

# AXIOM Innovations

The Magazine for Interventional Radiology, Cardiology and Surgery

December 2014

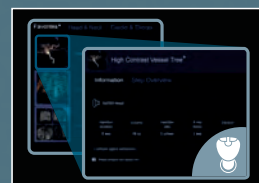
Issue 19



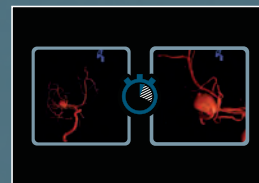
## Artis with PURE

Adding Smooth to Smart.

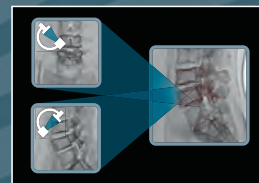
### 3D Wizard



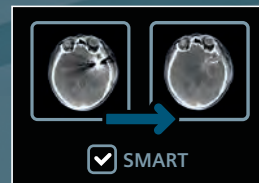
### QuickZoom



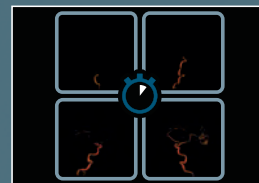
### syngo 2D/3D Fusion

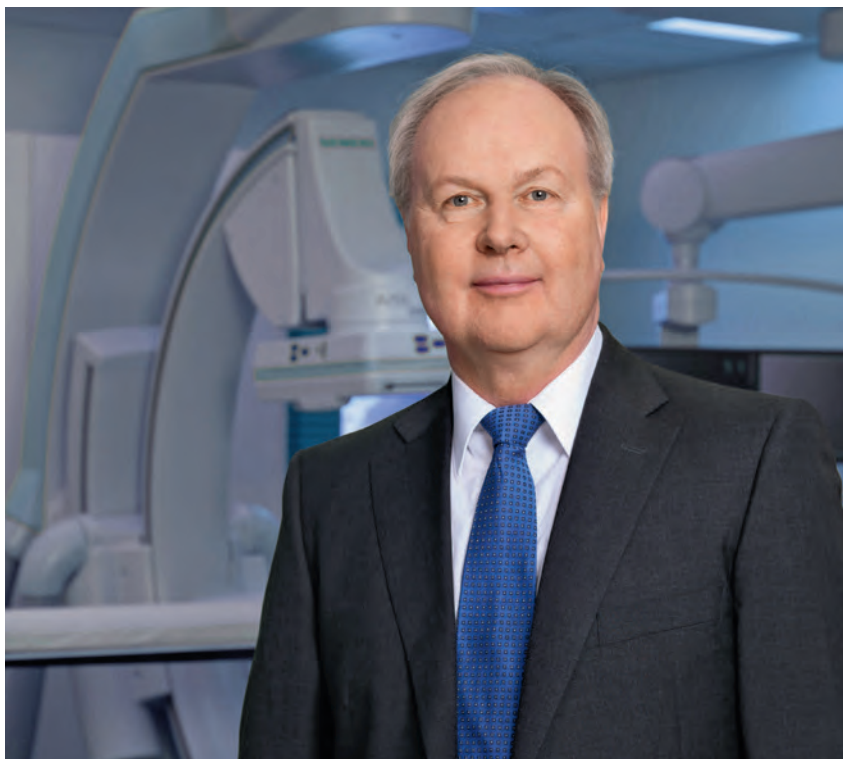


### syngo DynaCT SMART



### syngo Dyna4D





## Dear Reader,

When driving a powerful car, you want the control to be intuitive so that you can concentrate on the essential – the road ahead. In the angiography suite, you need your system to support your workflow without delay or distraction so that you can focus on the essential – your patient. And like a high performance vehicle, speed, accuracy, and intuitive use are key aspects of interventional radiology, cardiology, and surgery.

So, how can we make system interaction as smooth and secure as driving a high-end automobile? Our answer is PURE® – an extensive new platform that complements true ease of use with our smart technologies. Our Artis® systems are well known for their advanced capabilities, but now we've added smooth use that makes interventional procedures safer and workflows more efficient, allowing more clinical possibilities and extending access to a broader range of users.

Previously, when navigating a route, you had to stop the car, take out a map, and spend time working out where you are. Now, we simply switch on our navigation system

and are led to our destination. Our new PURE platform brings similar smooth guidance to your angiography suite. With the heads-up display, the user is free of the distraction to look up and down between the touchscreen and the display. A feature such as 3D Wizard allows even less experienced users to navigate through complex procedures.

In those complex procedures, you need to be able to maneuver with safety and accuracy with quick access to the most detailed information available. With PURE's *syngo*® 2D/3D Fusion, for example, pre-operative 3D data-sets can now simply be fused with two 2D projection images for live image guidance during the procedure.

Our partners who have been working with our PURE platform are already convinced by the increased speed and ease of use while actually making procedures more efficient.

Another new application is *syngo* Dyna4D®, which makes it possible to visualize 3D flow patterns in the angio suite without the need for added radiation exposure or contrast dose. Leading interventional neurologist, Charles Strother, MD, reports here on the benefits of being able to evaluate

*“The focus of PURE® is to improve the ease of use of our systems, while increasing image quality and further reducing dose.”*

Heinrich Kolem, PhD,  
CEO of the Angiography & Interventional X-Ray Systems  
Business Unit AX at Siemens Healthcare

the dynamics of blood flow pattern in a 3D reconstruction of complex abnormalities such as AVMs and AVFs. An enormous advantage in his work is the improved ability to assess the risks of hemorrhage and choose the patients who are most suitable for endovascular therapy.

Our ultimate aim – always – is to support our customers with the best possible tools to help fight the most threatening diseases in angiography. With PURE guiding and powering the performance, the path has never been smoother.

**Enjoy reading this edition!**

Sincerely yours,



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Heinrich Kolem, PhD

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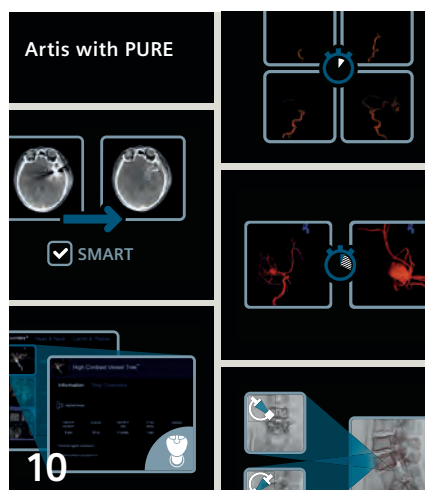
## Behind the Stories

Get in touch! Please share any questions, comments or suggestions for improvements you have with us.

Email: [axiom-innovations.healthcare@siemens.com](mailto:axiom-innovations.healthcare@siemens.com)



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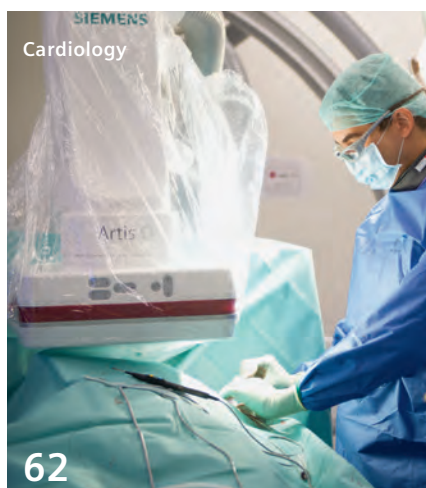
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The statements by Siemens' customers presented here are based on results that were achieved in the customer's unique setting. Since there is no "typical" hospital and many variables exist (e.g., hospital size, case mix, level of IT adoption), there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





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# Excellent Clinical Results from First Ever Artis one Installation in India

Following the launch of Artis one® at RSNA 2013, five Artis one systems have already been installed in India. The systems, based at Nashik, Hyderabad, Kerala, Jodhpur, and Udaipur, are all delivering excellent clinical results.

The first Artis one was installed at the Vijan Cardiac and Critical Care Center in Nashik (about 166 km from Mumbai) in April 2014. So far, 200 diagnostic and interventional procedures have been performed in a broad range of fields including interventional cardiology, pediatrics, electrophysiology, and peripherals. Vinod M. Vijan, MD, Senior Interventional Cardiologist, is very happy with the image quality and sees real clinical value in the new

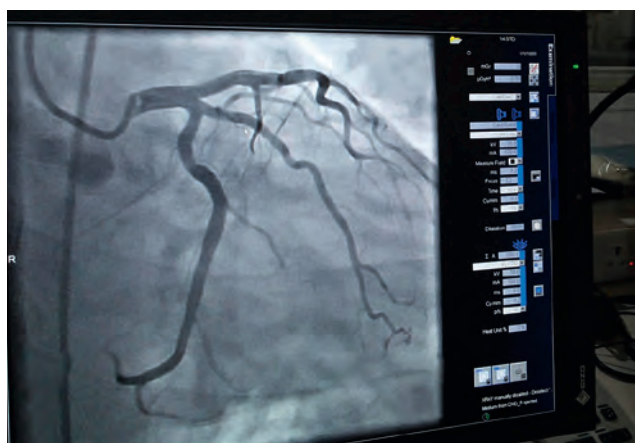
applications he received with his Artis one – HeartSweep and CLEARstent® Live. He is also excited about the flexibility of the new Artis one floor stand and the size of the midsize as30 flat detector, which allows him to cover both legs in one sweep during peripheral run-offs. In the past, he could only cover one leg at a time and had to perform two runs. Artis one has changed his workflow and allows him not only to save time but also radiation dose. Overall, Vijan states: “The Artis one is a cost-effective but high-end solution, which is an excellent fit for our multipurpose cathlab.”

*Vinod M. Vijan, MD, states:*

*“HeartSweep is a real asset with more information, low dose, and less contrast. It is especially useful for patients with renal failure, poor liver function, or those who need vessel grafts (LIMA, SVG).”*

*“CLEARstent is extremely helpful before stent deployment especially in ostial lesions, and also post-deployment to check expansion. It is like using non-invasive intravascular ultrasound. I’ve used it for bifurcation lesions and found it extremely useful.”*

Clinical set-ups of the Artis one at the Vijan Cardiac and Critical Care Center in Nashik, India.



# A World First in Austria

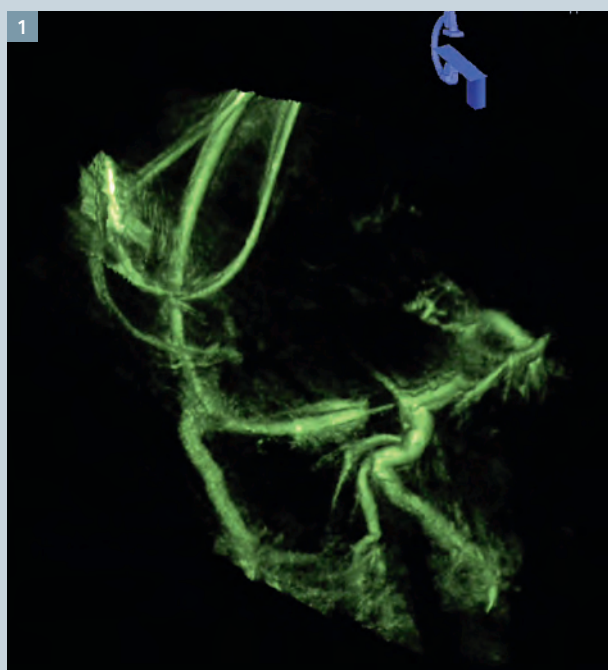
## CRT Device Implantation based on 3D Visualization of Coronary Sinus via Untriggered *syngo* DynaCT Cardiac

Now it is possible to visualize the three-dimensional morphology of the coronary sinus (CS) derived from just one 5s untriggered *syngo* DynaCT® Cardiac run. This anatomical information was found very useful for guiding the bi-ventricular pacemaker lead to the desired position within the CS. It can also mean a reduction in radiation exposure to patients and interventionalists, and seeks to further improve the quality of interventions.

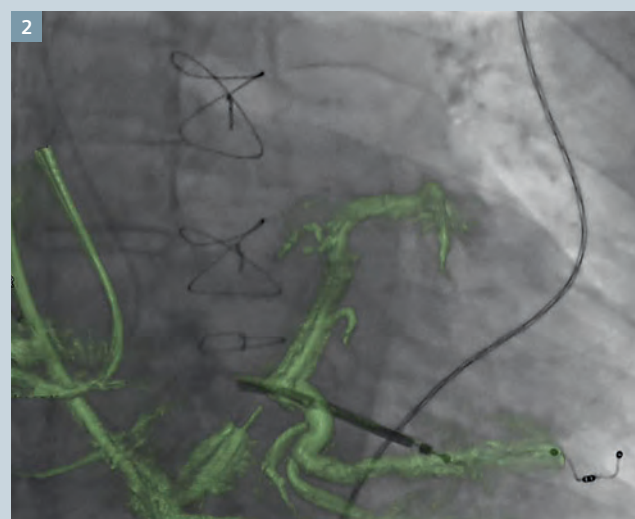
Cardiac resynchronization therapy (CRT) is indicated and effective for advanced drug-refractory heart failure, severe LV systolic dysfunction, and ventricular dyssynchrony.

After successful implantation of a CRT device, patients may benefit from improved quality of life and increased life expectancy including reduction in increased all-cause mortality.

Marcus Ammer, MD, from Hospital Wels-Grieskirchen in Austria is working with an Artis Q.zen system and *syngo* X Workplace to treat CRT patients. For 3D reconstruction and 3D visualization of the coronary sinus, he uses *syngo* DynaCT Cardiac.



**1** 3D visualization of the coronary sinus. 248 projection images were acquired with a single 5s rotational run during balloon occlusion of the coronary sinus. Retrograde manual contrast injection and right ventricular rapid pacing was applied during the 3D scan before automatic 3D reconstruction.



**2** Super-imposition of the 3D anatomy of the CS on 2D live fluoroscopy images shows the pacemaker lead during implantation.



# A Safer Place for Endo- and Cardiovascular Patients

A brand-new £6.4 million twin hybrid operating room suite opened its doors in June at Manchester Royal Infirmary. Central Manchester University Hospitals NHS Foundation Trust says they will “transform the treatment of patients undergoing minimally invasive endovascular and cardiovascular procedures”. This surgical suite makes the Manchester Royal Infirmary the UK’s first hospital to be equipped with two adjacent full hybrid theaters using Siemens’ Artis zeego® angiography system with the integrated Maquet MAGNUS surgical table.

Manchester Royal Infirmary is a large, extremely busy teaching hospital. One of the specialisms for which it has gained a strong reputation is as a center for vascular and cardiac services – increasingly being undertaken via endovascular, minimally invasive procedures.

David Wolferstan, Associate Director of Surgical Services: “The overall project goal was to design and build a high specification dual hybrid theater facility where our surgeons could undertake the full range of elective and

non-elective surgery. Primarily, this would be vascular and cardiac surgery and, secondarily, other specialties such as urology and emergency trauma surgery”.

At the heart of both Hybrid ORs is Siemens’ Artis zeego multi-axis angiography system. Based on robotic technology, it offers outstanding positioning and imaging capabilities. Both 2D and CT-like 3D imaging can be performed intraoperatively and in combination with the Maquet MAGNUS surgical table even in complex positions such as a seated patient during a carotid procedure.

Ferdinand Serracino-Inglott, consultant vascular surgeon, explained the usage and the expectations of the Hybrid ORs just before going into clinical service: “We initially expect to operate five days a week, although the theaters will be available 24 hours-a-day for emergencies, such as ruptured aneurysms. I am sure being able to treat such patients in this facility will improve our outcomes. I believe that Manchester will be one of the safest places to have an aortic aneurysm fixed.”

The hybrid operating room with Artis zeego at Manchester Royal Infirmary during a vascular procedure.





## News in Therapy

### Real-time image guidance in laparoscopic liver surgery: Initial clinical experience with a guidance system based on intraoperative syngo DynaCT imaging

First publication on the use of Artis zeego in liver surgery: Minimally invasive abdominal surgery can be a challenge for surgeons. Preoperative data from CT or MRI provide great support for surgical planning; however, this plan changes as soon as the procedure begins. When performing surgery through small incisions, the surgeon replaces his natural 3D vision with an endoscopic view and also loses his tactile sense. Navigation systems can add valuable information and help the surgeon to look "behind the surface" and resect the tumors with a minimized risk. Professor Beat Mueller-Stich, MD, and his group at the Heidelberg University Hospital evaluated the use of Artis zeego for a laparoscopic partial liver resection.

Surg Endosc. 2014 Mar;28(3):933-40.

doi: 10.1007/s00464-013-3249-0. Epub 2013 Nov 1.

Further information on the PubMed internet:  
[www.siemens.com/pubmed-liver-surgery](http://www.siemens.com/pubmed-liver-surgery)

### Novel technique using intraoperative fluoroscopy and syngo DynaCT for hydrocephalus treatment

Great news from the neurosurgical field: The treatment of hydrocephalus can be improved by the use of intraoperative fluoroscopy and syngo DynaCT. The treatment of choice is the placement of ventriculoperitoneal shunts (VPS) or ventriculoatrial shunts (VAS). With this conventional method, the failure rate of ventricular catheter systems still remains as high as 30–40% [1]. In an already published study, Kobayashi et al. report on a novel technique using intraoperative fluoroscopy and syngo DynaCT to facilitate and assist accurate placement of the VPS [2]. They carried out a study of 39 patients with consecutive ventricular catheters. With the use of a biplane system and syngo DynaCT, there was no ventricle catheter failure. The authors concluded that the surgical placement of a VPS assisted by intraoperative fluoroscopy and syngo DynaCT permitted the correct placement of ventricular catheters and was linked to a decreased need for shunt revision.

[1] Kang JK, Lee IW. Long-term follow-up of shunting therapy. Childs Nerv Syst. 1999 Nov;15(11-12):711-7.

[2] Kobayashi S, Ishikawa T, Mutoh T, Hikichi K, Suzuki A. A novel technique for ventriculoperitoneal shunting by flat panel detector CT-guided real-time fluoroscopy. Surg Neurol Int. 2012;3:119.

Further information on the PubMed internet:  
[www.siemens.com/pubmed-shunting](http://www.siemens.com/pubmed-shunting)

## Realtime Radiation Dose Management

Radiation exposure is a key issue in every imaging exam. To help monitor dose, the RaySafe i2 dosimeter collects data from each intervention and sends it directly to a touchscreen right next to the angio system display for instant feedback on scattered radiation.

See the article "Tweeting Dose" published August 2014, AXIOM Innovations (18), page 56, for more information.



## Make Radiation Visible!

### Lower Your Dose with Real-time Dose Monitoring

RaySafe i2 provides the ability to see your radiation exposure as you are receiving it, so you can immediately react and lower it.



Learn more at [www.raysafe.com](http://www.raysafe.com)

 **RaySafe™**

# Artis with PURE®

*“I definitely see an added value in the new platform. The functions of the Artis system are much easier and more comfortable to operate than before.”*

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Professor Martin Skalej, MD,  
Department of Neuroradiology, University Hospital Magdeburg, Germany

*“In the angio suite, easy-to-use standardized interfaces accelerate the learning curve and free up time for safe patient care.”*

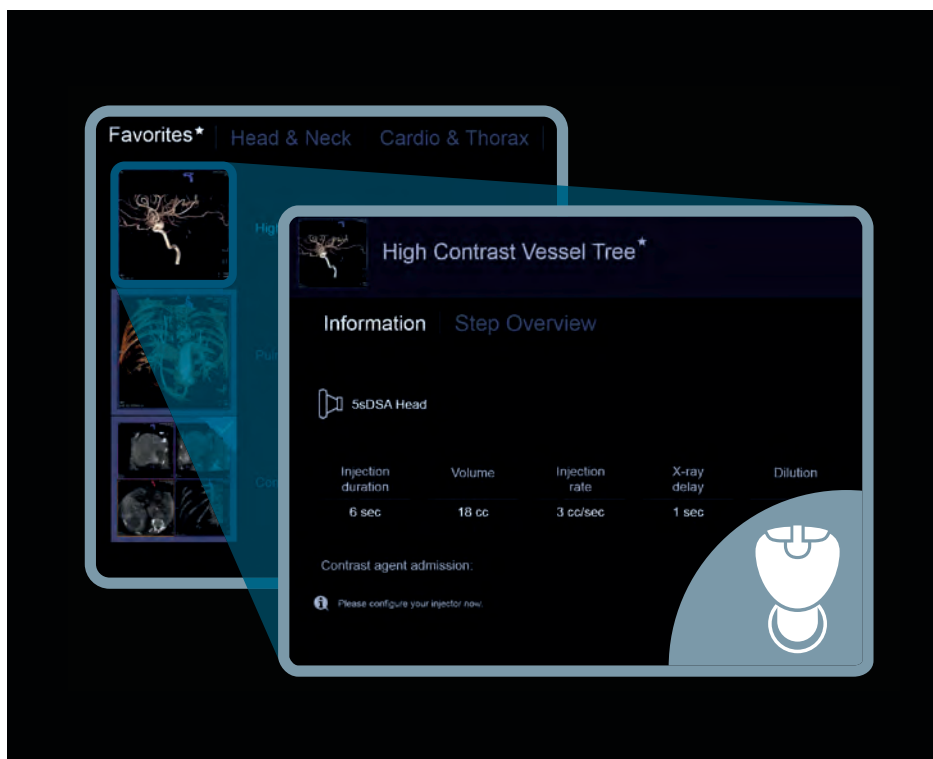
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Luann Culbreth,  
Executive Director of Medical Imaging at Saint Thomas Health Services, Nashville, USA

# Adding Smooth to Smart.

In angiography, many physicians do not get to experience the full capabilities of their modern interventional systems as both procedures and system interaction get increasingly complex. Siemens is changing this: The new PURE® platform brings smooth interactions to the Artis systems to make interventional imaging easier and generate smart performance.

By Irène Dietschi



## 3D Wizard

Simplify 3D imaging with expert guidance

Choosing an optimal 3D protocol is not always easy. The 3D Wizard provides step-by-step expert guidance to achieve the desired imaging results. Increase your confidence when using 3D and get the full benefits from your system.

"Simplicity is the ultimate sophistication," said Leonardo da Vinci. This sentiment is still valid in today's world, perhaps even more so than 500 years ago. Nowadays, we have countless ways to make our lives easier and we expect devices such as our smartphones to be intuitive. Ease does not need to involve a lack of functionality. Ease embraces fast initiation as well as a complexity of concepts the user needs to understand. Using a hammer, for example, is fairly easy to learn: By picking it up and feeling its weight and shape, even a novice can recognize its basic purpose. This same tool, however, is also intended for master carpenters and sculpturers to use with expert proficiency. A hammer's design has such potential that users can grow in skill over time.

The new PURE platform will bring this scope of ease to interventional imaging: By adding smooth use to smart technologies. PURE will come as a standard in all new Artis zee®, Artis Q®, and Artis Q.zen® systems as of summer 2015.

#### Focus on the patient

Picture yourself standing in the interventional suite of your hospital. The patient on the table has suffered a severe stroke and the CT has revealed a thrombus in the M1 segment. Your eyes are fixed on

the large monitor, intently following the progress of the catheter as it gradually edges its way through the vessels. Shortly after, your right hand is on the joystick, interacting with the X-ray images.

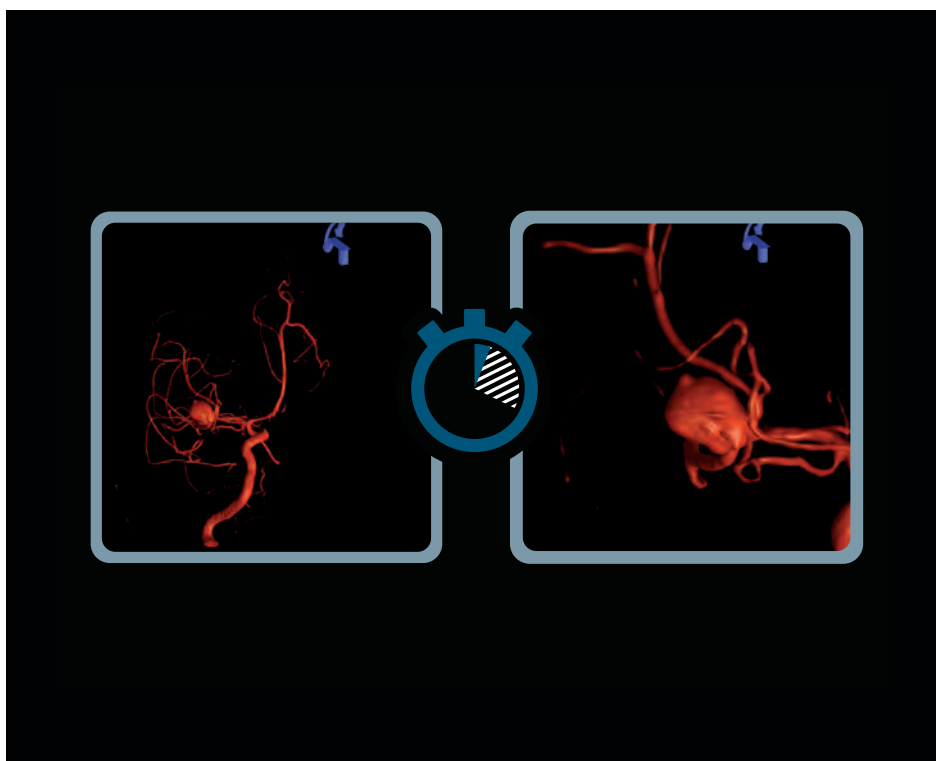
Your senses are on high alert, the interaction with the system needs to be simple. This is especially true in the clinical world – so that physicians can concentrate on the patient and on their task. Not all clinical staff have the same degree of experience. Think of the very young physicians in your team with their different backgrounds and levels of expertise: When it comes to operating the system in your interventional suite, there is much to learn. And the more often you use your tools, the more skilled you become: "It makes a considerable difference whether someone uses a system such as Artis Q only twice a week or every day," says Professor Martin Skalej, MD, Director of the Department of Neuroradiology at Magdeburg University Hospital.

When it comes to a fast learning curve, PURE makes all the difference by adding smooth use to smart technologies. Imagine yourself wanting to acquire a 3D volume. Select the 3D Wizard straight from the joystick at the table side. Immediately, you are presented with multiple model images for each body region, and you choose the one that fits most

### QuickZoom®

Focus and zoom at  
tableside with just one click

Interacting with 3D volumes at tableside can be cumbersome. QuickZoom helps you save time and speed up your workflow. Click onto your region of interest, and QuickZoom centers and zooms automatically, even provides high-resolution refinement of your 3D volume.





closely with the situation you want to visualize. Another click and the 3D Wizard automatically sets you up with all the necessary acquisition parameters you need for creating the desired 3D volume, including the ideal amount and injection rate of contrast fluid, X-ray delay, and other specifications. Even someone with little training on 3D acquisition and interaction is reliably able to get the 3D volume he or she is looking for.

### High image quality matched with ease of use

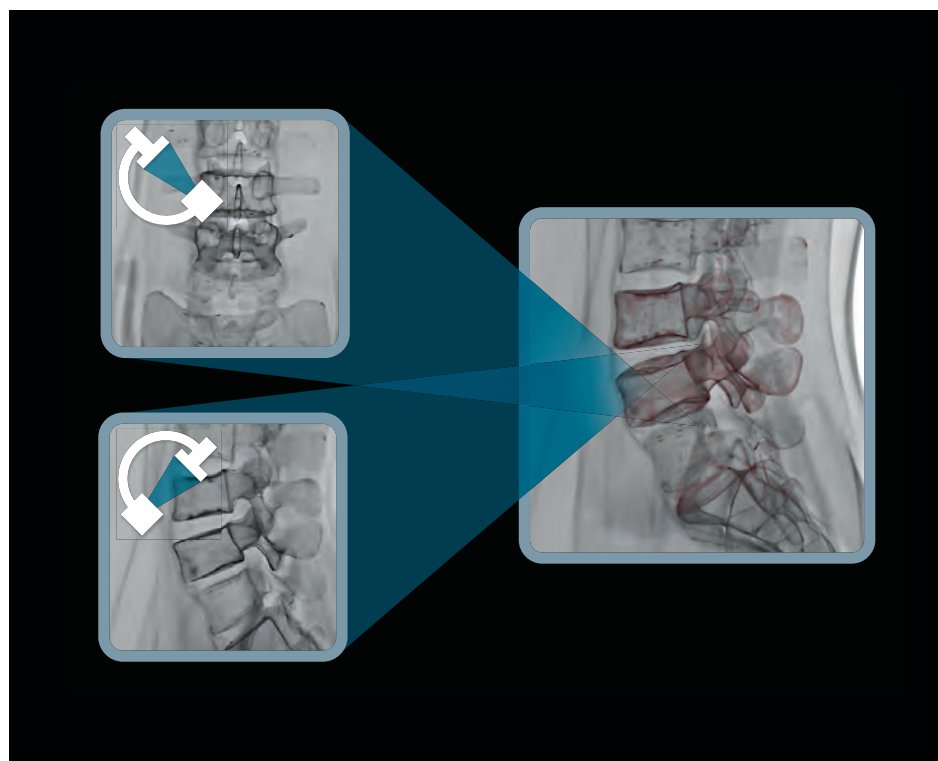
"It is very important that our systems become more self-explanatory and easier to use," says Heinrich Kolem, PhD, CEO of the Angiography & Interventional X-Ray Systems Business Unit AX at Siemens Healthcare. This is exactly what PURE delivers: Its focus is on ease of use for the Artis systems. While maintaining high standards in image quality and dose reduction, PURE will add smooth use to the smart technologies developed for the Artis family so that users of all levels can boost their productivity, outcomes, and capabilities.

A few years ago, experts at the Fraunhofer IAO (Institut für Arbeitswirtschaft und Organisation) in Stuttgart, Germany, took up the issue of usability in their research. Their study demon-

strated that usability and user-friendliness are key to any successful tool. Smooth and intuitive use contributes substantially to increased productivity and customer satisfaction. The authors specifically pointed out that usability is "a major factor to avoid mistakes and to reduce the need for training" and that positive user experiences are "likely to enhance the users' motivation and effectiveness."

What happens in the reverse scenario? When, for example, clinicians have to deal with systems that cannot be used intuitively? In such cases, they are likely to use only a fraction of the machines' capabilities. For example, they might ignore the 3D functions because they find these workflows too complicated and therefore become accustomed to using only a limited number of features as long as the image quality is still sufficient for everyday use.

With PURE and its focus on smooth interactions this will no longer be an issue, because PURE gives even the non-experienced user access to sophisticated functions, enabling him or her to use the full potential of an Artis system. Moreover, PURE has the potential to provide physicians with fascinating easiness and intuitiveness in using the system.



### syngo 2D/3D Fusion

Save 99% dose when integrating pre-op volumes for live image guidance<sup>1</sup>

Pre-op CT or MRI data is often available, but remains unused in the angio suite. With syngo 2D/3D Fusion, only two fluoro projections are required to easily fuse 3D volumes from other imaging modalities for live image guidance. Expand your capabilities while saving radiation dose and contrast media.

<sup>1</sup> This measurement was performed with an Alderson phantom using fluoroscopy with 10 images per 2D projection and a low-dose 6s DCT Body program. Results in actual clinical practice may vary.

### Tuned to user intuition

The 3D Wizard is just one of the new Artis with PURE features that appeal to the user's intuition by helping users of all experience levels to acquire the perfect 3D data. Another feature is the so-called QuickZoom – particularly useful for neuroradiologists when treating an aneurysm, for example. In order to focus and zoom to the aneurysms, previously, the physician would have to leave the patient, remove his gloves, and go to the workstation in the control room to perform those interactions. "This kind of interruption is really annoying, and it happens a lot," says Skalej.

With PURE, this is history as QuickZoom now allows physicians to stay in the exam room, and zoom and pan to e.g. an aneurysm easily, with just one click. After coiling the aneurysm, the physician who has acquired a post-interventional *syngo* DynaCT volume can eliminate metal artifacts in his images using *syngo* DynaCT SMART® (Streak Metal Artifact Reduction Technique) – again with just a click of a button. This allows the user to detect intra- and/or post-operative bleedings, for example. In the past, these bleedings would have been hidden by metal artifacts. This gives the physician more diagnostic confidence – a real clinical benefit.

Artis with PURE also brings even more ease of use with *syngo* 2D/3D Fusion, which enables a pre-operative volume (CT or MRI) to be fused with just two fluoroscopic images for live image guidance. This feature is especially helpful because it saves 99% of dose when integrating pre-op volumes for live image guidance<sup>1</sup> and simplifies and speeds up the workflow.

### Accelerated workflow

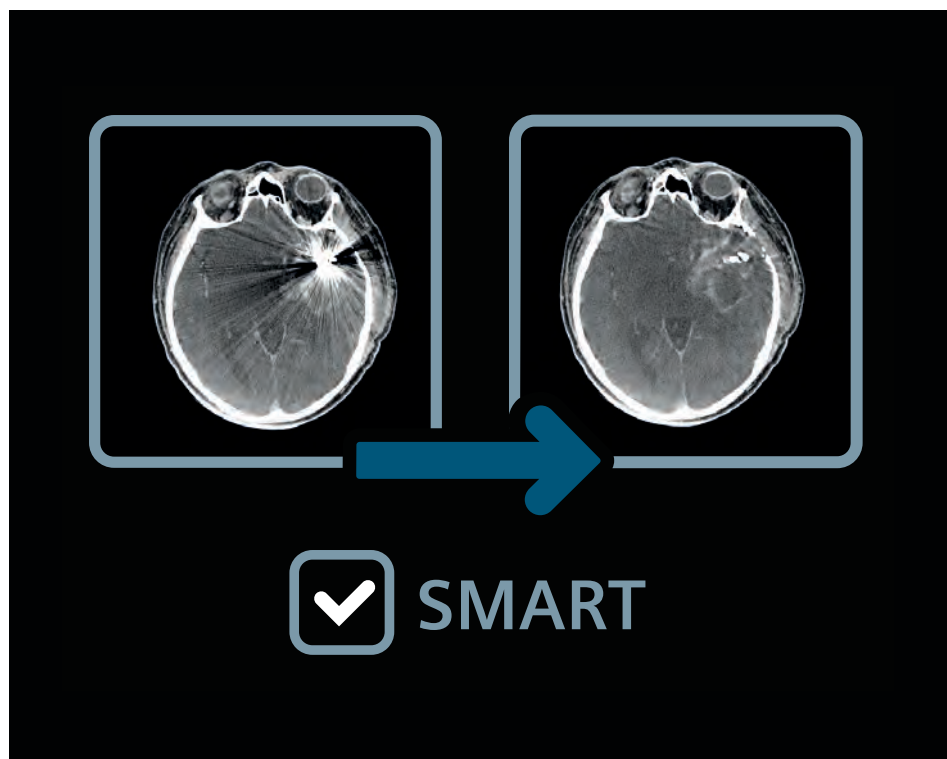
In 2014, Siemens tested the PURE platform in various hospitals all over the world. One of these was the Institute of Neuroradiology at Magdeburg University Hospital, whose experience of the new ease of use has been positive: "I definitely see an added value in the new platform," says head neuroradiologist Martin Skalej, "the functions of the Artis system are much easier and more comfortable to operate than before." Although he thinks that there is still room for improvement and better usability on certain levels, Skalej is convinced that PURE will make life smoother for interventional units. The system guides physicians through the intervention and lets them concentrate on the patient. Productivity is increased, not only because physicians become faster but also because many follow-up scans are no longer necessary.

### *syngo* DynaCT SMART

#### Reduce metal artifacts to see the unseen

Important diagnostic information can be obscured by metal artifacts. Reduce these artifacts by the click of a button – with *syngo* DynaCT SMART (Streak Metal Artifact Reduction Technique). This helps you increase diagnostic confidence and increases the chance for visualizing complications such as bleedings close to metallic objects.

<sup>1</sup> This measurement was performed with an Alderson phantom using fluoroscopy with 10 images per 2D projection and a low-dose 6s DCT Body program. Results in actual clinical practice may vary.



Moreover, better usability improves and accelerates the workflow of the whole clinic. For example, by transferring interventions such as pacemaker implantations or aortic valve implantations (TAVI) from the operating room into angiography, the capacity of the system can be raised significantly. Not only is the angiography system used more efficiently, but the operating rooms can be reserved for more complex procedures. From this point of view, the ease of use delivered by Artis with PURE not only benefits the physician, but also the organizational and financial running of an institution, rendering it attractive for the executive level, too. "In today's world of quality-based reimbursements, safe care is key to operational efficiency and financial effectiveness. In the angio suite, easy-to-use standardized interfaces accelerate the learning curve and free up time for safer patient care," says Luann Culbreth, Executive Director of Medical Imaging at Saint Thomas Health Services, Nashville, USA. She is well aware that intuitive interfaces require less time for training and that operational efficiency and safe care both directly impact their bottom line.

Finally, what speaks for PURE especially, in Skalej's view, is the quality aspect: "With these tools you have better security, at any time of the day, even during

the night with fewer trained staff," he says. "This means you have fewer complications, and your interventions either improve or are even made possible in the first place."

## Further Information

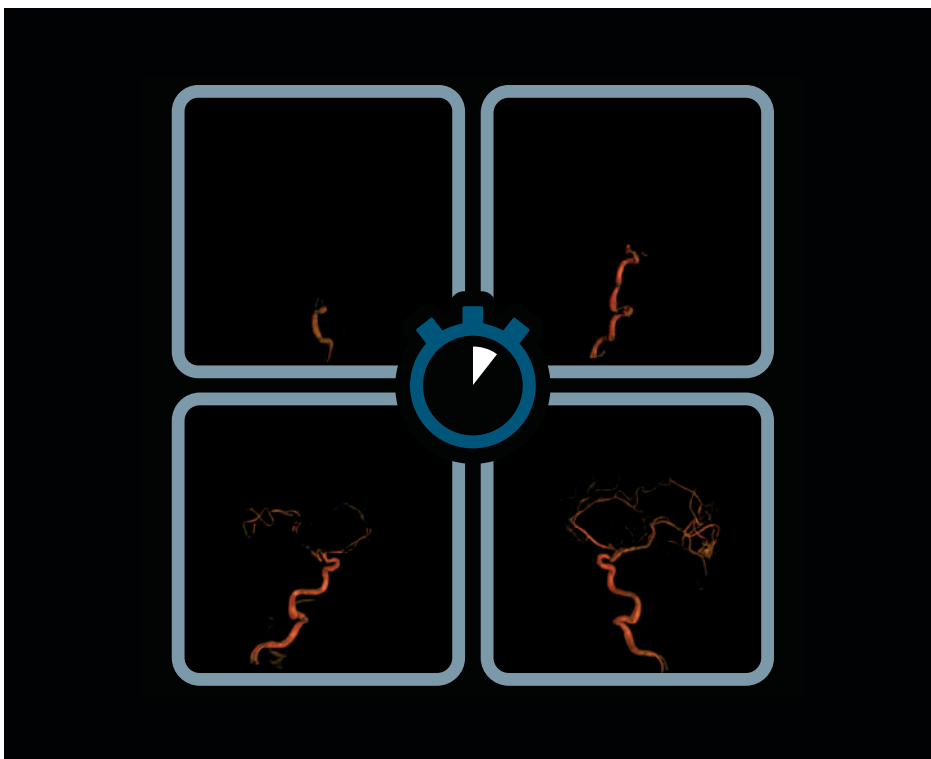
Find out  
more here



[www.siemens.com/artis-with-pure](http://www.siemens.com/artis-with-pure)

## Contact

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## syngo Dyna4D

Welcome the 4th dimension  
to the angio suite

Direct 3D flow information was limited to CT, MRI and ultrasound – yesterday. With syngo Dyna4D, you can now see flow patterns in 3D, providing a virtually unlimited number of DSA runs at no additional dose and contrast media<sup>2</sup>. syngo Dyna4D helps you expand your clinical capabilities in the angio suite by optimizing patient selection and individualized treatment strategies.

<sup>2</sup> This is the experience of individual users. Results may vary.





# Empowering System Usability in Interventional Radiology

At Hannover Medical School in Germany, Bernhard C. Meyer, MD, has been working with the Artis Q with PURE® for several months. He finds that handling the Artis system has become much smoother – thanks to PURE. In addition, he has observed that the safety and efficiency of image-guided interventions have also been improved.

*“The Artis system can be handled much more intuitively with PURE, allowing the physician to concentrate on the patient.”*

---

Bernhard C. Meyer, MD,  
Department of Interventional Radiology, Hannover Medical School, Germany



**Dr. Meyer, you've been testing the new PURE platform from Siemens in your Artis Q angiography suite since spring 2014. In general, what has been your experience?**

The most important innovation the new platform offers is that 3D information is now made easily available and simple to manipulate directly from tableside in the exam room. With PURE, you can rapidly call up any prior 3D patient volume dataset available and fuse it with the current images. The systems – both the Artis system and the workstation – have become easier to handle.

**In which respects is the Artis system easier to handle?**

The system allows us to focus easily on the essentials, so to speak. For example, object selection and manipulation via the tableside controls using the joystick rather than a mouse has always been demanding for the average user. Now, you control the whole workflow via contextual menus on a heads-up display, using the joystick only for navigation through the pull-down menus. This means that all the data you need – clinical images as well as workflow guidance and system operational information – are displayed at eye level without the radiologist having to avert his eyes. In short, usability is much more intuitive, almost gesture-like.

**The PURE platform comes with several innovative applications. Which ones do you find most useful in your daily work as an interventional radiologist?**

One application I really like is the new *syngo* 2D/3D Fusion. This allows us to fuse any external volume, be it CT or MRI, with just two 2D images, resulting in optimized use of these pre-operative 3D volumes. This is a significant dose reduction for the patient and time saving for us. In more complex procedures, you can work on the data in advance, plan the intervention, and store it until you recall all the data available in the exam room via the new bookmark function. This allows us to plan procedures at any given moment. It also saves time and dose, too.

**In which clinical situation is it most helpful to have pre-interventional data at your disposal?**

Any complex intervention involves planning based on pre-operative data such as CT or MRI. At our institute, for example, we are performing a new type of treatment on the lung vessels (Balloon Pulmonary Angioplasty). It is quite a challenging intervention where one must know the vascular paths with absolute precision. The PURE platform is very useful in this context because it enables us to segment and visualize these vessels exactly before catheterization. Later, in the exam room, we can use the external dataset to obtain a convenient working projection and align it with our live 2D images. This makes the procedure much safer.

**Which planning functions do you especially like and why?**

A very helpful tool is the polyline functionality that comes with the new 4D viewer. We use it for fast and easy marking and subsequent overlay of the position and course of the obstructed lung vessels. It allows catheterization with high precision without the need for repeated injection of contrast agent. Similarly, but in a much more automated way, *syngo* Embolization Guidance helps in path planning and lesion segmentation, for example when embolizing liver tumors – a function we've found to be very robust. For the presentation of vascular trees during the intervention, we also use the *syngo* 3D Roadmap function.

**You said that PURE empowers the user to handle the system more intuitively. Can you explain this a little more?**

Not only are external data rapidly available, you can also navigate through them using the joystick. PURE provides several tools that ease navigation considerably. For example, you can focus on a point of interest and zoom in using the new QuickZoom functionality, or you can choose different modes of visualization by simply selecting from the available preset menus. These func-

tions don't require fine motor skills – natural gestures are quite sufficient. Also, a number of technical as well as clinical processes have been integrated as workflows into the system. Their goal is to guide the user throughout the intervention so that he or she can concentrate on the patient and the procedure. For example, the user no longer needs to 'remember' to register if he wants to overlay a pre-interventional dataset; the system guides him automatically through all the necessary steps.

**Have you made use of parallel patient processing – another PURE innovation?**

Yes, we have. A very convenient feature that lets us process the data for two patients at the same time: One dataset from the patient lying in the exam room, the other dataset to prepare or post-process the volumes from a different patient. This is especially helpful for planning processes because it allows us to make use of the control room infrastructure without disturbing the exam room. This, of course, is also relevant in terms of time efficiency and departmental workflows.

**In conclusion, do you think that the Artis systems have become more user-friendly with the new PURE platform?**

I am certain that training time will be much shorter because the Artis systems can be handled more intuitively with PURE. In high-stress situations especially, it is convenient to have information available easily so that the physician doesn't have to leave the room but can concentrate on the patient.

Bernhard C. Meyer, MD, is Head of Interventional Radiology at the Institute for Diagnostic and Interventional Radiology at Hannover Medical School in Germany.

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# A Major Step Forward in the Life of a Neuroradiologist

Professor Martin Skalej, MD, Head Neuroradiologist at University Hospital Magdeburg, experiences a significant improvement of clinical procedures with the Artis Q with PURE®; this holds particularly true for aneurysm treatments.

*“The PURE platform eases and accelerates workflows in neuroradiology substantially.”*

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Professor Martin Skalej, MD,  
Department of Neuroradiology, University Hospital Magdeburg, Germany

**Professor Skalej, you have been testing the PURE platform in neuro-radiological interventions for the past eight months. What added value have you experienced during this time?**

I've definitely seen added value from working with PURE. In our experience, the functionality of the Artis system has become very user-friendly. Generally speaking, the PURE platform eases and accelerates workflows in neuroradiology substantially.

**Can you explain a little more?**

In neuroradiology, it is essential that you work with 3D images – essential in terms of procedure accuracy as well as patient safety. The *syngo* Dyna3D function of the Artis systems provides you with 3D volumes of very high quality. However, in the past, running a 3D acquisition used to be somehow cumbersome and required a lot of training. The PURE platform has made this function a lot easier. The new 3D Wizard shows even the less experienced users how to acquire and reconstruct volumes; it helps the user to place the contrast catheter at the intended injection site, to choose the adequate amount of contrast agent and injection rate, and suggests the individual steps of the procedure. In short, PURE enables practically anybody to perform a perfect 3D run without the need to have experts around. This is particularly relevant for new staff members or more versatile teams like during night shift emergencies.

**Please give us an example of a typical neuroradiological procedure that you perform with PURE.**

Let's take the case of a patient who presented with a headache and was given a regular CT scan. The scan showed an MCA aneurysm, and we decided to treat this aneurysm by placing a flow diverter stent into the parent vessel. This is a procedure we plan carefully in advance by simulating the placement of the stent using the virtual stent application. In the exam room, after bringing up the catheter, we start a *syngo* Dyna3D acquisition to evaluate the entire vessel tree. The use of the tableside-mounted

joystick – for example when we rotate the volume to get a good overview – feels natural and easy. From then on, we concentrate on the aneurysm. For this, we use the new QuickZoom function that allows us quickly to focus simply on the aneurysm directly from the table side.

**Do you mean to say that this wasn't possible before?**

Zooming in on the aneurysm has always been possible on the Artis systems, but it used to be quite complex, actually requiring the radiologist to leave the lab and go to the workstation in the control room. Thanks to the PURE platform, this is no longer necessary, meaning that we can stay at the tableside with the patient and proceed without interruption. This is a big step forward in terms of usability and ease – and it saves time.

**Why is focusing on the aneurysm so important?**

Because only then can we define the perfect projection for placing the stent. Once we've found the best orientation, we send the data to the C-arm, which automatically rotates to the working angulation. Placing the stent and/or coiling the aneurysm now only takes a few minutes. If the DSA shows good results, before discharging the patient we carry out a *syngo* DynaCT to validate the satisfactory opposition of the stent to the vessel wall and to make sure that we did not cause any unwanted complications such as bleedings.

**Do you use the *syngo* DynaCT SMART function – part of the PURE platform – for this?**

Yes we do, and we find it very useful. *syngo* DynaCT SMART allows us to reduce the artifacts caused by metal coils or clips. This function enhances the image quality of the *syngo* DynaCT significantly. It is a major improvement in the everyday life of a neuroradiologist, increasing the safety and reliability of treating patients with metal implants.

**From your experience, which is the most important feature of the new platform? And which**

**new application do you find most exciting?**

I think the most important aspect of PURE is the increased ease of use and the resulting quality. All these tools together bring about greater safety for the patient. One application I really like is *syngo* Dyna4D, a dynamic 3D imaging tool that enables us to visualize the blood flow in volume datasets. This function makes it much easier to find and classify fistulas. You can also see the flow patterns within an AVM or detect potential high-flow streams in AVMs and fistulas with the new *syngo* Dyna4D. This might potentially revolutionize the way we select patients and look at images. I'm very excited about this.

Professor Martin Skalej, MD, is Director of the Institute of Neuroradiology at University Hospital Magdeburg.

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# Reduce Metal Artifacts to See the Unseen

## Supported by syngo DynaCT SMART

### syngo DynaCT

syngo DynaCT is a 3D-angiography technique often used in neuro-interventional cases to visualize complex vascular structures before treatment and to give the physician guidance during the procedure. syngo DynaCT can also provide contrast-enhanced follow-up images in the angiography suite, either immediately after the procedure or during a follow-up examination. Following the placement of a flow diverter, for example, it can give valuable detail about potential issues such as in-stent restenosis or bleedings. However, syngo DynaCT has had limited application in assessing patients after aneurysm coiling or clipping procedures as these metal masses cause disruptive image artifacts.

*“With syngo DynaCT SMART the metal artifacts are reduced and the image quality of the DynaCT is improved a lot.”*

*“syngo DynaCT SMART is a big improvement in everyday life for a Neuroradiologist, and it increases safety and confidence of the procedure.”*

**Professor Martin Skalej, MD,**  
Department of Neuroradiology, University Hospital Magdeburg,  
Germany

*“Intravenous DynaCT with syngo DynaCT SMART is our method of choice over conventional CTA or MRA to follow-up aneurysm patients after clipping and stent/ coil treatment.”*

**Demetrius Lopes, MD,**  
Director of Endovascular Surgery, Rush University Medical Center,  
Chicago, USA

[1] E. Meyer, R. Raupach, M. Lell, B. Schmidt, M. Kachelrieß, “Normalized metal artifact reduction (NMAR) in computed tomography”, Med. Phys. 37 (10), October 2010.

[2] Psychogios MN, Scholz B, Rohkohl C, Kyriakou Y, Mohr A, Schramm P, Wachter D, Wasser K, Knauth M “Impact of a new metal artefact reduction algorithm in the noninvasive follow-up of intracranial clips, coils, and stents with flat-panel angiographic CTA: initial results”, Neuroradiology. 2013 Jul;55(7):813-8. doi: 10.1007/s00234-013-1165-6. Epub 2013 Apr 16.

[3] C Cay, Baltimore, MD; M Wells; A S Wang, PhD; J H Siewerdsen, PhD; T Ehtiaty, PhD; C Rohkohl; et al., Quantitative Assessment of Metal Artifact Reduction in C-arm Cone-beam CT Guidance of Neurovascular Interventions, Oral presentation at RSNA 2013.

### syngo DynaCT SMART

syngo DynaCT SMART (Streak Metal Artifact Reduction Technique) is a new application that can reduce these image artifacts with the click of a button.

Reduce of the metal artifact consists of the following steps:

First, the user identifies the metal by windowing the non-corrected syngo DynaCT reconstruction. From location, size, and shape of the metal objects, syngo DynaCT SMART determines the metal regions in each measured X-ray projection image automatically. The data generated by X-rays through metal objects are responsible for the artifacts. Therefore, they have to be replaced by a non-linear interpolation procedure using the data along the metal boundaries. This step is automatically performed by the algorithm within syngo DynaCT SMART.

These corrected projection images are reconstructed using an iterative metal artifact correction approach [1], resulting in a syngo DynaCT SMART volume that reveals the image information previously hidden by these metal artifacts.

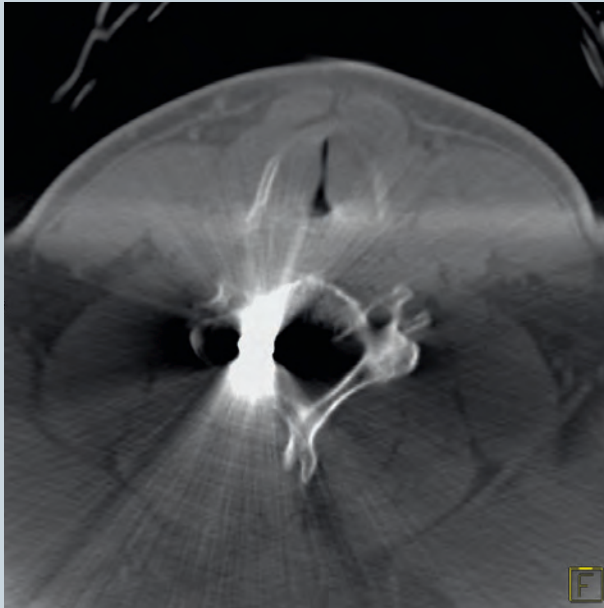
A team of collaborators worldwide evaluated a prototype version of syngo DynaCT SMART. They have applied it to both non-contrast and contrast-enhanced images of metal implants (e.g. stent markers, aneurysm coils, and clips) and assessed the quality of the reconstruction [2, 3 and 4].

Some results can be seen in the clinical images on the following pages.

### Benefits

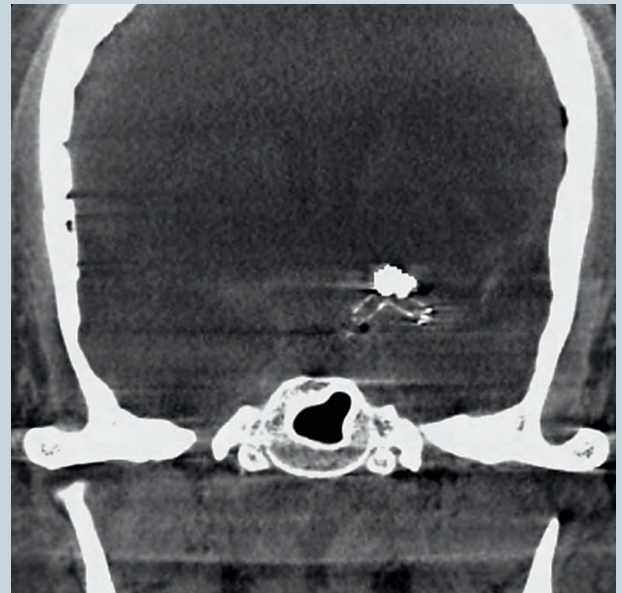
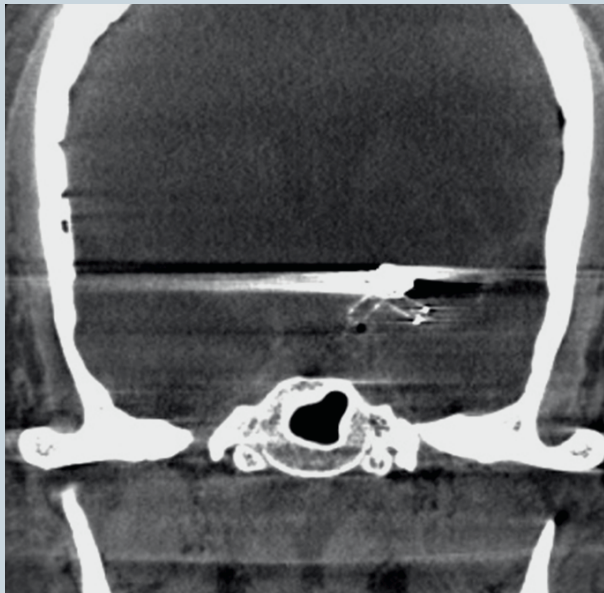
- Detect important diagnostic information such as bleedings close to metallic objects.
- Save time and money by replacing endovascular procedures with intravenous follow-ups for shorter and less invasive procedures.
- Reduce patient transfer efforts between CT and angio by performing control CT's without metal artifacts to exclude intracranial hemorrhage.
- Increase confidence in diagnosis and decision making in the angio lab.
- Exclude in-stent stenosis and residual aneurysm fillings in follow-up scans due to reduced metal artifacts.
- Helps to increase diagnostic confidence and increases the chance for visualizing complications such as bleedings close to metallic objects.





- 1 On a patient with a gunshot wound to the cervical spine, syngo DynaCT SMART was helpful in understanding the trajectory of the bullet to the vertebral artery or the dural sac.

Images courtesy of Demetrius K. Lopes, MD, Rush University Medical Center, Chicago, USA

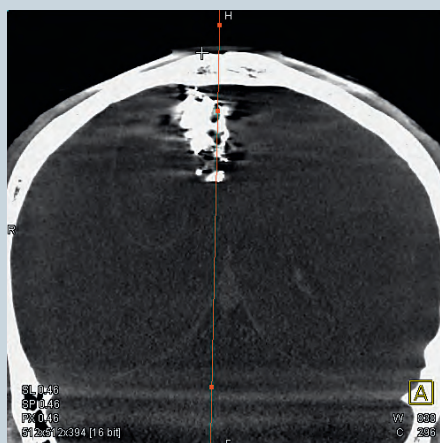
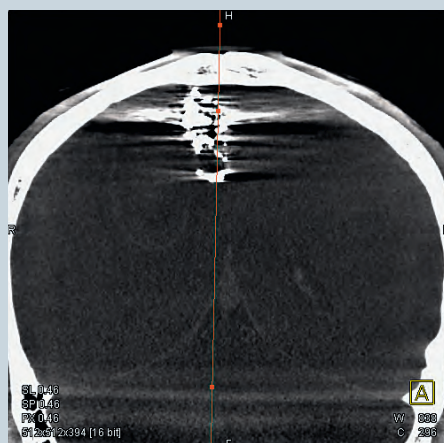


- 2 57-year-old female after stent-assisted coiling of a left internal carotid artery terminus aneurysm. Following correction with syngo DynaCT SMART, the coil mass can be visualized much more clearly.

Images courtesy of Martin Radvany, MD, Johns Hopkins University, Baltimore, USA

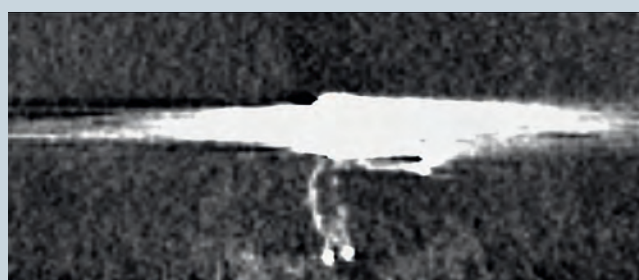
*“By using syngo DynaCT SMART in stent-coil cases, I’m more confident about excluding in-stent stenosis and residual aneurysm filling.”*

Demetrius Lopes, MD,  
Director of Endovascular Surgery, Rush University Medical Center, Chicago, USA



- 3** 31-year-old male with ruptured cerebral arteriovenous malformation and adjacent resolving hematoma. Following syngo DynaCT SMART reconstruction, the images clearly show the enhancing wall of the hematoma (particularly in the superior aspect) and delineate the anatomy far better than without syngo DynaCT SMART.

*Images courtesy of Michel Mawad, MD, St. Luke's Episcopal Hospital, Houston, USA*

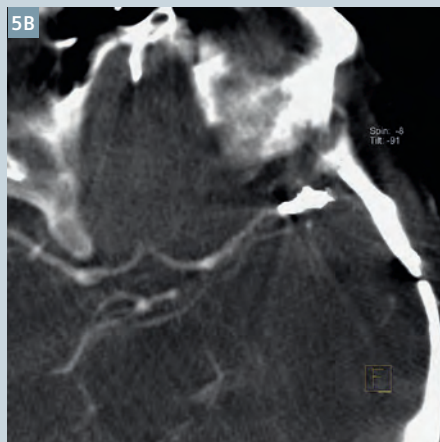
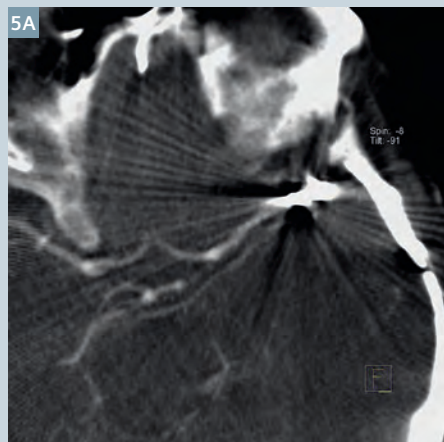


- 4A Pre-image:**  
Initial image without syngo DynaCT SMART: Cerebral aneurysm treated with stent-assisted coiling. Here, it is not possible to assess the relationship between coils and stent due to severe metal artifacts caused by the metal coils.



- 4B Post-image:**  
syngo DynaCT SMART reconstruction of the same projection. The streak artifacts around coils and stent here are mostly removed to give an image quality sufficient for assessment. The oblique coronal plane showed that the stent did not kink and coils adhered to the stent very well.

*Images courtesy of Jianmin Liu, MD, Qinghai Huang, Changhai Hospital, China*



- 5** 40-year-old male with a broad-based aneurysm of the middle cerebral artery bifurcation which has been treated by surgery. The control image after clipping was produced using intravenous DynaCTA.

In the uncorrected image (5A), extensive artifacts are visible making assessment of the clip difficult. After correction (5B), these artifacts are almost entirely eliminated and vascular structures adjacent to the clip become visible.

*Images courtesy of Professor Arnd Dörfler, Professor Tobias Struffert, University Hospital Erlangen, Germany*

## Contact

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[4] Stidd DA, Theessen H, Deng Y, Li Y, Scholz B, Rohkohl C, Jhaveri MD, Moftakhar R, Chen M, Lopes DK, Evaluation of a metal artifacts reduction algorithm applied to postinterventional flat panel detector CT imaging. AJNR Am J Neuroradiol. 2014 Aug 14 (Epub ahead of print).



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# See the Flow Pattern in 3D Supported by syngo Dyna4D

Courtesy of Azam Ahmed, MD, David Niemann, MD, Beverly Aagaard-Kienitz, MD, and Charles Strother, MD

University of Wisconsin, Madison, USA

## Patient History

48-year-old female with acute right parietal hemorrhage and acute right fronto-parietal sub-dural hematoma.

## Diagnosis

Large parietal arteriovenous malformation (AVM).

## Treatment

After evacuation of the sub-dural and parietal hematoma, a DSA was performed (Fig. 1). This revealed a complex AVM with supply from the right-middle and anterior cerebral arteries, and the right-posterior cerebral arteries. This diagnosis had been improved by 4D DSA (syngo Dyna4D). Treatment included successful embolization and subsequent resection of the AVM.

## Comments

4D DSA (syngo Dyna4D) was very useful in allowing clear visualization of the internal features of the nidus of this AVM (Fig. 2). Seeing just how the feeding arteries entered the nidus, the way venous drainage exited from the nidus, and the presence of intra-nidal aneurysms supported the strategy decision for embolization and the positioning of the patient for surgical excision of the lesion. A small flow-related aneurysm was noted on the proximal portion of the right-posterior cerebral artery. A small cortical artery was incorporated into this aneurysm. This was more clearly seen with syngo Dyna4D than with the other DSA studies (Fig. 3).

This case is an excellent example of how the ability to see any view of an abnormality at any time of its opacification adds value to the care of patients with such complex vascular diseases. This new technology allows for a more tailored treatment planning to the individual patient.

## Protocol

Contrast amount:  
18 cc, injection rate: 3 cc/s,  
X-ray delay: 0 s, no contrast  
dilution (100% Omnipaque 350)

*"It is already apparent that this technology (syngo Dyna4D) will translate into fewer X-rays and therefore less radiation exposure for the patient, but also into lower costs."*

Charles Strother, MD,  
University of Wisconsin, Madison, USA

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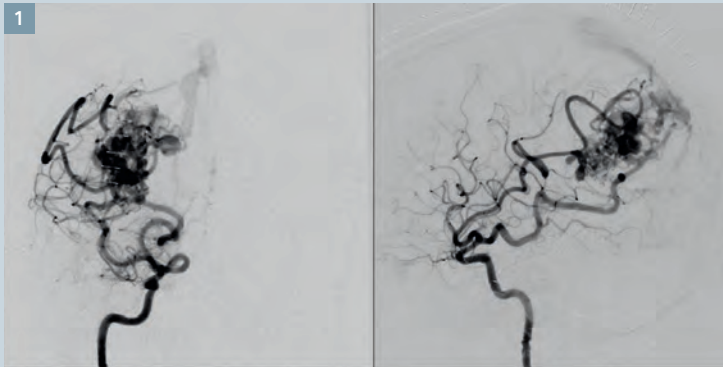
Charles Strother, MD, who has treated countless patients in a clinical career spanning more than 45 years, is one of the world's leading experts in interventional neuro-radiology. He has researched and invented numerous successful treatment methods and technologies. The latest one is syngo Dyna4D, which he developed in cooperation with Siemens, realizing that 3D modeling with the contrast medium flowing through the vessel should also include temporal information in the interventional image dataset.

Dr. Strother is an Emeritus Professor at the University of Wisconsin School of Medicine and Public Health in Madison. In 2014, he was the recipient of the ASNR Foundation Outstanding Contributions in Research Award. As an expert in interventional neuro-radiology, including stroke, Dr. Strother is the author of four books and more than 150 scientific publications, including some of the most frequently cited publications in this discipline.

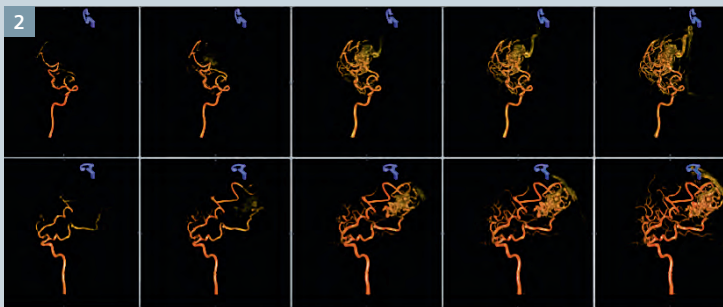


*"This case confirmed the new 4D technique has better spatial and temporal resolution than any other imaging modality. It is an excellent example of how the ability to see any view of an abnormality at any time of its opacification adds value to the care of patients with such complex vascular diseases."*

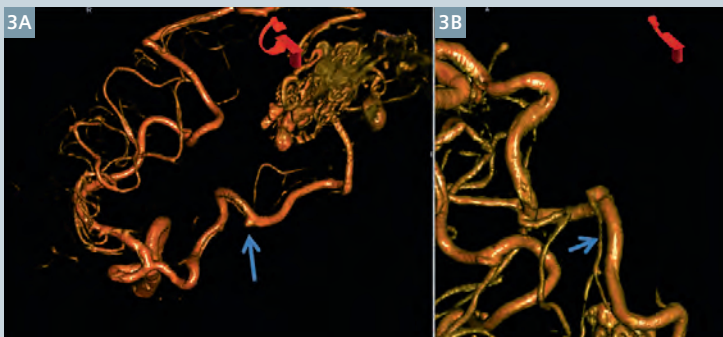
Beverly Aagaard-Kienitz, MD,  
University of Wisconsin, Madison, USA



1 2D DSA images showing the angioarchitecture of the AVM.



2 Time-resolved 4D DSA (syngo Dyna4D) from AP and lateral views.



3 Early 4D DSA (syngo Dyna4D) time frame highlighting the small flow-related aneurysm (3A) and the small cortical artery emerging from the aneurysm (3B). Please note that these projection views are not possible with conventional 2D DSA.

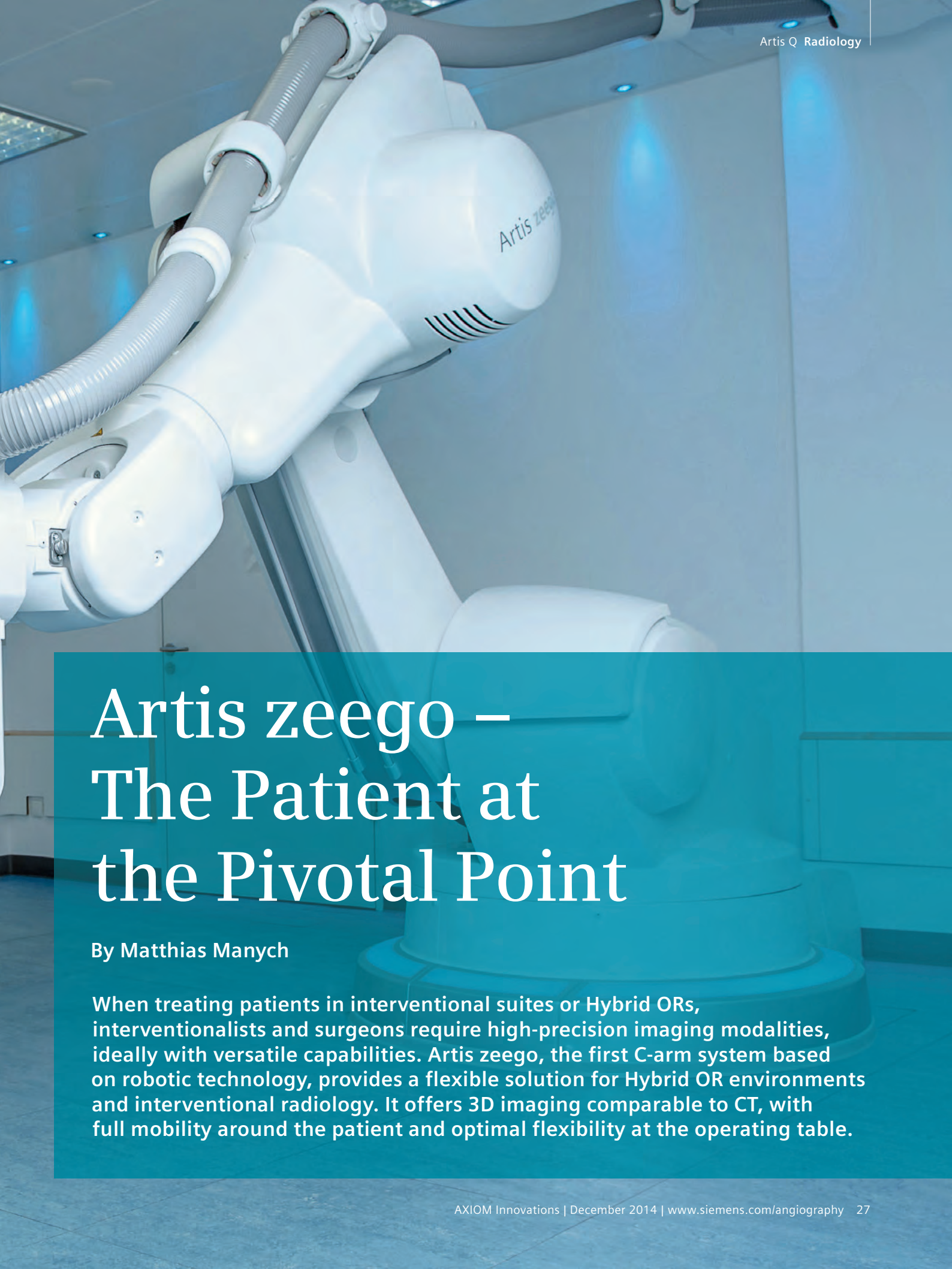


4 The flexibility of 4D DSA (syngo Dyna4D) allows for visualization of any time point at any view angle for optimal visualization of the AVM nidus, feeding arteries, and draining veins. Visualization can be enhanced with volume rendering (VRT) or maximum intensity projection (MIP) rendering.



CARE+CLEAR



A large, white, robotic C-arm system, the Artis zeego, is shown in a clinical setting. The arm is extended, and the brand name 'Artis zeego' is visible on its side. The background is a light blue wall with some recessed lighting.

# Artis zeego – The Patient at the Pivotal Point

By Matthias Manych

When treating patients in interventional suites or Hybrid ORs, interventionalists and surgeons require high-precision imaging modalities, ideally with versatile capabilities. Artis zeego, the first C-arm system based on robotic technology, provides a flexible solution for Hybrid OR environments and interventional radiology. It offers 3D imaging comparable to CT, with full mobility around the patient and optimal flexibility at the operating table.

Professor Ulf Teichgräber, MD, Director of the Department of Radiology (IDIR) at Jena University Hospital, Germany, was sceptical – would the angiography deliver useful images this time? It was a routine procedure: an examination of the peripheral arteries of the lower extremity. Yet the patient had contractures, which meant that his leg and foot were bent and turned inwards. “I thought it was going to be a terrible result, but it turned out great,” Teichgräber reports. The reason for his enthusiasm is the Artis zeego with Q Technology, the robotic multi-axis C-arm system that uses the state-of-the-art GIGALIX® X-ray tube and HDR flat-panel detector technology. The radiologist positioned the C-arm via joystick around the patient, and then moved it along his leg with speed and precision, achieving all the essential angulations required for this anatomically complex situation. It was not necessary to move the patient, in spite of his contractures, and Teichgräber needed only one single acquisition. This saved time, radiation dose, and contrast agent, and – more importantly – it saved the patient from the painful task of stretching his leg.

An impressive system both in outward appearance and inner function, the C-arm system was installed at the IDIR in April 2014. Currently, 500 Artis zeego systems are installed around the world; Jena was one of the first places in Germany to use the latest generation of systems, with Q-technology, in its radiology department. The hospital has 1,400 beds in total, and has around 140,000 consultations annually. It is the only university hospital in the state of Thuringia, so its patient referral area is large. “This is why our choice of system was strategic,” says Teichgräber, who believes it is necessary to invest in state-of-the-art technology to ensure a strong regional base and national appeal. It was clear from the start that the hospital was looking for a robotic-assisted system in order to open up new clinical approaches.

As well as faster diagnostics, more precise interventions, and a reduction in radiation exposure, Jena is looking to expand the diagnostic and therapeutic range for vascular and tumor diseases in particular. Teichgräber and his team cover the entire area of interventional radiology at Jena, performing around 1,500 procedures per year. With an increasing number of older patients, much of the work involves diseases in peripheral vessels and interventional oncology. Artis zeego opens up new possibilities for clinical applications, including prostate artery embolization and interventions using carbon dioxide as a contrast agent.

### Greater flexibility, more space

During the planning phases, it was initially thought that the room that was earmarked for the system in the IDIR was too small. The fears were unfounded, however: The multi-axis C-arm system forms a compact unit in the parking position, and gives space for the team and supplies. When the joystick is used to move the C-arm to the patient table, the extent of the system’s flexibility is demonstrated in the five different axes of movement. Whether the patient is lying on their back or on their side, sitting,

or on an inclining table, the flat-panel detector is quickly and accurately positioned to image the relevant structures. For Teichgräber, the benefits are clear: “With Artis zeego, I allow the robotic arm to move along the patient; the patient can stay in the same position, making the entire process faster, better, and more precise.”

In Japan, Tohru Sakuragi, MD, Department for Thoracic and Cardiovascular Surgery, Oosumi Kanoya Hospital, is also impressed by Artis zeego: “The C-arm is elegantly extended. It’s as if a swan had spread its wings. It comes when we need it and goes to where we need it.” During video-assisted thoracoscopic surgeries (VATS), Sakuragi often treats obese patients who have to be positioned on their side during the operation to ensure a safe and successful procedure. The surgeon is convinced: “If we were not using Artis zeego, we couldn’t have turned the patient in lateral position. To be able to take CT-like images of patients in this position during an operation is very revolutionary for us thoracic surgeons.” Safe and variable maneuverability is a huge advantage in Hybrid OR environments in particular. In China, Professor Xiaobai Wang, MD, from the Interventional and Vascular Department, Guangzhou Overseas Chinese Hospital, explains that the robotic C-arm ensures that the laminar airflow is unobstructed, which means that it meets the highest hygiene requirements. At the same time, all medical staff, including the anesthetist, have full access to the patient. This ensures an ergonomic and efficient workflow throughout the entire procedure.

### Optimized 3D visualization

The Artis zeego offers more than flexibility and precision. It can rotate the flat-panel detector around the patient for syngo DynaCT to generate highly detailed cross-sectional images while the intervention is being performed. The result can be viewed by the physician on the monitor in under a minute. The large-volume 3D images generated by syngo DynaCT show soft tissue differentiation, which is required for neuroradiological, abdominal, and oncological interventions. Sakuragi has been using the software for three years, and believes that its capacity to generate CT-comparable images directly at the OR table is one of the system’s most important features.

**Professor Ulf Teichgräber, MD,**  
Director of the Department of Radiology (IDIR),  
Jena University Hospital, Germany





*“With Artis zeego, I allow the robotic arm to move along the patient; the patient can stay in the same position, making the entire process faster, better, and more precise.”*





The Artis zeego  
advantage

*syngo* DynaCT has set the agenda when it comes to one-stop-shop treatment – the combining of diagnostics and therapy in one modality. “It plays a central role in oncological applications, which is where we routinely use *syngo* DynaCT,” Teichgräber explains. The radiologist plans these interventions directly at the table. For example, if he already knows that a patient has hepatocellular carcinoma or liver metastases, Ulf Teichgräber does not need to perform an extra pre-interventional CT scan. With Artis zeego, “we can assess the situation on the table directly,” Teichgräber reports, based on his experience.

Wang emphasizes that the one-stop treatment facilitated by *syngo* DynaCT is hugely advantageous in hybrid operations: With aneurisms, for example, the situation can be assessed immediately before and directly after the intervention. With Large Volume *syngo* DynaCT especially, these procedures are now safer and faster. This new quality grade in CT-comparable imaging optimizes 3D visualizations of the body. The field of view now extends up to 45 cm in diameter and 18.5 cm in height, which covers the entire liver or abdomen, or a long section of the spine column, for example. Prostate artery embolization is a particularly complex procedure due to the incredibly fine vessels that have often been affected by atherosclerosis, the micro-catheter that is used, and the tiny embolization particles. Teichgräber comments on the use of Large Volume *syngo* DynaCT imaging for this purpose: “The spatial resolution is significantly better than what we previously had with a 64-slice CT.” The large 3D volumes are acquired in just six seconds (*syngo* DynaCT 360), which also results in a reduction in the radiation dose and increased patient comfort. Even shorter three-second protocols are possible (*syngo* Dyna3D High-Speed) for high-contrast imaging between the head and the groin, which reduces motion artifacts and makes it easier for patients to hold their breath. Using Q-technology, the Artis zeego has raised its extremely high quality of interventional imaging up another notch. This is the version that Jena University Hospital chose: The C-arm is equipped with a GIGALIX flat emitter X-ray tube and a High Dynamic Range detector. According to Teichgräber, the detectability of very fine structures has increased by up to 70 % in comparison with previous X-ray technology, which is a huge advantage for the pelvic vessels in particular.

### Unique and always at the center of attention – the flexible isocenter

Minimally invasive procedures in interventional radiology are often performed without anesthesia. This can result in situations where a patient’s blood pressure or breathing needs to be supported – problems that can easily be resolved by tilting the table by a few degrees on its lateral axis. The situation is similar in surgical procedures when the surgeon uses the table tilt to shift the organs in the patient’s body or to get the best viewing to the region of interest, while standing comfortable at the table. With conventional C-arm systems, these adjustments would always bring the prearranged structure out of the isocenter since the isocenter is fixed on a horizontal level. As a unique C-arm system, the Artis zeego has a flexible isocenter where the C-arm can adapt to virtually all elevations and angulations of the patient table – bringing ease to these situations: “The flexible isocenter means that the system requires less repositioning and searching – that ends up in less radiation. It is also faster as I require fewer series, fewer positions, and fewer control examinations,” Teichgräber is pleased to report.

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**Matthias Manych**, a biologist, is a freelance scientific journalist, editor, and author specializing in medicine. His work appears primarily in specialized journals, but also in newspapers and online.

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The interplay between the different components in the Artis zeego is proving extremely beneficial for the fields of interventional radiology and surgery. In response to the question as to whether the C-arm increases the likelihood of successfully completing procedures, Teichgräber answers with a resolute “yes”. This is directly related to the improved intra-operative decision-making and examinations. The possibility of merging diagnostics and treatment in the same room at the same time is what makes the Artis zeego pioneering technology, according to Teichgräber. For this it reduces the risk of complications and the rate of follow-up procedures. Smoother workflows with the

robotic-assisted C-arm means not only less pressure on the medical team, but also time savings of 20 – 30 % at Ulf Teichgräber’s department. This translates into a corresponding potential increase in patient numbers.

Artis zeego is already an attraction in Jena. There has been a significant increase in demand for seminars for referring physicians, operators, or companies in the medical industry that are installing the robotic-assisted C-arm. A prostate cancer self-help group with 60 members has also been to visit and was delighted by the angiography system and the treatment options.

# Radiofrequency Ablation for Lung Metastases Supported by *syngo iGuide*

Courtesy of Olivier Pellerin, MD

Department of Cardio-Vascular Radiology, Hôpital Européen Georges Pompidou, Paris, France

## Patient History

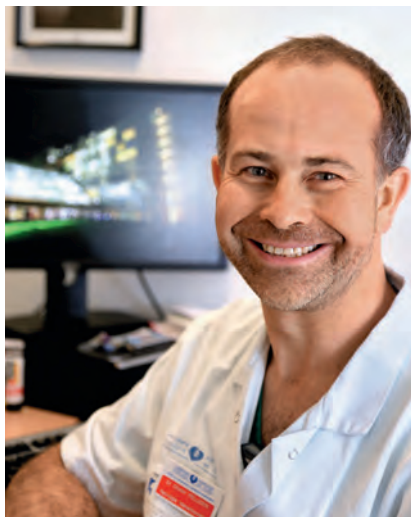
65-year-old male with colorectal cancer diagnosed three years ago. In a stable disease for primary tumor after first line of chemotherapy.

24 months after first-line treatment, the CT scanner showed two metastases (12 mm and 22 mm in diameter) in the left lung. According to the multidisciplinary oncology board the patient underwent two percutaneous ablations in the same session. The ablation was planned with a radiofrequency umbrella ablation probe, and the procedure was performed in the angiography room to allow for better patient access and more space for the general anesthesia. This approach allows easier targeting of a non-motion structure.

## Diagnosis

Two lung metastasis (12 mm and 22 mm) from CRC in left lung.

Olivier Pellerin, MD



## Treatment

Under general anesthesia, patient lying prone with selective intubation using a Carlens tracheal tube. While the right lung is ventilated, the left lung lobe is excluded and remains expanded under mild (2 to 3 cm of water pressure) positive expiration pressure with 100% oxygen.

For procedure planning, *syngo InSpace3D* (5s DR protocol, 133 projections) was performed and used as the basis for needle path planning with *syngo iGuide*® software (Fig. 1). The needle was positioned at the skin entry point in accordance with the planning data using the integrated cross-hair laser light. The Artis system provided two progression views overlaying the planned needle path onto live fluoroscopy for safe needle progression (Fig. 2). A second *syngo InSpace3D* confirmed the correct needle position (Fig. 3). Radiofrequency ablation was performed on the first and then on the second lung nodule following the same workflow.

Final *syngo InSpace3D* confirmed that each ablation area covered the tumor nodule including a safety margin (Fig. 4).

## Comments

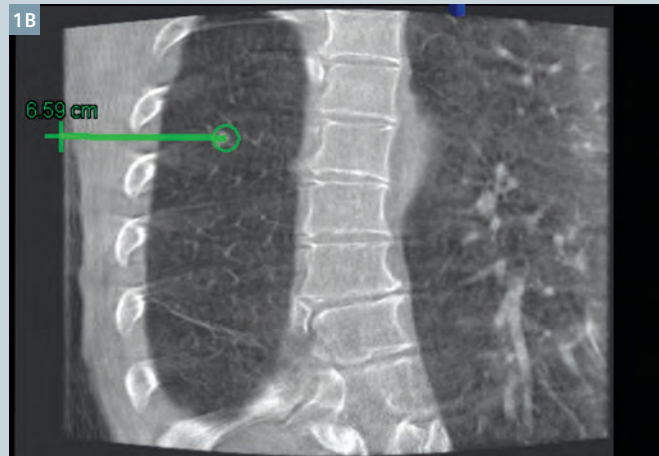
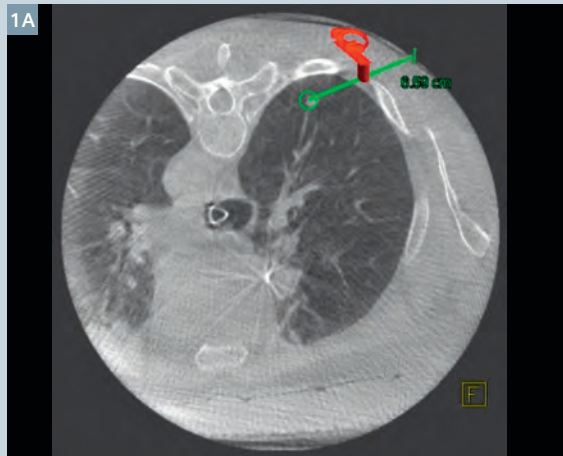
The procedure requires a high level of expertise and the use of C-arm cone beam computer tomography technology. It was possible to show that a 5s DR run provides sufficient image quality for procedure planning, verification of the final needle position, and confirmation of complete ablation, while saving about 66% dose compared with a regular 6s *syngo DynaCT Body*.

Close collaboration with the anesthetic team is a prerequisite for a successful and safe intervention.

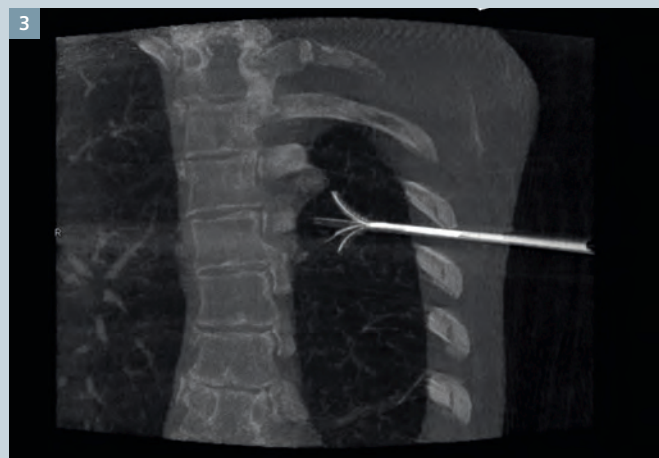
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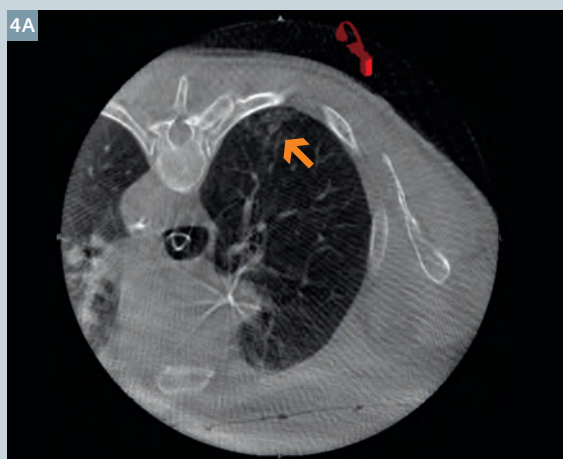


- 1 Needle path planning with *syngo* iGuide done on *syngo* InSpace3D intraprocedural dataset. Oblique axial and coronal views aligned to needle path.



- 2 AP progression view showing successful exact positioning of RFA probe according to planned needle path.

- 3 Confirmation of exact needle positioning using intra-procedural *syngo* InSpace3D. Oblique coronal views aligned to needle path.



- 4 Final *syngo* InSpace3D confirmed each ablation area covered the tumor nodule including a safety margin.

# Angiography Offers Hope for Patients Suffering from Prostate-Related Urinary Disorders

By Chris Kraul

A minimally invasive catheterization technique known as prostatic artery embolization shows promise as an outpatient treatment for patients suffering from increasingly prevalent prostate hyperplasia. Pioneered by a Brazilian radiologist, the procedure began U.S. Food and Drug Administration approved trials this fall in twelve medical centers in the USA and Europe.



Francisco Cesar Carnevale, MD, PhD, known as the pioneer of the prostatic artery embolization (PAE) procedure, has been Chief of Interventional Radiology at University of Sao Paulo Medical School since 2002.

A native of Sao Paulo, he studied medicine at the city's University of Mogi das Cruzes, and subsequently undertook fellowships and research stays at several U.S. institutions including the MD Anderson Cancer Center, the University of California-San Diego, and Beth Israel Deaconess Medical Center – Harvard Medical School, Boston, MA. He returned to the University of Sao Paulo in 1997 to complete a PhD in interventional radiology. He is a co-founder of the Brazilian Society of Interventional Radiology and Endovascular Surgery (SoBRICE). He has published over 50 peer-reviewed articles, as well as 25 book chapters on IR. The second edition of his vital reference book guide, *Radiologia Intervencionista e Cirurgia Endovascular*, originally published in 2006, is pending publication.

# *“By lessening pressure on the urethra and easing the mechanical obstruction of the bladder, PAE enhances quality of life.”*

**Professor Francisco Cesar Carnevale, MD, PhD**

Department of Radiology, Interventional Radiology Section, University of Sao Paulo, Brazil

Uses of interventional catheterization have evolved far beyond the angioplasties that were its original focus. Increasingly versatile catheters, guided with the aid of angiography are competing with surgery to treat cases ranging from liver cancer and brain aneurysms, to uterine fibroids and faulty heart valves. This can save recovery time and costs for patients, while reducing the risk of post-operative complications and after-effects.

A procedure known as Prostatic Artery Embolization (PAE) has now joined angiography's therapeutic array as an option for men who suffer from benign prostatic hyperplasia (BPH), the principle cause of lower urinary tract symptoms experienced to some degree by around half the male population over 60. Symptoms include an increased frequency and urgency of urination, painful burning sensations, and intermittence of urinary stream due to mechanical compression of the urethra.

In simple terms, PAE involves the insertion of a catheter with a diameter of 2 mm at the femoral artery, which is then guided to the two main arteries feeding blood to the prostate gland. Safe catheter navigation is performed

under image guidance using Siemens angiographic equipment. When the catheter is in the correct position, microspheres are injected into the feeding arteries of the prostate in order to block blood flow. This creates an obstruction that can reduce the volume of the prostate by as much as 30–40 percent over the ensuing three months.

The shrinkage of the prostate in turn eases pressure on the urethra, allowing for better urine flow and a reduction in BPH symptoms.

Pioneered by Brazilian interventional radiologist Francisco Cesar Carnevale, a radiology professor at the University of Sao Paulo Medical School, the procedure is performed using Siemens imaging equipment and syngo DynaCT guidance and mapping software as an outpatient alternative for those who might otherwise have to resort to prostatectomies or a resection technique called TURP and laser, all of which require hospitalization.

## **Improved Quality of Life**

PAE is still a comparatively novel technique – approximately 1,000 patients have so far been treated

mainly in Brazil, Portugal, the USA and France. Other centers performing PAE are Italy, Spain, Russia and China. However, urologists and interventional radiologists are enthused by early results that show prostate shrinkage and positive outcomes for quality of life.

“By lessening pressure on the urethra and easing the mechanical obstruction of the bladder, PAE enhances quality of life. And if you have extreme BPH symptoms, life can be miserable. In extreme cases, patients may require permanent catheterization or have to self-catheterize every time they have to urinate,” Carnevale explains. “A common symptom among BPH sufferers is nocturia – waking up several times a night to urinate, which causes loss of sleep and makes you tired at work the next day.”

The bonus for PAE recipients is that they go home the same day and suffer none of the possible TURP-associated side effects such as retrograde ejaculation and temporary incontinence.

The new treatment is entering a critical stage this fall with the launching

*“syngo DynaCT is the most important software for the embolization procedure. It identifies the arteries feeding the prostate, gives me an idea of the percentage of the prostate I am treating, and – even more importantly – helps me avoid non-targeted embolization.”*

**Professor Francisco Cesar Carnevale, MD, PhD**

Department of Radiology, Interventional Radiology Section, University of Sao Paulo, Brazil

of the first large-scale clinical trial under the auspices of the U.S. Food and Drug Administration (FDA). Carnevale will act as principal investigator in the trial. The four-year test will track 186 patients in twelve USA and European hospitals to compare the experience of patients that undergo PAE with those treated with TURP.

#### **The Cost of BPH**

Success in FDA trials could significantly impact BPH protocols. Data from a study in 2005 show that treatment of the condition costs an estimated 3.9 billion U.S. dollars annually and accounts for up to 38 million lost hours of worker productivity. Authors said BPH patients also make 4.4 million medical office appointments and more than 117,000 emergency room visits. More than 105,000 patients are hospitalized in the U.S. each year.

Incidences of highly prevalent BPH is likely to rise in the foreseeable future as the global male population lives longer. Environmental factors including rising obesity, diabetes, and sedentary lifestyles are also fueling increased reporting of enlarged prostates – which is not

necessarily an indicator or precursor of prostate cancer.

#### **Advantages of PAE**

While TURP has been recognized with excellent efficacy in prostate size reduction and symptoms relief, it can also carry the risk of retrograde ejaculation, which means sperm and seminal liquid are ejaculated into the bladder, instead of out through the penis. TURP also requires general, intradural or peridural anesthesia, whereas PAE patients receive only local anesthesia.

#### **Disadvantages of PAE?**

Carnevale explains that the use of angiography means doctors, patients, and medical technicians are exposed to radiation for 30–40 minutes during the two-hour procedure, although Siemens engineers are working to reduce fluoroscopy time and dose based on proprietary Artis low-dose software. Another risk is that some patients' kidneys react poorly to contrast agents used in angiography, which can cause renal failure in rare instances.

It is crucial to occlude both left and right prostatic artery since unilateral embolization can lead to recurrence.

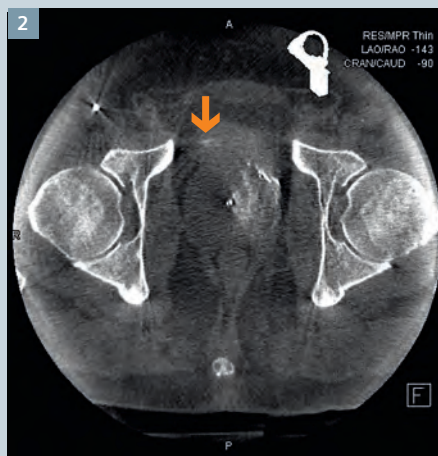
In Sao Paulo, 92 % of the patients are embolized bilaterally. “This is how we define technical success of a PAE procedure.” However bilateral embolization goes along with longer procedure and fluoroscopy times and a higher amount of contrast medium used. “Therefore we need to make use of all available measures to reduce dose for patient and staff. We all use protective goggles and clothing and Siemens CARE+CLEAR to lower the dose. In some interventions we even have performed the procedure with as little as 20–30 minutes fluoroscopy time,” Carnevale said.

#### **Avoiding Non-Targeted Embolization with syngo DynaCT**

Low-dose imaging is one of the many advantages that derive from working with Siemens, according to Carnevale. Others include after-sales consultation and engineering, image clarity, and user friendly syngo DynaCT software.

“syngo DynaCT is the most important software for the embolization procedure because it identifies the arteries feeding the prostate. It can guide you to where you have to go with the microcatheter. While I’m working, it also gives me an idea of the percent-





- 1 Digital subtraction arteriogram (DSA) with the microcatheter positioned into the left inferior vesical artery (left ipsilateral oblique perspective) previously to the left lobe prostate embolization. Note the opacification of the left intraprostatic branches. Procedure performed using the Artis zeego.
- 2 syngo DynaCT with reduced dose acquired before embolization of left prostatic lobe shows risk of non-target embolization of bladder wall (arrow). In addition, only partial left prostate enhancement is observed indicating either additional prostatic feeder or catheter position being too distal.

age of the prostate I am treating," Carnevale said. "Even more importantly, it helps me avoid non-targeted embolization – the areas I don't want to affect – because with syngo DynaCT, we can identify the arteries feeding the non-targeted organs."

The idea for PAE came to Carnevale in 2006 after he had read an article in a medical journal about doctors who used embolization to stop a patient's persistent BPH-related prostate bleeding. In a one-year follow-up of this case, the doctors noticed that in addition to a stop to the bleeding, the embolization caused a reduction in prostate size and an improvement in his quality of life by easing urinary tract symptoms.

"It was just an observation, but we thought, why not look at prostate embolization as a therapy for BPH," Carnevale said. Fortunately, he was invited and moved to Harvard University in 2007 on a research grant and was able to test the theory by embolizing animals with that group. They injected resin microspheres into the prostate arteries of six dogs and one month later, saw that the dogs' prostate glands had shrunk by 40 percent. He then knew he was on to something.

### FDA study launched

Since Carnevale administered the first PAE procedure in 2008 at the University of Sao Paulo Medical School, the use of the technique has slowly grown. In recent years, he helped set up training centers in Paris, Zaragoza and Milan. He has trained close to 30 interventional radiologists in the procedure. Recently, he went to Mount Sinai and Johns Hopkins, both in the USA, where he launched the FDA trial by treating the first of 186 patients in the test population.

"The fact that we have developed this technique and are pioneers in training doctors on several continents in its use is adding to Brazil's medical prestige," Carnevale said, who is aware of the economic condition in health care in his country. And he finalizes "this is very important for our department, our university and our country."

A former foreign correspondent for the Los Angeles Times, **Chris Kraul** is a Bogota-based freelance writer who specializes in economics, healthcare, and the environment.

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# The Benefits of PAE over TURP: “Fewer Minor and Major Complications”

**Marc Sapoval, MD, PhD, Head of the Vascular and Oncological Interventional Radiology Department at the Hôpital Européen Georges Pompidou in Paris, France, and Olivier Pellerin, MD, Deputy Head of Interventional Radiology talk about the practical aspects of prostate artery embolization (PAE) to treat benign prostatic hyperplasia (BPH).**



Marc Sapoval, MD, PhD, is Professor of Clinical Radiology and Chair of the Vascular and Oncological Interventional Radiology Department at Hôpital Européen Georges Pompidou in Paris, France. He is co-founder and course director of the Global Embolization Symposium and Technologies (GEST). He also served as 2008 – 2009 Program Chairman for the Cardiovascular and Interventional Radiological Society of Europe. Holder of a PhD as well as an MD, Marc Sapoval is an expert in the area of renal disease.



Olivier Pellerin, MD, is Assistant Professor of Clinical Radiology at Hôpital Européen Georges Pompidou in Paris. He was a visiting research radiologist at Johns Hopkins University in 2011 – 2012 and has authored or co-authored more than 30 peer-reviewed publications. Since 2013, Marc Sapoval and Olivier Pellerin have trained more than 30 radiologists from several countries in the PAE technique.

**What are the complexities and risks of PAE?**

**Sapoval:** PAE is a complex procedure. The target arteries are small and difficult to access and there are a lot of anastomoses and tiny vessels that go to the bladder, rectum and penis that you don't want to embolize. In PAE you need to be 100% sure to block the appropriate artery.

**Please describe the optimal patient for PAE.**

**Sapoval:** PAE is particularly suitable for relatively young patients – say less than 70 – as they are easier to catheterize. Patients with large prostates around 80 g benefit the most from the treatment. It's also an eligible treatment option for patients who are afraid of or don't qualify for surgical therapy. We would not treat patients at risk or with suspected cancer.

**What is the workflow for PAE treatment?**

**Sapoval:** Patients are referred to us by urologists and sometimes directly through various communication pathways. In this case we send the patient to the urologist in order to allow multi-disciplinary assessment. In the pre-procedure phase we as a board of specialists all come together to collate all the pertinent information including scores like PSA (prostate-specific antigen), urinary flow max, IPSS (International Prostate Symptom Score) and QoL (Quality of Life) as well as imaging information such as MR, MRA, and echographs of the prostate. We discuss treatment with the patient and staff and make sure the case is suitable for PAE. We explain that we have a success rate of between 80 and 90 percent and that we've never had major complications.

When preparing the patient for the intervention, we place a foley catheter in the bladder that we use as additional landmark during the procedure. For assessing the vascular anatomy of the pelvic region, we acquire a syngo DynaCT at the very start of the procedure. We study this dataset thoroughly to understand the vascular supply of the prostate and neighboring organs such as bladder, rectum and penis. And we use it for access path planning using syngo Embolization Guidance. The planning data is overlaid on live fluoroscopy to guide us in catheter navigation.

After having positioned the micro-catheter according to the planning, we perform another DynaCT. It visualizes which portion of the prostate will be affected by embolization from this catheter position, but it also reveals potential areas of non-target embolization. When we see the catheter position is safe and ensures embolization of left or right prostate portion, we slowly inject microspheres until stasis is reached.

#### **How much training is required to perform the procedure and why is it essential?**

**Sapoval:** You need to have an in depth understanding of the anatomy and the potential complications. You also need to learn imaging skills to get the necessary confidence to begin performing PAE. First, interested doctors go to conferences and expert meetings. Then, they can come to our institution for two days in groups of five or six. They are exposed to lectures and previous case studies, and they observe at least three live cases to see how the procedure is performed with all the difficulties and problems. Later, we go to their medical centers to follow up. So far we have taught the procedure to about 30 people since 2013.

#### **How important is Siemens technology to the success of PAE?**

**Sapoval:** PAE is still a new technique and Siemens knows PAE is challenging technically. Therefore Siemens has developed several imaging tools that help us do the procedure with more confidence, and we are working with Siemens engineers to refine the tech-

nological support and make it easier and safer.

Most important software applications today are syngo DynaCT, providing intraprocedural CT-like crosssectional imaging, and syngo Embolization Guidance for access path planning.

#### **Can you discuss the various Siemens PAE software applications and how they help?**

**Pellerin:** syngo DynaCT serves two main purposes during the procedure. First, it allows us to assess the vascular anatomy and define target vessel(s) in the beginning of the intervention. Second – and even more important esp. in PAE – it is a crucial intraprocedural tool to confirm safe catheter position for embolization, avoiding non-target embolization.

In the context of the very complex pelvic vessel anatomy, access path planning and guidance during catheter navigation is a very much desired support functionality. This is where syngo Embolization Guidance comes into play as a navigation tool to the prostate. It helps speed up the procedure and thereby facilitates reduction of fluoroscopy time and contrast material.

And there is the exciting possibility of assessing the functionality of tissue using syngo DynaPBV Body. This software can help you quantify the reduction in blood volume in the prostate due to PAE by making comparisons of the blood volume maps from before and after the procedure. We hope in the future it will prove to be predictive and well correlated with results, but we still need further mid-term clinical studies to provide evidence.

#### **Is dose reduction an important factor in PAE?**

**Sapoval:** It's the way we have to work as we stand every day in the Angio lab and for the patient, this is a very dose sensitive area of the body.

**Pellerin:** The PAE procedure is still quite long, at least one and a half hours, but we apply radiation only while we are manipulating the

catheter and embolizing the target. That adds up to about 40 minutes of radiation. However, we are just in the initial phase, and intervention time and radiation dose will decrease with experience. Moreover, through our collaboration with Siemens, we will find technical ways to reduce dose in addition to the already existing wide range of CARE options that come with each Artis system.

If patient size allows, we apply low-dose fluoroscopy at very low framerates. And we constantly use the DynaCT Body Care protocol – a dedicated cone-beam CT that saves more than 30% of dose compared to standard DynaCT.

If anatomy allows, we even collimate our DynaCTs cranial/caudally to expose the patient and ourselves to as little dose as possible. Due to the fact that we are working in a region with extremely small and fragile vessels most DynaCTs are done with manual injection which requires us to stand table-side during the rotational angiography. And as mentioned before, the use of navigation tools reduces fluoroscopy time and therefore overall dose.

#### **Based on the experiences you gained so far – Are all signs for PAE being an effective treatment of BPH positive?**

**Sapoval:** It's too soon to measure the complications in a really large number of medical centers. And we don't have the answers to long-term questions such as relapse rate because the procedure is too new. But the basic message so far is that with PAE you have the same results as with TURP but with fewer minor and major complications, especially sexual dysfunction. That's why it's important for us that Siemens is really focused on understanding what we need to improve our results and our safety in specific clinical situations.

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# Benign Prostatic Hyperplasia Supported by syngo DynaCT

Professor Marc Sapoval, MD, PhD

Department of Vascular and Oncological Interventional Radiology, Hôpital Européen Georges Pompidou, Paris, France

## Patient History

A 66-year-old male with benign prostatic hyperplasia (BPH). Received drug treatment (alpha blockers and 5 alpha reductase inhibitors) for one year. Symptoms worsened gradually to the point where the patient needed invasive treatment due to a major dysuria. Patient rejected transurethral resection of the prostate (TURP) because he was afraid of potential side effects such as urinary incontinence or impact on sexual life. Patient was referred to interventional radiology for prostatic artery embolization after multidisciplinary discussion.

## Diagnosis

Prostate volume: 60g, Prostate-specific Antigen (PSA): 0.85, International Prostate Symptom Score (IPSS): 13; Quality of Life (QoL): 4; Flow Max 5ml/s

## Treatment

Bilateral prostatic artery embolization using 300–500 µm Embospheres® (Merit Medical). Homogeneous solution of 2 cc spheres combined with 10 cc contrast agent and 10 cc saline. Fathom™ .014" steerable microwire (Boston Scientific) and 2 Fr Progreat® Microcatheter (Terumo).

Assessment of prostate in pre-interventional MRI for identification of central gland and transitional/peripheral zone before intervention.

Foley catheter filled with contrast medium and saline placed and used as basic landmark in 2D imaging.

syngo DynaCT imaging when catheter in left/right iliac artery for assessment of 3D vessel tree and identification of prostatic arteries using access path planning software syngo Embolization Guidance (Fig. 1A, 1B).

syngo DynaCT with reduced dose (5s syngo DynaCT Body CARE protocol, 248 projections) with hand injection of diluted contrast agent via catheter in right prostatic artery to exclude non-target embolization (Fig. 3A, 3B). This CBCT was acquired with the angiography system on the left side of the table to reach pelvic area also in taller patients.

Successful superselective embolization with very slow injection into right and left prostatic artery until stasis was reached.

## Comments

The procedure requires a thorough understanding of the vascular anatomy and use of CBCT technology to exclude non-target embolization. It was possible to show that a 5s syngo DynaCT Body CARE run provides sufficient image quality to confirm safe catheter position, while saving about 37% dose compared with a regular 6s syngo DynaCT Body.

Injection of diluted contrast is mandatory to obtain optimal syngo DynaCT imaging.

With cranial/caudal collimation during syngo DynaCT acquisitions, dose can be reduced while image quality improves even further due to less scatter radiation.

syngo Embolization Guidance for faster navigation to the target vessel saves contrast media, shortens fluoroscopy time, and enables dose reduction (Fig. 2).

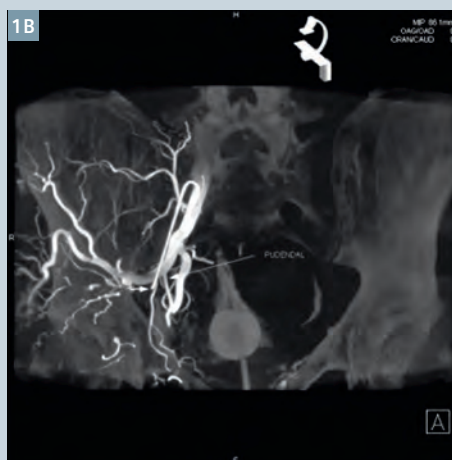
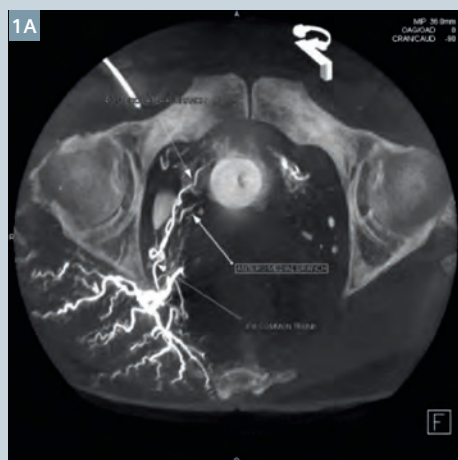
Professor Marc Sapoval, MD, PhD



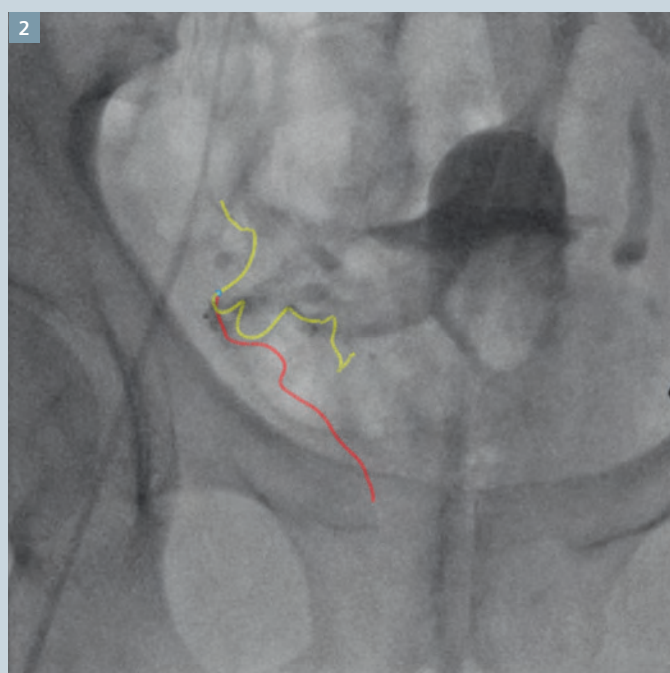
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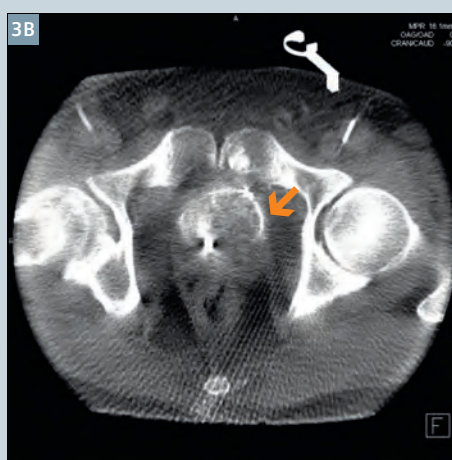
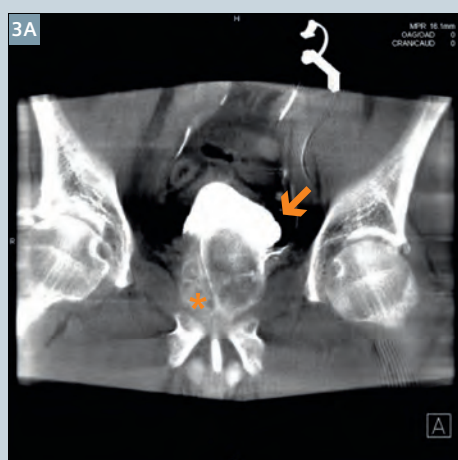




- 1 Axial and coronal views can help to identify the prostate artery feeders. Here, an antero-medial and postero-medial branch are visible.



- 2 Store fluoro showing overlay of syngo Embolization Guidance centerlines (yellow line represents the anterosuperior branch to the right prostatic artery).



- 3 A syngo DynaCT (5s syngo DynaCT Body CARE protocol, 248 projections) is performed before starting the embolization. It confirms the safe catheter position into the prostate artery away from non-target arteries (rectal/vesical branches). Coronal and axial view with arterial contrast media injection show a right lobe contrast staining (\*), without vesical or rectal wall enhancement. Arrows point to contrast agent in the bladder.

# Treatment of Multifocal Hepatocellular Carcinoma Supported by *syngo* DynaPBV Body

Courtesy of David Liu, MD, Darren Klass, MD, PhD, and Marie Punzalan, CCRP

University of British Columbia, Department of Radiology, Vancouver General Hospital, Canada

## Patient History

64-year-old male patient with hepatitis B and multifocal hepatocellular carcinoma throughout both lobes of the liver. Previously underwent conventional transarterial chemoembolization (TACE), with progressive disease.

## Diagnosis

Multifocal hepatocellular carcinoma

## Treatment

Previous left lobar administration one month earlier, now presents for sequential right lobar administration. Therefore treatment with selective internal radiation therapy (SIRT Y90 Theraspheres) was performed.

## Comments

The parenchymal blood volume acquisition provides information on vascularity in tissue, which is an information that was up to now not available in the angio room. The knowledge gained regarding blood volume in a tumor may help predict embolic loads in a tumor, preferential uptake of therapeutics including transarterial chemotherapy, SIRT and chemoinfusions.

## Protocol

5s DSA scan (4x4 binning), 6 s X-ray delay. Injection: 4 cc/s, 50% dilution, total volume 44 cc (11 s injection duration).

*"The parenchymal blood volume imaging demonstrated an overall decrease in tumor perfusion following the administration of Y90 microspheres. The treatment is thought to be non-embolic, however the perfusion is clearly altered in the tumor. This may have implications for the efficacy of the radiation, given the global decrease in oxygenation of the tissue. Our ongoing research aims to address the perfusion through tumors both pre and post embolotherapy and selective internal radiation therapy. Our aim is to understand intratumoral tissue perfusion more and hopefully improve outcomes with these therapies."*

David Liu, MD



Darren Klass, MD, PhD



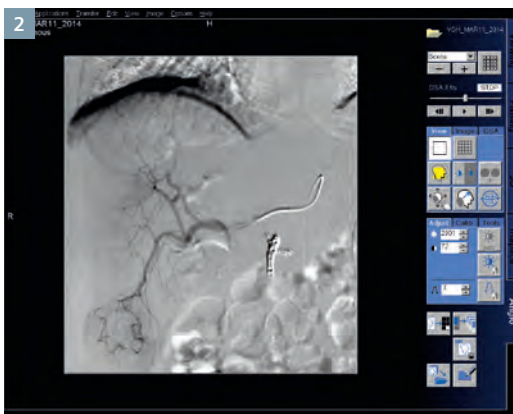
Darren Klass, MD, PhD,  
University of British Columbia,  
Department of Radiology,  
Vancouver General Hospital, Canada

## Contact

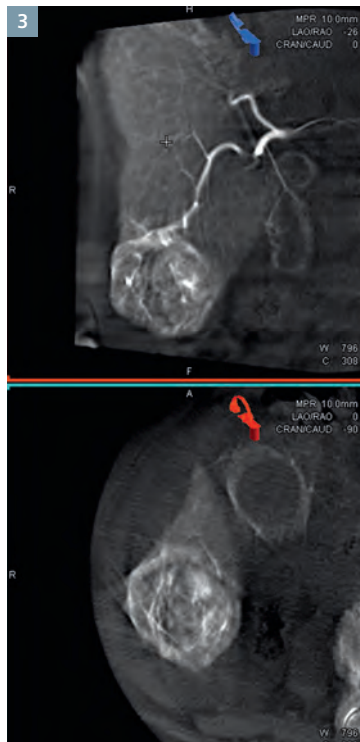
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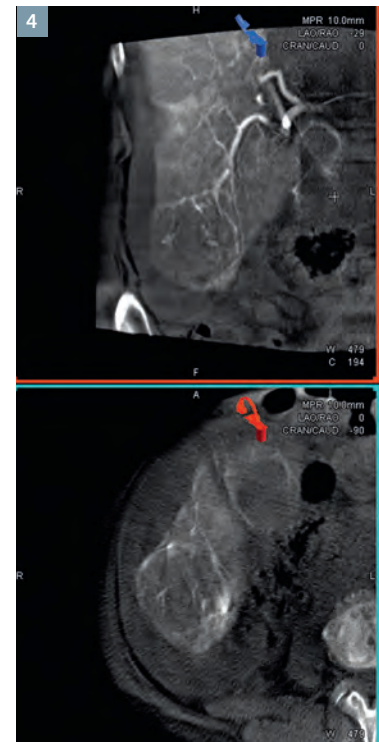
1 Pre Y90, 2D DSA



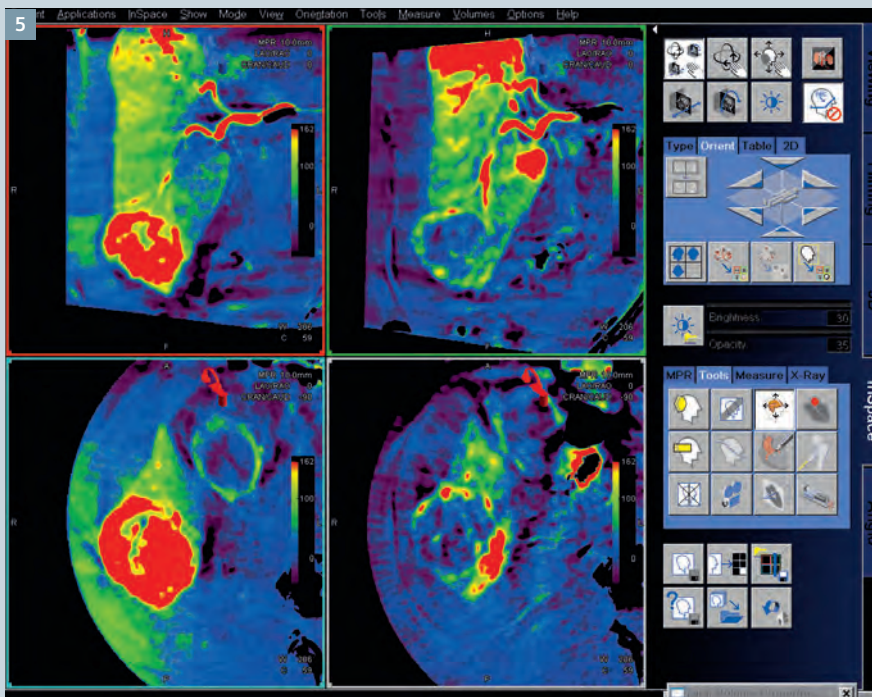
2 Post Y90, 2D DSA



3 Pre Y90 native reconstruction of the fill run from syngo DynaPBV Body acquisition – coronal (top) and axial (bottom)



4 Post Y90 native reconstruction of the fill run from syngo DynaPBV Body acquisition – coronal (top) and axial (bottom)



5 Pre (left) and post (right) Y90, coronal (top) and axial (bottom) views



# How MIYABI Angio-CT, syngo DynaCT and syngo Embolization Guidance Play Together at Hokkaido University Hospital

Hokkaido University Hospital is located on vast, lush grounds at the heart of Sapporo City, Japan. As well as contributing to advanced local medical care supported by state-of-the-art equipment and developing new treatment methods, this hospital has also been designated as a core clinical research and pediatric oncology center. Doctors working at the forefront of the clinical use of the MIYABI Angio-CT solution report here on their experience.

**Please explain how the MIYABI Angio-CT is used at your institution.**

**Yusuke Sakuhara, MD:** We already had a combined Angio-CT solution. Since we have so many cases of hepatocellular carcinoma (HCC) and several complex disease scenarios that need to be treated by intervention with CT fluoroscopy, a decision was made to boost our efficiency by acquiring another computed tomography scanner for dedicated use in the angiography room.

**Daisuke Abo, MD:** There are always some cases that cannot be addressed with an angiography system alone, so the MIYABI solution which combines an angiography system with the high performance of a multidetector computed tomography (MDCT) was essential for our needs.

**Hiroshi Arai, Chief Technician:** During negotiations with our administrative department, we discussed whether we needed a CT or if syngo DynaCT would be sufficient. In the end, after considering clinical requirements and the performance scope of the multislice CT, a decision

was taken to acquire a solution with both angiography and CT imaging functions.

**Shunichi Ueda, Deputy Chief Technician:** The vascular imaging room is narrow (55 m<sup>2</sup>) and so a general straight configuration was not possible. However, Siemens proposed a solution similar to that for the previous MIYABI: The sliding gantry rails could be installed via a 90-degree rotation. After that, the installation became relatively smooth.

**Which types of examination is MIYABI Angio-CT particularly useful for and how often are examinations performed?**

**Ueda:** We examine 180 cases per year with the combined solution. Procedures where only confirmation of the puncture position is required are often performed under CT guidance only.

**Sakuhara:** MIYABI is particularly useful in blood flow diagnosis of the hepatocellular carcinoma (HCC). Recently, the diagnostic imaging capability of MRI for hepatocellular carcinoma and liver tumors has improved and the importance of CT

(CTAP, CTHA) is no longer as great as it was. However, sometimes evaluation of arterial blood flow using Dynamic CT and MRI is not enough, so CT angiography is still useful. When performing a CT of the hepatic artery (CTHA) before TACE treatment, the targets for embolization can be set more accurately.

**Abo:** I think the strength of the MIYABI solution is the combination of CT and angiography for qualitative evaluations. Although, DynaCT imaging can substitute MIYABI Angio-CT in certain cases, the superiority of the combined approach is undisputed. Now, thanks to the installation of the 64-slice SOMATOM® Definition AS with the MIYABI suite, many more patients can also be treated.

**In addition to treating HCC, which other clinical applications are possible?**

**Abo:** MIYABI Angio-CT is helpful in placing therapeutic markers. We generally use echo for punctures if there is a lack of confidence in the three-dimensional relationship of the position. On a CT image, the relationship between the lesion and the marker can be seen immediately. This means that unnecessary punctures can be avoided and any potential complications can also be identified from the image.

**Sakuhara:** In complex drainages the operation is performed under fluoroscopic guidance of the angiography equipment. And to confirm the position we use the CT – this increases accuracy. When the drainage catheter



*“The greatest advantage of the combined solution is its accurate diagnosis of arterial blood flow.”*

**Yusuke Sakuhara, MD,**  
Department of Diagnostic and Interventional Radiology,  
Hokkaido University Hospital,  
Sapporo, Japan



Daisuke Abo, Yusuke Sakuhara, Hiroshi Arai, Shunichi Ueda and team in front of their MIYABI Angio-CT solution (Artis zee ceiling + SOMATOM Definition AS).

## Contact

[andrea.beulcke@siemens.com](mailto:andrea.beulcke@siemens.com)

is inserted under CT guidance and we switch to the angiography system the patient can stay on the same table as the CT is placed in the angiography suite. Thus movement of the puncture needle and wires can be avoided.

### How does syngo Embolization Guidance support your work?

**Abo:** syngo Embolization Guidance shows the 3D relationship between tumors and the arteries connected to the tumors and also shows correspondence with the X-ray fluoroscopic image in an easily accessible way. The very fine feeding artery can also be tracked with a high degree of accuracy.

Before we had this new software, there were cases where the artery feeding the tumor could not be identified and so treatment was abandoned. These cases have also decreased.

**Sakuhara:** The movement of the C-arm can be tracked. If we do a vessel overlay this allows us to easily identify which blood vessel was entered before and after it. Overall, the amount of contrast agent used and the duration of the fluoroscopy have decreased markedly.

### In the future, how do you think syngo Embolization Guidance should be used?

**Sakuhara:** In the treatment of uterine artery embolization, identification of the bifurcation section of the uterine artery is difficult, which means that fluoroscopy tends to take longer. I think that if the DynaCT exposure is

reduced to a minimum level, it could be used when imaging the pelvic area. I also think it would be valuable to test TAE of the kidney and the prostate.

**Abo:** I would also like to use it in the bladder artery.

### How is the operability of the combined solution?

**Ueda:** The CT and the angiography have the same syngo user interface, so it can be mastered swiftly – even by newly deployed technicians. The rails of the sliding CT are also flat, so they can be kept clean easily.

### How do you see the future for MIYABI Angio-CT solutions?

**Sakuhara:** I think that improvements in the grey-scale resolution ability of syngo DynaCT, a decrease in artifacts, and an expansion of the field of view will decrease the differences between the two modalities. The greatest advantage of the combined solution is its accurate diagnosis of arterial blood flow. There are many instances where syngo DynaCT is not sufficient, for example, for diagnosis of the blood flow to organs and tumors.

**Abo:** Transarterial and transvascular diagnosis of blood flow require the high temporal resolution of MDCT to understand the pathology of the condition. In my opinion, MIYABI Angio-CT offers the best performance for treating our patients at the present time of development.

MIYABI Angio-CT is a customized solution and not commercially available in all countries. Due to regulatory reasons the future availability cannot be guaranteed. Please contact your local Siemens organization for further details.



Hiroshi Arai,  
Chief Technician



Shunichi Ueda,  
Deputy Chief Technician



*“MIYABI Angio-CT offers the best performance for treating our patients at the present time of development.”*

**Daisuke Abo, MD,**  
Department of Diagnostic and Interventional Radiology,  
Hokkaido University Hospital,  
Sapporo, Japan

# Verification of Portal Vein Patency before TIPS Procedure Supported by *syngo* DynaCT 360 with Intravenous Injection

Courtesy of Professor Ulf Teichgräber, MD, and PD René Aschenbach, MD

Department of Diagnostic and Interventional Radiology, Jena University Hospital, Germany

## Patient History

A 48-year-old female patient with liver cirrhosis due to history of alcohol abuse.

## Diagnosis

Recurrent ascites and portal hypertension. The patient was referred for TIPS procedure.

## Treatment

The patient was admitted and scheduled for a TIPS (transjugular intrahepatic portosystemic shunt) procedure. A dual phase CTA, acquired with a Multislice CT, is usually performed as part of patient evaluation prior to this procedure in order to evaluate portal vein patency. However, such pre-procedural information was not available for this patient. Ultrasound imaging provided suboptimal results due to the patient's ascites and additional information was still required. To prevent a time-consuming transfer to the CT scanner and, as a consequence, a delay to the scheduled procedure, a "one-stop-shop" workflow

was used for this patient:

A *syngo* DynaCT 360 run with an intravenous injection was performed to evaluate the portal vein patency prior to jugular vein puncture. The *syngo* DynaCT images were immediately evaluated and the portal vein was prominent. Liver veins were clearly visible as well and the TIPS procedure could be performed as planned.

## Protocol

6s DCT360

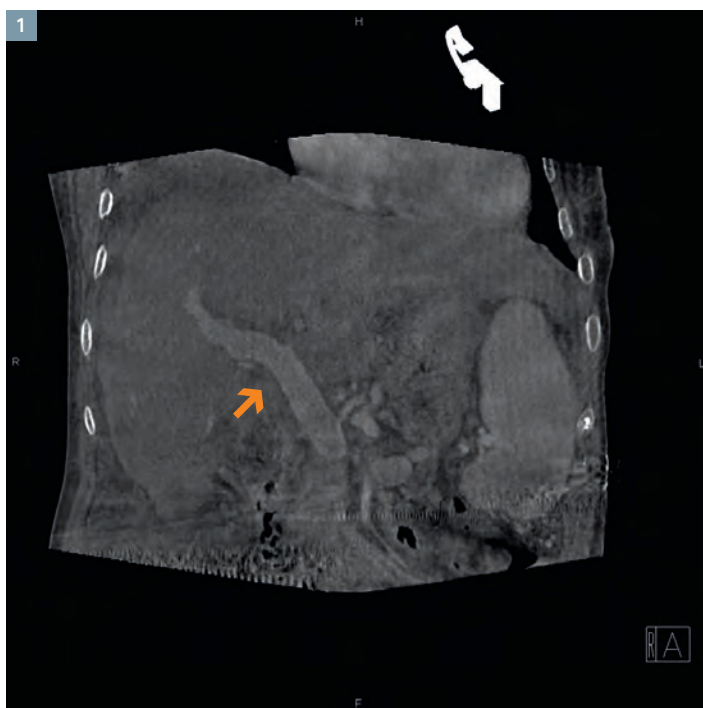
PD René Aschenbach, MD,  
in front of the Artis zeego at Jena University Hospital.



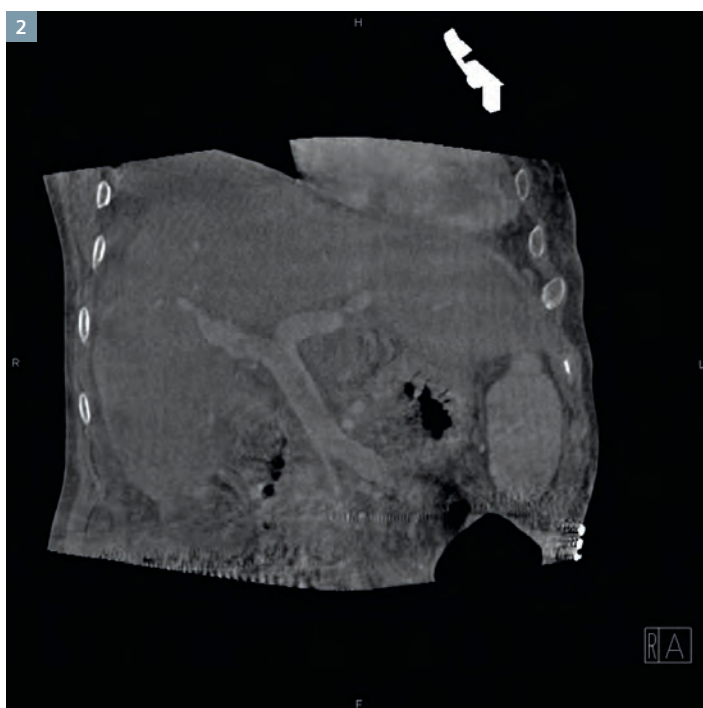
## Contact

[hadas.zadikario@siemens.com](mailto:hadas.zadikario@siemens.com)





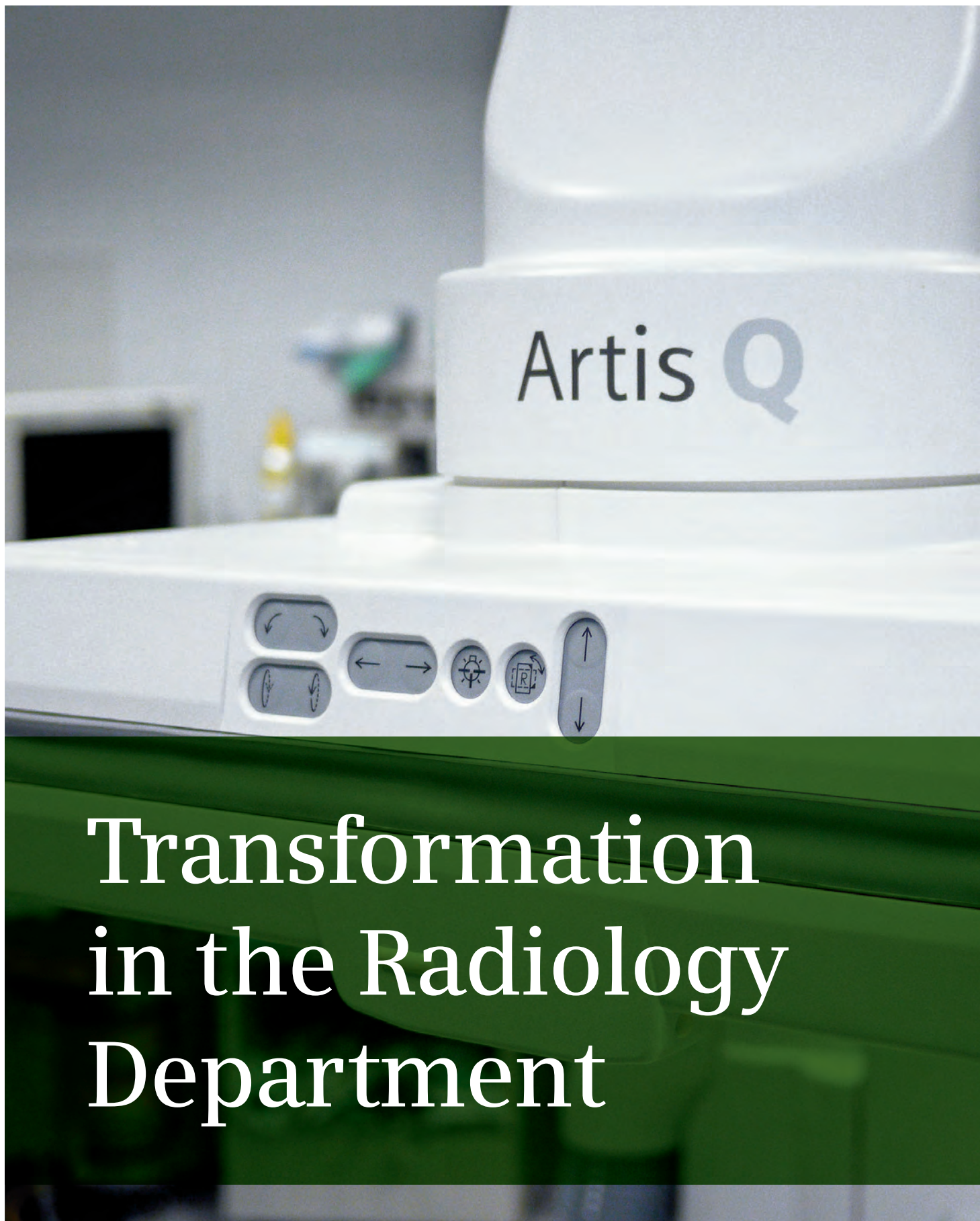
1 The syngo DynaCT reconstruction (MPR thin visualization) showing the portal vein from a coronal view. Portal vein is patent.



2 MPR thin – coronal view of the left and right portal.



3 MPR thin – axial view of the right portal vein.



# Transformation in the Radiology Department

**The Department of Radiology at University College Hospital in Galway was the first to install Artis Q in Ireland. Since November 2013, the ceiling configuration of the Artis Q has not only been changing established interventional procedures, but has also influenced overall clinical workflow at the institution by shifting CT-guided procedures to Artis Q in the angiography suite.**

University College Hospital in Galway is a busy district hospital with 600 beds. Six to eight major interventional procedures are performed per day in the Department of Radiology, along with multiple other smaller procedures. The department covers routine procedures, such as biopsies or radiofrequency ablations, as well as advanced interventions, like thrombectomy or stenting. Consultant radiologist Gerard O'Sullivan, MD, specializes in iliac venous recanalization, deep venous thrombosis treatment, and tumor ablation. Since the installation of the Artis Q, O'Sullivan has been excited about the new possibilities. "The Artis Q system is a huge advantage: The image quality is far superior and the dose is much lower – a fraction of the previous system that we had."

#### **CT-like 3D image quality in the angio suite**

In Galway, O'Sullivan performs five to six biopsies per week on average, three of which were CT-guided in the past. He notes, "The Artis Q has essentially replaced the need to go to CT. Previously, I did three CT biopsies per week. Since the installation of Artis Q, I have been to the CT department once in nine months." According to O'Sullivan, the main features driving this workflow transformation are the syngo DynaCT capabilities in combina-

tion with the syngo iGuide software. "It has completely transformed our department," said O'Sullivan. Since the installation of the Artis Q, the CT scanner is now available all day for diagnostic scans, rather than being blocked for 2 hours of radiofrequency ablations. "This has a significant impact on departmental efficiency and, ultimately, on our bottom line".

#### **syngo DynaCT and syngo iGuide – from CT to the angio suite**

Reliable needle guidance requires a high-quality, 3D CT-like dataset. The Artis Q ceiling configuration excels in this regard, as it enables syngo DynaCT to run from the left and the right side of the table. It further features a unique hardware combination that allows for unprecedented soft tissue visualization in 3D studies: The GIGALIX X-ray tube provides the highest spatial resolution for a clear delineation of the smallest vessels. The large high dynamic range (HDR) detector together with the dedicated imaging pipeline enable true 16-bit sampling for CT-like, low contrast resolution. O'Sullivan reports that, particularly in the area of tumor ablation, Artis Q has been exceptional. "It means that I can stay in the fluoroscopy suite for almost all cases and do not have to break to go to do cases in CT."

*"Previously, I did three CT biopsies per week. Since the installation of Artis Q, I have been to the CT department once in nine months."*

**Gerard O'Sullivan, MD**

Interventional Radiologist,  
University College Hospital, Galway, Ireland





*“Artis Q has made a huge difference to our department. In fact, I would like to have a second Artis Q system to improve our efficiency even further.”*

Clare Roche, MD

Clinical Lead,  
University College Hospital, Galway, Ireland



#### Optimal patient access with syngo iGuide

According to O’Sullivan, the major advantage of syngo iGuide is being able to perform biopsies and ablations in difficult to reach lesions such as the adrenal gland. When using CT, misplacement of the probe may lead to complications. In the interventional lab, it is much easier to change the angle of entry and position the needle more accurately. syngo iGuide clearly displays the length and angulation of the needle path and automatically positions the C-arm. The laser crosshair projected onto the skin enhances needle guidance by indicating the entry point as well as the angle of the needle at no additional dose. This helps position the needle more comfortably and precisely. O’Sullivan explains, “syngo iGuide and Artis Q help me to get a safer result in much less time and at a lower dose.”

Regarding future developments, the treatment of benign prostate hyperplasia with prostate artery embolization is of great interest to Gerard O’Sullivan. Here, he expects the software syngo Embolization Guidance to be especially beneficial. His department is in the process of hiring new clinicians who will, among other procedures, specialize in this new and interesting field. In terms of his experience of Artis Q, O’Sullivan summarizes, “It’s been a huge change for the good.”

#### Improving interventional service efficiency

At University Hospital in Galway, Clare Roche, MD, is the Administrative and Clinical Lead for the Department of Radiology. Since the installation of Artis Q in 2013, she has observed a positive impact on the Department of Radiology as a whole: “The new system increased patient throughput. Patients no longer need to have their inter-

*“The biggest advantage of Artis Q is its ability to take patients from the CT to the angio lab and perform formerly CT-guided procedures with syngo DynaCT and syngo iGuide.”*

Gerard O’Sullivan, MD

Interventional Radiologist, University College Hospital, Galway, Ireland



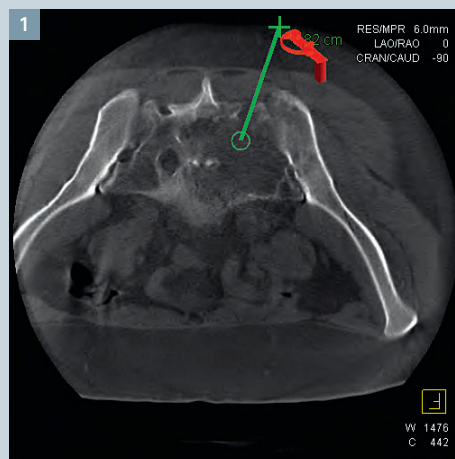
O'Sullivan, MD, during the treatment of deep-vein thrombosis.

## *“It has completely transformed our department.”*

ventional procedure performed in the CT department; instead they can now be performed in the interventional suite using Artis Q. That frees up space in the CT for diagnostic cases. We are saving 20 slots per month.”

Interventional service can now be concentrated in the interventional area. Patients benefit from dedicated nursing and radiographic staff. According to Roche, Artis Q also helps to cut cost on a per-procedure basis: “We are constantly trying to reduce our costs and improve the quality of the service we provide. We have found that the amount of intravenous contrast has been reduced due to shorter procedures and new organ protocols. We now tend to use less contrast per case than before.”

“The Artis Q has made a huge difference to our department. In fact, I would like to have a second Artis Q system to improve our efficiency even further.”



1 Bone biopsy in sacral osteolytic lesion facilitated by syngo iGuide.

### Further Information

[www.siemens.com/artis-q](http://www.siemens.com/artis-q)

### Contact

[philip.stenner@siemens.com](mailto:philip.stenner@siemens.com)

# Treatment of Right Renal Artery Stenosis Supported by syngo DynaCT and syngo InSpace 3D/3D Fusion

Courtesy of Glen Schlaphoff, MD, Interventional Radiologist,  
and Tracy Cordes, Senior Interventional Radiographer

Department of Interventional Radiology, Liverpool Hospital, NSW, Australia

## Patient History

Patient has a complex vascular history with an AAA repaired using an endovascular stent graft (May 2011). Complete occlusion of the right common iliac artery was present. The stent graft extends to the left common iliac artery with a femoral-femoral crossover graft supplying the right lower limb. In May 2013, the patient had a renal duplex doppler study suggesting a critical stenosis at the origin of the right renal artery with the left renal artery noted to be occluded. Renal function was noted as having deteriorated. At the time of EVAR, there was 50% stenosis at origin of right renal artery.

## Diagnosis

Critical stenosis of the right renal artery with total occlusion of the left renal artery.

## Treatment

The procedure was planned with the goal of minimizing the use of iodinated contrast media.

In performing syngo InSpace 3D/3D Fusion, the novel idea of using an old CT scan from 2011 was used. This obviated the need to repeat CTA scan at the time of the procedure, also minimizing potential iodinated contrast use and patient radiation dose.

Under ultrasound guidance, the graft was punctured in the common femoral artery on the left and a 7F sheath inserted. A 7F guiding sheath was then advanced to the origin of the right renal artery via a 0.035 inch GLIDEWIRE®.

syngo InSpace 3D/3D Fusion allowed for optimal prediction of the correct working angle without requiring DSA for planning.

A single DSA acquisition with half-strength contrast demonstrated a critical stenosis at the origin of the right renal artery and confirmed the optimal working angle. At this acquisition angle, using the double wire technique, a 0.014 in Spartacore guide wire was advanced into the right renal artery.

A 7 mm x 18 mm Herculink balloon mounted stent was then placed accurately at the origin.

The post-stent limited DSA acquisition demonstrated accurate stent placement and no residual stenosis.

A total of 10 cc iodinated contrast was used for the entire procedure.

The access site was closed using an angioseal under ultrasound guidance.

Tracy Cordes and Glen Schlaphoff, MD



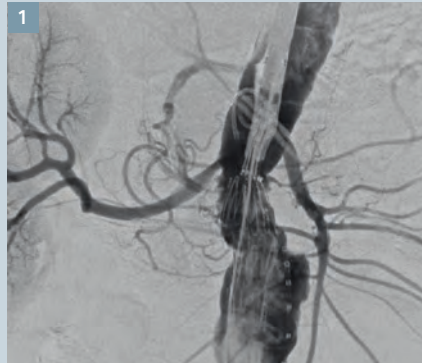
## Contact

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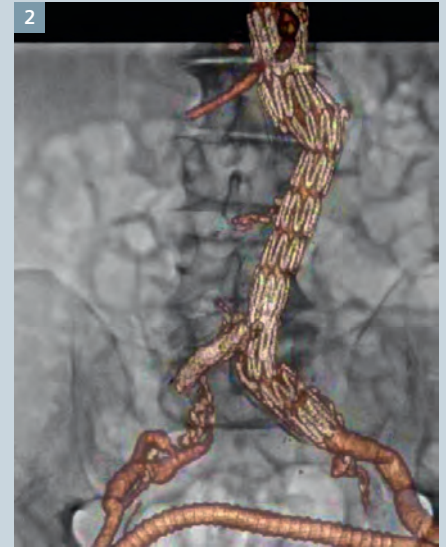


*"The old CT was extremely useful to see the anatomy of the renal artery before stenosis. This helped us in planning the working position (angles) without the need of additional CT and radiation. Overall, contrast dose and procedure time were reduced."*

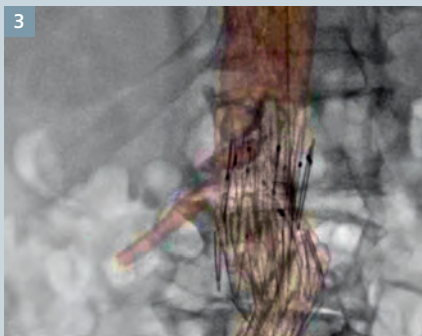
**Glen Schlaphoff, MD,**  
Interventional Radiologist, Department of  
Interventional Radiology, Liverpool Hospital,  
NSW, Australia



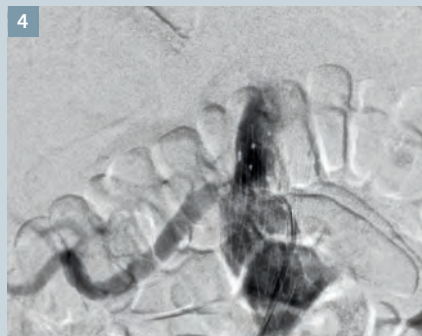
**1** Angiogram at EVAR, occluded left renal artery and 50% stenosis right renal artery.



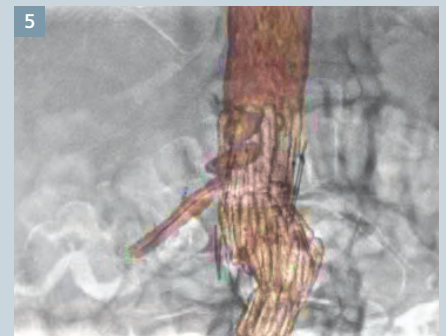
**2** Fusion of 2-year-old historical dataset supported by syngo DynaCT and syngo InSpace 3D/3D Fusion.



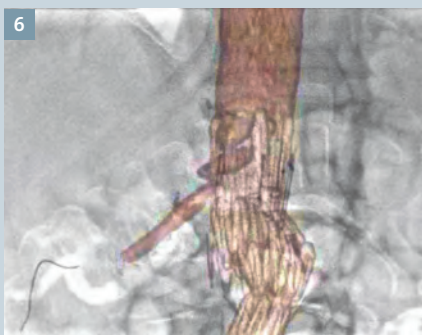
**3** syngo InSpace 3D/3D Fusion applied and fused dataset rotated to optimize working angle.



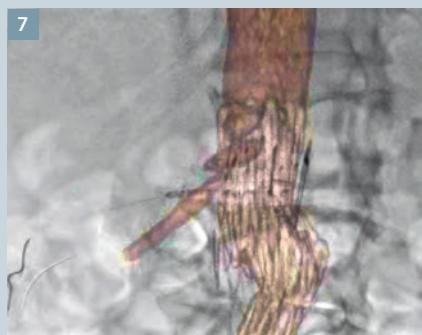
**4** Single DSA acquisition demonstrating optimal working angle and critical stenosis at origin at half contrast dose.



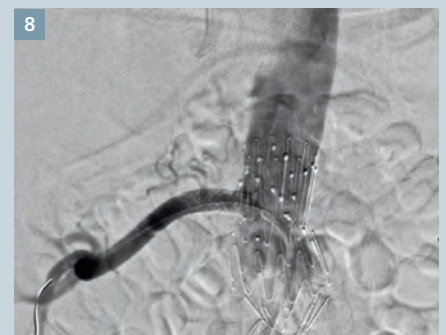
**5** 0.014 in wire accessing the renal artery using acquisition overlay supported by syngo iPilot.



**6** Final wire position prior to advancing stent.



**7** Balloon-mounted stent placement prior to deployment.



**8** Final DSA acquisition demonstrating stented right renal artery. Total contrast used for entire study: 10 cc.

# Guiding Sclerotherapy for Deep Lying Lesions using Advanced Angiographic Imaging Applications and MR Fusion

Courtesy of Beverly Aagaard Kienitz<sup>1</sup>, MD, and Lucas Elijevich<sup>2</sup>, MD

<sup>1</sup>University of Wisconsin, Madison, USA

<sup>2</sup>University of Tennessee, Memphis, USA

## Patient History

Patients with deep head and neck lesions can be challenging to treat using conventional sclerotherapy guidance, such as ultrasound (US) and fluoroscopy. High impedance structures prevent the use of US, while fluoroscopy lacks resolution of the targeted lesion. New tools allow the fusion of 3D MR images with Low-dose *syngo* DynaCT images of the patient and enable different guidance methods for successful deep lying lesion treatment. Two approaches were investigated: 1) overlaying the lesion in MR images onto the live fluoroscopy images and 2) path planning and target delineation on MR images with subsequent path and target overlay on live fluoroscopy images.

## Diagnosis

Two patients with either a cystic lesion in the right submalar retro-maxillary region or an intra and periorbital macrocystic and microcystic lymphatic will be described.

## Treatment

With patients under general anesthesia, a Low-dose *syngo* DynaCT scan (~1/20 dose of Head CT) was obtained. T2-weighted MR images were then imported and fused with the *syngo* DynaCT image (Fig. 1A and 1B). Overlay on fluoroscopy: The lesion was identified and segmented (Fig. 2A) and needle advancement into the overlaid lesion was then performed under fluoroscopy (Fig. 3A). Path planning: An unobstructed path was constructed to the target avoiding bony or critical structures (Fig. 2B). The path was overlaid on live fluoroscopy and the needle advanced (Fig. 3B). For both methods a Low-dose *syngo* DynaCT run was acquired to assess needle placement, and if required, corrections were performed. The sclerosing agent mixed with contrast was then injected. A final Low-dose *syngo* DynaCT image, fused with MR, and the distribution of the agent with respect to the lesion was evaluated (Fig. 4A and 4B).

## Comments

Using a combination of MR, Low-dose *syngo* DynaCT, *syngo* InSpace 3D/3D Fusion and low-dose fluoroscopic imaging, single pass needle placement into deep subosseous macrocystic facial or deep ocular lesions was performed in multiple patients. A benefit of fusion imaging with microcystic lesions was also found. Post-treatment, repeat fusion was performed as treatment demonstrated accurate intra-lesion deposition without extravasation. For microcystic lesions, fusion improved conspicuity of the overall target lesion and confirmed sclerotherapy confined to target territory. The combination of Low-dose *syngo* DynaCT and sclerotherapy specific fluoroscopy settings reduced radiation dose compared with standard protocols while providing procedure-specific information.

Overall, the use of MR fused with Low-dose *syngo* DynaCT displayed with low-dose fluoroscopy provides improved lesion visualization during sclerotherapy treatment and may improve treatment accuracy and clinical outcomes.

## Protocol

5s DR-L (3D, 0.1  $\mu$ Gy/fr)



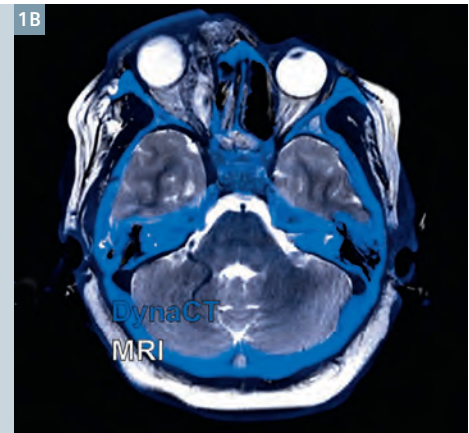
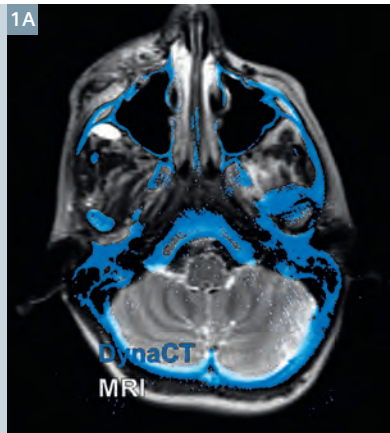
Beverly Aagaard Kienitz, MD,  
and Lucas Elijevich, MD.

## Contact

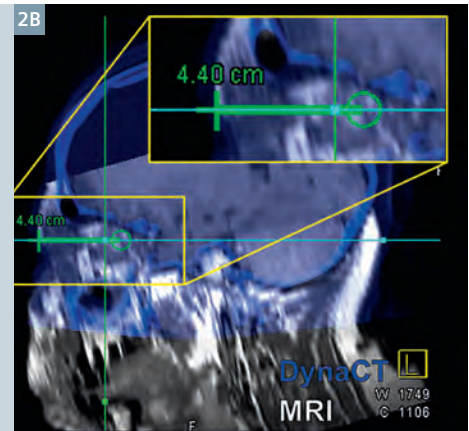
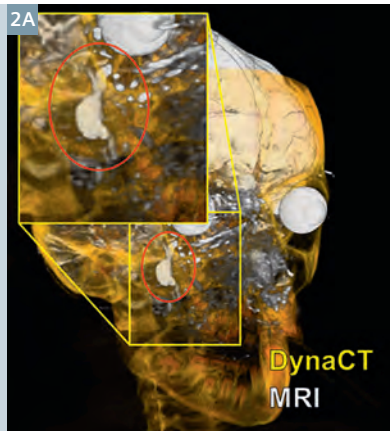
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sebastian.schafer@siemens.com



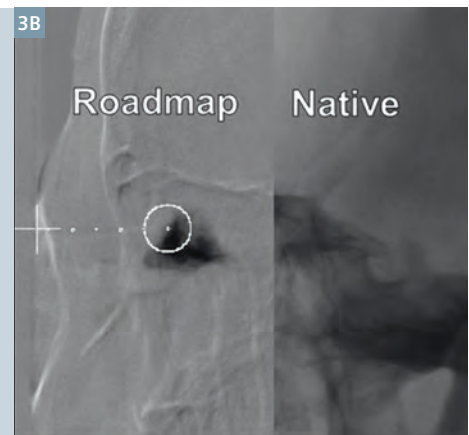
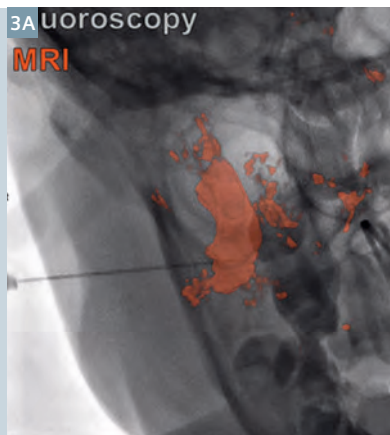
- 1 Fusion of Low-dose syngo DynaCT (blue) and T2-weighted MR images (grey) (1A) target cystic lesion in the right submalar retromaxillary region for overlay technique. (1B) Intra and periorbital macrocystic and microcystic lymphatic malformation for path planning.



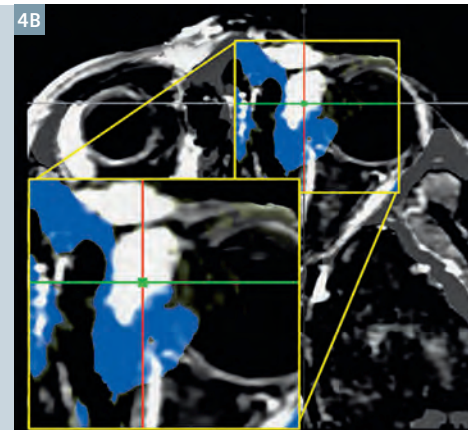
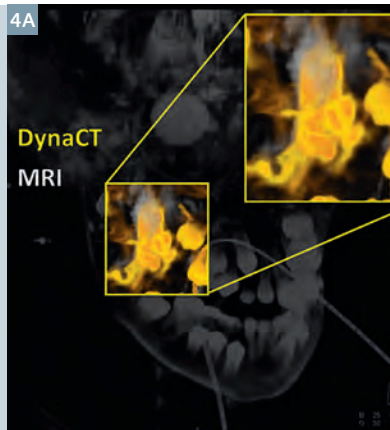
- 2 Lesions are identified on fused images. (2A) The lesion is identified in volumetric view, and segmented using volume cropping. (2B) The lesion is identified in slice view and needle guidance software is used to plan the path.



- 3 Placement of needle prior to injection. (3A) Lesion overlay on fluoroscopy is used to guide needle insertion. The C-arm can be adjusted freely with the overlay following the changed angulation. (3B) Planned needle path is overlaid on fluoroscopy. Needle is inserted following trajectory, with the C-arm allowing free positioning with correct path display.



- 4 At key stages during treatment, additional Low-dose syngo DynaCT scans can be acquired, MR fusion performed and embolization agent distribution assessed. A final scan allows the assessment of completion of lesion filling and provides support in defining an end point for treatment.





# A Powerful Combination for Coronary Interventions

Common causes of coronary stent thrombosis and restenosis include the incomplete expansion of a stent and poor apposition to the vessel wall. In a standard angiography procedure, the thin stent struts can be difficult to see, and intravascular imaging – such as ultrasound and optical coherence tomography – is not routinely used for coronary interventions.

We spoke with Professor Stephan Achenbach, MD, Chairman of Cardiology at Erlangen University Hospital, about the benefits of using CLEARstent and CLEARstent Live for stent enhancement during percutaneous coronary interventions.

By Hildegard Kaulen, PhD

Before sharing his experience using stent enhancement, Stephan Achenbach explains the challenges that he faces on a day-to-day basis: “We are performing increasingly complex procedures that we would previously not have considered routine or even possible,” he says. “And these require perfect visualization not only of the vessel lumen, but also of the implanted coronary stents. At the same time, stent struts are becoming thinner and thinner and less radiopaque. Strut thickness used to be 140  $\mu\text{m}$ ; now it is usually 80–100  $\mu\text{m}$ .” This is not all: Achenbach goes on to explain the new bioresorbable scaffolds: “These most modern versions of coronary stents can only be recognized by extremely small platinum markers at either end. Their

framework is no longer visible in angiography. In addition, patients are getting older, sicker, and more overweight,” Achenbach says. “It is much harder to see the stents in obese patients than it is in slim patients. Also, we often have to insert multiple stents in order to cover longer stenoses, chronic occlusions, or because the procedure involves bifurcations. We are treating more and more patients who already have one or multiple stent implants from previous coronary interventions.”

## Improved Decision-Making Process

Achenbach uses a clinical example to illustrate the importance of good stent visibility. A few weeks ago, he was treat-



*“CLEARstent allows us to see stents that are poorly expanded, stent fractures, and other situations that we might not even be able to identify without stent enhancement, but which are important for making clinical decisions.”*

**Professor Stephan Achenbach, MD,**  
Chairman of Cardiology at  
Erlangen University Hospital, Germany

ing a patient who presented stent restenosis for the third time. With CLEARstent, he could see that the stent had been incorrectly deployed the first time and was never fully expanded (Fig. 1), and that more aggressive post-dilation should have been performed during the previous interventions. Without CLEARstent, this would not have been visible.

He gives a second example to demonstrate a potential benefit of stent enhancement. An overweight patient with a history of bypass surgery was admitted with acute chest pain. “Angiographically, we found a high-grade stenosis at the insertion of a bypass graft,” says Achenbach. “It was not until we used CLEARstent that we

saw a stent had been implanted in that anastomosis, and what we considered to be de-novo lesion was, in fact, an in-stent stenosis based on a stent fracture (Fig. 2A and 2B). This, of course, influenced our treatment strategy.”

Achenbach has been using both applications for just over a year now and employs them in nearly every interventional procedure he performs. “When I show colleagues the images, they are really enthusiastic,” he says. CLEARstent and CLEARstent Live enable him to answer important questions with confidence: Is the stent expanded completely? Is it severe calcium that prevents full stent expansion? Has the deployment

of one stent led to the deformation of another, for example in a bifurcation? Post-dilation with carefully selected balloon size may be necessary. “This is where the modeling work begins,” Achenbach says. And he knows very well that good visibility is mandatory when handling the complex meshwork of the stents.

### **The Principles of Stent Enhancement**

CLEARstent is a post-processing tool. CLEARstent Live displays the stent enhancement in real time. Both tools are based on the same principles. Balloon markers are identified by the algorithms and the images are enhanced by aligning consecutive

frames according to balloon markers, decrease noise, and improve contrast and resolution, which improves stent visibility. CLEARstent acquires images over multiple cardiac cycles, and projects a high-quality still image. The algorithm requires a few seconds to complete and generates this single high-quality still image. The CLEARstent image is automatically saved as a regular DICOM image; it is enlarged and can be exported to a PACS system for documentation purposes. CLEARstent Live, on the other hand, uses the same principle, but it operates in real time and generates stabilized, enhanced live images even as the balloon or stent is manipulated and moved within the coronary arteries. CLEARstent and CLEARstent Live are fast and easy to use – without requiring any extra effort.

## Perfect Partners

Are both tools really necessary? Achenbach answers with a resolute “yes” and names four applications that show how the tools complement each other, and how they are typically used during a percutaneous coronary intervention:

1. Achenbach uses CLEARstent to check that the stent has been fully expanded (Fig. 3). He believes that incomplete stent expansion is probably the reason for in-stent restenosis in a relevant number of cases (as with the patient in the first clinical example he gave).
2. Achenbach uses the stent enhancement tool in real time when he wants to position the balloon for post-dilation using maximum precision (Fig. 4). “We use CLEARstent Live to check that the edge of the balloon is properly aligned with the end of the stent,” he says. “Then we can be relatively confident that we will avoid damaging the coronary artery outside the implanted stent.”
3. He subsequently uses CLEARstent to check that multiple stents have been correctly implanted next to one another, and to ensure the optimal distance between an old and a new stent (Fig. 5). Gaps between stents may also contribute to restenosis.

Too much overlap, on the other hand, may cause a predisposition to stent thrombosis or fractures. The precise positioning of multiple stents is particularly important in bifurcations, when ostia or side branches have to be covered. CLEARstent Live is able to aid in positioning a second stent in real time with optimal precision.

A fourth application is the evaluation of stents that are already in place. “CLEARstent allows us to see stents that are poorly expanded, stent fractures (Fig. 6), and other situations that we might not even be able to identify without stent enhancement, but which are important for making clinical decisions.” To Achenbach, it seems obvious that if the procedure of stent implantation can be optimized through better visualization, long-term clinical results may be improved. He points out, however, that no clinical studies to this effect are available so far.

## The Challenge of Bioabsorbable Scaffolds

Achenbach turns his attention to the new bioabsorbable scaffolds. These devices are no longer made of metallic material, but typically from derivatives of poly-L-lactic acid. They are usually not radiopaque and, hence, invisible in X-ray angiography. To support the implantation procedure, most scaffolds carry small radiodense markers at either end (Fig. 7). Their use in coronary interventions is promising to many cardiologists because they completely dissolve within a few years. Achenbach sees two advantages in their use: First, if the scaffolds disappear over time, no foreign objects are left in the vessel. If a second coronary intervention or even bypass surgery become necessary at a later date, there is no metal mesh preventing a free choice of treatment options in any particular area. Second, the ability of the coronary vessel to expand in situations of increased blood flow is likely to be better without a foreign object inside it, which some researchers link to the observation that patients may have less chest pain after treatment with

bioresorbable scaffolds as opposed to conventional stents made of metal. “I personally think that bioresorbable scaffolds will be the primary form of intracoronary devices used for interventions in the future,” says Achenbach. “However, we have to be aware that clinical studies are still ongoing. Initial results are proving positive and bioresorbable scaffolds appear to be as effective and safe as drug-eluting stents. Still, we need to wait for longer-term results of larger studies in a wider range of patients before making a final assessment.” In fact, stent enhancement may be particularly important for interventions using bioresorbable scaffolds, given their requirement for very accurate positioning and post-dilatation, combined with the often very poor visibility of their miniaturized metal markers.

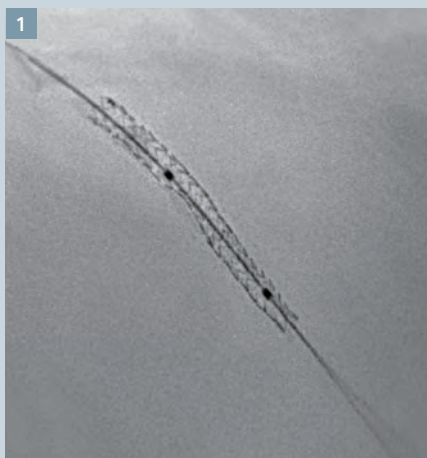
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**Hildegard Kaulen, PhD**, is a molecular biologist. After stints at the Rockefeller University in New York and Harvard Medical School in Boston, she moved into the field of freelance science journalism in the mid-1990s and contributes to numerous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

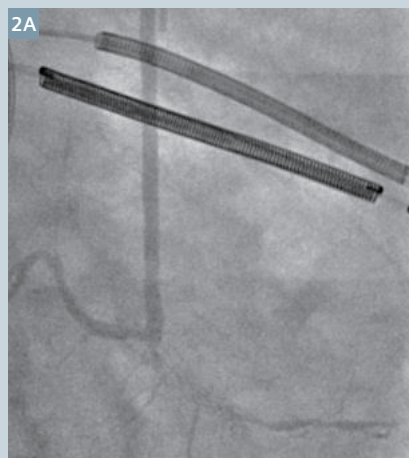
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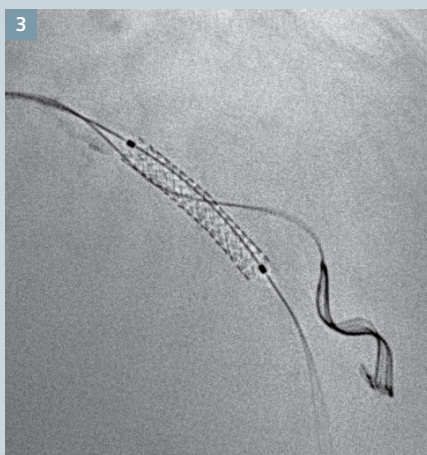
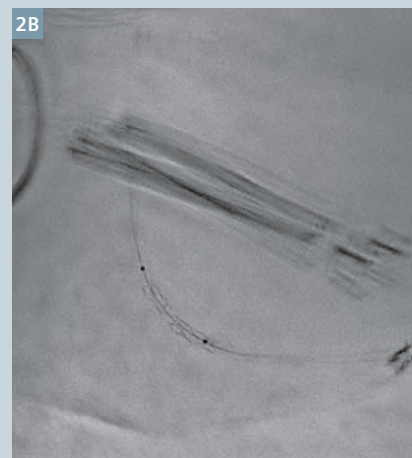




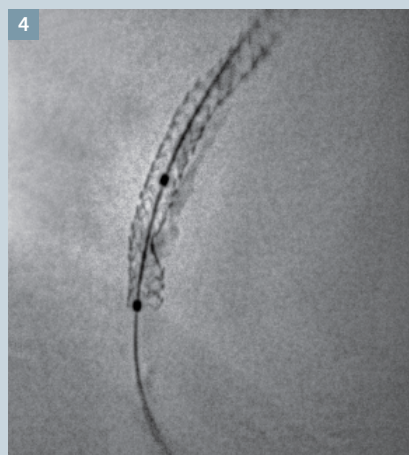
**1** CLEARstent shows an incompletely expanded stent.



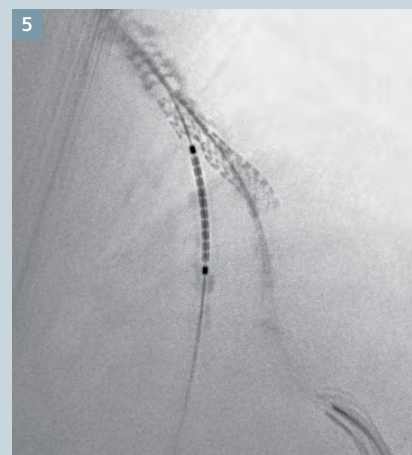
**2** High-grade stenosis at the insertion of a bypass graft showing an implanted stent, which was not seen until the use of CLEARstent.



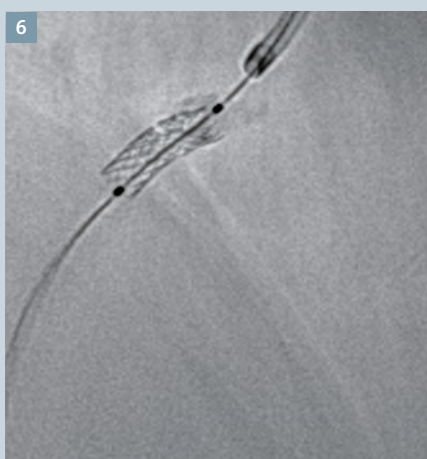
**3** CLEARstent of a fully expanded stent.



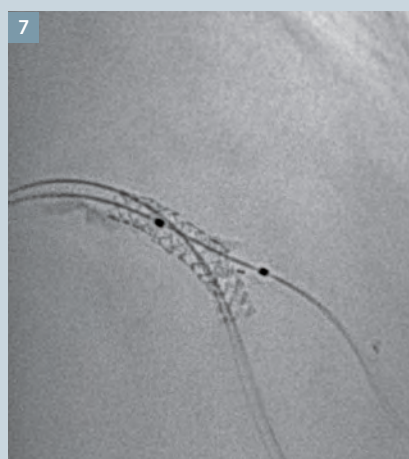
**4** CLEARstent Live frame shows the positioning of a precisely aligned balloon for post-dilatation.



**5** CLEARstent used for multiple stent implantations to check the positioning between the old and the new stent – in this case with a gap.



**6** CLEARstent allows to see stent fractures, which might not be visible without stent enhancement.



**7** Bioabsorbable scaffolds are equipped with small radiodense markers, which can easily be seen with CLEARstent.

# Stent Deformation in Bifurcation Stenting with Final Kissing Balloon Inflation In Vivo Demonstration Supported by CLEARstent

Courtesy of Professor Stephan Achenbach, MD, and Christian Schlundt, MD

Department of Cardiology, University of Erlangen, Germany

## Patient History

78-year-old woman with typical chest pain and left anterior descending coronary artery stenoses, with a fractional flow reserve of 0.76.

## Treatment

A bioresorbable scaffold (Absorb 2.5/18 mm, Abbott Vascular, Abbott Park, Illinois) was used to treat the midsection-left anterior descending coronary artery. A high-grade bifurcation lesion of the left anterior descending/1st diagonal branch remained (Medina 0/1/0). This lesion was treated with a drug-eluting stent (Xience Prime 3.0/15 mm, Abbott Vascular) which was implanted in the left anterior descending coronary artery, followed by rewiring and balloon angioplasty of the diagonal branch and final kissing balloon inflation. Figures 1–8 illustrate the various steps of the procedure and resulting changes in stent geometry.

## Comments

Various techniques for stent deployment in bifurcation lesions have been developed. In general, a single-stent approach is preferable, but balloon dilation of the side branch can lead to deformation of the main branch stent, which is incompletely resolved by “final kissing balloon dilation” [1,2]. In vivo imaging of stent expansion and deformation by fluoroscopy is challenging, given the poor X-ray absorption of modern thin-strut stents. Software tools have become available that permit improved visualization of coronary stents in cine fluoroscopy. They improve contrast-to-noise ratio (and, hence, resolution) by averaging consecutive cine fluoroscopic frames. Balloon markers are used as reference points in order to eliminate motion. The images presented on the right side have been acquired by an Artis zee system with CLEARstent software.

[1] Sgueglia GA, Chevalier B. Kissing balloon inflation in percutaneous coronary interventions. *J Am Coll Cardiol Interv* 2012;5:803–11.

[2] Foin N, Secco GG, Ghilencea L, Krams R, Di Mario C. Final proximal post-dilatation is necessary after kissing balloon in bifurcation stenting. *EuroIntervention* 2011;7:597–604.

Professor Stephan Achenbach, MD



Christian Schlundt, MD



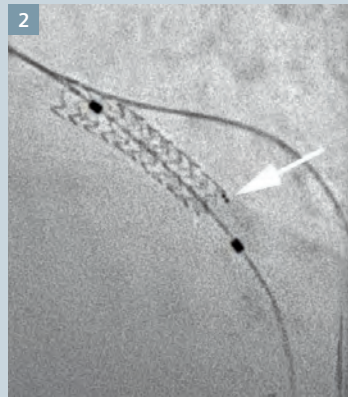
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**1** Coronary angiogram showing bifurcation stenosis

Bifurcation stenosis (arrow) of the left anterior descending coronary artery/1st diagonal branch (Medina 0/1/0). Fractional flow reserve in the left anterior descending coronary artery was measured as 0.76.



**2** Stent placed in main branch

CLEARstent image of a drug-eluting stent (Xience Prime 3.0/15 mm, Abbott Vascular) placed in the left anterior descending coronary artery. The side-branch wire is jailed. Note the two markers of the bioresorbable scaffold (Absorb 2.5/18 mm, Abbott Vascular) placed immediately distal to the drug-eluting stent (arrow).

**3** Rewiring of side branch

The side branch has been rewired. Note the passage of the side-branch wire further distal as compared with Figure 2 (arrow).

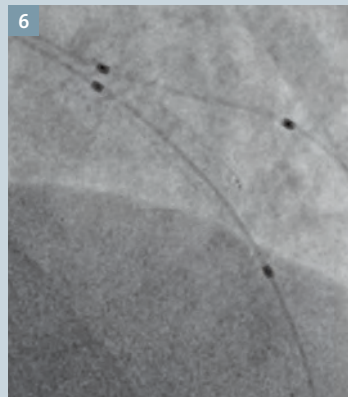
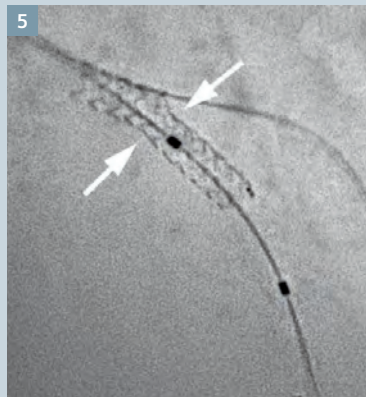


**4** Balloon positioned in side branch

A balloon (compliant, 2.5/15 mm) has been introduced into the side branch and will be inflated to 10 atm.

**5** Stent deformation following side-branch angioplasty

After side-branch balloon inflation, the stent struts are opened towards the side branch, but the main branch stent shows the typical deformation with an inward displacement of the stent struts distal to the bifurcation (arrows).

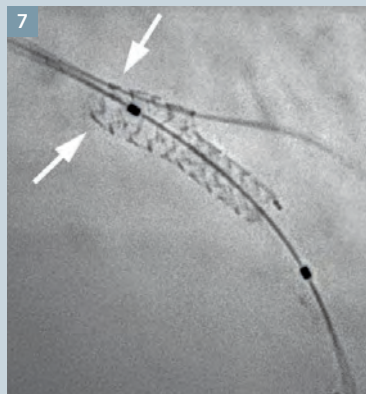


**6** Balloon placement for kissing balloon angioplasty

Balloon placement for kissing balloon inflation (2.5/15 mm non-compliant balloons in both the main branch and side branch). This is a nonenhanced original cine fluoroscopic image.

**7** Stent configuration following kissing balloon angioplasty

CLEARstent image after kissing balloon inflation. The side-branch struts remain open, the deformation of main branch struts distal to the bifurcation has been corrected. A slight inward displacement of the very proximal stent struts has occurred (arrows).



**8** Final contrast-enhanced angiogram

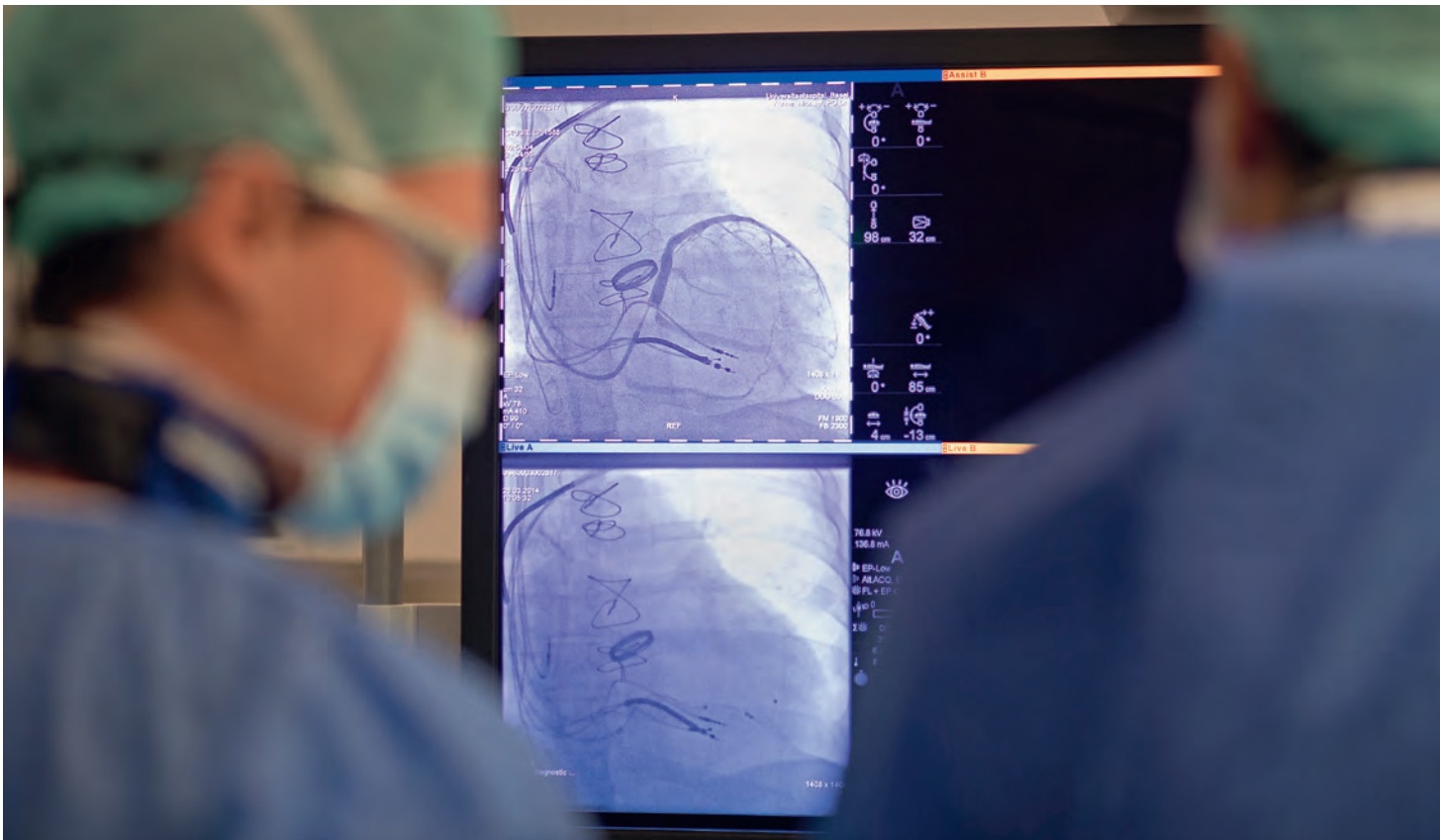
The final contrast-enhanced angiogram shows successful percutaneous coronary intervention of the stenosis and absence of residual stenosis in the main and side branches.



# “Now I See the Stent at All Times”

As procedures in interventional cardiology become more and more challenging, the need for better image quality rises and radiation dose exposure has become an increasingly important topic. The Siemens Artis Q.zen answers the challenge, achieving high image quality with half the radiation dose of established angiography systems. This was the conclusion of a clinical study at Basel University Hospital, where the first Artis Q.zen system worldwide was installed.

By Juliane Lutz | Photos: Uwe Mühlhäusser



## New tube, new detector: less exposure and sharper images

Artis Q.zen achieves a reduced radiation dose thanks to the new GIGALIX X-ray tube and a revolutionary new type of detector. To date, the angiography tube is the only one on the market that is fully equipped with flat emitter technology. The new tube enhances image quality in challenging situations such as with obese patients or in steep angulations. The small square focal spots of the GIGALIX result in higher spatial resolution for all clinical applications and help to better visualize small devices and vessels.

The new detector in Artis Q.zen allows imaging at the ultra-low dose range of 6 nGy per pulse. What makes the system unique is that the detector is based on crystalline silicon technology, instead of amorphous silicon technology. Crystalline silicon has a homogeneous chemical structure. It helps to amplify the image signal directly at the detector and significantly reduces the electronic noise in the image. Cardiologists can therefore achieve the same image quality at a lower dose.

The cardiology team at Basel University Hospital found the right solution to their demand for optimal image quality at significantly reduced dose: Artis Q.zen.



Basel University Hospital's Cardiology Department is one of the leading interventional centers in Europe – a fact reflected by the significant number of patients from neighboring Germany, Austria, and countries even farther away. Statistics show that, among other procedures, 2,292 coronary angiographies were performed here in 2013, including 1,130 coronary interventions and 436 ablations. 99 patients received a transcatheter aortic valve implantation (TAVI), additionally 237 pacemakers and 99 implantable cardioverter defibrillators (ICDs) were inserted.

Since cardiac procedures are performed much more frequently today than just a few years ago, and their complexity is increasing, it is becoming ever more important to reduce the radiation dose in the cath lab. This clearly benefits patients as well as medical staff. Typically, interventional cardiologists and electrophysiologists are exposed to scattered radiation for decades throughout their careers. There are indications of an increased incidence of brain tumors among interventional cardiologists, and this is a big driver in the currently ongoing discussions about radiation safety.

In 2012, Israeli and French researchers reported four cases of left-hemispheric brain tumors detected in cardiologists from Haifa and Paris who worked long-term in cardiac catheterization labs. In March 2014, the Israeli cardiologist Ariel Roguin published a report

in the European Heart Journal about 35 cardiologists and radiologists who had developed brain or neck tumors. In 26 cases, the tumor was left-sided, which might be explained by the fact that interventionalists generally work on the right side of patients, where they are close to the X-ray tube [1].

"During procedures, we stand next to the source of radiation practically all day long," says Professor Stefan Osswald, MD, Head of Cardiology at Basel University Hospital. "That's why I was immediately ready and willing to try out the Artis Q.zen." In fall 2012 the system was installed in Basel for the first time anywhere in the world. The Artis Q.zen helps to perform electrophysiological and cardiological procedures with an unprecedented reduction in radiation dose – far below the level that is usually required. This improvement is attributable to a change in detector technology. Conventional detectors consist of amorphous silicon, whereas the silicon in the new detector has a crystalline structure, which is more homogeneous. This allows to amplify the electric signal on pixel-level and minimizes electronic noise in the image significantly. Additionally, the Artis Q.zen's X-ray tube is completely equipped with flat emitters that allow for smaller square focal spots. This improves the system's ability to detect even the smallest structures by up to 70%.



*“With the help of CLEARstent Live, I now see the stent at all times in excellent detail. That makes life much easier.”*

**Professor Christoph Kaiser, MD,**  
Head of Interventional Cardiology at Basel University Hospital,  
Switzerland

### A 50 % lower dose during electrophysiological procedures

No one knows better how well the new Artis Q.zen system performs than Michael Kühne, MD, Head of the Electrophysiology Lab. “We found out that doses are significantly lower compared to previous systems,” he explained. In complex cases, like an ICD implantation for cardiac resynchronization therapy, it might take more than an hour to place all three intracardiac electrodes correctly. “During this time, the patient is exposed to long periods of fluoroscopy, so keeping the dose as low as possible is very beneficial,” Kühne says. In the case of a recently implanted CRT-D, for example, he needed 9.3 minutes of fluoroscopy, with a total applied radiation dose of 824  $\mu\text{Gym}^2$ . “The total radiation dose depends, of course, on various factors, such as the patient’s body mass index (BMI) and the anatomies of the coronary sinus and great cardiac vein,” Kühne explains.

The Artis zee is another member of Siemens’ angiography system portfolio, and it is also installed in Basel. The Artis zee is known for its state-of-the-art-technology. A level of 40 nGy per pulse is necessary to achieve diagnostic image quality, according to Sven Knecht, MD, research engineer in the Cardiology Department in Basel. With the Artis Q.zen, just 15 nGy per pulse is sufficient.

An effective dose reduction of about 50 % was documented in a study conducted in the Electrophysiology Lab with 180 patients between March 2013 and March 2014. The results will be presented at this year’s Congress of the European Society of Cardiology (ESC), which will take place in Barcelona at the end of August [2].

Knecht points to another advantage of the new technologies incorporated into the Artis Q.zen: “The larger size of the new detector simplifies the procedure, especially in rotational angiography.” Previous smaller detectors were often inadequate for that, he notes. The close collaboration with Siemens is also positive. “The application specialist and the service technician are often with us in the hospital,” he says. “And I can call them up at any time.” Knecht also values the solid technical expertise of the Siemens employees. The bottom line for him: “The system delivers what has been promised.”

### New software applications simplify the work with stents and intravascular ultrasound

The Artis Q.zen also finds a strong support in the Interventional Cardiology Department at Basel University Hospital. “I find the combination of reduced radiation and improved image quality very persuasive,” says Professor Christoph Kaiser, MD, Head of Interventional Cardiology. “Whether in TAVI or coronary stent implantations, we benefit from the new system in all procedures.” During TAVI, Kaiser says, the optimized image quality lets him visualize the valve more clearly and therefore place it more accurately. For him the new software application CLEARstent Live is particularly helpful. During implantation, CLEARstent Live enhances stent display while compensating for motion at the same time. “Stents are becoming thinner and more difficult to visualize in detail. When we overlap them to cover very long lesions, their placement has to be precise to the millimeter,” says Kaiser, describing the particular challenges in his field of expertise. Any gaps between the stents could lead to complications such as embolisms, thrombosis or renewed narrowing. The previous application, CLEARstent, displayed the stent only as a frozen image. Kaiser explains: “You had to continually check where you were. With the help of CLEARstent Live, I now see the stent at all times in excellent detail. That makes life much easier.”

Another new software tool for the Artis Q.zen, called IVUSmap, also enhances the work of interventional cardiologists. During treatment of coronary heart disease, the software helps synchronize angiography images precisely with IVUS (intravascular ultrasound) images. “In the past, you had to continually switch back and forth between views,” says Kaiser. “Now I know the accurate location of the IVUS probe which is updated every second. This reduces the need for fluoroscopy, and that means a lower radiation dose. Also, the amount of iodinated contrast agent, which can induce kidney damage, can be reduced.”





*“In my view, Artis Q.zen rates as one of the world’s best angiography X-ray systems.”*

**Professor Stefan Osswald, MD,**  
Head of Cardiology at Basel University Hospital, Switzerland

## A guarantee for long-term quality and service

“Something that speaks very clearly in favor of the Artis Q.zen is that it works with lower doses than conventional devices,” says Osswald, summarizing his experience. Thanks to the very high resolution of individual images, he notes, the pulse rates can be reduced even more. “And despite that, we still see the very fine PTCA wires when they are moved, for example,” Osswald says. In his view, Artis Q.zen rates as one of the world’s best angiography X-ray systems.

Speaking as an experienced interventional cardiologist, Osswald thinks there’s something else that speaks in favor of the system: “An angiography system has to run for years. For that reason, a company’s service performance is at least as important as the product itself.” He says his experience with the Artis zee has been very good, in terms of long-lasting quality as well as service.

For the future, the Head of Cardiology at Basel University Hospital would like to see rotational angiography automatically fused with the EP mapping system, so that they no longer require manual adjustments at the electro-anatomical mapping system.

[1] <http://eurheartj.oxfordjournals.org/content/35/10/599.full>

[2] Source: Basel University Hospital

Juliane Lutz is the business editor of the Swiss newspaper BERNER ZEITUNG. Her areas of specialization include the pharmaceutical industry, HR and consumption. In addition, she is a freelance writer for the German daily Süddeutsche Zeitung.

## Further Information

[www.siemens.com/artis-q-zen](http://www.siemens.com/artis-q-zen)

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## Challenge

The rising number of complex procedures in electrophysiology and interventional cardiology increases the exposure to radiation for both patients and interventionalists.

## Solution

The Siemens Artis Q.zen is an angiography system that provides optimal image quality at a significantly reduced dose, thanks to innovative components introduced to the market for the first time.

## Result

Basel University Hospital was the first hospital in the world to install the Artis Q.zen. Its cardiology department has been using it since 2012, with impressive results, such as 50% less dose in electrophysiological procedures. The doctors in charge conclude that the system delivers what the manufacturer promises: top image quality at reasonably low dose.



# Save Time and Reduce Costs in Afib Procedures Using Rotational Angiography and 2D-3D Overlay Technique

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**According to World Health Organization data, 33.5 million people worldwide suffer from Atrial Fibrillation (Afib) and the affected population is growing. In contrast to costly drug therapy which simply manages the symptoms of Afib, ablation therapy can cure the disease.**

**Castellanza's Humanitas Mater Domini Hospital has adopted a new 2D-3D overlay technique using rotational angiography for treating atrial fibrillation which can save time and reduce procedure cost with no increase in complication rate.**

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The Humanitas Mater Domini Hospital in Castellanza, Italy opened its Electrophysiology Department in 1997 and currently performs one of the largest number of Afib procedures in the region. A clinical collaboration project with Siemens has allowed Department Head Massimo Tritto, MD, to develop and optimize his workflow for Afib ablation procedures by studying two powerful Siemens cardiac applications: *syngo* DynaCT Cardiac and *syngo* iPilot. Tritto's new technique for image guidance during ablation calls for a 3D visualization of the left atrium to be overlaid onto live 2D fluoroscopy images. This new method using rotational angiography and 2D-3D overlay applications can eliminate the need for a pre-procedural CT, reduce the use of electro-anatomical mapping systems and hence lead to significant cost savings.

Tritto's conclusions are based on his experience with close to 150 procedures where 3D acquisitions of the left atrium were obtained. From the start of the collaboration with Siemens, Tritto believed that 3D reconstruction of the left atrial morphology by rotational angiography had the potential of easy and rapid image acquisition, but felt workflow protocols could be optimized.

After determining that injection of contrast in the pulmonary artery without an additional catheter in place did not provide optimal 3D visualization, his team modified the protocol to include right ventricular rapid pacing during the 3D scan. This method provided the best three dimensional left atrium reconstruction. Nonetheless, Massimo Tritto was not yet completely satisfied with the automatic synchronization between 3D reconstruction and the 2D real-time fluoroscopy.

Next, he experimented with inserting a decapolar catheter into the coronary sinus to create an easily recognizable artifact for aligning the 3D image on the live fluoroscopic 2D images. However, after further investigation, Tritto and his team concluded that the best way to obtain a reliable image merge was to overlay the pulmonary venograms with the 3D reconstruction using the *syngo* iPilot application (Fig. 2).

After having performed close to 150 Afib cases using the imaging protocol described above, the Castellanza group found that 3D image quality of the left atrial morphology obtained by segmentation via *syngo* InSpace EP was very good in the majority of the cases (80%) and acceptable in the remaining cases (Fig. 1).

In most cases there was no need to use electro-anatomical mapping systems. In the cases where it was necessary, left atrial 3D visualization was successfully integrated into the CARTO® mapping system (Biosense Webster). In these instances, the Siemens rotational angiography perfectly replaced the CT scans previously required at Castellanza.



*“In most cases I save roughly €1,000 per Afib procedure by using syngo DynaCT Cardiac and syngo iPilot.”*

Massimo Tritto, MD,  
Head of Electrophysiology, Department of Cardiology,  
Humanitas Mater Domini, Castellanza, Italy

## Conclusion

Three dimensional rotational angiography and the subsequent 3D reconstruction overlaid on live 2D fluoroscopic images for guidance during atrial fibrillation catheter ablation shows similar outcomes and radiation exposure compared with the traditional lasso-only guided method.

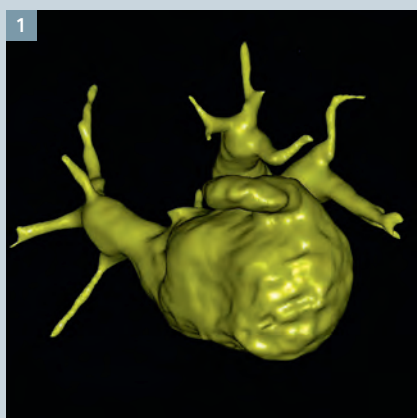
Optimization of the acquisition setting and improved accuracy of overlay using pulmonary venograms improved the quality of the 3D images for guidance with a positive impact on procedural safety and operator satisfaction (Fig. 3). Ease of use, reduced radiation dose and real-time peri-procedural acquisition are important advantages of rotational angiography over standard CT acquisition.

Finally, by using syngo DynaCT Cardiac for 3D imaging and syngo iPilot in most cases Tritto was able to save roughly €1,000 per Afib ablation procedure by eliminating his need for electro-anatomical mapping systems.

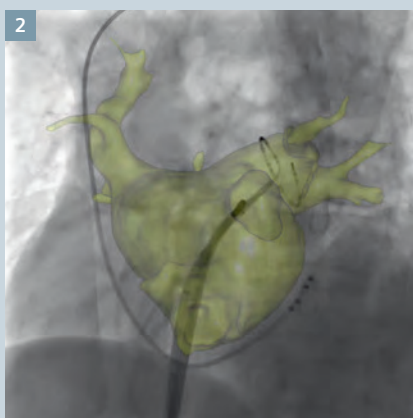
Additionally, Tritto has succeeded in reducing procedure time by more than 20 minutes by working without mapping systems. The procedural complication rate did not increase.

## Contact

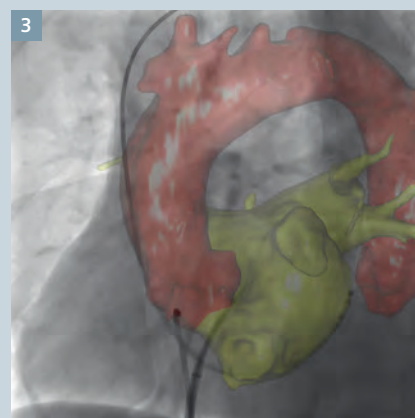
[gaia.banks@siemens.com](mailto:gaia.banks@siemens.com)



1 3D segmentation of the left atrium using syngo InSpace EP.



2 syngo iPilot: 3D segmentation overlaid on live fluoroscopy for realtime guidance.



3 Visualization of the aorta and the left atrium for safe transseptal puncture.



# Upcoming Congresses 2015

We always 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 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
AO Foundation	Davos, Switzerland	AO Foundation	Dec 07 – 18	<a href="http://www.aofoundation.org">www.aofoundation.org</a>
LTCS	Dallas, USA	Latest Techniques in Cardiac Surgery	Dec 10 – 12	<a href="http://www.dallasleipzigvalve.org">www.dallasleipzigvalve.org</a>
DWG	Leipzig, Germany	Deutscher Wirbelsäulenkongress	Dec 11 – 13	<a href="http://www.dwg-kongress.de">www.dwg-kongress.de</a>
Asia PCR, SingLIVE	Singapore, Singapore	Asia-pacific cardiovascular community	Jan 22 – 24	<a href="http://www.asiapcr.com">www.asiapcr.com</a>
STS	San Diego, USA	The Society of Thoracic Surgeons	Jan 24 – 28	<a href="http://www.sts.org">www.sts.org</a>
Arab Health	Dubai, UAE	Healthcare Exhibition & Congress	Jan 26 – 29	<a href="http://www.arabhealthonline.com">www.arabhealthonline.com</a>
Linc Leipzig	Leipzig, Germany	The Leipzig Interventional Course	Jan 27 – 30	<a href="http://www.leipzig-interventional-course.de">www.leipzig-interventional-course.de</a>
ISET	Hollywood, USA	International Symposium on Endovascular Therapy	Jan 31 – Feb 04	<a href="http://www.iset.org">www.iset.org</a>
DGTHG	Freiburg, Germany	Deutsche Gesellschaft für Thorax-, Herz- und Gefäßchirurgie	Feb 08 – 11	<a href="http://www.dgthg-jahrestagung.de">www.dgthg-jahrestagung.de</a>
ISC	Nashville, USA	International Stroke Conference	Feb 11 – 13	<a href="http://www.my.americanheart.org">www.my.americanheart.org</a>
CADECI	Guadalajar, Mexico	Congreso Anual de Cardiología Internacional	Feb 19 – 21	<a href="http://www.cadeci.org.mx">www.cadeci.org.mx</a>
SIR	Atlanta, USA	Society of Interventional Radiologists including sponsorships	Feb 28 – Mar 05	<a href="http://www.sirmeeting.org">www.sirmeeting.org</a>
ECR	Vienna, Austria	Annual Meeting, European Society of Radiology	Mar 04 – 08	<a href="http://www.myesr.org">www.myesr.org</a>
EVC	Maastricht, Netherlands	European Vascular Course	Mar 08 – 10	<a href="http://www.vascular-course.com">www.vascular-course.com</a>
TCTAsia	Shanghai, China	TCT Asia	Mar 12 – 13	<a href="http://www.tctasia.com.cn/en">www.tctasia.com.cn/en</a>
ACC	San Diego, USA	American College of Cardiology	Mar 14 – 16	<a href="http://accscientificsession.cardiosource.org/ACC.aspx">http://accscientificsession.cardiosource.org/ACC.aspx</a>
IPC	Milan, Italy	International Workshop on Interventional Pediatric and Adult Congenital Cardiology	Mar 19 – 21	<a href="http://www.workshopipc.com">www.workshopipc.com</a>
CIT	Beijing, China	China Interventional Therapeutics Conference	Mar 19 – 22	<a href="http://www.citmd.com">www.citmd.com</a>
EAU	Madrid, Spain	Annual Congress, European Association of Urology	Mar 20 – 24	<a href="http://www.uroweb.org">www.uroweb.org</a>
AAOS	Las Vegas, USA	American Academy of Orthopedic Surgeons	Mar 24 – 28	<a href="http://www.aaos.org/education/anmeet/anmeet.asp">www.aaos.org/education/anmeet/anmeet.asp</a>
ALICE	Essen, Germany	Advanced Life International Course in Essen	Mar 25 – 27	<a href="http://www.alice-the-course.com">www.alice-the-course.com</a>

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China Med	Beijing, China	International Medical Instruments & Equipment Exhibition	Mar 26 – 28	<a href="http://www.chinamed.net.cn/en">www.chinamed.net.cn/en</a>
DGK	Mannheim, Germany	Annual Conference, Deutsche Gesellschaft für Kardiologie – Herz- und Kreislaufforschung e.V.	Apr 08 – 11	<a href="http://www.dgk.org">www.dgk.org</a>
ITEM	Yokohama, Japan	International Technical Exhibition of Medical Imaging	Apr 17 – 19	<a href="http://www.j-rc.org">www.j-rc.org</a>
ECIO	Nice, France	Cardiovascular and Interventional Radiological Society of Europe	Apr 22 – 25	<a href="http://www.ecio.org">www.ecio.org</a>
AATS	Seattle, USA	Annual Meeting, American Association for Thoracic Surgery	Apr 25 – 29	<a href="http://www.aats.org">www.aats.org</a>
Charing Cross	London, UK	Vascular & Endovascular Consensus Update	Apr 28 – May 01	<a href="http://www.cxvascular.com/cxsymposium">www.cxvascular.com/cxsymposium</a>
AANS	Washington, USA	Annual Scientific Meeting, American Association of Neuro Surgeons	May 02 – 06	<a href="http://www.aans.org">www.aans.org</a>
ASCVTS	Hong Kong, China	Annual Meeting of the Asian Society for Cardiovascular and Thoracic Surgery	May 11 – 14	<a href="http://www.ascvts2015.org">www.ascvts2015.org</a>
HRS	Boston, USA	Heart Rhythm Society	May 13 – 16	<a href="http://www.heartrhythmsupport.org">www.heartrhythmsupport.org</a>
DRK	Hamburg, Germany	Deutscher Röntgenkongress	May 13 – 16	<a href="http://www.roentgenkongress.de">www.roentgenkongress.de</a>
AUA	New Orleans, USA	Annual Meeting, American Urological Association	May 15 – 19	<a href="http://www.aua2014.org/attendees/future-annual-meeting-dates.cfm">www.aua2014.org/attendees/future-annual-meeting-dates.cfm</a>
EuroPCR	Paris, France	Cardiovascular Course	May 19 – 22	<a href="http://www.europcr.com">www.europcr.com</a>
Global Spine	Buenos Aires, Argentina	Global Spine Congress	May 20 – 23	<a href="http://www.globalspinecongress.org">www.globalspinecongress.org</a>
EFORT	Prague, Czech Republic	European Federation of National Associations of Orthopaedics and Traumatology	May 27 – 29	<a href="http://www.efort.org">www.efort.org</a>
ESTS	Lisbon, Portugal	European Conference, European Society of Thoracic Surgeons	May 31 – Jun 03	<a href="http://www.ests.org">www.ests.org</a>
GEST	Seville, Spain	Global Embolization Symposium and Technologies	Jun 03 – 06	<a href="http://www.gestweb.org/symposium">www.gestweb.org/symposium</a>
ISMICS	Berlin, Germany	The International Society for Minimally Invasive Cardiothoracic Surgery	Jun 03 – 06	<a href="http://www.ismics.org">www.ismics.org</a>
WLNC	Chicago, USA	World Live Neurovascular Conference	Jun 08 – 10	<a href="http://www.wlnc.org">www.wlnc.org</a>
EHRA-Europace-Cardiostim	Milan, Italy	World Congress in Cardiac Electrophysiology and Cardiac Techniques	Jun 21 – 24	<a href="http://www.escardio.org/communities/EHRA/courses-meetings/Pages/europace-congresses.aspx">www.escardio.org/communities/EHRA/courses-meetings/Pages/europace-congresses.aspx</a>

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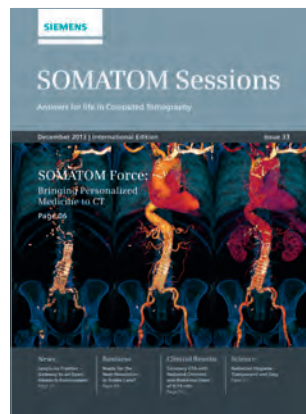
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# AXIOM Innovations

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