AXIOM Innovations

The Magazine for Interventional Radiology, Cardiology and Surgery

Issue Number 13 | June 2011

SIEMENS

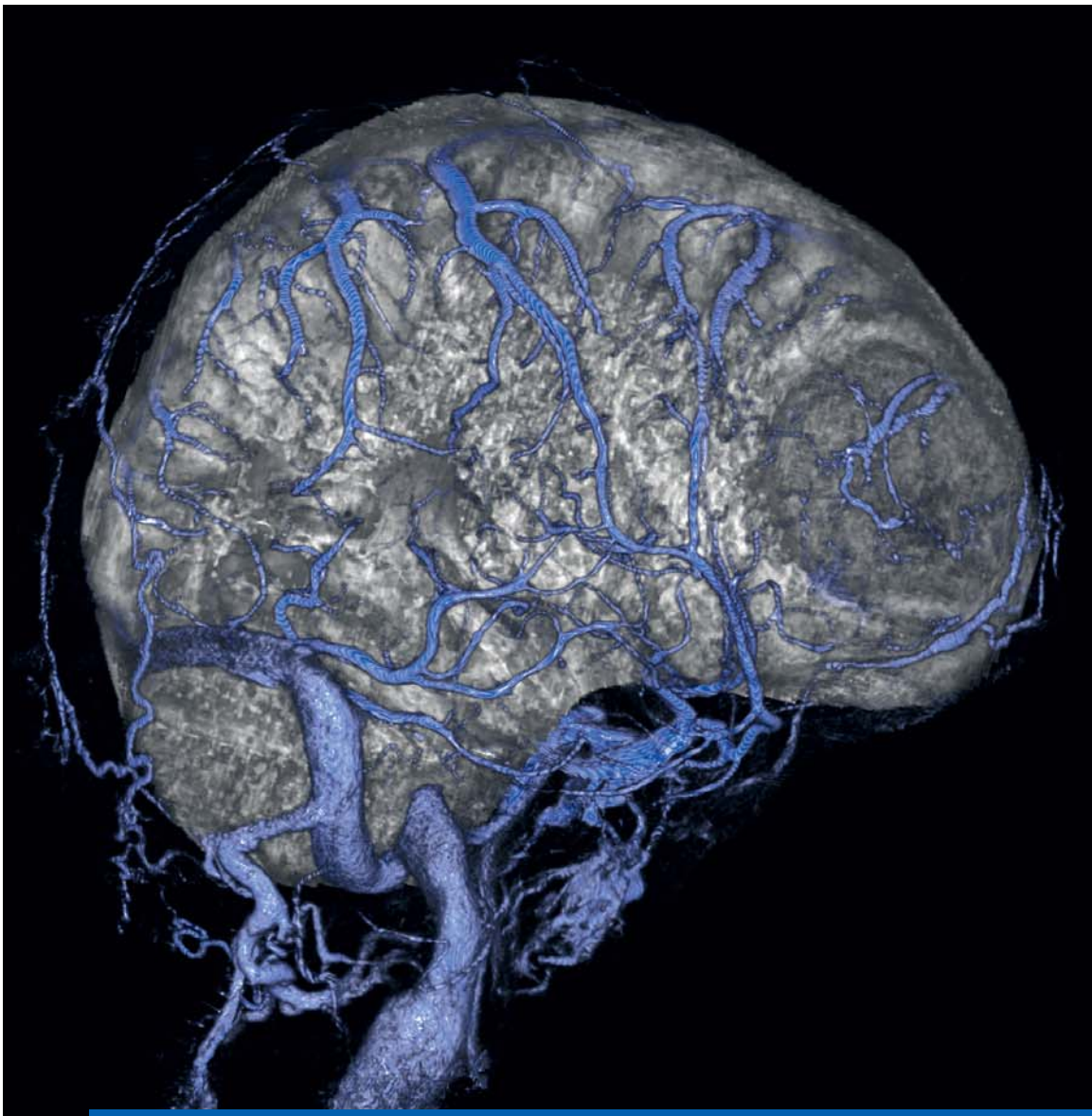

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Image Fusion with MRI and Angiographic Data Sets to Reduce Radiation Dose

"Pioneering into new fields and exploring new applications for interventional imaging is the driving force for our innovations – for our customers, their patients and advancements in medicine."

Dr. Heinrich Kolem,
CEO of the Angiography & Interventional X-Ray Business Unit (AX)
at Siemens Healthcare

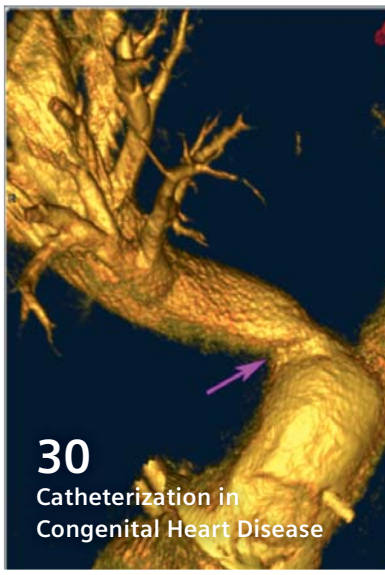
Dear Reader,

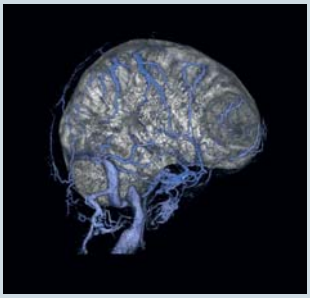
Dr. Heinrich Kolem
CEO AX Division

One of our customers once said: "What I can see, I can do." Short and to the point, this describes exactly the major challenges in interventional imaging today. Doctors need excellent image quality for correct diagnosis and treatment of their patients. They rely on the images prepared by medical imaging equipment for their daily work.
This is especially true when they treat patients minimally invasively by catheter. With the patient on the examination table, the catheter inserted and in place, it is vital for the medical team to reach a fast diagnosis and a fast treatment decision. Sometimes a patient's life depends on it.
Keeping this in mind, we at Siemens Healthcare want our customers to have the best possible image quality and guidance to make their treatment decisions with confidence. For imaging challenges during interventional procedures we have introduced CLEAR – an imaging technology to enhance the contrast of vessel edges, improve stent visibility and to correct noise and motion artefacts, but without increasing X-ray dose for the patient or staff.
Over the last years, 3D imaging has become equally important in the interventional suite. 3D applications like *syngo* DynaCT have improved greatly, providing excellent guidance and orientation during interventions. And not only radiologists and cardiologists can benefit in their labs. In hybrid surgery, too, fixed C-arm systems and 3D imaging have become more than just a trend, especially in cardiac and vascular surgery. But there are more clinical disciplines that benefit tremendously from using 3D imaging. For instance neurosurgeons and thoracic surgeons see a lot of potential in our solutions for their ORs. Thoracic surgery is a field that could benefit greatly from angiographic 2D and 3D image guidance for the biopsy and treatment of lung nodes.
In addition, the ability to guide the catheter to peripheral lesions and immediately start therapy could be very useful in treating lung cancer.
Learn more about CLEAR technology, new approaches in neuro and thoracic surgery and many other innovative topics in this issue of AXIOM Innovations.
I hope you enjoy reading it.

Dr. Heinrich Kolem

Content

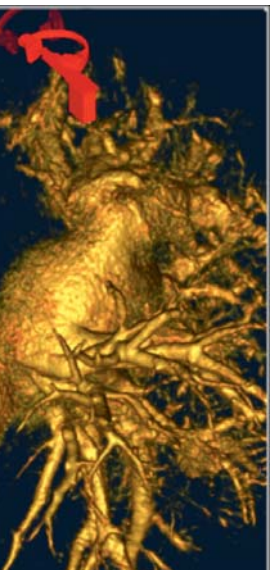


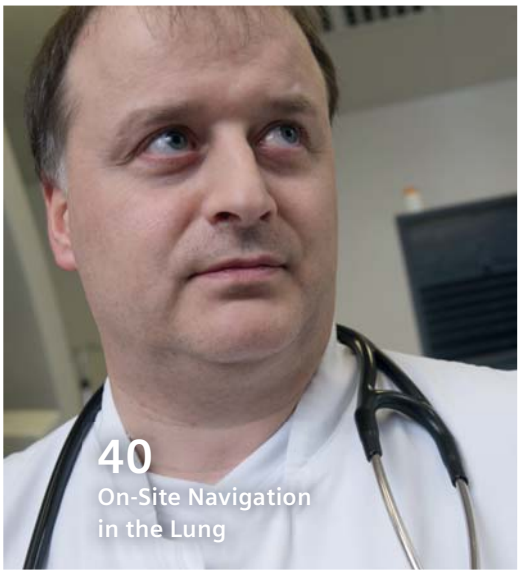


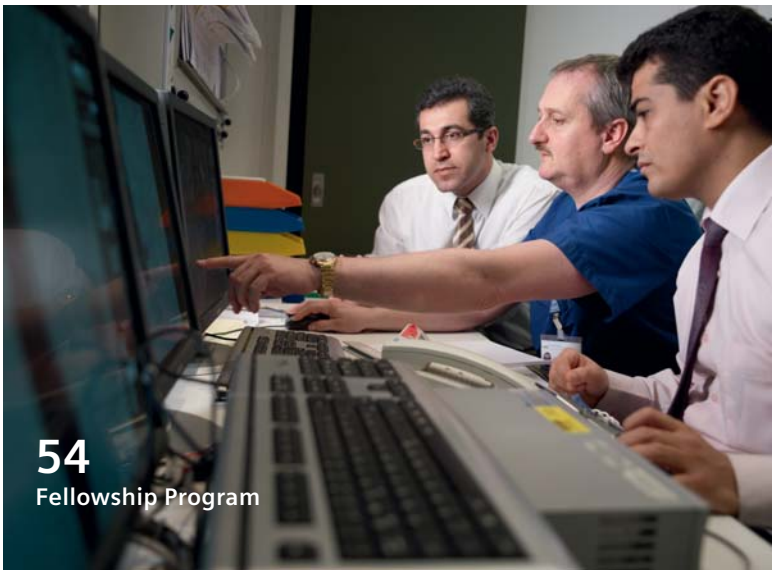
Cover

Image fusion of a meningioma using MR images and angiographic data.

Courtesy of Akira Iishii, M.D., Department of Neurosurgery, Kyoto University Graduate School of Medicine, Kyoto, Japan







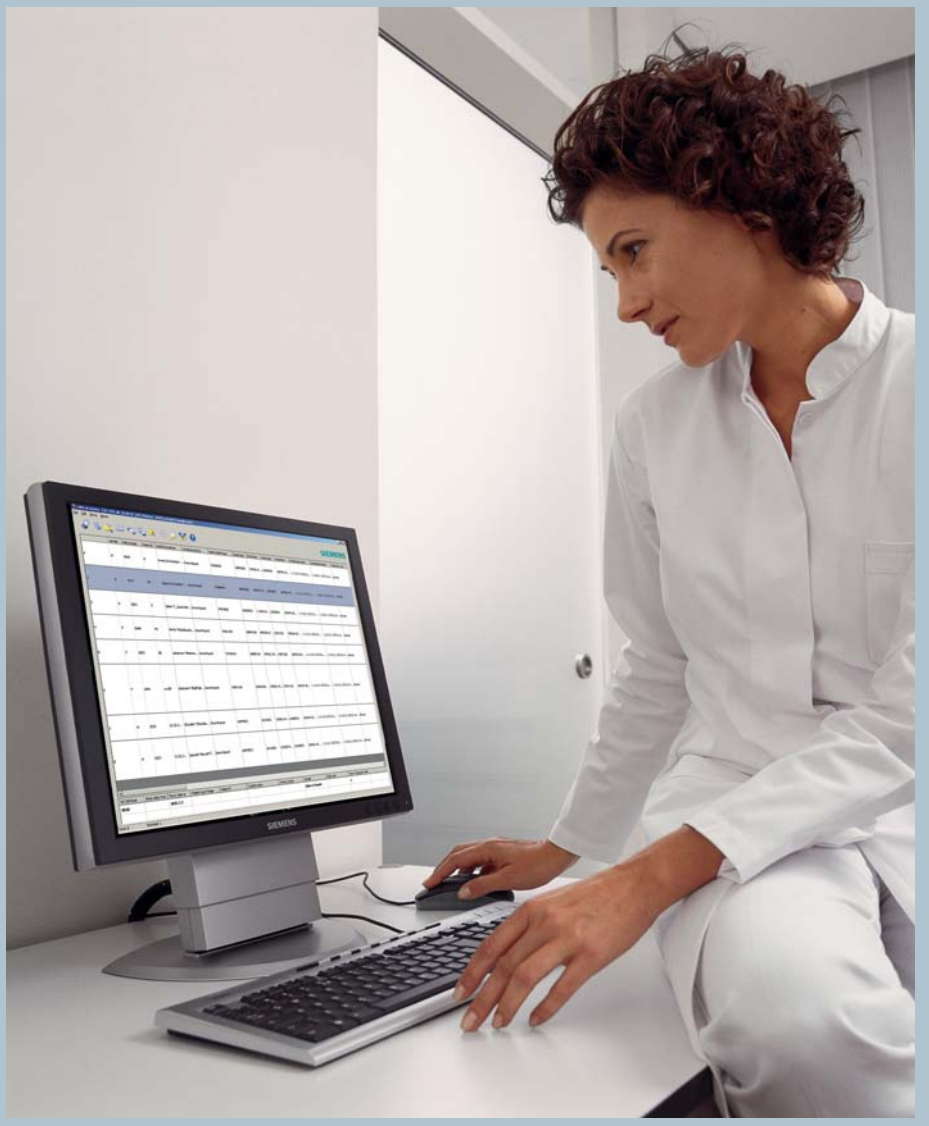
Angiography

Cardiology

Surgery

Customer Care

CARE Analytics Provides Optimized Dose Reporting



The measurement and calculation of radiation dose during interventions is an important topic for efficient dose management. Now Siemens takes dose management to a new level by providing tools such as DICOM Dose Structured Reports (DICOM SR) and CARE Analytics. The DICOM SR contains comprehensive data for each irradiation event, the data is provided in DICOM standard format that can be sent to any system which receives stores or processes dose information, such as conventional PACS or workstations.

In order to evaluate and analyze the information contained in the DICOM SR files Siemens provides a new free tool, CARE Analytics. It is available for a multiple of radiology imaging modalities. This dose analysis application is part of a comprehensive portfolio of CARE (Combined Applications to Reduce Exposure) applications, which help medical staff to reduce X-ray dosages. The dosages received by each individual patient can be logged on computed tomography systems, radiography and angiography systems from Siemens after the examination. The data, such as CT dose index (CTDI), dose length product (DLP), total recording time or the dose surface product during an intervention are imported into DICOM dose structured reports – DICOM SR. CARE Analytics extracts these data from the DICOM SR, exports and prepares them for analyses. The medical staff is now able to compare dosages given during different examinations with one another in order to further optimize the examination protocols. In addition, it is possible to ascertain the dose a patient has received on different systems over a series of examinations. Dose reporting between multiple hospitals is also possible. The increased transparency lets clinicians improve their working practices and be more sparing than in the past with the dosages given.

CARE Analytics can be installed on any PC connected to the hospital network to retrieve the radiation dose values from the DICOM reports for analysis, making it easy for hospitals to analyze and monitor their monthly applied dose levels for specific body regions and promptly take corrective actions, if necessary.

Benefits at a glance

- Enhanced in-house dose reporting and assessment
- More transparency regarding dose per case
- Improved reporting on patient dose history
- Better cross-institutional reporting

Robotic System Traveling Around the Patient

The Department of Neuroradiology at the University Hospital in Erlangen is the first neurological hospital in Europe where an Artis zeego was installed for cerebro-vascular examinations. The system is used for a variety of diagnostic and interventional procedures, such as e.g. intracranial stent follow-up exams, cochlea implant studies and endovascular stroke treatment. The flexible C-arm includes a performance-oriented robot traveling around the patient's body. "This allows our medical personnel to check their patient-protective treatments more directly and accurately," said Professor Arnd Dörfler, head of the Department of Neuroradiology at the University Hospital. Due to the excellent spatial resolution of *syngo* DynaCT, the fine details of the inner ear can be visualized which is extremely important for cochlea implant imaging.
Also follow-up exams to check the patency of intracranial stents, which were formerly scheduled for conventional CT imaging, are now performed with Artis zeego and *syngo* DynaCT along with a non-invasive intra-venous contrast administration. "With this acquisition technique we can see the fine details and can check if the stent is patent," said Professor Arnd Dörfler. The Artis zeego system is also equipped with the unique application to visualize the perfused brain volume directly in the angio room based on a special *syngo* DynaCT protocol.
Especially for endovascular stroke treatment it is extremely important to have this information available without the need to transfer the patient to another acquisition system like CT or MR. With this application, *syngo* Neuro PBV IR*, it is possible to visualize the perfusion status of the entire brain in a color-coded display mode in order to immediately decide the further treatment plan.

Prof. Arnd Dörfler, M.D. and his assistant during endovascular treatment.
(Photo: University Hospital, Erlangen)

Expanded Navigation in the EP Lab

Proven compatibility of Siemens cath lab solution and Hansen Medical's Sensei® X Robotic Catheter System.

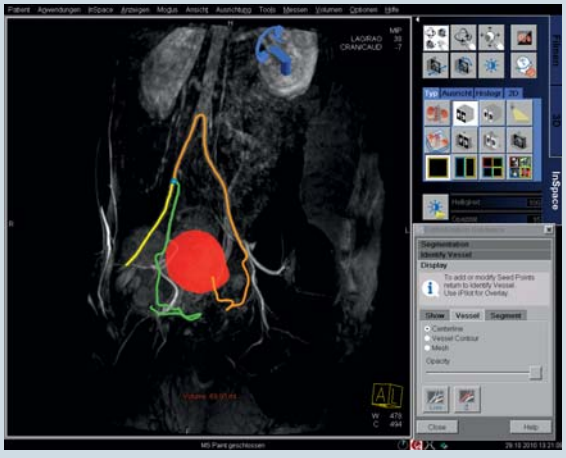
In January 2010 Siemens Healthcare signed a collaboration agreement with Hansen Medical, Inc. The joint integration tests have been successful and we now can declare the compatibility of all our AXIOM Artis/Artis zee* systems, AXIOM Sensis XP and the *syngo* X Workplace with Hansen Medical's Sensei X Robotic Catheter System.
The combination of the excellent 2D and 3D imaging capabilities of Artis zee systems and the Sensei X System's 3D robotic catheter control allows the electrophysiologist to navigate more efficiently in complex catheter-based procedures. Less exposure to radiation for user and patient is another benefit of the integrated solution with the Siemens Artis CARE Features (Combined Applications to Reduce Exposure) and the precise remote-controlled navigation of the Hansen Artisan control catheter.

* For Artis zeego (VC14). This information about this product is preliminary. The product is under development and not commercially available in the U.S., and its future availability cannot be ensured.

Uterine Fibroid Embolization

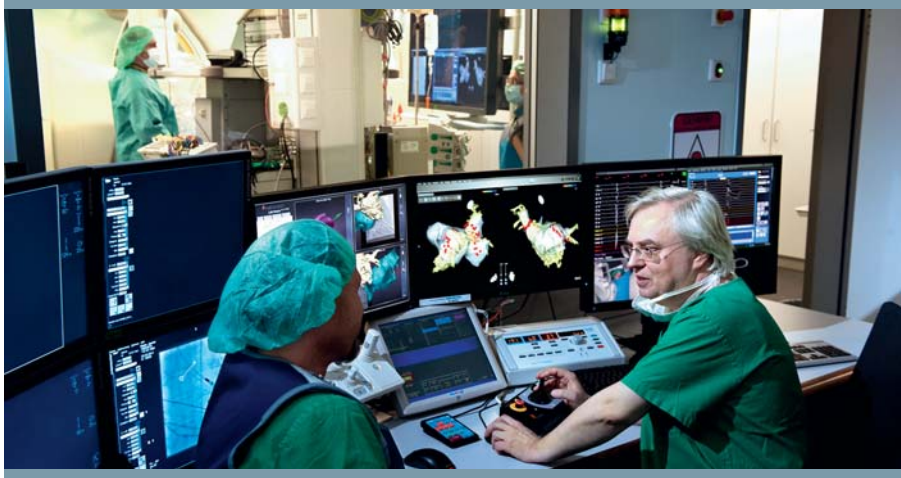
syngo Embolization Guidance helps to increase efficiency of uterine fibroid embolization procedures and reduces exposure to dose and contrast medium. The new version of *syngo* Embolization Guidance has been advanced to simplify and accelerate the minimally invasive embolization of benign tumors such as uterine myomas. The imaging software assists with treatment planning and delivery, and supports checking treatment outcomes. *syngo* Embolization Guidance enables physicians to mark the fibroid and its feeding arteries on pre-interventional MR* or CT* images. Planning the intervention on MR images drastically reduces patient exposure to dose. As with the previous version of *syngo* Embolization Guidance, *syngo* DynaCT images can be also used for pre-interventional planning. The software calculates the volume of the fibroid as well as the access path for catheter navigation and shows both in the 3D image. Superimposing this planning information on 2D live fluoroscopy during the intervention speeds up catheter navigation and largely removes the need for contrast medium, as the planned access path is overlaid on live fluoroscopy. Treating myomas with *syngo* Embolization Guidance is thus easier on the patient, as both the amount of contrast medium and radiation dose can be reduced as compared with existing embolization procedures.

* The product/function described here is not yet available for sale. No assertions can be made as to its future availability due to the special legal provisions governing medical devices.



Embolization path planning on a pre-procedural MR image.

An Investment in Top-Notch Medicine



Dr. Konrad Göhl performs the procedure remotely from the control room.

With its new Cardiac Vascular Center, Nuremberg Hospital is reaching for the stars in the treatment of patients with cardiovascular disease. The three mainstays of the new center are the departments of cardiology, vascular surgery, and cardiac surgery. State-of-the-art medical technology, combined with a mature process structure, allow an annual throughput of approx. 4,000 patients.

The departments are located right next door to each other. “The patients here expect wait times and walking distances to be short,” emphasizes hospital director Dr. Alfred Estelmann, “and that’s especially important for our aging patient population,” adds Prof. Theodor Fischlein, head physician of the cardiac surgery clinic. Lastly, modern surgical technology is increasingly enabling gentle, minimally invasive cardiac interventions on patients well advanced in years. Dr. Eric Verhoeven, head physician of the vascular surgery clinic, affirms, “We’ll be working more closely than ever and treating more patients as a team.”

The top floor of the new building boasts three new operating rooms, including a hybrid OR with the modern, robot-assisted Artis zeego angiography system, which opens up new possibilities for minimally invasive procedures thanks to its high image quality and 3D imaging capability.

Cardiac arrhythmias are treated using an Artis zee Magnetic Navigation biplane angiography system, allowing physicians to perform often complex procedures with greater confidence and less radiation. Whether the pathway to diagnosis and treatment is interventional, endovascular, or open surgery, patients now enjoy everything under one roof. “Nuremberg Hospital offers state-of-the-art medicine, and can hold its head high in comparison with other treatment centers,” explains Professor Matthias Pauschinger, head physician of the cardiology clinic.

It's Time to Clear up Your EP Control Room

Since January 2011 third-party vendor systems can also be connected to the Artis zee Cockpit, the Siemens solution to declutter the control room by combining various images from different systems into one workplace. Even the latest versions of electroanatomical mapping systems like the Ensite Velocity from St. Jude Medical and Carto3 from Biosense Webster can now be displayed with full HD resolution of 1920 x 1200 in real size on the medical-grade display of the Artis zee Cockpit. Additionally, the signals can be integrated in the Artis zee Large Display in the examination room. Complex procedures require a number of dedicated systems in addition to the Siemens Artis zee imaging system to support patient treatment. These systems need to be operated from the control room desk, every system with its own monitor, with its own mouse and keyboard. The result: multiple displays and keyboards on one desk. Artis zee Cockpit combines them all in one workplace and creates more free space to work efficiently in the control room.

Taking CARE of the Installed Base

The Angiography and Interventional X-Ray Unit (AX) of Siemens Healthcare is currently undergoing its largest field update in history. Over 2,000 Artis zee systems installed worldwide will be updated to the latest software platform VC14 H. Additionally all Artis zee customers will benefit from image quality enhancements and receive all of the AX CARE features for improved dose saving, dose monitoring and dose reporting. In addition the update opens the door to new advanced applications and innovations such as the Large Display or the Cockpit to be installed on the systems. One of the first updated customers since the roll-out started in December 2010 was Hacettepe University in Ankara, Turkey. The neuroradiologist and head of the department, Professor Cekirge, now enjoys better image quality than ever before. "Since Siemens updated my Artis zee biplane system to the latest software platform, the image quality for 2D and 3D is excellent at the lowest possible dose. I have never seen the fine structures of a stent that well," states Cekirge after the update. Artis zee systems around the world are getting updated during this year, and Dr. David Lord from Westmead Children's Hospital in Sydney, Australia is also very satisfied with his system performance: "I am very impressed with the VC14H update. Originally I was skeptical that there would be any difference from a system upgrade but I was totally surprised by the improvement in image quality both in contrast and spatial resolution, and with lower dose. The biggest surprise was that Siemens is making this update available gratis across the whole world. This initiative tells me that Siemens are a company unafraid to show leadership in a critical area. Dose reduction in pediatric interventional radiology protects the most vulnerable members of our society: sick children and babies. Thank you!"

Prof. Cekirge is impressed with the performance of his new updated Artis zee system.

Precise Imaging Far Beyond the Basics

Every second, and often every millimeter counts in the cardiac catheter laboratory. Physicians have to be able to visualize the state of the fine vessels with ultimate precision for diagnostic purposes and during interventions. And, as surgical invasiveness is reduced to a minimum, the necessary devices are being progressively miniaturized. The demands placed on modern angiography systems have increased in line with these developments. Professor Stefan Sack, a cardiovascular specialist and interventionalist based in Munich, relates his experiences of and plans for Artis zee.

A rotablator is sometimes the only answer. Coronary vessel constrictions occasionally display such high-grade calcification that it is impossible to enlarge them with an angiography balloon. In these cases, a special guidewire is the only way to thread a diamond-tipped rotational catheter (with a diameter of a mere 1.2 to 2.5 millimeters) along the artery to the stenosis, which is subsequently opened at a speed of up to 280,000 revolutions per minute. Professor Stefan Sack comments: "This is just one of the instruments we use where excellent imaging is essential." The physician heads the Department for Cardiology, Pneumology and Internistic Intensive Care Medicine at the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Schwabing Clinic in Munich, Germany. Approximately 1,600 patients are treated in the clinic's two cardiac cath labs each year, which operate 24 hours a day to ensure that patients with acute myocardial infarctions receive immediate attention. This is normally necessary 10 to 15 times a week.
The angiography system selected for one of the two cardiac cath labs, a newly-built hybrid room, had to satisfy diverse requirements. On the one hand, physicians need a high-performance, flexible imaging instrument for acute clinical practice. On the other, the device must facilitate the further development of modern interventional procedures and completely new methods. Particular emphasis was placed on the following criteria: optimal image acquisition and post-processing; the variable, precise control of C-arm and examination table; customization options in line with physicians' specific requirements and the full technical integration of additional procedures. The choice fell on Artis zee, which was commissioned by Professor Sack and his team in August 2010.

Improved Images with Reduced Radiation Dose

Stefan Sack on working with Artis zee: "The resolution is outstanding and the image quality excellent, despite the smaller detector." This flat-panel detector, which measures just 20 by 20 centimeters, was an important selection criterion, as space for treating acute patients with resuscitation technology is limited in the new cardiac cath lab. Here, a larger detector would impair the chances of achieving specific camera angles with the C-arm. The new, more powerful X-ray tubes have already proved that higher-resolution images are possible. This also pays off when it comes to screening adipose patients. According to Professor Sack, it is theoretically possible to operate Artis zee in high-energy mode, but this has proved unnecessary to date. On the contrary, the latest generation of high-tech C-arm systems is equipped with

CLEAR and CARE technologies, which facilitate optimal image quality even in low-dose conditions.
These technical advances provide interventionalist Stefan Sack and his team with a broad spectrum of possible applications. CLEAR, a software package for improved image quality, further reduces image noise via filter algorithms. Additional algorithms provide for effectively compensated movement artifacts – a prerequisite for improving images of regions including the beating heart.
It's all in the name with CARE, too. This software reduces exposure for examiners and patients avoiding unnecessarily high radiation doses. If, for example, a slim patient is screened, a corresponding low-dose program can be selected. Alternatively, the radiation dose is optimized by decreasing the number of X-ray pulses. Stefan Sack explains: "This is suitable for ventriculographic applications, that is images of the cardiac chambers, or for normal coronary angiography."

Precision from all Perspectives

He is impressed by his achievements with Artis zee. Firstly, progress is evidenced by sharper image definition and, secondly, by an overall quality improvement with simultaneously increased flexibility. As Stefan Sack reports, the individual technologies can be selected to meet specific requirements: "We have a special program for the coronary vessels and another for ventriculography. On the other hand, we can also customize device programming so that the projections run automatically, while the equipment's designated algorithms simultaneously provide optimal image quality and radiation reduction."
This can be termed the personalization of image quality. In addition, the ergonomics – controlling the entire system via the touch screen, joystick and foot

switch for example – have improved considerably, even enabling the rapid, precise positioning of the C-arm and examination table. In the new cardiac cath lab, full-body images are no longer a problem.
Stefan Sack says: "It's necessary to observe the heart from different angles in order to view and fully evaluate a stenosis." This is where another special Artis zee feature comes into play: *syngo* DynaCT Cardiac, which enables CT-like 3D reconstructions. After an injection of contrast media, the heart is displayed from all angles with a single rotation of the C-arm. The rotation takes just five seconds, and the 3D results can be superimposed over the fluoroscopy images in less than a minute.
Does the precision of Artis zee measurements bear comparison with another procedure whose accuracy is generally acknowledged? The modern C-arm facilitates vessel measurement via quantitative coronary analyses (QCA). Prof. Sack has compared the results with those of the intravascular ultrasound (IVUS), in which a tiny ultrasonic probe measures the vessel from the inside.
The results of both procedures tally very well. Examiners can see this on the system monitors, which display high-definition images of vessel edges and instruments in the sub-millimeter range in real time.

Faster Diagnosis and Therapeutic Decisions

The coronary angiography of a woman in her early seventies demonstrates the success of the progressive Artis zee system during a supposedly routine examination, in which the dispersion of the contrast agents aroused the surgeons' suspicions. Standard projections have just revealed a tiny deviation in the flow of contrast agent in the branch of the right coronary artery as it exits the aorta, whereupon Stefan Sack selects a 90 degree display angle. He rapidly identifies a high-grade stenosis and decides to treat it immediately.
The vital coronary vessel is narrowed to such an extent that it initially requires

> "The resolution is outstanding and the image quality excellent, despite the smaller detector."
>
> Prof. Stefan Sack, M.D., Head of the Department for Cardiology, Pneumology and Internistic Intensive Care Medicine, Schwabing Clinic Munich, Germany

enlargement via a balloon. When the stent is subsequently inserted, every millimeter counts. Focusing intently on the task at hand, the interventionalists follow their progress on the monitors. The small stent must be positioned in such a way that it extends 2 to 3 millimeters into the aorta from the artery and remains securely in place. After the intervention is concluded via radiographic monitoring, Professor Sack uses the fully-integrated IVUS system to check the results. Of the three screens opposite the examination table, the right-hand monitor clearly shows that both the size of the stent and its position are correct.

Summing up the intervention in the control room afterward, the physician comments: "The stenosis was located in a position which is easy to overlook." The case effectively demonstrates the extent to which diagnostic accuracy and the reliability of therapeutic decisions have increased with Artis zee. According to Stefan Sack, the combination of improved imaging quality, sharper contrasts and higher resolution is like driving out of the mist into sunlight.

Innovative Basis

The central importance of imaging in the cardiac cath lab is emphasized once again in Professor Sack's department. With its high-definition images and advanced image processing abilities, Artis zee optimizes standard examinations and interventions. However, this latest C-arm generation simultaneously constitutes the basis of further and even new interventional developments. Stefan Sack and his team are already using the system for percutaneous aortic valve replacement and mitral valve reconstruction. At the same time, the demands placed on imaging are increasing in line with the growing complexity of interventions. In a collaboration with Siemens, the reconstruction of the mitral valve function is being used to define what imaging still has to achieve. In Munich 3D imaging with *syngo* DynaCT is already being used successfully in order to examine neck vessels. And Stefan Sack is planning a series of new projects with this feature: implantation of atrial appendage occlusion systems and therapeutic arteriovenous fistulas to treat patients with severe chronic obstructive pulmonary disease (COPD).

Matthias Manych *is a biologist, freelance science journalist and editor specializing in medicine. Among other topics, he writes about imaging procedures on a regular basis.*

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Stony Brook Medical Center CAREs – With Low Dose Interventional Imaging

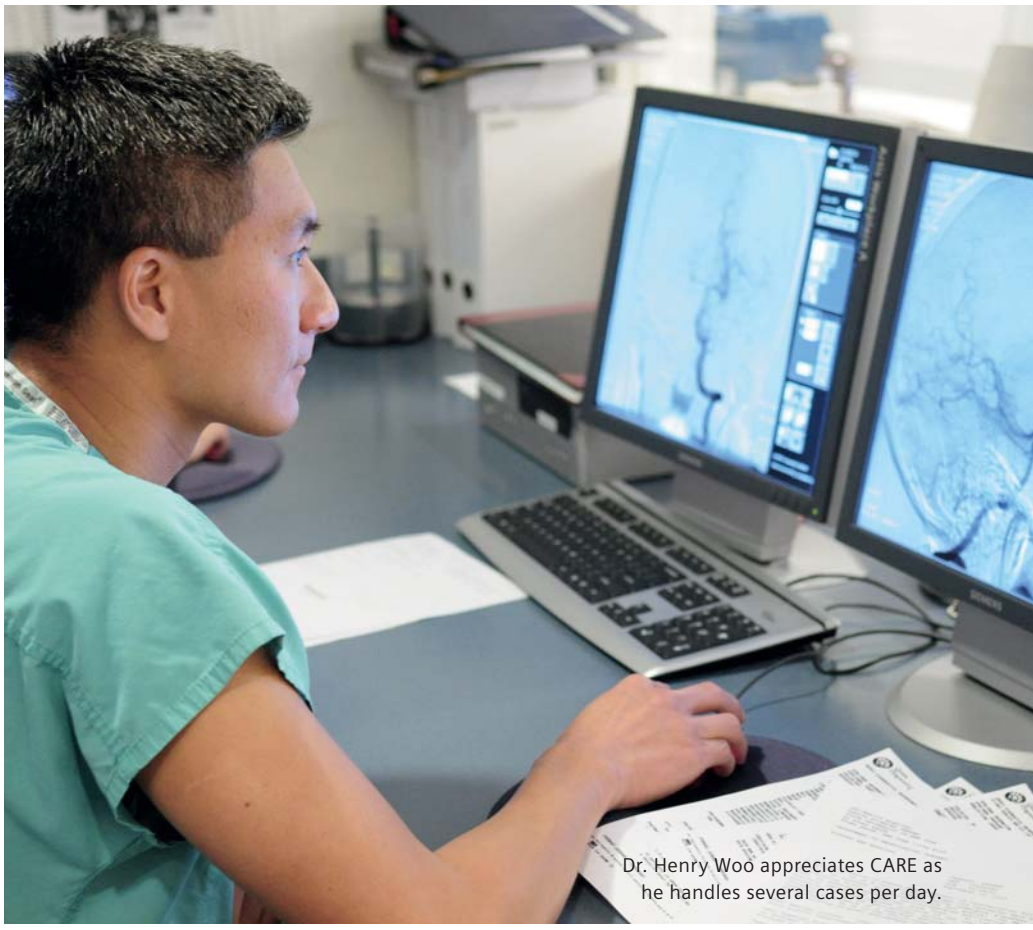
No question, radiation dose management is serious business in diagnostic and interventional imaging. There is growing awareness and urgency about the need for safeguards to protect both patients and medical staff from unnecessary radiation or overexposure. As a pioneer in dose management strategies, Siemens has been at the forefront of innovation, developing dose reduction technologies since 1994. Today, Siemens offers a comprehensive range of technologies for devices that work with X-rays or radioactive tracers; CARE (Combined Applications to Reduce Exposure) enables dose to be significantly reduced without compromising image quality.

CARE combines a variety of advanced applications that optimize outcomes while significantly reducing radiation exposure for both patients and physicians and medical staff. CARE is fully integrated with the Artis zee family of C-arm systems, making dose reduction a seamless aspect of diagnostic and interventional care.

> "*syngo* DynaCT and the integrated CARE features make the task of keeping the dose low virtually effortless"
>
> Charles Mazzarese, Medical Radiographer, Cerebrovascular Center, Stony Brook Medical Center, New York, NY, USA

The Cerebrovascular and Stroke Center at Stony Brook University Medical Center (SBUMC) has been using CARE since early 2008 with the installation of their first Artis zee biplane, and the Center now boasts two new Artis zee biplane rooms, each equipped with *syngo* DynaCT and integrated CARE features. The technologies allow physicians and staff to work with peace of mind, knowing that procedures can be managed with the lowest doses of radiation possible. Charles Mazzarese, R.T.(R)(CT), LRT, medical radiographer in the Cerebrovascular Center at Stony Brook Medical Center (SBUMC), New York, says the facility is using low dose acquisition to merge with already acquired CT and angiographic sets to navigate and reduce both radiation dose and contrast agent. "It's integrated seamlessly with an easy-to-use interface and can be accessed right from the footswitch. It makes the task of keeping the dose low virtually effortless."
Mazzarese, who has been the technical point-person for technology implementations in the Center, says all of the CARE features are implemented and in use, with the exception of CAREguard for skin dose management, which is anticipated with future upgrades.

Stony Brook also uses the optional Low Dose *syngo* DynaCT to acquire real-time 3D CT-like images which incorporates CARE for lower dose radiation.
Dr. Henry Woo, cerebrovascular and endovascular neurosurgeon, and director of the Cerebrovascular and Stroke Center at SBUMC, says CARE has been an important feature. Dr. Woo's interdisciplinary team of neurologists, interventional neuroradiologists, and cerebrovascular neurosurgeons diagnoses and treats cerebrovascular diseases from arteriovenous malformations, arteriovenous fistulas, hemorrhagic strokes, ischemic strokes, atherosclerosis, and carotid stenosis. The center also is home to an active clinical trials unit with four clinical research coordinators and an NIH-funded hemodynamics lab.
"As a high volume center, we handle many cases." explains Dr. Woo. "With certain modalities, such as angiography, you can potentially deliver large amounts of radiation without even realizing it. In emergency situations, for example, and especially in circumstances when you are managing a complex, delicate procedure, you may not be able to pay as close attention to radiation exposure and dose as you would like. Having the technology to manage it for you automatically puts a lot of minds at ease."
Dr. Woo says for certain procedures, new processes could potentially lead to more exposure, so the technology is essential. "In particular, for arteriovenous malformations where we are using Onyx, the new liquid embolic, injections can last for hours, as opposed



Dr. Henry Woo appreciates CARE as he handles several cases per day.

> "*syngo* iPilot and *syngo* iGuide allow us to focus our attention above all on patient care"
>
> Henry Woo, M.D., Director of the Cerebrovascular and Stroke Center, New York, NY, USA

Dr. Woo's interdisciplinary team.

Combined Applications to Reduce Dose: An Integrated Answer to Dose Reduction

CAREvision: pulsed fluoroscopy application that provides extremely low frequencies to meet individual dose saving targets. Pulses can drop from a range of 30 p/s to only 0.5 p/s. When dropped to 7.5 p/s, a 75% dose reduction is achieved.

CAREfilter: a variable lead filter (0.2 mm-0.9 mm) is automatically set according to current transparency of the object/C-arm angulation, without any necessary interaction from the user. Dose reduction: up to 50 %.

CAREposition: positioning without repeated fluoroscopy. The feature is especially needed during long-lasting neurointerventions that can take several hours as the provider can control patient positioning without the need for additional fluoroscopy. Dose reduction: up to 5%.

CAREprofile: radiation-free adjustment of collimators as well as radiation-free semitransparent filter parameter setting. Dose reduction: Up to 9%

CAREguard: a new real-time application that monitors skin dose exposure and allows for effective skin dose control. Three separate thresholds can be defined with warning indicators that alert to length of exposure time. The feature reduces exposure for radiologists, technicians, and patients.

Low Dose Acquisition: additional low dose protocols that can be accessed hands free, directly from a footswitch. These tools can reduce radiation dose by 67%.

Low Dose *syngo* DynaCT: an optional feature, offers CT-like 3D imaging for radiosensitive patients and others. As an example, 5 sec protocol can be done at 0.1 µGy/frame instead of 0.36 µGy/frame which results in a 72% reduction.

CAREreport: a structured dose report that contains all patient demographics, procedure, and dose information. Using commercially available programs or in-house software, this information can be filtered for further processing, such as dose analysis.

to just the several minutes the old nBCa injections would take. You're talking about a large, large difference in dose you would be delivering, so dose saving features are absolutely essential."
Mazzarese says today's educated public is also driving home the need for more attention to dose control in radiation interventions. "We're in a world where patients are more educated and savvy about radiation dose and risk. It's comforting as providers to know – and to be able to tell patients – that our system has the ability to help us keep radiation doses as low as possible. This is especially important for outpatients and those with follow ups, who require a lot of serial imaging. The exposure is definitely a factor in the long term. It puts patients at ease when they understand we use the lowest dose possible to get the information we need."
But what about image quality? Dr. Woo says the image quality remains excellent, despite reductions in dose. "Image quality is critically important for us. These sophisticated tools allow us to see what we need to see without delivering as much radiation."
Stony Brook is also using *syngo* DynaCT, which can produce CT-like images using a Siemens C-arm system with flat detector technology. "The flat technology allows you to produce traditional fluoroscopic, subtracted roadmap, and digital subtraction angiographic images as well as CT and CTA images," says Mazzarese. "The fact we can provide cutting-edge technologies (like *syngo* DynaCT, angiography, or CT perfusion) and deliver real-time advanced data sets right on the table, contributes greatly to the quality of care we provide to patients. Despite the dose reduction, we aren't compromising image quality."
Reporting is also made easier with the use of CAREreport. "We report on every case, including the dose that was received by the patient and reported in dictation; if we reach a certain threshold, we document it and follow up with a medical physicist," says Mazzarese. "We use CAREreport extensively. Instead of having to print a report and scan it into the system, we can send a direct DICOM image as part of the study. That makes the image readily available and easier to look at, which speeds up dictation as well," Dr. Woo agrees. "We use CAREreport to dictate directly into our final reports, not only in DICOM, but also into the final procedural reports."
According to Mazzarese, dose exposure reduction bears out in daily TLD (thermoluminescent dosimeter) readings. He says the staff's TLD readings are consistently quite low for interventional radiology and explains that he and the other Stony Brook radiology staff are consistently at the lower end of the acceptable spectrum of dose exposure. "Managing radiation exposure and dose – as well as contrast administration – is particularly important for me and my staff, because we are in those rooms all the time. It has a direct effect on us and on the type of care we can deliver to our patients. Radiation dose management is absolutely crucial; Siemens' attention to this is one of the key reasons we use Siemens equipment. The built-in dose reduction applications, the ability to use tools like *syngo* DynaCT, and the more sophisticated software packages like *syngo* iPilot and *syngo* iGuide allow us to focus our attention above all on patient care," says Dr. Woo.

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Diagnosis of Splenic Steal Syndrome in Liver Transplant Recipients Supported by *syngo* iFlow

Courtesy of Wael E. Saad, M.D., FSIR, Curtis Anderson, M.D., Ph.D., John F. Angle, M.D.
Division of Vascular and Interventional Radiology, Department of Radiology, University of Virginia Health System, USA

Wael E. Saad, M.D., FSIR, Division of Vascular and Interventional Radiology, Department of Radiology, University of Virginia Health System, USA

Splenic steal syndrome is a controversial diagnosis of hepatic artery hypoperfusion that is an under-recognized cause of graft ischemia. There is no objective imaging criteria for the diagnosis. It is diagnosed subjectively by angiography where there is "sluggish" flow in the hepatic artery compared to the splenic artery.

Patient history

50-year-old female liver transplant recipient with hepatic graft dysfunction 14 days after transplantation and a biopsy suspicious of ischemia. A conventional angiogram of the celiac axis demonstrated reduced flow in the hepatic artery relative to the splenic artery.

Diagnosis

Celiac angiographic images are obtained pre- and post-balloon test occlusion of the splenic artery. Quantification of potential increase in the hepatic arterial flow was obtained by quantitative digitally subtracted angiography (Q-DSA) utilizing *syngo* iFlow. The upstroke (rate) of the hepatic arterial flow, total arterial flow, and peak contrast density are compared pre- and post-test balloon occlusion of the splenic artery.

In this particular patient, the rate of hepatic arterial flow (upslope of the arterial flow), the peak contrast density, and the amount of contrast in the arterial phase of the angiogram (AUC: Area Under Curve during upslope) increased by 12.8-fold, 6.3-fold, and 7.6-fold, respectively after the splenic artery was test-occluded. These are encouraging results that would suggest that a permanent embolization of the splenic artery would increase the hepatic arterial flow and potentially improve the ischemic complications associated with splenic steal syndrome.

Treatment

The patient subsequently underwent a splenic artery embolization and has done well for at least 6 months post-embolization. The hepatic graft dysfunction was reversed.

Comments

The excellent detail resolution of *syngo* DynaCT helped to check the correct deployment of the Neuroform EZ stent and to further analyze the aneurysm architecture before coiling.

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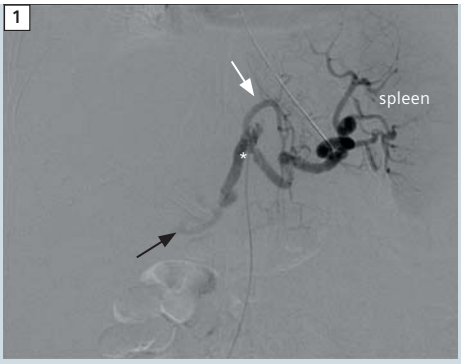
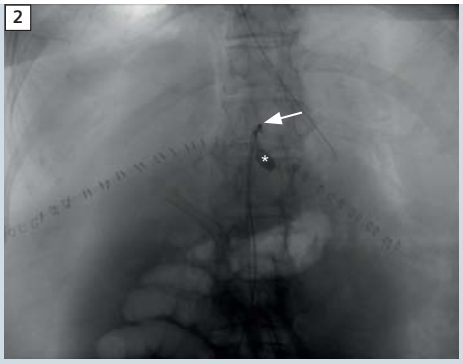
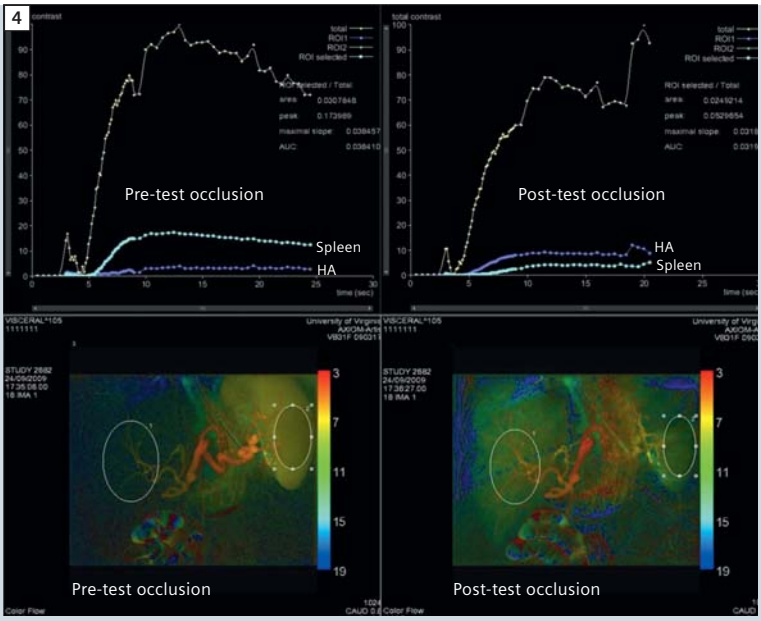


1 Celiac angiogram demonstrating a prominent left gastric artery (white arrow) and delayed filling (sluggish flow) in the hepatic artery (black arrow) compared to the splenic artery where the contrast has reached the splenic parenchyma (spleen).



2 Fluoroscopic image demonstrating the catheter technique for the test balloon-occlusion angiogram. The balloon-occlusion catheter is inflated with diluted contrast (asterisk). From an additional femoral access, an adjacent 5-French catheter has been advanced into the celiac axis. It is this catheter that will be used to perform the post-test occlusion celiac angiogram.

3 Celiac angiogram with test balloon occlusion (asterisk, denotes site of balloon occlusion of splenic artery) of the splenic artery demonstrating the considerably improved flow (albeit subjective) in the hepatic artery (black arrow). Again noted is the prominent left gastric artery (white arrow).



4 *syngo* iFlow image showing pre- and post-test occlusion.

5 Fluoroscopic image after blockage (definitive treatment of splenic steal) of the splenic artery utilizing coils (between black arrows) and Amplatzer Vascular Plugs (between white arrows).

6 Celiac angiogram after proximal splenic artery embolization demonstrating the considerably improved flow in the hepatic artery (black arrow). Again noted is the prominent left gastric artery (white arrow) which helps reconstitute the distal splenic artery (yellow arrow) and thus vitalizes the spleen.

Stent Placement across Cerebral Aneurysm Supported by *syngo* DynaCT

Courtesy of Demetrius Lopes, M.D.
Rush University Medical Center, Chicago, IL, USA

Demetrius Lopes, M.D.
Director Endovascular Surgery
Rush University Medical Center,
IL, USA

Patient history

65-year-old male with hypertension and history of myocardial infarction and coronary stenting with incidental left internal carotid artery aneurysm.

Diagnosis

The patient had a wide-necked aneurysm of the supraclinoid portion of the internal carotid artery. The patient was on antiplatelet medication due to the coronary stent increasing the risk of surgery, and the wide-neck of the aneurysm made simple coiling a poor option.

Treatment

The patient was brought to the angiography suite and placed under general anesthesia and neurological monitoring. We proceeded to catheterize the left internal carotid artery with a Neuron guide catheter and with a Berenstein Select catheter. Once the guide catheter was in position in the left ICA, the patient was heparinized to an activating clotted time of 250 or greater for the remainder of the procedure. The left middle cerebral artery was catheterized with the Hi-Flo Neuro Renegade system, and a Neuroform EZ 4.5 x 30 mm stent was deployed across the wide-necked aneurysm from left M1 segment to left internal carotid artery just beyond the ophthalmic artery takeoff. Subsequently, the deployed stent was recrossed, and a second stent, Neuroform EZ 4.5 x 20 mm, was placed across the aneurysm. Following stent placement, *syngo* DynaCT was performed to verify 3-dimensional conformation of stents across the aneurysm. An SL-10 microcatheter and a Synchro micro-guidewire were used to gain access to the aneurysm, before the aneurysm was coiled with Matrix coils.

Comments

The excellent detail resolution of *syngo* DynaCT helped to check the correct deployment of the Neuroform EZ stent and to further analyze the aneurysm architecture before coiling.

Examination Protocol

Imaging Protocol	20 s DR
Contrast Injection	
Injection rate	2 cc/sec.
Volume	40 cc
Injection dilution	20 % contrast
X-ray delay	2 sec.
VOI size	Medium
Slice Matrix	512 x 512
Kernel Type	Bone
Image Characteristics	Normal
Automatic Visualization	Yes
Reconstruction Mode	Native
Viewing Preset	DynaCT Soft Tissue
Secondary Reconstruction	
MIP thin (10 mm) slices	
Images obtained with parallel and radial ranges	

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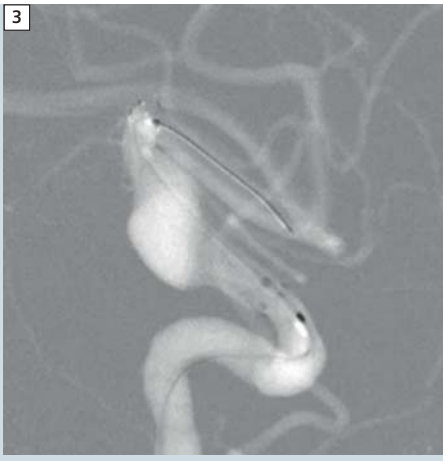
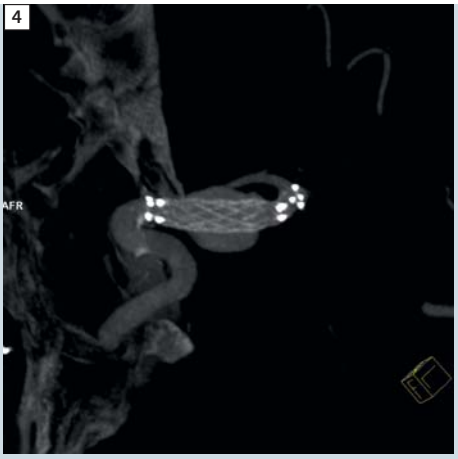
1 AP digital subtraction angiography of wide-necked left internal carotid artery aneurysm.

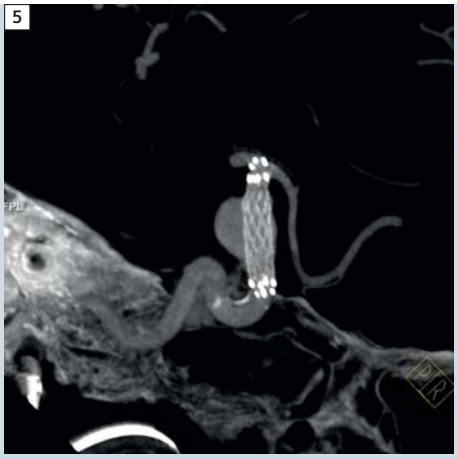
2 Lateral DSA of left ICA aneurysm.



3 Advancement of microcatheter through first stent for deployment of second stent. The radio-opaque tines demonstrate the limits of the first stent.



4 Slices through the aneurysm after stent placement using *syngo* DynaCT.



5 Rotation about the axis of the Neuroform EZ stents using *syngo* DynaCT, demonstrating the architecture of the aneurysm and the exact placement of the stents prior to coiling.

6 Final AP angiography showing occlusion of the aneurysm.

Stenting Innovations Made in China

The First Affiliated Hospital of Zhengzhou University and Interventional Therapy Center will soon become one of the largest hospitals in China. With an annual throughput of about 3,200 procedures, they need imaging technologies that are reliable and precise.

The First Affiliated Hospital of Zhengzhou University in China was built in 1928. More than 80 years of development has now made it the biggest hospital in the He Nan province. The hospital recently grew to 4,000 beds and two new buildings are currently under construction. After construction work will be finished, the hospital will increase the total amount of beds to 8,000 making it one of the largest hospitals in China.

The Interventional Radiology Department is a key department for the hospital. There are 25 doctors managing 180 beds for their daily work. The department performs various kinds of interventional procedures such as interventional neuroradiology procedures and interventional peripheral vascular procedures. But its specialty is the interventional treatment of airway and esophageal lesions. Professor Han, the director of the department, is renowned for this kind of procedure. He has also invented numbers of airway and esophageal stents and is holding the patent for a bullet stent for a residual segment fistula of the bronchus and a Y-type stent for carina lesions or complex lesions with both left and right main bronchus (see image on the left). They were all invented by Professor Han's team.

In August 2009, Artis zeego, the multi-axis system based on robotic technology from Siemens was introduced into the department. With its high end technology, 3,200 procedures were

Prof. Dr. Han and his team in front of the Artis zeego imaging system, which is very well integrated in their daily routine work at the interventional radiology department.

performed in the first year after installation. The high image quality and its advanced applications such as *syngo* DynaCT, *syngo* iPilot and *syngo* iGuide help to improve the workflow and enable such high patient throughput for the department.

The following clinical case example shows how the stents are being used in the daily case load of the department. In this case a 7-year-old boy was referred to the interventional radiology department because he suffered from severe dyspnea. Prof. Han´s airway stent was able to drastically improve the condition of the young boy.

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Airway Stenting
Supported by *syngo* DynaCT

Courtesy of Prof. Xinwei Han, M.D.
Director of Interventional Radiology Department, Hospital of Zhengzhou University, Henan, China

Patient history
A 7-year-old male was admitted due to moderate to severe dyspnea.
The patient received tracheotomy one year ago because of laryngeal edema. After intervention, he felt gradually short of breath. CT scan showed a severe stenosis 5 cm cranial to the carina with the narrowest area being 2.9 x 4.5 mm*.

Diagnosis
Tracheal stenosis, post-tracheotomy.

Treatment
The patient underwent a pre-procedural *syngo* DynaCT scan to assess the degree of the stenosis. Both MPR images and VRT image were reconstructed with respective advantages. MPR images provide accurate measurements comparable to the CT scan. From the 3D reconstructed image, the overview of tracheobronchial tree could be shown and the area of stenosis could be appraised in different angles.
The patient was under general anesthesia for the airway stenting procedure. A 5 F angiographic catheter (Cordis, USA) was navigated into the trachea with the aid of a 0.035" guidewire (Terumo, Japan) orally. When the catheter was in the proper position, the 0.035" guidewire was exchanged for an Amplatzer extra-stiff wire guide (Cook, USA). Then a covered airway stent system (5.0 x 12 mm, Micro-Tech, China) was precisely positioned in the center of the stenosis covering its whole length. After stenting, a post-procedure balloon dilation was performed.
During the procedure, the 3D reconstructed tracheobronchial tree was overlaid onto live fluoroscopy for guidance. This technique provided better anatomic orientation, resulting in the enhanced confidence of the interventionalists. After stenting and post-procedure balloon dilation, *syngo* DynaCT was performed to check the position and morphology of the stent. Compared to the pre-operative *syngo* DynaCT, the diameter of the trachea enlarged significantly (pre-operative diameter: 3.0 x 4.9 mm*, post-operative diameter: 3.9 x 4.9 mm).

Prof. Dr. Xinwei Han is known for complicated procedures such as airway stenting using his own innovative stents and Siemens equipment for graft implantation.

Comments
After stenting, the minor axis of the stenosis changed from 3.0 mm to 3.9 mm, with a 0.9 mm increase. The patient's symptoms improved immediately. However, doctors pay more attention to the percentage increased and the result at of 3 - 5 days after the procedure than the immediate increased number and the result.
It usually takes 3 - 5 days for the stent to expand to its maximum of 90 % - 100 % of the normal diameter. For this case, there was 0.9 mm increase and the enlarged diameter accounted for about 80 % (3.9/4.9) of the normal one immediately.
Six days later, the stent was pulled out, with the airway diameter assumedly enlarged to more than 90 %. The patient was discharged showing no symptoms of dyspnea. No complications such as stent migration or bleeding occurred.

* 2.9 x 4.5 mm in the first paragraph is the value measured by CT, 3.0 x 4.9 mm is the value measured by *syngo* DynaCT. There is a minor difference between them because of the window center and window width. This shows that *syngo* DynaCT measured are comparable if not more precise compared to CT measures.

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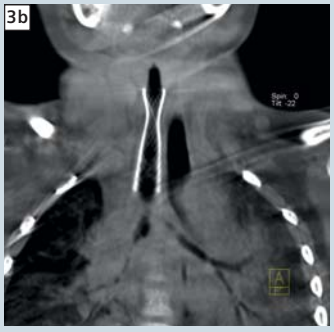
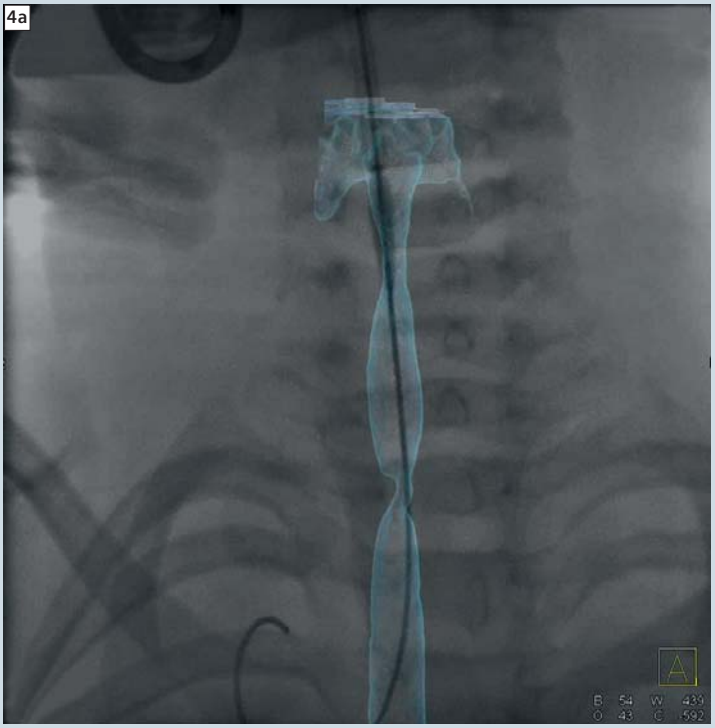
2 *syngo* DynaCT images in sagittal (a) and coronal (b) plane by MPR mode of airway stenosis before procedure.



3 *syngo* DynaCT images in sagittal (a) and coronal (b) plane by MPR mode of airway stenosis after procedure.

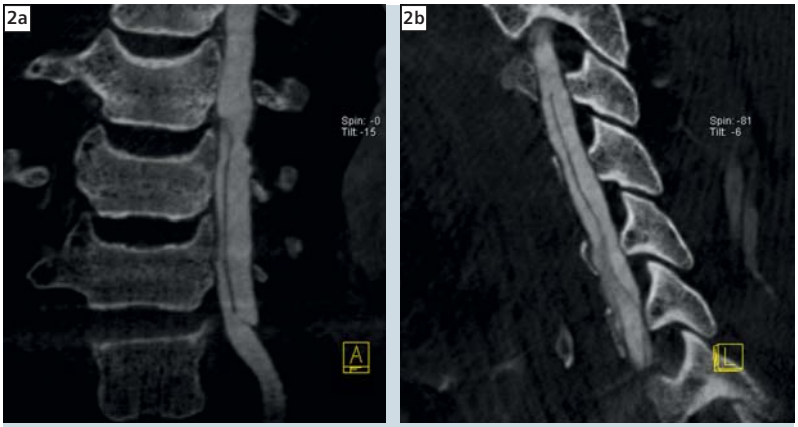


4 *syngo* iPilot shows stent system introducing (a) and post-stenting balloon dilation (b).

Interventional Therapy of Vertebral Artery Dissection Supported by *syngo* DynaCT

Courtesy of Prof. Jianmin Liu, M.D.
Director of Neurology Medical Center, Interventional Radiology Department,
The Affiliated Changhai Hospital of Second Military Medical University, Shanghai, China

1 Pre-procedural view of C3 and C7 with DSA in frontal (a) and *lateral view* (b).



2 Pre-procedural *syngo* DynaCT images in coronal view (a) and sagittal view (b), MPR mode.

Patient history

37-year-old male presented with headache and nausea associated with vertigo already lasting one week. Patient was admitted into the hospital. Immediate CT scan showed cerebellar infarction, and CTA revealed dissection of the left vertebral artery.

Diagnosis

Cerebellar infarction, left vertebral artery dissection

Treatment

The patient underwent a pre-procedural *syngo* DynaCT scan to assess the range and morphology of the dissection. The comparison of *syngo* DynaCT data and DSA provided more detailed information. The dissection located at V2 segment of left vertebral artery, covering an area from C7 to C3 (C stands for cervical vertebra). The diameter of the dissection is 5.81 mm, while the diameter of the distal healthy artery is 5.1 mm. Sagittal and coronal plane of VA dissection shows similar images in *syngo* DynaCT and DSA, however the dissection is much more vivid. Moreover it was possible to get the actual morphology of the VA dissection in the longitudinal axis from the axial plane which could not be assessed in DSA.
A transfemoral access was chosen to navigate the microcatheter (VASCO Balt Extrusion, France) under magnified fluoroscopy and digital biplane road mapping into the true lumen of the dissection with the aid of a guidewire. Then two stent systems (Leo 5.5/50 and Leo 5.5/50, Balt Extrusion, France) were introduced in the distal and proximal segment of the dissection respectively. In order to reinforce the occlusion of the intimal tear, a third stent (Leo 5.5/35 Balt Extrusion, France) was placed in the proximal segment of the dissection. The procedure was successfully done without any complication. After stenting, a post-procedural *syngo* DynaCT was performed to check the position and morphology of the stent. Furthermore a comparison between the pre- and post-*syngo* DynaCT was done to assess the outcome of the procedure. From the post-operative *syngo* DynaCT, the structure of stents could be seen very clearly. The false lumen still existed, however, it shrank to some extent, with the true lumen enlarged significantly compared to the pre-operative *syngo* DynaCT.

Comments

Patient's symptoms disappeared at the second day after the operation. Eight days postprocedure the patient was discharged free of symptoms.

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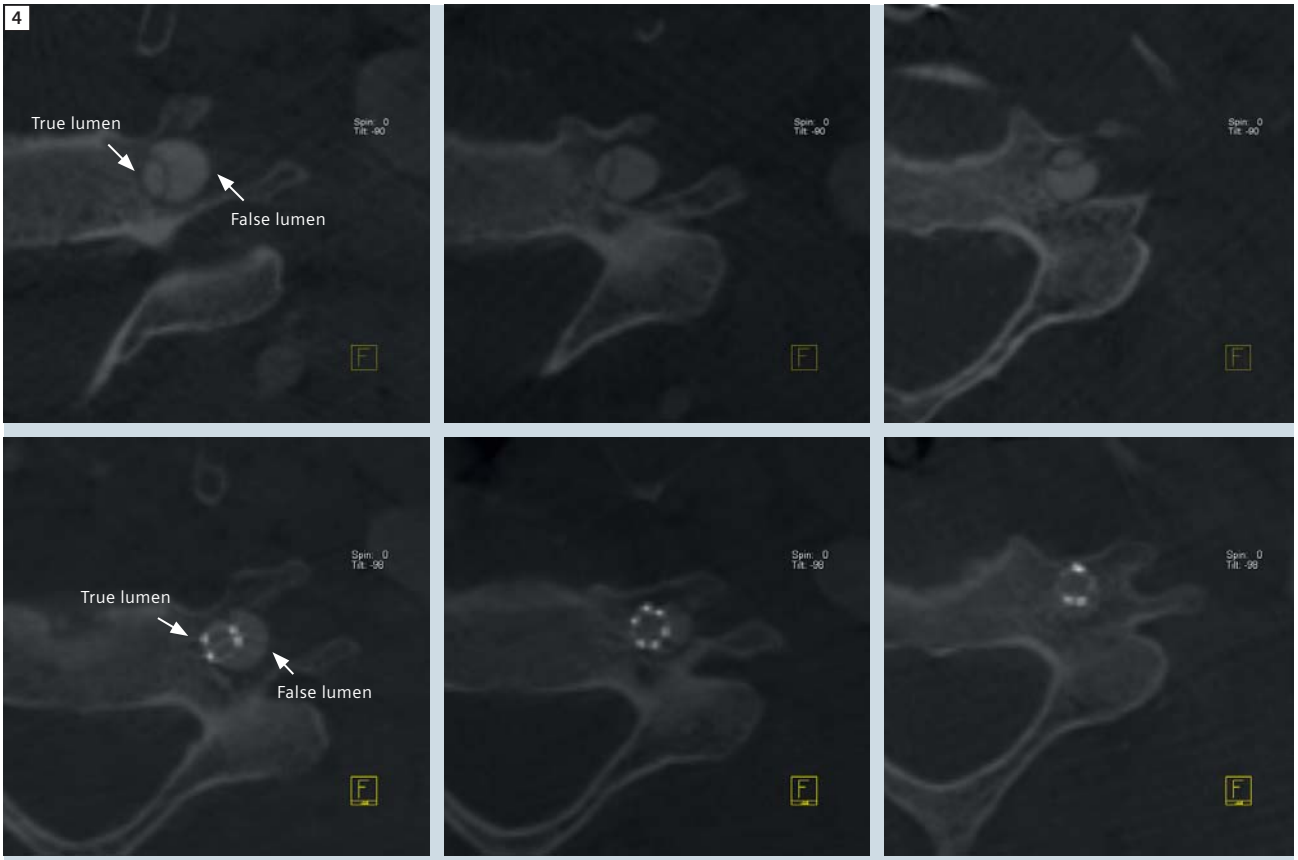
3 Post-procedure DSA in lateral view (a), post-procedure *syngo* DynaCT in coronal view (b) and sagittal view (c), MIP mode.



4 Pre- and post-comparison in axial plane, MPR mode.

Catheterization in Congenital Heart Disease with *syngo* iPilot

For about one year now, the Pediatric Cardiology department of the University Hospital Erlangen in Germany has been using one of the most modern imaging systems in Europe to treat children with congenital heart defects. Compared to the previous system, the new Artis zee system features *syngo* DynaCT Cardiac with low dose protocols for 3D imaging in the cathlab.

By Dr. Martin Glöckler

"In recent years, the number of minimally invasive percutaneous interventions for congenital heart diseases has grown constantly. Enhanced imaging capabilities with less radiation are essential for therapy. But especially the new intra-procedural 3D imaging capabilities with *syngo* DynaCT provide a new perspective and help us to perform complex procedures with more efficiency," says Prof. Dittrich, Head of Pediatric Cardiology Department at the University of Erlangen. With *syngo* DynaCT Cardiac, 3D images of the heart and great vessels can be acquired using rotational angiography within 5 seconds while the patient is on the table. The images are automatically reconstructed and presented as a CT-like dataset at the workstation monitor in the examination room. Relevant structures are segmented out of the dataset and the result is then finally superimposed with the live fluoroscopy data using *syngo* iPilot. "The overlay of the 3D structures onto the live fluoroscopy image saves procedure time and contrast media. For our young patients, this means gentler and more efficient treatment," explains Prof. Dittrich.

More information for the right decision

The main advantage of *syngo* DynaCT Cardiac is the availability of 3D imaging within one procedure directly in the cath lab. For young patients this means only one procedure instead of an additional scan in a CT or MRI scanner. Using *syngo* DynaCT Cardiac with administration of contrast media directly in the region of interest enables angiographic imaging with high resolution.
Dr. Martin Glöckler, Assistant Medical Director, has used *syngo* DynaCT Cardiac in more than 80 cases (23 percent of total cases performed in one year with 40 of them being interventional catheterization cases). In addition, he also uses the *syngo* iPilot application to overlay the 3D image onto fluoroscopy in all of the cases he performs. For him the results are very positive, as he explains: "The 3D reconstruction and the live fluoro overlay make it easier for us to understand a complex anatomic relationship. We can start the procedure with the right C-arm angulation, choose the ideal catheter or implantation materials, navigate easily through difficult vascular crossings and find the ideal implant position for stents, plugs, coils, or valves."

Better treatment possibilities

Using *syngo* DynaCT Cardiac as a new imaging tool requires experience. The University of Erlangen optimized application protocols to visualize the pulmonary artery to the far periphery, the cavo-pulmonary connections, the pulmonary veins, the aorta and the coronary arteries accurately. An axial view reveals much more information than with normal biplane angiographies.

Before starting the procedure Prof. Dittrich checks the placed catheter monitored at the flat detector.

"The overlay of the 3D structures onto the live fluoro image saves procedure time and contrast media. For our young patients this means gentler and more efficient treatment."

Prof. Sven Dittrich, M.D., Head of the Department of Pediatric Cardiology, University of Erlangen, Germany

In the case of a nine-year-old boy with pulmonary atresia and ventricular septal defect, after unifocalization on a main pulmonary artery conduit, stenosis of the right pulmonary branch can be seen by a view from head end. The stenosis is marked by an arrow (Fig. 1).
For visualizing the aorta or the coronary arteries, image quality might be slightly compromised because of moving artifacts and the 5 sec imaging time and the fast drainage of the contrast volume (Fig. 2).
But good results can be achieved by blocking the aorta with a balloon catheter in neonates or by the use of rapid pacing in schoolchildren. In this way even the coronary arteries and the aortic valve can be visualized sufficiently (Fig. 2).

syngo iPilot is essential

Another benefit of *syngo* DynaCT Cardiac is the 3D image overlaid onto the live fluoroscopy image using *syngo* iPilot. This three-dimensional landscape follows the C-arm movement and vice versa. With this technique the ideal C-arm angle can be easily found to accurately visualize e.g. a vascular crossing that is difficult to reach by a catheter or wire. The optimal implant position for coils, plugs, stents and valves can be shown, especially their spatial relationship to critical surrounding anatomical structures. For example, by implanting a pulmonary valve the coronary arteries can be spatialized (Fig. 2). "We regard the impact of overlaid 3D images in 60 % of all our cases as very useful."
Image integration from previous examinations (MRI, MDCT) is also possible. The registration on the imaging system can be done with a low dose *syngo* DynaCT Cardiac run without contrast medium. After registration a large region of the body, such as the whole aorta from an MRI angiography, can be overlaid onto fluoroscopy (Fig. 3 + 4) and can be used for 3D roadmapping.

A worthwhile investment

"After one year experience with the new imaging technique, we found that *syngo* DynaCT Cardiac during catheterization of congenital heart disease offers new possibilities in preoperative diagnostics and in catheter interventions. The visualization of the spatial relationship to specific surrounding structures, for example coronaries, trachea or bronchi seems to be very important, just as the possibility to view the 3D model in a position like, lets say the 'surgical view', or to have a look from every angle of the 3D model. With dedicated application protocols the image quality is useful in about 90 %," says Dr. Glöckler. The use of *syngo* DynaCT Cardiac with overlay onto live fluoroscopy is a promising aid in complex interventions; a 3D angiographic image from other imaging modalities like MRI or MDCT can be used by image fusion in the same way (Fig. 5). Prof. Dittrich explains confidently: "It is not only possible to obtain immediate CT-like images during interventions, but also if there are complications like a bleed, the patient does not have to be transported in a critical situation and can be imaged right in the cath lab."

Dr. Glöckler prepares segmentation at the workstation.

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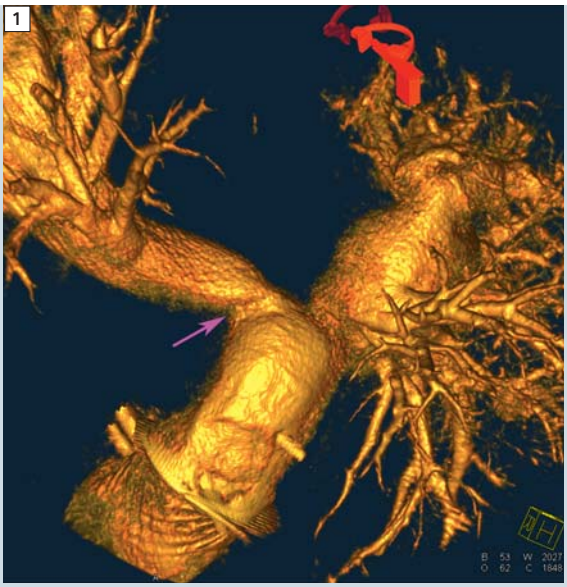
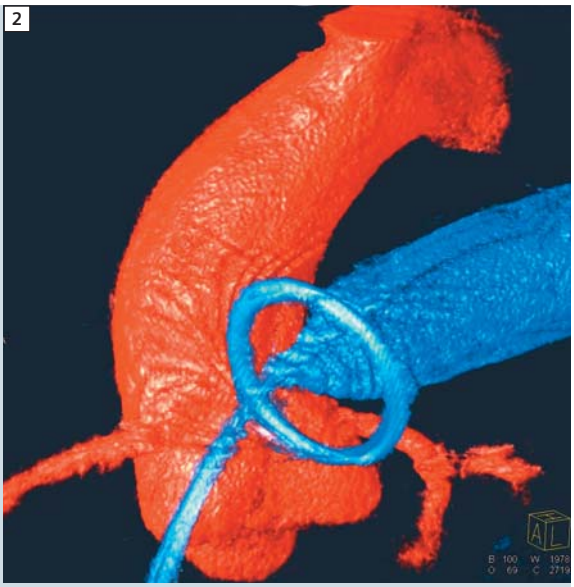


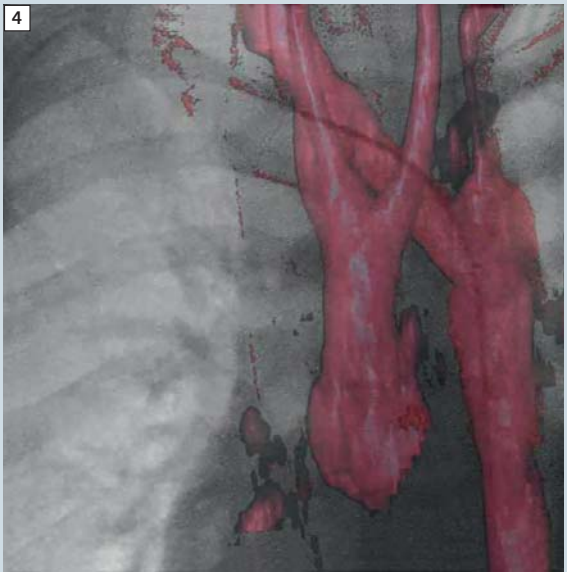


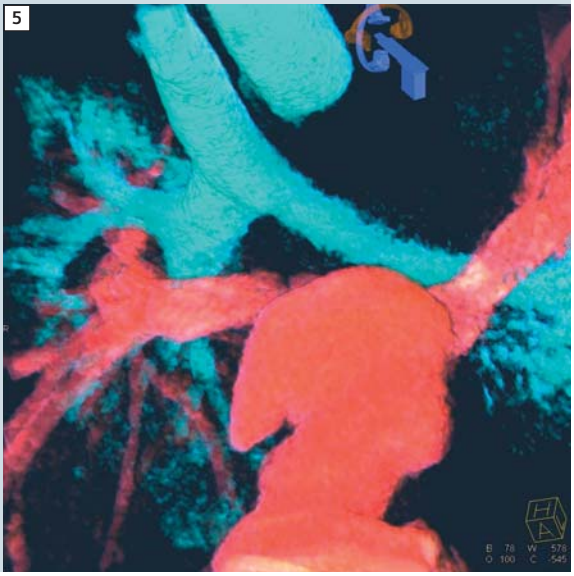
1 Pulmonary artery conduit, the stenosis of the right pulmonary branch can be seen via a view from the head end. The stenosis is marked by an arrow.

2 Imaging during transcatheter valve implantation in a 16-year-old boy with Tetralogy of Fallot. A balloon is inflated with contrast medium positioned in the old pulmonary conduit for sizing. Simultaneously, contrast agent is introduced into the aortic root to display the coronary arteries and to visualize their spatial relationship to the new valve.

3 + **4** Stenting of the aortic arch, 3D MRI image integrated in the live fluoroscopy picture; positions of the stenosis, vascular crossings and the stent are always displayed. 3D image follows the C-arm.

5 To visualize the spatial relationship between bronchi and bronchial arteries in a 9-month-old girl with pulmonary atresia and ventricular septal defect, stented pulmonary branches.





Treating Atrial Fibrillation, Preventing Stroke

Atrial fibrillation (AF) is the most common cardiac arrhythmia with a prevalence of 0.9 % in the general population, increasing to over 13 % in people over the age of 80. As the population ages, the prevalence of AF will continue to rise. The most catastrophic complication resulting from AF can be a stroke.

Proven therapies to reduce AF-associated stroke include oral anticoagulation such as Warfarin. However, Warfarin side effects are frequent, often severe and include significant bleeding complications. As a result, many people are unable to take Warfarin. Studies estimate that up to 50 % of patients at risk for AF-related stroke may be unable to use the drug.

Therefore several surgical and percutaneous endovascular techniques have been explored to occlude the left atrium appendage (LAA). As an alternative of the surgical closure, percutaneous exclusion of the LAA is a new approach used to prevent strokes in high-risk patients with AF and contra-indication to long-term oral anticoagulant therapy. Although the Amplatzer septal occluder device was not originally intended to occlude the LAA it has been used with success in the hospital in Coburg, Germany for this purpose.

According to Dr. Harald Johannes Rittger, cardiologist at the Klinikum Coburg in Germany, the reconstruction of the left atrial appendage using *syngo* DynaCT Cardiac is feasible and enhances preprocedural diagnostic information for proper device selection.

syngo DynaCT Cardiac can be used for imaging patients during LAA occluder implantation and allows visualization of the LAA. It adds important information regarding the selection of the optimal LAA occluder size and might be an effective adjunct to LAA-occlusion device selection.

Using rotational angiography and *syngo* DynaCT Cardiac it is possible to create CT-like 3D images of the heart directly in the cath lab in less than one minute. The unique one-click segmentation of *syngo* InSpace EP allows quick and convenient segmentation of the cardiac chambers, thus reducing time-consuming manual interactions. The 3D segmentation image can be explored via endoscopic view.

Additionally, catheter guidance during device implantation can be enhanced by using *syngo* iPilot, which provides an overlay of 3D segmentation results and live fluoroscopy. Angulations, even table movements, are synchronized between the 3D view and the Artis zee imaging system. Quantitative measuring tools are also available to determine, for example the proper occluder size. These innovations in 3D imaging during interventional cardiology procedures make it possible to explore such new treatment methods and help physicians to make the right decision for their patients.

The clinical cases on the following pages show two left atrial appendage occlusion treatments using *syngo* DynaCT and other 3D imaging applications.

> “Reconstruction of the left atrial appendage using *syngo* DynaCT Cardiac is feasible and enhances preprocedural diagnostic information for proper device selection.”
>
> Harald Johannes Rittger, M.D., Department of Cardiology, Klinikum Coburg, Germany

Left Atrial Appendage Occlusion Supported by *syngo* DynaCT

Courtesy of Harald Johannes Rittger, M.D.,
II. Medizinische Klinik, Klinikum Coburg, Germany

Case 1

Patient history

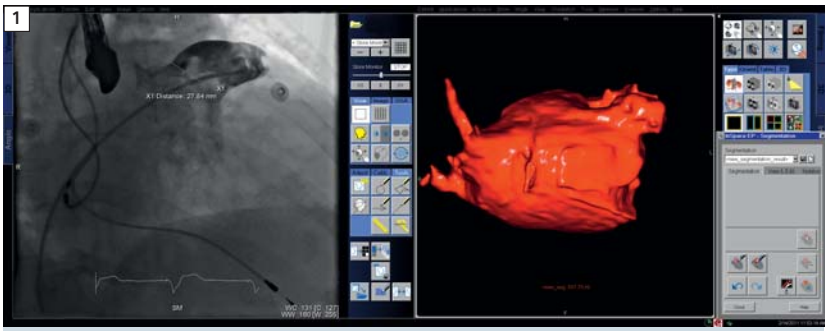
79-year-old female with coronary artery disease. The patient has a history of coronary artery disease and a reduced ejection fraction of 35 %, diabetes mellitus, hypertension, atrial fibrillation since November 2005. Ten months later the patient developed ischemic stroke and she underwent coumadin therapy. In the following month she suffered from an acute brain hemorrhage and therefore oral anticoagulation was contraindicated.

Diagnosis

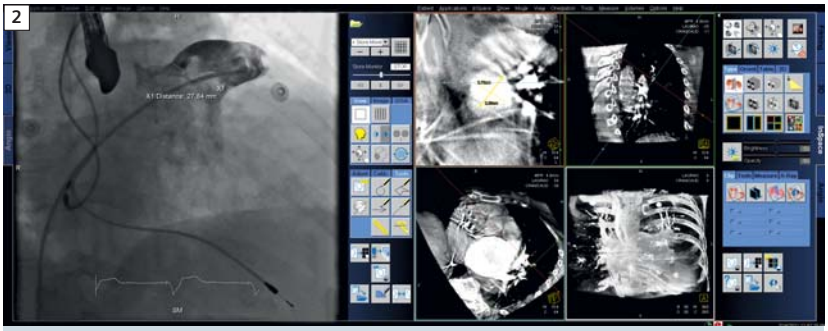
Her overall condition forced the decision for closure of left atrial appendage.

Treatment

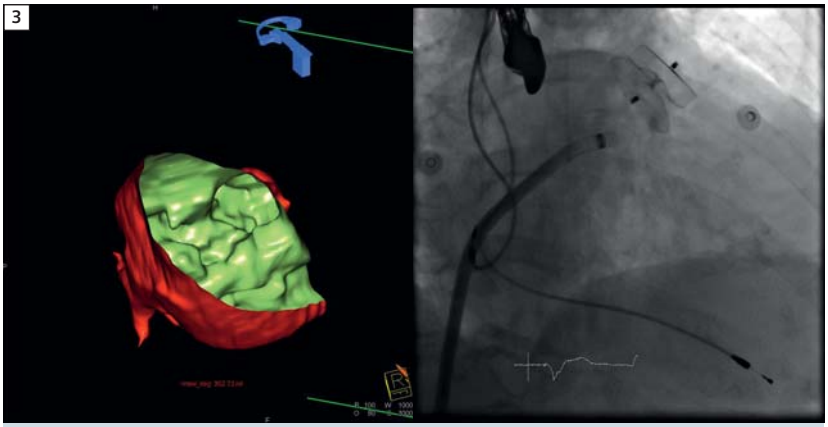
- Estimation of the pulmonary transition time with test injection of 20 cc CM (flow 20 cc/sec.) into the main pulmonary artery measuring the time to the appearance of CM in the LA by overview acquisition angiography.
- Rotational angiography in inspiration breath hold along a circular 198° arc (99° RAO to 99° LAO) in 5 sec. with the C-arm system.
- Image acquisition with administration of 80 cc of CM into the main PA with a standard pigtail catheter (flow 15 cc/sec.) using a large focus with preferred 70 kVp, automatic exposure control, system dose 0.54 µG/pulse. Collection of about 250 projection images data at 60 frames/sec.
- Device implantation: Successful closure of the LAA with an ACP Occluder (Amplatzer Cardiac Plug, 28 mm) after transseptal puncture.



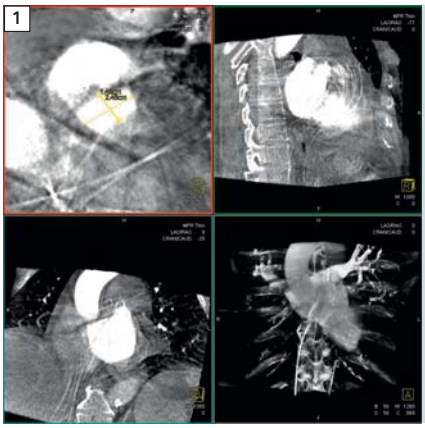
1 Side by side display of angiography and segmented left atrium.



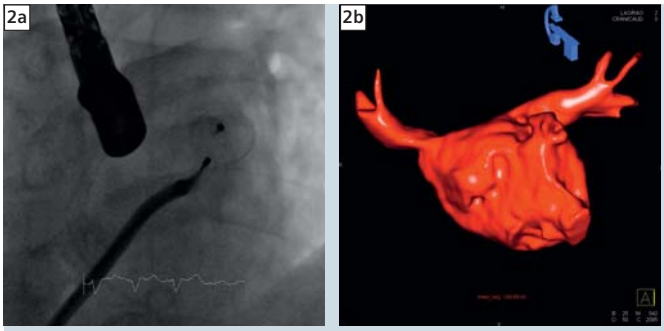
2 Quantitative measurement of the size of the left atrial appendage.



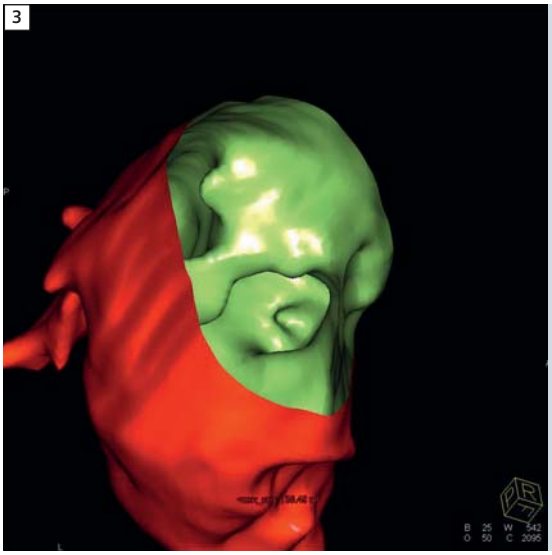
3 Mesh clipped inside view of the left atrium towards the ostia of the left atrial appendage.



1 Quantitative measurement of the size of the left atrial appendage.



2 Side-by-side display of angiography (a) and segmented left atrium (b).



3 Mesh clipped inside view of the left atrium towards the ostia of the left atrial appendage.

Case 2

Patient history

81-year-old male. The patient has a history of atrial fibrillation since September 2008. In the following year he developed ischemic stroke and allergy to coumadin therapy (tongue swelling) and hematuria

Diagnosis

Decision for closure of left atrial appendage.

Treatment

- Test injection with 10 cc CM (transit time).
- Injection of 70 cc contrast (flow 15 cc/sec.) into the pulmonary artery.
- Rotational angiography (*syngo* DynaCT Cardiac run) 5 sec. with radiation delay of 7 sec.
- Device implantation: After transseptal puncture, successful closure of the LAA with an ACP Occluder (Amplatzer Cardiac Plug, 24 mm).

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Closure of Paravalvular Mitral Valve Leakage Supported by *syngo* DynaCT

Courtesy of Samir Kapadia, M.D.,
Heart and Vascular Institute, The Cleveland Clinic Foundation, Cleveland, OH, USA

Patient history

72-year-old, male patient with previously placed bioprosthetic mitral valve.

Diagnosis

The patient had a wide-necked aneurysm of the supraclinoid portion of the internal carotid artery. The patient was on antiplatelet medication due to the coronary stent increasing the risk of surgery, and the wide-neck of the aneurysm made simple coiling a poor option.

Treatment

Mitral regurgitation (grade 3+) due to periprosthetic leak (see Fig. 1).
Closure of the paravalvular leak with an 8 mm VSD closure device under TEE (transesophageal echo) and fluoroscopic guidance. *syngo* iGuide Toolbox graphics were overlaid as additional guidance. Pre-procedural cardiac CT data was retrieved from the PACS (Fig. 2). The following structures were marked with *syngo* iGuide Toolbox graphics:

- Mitral valve plane
- Positions of the paravalvular leaks (based on the information of the diagnostic TEE, (Fig. 3)
- Aortic valve plane, (Fig. 4)
- Area for transseptal puncture, (Fig. 5)

The patient was positioned on the table with arms up to match the patient's position during the pre-procedural cardiac CT. Arms were kept up during the whole procedure.

A 5-second *syngo* DynaCT Cardiac run was performed without contrast (Fig. 6). During this rotational acquisition a pigtail catheter was positioned in the aortic root to visualize the position of the aorta and the aortic root as landmarks for the *syngo* InSpace 3D/3D registration (Fig. 7). Patient was asked just to hold his breath, i.e., no deep inspiration or expiration in order to be in a similar breathing situation as during the remaining procedure. This helps increasing the overlay accuracy.
3D/3D registration of *syngo* DynaCT Cardiac image and CT was performed in *syngo* InSpace with the pigtail catheter and the mitral valve serving as landmarks. (Fig. 9).

The overlaid 3D markers helped as additional guidance during the procedure for:

a) the puncture of the atrial septum
b) the progression of a guidewire through a leak, (Fig. 8)
c) the adjustment of the closure devices, (Fig. 9)

Comments

The excellent detail resolution of *syngo* DynaCT helped to check the correct deployment of the Neuroform EZ stent and to further analyze the aneurysm architecture before coiling.

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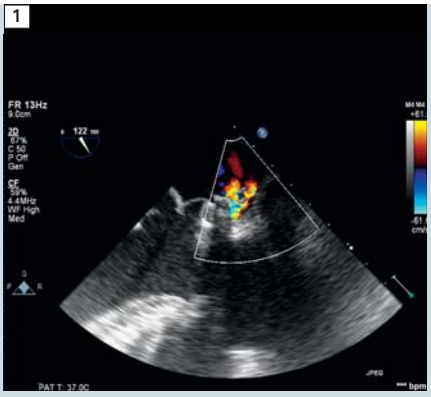
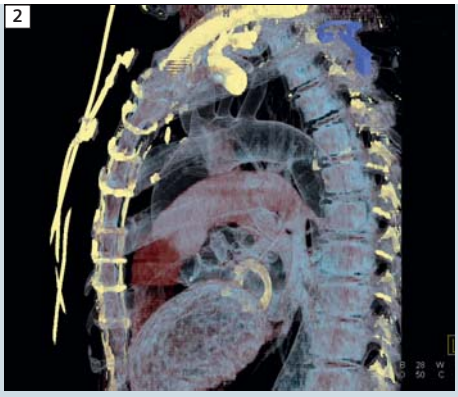
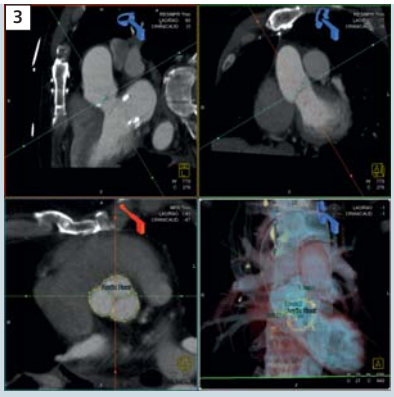


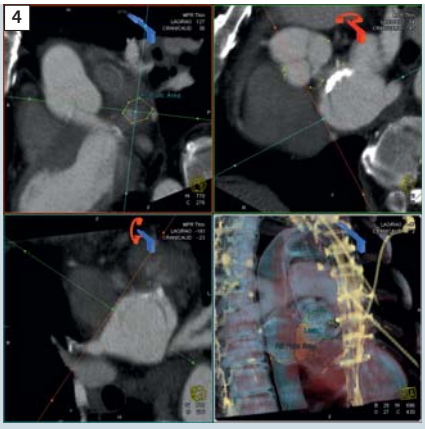
1 Diagnostic TEE showing the paravalvular leak.



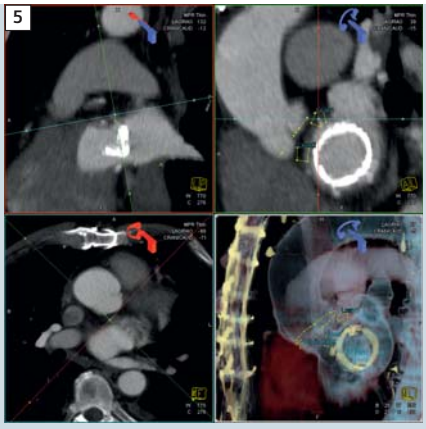
2 Pre-procedural cardiac CT.



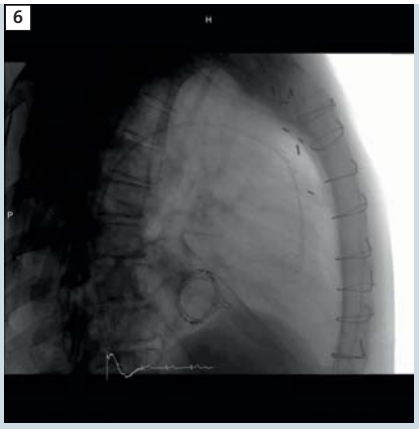
3 The positions of the paravalvular leaks from TEE.



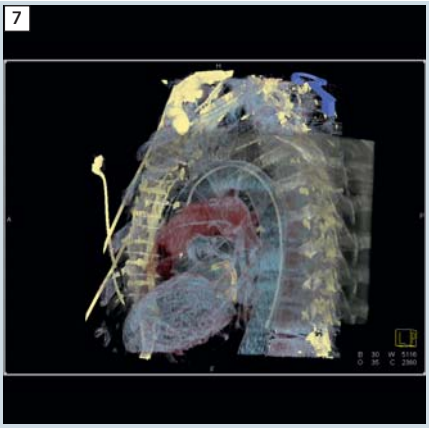
4 The plane of the aortic valve.



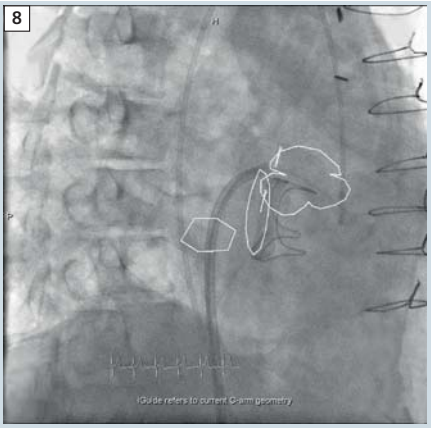
5 The desired region of the transseptal puncture. Rotation about the axis of the Neuroform EZ stents using *syngo* DynaCT, demonstrating the architecture of the aneurysm and the exact placement of the stents prior to coiling.



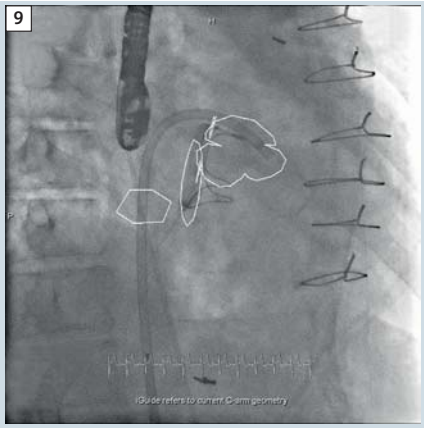
6 5s *syngo* DynaCT Cardiac acquisition; Protocol: 5sDRc. Final AP angiography showing occlusion of the aneurysm.



7 3D/3D registration of cardiac CT and *syngo* DynaCT Cardiac.



8 Live fluoroscopic image with overlaid *syngo* iGuide Toolbox graphics. It shows the alignment of a closure device (two radiopaque markers).



9 Live fluoroscopic image with overlaid *syngo* iGuide Toolbox graphics. It shows the guidewire through a leak.

syngo DynaCT – A New Tool for Onsite Navigation in the Lung

syngo DynaCT 3D image datasets not only allow physicians to navigate the blood vessel system, but through the bronchial tree as well. This permits minimally invasive access to even peripheral solitary pulmonary nodules with obscure malignancy.

By Hildegard Kaulen, PhD

The lung is a ramified system consisting of large bronchial tubes and smaller bronchioles. Each mainstem bronchus divides 22 times before terminating in the alveoli. As bronchoscopes are virtually impossible to control, conventional bronchoscopies only show the major branches of the bronchial tree. Large sections of the lung are thus only accessible via invasive procedures. When asked whether a navigation system for minimally invasive access to peripheral lesions is required, Dr. Wolfgang Hohenforst-Schmidt, Senior Physician at the Coburg Hospital in Germany, answers emphatically in the affirmative. He attributes this need to the growing significance of bronchial carcinomas. This tumor group is often diagnosed in the advanced stages, resulting in a poor prognosis. The median survival period is six months in the case of grade III and IV tumors. If the tumor is discovered at grade I, 88 percent of patients are still alive after a decade has passed. Dr. Hohenforst-Schmidt explains: "The close correlation between grading and survival rate means that smokers and former smokers benefit highly from screening procedures. If the lesions are discovered at a very early pre-clinical stage, the 10-year survival rate could even increase to 92 percent. However, a less invasive procedure for the clarification of abnormal findings is required in order to balance the risk-benefit ratio. Additionally, the accuracy of biopsies obtained during bronchoscopies must be high in order to prevent too many false-negative results. If possible, these should be taken from lung sections which have proved inaccessible to date. This is only feasible via navigation."
A few months ago, the National Lung Screening Trial in the USA was abandoned prematurely after eight years. It underlines the importance of screening for smokers and former smokers and is guaranteed to increase interest in the procedure. During this mass screening, which was sponsored by the National Cancer Institute, participants were offered either a low-dose CT or a conventional X-ray image for the early detection of lung cancer. The analysis revealed that participants who received low-dose CT scans were 20 percent less likely to die of lung cancer than those offered conventional X-ray examinations.

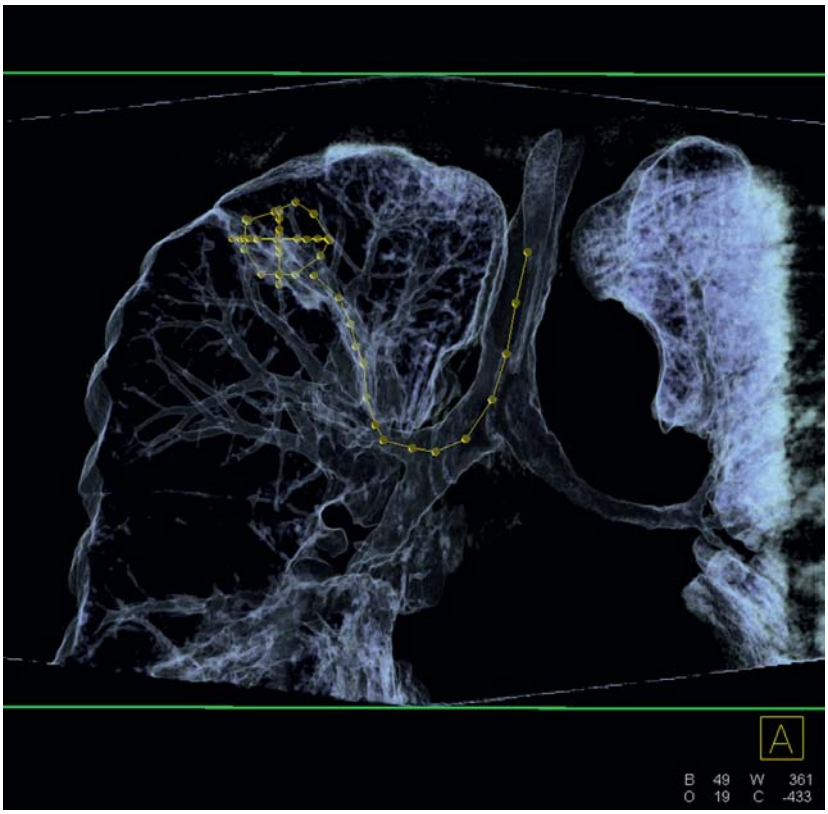
Problem: Incidental Diagnosis

However, many solitary pulmonary nodules are discovered purely by chance. It would appear that one in every two hundred thorax CT scans reveals a lung lesion which requires further clarification. This is a substantial figure in light of the many scans performed nowadays. This also places diagnostics in a dilemma, particularly as far as the very small peripheral solitary pulmonary nodules are concerned. The likelihood of a lesion being malignant depends not only on age and smoking behavior,

but also on its size. Lesions measuring less than 4 millimeters found in low-risk individuals only prove malignant in one percent of cases, those measuring 4 to 8 millimeters have an 8 to 10 percent chance of being malignant and 50 percent of lesions over 20 millimeters are cancerous. It follows that lesions measuring between 10 and 20 millimeters are frequently critical, with 10 to 20 percent of solitary pulmonary nodules within this interval found to be malignant, making clarification essential. However, the accuracy of tissue samples taken from lesions of this size is relatively low: 33 percent accuracy in the case of lesions under 20 mm as opposed to 62 percent for lesions over 20 millimeters. Dr. Hohenforst-Schmidt says: "This poses a real problem. Although very small solitary pulmonary nodules tend to be benign rather than malignant, they require more invasive treatment because conventional bronchoscopies on lesions of this size result in a low accuracy rate and tissue samples can be false-negative. The German S3 guideline proposes the surgical clarification of solitary pulmonary nodules under three centimeters via transthoracic needle aspiration or wedge resection. However, in plain language, this means that we subject patients with very small lesions to potentially useless interventions instead of giving them the necessary treatment. The alternative would be watchful waiting. Unfortunately, many individuals find this too difficult to endure. Besides, small-celled bronchial carcinomas can grow rapidly in the meantime, which can worsen the prognosis substantially. As a result, we urgently require an enhanced solution for the diagnostic clarification of small, peripherally located lung lesions."

Navigation under Jet Ventilation

Hohenforst-Schmidt believes that the solution lies in guided navigation with *syngo* DynaCT. He has access to an angiography suite equipped with a ceiling-mounted angiography system, because the pulmonary medicine department at the Coburg Hospital is located in the cardiology department headed by Professor Dr. Johannes Brachmann. The *syngo* DynaCT application generates a CT-like dataset within just a few seconds, and real-time fluoroscopic images are superimposed on this during the bronchoscopy, facilitating navigation within the bronchial tree. Hohenforst-Schmidt uses no contrast agents, but ensures that the diaphragm remains in a fixed position via jet ventilation during deep sedation. According to the lung specialist, the major benefit of this approach is that it is a real-time procedure. Both stages, namely the acquisition of the *syngo* DynaCT dataset and the bronchoscopy under fluoroscopic guidance, are performed at the same time, in the same place and in the same position in the diaphragm. By contrast, electromagnetic navigation involves two stages. A CT scan is initially performed in one room, followed by the bronchoscopy in another room. During the intervention, the computer indicates the position of the electromagnetic probe's tip on the CT image. Dr. Hohenforst-Schmidt: "The position of the target volume is variable within limits under these conditions. A solitary pulmonary nodule can shift by several centimeters via breathing alone. This reduces the accuracy of two-phase navigation." To date, the lung specialist has taken biopsies from close to thirty patients via *syngo* DynaCT-guided bronchoscopies. In lesions with an average diameter of 24 x 23 x 23 mm, the hit rate was 78%. Even in very small nodules with an average diameter of 13 x 12 x 14 mm the hit rate was 50% - and this during the proof-of-concept period. He also demonstrated that it is possible to dye small lesions so that they are more visible and easier to remove during subsequent surgical interventions.



The tumor and the path for the biopsy tool through the bronchia are clearly visible in the *syngo* DynaCT image

Hybrid Room for Pulmonary Medicine

So which departments could benefit from an angiography suite? As the navigation is particularly effective for the clarification of very small solitary pulmonary nodules with obscure malignancy, Dr. Hohenforst-Schmidt believes that the procedure is chiefly suited to hospitals with high patient circulation, in which at least 800 to 1,000 bronchoscopies are performed annually. The physician says: "Around 10 percent of bronchoscopies are performed as a result of small lesions. So a certain volume is required to legitimate the investment. Large solitary pulmonary nodules will continue to be treated with conventional bronchoscopies or surgical interventions. On the one hand, the accuracy rate in lesions of this size is high, while on the other, they are more likely to be malignant, which then justifies an operation."

Dr. Hohenforst-Schmidt also points to the fact that hybrid rooms could soon be used in pulmonary medicine. This concept is already well established in such fields as cardiology and cardiac surgery, where angiographies and open-heart surgery take place on the same table. Hybrid rooms are used in the event that a combination of minimally invasive procedures and open surgery is required, or when diagnostic angiographies are necessary prior to, during or right after surgery. Dr. Hohenforst-Schmidt is convinced that a similar collaboration is also conceivable for pulmonary medicine. Because pathologists can now determine whether tissue samples are benign or malignant after just thirty minutes, it would be possible to operate directly in the case of positive results, and patients would only require a single anesthetic.

Which complications are possible with *syngo* DynaCT-supported bronchoscopies? According to Dr. Hohenforst-Schmidt, they are comparable with those which could arise as a result of conventional bronchoscopy under fluoroscopic guidance: bleeding, pneumothorax and problems which could develop during deep sedation. Although the procedure involves additional radiation exposure of between three and four millisieverts, which corresponds to that of a normal CT scan, the CARE programs, which are a standard feature of every Siemens Artis zee angiography system, help to minimize this as far as possible. Ultimately, Dr. Hohenforst-Schmidt feels this level of radiation exposure is justified in the light of the improved access to smaller peripheral lesions and the increased accuracy rate in terms of biopsy diagnostics.

Dr. med. Wolfgang Hohenforst-Schmidt
Studied medicine at the University of Marburg, Germany, internist specializing in pneumology, advanced training in internistic intensive care medicine and interventional cardiology, additional qualifications in medicinal tumor therapy and sleep medicine. Training completed at Imperial College London, Trinity College of Dublin and several institutions in Germany (Neuss, Düsseldorf, Immenhausen). Previous posts include that of Senior Physician at the Evangelical Specialist Hospital for Respiratory Diseases in Neustadt and at hospitals in Pirna and Bayreuth. Senior Physician at the Coburg Hospital since April 2010.

Dr. Hildegard Kaulen *is a molecular biologist. After stints at the Rockefeller University in New York and the Harvard Medical School in Boston, she moved to the field of freelance science journalism in the mid-1990s, and contributes to numerous reputable daily newspapers and scientific journals.*

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VIPER 2

Artis zeego – A Real Imaging Innovation in the OR

Since minimally invasive therapy has conquered spinal surgery, the target of the intervention is no longer visible to the surgeon. A challenge that can be elegantly met using the Artis zeego. Spinal implants for patients with unstable vertebrae are one example. But that is only the beginning.

By Wiebke Kathmann

For Christian Raftopoulos, MD, PhD, Head of the Neurosurgery Department at the University Hospital Saint-Luc in Brussels, Belgium, these are exciting times in spinal surgery. He has finally found a way to improve the outcome in patients undergoing osteosynthesis of vertebrae, a delicate procedure that requires utmost precision. The vertebrae first have to be fixed in place with screws through the pedicles of each vertebra. The angle and depth of insertion have to be exactly right in all pinnacles in order to achieve maximal stability when attaching the screws to the metal rod on either side of the vertebrae. In the era of percutaneous spinal surgery improved image guidance is needed in these patients. It supports pre-operative planning, intra-operative navigation, confirmation of the accurate localization of the pinnacle screws and visualization of special anatomical structures or artifacts from prior interventions.
In general, neurosurgeons around the world use 3D imaging only before and 48 hours after the surgery. For the insertion of the pedicle screws they rely on 2D fluoroscopy systems. With the 2D approach *clinical* screw misplacements can occur in up to 7%.

Quality Control Right on the Table

In his search for ways to spare patients, surgeons and hospitals avoidable and costly reoperations, Dr. Christian Raftopoulos has come to use the unique robot-supported, fixed-mounted Artis zeego C-arm system in the OR. It provides exceptional 3D image quality right in the OR, allowing for quality control during the procedure: "If we want to be better tomorrow than today, we have to introduce quality control into the OR. We build cars and motorcycles very precisely and check the quality of what we are doing during the set-up of the machine. We should do the same in the OR. So far surgeons control what they are doing 48 hours after the intervention. With Artis zeego we can do it right there on the operating table."
In his experience integrated intra-operative imaging in the OR not only provides comprehensive diagnostic and therapeutic support. It also saves time

and costs, he states. “In spinal implants, using Artis zeego saves money because we avoid second operations. That way the patient is happy, the surgeon is happy and the hospital is happy. Avoiding second surgeries and medical-legal problems is a big plus. Especially here in Brussels, being the capital of Europe, patients are very demanding. They want the best result immediately.”

More Flexibility in the OR

So far Dr. Raftopoulos has used intraoperative MRI in spinal osteosynthesis procedures. “Artis zeego, however, is the future in minimally invasive spine surgery,” he states. “The patient does not have to go into the tube. You have full access to the patient and you can move the C-arm out of the surgical field if required. That gives you maximal space in the OR.”

For Dr. Raftopoulos the most important feature of the system is its integrated robotic technology. “You can program it to do the same movement ten times without errors. Mobile C-arms require manual positioning with less reproducibility. With zeego it is always the same move with the precision of a robot.”

Another argument in favor of Artis zeego is its high quality 3D imaging, which is essential for spatial orientation during the procedure. “The pedicle screw must be implanted with the best precision possible if you want to achieve the best possible stability.”

Asked why he prefers Artis zeego to O-arm systems in spinal surgery Dr. Raftopolous states that the O-arm was too bulky for him. He was on the verge of getting the Artis zee system when he discovered Artis zeego. “The standard Artis zee system does not use robotic technology. To find the perfect position for the pedicle screw you need to carefully reposition the machine to find the optimal fluoroscopic view. If you have to fixate three vertebrae that means you have to find six views for the pedicle screws. Sometimes you need to repeatedly move the machine to the same views to correct the position of the pedicle perforator. With Artis zeego we store the fluoroscopic views once and the system travels to these views fully automatically just by pressing the control.”

New Indications

So far Dr. Raftopoulos has a limited access to Artis zeego. In spinal surgery Dr. Raftopoulos uses it mainly on elderly patients and those with complex spines. "For example this morning we implanted four pedicle screws. One of them had to be implanted in a compact dense pedicle. So in order to enter into it I had to hammer on my pedicle perforator with more force than usual. Intraoperative 3D imaging reconfirmed the special situation created by a prior intervention and kept the stress level down during the intervention." Dr. Raftopoulos believes he is faster when using 3D imaging before and during surgery because he has a better 3D perception of the patient's spine.

He sees the future of Artis zeego less in vertebroplasty and kyphoplasty but more in the minimally invasive placement of stabilizing implants, not just for the spine but also of the head and in neuromodulation technologies for essential tremor, Parkinson's or psychiatric diseases."

"The future of Artis zeego can be very bright and the potential is much greater than it appears even now."

Artis zeego in the Hybrid Room

It takes about 10 to 20 procedures to familiarize oneself fully with the system in order to get most out of robot-assisted intraoperative 3D imaging using the Artis zeego. All surgeons at the table need to be fully trained and have to familiarize themselves with the workflow, according to Dr. Raftopoulos. "Doing six cases per month we have a satisfactory experience with this intervention. And we already have a backlog of four months." Dr. Raftopoulos shares the OR with the vascular surgery department in his hospital, giving him access to Artis zeego one day every two weeks. Therefore, he is eager to get his own OR with an Artis zeego. Several treated patients were so conscious of the need for such a system they made donations for a new system in order to give more patients access to the same quality intervention. By 2012 this pioneer of 3D intraopertive imaging in spinal surgery hopes to have his own Artis zeego, under full control of his neurosurgical team. His goal is to maximize its use by designing a new double OR. "I am pretty sure that in one or two years, using Artis zeego full-time, we should be able to recoup our investment."

Medical writer Wiebke Kathmann is a frequent contributor to medical publications. She holds a Master in biology and a PhD in theoretical medicine and worked as an editor for many years before she became a freelancer in 1999. She is based in Munich, Germany.

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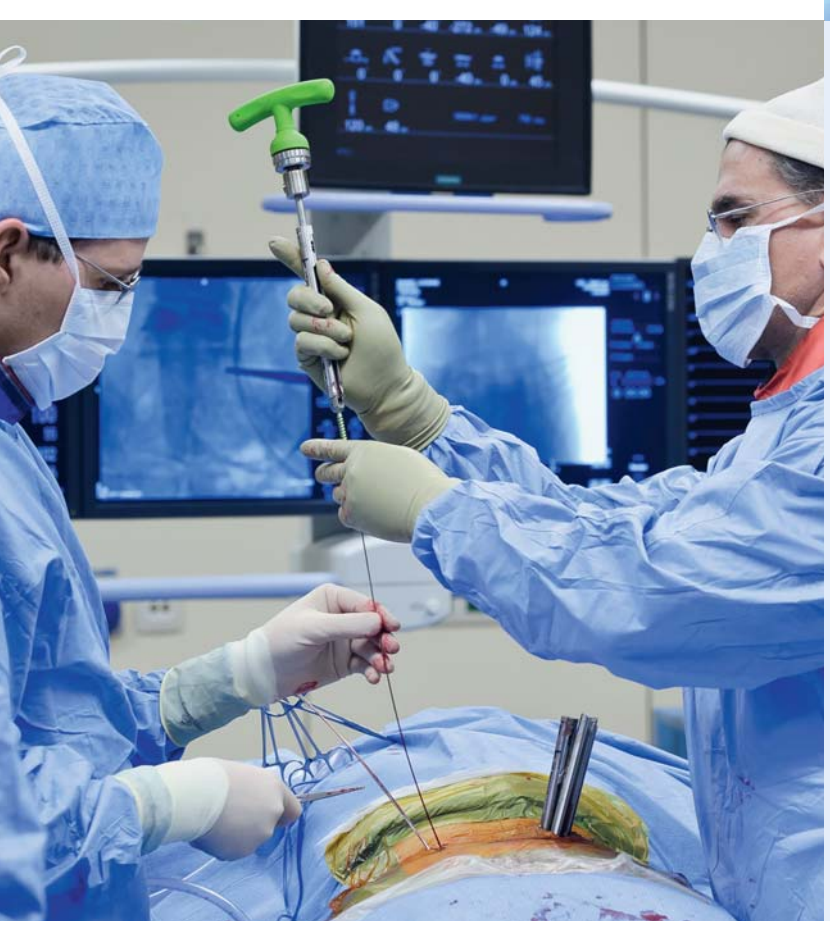
"Surgeons do things and verify what they have done 48 hours after the intervention. In up to 7% of the cases they have to tell the patient: 'It's not perfect. We have to operate on you again.' We want to reduce those numbers through intraoperative 3D imaging with the Artis zeego."

Christian Raftopoulos, MD, Head of Neurosurgery Department, University Hospital Saint-Luc, Brussels, Belgium



Advantages of the Fixed C-Arm System

- CT-like images (*syngo* DynaCT) due to high precision and speed of detector movement around the patient
- Fluoroscopic views can be stored and the robotic C-arm travels into these exact positions, reducing human interaction, therefore speeding up the procedure.
- Imaging of the whole spine and from both sides of the patient
- Exceptional image quality
- Fast 3D reconstruction
- Roadmapping by merging 3D images with 2D fluoroscopic live images (*syngo* iPilot)
- Large display
- Support of the workflow due to synchronized movements of C-arm and table
- Flexibility during the procedure (park positions)

Minimally Invasive Spinal Osteosynthesis
Using robot-assisted 3D imaging with Artis zeego

Courtesy of Christian Raftopoulos, M.D.,
University Hospital Saint-Luc in Brussels, Belgium

Patient history
An 88-year-old female patient suffered from lower back pain. She was operated on before due to a traumatic fracture of L5 which required cementoplasty.

Diagnosis
Spinal instability in spinal cord from L4 – L5 – S1

Treatment
A spondylodesis of L4, L5 and S1 was planed for fixation of the spine under fluoroscopic and 3D image guidance. Intraoperatively, the robot-assisted C-arm is moved interactively to six preferred fluoroscopy positions in order to place, under 2D image guidance, two screws in each vertebra at L4, L5, and S1. These six C-arm positions are stored in the Artis zeego system and can be recalled and automatically revisited by the robot during the procedure.
A frontal and lateral view is taken as a reference image (Fig 1a, b). The 6 needles are placed under fluoroscopic guidance from the stored C-arm positions. The exact position of the needles is reconfirmed by a 3D *syngo* DynaCT image using an 8-second run. 3D reconstruction of the spine and MPR slices visualize the depth and direction of the 6 placed needles. In this case, the cement in L5 poses a problem, thus, the needles need repositioning in order to put the trajectory for the screw more inward and create better stability of the implant. Re-positioning of the selected needle was performed by recalling the stored C-arm position for this vertebra which drives automatically the robot into the exact position of the preferred fluroscopy view. After optimizing the location of the K-wire and final confirmation with 3D *syngo* DynaCT, the pedicle screws are implanted along the needles. The final positions of the pedicle screws are again verified by a *syngo* DynaCT acquisition before the metal bars on both sides of the spine are attached.

Comments
Intraoperative 3D imaging with *syngo* DynaCT can help to confirm the accurate position of the pedicale screws and to visualize special anatomical structures or artifacts due to prior interventions. It can re-ensure the correct progress of the intervention and might indicate necessary adjustments right in the OR.
The unique robotic drive of Artis zeego allows surgeons to store specific fluroscopic views which can be re-called during the procedure. This reduces both manual interaction and error and speeds up the workflow in the OR without losing flexibility.

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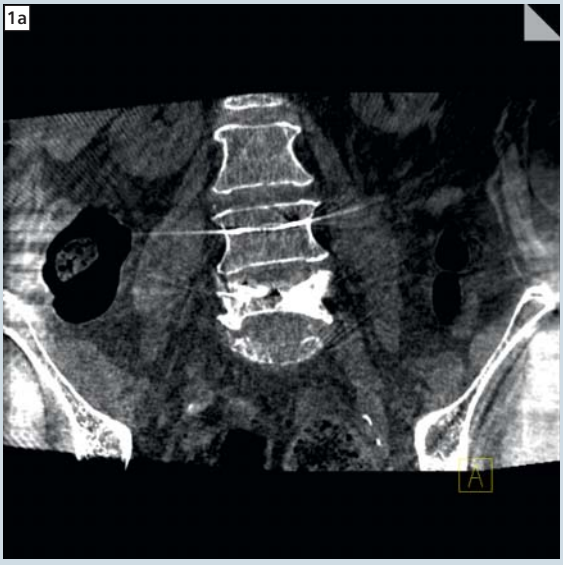
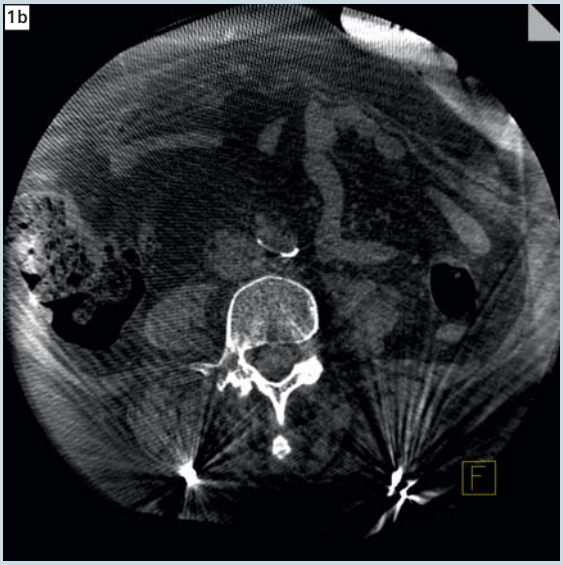
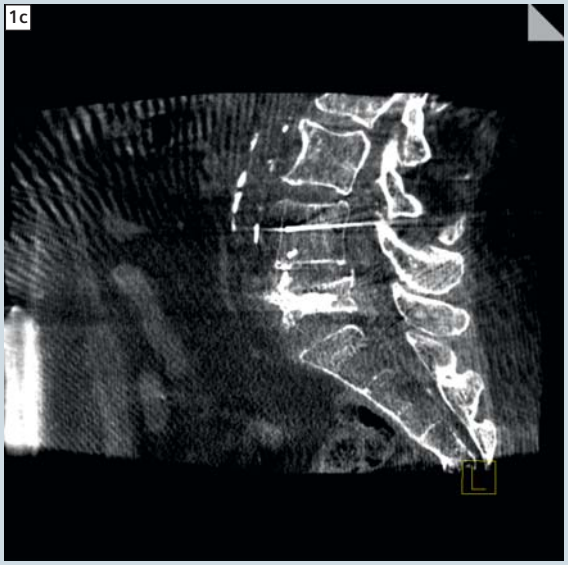
Dr. Raftopoulos verifies the progression of the procedure on the live fluoro monitors. The left monitor displays a reference image which was acquired at the beginning of the intervention. Besides the image itself, the exact position in which this image was taken is stored by the system, as well. During the procedure, Dr. Raftopoulos recalls this position and the robotic system automatically moves the C-arm to the same fluoroscopic angulation. In this way, Dr. Raftopoulos can directly compare the anatomy at the beginning of the procedure in the reference image with the actual anatomy in the live fluoro image on the right monitor. Note, that the angulation of the C-arm and, thus, the fluoroscopic views are exactly the same for the images on both monitors.

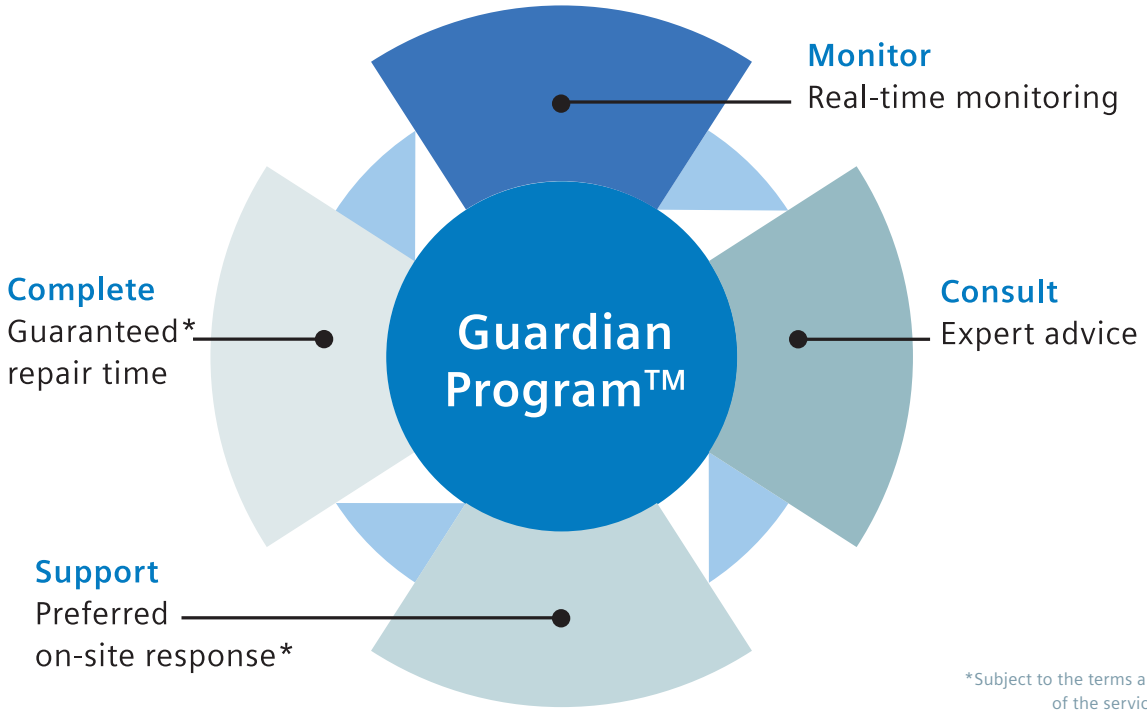


1 Intra-operative 3D *syngo* DynaCT images showing a lateral (a), frontal (b), and axial (c) view of the spine after the K-wires are placed. Such 3D reconstruction of the spine reconfirms visually the depth and the direction of the K-wires and might indicate necessary adjustments of the screw trajectories.





High System Availability through High-End Service



*Subject to the terms and conditions of the service agreement.

The availability of medical equipment is one of the most crucial factors affecting economic efficiency at any clinical facility. Unexpected failures and downtimes can quickly lead to gaps in the provision of care and significantly affect the facility's income. With the Guardian Program, Siemens Healthcare has put together an extensive service package that continuously remotely analyzes equipment in real time, making it possible to predict failures and downtimes, and thereby, helps to ensure system availability. The number of patient examinations at the University Hospital Brussels (UZ Brussels) increased about 25 percent over the last three years and the systems operate at full capacity. Any unplanned system downtime not only comprises patient comfort but also damages the clinic reputation. That's why UZ Brussels opted for the Siemens Guardian Program.

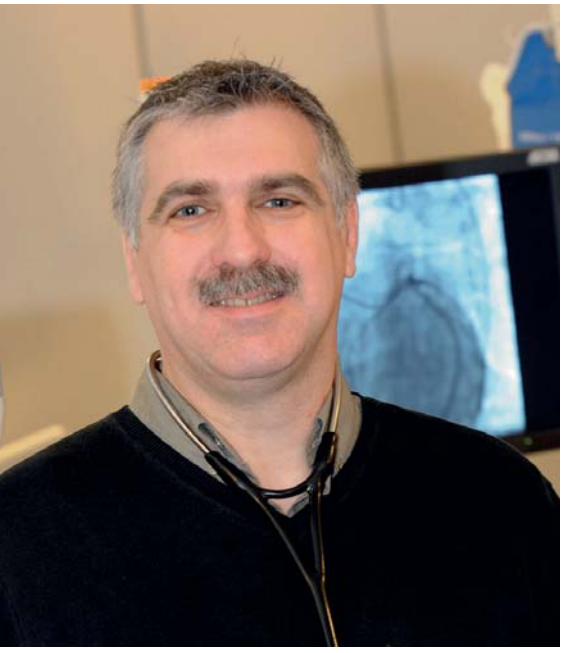
As an advanced service offering, the Guardian Program provides proactive online monitoring of medical system performance on an ongoing real-time basis – making it possible to detect and resolve system errors before malfunctions occur.

Rapid service support

Professor Danny Schoors, head of the Cardiology Department, describes how the Guardian Program prevented a system failure on an angiography system: "One day we were treating a patient on the AXIOM Artis dBC and were just about to place a stent when we received a call from the Siemens service center." The Siemens expert informed Professor Schoors that the electronic cabinet had exceeded its normal temperature limit and recommended a system shutdown in order to prevent damage on the system. "This call took us by surprise since we had not determined any inconsistency in the system's operation. After the call, one of our engineers went to the room where the electric cabinet stands. Opening the door, we quickly realized that the room air conditioning was not working properly. Fortunately, just opening the door of the room helped to lower the temperature of the system below the critical level and we could continue the treatment while a technician fixed the cooling," reports Schoors.

Customer transparency – a pillar of the Guardian service level

The Nuremberg Hospital, Germany, also decided on Guardian service as part of a facility-wide service and maintenance agreement. The service is not limited to a specific kind of equipment or subject to different rules: "The different kinds of service have been harmonized.



Professor Danny Schoors,
Head of Cardiology Department,
University Hospital Brussels, Belgium

Left to right: Roland Simmler, IT Manager; Reinhard Loose, MD, head of the Diagnostic and Interventional Radiology Department and Michael Wucherer, PhD, head of the Department of Medical Physics at the Nuremberg Hospital, Germany

There is a standing rule how to reach service technicians. This way, we feel that we are a kind of premium customer for Siemens Healthcare," says Reinhard Loose, MD, a university lecturer with a double doctorate and head of the Diagnostic and Interventional Radiology Department at Nuremberg Hospital North.

Segment	Interventional Radiology and Cardiology				
System Family / Service	Artis zee	Artis zeego	AXIOM Artis*	AXIOM Sensis	ACOM.Net
Siemens Guardian Program	✔	✔	✔	✔	✔

*Except AXIOM Artis U

Service Availability X-Ray Systems

Our Challenge

- Keeping imaging equipment up and running with minimum downtime despite heavy wear and tear
- Maintaining patient satisfaction and comfort level
- Tight appointment scheduling of angiography systems
- System failures impede workflow

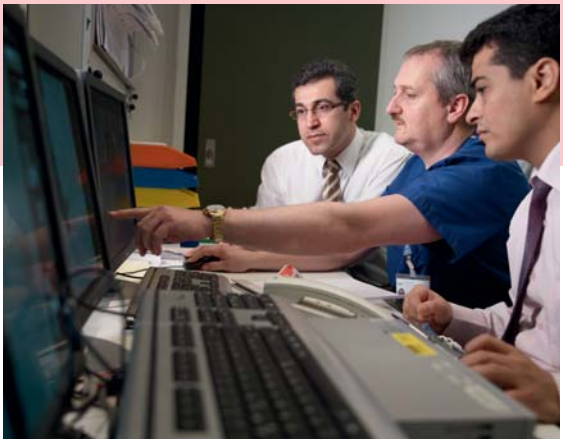
Further information:

www.siemens.com/guardian-program

www.siemens.com/remote-service

Customers from Tehran, Iran took the opportunity to learn about the Artis zeego imaging system at University of Munich, Grosshadern Campus in Germany for one week during our Fellowship Program.

Clinical Education is Key: Interventional Fellowship Program



Two medicals physicists from Teheran took part in the Siemens Clinical Fellowship program and visited the Department of Radiology at the University of Munich at Grosshadern, Germany for one week. During their stay they had the chance to observe clinical procedures performed with Artis zeego and to exchange experiences and knowledge with the German physicians.
The Fellowship Program offers Siemens customers from all around the world the opportunity to spend a few days in a department of a Siemens partner hospital. Customers can use this opportunity to further improve their knowledge and skills by observing clinical workflows and seeing interventional systems in clinical operation outside their own institution. So they can learn through sharing knowledge, experience, and best practices with other clinical experts in their field during a three- to five-day period.

Looking over the Shoulder of Clinical Experts

Mohammad Reza Salmani and his colleague Shahryar ShahrAshoob Risheh, two medical physicists from Pars Hospital in Tehran came to Munich for one week to see Dr. Waggershauser and his team, who have been working with the Artis zeego for a few years now. They were especially interested in the settings and workflows configured into the system by the colleagues in Gros-

Clinical Field	Institution	System
Interventional Neuroradiology	Vivantes Hospital Berlin	Artis zee biplane (mixed detectors)
	University Hospital Erlangen, Germany	Artis zee biplane
Interventional Radiology	Vivantes Hospital Berlin	Artis zee ceiling-mounted system Artis zee multi-purpose system
	Städtisches Klinikum Karlsruhe, Germany	AXIOM Artis dMP
	University of Munich Grosshadern, Germany	Artis zeego with *syngo* DynaCT
	Martha Maria Hospital Nuremberg, Germany	AXIOM Artis MP
	University Hospital Frankfurt, Germany	Artis zeego
Interventional Cardiology	University Hospital Frankfurt, Germany	Artis zee ceiling-mounted system Artis zee floor-mounted system Artis zee biplane system
	Leopoldina Hospital Schweinfurt, Germany	AXIOM Artis dBC with AXIOM Sensis Artis zee floor-mounted system

University of Munich, Campus Grosshadern, Germany

The LMU Munich is one of the world's largest hospitals with a total of 2,000 beds and two different clinics and several departments. The Grosshadern Campus is specialized in:

- Surgery (liver / heart)
- Transplants
- Internal medicine
- Gastroenterology
- Oncology

Dr. Waggershauser has been working at the University of Munich for over 20 years and started with Siemens Multistar Top imaging system in 1994. Today, he is working with one of the most innovative systems in the arena of interventional imaging: Artis zeego.

shadern and welcomed the opportunity to see how they use the *syngo* DynaCT imaging application in their daily work. One of the first procedures the guests from Tehran were able to follow was a chemoembolization and their interest was high when the rotational angiography was performed using *syngo* DynaCT. The visitors were able to view the procedure from the control room and could also watch in detail right beside the table. Dr. Waggershauser explained the cases to the customers, showed them how the images could easily be reconstructed and visualized on the *syngo* X Workplace and shared the latest tips and tricks on how to work with the system efficiently. During the course of their visit, the guests from Tehran had the opportunity to see many different kinds of interventional procedures largely in the field of interventional oncology, especially procedures for:

- Port implantation and explantation
- Chemoembolization
- Technetium angiography
- Selective Internal Radiation Therapy (SIRT)
- Transjugular intrahepatic portosystemic shunt (TIPSS)
- Leg-pelvic angiography

An Outstanding Learning Experience

After a busy week in Grosshadern, everyone had an outstanding learning experience. According to Mohammed Reza Salmani the program was a great success. "I am so glad to cooperate with Siemens in this way; the fellowship gave me the opportunity to acquire clinical and application knowledge and I am proud to share this to my colleagues in my country," he states.
Not only the visiting customers but Dr. Waggershauser was also very impressed and positive about the program and adds: "What I really like is the exchange of experience between doctors, technicians and Siemens engineers, since I am not just trained as a doctor but also have an engineering background."

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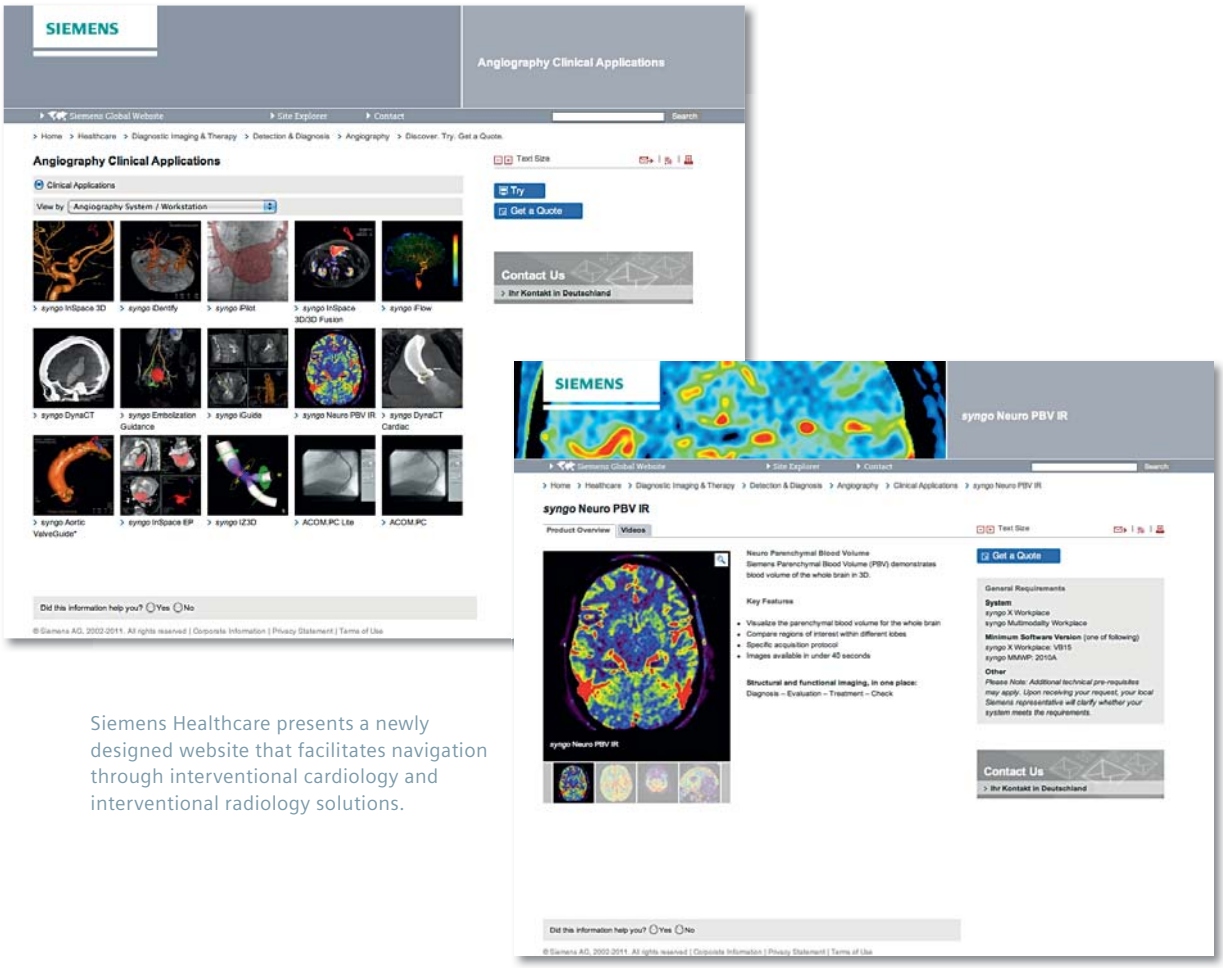

Siemens Healthcare presents a newly designed website that facilitates navigation through interventional cardiology and interventional radiology solutions.

Discover. Try. Get a Quote.

A New Website to Individually Expand Your System's Clinical Capabilities.

The new Siemens Healthcare Website for clinical applications in interventional radiology and cardiology is now online. On this online portal, customers can discover clinical applications via key feature descriptions, demo videos and clinical image galleries. Case studies describe the experience of users in order to illustrate how these applications can improve clinical routine. These new online pages offer comprehensive information – easily accessible, all in one place.
One of the highlight applications is *syngo* iFlow. For the first time in the interventional suite, *syngo* iFlow allows for the visualization of a complete digital subtraction angiography (DSA) run in a full color single image, all at the press of a button. *syngo* iFlow provides a greater understanding of the contrast flow within the pathology, greater ease in visualizing the success of a procedure and assists the clinician in image review.
On the angiography Website, a clinical case book shows the advantages of *syngo* iFlow when comparing pre- and post-treatment acquisitions to visualize contrast flow within pathologic blood vessels.
Siemens Healthcare exclusively offers customers the opportunity to discover and try *syngo* iFlow for a 90-day period at no cost. The free trial license program is available for many more clinical applications

More Information
www.siemens.com/
discoverInterventionalImaging

Upcoming Congresses 2010/2011

We always would like to give you the opportunity to get in "touch" with the real system and learn more about system handling to keep you in step with the latest technological advances. You will have the chance to experience our technology at international congresses, trade fairs, and workshops. In the list below you will find information on various events where we offer you the opportunity to meet AX.

Title	Location	Short Description	Date	Contact
SIRM	Torino, Italy	Società Italiana di Radiologia	June 1 - 5, 2011	www.congresso.sirm.org/
UKRC	Manchester, UK	UK Radiological Congress	Jun 6 - 8, 2011	www.ukrc.org.uk/
ISMICS	Washington DC, USA	Interventional Society for Minimally Invasive Cardiothoracic Surgery	June 8 - 11, 2011	www.ismics.org/
WCIO	New York, USA	World Conference on Interventional Oncology	June 9 - 12, 2011	www.wcio2011.com/
SVS	Chicago, Illionois, USA	Society for Vascular Surgery	June 16 - 18, 2011	www.vascularweb.org/
CSI	Frankfurt, Germany	Congenital & Structural Interventions	June 23 - 25, 2011	www.csi-congress.org/
PICS-AICS	Boston, MA, USA	Pediatric & Adult Interventional Symposium	July 24 - 27, 2011	www.picsymposium.com/
SNIS	Colorado Springs, Colorado, USA	Society of Neurointerventional Surgery	July 25 - 28, 2011	www.snisonline.org/
ESC	Paris, France	European Society of Cardiology Congress	Aug 27 - 31, 2011	www.escardio.org/
ESMINT	Nice, France	European Society of Minimally Invasive Neurological Therapy	Sept 8 - 10, 2011	www.esmint.com/
CIRSE	Munich, Germany	Cardiovascular and Interventional Radiological Society of Europe	Sept 10 - 14, 2011	www.cirse.org/
ESVS	Athens, Greece	European Society for Vascular Surgery	Sept 22 - 25, 2011	www.esvs.org/
ESNR	Antwerp, Belgium	European Society of Neuroradiology	Sept 22 - 25, 2011	www.esnr.org/
EACTS	Lisbon, Portugal	European Association for Cardio-Thoracic Surgery	Oct 1 - 5, 2011	www.eacts.org/
DGNR	Köln, Germany	Deutsche Gesellschaft für Neuroradiologie	Oct 6 - 8, 2011	www.dgnr.org/
Radiologie Kongress Ruhr	Bochum, Germany	Radiologie und Nuklearmedizin	Oct 13 - 15, 2011	http://radiologiekongressruhr.de/
ESPR	Newcastle, UK	European Society for Paediatric Radiology	Oct 14 - 17, 2011	www2.kenes.com/espr2011/pages/home.aspx
JFR	Paris, France	Journées Francaise de Radiologie	Oct 21 - 25, 2011	www.sfrnet.org/
TCT	San Francisco, CA, USA	Transcatheter Cardiovascular Therapeutics	Nov 7- 11, 2011	www.tctconference.com/
Medica	Düsseldorf, Germany	Trade Show	Nov 16 - 19, 2011	www.medica.de/
RSNA	Chicago, IL, USA	Annual Meeting	Nov 27 - Dec 2, 2011	www.rsna.org/
LINC	Houston, TX, USA	Live Interventional Neuroradiology Conference	Dec 5 - 7, 2011	www.linccourse.org/

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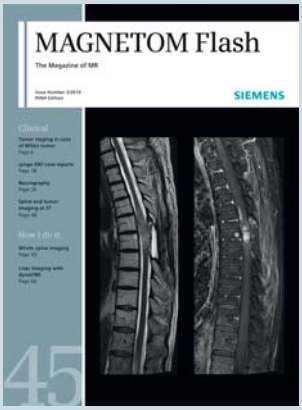
AXIOM Innovations
Everything from the worlds of interventional radiology, cardiology, and surgery. This semi-annual magazine is primarily designed for physicians, physicists, researchers, and technical personnel.



MAGNETOM Flash
Everything from the world of magnetic resonance imaging. The magazine presents case reports, technology, product news, and how-to's. It is primarily designed for physicians, physicists, and technical personnel.

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Everything from the world of computed tomography. With its innovations, clinical applications, and vision, this semiannual magazine is primarily designed for physicians, physicists, researchers, and technical personnel.

Perspectives
Everything from the world of clinical diagnostics. This semi-annual publication provides clinical labs with diagnostic trends, technical innovations, and case studies. It is primarily designed for laboratorians, clinicians and technical personnel.

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Order No. A91AX-81101-12C1-7600 | Printed in Germany | CC AX ZS 061120. | © 6.2011, Siemens AG

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