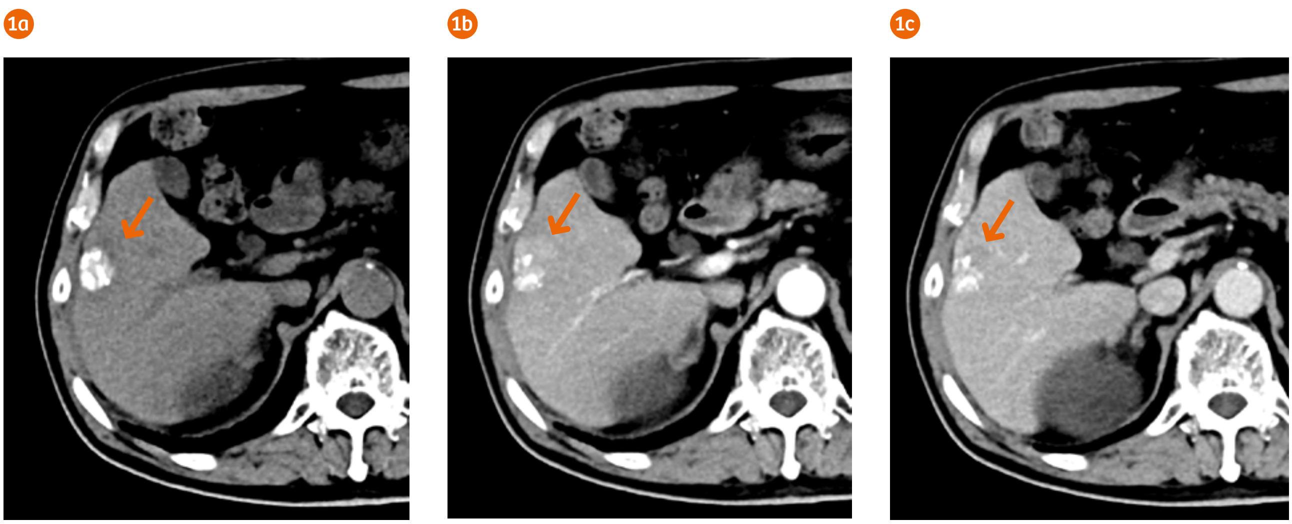
2a

2b

2 Right oblique view of a cinematic rendering image (Fig. 2a) and a sagittal MPR image (Fig. 2b), acquired in the venous phase, show a soft tissue mass with gross vascularity in the anterior abdominal wall without the presence of major A-V shunts or draining veins.

Recurrent Hepatocellular Carcinoma after TACE in a Patient with Renal Function Insufficiency

By Morikatsu Yoshida, MD
Department of Radiology, Amakusa Medical Center, Kumamoto, Japan



1 Axial images in noncontrast (Fig. 1a), arterial (Fig. 1b) and portal venous (Fig. 1c) phases show a low attenuation, irregular-shaped lesion (Fig. 1a, arrow) adjacent to the previous TACE site in S5 of the liver, with early enhancement (Fig. 1b, arrow) and washout (Fig. 1c, arrow). The image in the portal venous phase (Fig. 1c) shows significant contrast enhancement of the liver parenchyma and indistinct image noise.

History

An 80-year-old male patient, suffering from liver cirrhosis and chronic hepatitis B, was diagnosed with hepatocellular carcinoma (HCC) and underwent transarterial chemoembolization (TACE) in 2010. Due to his chronic renal damage (the estimated glomerular filtration rate was 28–35 mL/min/1.73 m^2), noncontrast CT or MRI had been performed for post-TACE follow-ups. In the last CT examination, a low attenuation lesion adjacent to the previous TACE site was visualized, raising the suspicion of a HCC recurrence. Considering his renal function insufficiency, a contrast-enhanced CT (CECT) scan was performed using a contrast agent with lower concentration (180 mgI/mL) and 70 kV setting. MRI was not performed due to anticipated patient's intolerability of the examination time.

Diagnosis

Noncontrast CT images showed a hypodense, irregular-shaped lesion, measuring 20 × 13 mm in size, arising from the adjacent previous TACE site in segment 5 (S5) of the liver (Fig. 1a). The lesion showed an early enhancement in the arterial phase (Fig. 1b) and washout in the venous phase (Fig. 1c), which characterized a HCC recurrence. The digital subtraction angiography (DSA) from celiac artery showed the tumor stain (Fig. 2), which confirmed the CT findings. A TACE was performed from the artery of S5 (A5) of the liver with a suspension of epirubicin and lipiodol.

Comments

CECT is routinely performed for the visualization of liver lesions. However, in practice, it can be very challenging in patients suffering from moderate to severe chronic renal damage, as in this case, due to the concern of contrast-induced nephrotoxicity (CIN). On the one hand, reduction of concentration and volume has to be considered when applying contrast agent to these patients; on the other hand, the required lesion enhancement should be achieved for differential diagnosis. Although it is known that enhancement can be improved through lower kV settings, limitations on tube current output often prevents its application in clinical routine. In this case, a Dual Source CT dedicated scan mode called "Dual Power" was applied. This uses the power of both X-ray tubes simultaneously to provide a higher tube current needed at the 70 kV setting. Excellent lesion enhancement and image quality are achieved with an ultra-low contrast dose of 180 mgI/mL, as well as a significant radiation dose (mean $CTDI_{vol}$) reduction when compared with previous follow-up CT scans.

In our opinion, the combination of dual X-ray tube power at lower kV settings has significant potential in clinical use for patients with renal function insufficiency. It also helps the physicians to make a confident diagnosis. ●

Note

[1] the same scan protocol was performed for all three phases.

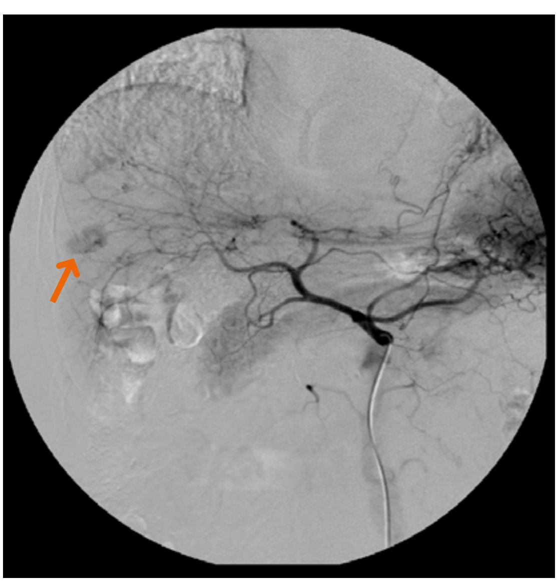
[2] the DSA was performed on AXIOM Artis U.

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.

Examination Protocol

Scanner	**SOMATOM Drive**
Scan area	Abdomen
Scan mode	Dual Power spiral mode
Scan length	290 mm
Scan direction	Cranio-caudal
Scan time	12 s
Tube voltage	70/70 kV
Effective mAs	557 mAs
Dose modulation	CARE Dose4D™
$CTDI_{vol}$	6.5 mGy
DLP	188.1 mGy cm
Effective dose	2.6 mSv
Rotation time	0.5 s
Pitch	0.7
Slice collimation	32 × 0.6 mm
Slice width	1.0 mm
Reconstruction increment	0.7 mm
Reconstruction kernel	I30f ADMIRE 3
Contrast	180 mgI/mL
Volume	34 mL + 30 mL saline
Flow rate	1.1 mL/s
Start delay	Bolus triggering in the descending aorta with a threshold of 100 HU and an additional delay of 18 s

2



2 A DSA image from celiac artery demonstrates the tumor stain (arrow) confirming CECT findings.

Metastatic Clear Cell Renal Cell Carcinoma and Complicated Renal Cyst

By Matthias Benz, MD, and Professor Daniel Boll, MD
Clinic of Radiology and Nuclear Medicine, University Hospital Basel, Basel, Switzerland

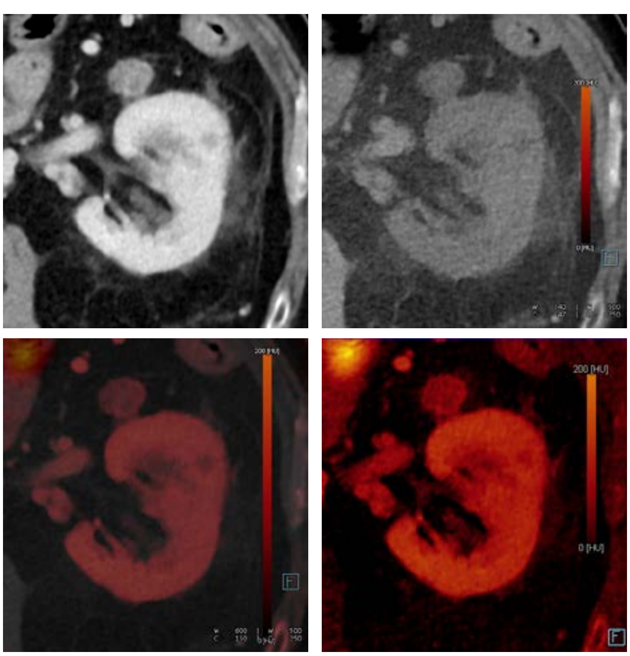
History

A 76-year-old male patient, suffering from metastatic clear cell renal cell carcinoma (RCC), underwent a right-sided nephrectomy and was post-operatively treated with Pazapanib. A follow-up thoraco-abdomino-pelvic CT examination was ordered for restaging. TwinBeam Dual Energy (TBDE) CT was performed.

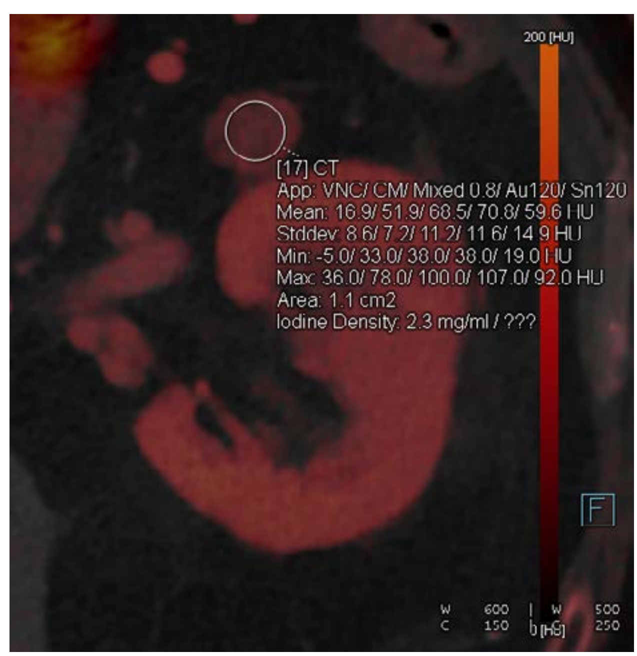
Diagnosis

TBDE CT mixed images revealed two small, regular-shaped renal lesions – middle anterior (lesion 1) and upper posterior (lesion 2) to the left kidney, measuring 2.1 × 1.6 cm and 1.2 × 1.5 cm in size, with elevated attenuation. Lesion 1 was hypodense in the virtual noncontrast (VNC) image and showed iodine uptake in the iodine map and iodine/VNC fused image (Figs. 1 and 3). This suggested a metastasis. Lesion 2 remained hyperdense in the VNC image, and showed no iodine uptake in the iodine map and iodine/VNC fused image (Figs. 2 and 3). The lesion demonstrated characteristics compatible with a complicated cyst (Bosniak category II).

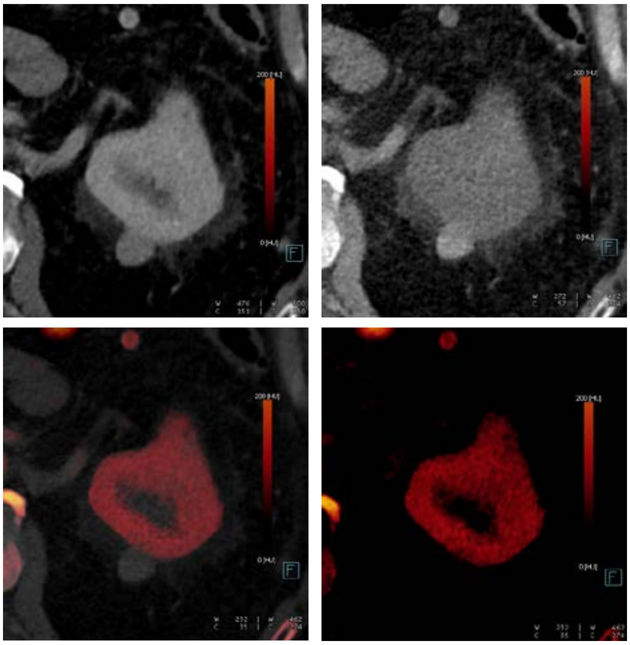
1a

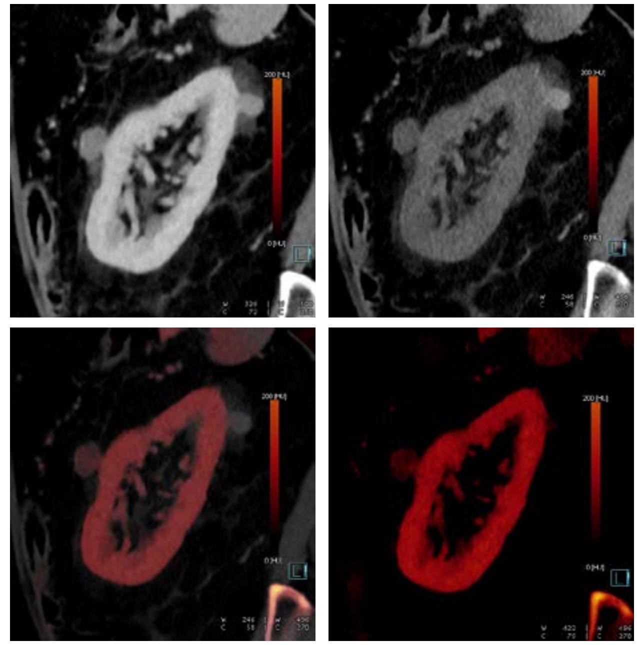


1b



1 Lesion 1 is hypodense in VNC (UR) image and shows clear enhancement in mixed (UL), VNC/iodine fused (LL) and iodine (LR) images (Fig. 1a). DE ROI measurements (Fig. 1b) reveal an increased CT value of 51.9 HU with an iodine density of 2.3 mg/mL.





2 Lesion 2 is hyperdense in VNC (UR) image and shows no enhancement in mixed (UL), VNC/iodine fused (LL) and iodine (LR) images (A).

3 An overview of both lesions.

Comments

The differential diagnosis of a newly visualized renal lesion becomes essential for management of the patient and estimation of the prognosis.[1] In this case, two renal lesions were visualized and both showed elevated attenuation in the contrast scanning – does the increased density characterize contrast enhancement? Traditionally, it would require another noncontrast scan to find out. However, TBDE CT enables simultaneous image acquisition at two different energy levels. The same dataset can be processed using *syngo*.CT DE Virtual Unenhanced to generate virtual noncontrast images as well as iodine maps. Comparison of the attenuation values in the VNC images, mixed images, and iodine maps reveal iodine uptake in lesion 1 and no uptake in lesion 2, which correlates with the lesion characteristics of a metastasis (lesion 1) and a complicated cyst (lesion 2). In such a clinical scenario, TBDE CT helps the physician to make a confident differential diagnosis. ●

Examination Protocol

Scanner	SOMATOM Definition Edge		
Scan area	TAP	**Rotation time**	0.33 s
Scan mode	TwinBeam Dual Energy	**Pitch**	0.25
Scan length	648 mm	**Slice collimation**	64 × 0.6 mm
Scan direction	Cranio-caudal	**Slice width**	1.5 mm
Scan time	22 s	**Reconstruction increment**	1 mm
Tube voltage	AuSn120 kV	**Reconstruction kernel**	Q30f
Effective mAs	554 mAs	**Contrast**	370 mg/mL
Dose modulation	CARE Dose4D™	**Volume**	90 mL
$CTDI_{vol}$	11.8 mGy	**Flow rate**	3 mL/s
DLP	788.2 mGy cm	**Start delay**	45 s
Effective dose	11.8 mSv		

References

[1] L. Pallwein-Prettner et, al. Assessment and characterisation of common renal masses with CT and MRI. Insights Imaging (2011) 2:543–556

An Incidental Renal Mass

By Professor Alec J. Megibow, MD
Department of Radiology, NYU-Langone Medical Center, NY, USA

History

A 75-year-old male patient with recent unexplained bowel obstruction was sent for a follow-up CT enterography. TwinBeam Dual Energy (TBDE) CT was performed.

Diagnosis

TBDE images showed a left renal soft tissue lesion, measuring 1.8 × 2.1 × 2.1 cm in size, with contrast enhancement compatible with a renal neoplasm. This was later confirmed by PET. There was no evidence of bowel obstruction or the presence of any obstructing lesions. The patient subsequently underwent partial nephrectomy for this unsuspected lesion. Pathology revealed a clear cell renal carcinoma.

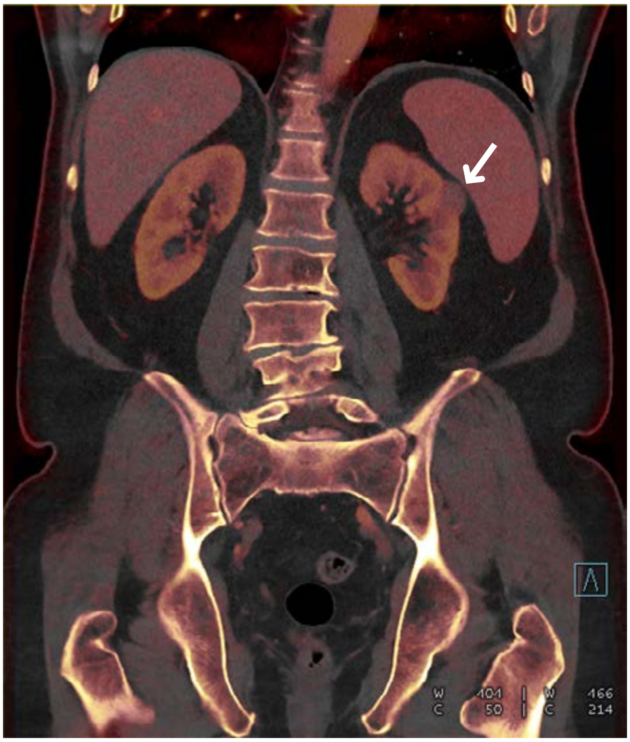
Comments

This is a common scenario, in which a finding is observed that would require further testing to characterize for treatment decision. TBDE CT is ideally suited for these patients, allowing simultaneous acquisition of high and low kV datasets in a single scan. The dataset can then be processed in *syngo*.CT DE Virtual Unenhanced to create either a virtual noncontrast (VNC) (Fig. 1d) image or an iodine map (Figs. 1a, 1c and 2) for presenting and quantifying the iodine uptake, which is more useful in clinical practice. In this case, the unsuspected renal mass enhanced 38 HU (CM) from 45.9 HU (VNC) to 83.7 HU (mixed). This change in HU would be close to what might be observed if a "traditional" noncontrast CT acquisition were to be compared to a contrast-enhanced acquisition. This approach could eliminate the need for a noncontrast scan. The value of not having to recall the patient for another exam and avoidance of additional exposure is obvious. ●

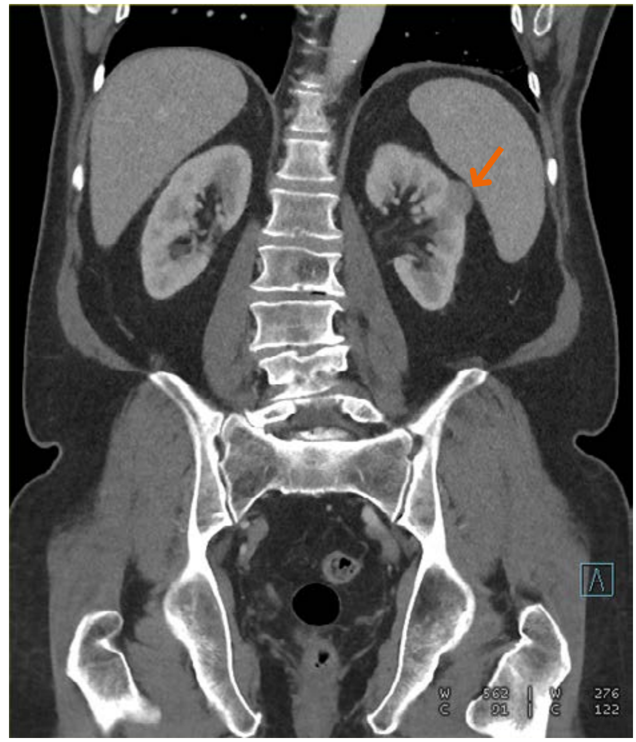
Examination Protocol

Scanner	SOMATOM Definition Edge		
Scan area	Abdomen	**Rotation time**	0.33 s
Scan mode	TwinBeam Dual Energy	**Pitch**	0.3
Scan length	446 mm	**Slice collimation**	64 × 0.6 mm
Scan direction	Caudo-cranial	**Slice width**	0.75 mm
Scan time	12.6 s	**Reconstruction increment**	0.5 mm
Tube voltage	AuSn120 kV	**Reconstruction kernel**	Q40f
Effective mAs	381 mAs	**Contrast**	300 mg/mL
Dose modulation	CARE Dose4D™	**Volume**	124 mL
$CTDI_{vol}$	8.16 mGy	**Flow rate**	2.5 mL/s
DLP	387.2 mGy cm	**Start delay**	60 s
Effective dose	5.81 mSv		

1a

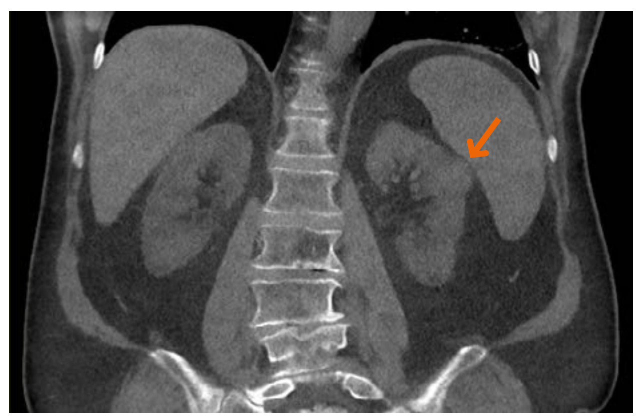


1b

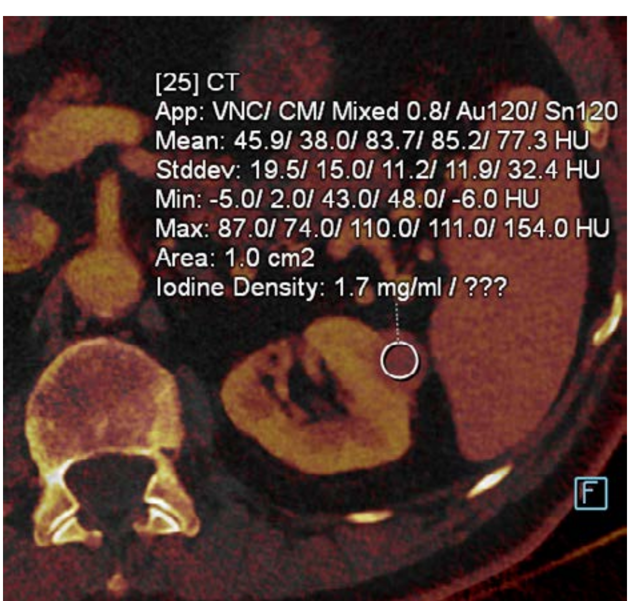


1c

1d



2



1 Coronal views of an iodine/mixed fused image (Figs. 1a, and 1c, different window settings) and a mixed image (Fig. 1b) show an enhanced left renal lesion (arrows) which was isodense in a VNC image (Fig. 1d, arrow). The enhancement is much easier to depict in the iodine/mixed fused images.

2 Quantitative measurements show a significant enhancement of 38 HU in the left renal lesion, with an iodine uptake of 1.7 mg/mL.

Complicated Silicosis

By Márcio Rodrigues, MD; André Carvalho, MD; Patrícia Leitão, MD; António Madureira, MD and Rui Cunha, MD
Department of Radiology, Centro Hospitalar de S. João, Porto, Portugal

History

A 45-year-old male patient, complaining of progressive shortness of breath, coughing with sputum production and weight loss for the past two years, was referred to a chest physician for checkup. He had worked as a quarryman since the age of 20, without using respiratory protection. A chest CT scan was ordered on suspicion of an occupational lung disease.

Diagnosis

CT images showed diffuse, small, well-defined nodules, mainly in a centrilobular distribution (Figs. 1 and 2). In the posterior segments of the upper lobes and superior segments of the lower lobes, the nodules were more confluent (Figs. 1 and 2), forming conglomerate masses, with some punctiform calcifications (Fig. 3). There were also enlarged calcified hilar and mediastinal lymph nodes along with pleural pseudoplaques (Fig. 3).

Taking into account the clinical context, the CT findings are compatible with complicated silicosis (progressive massive fibrosis).

Comments

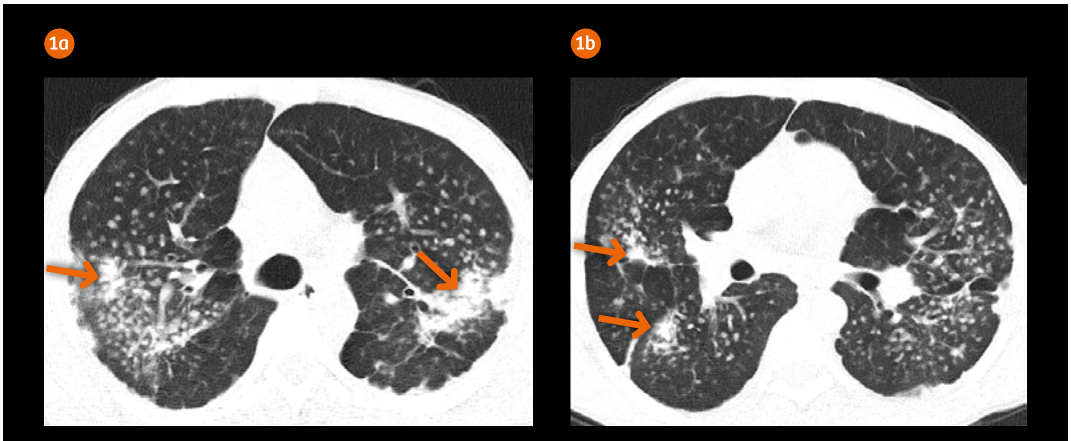
Silicosis is a fibrotic pneumoconiosis caused by the inhalation of fine particles of crystalline silicon dioxide (silica). It occurs in two clinical forms – acute or classic. The classic form is much more common than the acute form and can be classified as simple or complicated. The designation of complicated silicosis (also called progressive massive fibrosis) is used when conglomerate masses are larger than 1 cm in diameter. Occupations such as mining, quarrying, and tunneling are associated with silicosis. Although chest radiography is the first-line imaging method in the workup of suspected occupational lung disease, CT is more sensitive and specific for the visualization and characterization of this.[1] The concern regarding radiation dose for chest CT scans, has prevented its use in the early assessment of occupational lung disease. However, advanced technology development has made it possible to achieve a very high spatial resolution at an ultra-low radiation dose. In this case, the Tin Filter technique was applied. This technique cuts out lower energies from the X-ray spectrum to reduce dose and minimizes beam-hardening artifacts to optimize image quality. An exceptional low dose of $CTDI_{vol}$ 0.67 mGy was achieved without compromising image quality for diagnosis.

Examination Protocol

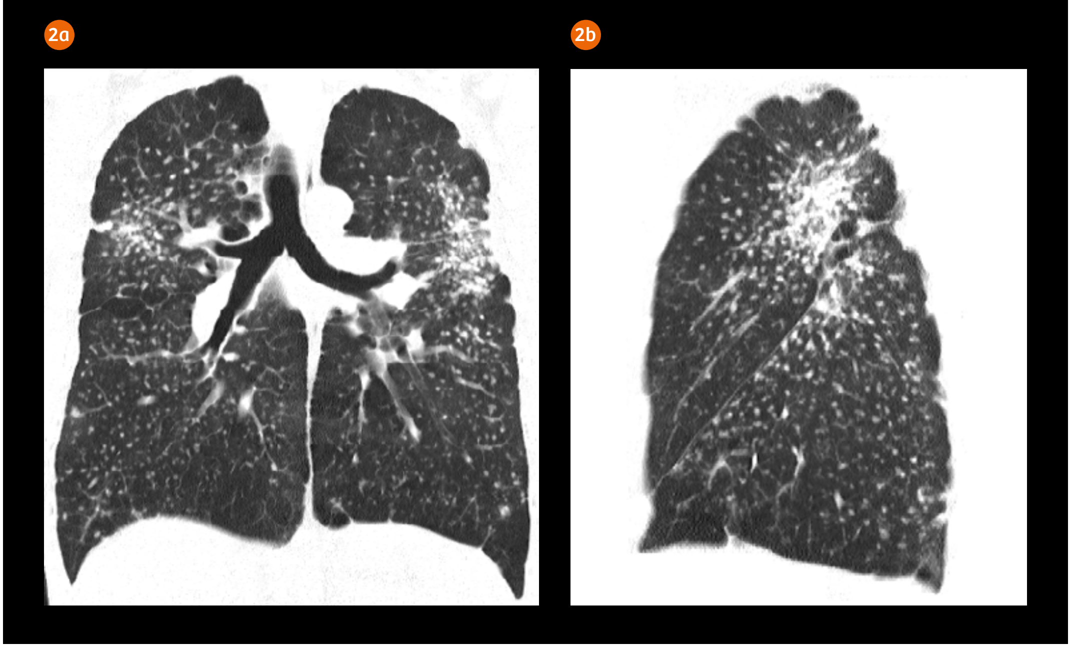
Scanner	SOMATOM go.Up		
Scan area	Thorax	DLP	28 mGy cm
Scan mode	Spiral	Effective dose	0.39 mSv
Scan length	374.7 mm	Rotation time	0.8 s
Scan direction	Cranio-caudal	Pitch	1.5
Scan time	8.5 s	Slice collimation	32 × 0.7 mm
Tube voltage	Sn110 kV	Slice width	5 mm
Effective mAs	47 mAs	Reconstruction increment	5 mm
Dose modulation	CARE Dose4D™	Reconstruction kernel	Br40/Br60
$CTDI_{vol}$	0.67 mGy		

References

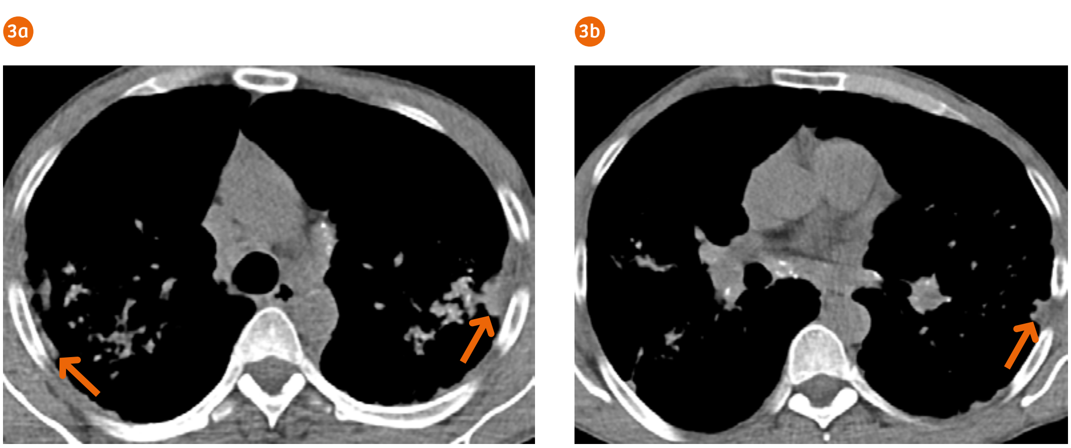
[1] Champlin, J., Edwards, R. and Pipavath, S. (2016). Imaging of Occupational Lung Disease. Radiologic Clinics of North America, 54(6), pp.1077-1096.



1 Axial images in lung window demonstrate diffuse pulmonary nodules in the upper (Fig. 1a) and lower (Fig. 1b) lobes, forming conglomerate masses (arrows).



2 Coronal (Fig. 2a) and sagittal (Fig. 2b) MPR images in lung window depict the predominance of nodules in the upper and posterior zones of lungs, coalescing to form masses.



3 Axial images in soft tissue window show pleural pseudoplaques (arrows) and speckled calcifications in the enlarged hilar and mediastinal lymph nodes as well as in the conglomerate masses.

Right-sided Aortic Arch with Aberrant Left Subclavian Artery from Kommerell's Diverticulum

By KG Srinivasan, MD
KGS Advanced MR and CT Scan, Madurai, Tamil Nadu, India

History

A 38-year-old female patient, complaining of occasional breathlessness and dyspnea upon exertion, presented herself to the hospital. A thoracic CT angiography (CTA) was requested for further investigation.

Diagnosis

CTA images showed a right-sided aortic arch with the thoracic aorta descending along the right side of the spine and an aberrant left subclavian artery rising from the Kommerell's diverticulum (Figs. 1a–1e). The branches of the right-sided aortic arch, from proximal to distal were the left common carotid, innominate, and left subclavian arteries. The Kommerell's diverticulum was situated posteriorly to the trachea and esophagus forming a vascular ring (Figs. 1a, 1b, and 1d). The right principal bronchus was compressed by the right pulmonary artery and the right-sided descending aorta (Fig. 1f).

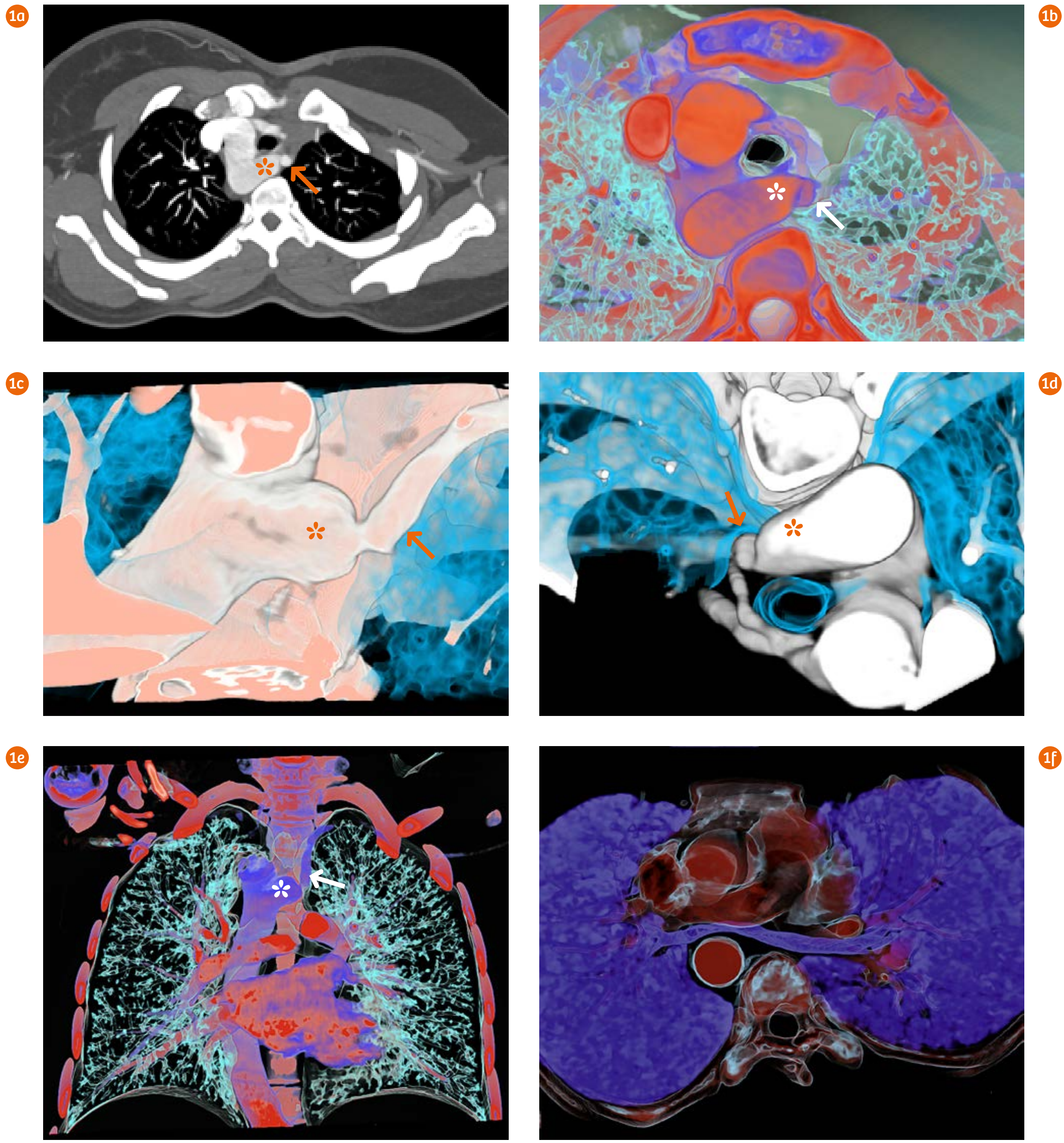
All pulmonary vessels were clear, showing no evidence of pulmonary embolism (PE).

Comments

The diverticulum is the remnant of the left fourth aortic arch and was originally described by Burckhard Friedrich Kommerell in 1936. The aberrant left subclavian artery usually originates from a Kommerell's diverticulum. Patients with right-sided aortic arch and aberrant subclavian artery might have symptoms related to the presence of the vascular ring. In this case, there was additional evidence of the compressed right principal bronchus suggesting that the patient's symptoms were related to the vascular variations. The combination of 80 kV and sub-mm collimation was applied to obtain high quality CTA images with reduced radiation dose and contrast agent. This is especially valuable for visualizing small distal vessels, helping the physician to rule out small peripheral PEs. ●

Examination Protocol

Scanner	SOMATOM go.Now		
Scan area	Thorax	**Rotation time**	0.8 s
Scan mode	Spiral	**Pitch**	1.5
Scan length	199 mm	**Slice collimation**	16 × 0.7 mm
Scan direction	Cranio-caudal	**Slice width**	1.5 mm
Scan time	9.2 s	**Reconstruction increment**	1.0 mm
Tube voltage	80 kV	**Reconstruction kernel**	Br40
Effective mAs	164 mAs	**Contrast**	350 mg/mL
Dose modulation	CARE Dose4D™	**Volume**	50 mL + 40 mL saline
$CTDI_{vol}$	5.17 mGy	**Flow rate**	5 mL/s
DLP	115 mGy cm	**Start delay**	Bolus tracking + 4 s
Effective dose	1.6 mSv		



1 Axial (Fig. 1a) and VRT images (Figs. 1b–1f) show a right-sided aortic arch with the thoracic aorta descending along the right side of the spine (Fig. 1e), and an aberrant left subclavian artery (Figs. 1a–1e, arrows) rising from the Kommerell’s diverticulum (Figs. 1a–1e, asterisk), which is posterior to the trachea and esophagus forming a vascular ring. The right principal bronchus is compressed by the right pulmonary artery and the right-sided descending aorta (Fig. 1f).

Cardiac and Respiratory CT Evaluation in a Neonate Prior to Pulmonary Balloon Valvuloplasty

By Xilong Mei, MD; Ting Huang, MD; Kai Deng, MD and Qinru Liu, MD
Department of Radiology, the Second Xiangya Hospital of Central South University Changsha, Hunan, P. R. China

History

A neonate, born with cyanosis and tachypnea, was presented to the hospital. An echocardiography revealed an atrial septal defect (ASD), a pulmonary valve stenosis (PVS), a patent ductus arteriosus (PDA) and a tricuspid regurgitation. Pulmonary balloon valvuloplasty (PBV) was indicated and a CT examination was requested to confirm the echocardiography findings and to evaluate the respiratory system prior to the intervention.

Diagnosis

CT images showed a significantly enlarged right atrium, an ASD (Fig. 1), a PVS with an infundibular stenosis and a PDA (Fig. 2). The three-dimensional reconstruction of the airways (Fig. 3) appeared normal. Hyperdense patchy shadows (Fig. 3) were seen locally in the left lower lung hereby suggesting exudative lesions.

A PBV guided by transesophageal echocardiography (TEE) was successfully performed and the differential pressure of the pulmonary valve was significantly reduced, as shown in a color Doppler ultrasound (CDU) examination performed directly after the intervention.

Comments

Echocardiography is traditionally the technique of choice for the evaluation of congenital heart diseases. However, with advances in technology, CT imaging is increasingly playing an important role in the evaluation of these disorders.[1] Higher spatial resolution and isotropic multiplanar data reconstruction are major advantages of cardiac CT. Prior CT evaluations of

Examination Protocol

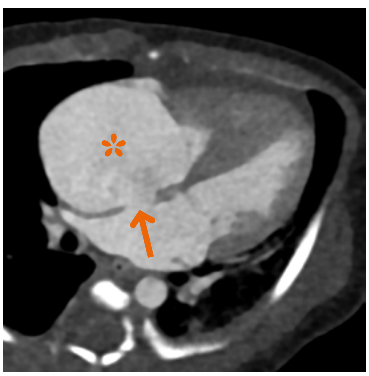
Scanner	SOMATOM Force		
Scan area	Thorax	Rotation time	0.25 s
Scan mode	Turbo Flash	Pitch	3.2
Scan length	106.8 mm	Slice collimation	192 × 0.6 mm
Scan direction	Cranio-caudal	Slice width	0.75 mm
Scan time	0.15 s	Reconstruction increment	0.4 mm
Tube voltage	70 kV	Reconstruction kernel	Bv40 (ADMIRE 3)
Effective mAs	104 mAs	Heart rate	117–122 bpm
Dose modulation	CARE Dose4D™	Contrast	370 mg/mL
$CTDI_{vol}$	0.3 mGy	Volume	6 mL
DLP	4.6 mGy cm	Flow rate	0.4 mL/s
Effective dose	0.48 mSv	Start delay	Bolus tracking with 100 HU at ascending aorta +4 s

the airways and the lungs are necessary when planning an intervention or surgery. In neonates, artifacts caused by higher heart rates and breathing rates, as well as reduced radiation dose are major challenges. In this case, a prospective ECG-triggered Turbo Flash Spiral scanning mode was performed to obtain a complete thoracic acquisition in 0.15 s within a single heart beat while the baby was breathing freely. The image quality was superb for the evaluation of the heart, the airways, and the lungs. A 70 kV setting was used to assure an excellent enhancement although only 6 mL contrast agent was applied. In addition, advanced modeled iterative reconstruction (ADMIRE) was integrated to achieve an effective dose as low as 0.48 mSv. ●

References:

[1] Saremi F, Gera A, Ho S Y, et al. CT and MR imaging of the pulmonary valve. Radiographics, 2014, 34(1):51-71.

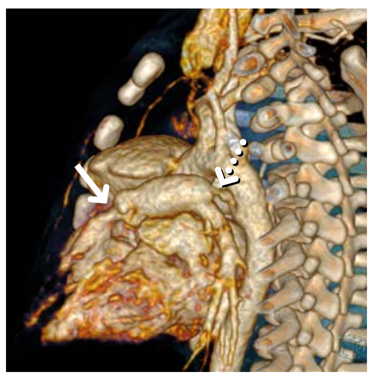
1a



1b

1 MPR images show a significantly enlarged right atrium (asterisk) and an ASD (arrows).

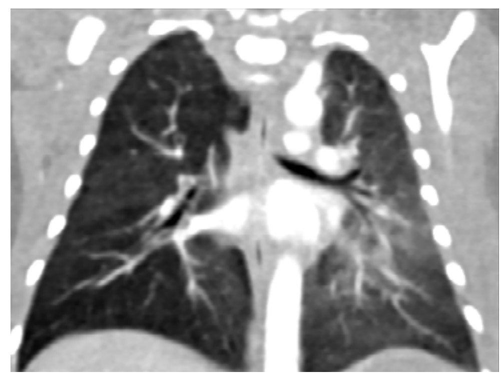
2a



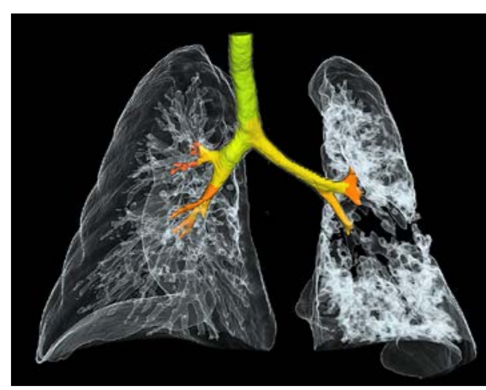
2b

2 VRT images show a PVS with an infundibular stenosis (arrows) and a PDA (dashed arrows).

3a



3b



3 Coronal MPR (Fig. 3a) and VRT (Fig. 3b) images reveal hyperdense patchy shadows in the left lower lung suggesting exudative lesions. The airways appear normal.

Diagnosis of an Ischemic Bowel Intussusception

By Professor Marilyn Siegel, MD
Mallinckrodt Institute of Radiology, Washington University School of Medicine, St. Louis, Missouri, USA

History

A 9-year-old girl, with a 2-week history of intermittent severe abdominal pain, had undergone an abdominal ultrasound which showed thickened loops of bowel with possible small bowel obstruction. A Dual Energy CT was recommended for further evaluation.

Diagnosis

The axial mixed contrast-enhanced CT images (Figs. 1a and 1c), reconstructed with a 0.5 blend of Sn140 kV and 80 kV data, demonstrated a long, large-caliber, dilated bowel loop representing a small bowel intussusception (ileo-ileal) with a lead mass (Fig. 1c, arrow). The hypo-enhancement of the bowel wall suggested bowel ischemia. The axial (Fig. 1b) and coronal (Fig. 1d) iodine maps show no enhancement of the bowel wall, confirming bowel ischemia. The color mapping is normal in the distal small bowel (Fig. 1d, arrow). Surgery confirmed small-bowel intussusception with ischemic bowel loops. Final pathological studies indicated that the patient had a mucosal hamartomatous polyp acting as the lead point.

Comments

Intussusception is the invagination of a bowel loop with its mesenteric fold (intussusceptum) into the lumen of contiguous bowel (intussuscipiens). Intraluminal polypoid lesions have a greater tendency to cause invagination of the bowel. CT is useful to differentiate between lead point and non-lead point intussusception and associated complications, such as bowel obstruction and ischemia, which can lead to intestinal infarction if not diagnosed early. In CT, segmental bowel wall hypo-enhancement is a highly suggestive sign of intestinal ischemia.

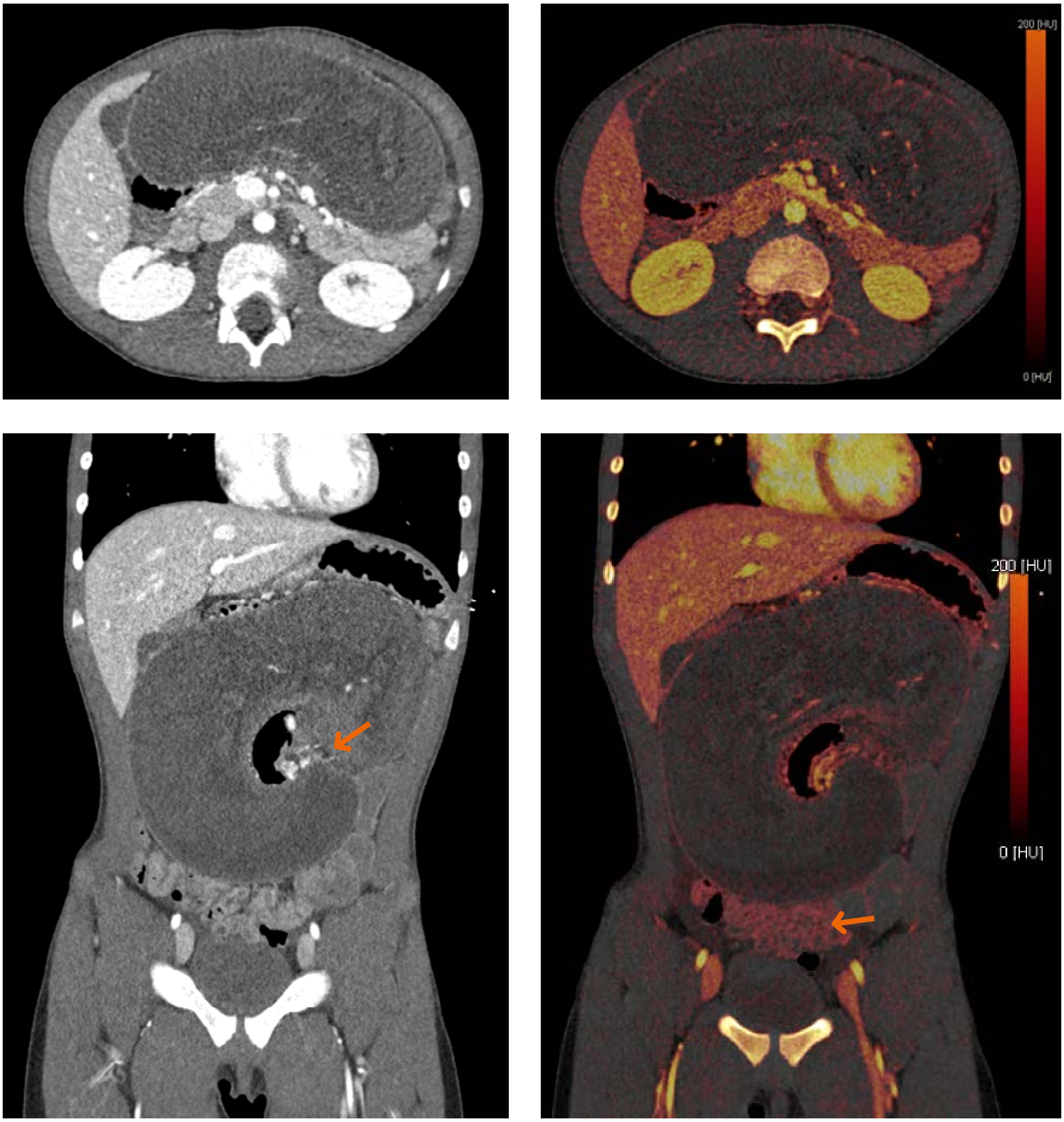
A potential benefit of Dual Energy CT is the possibility of improved visualization of ischemic bowel segments. The use of the iodine map, a technique only available when scanning with Dual

Examination Protocol

Scanner	SOMATOM Definition Flash		
Scan area	Abdomen	Rotation time	0.28 s
Scan length	357.7 mm	Pitch	0.8
Scan direction	Cranio-caudal	Slice collimation	128 × 0.6 mm
Scan time	3.3 s	Slice width	0.75 mm
Tube voltage	80/Sn140 kV	Reconstruction increment	0.7 mm
Tube current	54/29 mAs	Reconstruction kernel	Q33f
Dose modulation	CARE Dose4D™	Contrast	320 mg/mL
$CTDI_{vol}$	2.14 mGy	Volume	100 mL
DLP	85 mGy cm	Flow rate	2 mL/s
Effective dose	3.06 mSv[1]	Start delay	50 s

[1] Estimated by applying a conversion factor of 0.015, and an additional factor of 2.4 converting the reported DLP (32 cm) into the DLP (16 cm).

1a 1b 1c 1d



1 Axial (Figs. 1a and 1b) and coronal (Figs. 1c and 1d) mixed images (Figs.1a and 1c) and iodine maps (Figs. 1b and 1d) demonstrate a long, large-caliber, dilated bowel loop representing a small bowel intussusception (ileo-ileal) with a lead mass (Fig. 1c, arrow), and no enhancement of bowel wall confirming bowel ischemia. Color mapping is normal in the distal small bowel (Fig. 1d, arrow).

Energy CT, can allow for increased conspicuity of ischemic segments compared with that of conventional scanning. In this case, the blended images showed intussusception and hypo-perfused bowel. By using *syngo* Dual Energy iodine mapping, it was possible to allow the physician to confirm the absence of iodine concentration in the bowel wall, therefore providing a specific diagnosis of ischemia. Dual Energy CT technology allows improved diagnostic confidence and also results in a radiation exposure similar to or less than single source CT.

Gouty Tophi and Haglund's Deformity in the Right Foot

By Merli Matteo, RT; Vincent Tobe, MD; Medico Capo Clinica, MD;
Ermidio Rezzonico, RT, and Prof. Filippo Del Grande, MD
Department of Radiology, Lugano Regional Hospital, Public Cantonal Hospital Corporation,
Lugano, Switzerland

History

An 84-year-old male patient, suffering from long-term arthrosis, had been treated for hyperuricemia. Recently, although the serum uric acid test results were normal, the patient had been complaining of pain in the right foot. A TwinBeam Dual Energy (TBDE) CT scan was requested for further evaluation.

Diagnosis

DECT images revealed small discrete uric acid deposits next to the 1st, 2nd and 3rd metatarsophalangeal joints. Signs of bone erosion of the 2nd distal metatarsal were also seen. A Haglund's deformity of the calcaneus was shown with a bony prominence in the posterior superior aspect and this was associated with a calcaneus spur.

Examination Protocol

Scanner	SOMATOM Definition Edge		
Scan area	Right foot	**DLP**	154.2 mGy cm
Scan mode	TwinBeam Dual Energy	**Effective dose**	0.12 mSv[1]
Scan length	230 mm	**Rotation time**	0.5 s
Scan direction	Cranio-caudal	**Pitch**	0.35
Scan time	8.4 s	**Slice collimation**	64 × 0.6 mm
Tube voltage	AuSn120 kV	**Slice width**	0.75 mm
Effective mAs	290 mAs	**Reconstruction increment**	0.5 mm
Dose modulation	CARE Dose4D™	**Reconstruction kernel**	Q30f
$CTDI_{vol}$	6.2 mGy		

[1] Estimated by applying a conversion factor of 0.0008.

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.

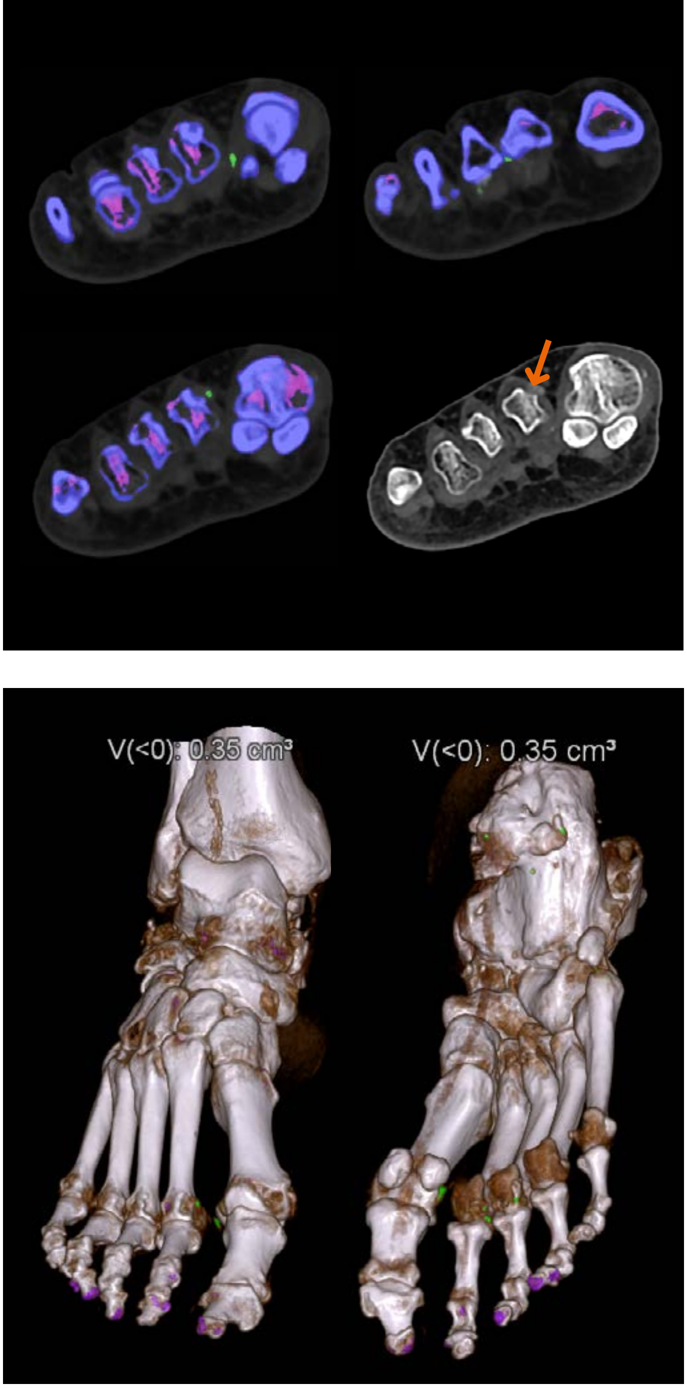
Comments

Before DECT, synovial fluid aspiration was accepted as the most reliable way of diagnosing gout. Hereby, the presence of monosodium urate crystals could be confirmed. The method does, however, have some inherent limitations such as sampling or interpretation errors.[1, 2, and 3] Therefore, alternative tests are desirable for the detection of MSU crystals in order to aid the clinicians in distincting gouty arthritis from other types of inflammatory arthritis and also to avoid unnecessary and ineffective treatment strategies. While the chemical composition of uric acid precipitates has unique characteristic patterns of CT numbers at high versus low kilovolts (kV), TBDE CT can acquire high and low kV datasets simultaneously in a single scan thus allowing visualization of MSU deposition. This is especially helpful in anatomic areas where aspiration can be difficult to perform as well as in cases of extra-articular MSU deposits around tendon and ligament attachment sites where the analysis of intra-articular SF would reveal negative results.

A Haglund's deformity was first described by Patrick Haglund in 1927. [4] It is characterized by an enlargement of the bony section of the heel (where the Achilles tendon is attached)

1a

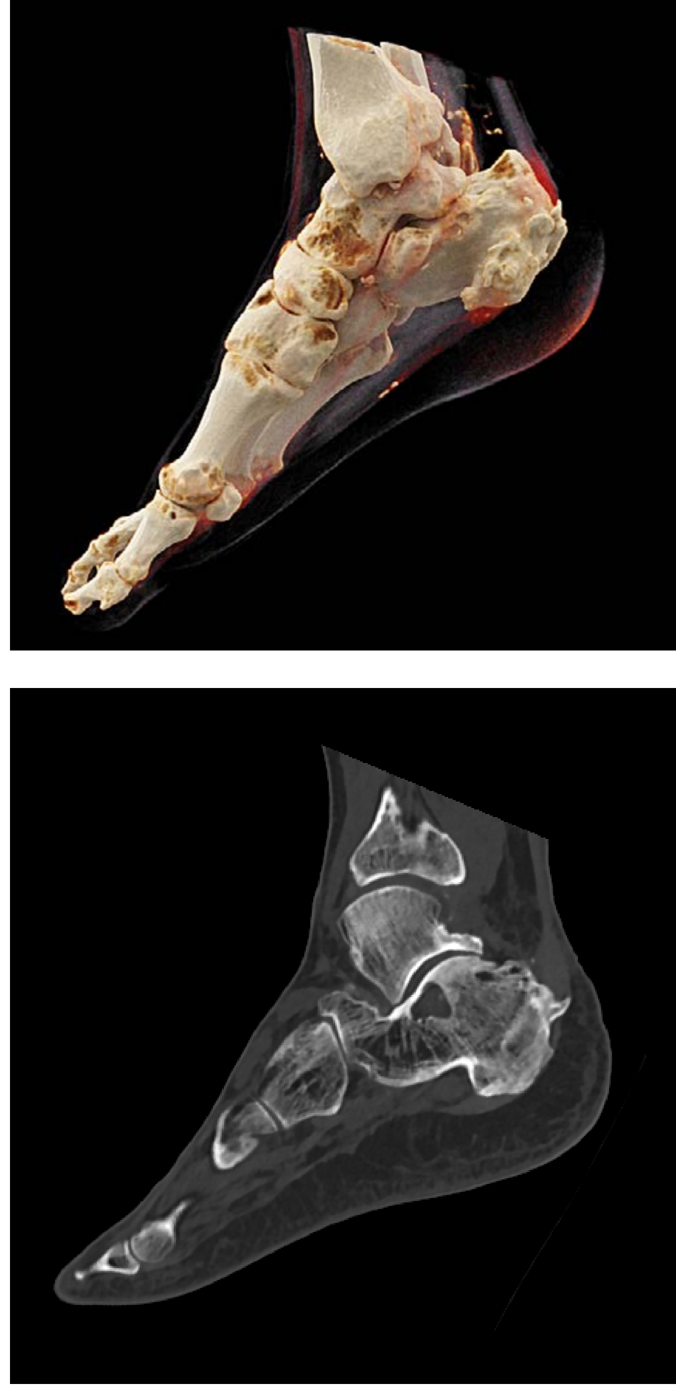
1b



1 DECT images revealed small discrete uric acid deposits next to the 1st, 2nd and 3rd metatarsophalangeal joints (in green) along with signs of bone erosion of the 2nd distal metatarsal (Fig. 1a, arrow).

2a

2b



2 Cinematic rendering (Fig. 2a) and MPR (Fig. 2b) images show Haglund's deformity of the calcaneus with bony prominence in the posterior superior aspect, and this was associated with a calcaneus spur.

which can aggravate the retrocalcaneal bursa causing bursitis and pain. It is also sometimes associated with a calcaneus spur.[5]

In this case, both diagnoses were made in one TBDE scan with an effective dose of only 0.12 mSv.

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Vertebral Compression Fracture – Fresh or Old?

By Yingmin Chen, MD, and Yuhang Wang, MD
Department of Radiology, Hebei General Hospital, Hebei, P. R. China

History

An 87-year-old female patient, with a history of lumbar spinal stenosis for the past 10 years, came to our hospital complaining of sudden back pain with physical limitation. A spinal fracture was suspected and a Dual Energy CT (DECT) examination was requested for further evaluation.

Diagnosis

Sagittal reformation, using mixed images reconstructed from DECT, showed a wedge-shaped vertebral body of T12 (Fig. 1a), suggesting a compression fracture. An extensive bone marrow edema of T12 was unmasked (Fig. 1b) using calcium subtraction offered by DECT. This correlated with the diagnosis of a fresh fracture. The same pattern was confirmed in MRI (Fig. 1c), which was performed to evaluate the status of the spinal stenosis prior to establishing a treatment plan.

Comments

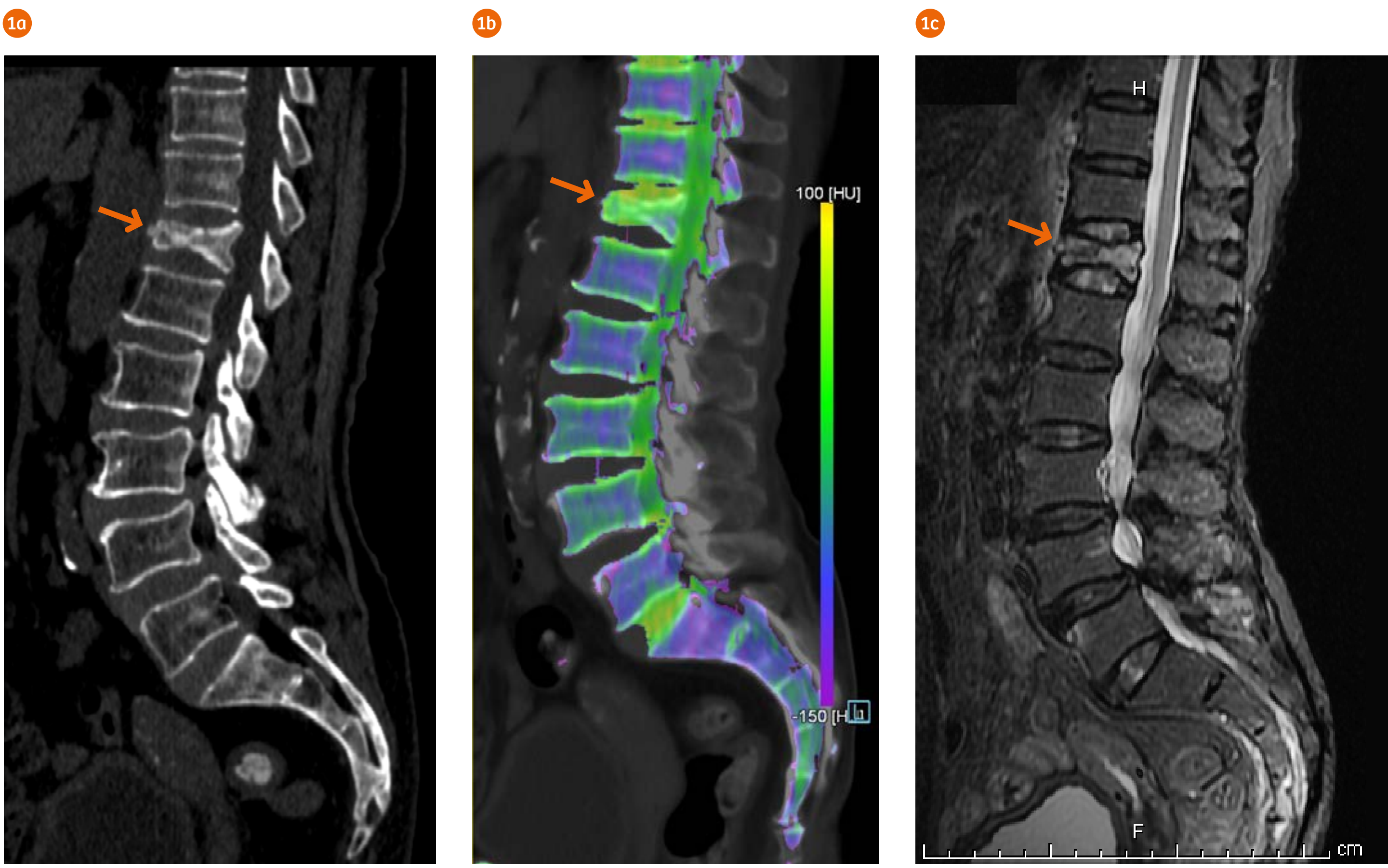
Standard CT imaging is commonly applied in the workup of spinal fractures as it clearly depicts bony structures. However, it is also important to

Examination Protocol

Scanner	SOMATOM Force
Scan area	Spine
Scan length	323 mm
Scan direction	Cranio-caudal
Scan time	7 s
Tube voltage	90/Sn150 kV
Tube current	88/65 mAs
Dose modulation	CARE Dose4D™
$CTDI_{vol}$	4.73 mGy
DLP	167.6 mGy cm
Effective dose	2.5 mSv
Rotation time	0.5 s
Pitch	0.6
Slice collimation	128 × 0.6 mm
Slice width	1.5 mm
Reconstruction increment	1 mm
Reconstruction kernel	Qr40

know whether the fracture is fresh or old since this has a clear impact on patient management. Although MRI offers the unique feature of showing bone marrow edema as a sign of fresh trauma, it is limited by its availability and contradictions such as patients with claustrophobia or metal implants or patients who are unable to lie quietly for the duration of the examination due to severe pain. DECT, with calcium subtraction technique, reveals not only the distorted anatomy but also the pattern of bone marrow edema allowing physicians to distinguish between a fresh and an old spinal fracture. Consequently, the diagnostic process can be sped up and the time to causative treatment can be shortened.

With a newly developed technique, the Selective Photon Shield (SPS II), the energy spectra at two different kV settings can be significantly better separated enabling a clear depiction of the bone marrow edema. In addition, dose reduction techniques, such as advanced modeled iterative reconstruction (ADMIRE) and CARE Dose4D™ (real-time anatomic exposure control), can help to achieve excellent image quality in a dose-neutral DECT examination.



1 A sagittal MPR image shows a wedge-shaped vertebral body of T12 (Fig. 1a, arrow), suggesting a compression fracture. DECT unmasked an extensive bone marrow edema of T12 (Fig. 1b, arrow), correlating with the diagnosis of a fresh fracture. The same pattern was confirmed in MRI (Fig. 1c, arrow).

Chronic Suppurative Otitis Media with Acquired Cholesteatoma

By KG Srinivasan, MD
KGS Advanced MR and CT Scan, Madurai, Tamil Nadu, India

History

A 40-year-old male patient, complaining of right-sided otorrhea for the past few weeks, presented himself to the hospital. The physical examination revealed the suspicion of chronic suppurative otitis media (CSOM) with a cholesteatoma. A CT scan was requested for further clarification.

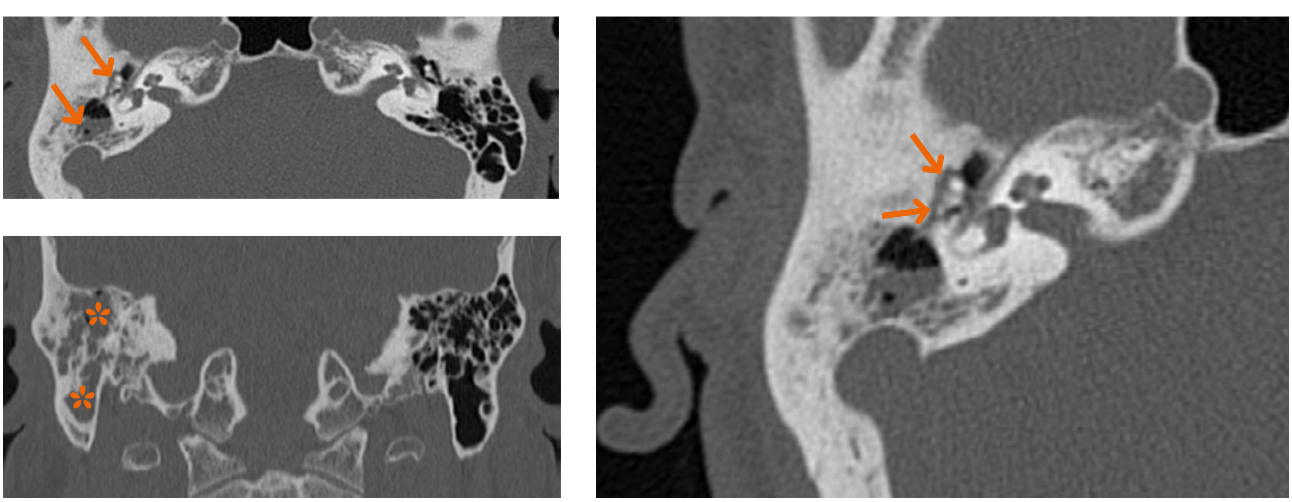
Diagnosis

CT images showed a right-sided soft tissue opacification in the middle ear including Prussak's space and epitympanum with blunting of the scutum and erosion of the ossicles. An absence of air in the mastoid air cells was seen suggesting sclerosis. These features are consistent with a cholesteatoma.

Comments

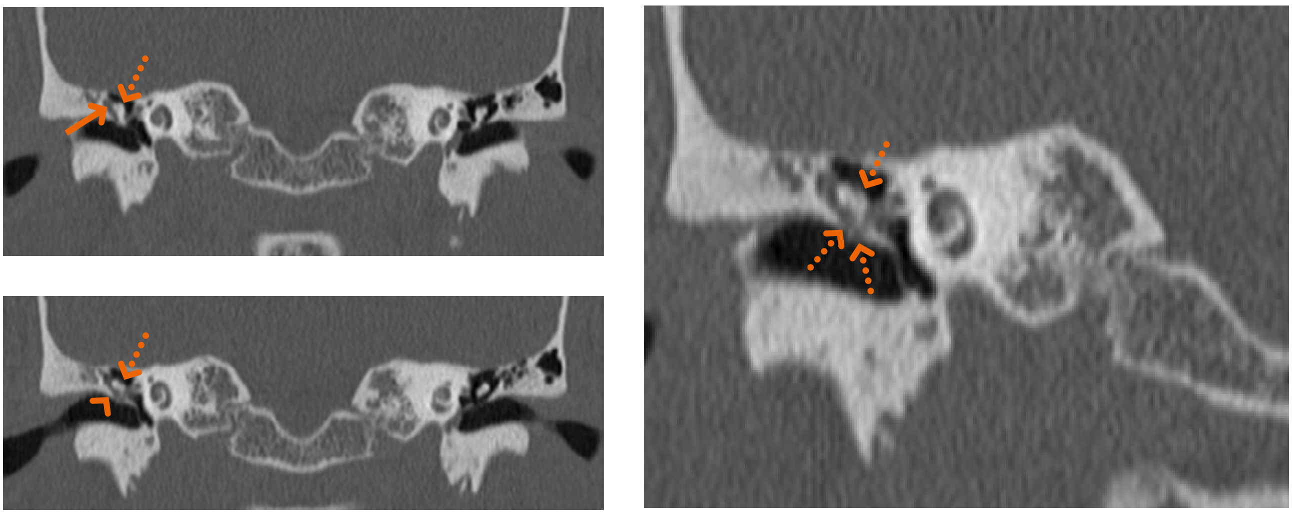
CSOM is a chronic inflammation of the middle ear and mastoid cavity. It is characterized by discharge from the middle ear through a perforated tympanic membrane for at least 6 weeks. It can occur with and without cholesteatoma and is often accompanied by hearing impairment. Cholesteatoma is traditionally diagnosed by an otoscopic examination. High resolution computed tomography (HRCT) is indicated to evaluate the extension and the complications of the cholesteatoma, which can draw the surgeon's attention to potential surgical dangers and complications of the disease. The most frequent CT signs for diagnosing a cholesteatoma are middle ear mass and bony lysis. The challenge is to achieve high resolution images, for visualizing the minute structural details, and at the same time, to keep the radiation dose as low as possible. In this case, the Tin Filter technique was applied. This technique cuts out lower energies from the X-ray spectrum to reduce dose and minimizes beam-hardening artifacts to optimize image quality. Thus an exceptional low dose $CTDI_{vol}$ of 7 mGy was achieved without compromising image quality.

1a
1b
1c



1 Axial (Figs. 1a and 1c) and coronal (Fig. 1b) MPR images show right-sided soft tissue opacification in the epitympanum (arrows) and absence of air in mastoid air cells (asterisks). Left side mastoid process is well pneumatized.

2a 2b 2c



2 Coronal MPR images show soft tissue opacifying the Prussak's space (Fig. 2a, arrow) with blunting of the scutum (Fig. 2b, arrow head) and erosion of the ossicles (dashed arrows) on the right side.

Examination Protocol

Scanner	**SOMATOM go.Now**		
Scan area	Middle & inner Ear	**DLP**	112 mGy cm
Scan mode	Spiral	**Effective dose**	0.35 mSv
Scan length	89 mm	**Rotation time**	1 s
Scan direction	Cranio-caudal	**Pitch**	0.8
Scan time	10 s	**Slice collimation**	16 × 0.7 mm
Tube voltage	Sn110 kV	**Slice width**	0.8 mm
Effective mAs	226 mAs	**Reconstruction increment**	0.4 mm
Dose modulation	CARE Dose4D™	**Reconstruction kernel**	Hr64
$CTDI_{vol}$	7.02 mGy		

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.

Cerebellar Arteriovenous Malformation – Complicated by Active Bleeding?

By Wuchao Li, MD; Rongpin Wang, MD; Hui Song, MD; Chong Tian and Xing Ming
Department of Radiology, Guizhou Provincial People's Hospital, Guiyang, P. R. China

History

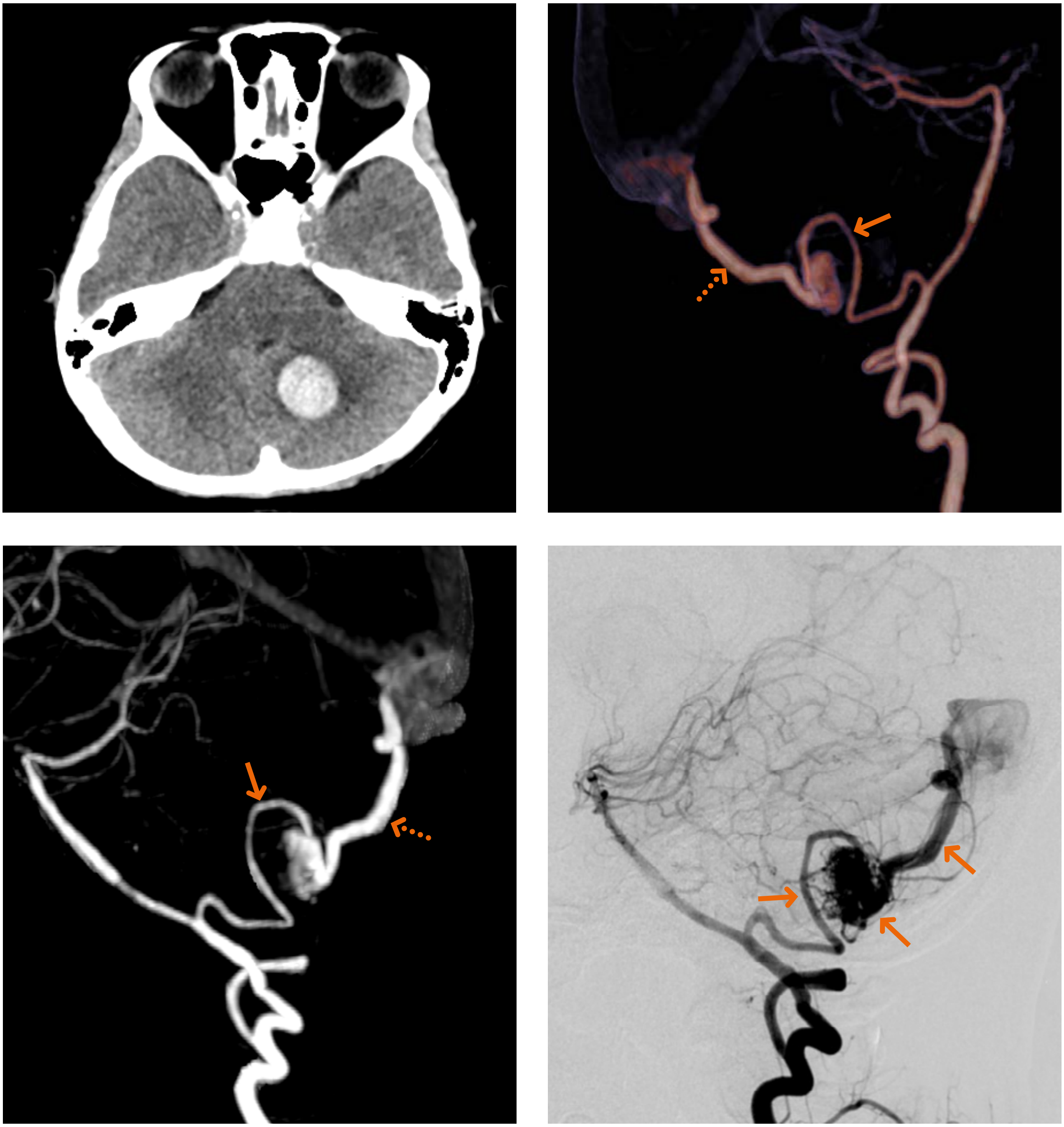
A 17-year-old female patient, suffering from an acute onset of a severe headache for the past 24 hours, was admitted to the emergency department. She neither had neurological symptoms, such as nausea, vomiting or confusion, nor a recent history of trauma. Physical examination revealed a decreased muscle tone in the right lower limb. An immediate cerebral noncontrast CT examination showed a hematoma with peripheral edema in the left cerebellar hemisphere (Fig. 1a). A Dual Energy CT (DECT) was requested to further investigate the cause of the hematoma and to rule out active bleeding.

Diagnosis

DECT angiography (CTA) images showed malformed vessels in the area of the left cerebellar hematoma, measuring approximately 10 mm × 6 mm × 10 mm in size. An anomalous feeding artery, arising from the posterior inferior cerebellar artery, and an enlarged vein draining into the torcular herophili were revealed (Figs. 1b and 1c). These findings suggested an arteriovenous malformation (AVM).

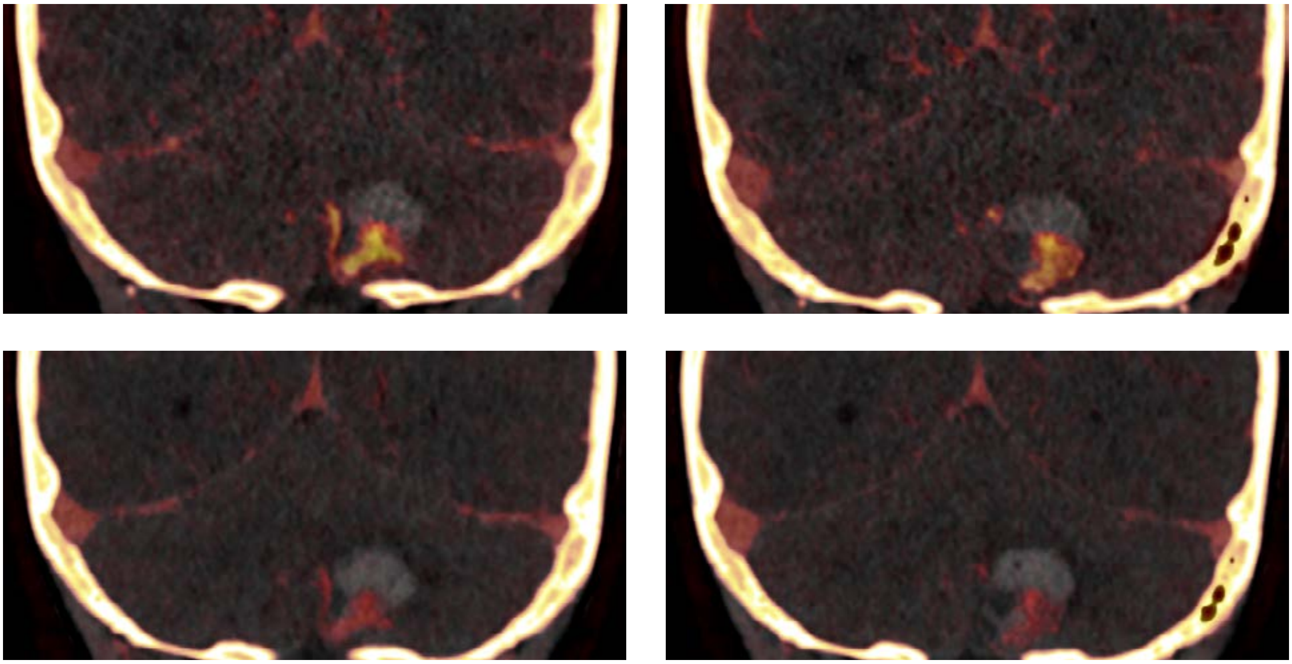
Examination Protocol

Scanner	**SOMATOM Force**	
Scan area	Head&Neck	Head
Scan mode	Dual Energy	Dual Energy
Scan length	299 mm	133 mm
Scan direction	Caudo-cranial	Caudo-cranial
Scan time	1.9 s	5 s
Tube voltage	80/Sn150 kV	80/Sn150 kV
Effective mAs	72/56 mAs	205/150 mAs
Dose modulation	CARE Dose4D™	CARE Dose4D™
$CTDI_{vol}$	3.76 mGy	21.44 mGy
DLP	130 mGy cm	331 mGy cm
Effective dose	0.4 mSv	1.02 mSv
Rotation time	0.25 s	0.5 s
Pitch	0.7	0.7
Slice collimation	192 × 0.6 mm	64 × 0.6 mm
Slice width	1 mm	1 mm
Reconstruction increment	0.7 mm	0.7 mm
Reconstruction kernel	Qr40	Qr40
Contrast	370 mg/mL	–
Volume	30 mL	–
Flow rate	5 mL/s	–
Start delay	Bolus tracking with 100 HU in the aortic arch + 2 s	30 s after CTA scan

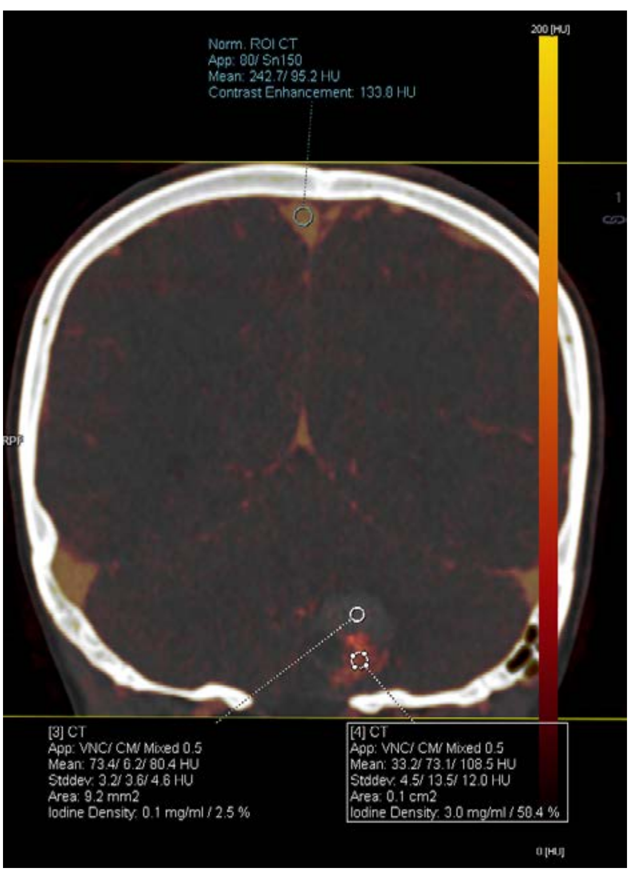


1 An axial image (Fig. 1a) shows a hematoma with peripheral edema in the left cerebellar hemisphere. VRT (Fig. 1b), and MIP (Fig. 1c) images reveal an anomalous feeding artery (arrows) arising from the posterior inferior cerebellar artery, the malformed vessels, and an enlarged vein (dashed arrows) draining into the torcular herophili. A DSA image (Fig. 1d) confirmed the CT finding.

2a 2b 2c 2d



3



2 DE Virtual Unenhanced images acquired in the arterial phase (Figs. 2a and 2b) and in the later phase (Figs. 2c and 2d) show irregular contrast enhancement around the malformed vessels, implying active bleeding.

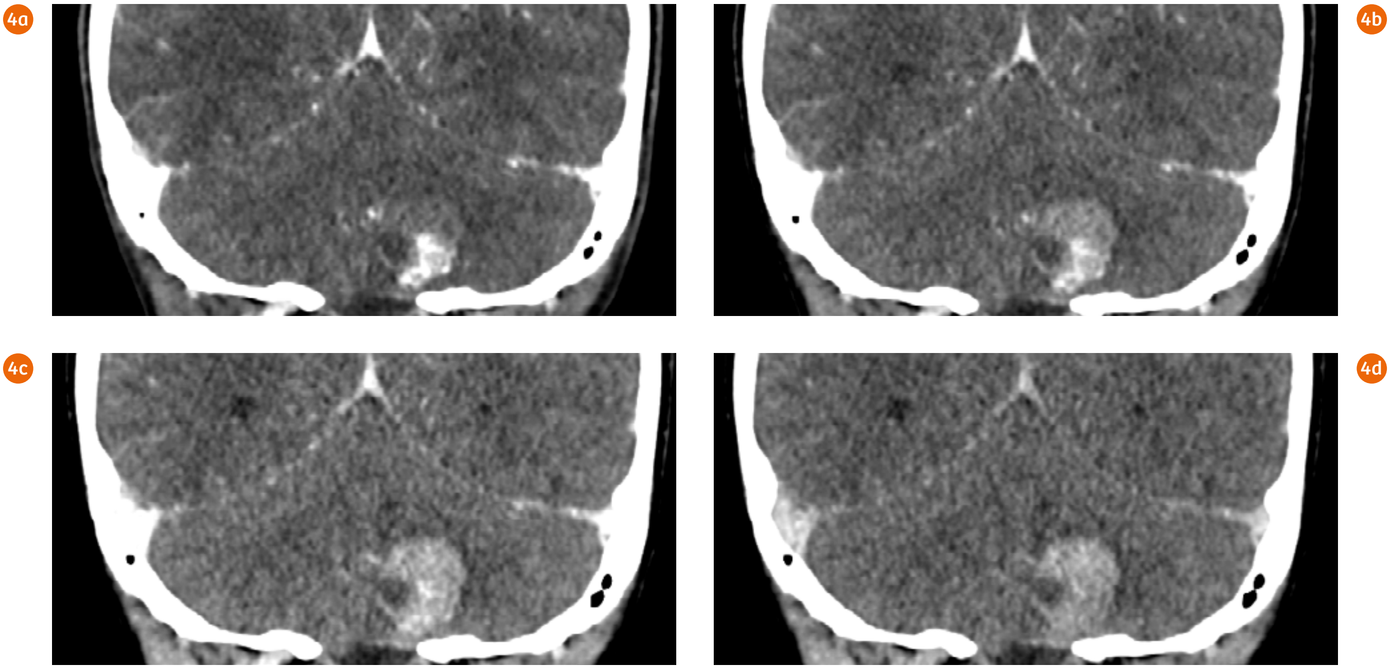
3 The evaluation of the iodine concentration in the suspicious active bleeding area (ROI 4) and in the hematoma (ROI 3) shows a significant difference. An ROI (in blue) is also placed in the sagittal sinus for normalization.

DE Virtual Unenhanced (Figs. 2 and 3) and Monoenergetic Plus (Fig. 4) images showed irregular contrast enhancement around the malformed vessels, implying active bleeding.

The CT findings of a cerebellar AVM were confirmed by digital subtraction angiography (DSA) (Fig. 1d) in subsequent interventional therapy.

Comments

An AVM, consisting of a congenital abnormal tangle of blood vessels without capillaries,[1] is a significant cause of intracranial hemorrhage in young adults.[2] DSA has been the gold standard for the diagnosis of AVMs due to its high temporal and spatial resolution.[3] Although a



4 DE Monoenergetic Plus images displayed at 40 keV (Fig. 4a), 70 keV (Fig. 4b), 90 keV (Fig. 4c) and 120 keV (Fig. 4d) energy levels show significant differences in the image contrast. The enhancement and its differences in the malformed vessels and in the active bleeding areas are significantly improved at 40 keV.

therapy decision heavily relies upon DSA results, DECT angiography has increasingly gained importance for initial diagnostic workup, since it is able to display high quality images of the feeding arteries and draining veins, using *syngo*.CT DE Direct Angio. This feature can help to differentiate hemorrhages from contrast agent and also quantify the iodine uptake using *syngo*.CT DE Virtual Unenhanced. This helps to increase the diagnostic confidence of the physician when active bleeding in the hematoma needs to be clarified. Furthermore, images can be displayed at energy levels between 40 and 190 keV and image contrast can be significantly enhanced at lower energy levels using *syngo*.CT DE Monoenergetic Plus. Hereby, the differentiation between the hematoma and the active bleeding areas can be greatly improved. All applications are performed in an automated workflow.

The three-dimensional features of AVMs including feeding artery, malformation vascular mass, and draining vein can be clearly demonstrated and highlighted using the volume rendering technique (VRT). In addition, DECT images can clearly demonstrate variable imaging characteristics such as the relationship between an AVM and the surrounding cerebral structures. This is crucial for treatment planning and for prognosis prediction.[4] Therefore, DECT can serve as a rapid and reliable diagnostic approach for identifying an underlying AVM complicated by active bleeding. ●

References

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Working Principle and Clinical Applications of Tin Filter Technology

Tin Filter imaging is an emerging technology that enables low X-ray dose noncontrast examinations with a focus on high-contrast anatomical structures.

By Sebastian Faby, PhD, Siemens Healthineers, Germany

Radiation doses can potentially be reduced by adapting the shape of the X-ray spectrum to match the required study. How this works and the patient groups that might benefit in particular from this will be explored in the following.

Physics behind the technology

In this approach, a movable pre-filter made of tin is mounted in the collimator box next to the radiation exit window of the X-ray tube. This is in addition to the conventional bow tie or wedge filters found on every scanner. This Siemens Healthineers unique Tin Filter technology removes low energy photons in particular from the broad X-ray spectrum. As a result, the emitted X-ray spectrum is narrower and the average energy is shifted to higher levels (see Fig. 1). This protects the patient from the low energy photons that would mainly be absorbed in the patient without any useful contribution to the image contrast. This is especially significant in visualizing high contrast structures such as bones or the air to soft-tissue contrast in the lungs or colon without contrast agent. Use of the Tin Filter also reduces the soft tissue contrast in conventional native scans, e.g. of the head or abdomen. Consequently, tin pre-filtered spectra are not recommended in such cases.

In Figure 1, the absorption coefficient of iodine is overlaid to highlight the K-edge position as compared with tin pre-filtered spectra. In the latter case, the reduction in the photons responsible for the iodine contrast can clearly be seen. Therefore, low kV imaging is still the preferred, more dose-efficient choice in studies requiring contrast agent.

Tube challenges

Implementing spectral shaping into the CT imaging chain is technically challenging. The first task is to identify a suitable material that meets all the mechanical and safety requirements demanded of a movable filter. This already excludes many materials. Equally important are the absorption properties: The interaction processes in the energy range relevant for clinical CT imaging (~20–150 keV) are the photoelectric effect and scattering (mainly Compton, but also Rayleigh scattering). Elements with a low atomic number Z, that is the number of protons in the nucleus, are dominated by scattering (see carbon / C, Z = 6, and aluminum / Al, Z = 13, in Fig. 2). However, the scattering process is unfortunately not suitable for spectral shaping since its impact is fairly constant over the entire energy range (see dashed lines in Fig. 2) meaning that only intensity is removed without actually shaping the spectrum. For elements with a higher atomic number, such as copper (Cu, Z = 29), at lower energies the photoelectric effect is now more important than scattering. There is a higher absorption of low energy than high energy photons resulting in spectral shaping. For elements with an even higher atomic number the photoelectric effect has a still greater impact. Here, the position of the K-edge begins to play a role. The K-edge of tin (Sn, Z = 50) is at 29 keV. Photon absorption is therefore very high up to about 60 keV where it drops back to the pre K-edge level.

The result is efficient spectral shaping. Copper would require a higher beam intensity to generate the same shaping effect. It does not make sense to use elements with even higher Z as the higher position of the K-edge will interfere.

Powerful tubes required

Since a Tin Filter reduces intensity, it relies on powerful X-ray tubes that can compensate for the photon flux losses. At the same time, good focal spot size control is required so that spatial resolution at high tube currents is not sacrificed. In the newly introduced scanner portfolio, Siemens Healthineers has implemented X-ray tubes that meet these high demands and enable Tin Filter technology.

Detector challenges

Not surprisingly, the detector also plays a significant role as Tin Filter imaging is often operated at low dose and subsequently in a low signal regime for the detector. This makes detectors with highly integrated electronics for very low electronic noise levels and a good linearity essential to good image quality. All the scanners in the new portfolio are therefore equipped with the highly integrated Stellar or Stellar^{Infinity} detector.

Image processing chain

Naturally, calibration data for the different shape of the tin pre-filtered spectra have to be integrated into the image processing chain. Due to the more narrow spectra enabled by the Tin Filter, images have the advantages of a lower susceptibility to beam hardening effects resulting in fewer artifacts from highly absorbing structures such as the shoulder region or implants.

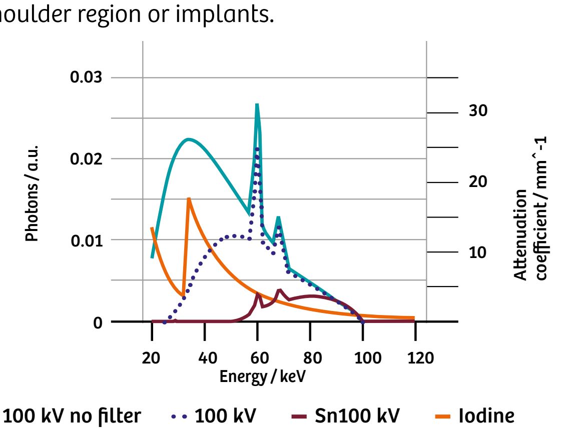


Figure 1: Illustration of 100 kV X-ray spectra with different pre-filtration, overlaid with the attenuation coefficient of iodine: The "100 kV no filter" spectrum shows a spectrum as emerging from the radiation exit window of the X-ray tube. The "100 kV" spectrum is pre-filtered by conventional filtration as found in any CT scanner. The "Sn100 kV" spectrum is enhanced by the additional Tin Filter. The spectra are not to scale.

Further dose reduction technologies

Imaging with the Tin Filter can, of course, be combined with other dose reduction technologies, like tube current modulation (CARE Dose4D™) and iterative reconstruction (IR) software such as SAFIRE and ADMIRE. IR is an important component of ultra-low dose imaging. It will be also possible to acquire a topogram using a Tin Filter to significantly reduce the dose contribution of the topogram to the total patient dose in the examination. As dose values for the CT scan itself come down, the contribution of the topogram becomes more and more important.

Scientific validation and potential clinical translation

As described in the previous section, Tin Filter imaging has greatest potential for native high contrast examinations. Potential clinical applications have already been evaluated and published in initial studies. Several studies have evaluated the technology for different applications in thoracic imaging and also calcium scoring in phantoms or animal models.[1–5] From its very introduction, the focus of tin pre-filtered scanning has been on lung [6–12] and paranasal sinus [13–15] imaging in several patient studies.

Pulmonary nodules

A prospective intra-individual study with over 200 consecutive adult patients focused on pulmonary nodule visualization for lung cancer screening.[12] The study evaluated the feasibility of ultra-low dose chest CT with tin pre-filtration at a $CTDI_{vol}$ of 0.24 mGy compared to a standard protocol without tin pre-filtration at 3.2 mGy as the standard of

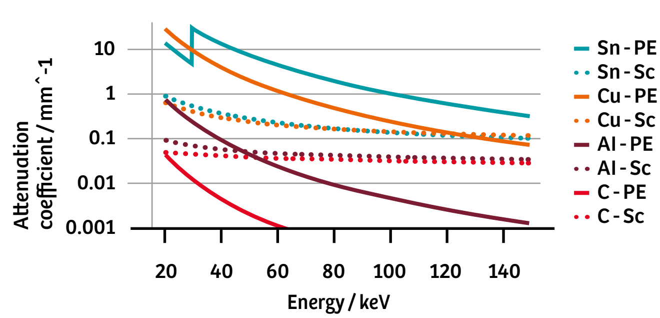
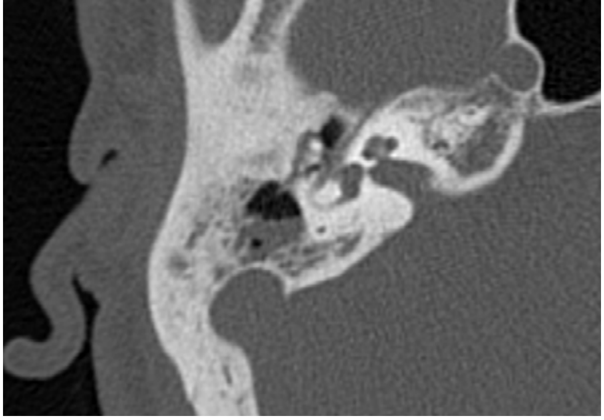


Figure 2: Energy-dependence of the photoelectric effect (PE) and the Compton scattering (Sc) component of the attenuation coefficients of carbon (C), aluminum (Al), copper (Cu), and tin (Sn).



An axial image, acquired with 0.35 mSv at Sn110 kV using Tin Filter technology, shows chronic suppurative otitis media with a cholesteatoma in a 40-year-old male patient. Read more in the case report on page 64.
Courtesy of KGS Advanced CT and MRI Scan Centre, Madurai, Tamil Nadu, India

An axial image, acquired with 0.39 mSv at Sn110 kV using Tin Filter technology, shows complicated silicosis in a 45-year-old male patient. Read more in the case report on page 52.
Courtesy of Centro Hospitalar de S. João, Porto, Portugal

reference. Evaluating sensitivity and specificity compared to the standard of reference, the study concluded that the dose can be lowered to 0.13 mSv with Tin Filter technology and the latest IR technology (ADMIRE). This exposure level is similar to that of a postero-anterior and lateral chest X-ray, which is on average 0.1 mSv.[16]

Pediatric chest investigation

In a pediatric patient cohort of 75 patients with a clinical indication for noncontrast chest CT, a prospective randomized study was conducted comparing a 70 kV protocol ($CTDI_{vol}$ of 0.82 mGy) with an Sn100 kV protocol (0.19 mGy) on an inter-individual basis regarding objective image metrics and subjective image impression.[11] Both protocols used a high-pitch dual source scan mode for ultra-fast acquisition without sedation or breathing instructions and employed IR for image reconstruction. Objective image metrics and subjective image impression were found to be similar between these two protocols, while the effective dose was reduced from already low 0.71 mSv for the 70 kV protocol to ultra-low 0.19 mSv for the Sn100 kV protocol.

This also leads to lower radiation exposure of radiation sensitive organs in this particularly sensitive cohort.

Paranasal sinus imaging

One trial studied the impact of using the Tin Filter in paranasal sinus CT imaging for inflammatory disease in a prospective randomized study with 100 consecutive patients. These were assigned either to the study protocol with Sn100 kV at a $CTDI_{vol}$ of 1.7 mGy or the control group with 100 kV without tin pre-filtration at 2.1 mGy.[14] Objective image metrics (spatial resolution, image noise, CNR) were compared between groups as well as subjective image impression. The results showed very low radiation in both groups, with the Sn100 kV protocol achieving an ultra-low mean effective dose of 0.055 mSv. Regarding spatial resolution, 10 line pairs per cm were discriminated in both protocols, with slightly better edge sharpness for the Sn100 kV protocol. Objective parameters and subjective image impression were found to be comparable between protocols and sufficient for rule-in or rule-out of sinusitis as well as for surgery planning. Such ultra-low dose is especially important given that many young patients are referred for paranasal sinus imaging. The radiation-sensitive eye lenses and thyroid gland are affected by this type of examination.

Calcium scoring and kidney stone investigation

In addition to the applications discussed above, tin pre-filtered imaging is also of interest for calcium scoring [17–19] and kidney stone imaging.[20, 21]

A recent study on use Tin Filter technology for coronary artery calcium scoring evaluated the accuracy of calcium scoring using tin pre-filtration combined with iterative beam hardening correction compared with the standard 120 kV protocol.[17] The Sn100 kV spectrum has a slightly higher average energy than the 120 kV spectrum, resulting in somewhat lower Agatston scores but within the usual inter-vendor variations.[22] The dedicated iterative beam hardening correction algorithm employed in this study should now correct even these differences. The data for 62 patients was retrospectively evaluated. Each patient underwent both a calcium scoring scan at 120 kV and a sub-sequent Sn100 kV scan for comparison. The results showed significantly lower doses with the Tin Filter protocol (average $CTDI_{vol}$ of 1.28 mGy vs. 4.06 mGy for the 120 kV protocol), resulting in an ultra-low effective dose of 0.19 mSv for the Sn100 kV versus 0.83 mSv for 120 kV. Agatston scores from the two acquisitions showed excellent correlation and no patients were re-classified according to absolute Agatston score categories.

Tin pre-filtered imaging at Sn150 kV was studied in patients with suspected urolithiasis.[20] In total, 130 consecutive patients were examined with one of three different scan protocols (Sn150 kV versus automatic tube voltage selection on the same system compared with automatic tube voltage selection on a different system). Objective image metrics and subjective image impression were inter-individually compared between groups. Results showed the best subjective image impression for the Sn150 kV protocol as well as no statistically significant differences in objective image metrics in terms of signal-to-noise ratios. At the same time, dose values were significantly lower for the Sn150 kV protocol compared with the other two protocols (mean $CTDI_{vol}$ of 2.1 mGy compared with 2.8 mGy and 2.7 mGy for the other two protocols). The mean DLP was 93 mGy cm for the Sn150 kV protocol, resulting in an effective dose of 1.4 mSv, using a conversion factor of 0.015 mSv/(mGy cm). Low dose imaging is important in this context due to the high prevalence of urolithiasis and frequent relapses.

The above studies used dose values that were already low in the standard protocols as they used a high-end scanner featuring the latest technology. Differences in dose levels between tin pre-filtered scanning and the standard protocols will be even more pronounced when compared to older technology or the current practice as manifested for example in national reference dose values. As a final note, the Tin Filter is an important enabler of dose neutral dual energy imaging [23-26] due to improved spectral separation.

In clinical practice, the use of SAFIRE or ADMIRE 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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New Scientific Evidence for Multi-energy Photon Counting CT

Multi-energy photon counting detectors are a promising new technology in clinical CT imaging. Latest research indicates great potential for use in examining humans.

By Stefan Ulzheimer, PhD, Siemens Healthineers, Germany

Photon counting detectors register individual photons and measure their energy at the same time in a direct conversion process. In addition, they are able to deliver much higher spatial resolution at full-dose efficiency and may potentially reduce patient dose significantly. This goes far beyond of current commercially available detector technology and dual energy solutions.

In 2011, a large group of experts set a goal of lowering the effective dose for all routine CT examinations to below 1 mSv. At that time, photon counting CT (PCCT) was already identified as one of the key enabling technologies.[1]

Now six years later, clinical specialists and researchers have been able to demonstrate the potential of the technology in this area while maintaining or even improving existing imaging capabilities. Furthermore, completely new clinical applications have been identified that are enabled by this technology.

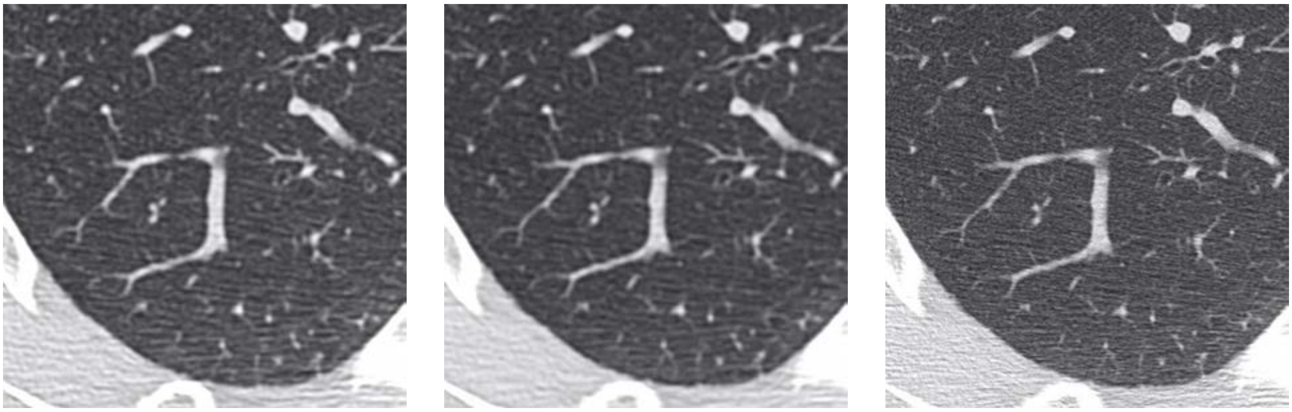
1st step: clinically equivalent image quality

Today, CT detectors produced by Siemens Healthineers are optimized to deliver excellent image quality with highly dose efficient and extremely robust design. Therefore, the hurdle for a new technology with enhanced performance is very high. Researchers have been able to demonstrate that photon counting CT from Siemens Healthineers is able to produce images that are clinically not inferior compared with existing technology.[2, 3, 4] The first clinical study systematically evaluating image quality in the abdomen even showed slight advantages of multi-energy PCCT in the areas of beam hardening artifacts in the spine.[3]

2nd step: potential clinical benefit and higher dose efficiency

In a next step, researchers showed the clinical use of PCCT in lung imaging in phantoms [5] and in humans. [6] PCCT outperformed existing technology in all areas and was able to deliver much more stable and accurate imaging results. Stable and quantitative results are often important for the initial diagnosis. They are even more relevant for monitoring the progression of a disease and determining treatment success at an early stage.

PCCT is able to deliver extremely high spatial resolution at full dose efficiency.[7] This can be used to reduce image noise due to much higher data sampling frequency at comparable spatial rresolution. Ref. 8 has shown an image noise reduction from 59.6 HU to 42.3 HU for PCCT compared to a conventional CT detector at equal radiation dose (120 kV, 1 s rotation, 280 mAs). This can be translated



Higher data sampling frequency with PCCT detectors allows for reconstructing images with the same resolution but lower image noise (middle) or significantly higher spatial resolution (right) compared to the conventional mode (left).
Courtesy of National Institutes of Health, Clinical Center, Bethesda, MD, USA

into a corresponding dose reduction. In combination with higher dose efficiency in view of the complete elimination of electronic noise [9] and optimized weighting of photons with different energies or mono-energetic imaging,[10] the potential for an additional dose reduction can be achieved for selected applications. Researchers have also developed algorithms to use the additional multi-energy data for further image noise reduction.[11–13] Many clinical applications may benefit from the enhanced spatial resolution.[14]

3rd step: completely new clinical applications

The availability of multi-energy data enables the differentiation of multiple contrast materials. While developing new contrast materials remains a time-consuming and expensive task, new contrast materials in combination with PCCT would open up exciting new opportunities. This is therefore already an active area of research. For instance, Symons et al. have shown the feasibility of separating multiple contrast agents in the heart and in the abdomen.[15, 16] One simple advantage would be to image more than one contrast phase in a single CT scan.

New dimensions in diagnostic information as standard

PCCT could enable completely new data dimensions with multi-energy information combined with extremely high spatial resolution. This data would be acquired in every scan regardless of the scan mode. There is significant potential to improve existing routine clinical applications and support innovative applications. ●

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This feature is based on research, and is not commercially available. Due to regulatory reasons its future availability cannot be guaranteed.

PE or not PE – Differential Diagnosis using Double Flash Scanning Technique in Cases of Congenital Heart Disease

A Double Flash scan with a single contrast bolus, to evaluate dynamic changes in the pulmonary flow, may help to establish the diagnosis of suspected pulmonary embolism (PE) in children with complex congenital heart diseases after palliative surgical procedures.

By Dany Jasinowodolinski, MD, PhD, and Adriano Camargo de Castro Carneiro, MD
Department of Radiology, Hospital do Coração, São Paulo, Brazil

CT techniques

Children with complex congenital heart diseases, who had been submitted to a Glenn procedure, have a non-physiological pulmonary flow. In this procedure, blood flow to the lungs is redirected from the superior vena cava (SVC) to the proximal right pulmonary artery (RPA) via a shunt. This causes artifacts in pulmonary CT angiography (PCTA) which may limit the interpretation of the diagnosis of a pulmonary embolism (PE).

The most common artifact is caused by the heterogeneous mixture of the blood with the contrast agent. This limits the visualization and characterization of a thrombus in the pulmonary arteries.

SOMATOM Definition Flash is our choice when performing CTA examinations on these children. The Double Flash technique consists of two high-pitch acquisitions with a single contrast bolus. It can be performed with or without ECG-triggering. The first one scans cranio-caudal and the second caudo-cranial, only three seconds apart.

The acquisitions are performed with free breathing and each scan requires about 0.3 s. Real-time anatomic exposure control (CARE Dose4D™) and sinogram affirmed iterative reconstruction (SAFIRE) are also combined to reduce radiation dose.

1

1 A photo of the Amazon River shows the phenomenon in nature – when two rivers with different temperatures and densities join, one side becomes muddy and the other side is clear.

Image post-processing and interpretation

To demonstrate the advantages of the Double Flash scan, here are two cases of children who had undergone the Glenn procedure and where a PE was suspected.

The first case (Fig. 2) is that of a 3-year-old boy with a history of critical aortic stenosis. After a failed neonatal aortic balloon valvuloplasty, he had undergone a Damus-Kaye-Stansel (DKS) surgery and a Glenn procedure. He was re-admitted due to worsening dyspnea and hypoxemia. In this situation, there is a univentricular functioning heart where the pulmonary trunk is connected to the ascending aorta and detached from the pulmonary artery branches. The pulmonary blood flow arrives from the SVC. The child is scheduled to have a Fontan surgery later in life, where the inferior vena cava will be connected to the pulmonary arteries through a tubular conduit.

The second case (Fig. 3) is a 6-month-old girl with transposition of the great arteries (TGA), restrictive ventricular septal defect, and right ventricular outflow tract obstruction (infundibular and valvar). She underwent a Glenn procedure and exclusion of the pulmonary trunk. She is now submitted for a tricuspid valve replacement, however, cannot get off extracorporeal mechanical support. A cannulation is placed in the right atrium, the right pulmonary artery, and the aorta. The contrast agent is arriving from the SVC to the pulmonary arteries.

2a

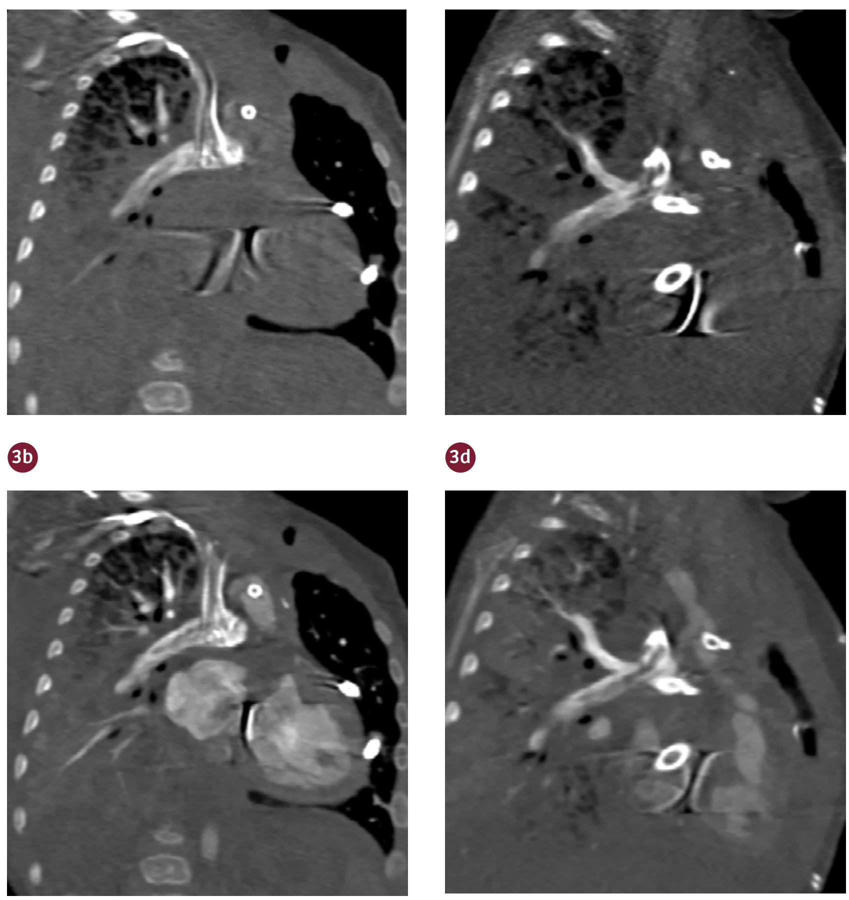
2b

3a

3b

3c

3d



2 An intraluminal filling defect shown in the segmental branch of the right lower lobe (Fig. 2a) disappears in the later acquisition (Fig. 2b), suggesting an artifact.

3 Intraluminal filling defects in the segmental branches of the right lower lobe (Figs. 3a and 3c) do not vanish in the subsequent acquisition (Figs. 3b and 3d), characterizing PEs.

Both children have unusual heart conditions and were submitted to Glenn procedures, meaning that the SVC is connected to the right pulmonary artery and contrast agent arrives in a later phase (not the usual arterial phase) to perfuse the lungs.

The interesting aspect of these cases is the exact differentiation between thrombus and artifacts where it is even more challenging than usual.

The mixed blood artifact is a well-known pitfall in the diagnosis of PE. A few aspects need to be considered when trying to differentiate between an artifact and a true thrombus:

1) **Position:** The thrombus is centrally located and usually centered at the bifurcations. The artifact occurs in layers since contrast agent tends to flow in the dependent aspect of the vessel, whereas noncontrast blood flows anteriorly. This phenomenon can also be observed in nature when two rivers with different temperatures and densities join – such as the Amazon River – one side is muddy and the other side is clear (Fig. 1).
2) **Extension:** The artifact is long and continuous, whereas the thrombus tends to be more focal and short.
3) **Technique:** With multiple acquisitions the artifact moves and vanishes whereas the thrombus does not.

So in the first case, we see intraluminal filling defects in the segmental branch of the right lower lobe (Fig. 2a), localized anteriorly in the vessels but which disappears in the later acquisition (Fig. 2b), suggesting an artifact. In the second case, we see intraluminal filling defects in the segmental branches of the right lower lobe (Figs. 3a and 3c), which do not vanish in the subsequent acquisition (Figs. 3b and 3d) characterizing PEs.

Examination Protocol

	Patient 1 w/o PE	Patient 2 with PEs
Scanner	**SOMATOM Definition Flash**	**SOMATOM Definition Flash**
Scan area	Thorax	Thorax
Scan mode	Flash mode, w/o ECG-triggering	Flash mode, with ECG-triggering
Scan length	185 mm	125 mm
Scan direction	Cranio-caudal/ caudo-cranial	Cranio-caudal/ caudo-cranial
Scan time	0.36 s	0.27 s
Tube voltage	80/80 kV	80/80kV
Tube current	120 mAs	216 mAs
Dose modulation	CARE Dose4D™	CARE Dose4D™
$CTDI_{vol}$	1.87 mGy	0.99 mGy
DLP	47 mGy cm	19 mGy cm
Effective dose	1.9 mSv[1]	1.1 mSv[2]
Rotation time	0.28 s	0.28 s
Pitch	3	3.4
Slice collimation	128 × 0.6 mm	128 × 0.6 mm
Slice width	0.6 mm	0.6 mm
Reconstruction increment	0.3 mm	0.3 mm
Reconstruction kernel	I26f SAFIRE 3	I26f SAFIRE 3
Heart rate	N/A	120 bpm
Contrast	370 mg/mL	370 mg/mL
Volume	18 mL (1.5 mL/kg)	12 mL (2 mL/kg)
Flow rate	Manual injection	Manual injection
Start delay	Bolus tracking	Bolus tracking

[1] Estimated by applying a conversion factor of 0.018, and an additional factor of 2.3 converting the reported DLP (32 cm) into the DLP (16 cm).

[2] Estimated by applying a conversion factor of 0.026, and an additional factor of 2.3 converting the reported DLP (32 cm) into the DLP (16 cm).

Fellowship Program Offers Chance to Optimize Clinical Skills

By Katrin Seidel, Siemens Healthineers, Germany

Siemens Healthineers is providing opportunities for customers to optimize their clinical skills with a clinical fellowship program. The goal is to support CT operators to use the full potential of their system.

Casper Mihl, MD, PhD, head of CT department (right) and Linda Jacobi-Postma, MD, PhD, program director radiology and nuclear medicine (left) are in charge of the CT fellowship program at the Maastricht UMC+ (Maastricht University Medical Center) in Maastricht, Netherlands.

Following the pace of daily life at the selected site, the program draws on real experience. Over a period of time, a clinical expert guides users with valuable tips and tricks that can be applied directly in daily clinical routine. The clinical specialists demonstrate proven clinical workflows, examination procedures, and reporting including software applications, scanner protocols, and contrast agent injection.

The fellowship program is aimed at radiologists and radiographers, who have given very good feedback in the past: Knowledge transfer and the ability to share expert knowledge with colleagues from different countries in a relaxed and professional atmosphere is the focus of the fellowship program.

"This workshop was very good and added to my experience. Good cooperation of the staff and warm welcome from the head of department."

Radiologist from Nairobi, Kenia

"This experience was high quality and gave me new knowledge."

Radiographer from Amman, Jordan

At present, nineteen multinational fellowship sites are available with different SOMATOM CT scanners covering: General CT, Cardiology, Neurology, Oncology, Virtual Colonoscopy, Intervention, and Virtual Autopsy & Forensics.

Please contact your local sales representative if you would like to take part. ●

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www.siemens.com/SOMATOMEducate

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.

Tips & Tricks: Quick and Intuitive 3D Image Reading

By Patricia Jacob and Athina Gorezis, Siemens Healthineers, Germany

Most radiological procedures typically require reconstruction of standardized views of different anatomies, especially in trauma cases. Enhanced image reading technology can support quick and intuitive navigation within complex 3D imaging data. This can increase both the efficiency and accuracy of radiological diagnostics in a range of clinical situations. Rapid Results Technology (RRT) in combination with ALPHA (anatomical landmarking and parsing of human anatomy) technology identifies human anatomy and provides standard visualizations of different anatomical structures, in various types and orientations. RRT automatically generates the "radial or parallel range" results and sends these to the archiving system without any manual user interaction.

How it works

ALPHA applies technology similar to face detection commonly used in photography. In *syngo*.via, fast one-

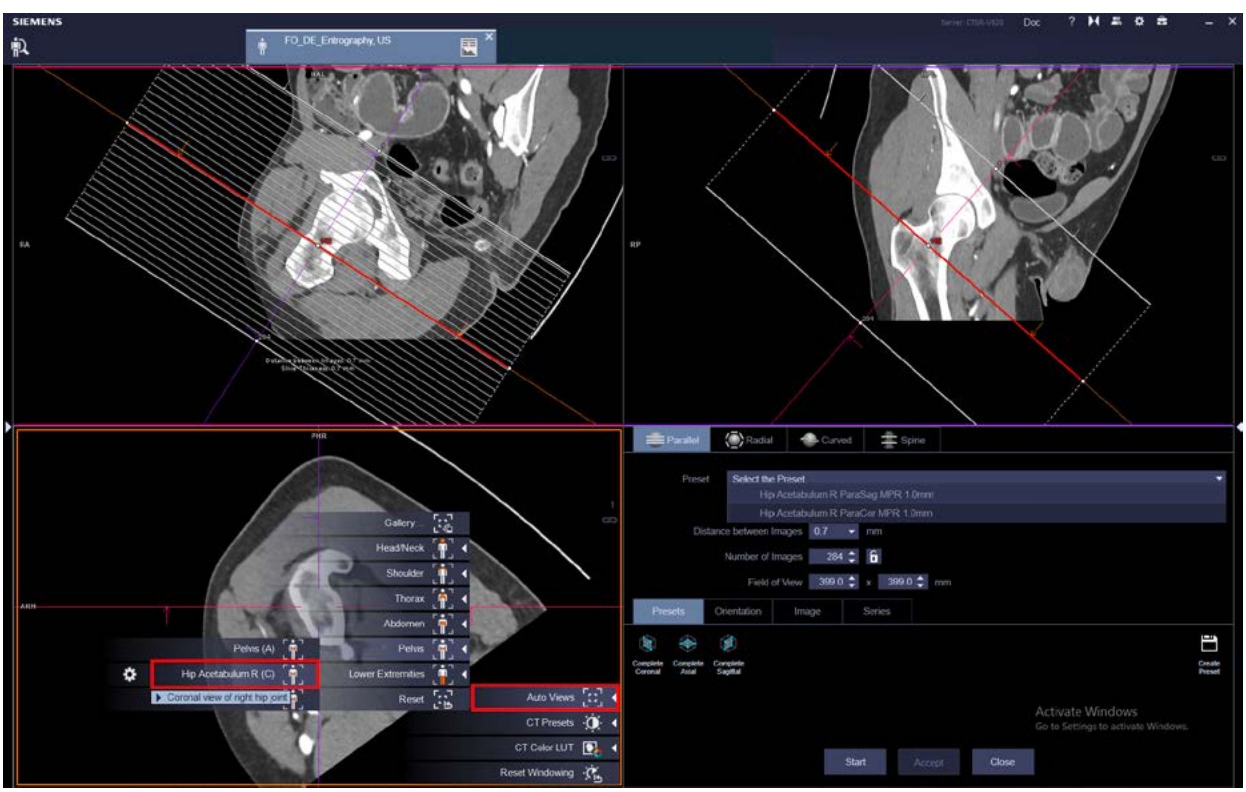

Figure 1: Anatomical range presets using ALPHA technology: It is possible to navigate virtually through a volume of data via presets for typical image reading situations, known as "Auto Views". This allows clinicians to see the acetabulum, orbita, or a four-chamber view of the heart within seconds.

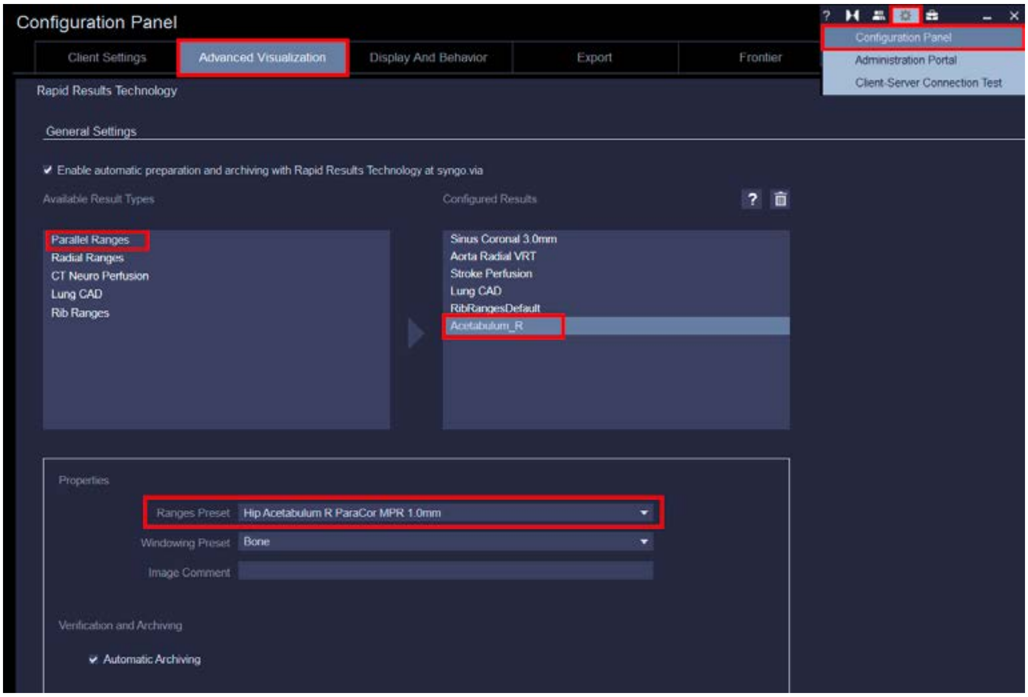

Figure 2: Configure the display options for "Parallel Ranges" or "Radial Ranges" in the PACS via the "Configuration Panel".

click access from the bottom right-hand corner menu allows the user to select anatomical presets (Auto Views) via the thumbnail gallery. With *syngo*.via VB20, RRT automatically creates and sends ready-to-read results, for example parallel and radial ranges of the acetabulum to the archiving PACS. These images are standardized and reproducible independent of the operator.

One of the many advantages of ALPHA is faster landmark detection, which improves clinical workflows. How does a system calculate the same view over a large number of images from a broad patient group? ALPHA technology registers numerous points of reference on bones, joints, organs, and blood vessels, for example. It then fits them together in realistic anatomic configuration models. This enables the automated processing of complex, 3D image data. Even images from different modalities, such as MRI and PET/CT scans, can be aligned and compared. This increases the efficiency and quality of image reading in various clinical situations.

RRT enables direct communication between *syngo*.via and SOMATOM CT scanners, triggering zero-click post-processing within the selected scan protocol. *syngo*.via automatically creates and sends ready-to-read results wherever it is needed, to PACS or a film printer without opening the workflow.

Without RRT, a radiologist or 3D lab would have to postprocess the images and create the result in *syngo*.via. With RRT, this step is no longer necessary; the results are ready-to-read for diagnosis and distribution in PACS right after *syngo*.via has preprocessed the data.

How to use it

RRT for "Anatomical Range Presets" – both parallel and radial – can be set up easily using ALPHA technology: Select the "Advanced Visualization" tab in the configuration panel of *syngo*.via VB20. Create a new preset and rename it as desired. In the properties section, select the ALPHA ranges preset of your choice and the windowing required for this range. In the example (Fig. 1), "Hip Acetabulum R ParaCor MPR 1.0mm" was selected. Clicking on the "Automatic Archiving" checkbox sends generated results to a configured DICOM node without further review. When a SOMATOM scanner is connected to *syngo*.via, the newly created range appears in the Scan Protocol Assistant where the configured data roles can be assigned to a particular series.

With ALPHA technology the following results can be specified:

- **Anatomical ranges (parallel ranges and radial ranges)**
- **VRT/MIP ranges with table removal and bone removal**
- **Lung CAD**
- **Bone Reading unfolded rib ranges**
- **CT Neuro Perfusion results**

Listen. Care. Improve.: A motto set to inspire all at the 13th SOMATOM World Summit.

A Valued Success Story: 13th SOMATOM World Summit

Around 500 visitors gathered at the 13th SOMATOM World Summit in Singapore to share the latest medical and technical developments in CT imaging. The event was supported by our partner Bayer Healthcare.

By Axel Lorz, Siemens Healthineers, Germany

Listen. Care. Improve.: A motto set to inspire all at the 13th SOMATOM World Summit. These well-chosen words set precisely the right tone for this prestigious event dedicated to knowledge and best-practice sharing across the various radiology disciplines. Singapore's national flower, the hybrid orchid Vanda 'Miss Joaquim', was the perfect symbol of synergy and resilience.

A balanced conference agenda included not only state-of-the art technology but also addressed sensitive topics such as the future role of artificial intelligence (AI) and the potential of population health management in radiology, including the automatic detection of imaging biomarkers. As André Hartung, CEO of Computed Tomography at Siemens Healthineers, outlined in his short but inspiring welcome speech, the scientific content to be presented over the two-day summit was based entirely on a combined effort between our clinical partners and the Siemens Healthineers CT team. Naturally, such long-standing partnerships build a solid basis for future development and are a cornerstone of the approach of Siemens Healthineers. An impressive range of experts gave insightful lectures covering the following wide-ranging themes:

1. **New trends in CT and the workflow challenge**
2. **Optimized radiation dose and contrast management**
3. **Cardiology**
4. **Vascular imaging**
5. **Functional imaging with CT**
6. **Pediatrics**
7. **Acute Care**
8. **Oncology**
9. **Future technologies**

In each of these areas, the current medical and technical standpoint was analyzed, explained, and discussed by three to eight clinical experts. Particular focus was placed on workflow optimization in CT imaging given today's demands on healthcare providers to deliver better outcomes at lower costs. Innovations that support greater efficiency in CT imaging include seamless integration of Dual Energy CT data into the PACS environment and the novel mobile workflow concept engineered for the SOMATOM go. platform. Matthias May, MD, University Hospital Erlangen, reflected on his experience of using the high-resolution tablet and Bluetooth remote control when operating the SOMATOM go. CT scanner, which allows staff to stay with patients for longer.

Traditionally, special emphasis has been given to patient dose management in daily routine and the efficiency of established products such as ADMIRE, high-pitch scanning, Tin Filter, low kV, CARE kV, and dose modulation. For obvious reasons, the Pediatrics session focused especially on low-dose scanning techniques including Dual Energy CT applications. In a presentation by Professor Marilyn J. Siegel, MD, of Washington University School of Medicine St. Louis, Missouri, she nicely summed up her results in assessing the chest-lung perfusion in the title: "The role of Dual Energy in pediatrics is fine". In the Pediatrics session, several speakers explained the special care necessary for a successful CT scan of our younger patients, including an appropriate child-oriented design of the scan room.

As anticipated, the insightful Cardiology session covered not only the state-of-the-art but also elaborated on the future role of CT imaging including fractional flow reserve (FFR) CT and machine learning using Dual Source CT.

The increasing role of Dual Energy CT scanning techniques based on single source or dual source scanners was outlined in various talks covering the lung, the abdomen, MSK, or explicitly on the visualization of uric acid crystals. Furthermore, the audience learned about the advantages of Dual Energy CT scans in a trauma setting (Thorsten Fleiter, MD, University of Maryland Medical Center on "Full-body Dual Energy CT for fast decision-making").

As ever, the final session on future technologies was a highlight. Here, the technical background and potential clinical benefits of the innovative photon-counting detector[1] were discussed. These detectors will likely offer numerous advantages including reduced electronic noise, increased spatial resolution, and a capacity for multi-energy CT scans. Investment in this promising new technology, while still far from commercial use, underlines the commitment of Siemens Healthineers to innovation in CT imaging. As Christiane Bernhardt, Head of Sales and Marketing for Siemens Healthineers Computed Tomography, notes: "CT has tremendous potential. Thank you for supporting us on this exciting journey to unleash it". ●

[1] This feature is based on research, and is not commercially available. Due to regulatory reasons its future availability cannot be guaranteed.

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In clinical practice, the use of ADMIRE 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.

10th International CT Symposium in Garmisch

By Monika Demuth, PhD, Siemens Healthineers, Germany

From January 18-20, 2018, the 10th International CT Symposium will be held in Garmisch-Partenkirchen, Germany.

This year, the Symposium is celebrating its 10th anniversary. Since its inception, computed tomography has continuously seen almost inconceivable developments both in terms of technology and methods. CT imaging is becoming even more significant in the treatment of patients. In addition to highly detailed morphological imaging, functional and metabolic information is now available from CT scans in line with hybrid techniques. Computed tomography also provides exceptional support for guidance and monitoring during minimally invasive procedures. These fascinating developments in the CT success story will be presented at the 2018 Symposium.

The International CT Symposium in Garmisch-Partenkirchen is celebrating its 10th anniversary. *(Photo courtesy of Aksonov)*

Over the course of the Symposium, many interesting topics will be addressed. For example, equal to the impressive progress made in oncology imaging, an increasingly important field is the use of CT in lung imaging – especially for the hot topic of lung cancer screening. When pinpoint precision is required, for example in interventional procedures, virtual colonoscopies, stroke diagnosis or to assess head and brain trauma, the role of computed tomography continues to expand.

The workshops, which are always extremely well received, provide an opportunity for medical residents and radiology technicians to interact and discuss interesting clinical cases with experts.

The Symposium is accredited by the Bavarian "Landesärztekammer". Participants will have the option of registering for CME credits. The conference language is German. ●

Further Information: www.ct-symposium.org

Upcoming Events & Congresses 2017/2018

Short Description	Date	Location	Title	Contact
Radiological Society of North America	November 26 – December 1, 2017	Chicago, USA	RSNA	www.rsna.org
Internationales Symposium Mehrschicht CT	January 18–20, 2018	Garmisch-Partenkirchen, Germany	Mehrschicht CT	www.mehrschicht-ct.org
Arab Health	January 29 – Feburary 1, 2018	Dubai, UAE	Arab Health	www.arabhealthonline.com
European Society of Radiology	Feburary 28– March 4, 2018	Vienna, Austria	ECR	www.myesr.org
European Stroke Conference	April 11–13, 2018	Athens, Greece	esc	www.eurostroke.eu
European Society for Radiotherapy & Oncology	April 20–24, 2018	Barcelona, Spain	ESTRO	www.estro.org
European Conference on Interventional Oncology	April 22–25, 2018	Vienna, Austria	ECIO	www.ecio.org
International Society for Computed Tomography	May 2–5, 2018	Montréal, Canada	ISCT	www.isct.org
Annual Meeting of the Association for European Paediatric and Congenital Cardiology	May 9–12, 2018	Athens, Greece	AEPC	www.aepc2018.org
German Congress of Radiology	May 9–12, 2018	Leipzig, Germany	DRK	www.roentgenkongress.de
Particle Therapy Co-Operative Group	May 21–26, 2018	Cincinnati, USA	PTCOG	www.ptcog.ch
European Society of Thoracic Imaging	May 24–26, 2018	Geneva, Switzerland	ESTI	www.myesti.org
American Society of Clinical Oncology	June 1–5, 2018	Chicago, USA	ASCO	www.am.asco.org
European Society of Gastrointestinal and Abdominal Radiology	June 12–15, 2018	Dublin, Ireland	ESGAR	www.esgar.org
European Society of Paediatric Radiology	June 18–22, 2018	Berlin, Germany	ESPR	www.espr.org
Jahrestagung der Deutschen Gesellschaft für Radioonkologie	June 21–24, 2018	Leipzig, Germany	DEGRO	www.degro.org
Society of Cardiovascular Computed Tomography	July 12–15, 2018	Grapevine, USA	SCCT	www.scct.org
European Society of Cardiology	August 25–29, 2018	Munich, Germany	ESC	www.escardio.org
European Society for Medical Oncology	October 19–23, 2018	Munich, Germany	ESMO	www.esmo.org
American Society for Radiation Oncology	October 21–24, 2018	San Antonio, USA	ASTRO	www.astro.org
The American Association of Physicists in Medicine	October 27–28, 2018	Alexandria, USA	AAPM	www.aapm.org
Radiological Society of North America	November 25–30, 2018	Chicago, USA	RSNA	www.rsna.org

Clinical Workshops 2017/2018

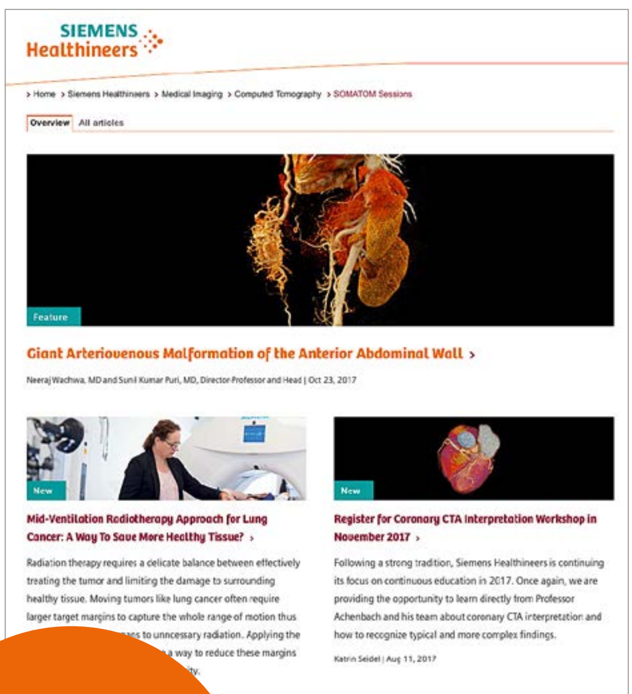
As a cooperation partner of many renowned hospitals, Siemens Healthineers offers continuing CT training programs. In a wide range of workshops, clinical experts share their experiences and report on the latest developments in clinical CT imaging.

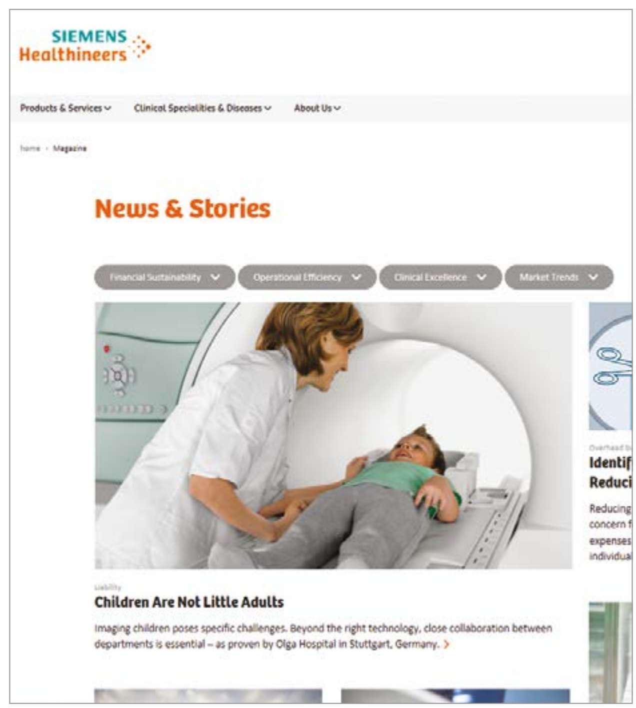
Workshop Title/ Special Interest	Date	Location	Course Language	Organizer – Course Director	Link
ESGAR CT Colonography Hands-on Workshop	March 14–16, 2018	The Hague, The Netherlands	English	ESGAR – Professor Jaap Stoker, Thierry Boellaard, MD	www.esgar.org
Workshop on Dual Energy	May 3–4, 2018	Forchheim, Germany	English	Siemens Healthineers – Professor Ralf Bauer, MD	www.siemens.com/ SOMATOMeducate
Oncology Imaging Course	June 28–30, 2018	Dubrovnik, Croatia	English	Professor Christian Herold, MD Professor Hedvig Hricak, MD Professor Maximilian F. Reiser, MD Assoc. Prof. Daniele Regge	www.oncoic.org
Hands-on at the ESC congress	August 25–29, 2018	Munich, Germany	English	Siemens Healthineers	www.siemens.com/ ESC
ESGAR CT Colonography Hands-on Workshop	October 17–19, 2018	Vigo, Spain	English	ESGAR – Professor Rosa Bouzas	www.esgar.org
Workshop for Physicists	October 25–26, 2018	Forchheim, Germany	English	Siemens Healthineers	www.siemens.com/ SOMATOMeducate
Coronary CTA Interpretation Workshop	November 22–23, 2018	Erlangen/ Forchheim, 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 **siemens.com/SOMATOMEducate**

Siemens Healthineers Publications

Our publications provide up-to-date information and context for every field of healthcare. We cover content that is relevant to everyone from hospital executives to radiological assistants.





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