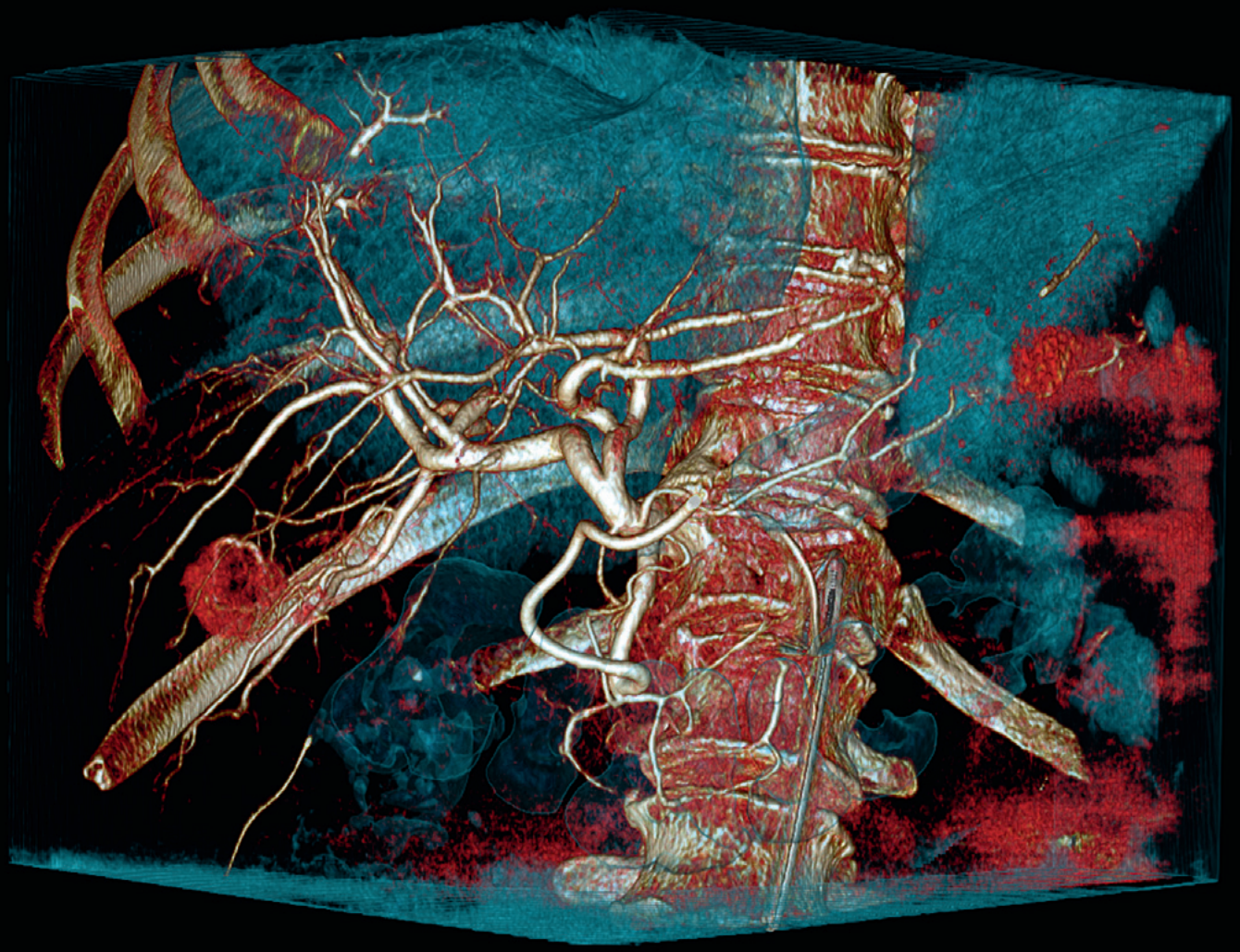
SIEMENS

AXIOM Innovations

The Magazine for Interventional Radiology, Cardiology and Surgery

October 2015 Issue 20



Dear Reader,

The world has always had pioneers. And it was always pioneers who changed the world to make it a little better – and the same is true in healthcare.

Siemens Healthcare is very proud to be a pioneer who aims to make people's lives healthier and to help physicians fight the most threatening diseases. In the recent months we have been working on sharpening our strategy to become an even more customer-centric partner for healthcare institutions worldwide. One strategic key pillar is image-guided therapy.

Under the umbrella of 'Advanced Therapies' we want to enable our customers in Cardiology, Interventional Radiology, Surgery and Radiation Oncology to address current challenges better. Whether it is managing an increasing number of patients with less budget, changing payment models that are putting clinical and financial outcome into focus or operational efficiency needs.

Innovation will continue to play a major role on our future path.

It is now over 10 years since we reported the launch of our groundbreaking software *syngo* DynaCT in our very first edition of AXIOM Innovations. This innovative imaging technique for CT-like soft tissue images in the angio suite revolutionized decision-making and provided unique support in complex interventional cases.

Now, in this 20th edition of our customer magazine, we are pleased to feature the latest technological developments and report on real clinical successes. Evidence of the value that *syngo* DynaCT especially brings is reflected in its expansion beyond angiography and radiology to cardiology and, most recently, to surgery.

And we continue our pioneering work. At RSNA 2014, we launched another groundbreaking technology in interventional imaging: *syngo* Dyna4D now introduces the 4th dimension to the angio suite for the first time. Incorporating temporal information into 3D imaging enables neuroradiologists to see any view of an abnormality at any time – adding significant value in the care of patients with complex vascular diseases.

"A customer saying: 'I am even more excited about this technology now than I was when it was first introduced!' is what drives us to innovate."

Heinrich Kolem, PhD,
Head of Advanced Therapies
at Siemens Healthcare

We are a pioneering company that embraces change as opportunity. New clinical challenges in diagnosis and therapy demand that we support healthcare providers as efficiently and effectively as possible. We hope that you enjoy reading this edition and that you continue to accompany us on the exciting road ahead!

Enjoy reading this edition!

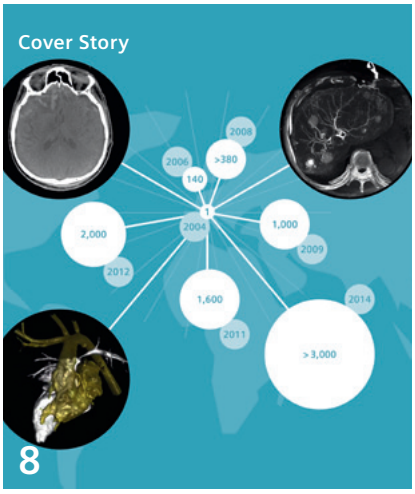
Sincerely yours,

Heinrich Kolem, PhD

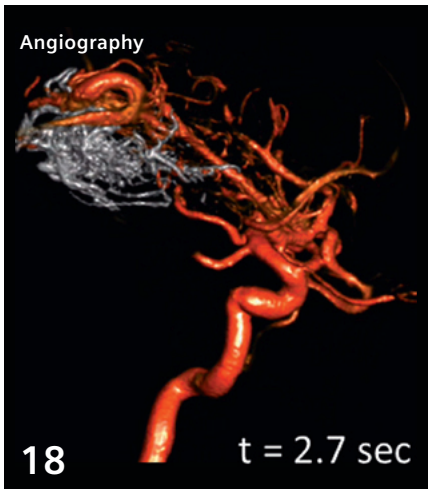
Behind the Stories

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

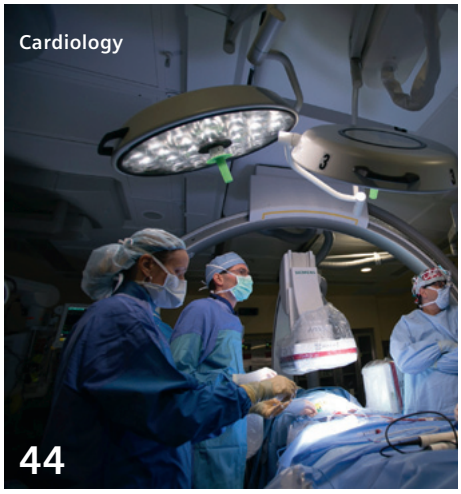
Email: axiom-innovations.healthcare@siemens.com



A Decade of *syngo* DynaCT:
A Revolution in Angiography



syngo Dyna4D –
Visualizing 3D Flow Patterns



Artis Q.zen –
Raising the Bar by Lowering Dose

News

Cover Story

Angiography

Cardiology

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.

A Winning Team Goes TAVI

Fracture Reduction and Stabilization of Distal Radial Fracture

Quality Control when it Counts Most: The World's First Hybrid OR Dedicated to Spine Surgery

The Future of Interventional Imaging – Integrated and Combo Labs

With over 40 years of experience of hospital operation and administration, The Medical City (TMC) in Pasig City, Philippines, upholds its commitment to provide premium quality care to some 40,000 in-patients and 400,000 out-patients annually. Performing about 1,200 cardiac procedures each year, TMC's state-of-the-art Cardiac and Vascular Catheterization Laboratory hosts two Siemens Artis zee systems to ensure efficient and timely scheduling of coronary cases, including emergencies.

In 2010, TMC's first Artis zee was installed as a combo system featuring a large detector with interventional cardiology, electrophysiology, and interventional radiology capabilities. The equipment's advanced 3D imaging technology, in particular with *syngo* DynaCT, allowed the hospital to achieve optimum visualization of the soft tissue characteristics of the brain and liver in the angiography laboratory.

Artis zee's capacity to support a wide range of clinical applications while also allowing users to operate easily the majority of its functions was a significant factor in the decision to acquire the first system. Initially performing cardiac procedures, the facility eventually covered various clinical cases including interventional radiology and interventional neuroradiology. As cardiovascular cases increased, it was essential for TMC to be fully equipped to address their growing clinical challenges.

Expansion of the institution's Cardiac and Vascular Catheterization Laboratory was intended to complement the first cath lab by enabling simultaneous procedures to be performing when the need arises. In 2014, the second Artis zee was installed equipped with a small cardiac detector and DSA capabilities.

The small cardiac detector profile allows steeper angulations for the interventional cardiologist at optimized image quality for cardiology. CLEARstent allows precise visualization of stent deployment and is instrumental in performing both simple and complex percutaneous coronary intervention (PCI) – enabling physicians to fully assess stent expansion, overlap, and position.

Another key element in the acquisition of the second Siemens cath lab was the integration of both angiography labs. With the seamless and bidirectional sharing of hemodynamic, image and dose data, a returning patient with post-interventional complications can be examined in either operating rooms without delay, eliminating waiting time especially for patients who require immediate attention.

With the availability of both labs for cardiac imaging, TMC's Cardiovascular Center can respond to emergency cardiac cases through its Acute Myocardial Infarction Program where primary PCI can be performed even within a narrow time frame. "The program targets a 90 minute door-to-balloon time. This means that a heart attack patient who comes through the doors of our hospital emergency room should have the blocked coronary artery opened in the cath lab within 90 minutes," explains Gregorio Martinez, Jr., MD, Head of the Cardiac and Vascular Catheterization Laboratory and the Cardiovascular Center at TMC. "Moreover, an integrated cath lab setup further increases patient safety and throughput."

With its proven track record and after sales support, Siemens was The Medical City's partner of choice in the treatment and alleviation of cardiovascular diseases in the Philippines.

"Moreover, an integrated cath lab setup further increases patient safety and throughput."

Gregorio Martinez, Jr., MD,
Head of the Cardiac and Vascular Catheterization Laboratory and the Cardiovascular Center at The Medical City (TMC) in Pasig City, Philippines

First Artis one in Brazil: A loyal partnership

Roberto Vieira Botelho, MD, is one of the few Brazilian doctors testing bioabsorbable coronary stents in an international clinical trial involving 15 countries conducted at the Eurolatino Medical Center (EMC). As one of the leading cardiologists worldwide, he recalls very vividly how his relationship with Siemens started 20 years ago.

"As I was still a resident, Siemens invested in me. They agreed to provide funding to support a collaboration project with Latin America that I was responsible for. As a result the first COROSKOP T.O.P. was installed. That helped me acquire a deeper understanding of image quality and radiation dose at a very early stage. Consequently, I became deeply familiar with imaging techniques. This knowledge helped me many years later to take imaging one step further and create the Tele-medicine Network. The DICOM images produced by our Artis systems are available here on my cell phone," says Botelho as he taps on the app that he developed himself giving him access to all the imaging performed at his Center. "With the Tele-medicine Network, I can look up on my phone the exams being done and their results anytime and from anywhere."

The Eurolatino Medical Center – part of the UMC Center in Uberlândia, a huge center that sees around 5,000 patients per year in the cath lab – is expanding exponentially. Still, it always focuses on delivering the highest quality of treatment. The Eurolatino Medical Center received the FDA inspection and approval for adhering to the applicable statutory requirements and FDA regulations governing the conduct of clinical investigations and the protection of human subjects. Bound by international quality requirements, Botelho and team decided to acquire the first Artis one for the Eurolatino Medical Center in Brazil to provide uncompromised cardiac imaging for all procedures. They were especially pleased with the easy system positioning, the onscreen user interface, and the excellent imaging. "The HeartSweep is something we tried to do manually with our systems. It took too long and used too much contrast to obtain the right images. It is very impressive that the system achieves dual-axis rotation in just five seconds with such high image quality," says Botelho.

"The Artis one is the next piece of Siemens equipment that will help us increase our patient flow."

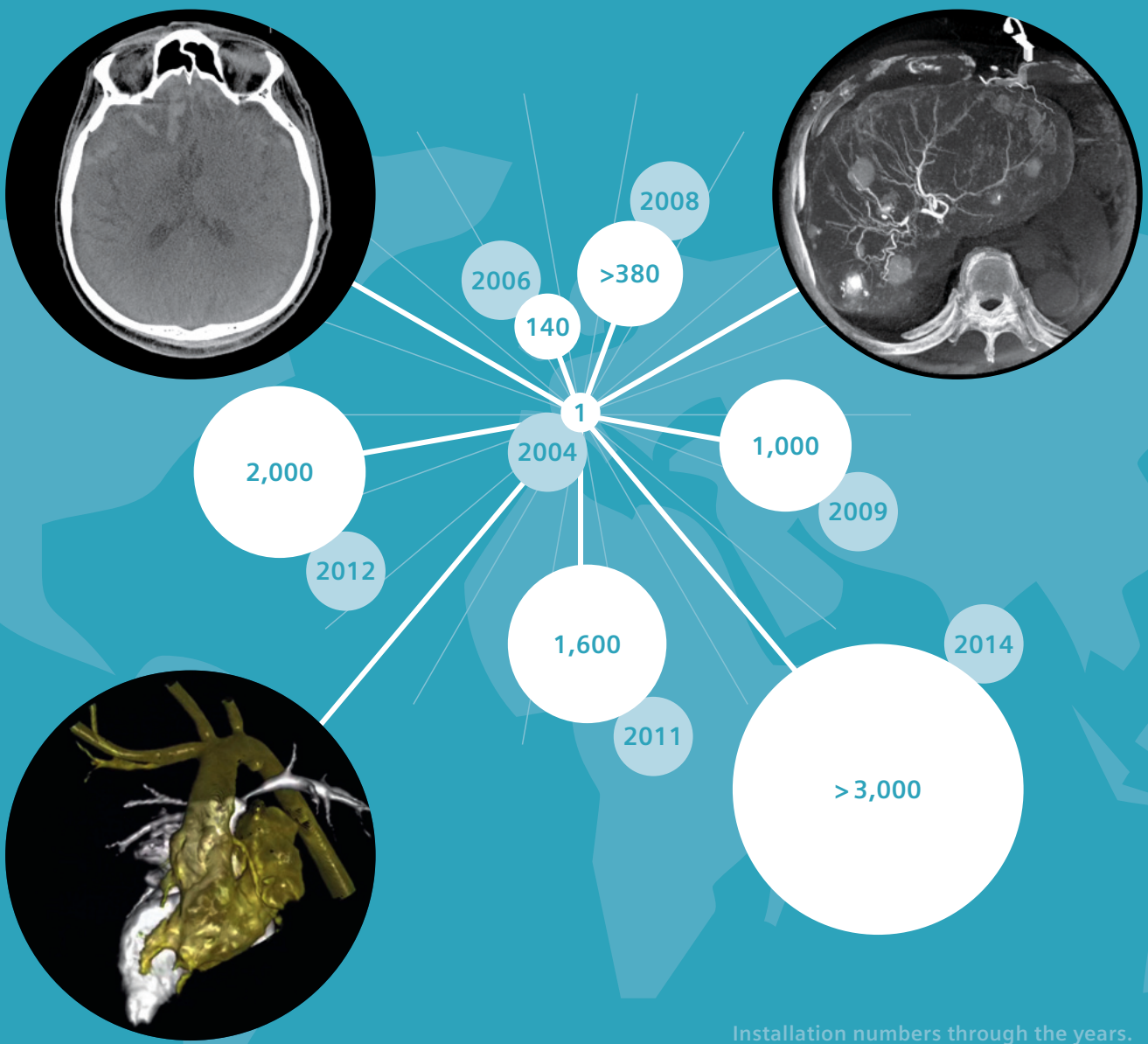
Roberto Vieira Botelho, MD,
President Director of the Eurolatino Medical Center (EMC) and of the Uberlândia Medical Center (UMC)

The UMC continues to expand. "In the near future we want to build two new hybrid operating rooms and we will also bring in other specialists, such as orthopedics and neurosurgeons to work here with us. The Artis one is the next piece of Siemens equipment that will help us increase our patient flow," says Botelho.

A Decade of *syngo* DynaCT: A Revolution in Angiography

Text: Diana Smith

More than ten years ago, Siemens was the first to introduce an innovative new imaging technique using cone beam computed tomography (CBCT) to create CT-like cross-sectional images in the angiography suite. In this setting, *syngo* DynaCT revolutionized decision-making and provided groundbreaking support for complex interventional neuroradiology, radiology and cardiac procedures.



Installation numbers through the years.

"We could see vascular abnormalities and the surrounding environment with a degree of detail we had never had before."

Charles Strother, MD,
Emeritus Professor at the University of Wisconsin School of Medicine and Public Health in Madison, Wisconsin, USA

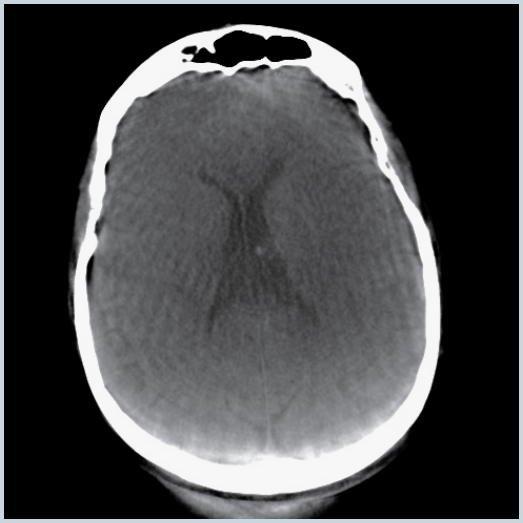
"It has become an everyday tool such that one hardly thinks twice about using it."

Ziv Haskal, MD,
Professor of Radiology at the University of Virginia School of Medicine in Charlottesville, Virginia, USA

"It has improved our clinical workflow because the decision on which device to use is made much easier and better."

Christian Schlundt, MD,
Cardiologist and Researcher at the University of Erlangen Medical School, Germany

2004

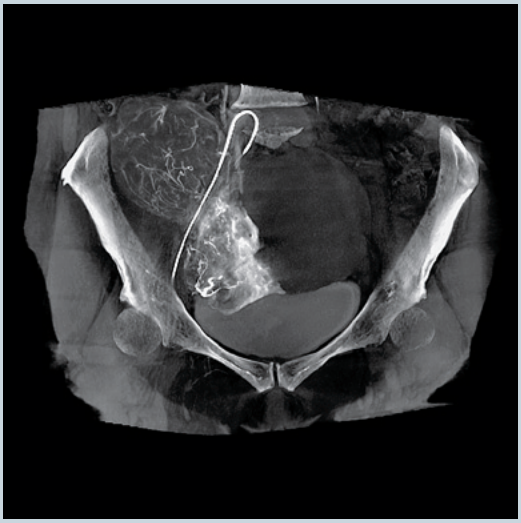


***syngo* DynaCT**
The first CBCT is launched

2007

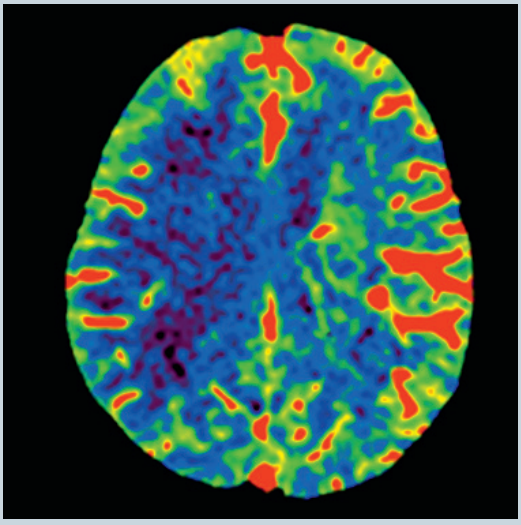
***syngo* DynaCT Cardiac**
A dedicated DynaCT application for the heart

2008



***syngo* DynaCT Large Volume**
A DynaCT acquisition unique to Artis zeego enables a larger field of view

2009



***syngo* DynaPBV Neuro**
Parenchymal blood volume images obtained in the angiography suite

A decade ago, neuroradiologist Charles Strother was one of the first to recognize the significant benefits of a new technology – *syngo* DynaCT – and pioneered efforts to bring this technology to the angiography suite. With a career spanning 45 years, Charles Strother, MD, is an internationally recognized expert in interventional neuroradiology and an Emeritus Professor at the University of Wisconsin School of Medicine and Public Health in Madison, Wisconsin, USA. He served as a key consultant for Siemens engineers in developing the DynaCT application, and contributed to an article in the very first issue of AXIOM Innovations where *syngo* DynaCT was first featured.

"I was in Houston at the Methodist Hospital when we had the first DynaCT," he recalls. "We were obviously excited about the ability to do CT-like imaging with an angiography system. I remember everyone was very excited about the ability to see blood in the angio suite – to see big hemorrhages and look at the relationships of the vessels to the soft tissue structures. We could see right away that this was an element that had been missing," he adds.

Better treatment decisions

The new DynaCT technology quickly became an essential guidance tool, enabling physicians to visualize brain tissue and detect intracranial hemorrhages. "We could see vascular abnormalities and the surrounding environment with a degree of detail we had never had before," Strother says. "If you saw the ventricles were getting larger, you might decide to put a ventricular drain in before you did the angiogram. If you saw bleeding was to an extent causing great pressure on the brain, it might be necessary to go to the operating room before the angiogram," he says.

Time is brain

The ability to obtain soft tissue images quickly during the interventional procedure contributes to faster interventions and eliminates the risky and difficult process of moving patients with ruptured blood vessels to another room for a CT scan. This is a very important step in the treatment process, according to Strother. With today's *syngo* DynaCT, physicians can confirm accurate stent placement rapidly and facilitate aneurysm analysis before coiling, leading to less strain on the patient and better outcomes. Moreover, *syngo* DynaCT is used by some centers nowadays to support the faster management of stroke patients, reducing the "time-to-needle" and improving the clinical workflow.

New frontiers

"I think the next step for *syngo* DynaCT, which has to some extent already been taken, is to try to measure physiological as well as anatomical parameters using *syngo* DynaCT," says Strother. "We're trying to do the same type of perfusion imaging that's done with multidetector

CT and we've had success in that. Measuring perfusion in the angio suite adds value to the selection of patients and the treatment of patients with ischemic stroke."

He cites a study entitled "MR CLEAN," published in the January 2015 edition of the New England Journal of Medicine [1]. "The study showed interventions in acute stroke were not just associated with higher re-perfusion rates, but they're associated with an improvement in clinical outcomes. I think that's going to significantly increase the volume of ischemic stroke patients who are seen and treated in the angio suite, which will play right into the strong points of *syngo* DynaCT to be able to measure their perfusion parameters."

Strother notes, "Within three to five years, you'll see the significant increase in the use of these physiological measurements, and then who knows what is going to happen? I only wish I were 30 years old again!"

No longer a science experiment

Ten years ago, the accuracy and speed of the system were remarkable for the time, but it could still take seven minutes or longer to obtain the reconstructed information. Now, CBCT datasets are acquired in mere seconds and immediately reconstructed with exceptional accuracy, which is paramount for physician decision-making and improves the workflow.

This has led to the use of *syngo* DynaCT as a daily tool, according to Ziv Haskal, MD, a tenured professor of radiology at the University of Virginia School of Medicine and one of the world's leading experts in interventional radiology. "We use it commonly and routinely for tumor embolization," says Haskal. "It has become an everyday tool such that one hardly thinks twice about using it. The images are strikingly good and surprising, and they have great impact."

Targeting treatment

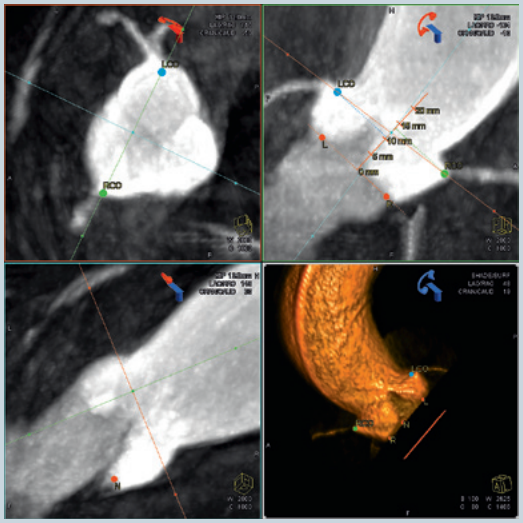
In one example, he explains, "I was treating a patient with colon cancer metastatic to the left lobe of his liver and a lesion between the left and right lobes. Naturally I did not wish to radiate more liver than was necessary – with 2D technique, the arterial supply to the hypovascular tumor was not evident. With DynaCT we found the 'straddling' tumor to be, surprisingly, entirely supplied by the left lobe of the liver – it was crystal clear. We were able to treat all his tumors with left liver radioembolization, reserving the potential for future right radioembolization should tumors appear in the future."

A problem-solving tool

Being able to obtain views of soft tissue using an angiography system has opened up many new applications in abdominal or oncological interventions. Applications range from the visualization of the vascular system, with

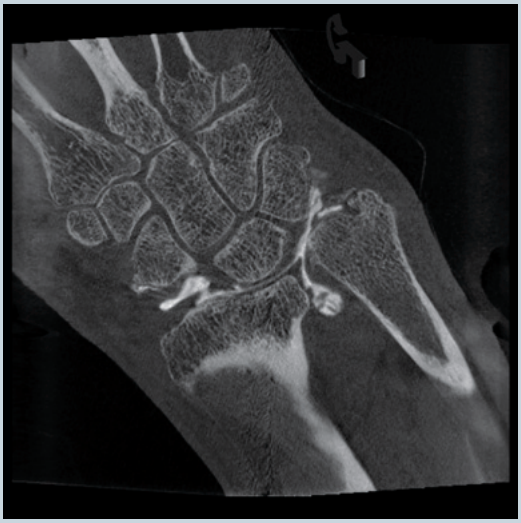
2011

***syngo* DynaCT 360**
A large volume DynaCT acquisition in only 6 seconds

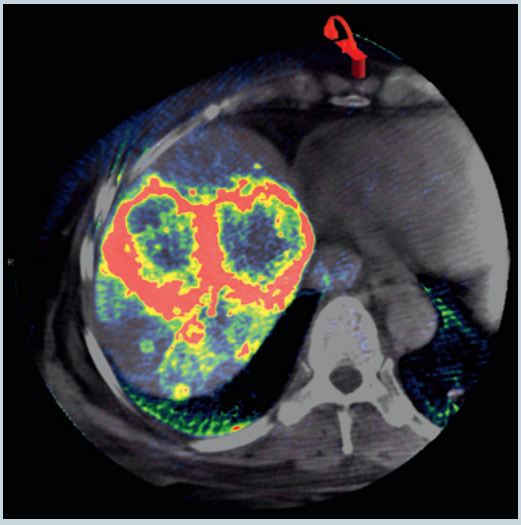


***syngo* Aortic Valve Guidance**
Automatic reconstruction of the aortic root and important anatomical markings with zero user interaction

2012



***syngo* DynaCT Micro**
High-resolution DynaCT images to see the smallest details



***syngo* DynaPBV Body**
Parenchymal blood volume images of the liver

the ability to detect hemorrhages and changes in size, to support for drainage procedures, as well as tumor embolization and ablation.

Haskal mentions that use of *syngo* DynaCT has gained increased recognition in vascular cases, for example to help guide and treat endoleaks in complex abdominal aortic aneurysm endograft repair. He believes that there will be continuing value in complicated removals of vena cava filters, and, certainly, in prostate artery embolizations. Cone beam CT also facilitates non-vascular procedures, such as abscess drainages to be performed in interventional suites, levering both fluoro and CT-like imaging.

Imaging and art

"The ability to use 3D imaging or to understand 3D structures and their implications is something we've all learned to do and something we're drawn to by this specialty," Haskal explains. "We do this in our heads, but the ability to actually see it in real time and make decisions based on this is the integration of cross-sectional imaging with high art."

Cardiac: a new perspective

In 2007, Siemens introduced a further innovation to the DynaCT family – *syngo* DynaCT Cardiac. Building on the breakthrough DynaCT technology, *syngo* DynaCT Cardiac enhances diagnostic and therapeutic capability by allowing physicians to visualize in 3D cardiac structures, such as the left atrium, during interventional procedures, reducing the need for pre-procedural CT or time-consuming magnetic resonance imaging (MRI) exams.

Christian Schlundt, MD, a cardiologist and researcher at the University of Erlangen Medical School in Erlangen, Germany, is using *syngo* DynaCT Cardiac increasingly to support interventional procedures such as left atrial appendage (LAA) closure. Recent interest has focused on the left atrial appendage as a potential source of thromboembolism and stroke in patients with atrial fibrillation, which may be amenable to permanent occlusion using catheter delivered devices.

Precise sizing, less dose

According to Schlundt, the use of *syngo* DynaCT Cardiac during LAA closures enables precise 3D analysis and sizing, which increases the potential to accelerate the procedure and make it safer since less contrast and radiation are needed. "That's the real advantage of doing a DynaCT Cardiac run (for those patients) because the data you get from *syngo* DynaCT Cardiac is very reliable, and it is real-time data. When choosing your devices to close an LAA, for example, DynaCT Cardiac gives you the exact measurements you need."

syngo DynaCT Cardiac uses images acquired from one rotational angiography run to display the 3D morphology of the heart, including the left atrium and left atrial

appendage. Image acquisition is achieved in about five seconds after injection of the contrast agent into the LAA. The 3D image is obtained by 3D reconstruction on the *syngo* X Workplace and is available for assessment in less than 20 seconds after acquisition.

"In my opinion, *syngo* DynaCT Cardiac should be a part of the routine, for example in LAA closures and perhaps closures of paravalvular leakages," says Schlundt. "It has improved our clinical workflow because the decision on which device to use is made much easier and better. We often do our sizing using *syngo* DynaCT Cardiac. It is so reliable and this helps you choose the right device to close such defects. We use one device, for example, not two or three devices, which is how it worked when deciding by echocardiography, for example. This translates into substantial cost savings in the service line."

Thoughtful interventions as people live longer

According to Schlundt, as the population ages and the prevalence of heart disease increases, performing interventional procedures with as little strain on the patient as possible will become increasingly important. "I think that the situations are getting more complex in a lot of cases of structural heart disease and many of our patients are older. Often, we need all the information about the heart we can get." *syngo* DynaCT Cardiac can deliver this level of detail.

Improved information, better decisions

syngo DynaCT is a valued technology being used in various clinical fields. It has been constantly improved by Siemens over the years, making it faster and easier to use while delivering excellent image quality. It has been enhanced by additional applications like *syngo* DynaCT Micro for high resolution images or *syngo* DynaCT SMART for reduction of metal artifacts, and, it provided the base for more imaging innovations in the interventional suite, such as *syngo* DynaPBV which depicts blood volume in tissue.

From the Industrial Revolution to the Information Age, technology has improved lives. In the medical arena, advancement in imaging techniques has paved the way for more informed decision-making, leading to maximized patient care, shorter procedures, and improved outcomes. Siemens *syngo* DynaCT, introduced in 2004 and constantly improving since, is a prime example.

Contact

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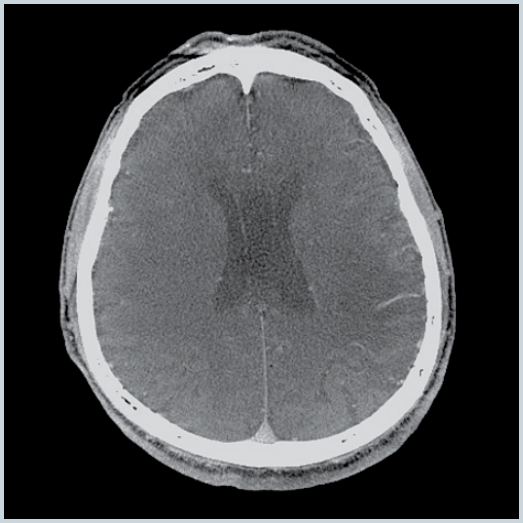
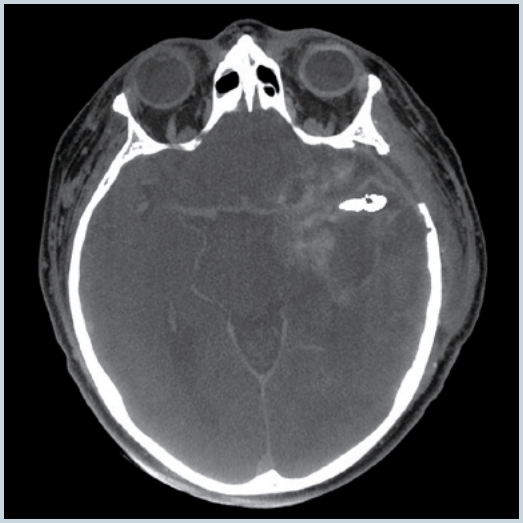
2012



***syngo* DynaCT with HDR detector**
Unmatched excellence in soft contrast resolution with *syngo* DynaCT on Artis Q systems

2014



***syngo* DynaCT SMART**
Reduction of metal artifacts in DynaCT images

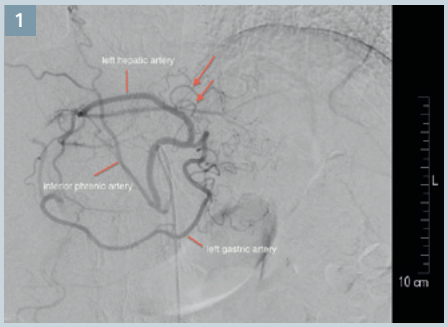
Chemoembolization with Drug-Eluting Beads (DEB-TACE) Supported by *syngo* DynaCT

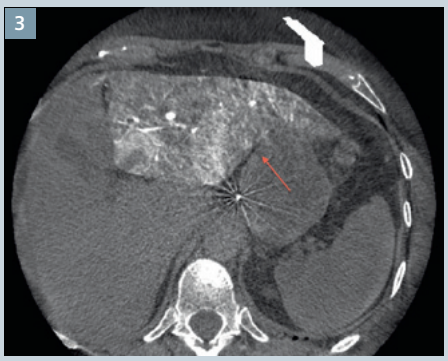
Courtesy of Tobias F. Jakobs, MD

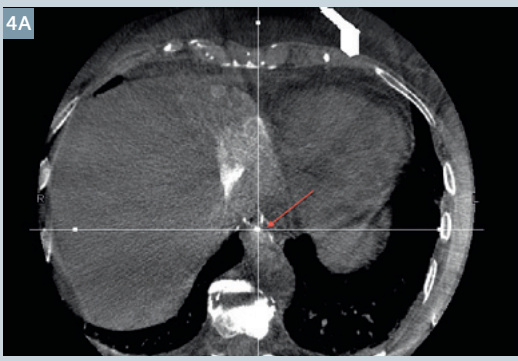
Department of Diagnostic and Interventional Radiology, Barmherzige Brueder Hospital, Munich, Germany

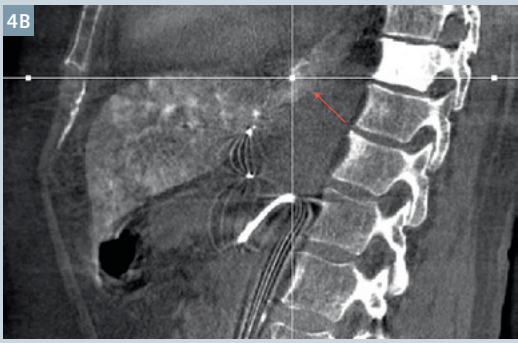
A 63-year-old female with liver metastases from breast cancer. SIRT (selective internal radiation therapy) of the right liver lobe was performed. Due to the complex arterial anatomy of the left liver lobe, SIRT of the left liver lobe was abandoned and DEB-TACE was scheduled.

syngo DynaCT, performed in order to confirm catheter position before embolization, revealed contrast enhancement in the distal esophagus. The images indicated that special consideration should be taken during embolization in order to avoid reflux into the inferior esophageal arteries, which were hardly noticeable in the DSA images.









1 Complex arterial anatomy of the left liver lobe with gastric branches (arrows) arising from the left hepatic artery.

2 Power injection angiography run: A falciform artery is visualized immediately (red arrow) by inserting a microcatheter in the left hepatic artery distal to the origin of the gastric branches. Suspicious arteries crossing the diaphragm are detected (blue arrows).

3 Instant multiplanar reformats (MPR) to demonstrate the contrast uptake of segments 2 and 3 of the left liver lobe without contrast enhancement of the gastric wall (arrow).

4 Furthermore, MPR visualizations (4A, 4B) reveal contrast enhancement of the distal esophagus (arrows), indicating that the suspicous arteries in figure 2 (blue arrows) are inferior esophageal arteries that should not be embolized with drug-eluting beads.

Published June 2012.
For the complete case see:
AXIOM Innovations Issue no. 15, pp. 24–25

Treatment of an Internal Carotid Artery Aneurysm Supported by *syngo* DynaCT

Courtesy of Demetrius Lopes, MD

Department of Neuroendovascular Surgery, Rush University Medical Center, Chicago, USA

A 65-year-old male with hypertension and history of myocardial infarction and coronary stenting with incidental left internal carotid artery aneurysm. The patient was still on antiplatelet medication which increased the risk with surgery. The aneurysm had a wide neck which made simple coiling a poor option and so it was decided to place a stent across the aneurysm and then proceed with coiling.

syngo DynaCT was used to check the correct deployment of the stent across the aneurysm and to further analyze the aneurysm architecture before coiling.

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

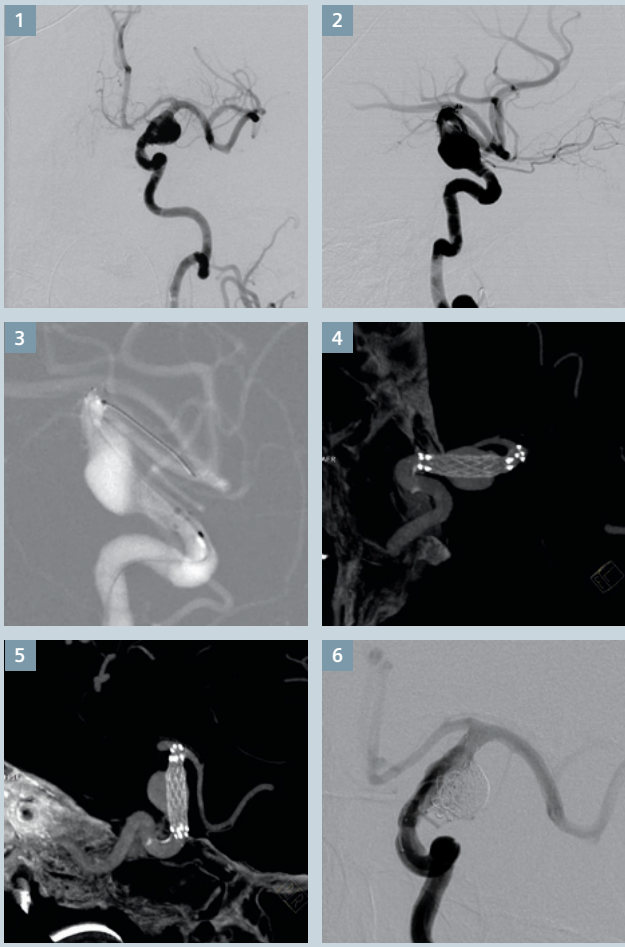
2 Lateral DSA of left ICA aneurysm.

3 Advancement of micro-catheter through first stent for deployment of second stent. The radio-opaque lines demonstrate the limits of the first stent.

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

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

6 Final AP angiography showing occlusion of the aneurysm.



Published June 2011.
For the complete case see:
AXIOM Innovations Issue no. 13, pp. 22–23

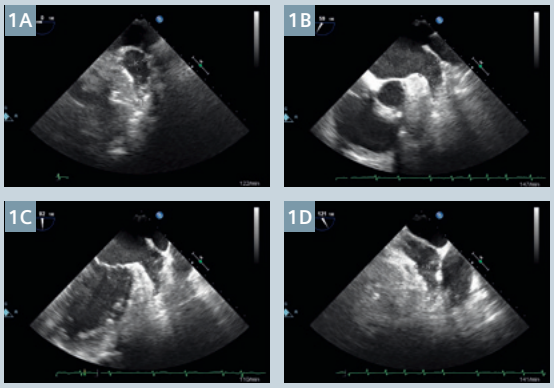
Left Atrial Appendage Closure Supported by *syngo* DynaCT

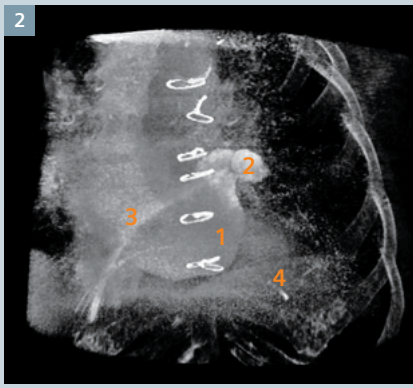
Courtesy of Markus Füller, MD, Georg von Bodman, MD, and Michael Block, MD

Department of Cardiology, Augustinum Hospital, Munich, Germany

An 82-year-old male patient presented with recurrent large subcutaneous hematomas and suffusion bleeding under oral anticoagulation with phenprocoumon and additional steroid therapy for treatment of polymyalgia rheumatica. Oral anticoagulation was required for persistent atrial fibrillation with a CHA2DS2-VASc Score of five points. The patient had undergone aortocoronary bypass grafting 20 years ago and had had a cerebrovascular transient ischemic attack two months before. The patient was referred for interventional left atrial appendage (LAA) closure.

syngo DynaCT Cardiac was used to easily find the working C-arm angles which best visualized the LAA ostium during the procedure.



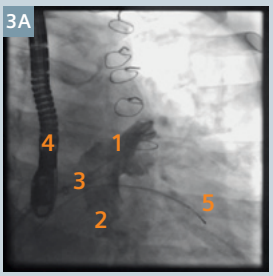


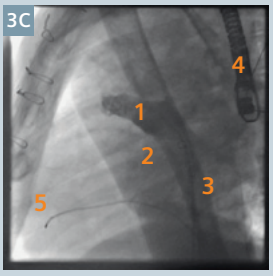
1 Pre-procedural TEE showing the left atrial appendage in 0° (A), 59° (B), 92° (C) and 121° (D) views. LAA ostium diameter was 19.2 – 21.0 mm, LAA length was 28.5 – 35.6 mm.

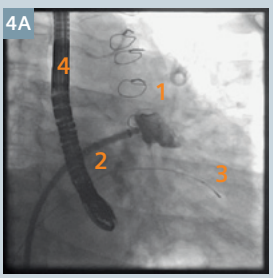
2 Rotational angiography of the left atrium showing LA (1), LAA (2), Watchman™ access sheath (3) and temporary pacing lead (4).

3 Fluoroscopic images of angiographies of the LAA in a RAO 21°, caudal 20° (A) and a LAO 104°, caudal 6° view (C). Corresponding overlay images (B and D) of three dimensional LAA reconstructions and fluoroscopy images using *syngo* iPilot. 1: LAA; 2: Left atrium; 3: Watchman™ access sheath; 4: TEE probe; 5: Temporary pacing lead.

4 Fluoroscopy (A) and overlay image (B) showing Watchman device after device deployment in a RAO 21°, caudal 21° view. 1: Watchman™ device; 2: Assembly of access sheath and device delivery system; 3: Temporary pacemaker lead; 4: TEE probe.







Published December 2013.
For the complete case see:
AXIOM Innovations Issue no. 17, pp. 40–41

Since the introduction of *syngo* DynaCT, the AXIOM Innovations magazine has published more than 50 clinical cases describing the contribution of *syngo* DynaCT and *syngo* DynaCT Cardiac to various clinical procedures performed in the fields of interventional radiology, interventional oncology, neuroradiology, structural heart disease, electrophysiology, and several surgical disciplines.

Some additional examples:

- **Airway Stenting supported by *syngo* DynaCT**
  Courtesy of Xinwei Han, MD
  Director of Interventional Radiology Department, Hospital of Zhengzhou University, Henan, China
  featured in AXIOM Innovations Issue no. 13, pp. 26–27
- **Benign Prostatic Hyperplasia supported by *syngo* DynaCT**
  Courtesy of Marc Sapoval, MD, PhD
  Department of Vascular and Oncological Interventional Radiology, Hopital Europeen Georges Pompidou, Paris, France
  featured in AXIOM Innovations Issue no. 19, pp. 40–41
- **Accurate Placement of Flow Diverter Device supported by *syngo* DynaCT**
  Courtesy of Ciceri Elisa, MD, Faragò Giuseppe, MD, Caldiera Valentina, MD, Sagaria Nazario, and Listrani Massimiliano
  Neurological Institute C. Besta, Milan, Italy
  featured in AXIOM Innovations Issue no. 17, pp. 28–29
- **Revision of an AAA Endograft supported by Artis zeego and *syngo* DynaCT**
  Courtesy of Amit V. Patel, MD
  Morristown Memorial Hospital, NJ, USA
  featured in AXIOM Innovations Issue no. 11, pp. 42–43
- **Stent Intervention in a 5-Month-Old Child supported by *syngo* DynaCT**
  Courtesy of Gregor Krings, MD
  Department of Pediatric Cardiology, Children's Heart Center, University Medical Center Utrecht, The Netherlands
  featured in AXIOM Innovations Issue no.18, pp. 34–35
- **Accurate Placement of Aortic Valves supported by *syngo* DynaCT Cardiac**
  Walters DL, MD (1), Crowhurst J., Chief Radiographer (1), and Aroney C., MD (1,2)
  (1) Cardiology Department, Prince Charles Hospital, Brisbane, Qld., Australia
  (2) Holy Spirit Northside Private Hospital, Chermside Qld., Australia
  featured in AXIOM Innovations Issue no. 14, pp. 36–37
- **Treatment of Atrial Fibrillation supported by *syngo* DynaCT Cardiac**
  Johannes Brachmann, MD, and Georg Nölker, MD
  Department of Electrophysiology, Coburg Hospital, Germany
  featured in AXIOM Innovations Issue no. 7, p. 35

For more clinical cases and additional information, please visit www.siemens.com/dynaCT or scan the code above.

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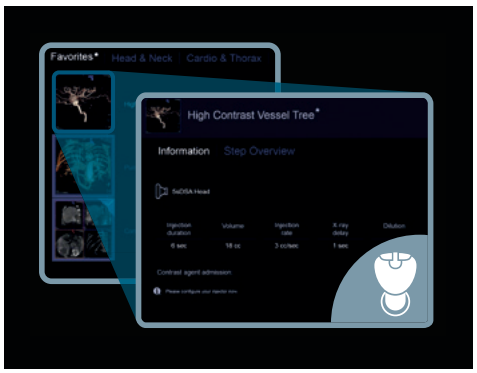

Incorporating Temporal Information into 3D Imaging – Visualizing 3D Flow Patterns Supported by *syngo* Dyna4D

Courtesy of Demetrius Lopes, MD

Rush University Medical Center, Chicago, USA

Patient History

A 13-year-old girl had been diagnosed with a left-frontal intraparenchymal hemorrhage ten months ago. On readmission, she presented with decerebrate posture and a dilated left pupil. Following an emergent decompressive hemicraniectomy and hematoma evacuation, she recovered to the point of voicing some words and following commands with a right hemiplegia. She was found to have a cerebral arteriovenous malformation.

Demetrius Lopes, MD

Diagnosis

The patient had a Spetzler-Martin grade IV left-frontal AVM with deep arterial supply. It was partially embolized via the left-anterior cerebral artery 10 months after rupture, but still had significant filling. A *syngo* Dyna4D acquisition was performed to inspect the AVM-related vessels. Based on this imaging, it was decided that a venous route would actually be preferable to a transarterial embolization via lenticulostriate feeders.

Treatment

The patient was taken to the angiography suite, and general anesthesia was administered. Access to both the femoral artery and vein were obtained using 5 and 6 French sheaths, respectively. A 5F diagnostic catheter was placed in the left internal carotid artery. A Navien™ 0.72", 95 cm guide catheter (eV3) was placed in the venous system. A Marathon™ microcatheter and Mirage™ microwire (both eV3) were guided to the AVM through a large draining vein. Onyx-18 was then injected into the AVM through the vein.

The patient tolerated the procedure well, eventually having further embolizations through an anterior cerebral artery branch and a second venous embolization. She is doing well, and now has had stereotactic radiosurgery for the small residual AVM.

Comments

syngo Dyna4D enables the assessment of complex AVM patterns, the identification of high-flow arterial AVM feeders, as well as the delineation of the vascular interaction within the AVM at any filling stage and from all viewing angles. Following embolization, the treatment product can be easily assessed via *syngo* Dyna4D and aids in further patient treatment decisions. Overall, the flow visualized in *syngo* Dyna4D corresponds to the flow in 2D DSA, adding volumetric information as well as the ability to visualize implanted structures such as onyx casts, but also stents and clips.

Protocol

12s Dyna4D, 3 ml/s, 21 ml,
7s injection duration, 100% contrast,
0.5s X-ray delay

"syngo Dyna4D enables the assessment of complex AVM patterns, the identification of high-flow arterial AVM feeders, as well as the delineation of the vascular interaction within the AVM at any filling stage and from all viewing angles."

Demetrius Lopes, MD,
Rush University Medical Center, Chicago, USA

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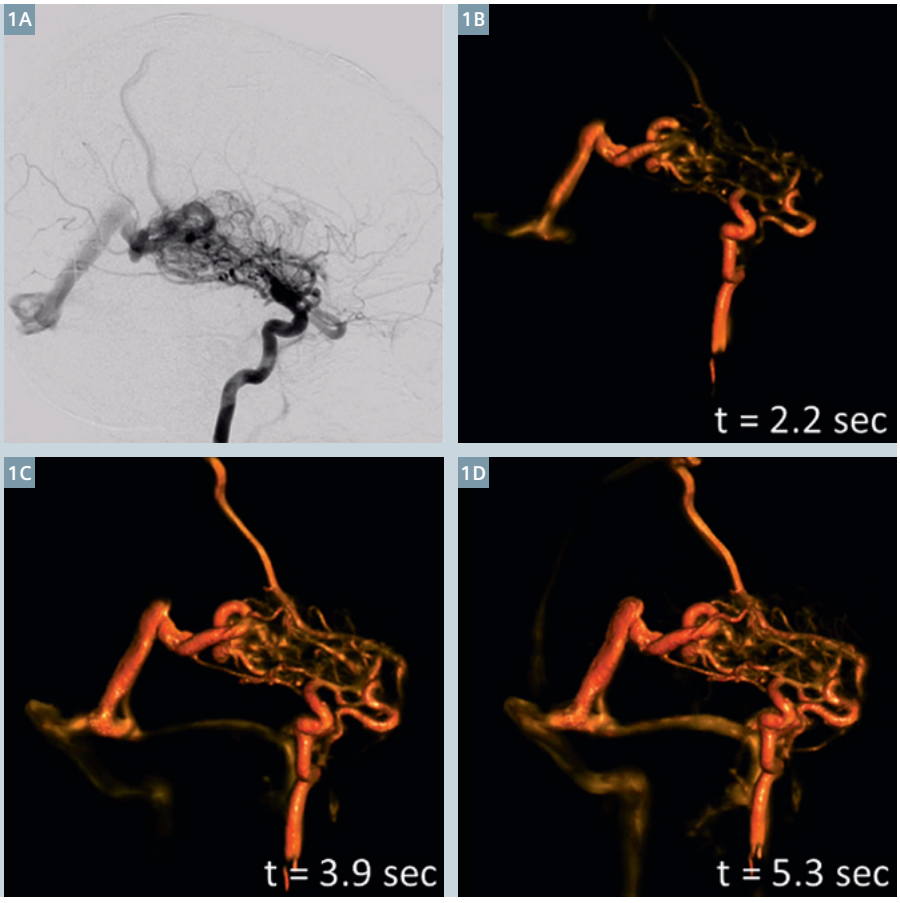
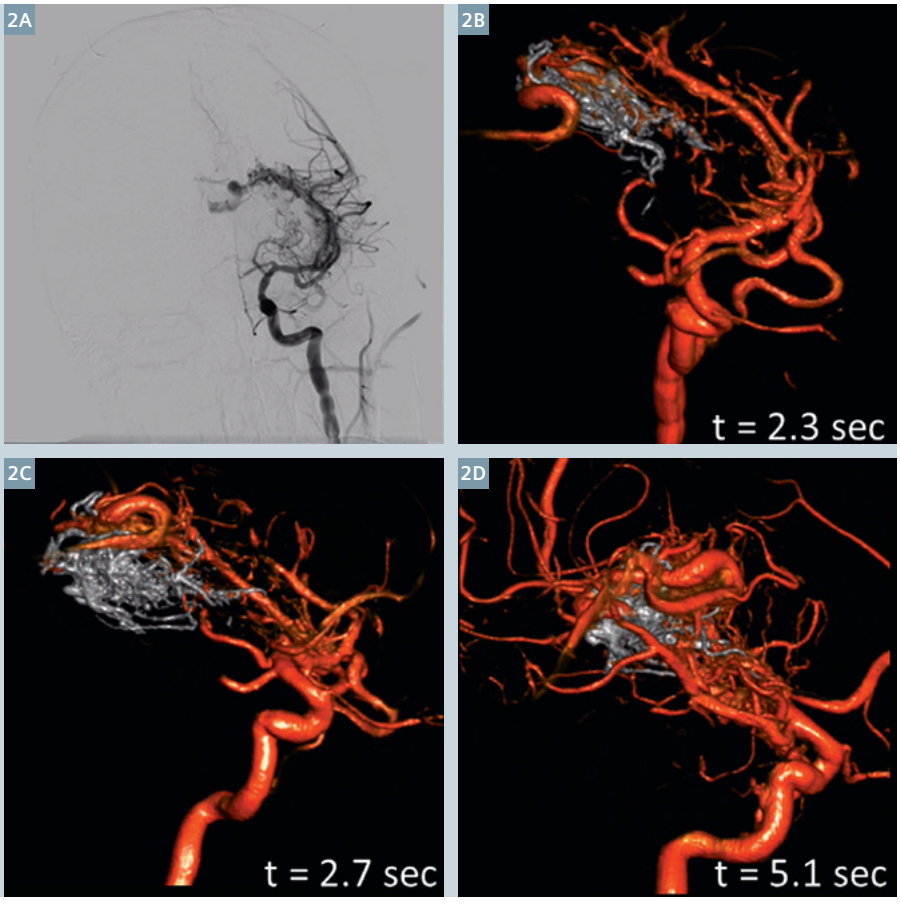
1 Diagnostic assessment of AVM prior to first treatment with onyx embolization. (1A) 2D DSA shows intricacy of AVM, but it is difficult to assess the complex in-flow and interaction within the AVM. (1B – 1D) Multiple *syngo* Dyna4D time-points allow assessment of high-flow AVM feeding arteries, as well as a better understanding of vessel connectivity. Time shown indicates seconds elapsed since acquisition start.



2 Assessment of treatment following AVM embolization. (2A) 2D DSA relevance is reduced by AVM overlay of structures of interest. (2B – 2D) *syngo* Dyna4D allows visualization of the created onyx cast with respect to the remaining vasculature and at any time-point from any view, as well as variable zoom. Time shown indicates seconds elapsed since acquisition start.



Integrated Solution Supports Leading Vascular Procedures

Huaqiao Hospital in Guangzhou is a leader in treating vascular diseases. Its Siemens Sensis recording system allows the hospital to integrate cardiology intervention, peripheral intervention, and hybrid procedures.

Text: Mathew Scott

"In fact, Sensis is used all the time, for all kinds of interventional procedures, and the greatest advantage is the integrated nature of Sensis."

Professor Xiaobai Wang, MD,
Huaqiao Hospital, Guangzhou, China

Huaqiao Hospital, Guangzhou, China.

China's rapid development over the past two decades has captured the imagination of the world, as the nation's emergence as an economic superpower lifts millions upon millions out of poverty. Such growth was recognized late last year when the International Monetary Fund (IMF) declared China to be the world's largest economy. This followed on from its prediction that China would make up 16.48% [1] of the world's gross domestic product (GDP) based on purchasing power parity by the end of 2014 – ahead of the United States at 16.28% [1]. But the changes that China is undergoing are not simply a matter of dollars and cents.

The health of China's estimated 1.4 billion people has also captured the headlines, as the country's medical profession faces new challenges and the ever developing needs of the modern Chinese community.

"China is a developing country," says Xiaobai Wang, MD. "Around the time the 'New China' was founded," – the People's Republic, in 1949 – "the major diseases were those such as influenza. In the second phase, it was tumor-related diseases. Now, as we are getting older, a lot of diseases are vascular."

At the forefront of innovation

Wang is well placed to respond to this development. He heads the imaging center and the interventional and vascular department at Huaqiao Hospital in the southern metropolis of Guangzhou, one of the leading medical institutions in China. In order to further prepare China's health system to deal with the increased prevalence of wealth-related diseases, he also takes a very hands-on role in the education and development of the next generation of his country's medical professionals through the hospital's affiliation with Jinan University.

Huaqiao Hospital inaugurated its interventional department in 1985 as a direct response to rising public demand, according to Wang. It has been at the forefront of advances in the treatment of vascular disease and in vascular surgery ever since.

"At present, the treatment of about 70 to 80% of vascular diseases involves interventional vascular surgery," explains Wang. "That's why I combine surgery and intervention; and it's why the hybrid operating room was established."

Vascular surgery at the highest level

"The interventional center of our hospital is a training center for interventional surgery and it is the best of its kind in the country," says Wang. "Any doctor who has trained here and walked away with a certificate can do most kinds of vascular surgeries." Among the procedures performed on the hospital's interventional floor are AAA, peripheral stenting, peripheral thrombectomies as well as interventional oncology, neuroradiology, PCI, and EP procedures.

Wang estimates that his team deals with around 3,000 cases per year – 60% from within Guangzhou, 30% from the surrounding Guangdong Province, and 10% from across the nation, with the occasional case from Southeast Asia. Of these cases, around 1,000 are interventional cardiology, 1,000 peripheral interventions, and around 800 neuro-radiological.

Huaqiao Hospital opened its first hybrid operating room in 2013 with lofty ambitions and Wang is proud of his team's success and the advances in treatment and diagno-

Professor Wang talks about his own particular experiences and knowledge with Sensis.

sis they have been able to explore using their Siemens systems – including a Sensis recording system in all interventional and hybrid suites.

Sensis – a total solution

"We have four operating rooms: Two are conventional, the other two are hybrid. The two hybrid rooms are of the highest standard in the country," he says. Among the systems installed are a Siemens Artis zeego and an Artis one. "The devices here are the best. The hospital's management team had researched options and finally chose Artis and Sensis because this offers a complete solution for the needs of our three departments – cardiology intervention, peripheral intervention, and hybrid procedures."

A highly adaptable system

Whereas usually Sensis might only be used in interventional cardiology, Xiaobai Wang uses it in vascular interventions and in vascular surgery.

"When it comes to interventional procedures, first we have to carry out monitoring work," explains Wang. "For example, we have to monitor the basic vital signs, pulse rate, heart pressure, and SpO_2. Sensis can integrate all these indices so that we have no need for any other devices.

The second step for us is to judge whether treatment is needed," continues Wang. "Morphological diseases are not necessarily functional diseases and functional diseases are not necessarily morphological diseases. We need to check whether there are any functional issues, that is, whether or not the patient's physical well-being is being affected. And Sensis can add this functional information to other imaging data perfectly due to its integrated nature." Wang adds: "The FFR (Fractional Flow Reserve) function is the most frequently used: If the reading is 0.9, then treatment is not needed; but if it drops to 0.7, we need to treat."

His department has trained its entire nursing staff to support any procedure using Sensis. This keeps room usage flexible. These are important adaptations for a hospital that combines interventions with its programs of education. Wang proudly shows his lecture hall, where he uses Sensis recordings to convey the functional information needed for diagnosis in interventions.

"The unique advantage of Sensis is its adaptability." Huaqiao Hospital is even able to do its electrophysiology (EP) procedures in the same operating room – as Sensis is a recording system that works both in hemodynamics and EP. "In fact, Sensis is used all the time, for all kinds of interventional procedures, and the greatest advantage is the integrated nature of Sensis."

[1] http://www.imf.org/external/pubs/ft/weo/2014/02/weodata/index.aspx

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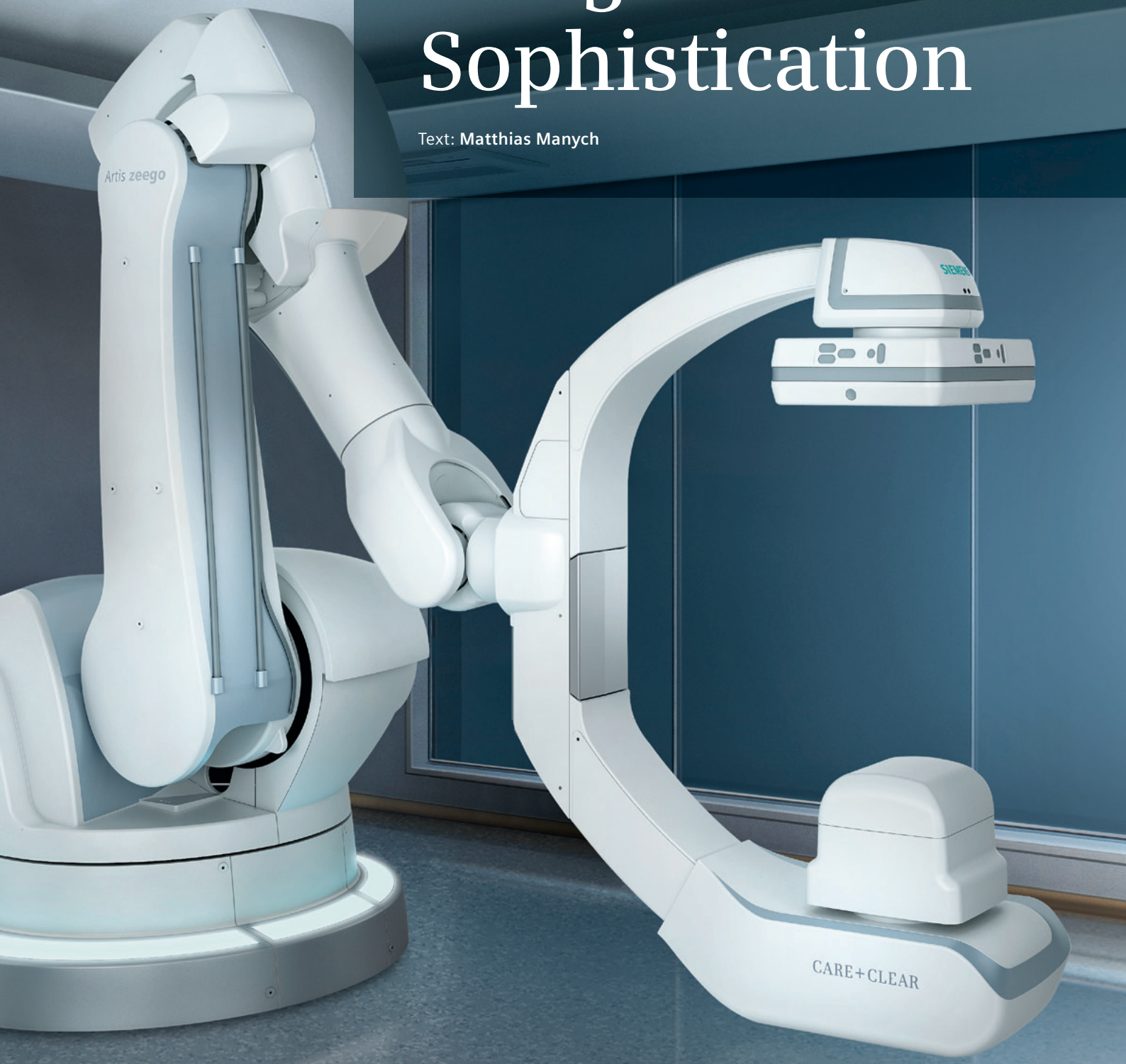
Artis zeego – A High Level of Sophistication

Text: **Matthias Manych**



For optimal results from image-guided treatment, the interventional imaging modality must simultaneously fulfill a number of criteria – it must generate CT-like 3D images, for example, as well as fast, safe maneuverability and maximum flexibility. The Medical Center of the University of Virginia (UVA) in Charlottesville, USA, has been home to the first robotic assisted C-arm system, an Artis zeego, for seven years now. Director of the Radiology Department, Alan H. Matsumoto, MD, and his colleague John Fritz Angle, MD, tell us about their experiences.

Medical Center of the University of Virginia (UVA) in Charlottesville, USA

Alan H. Matsumoto, MD

John Fritz Angle, MD

While the numerical difference between 80 percent and 100 percent may be minimal, this difference can mean the world. This is certainly the case in chemoembolization, for example, a minimally invasive tumor treatment mostly used for advanced cases of liver cancer or liver metastases – a procedure which has been performed at the UVA since the late 1980s. In view of this long history, Matsumoto was not expecting that much of a difference between standard 2D fluoroscopy and 3D imaging using Artis zeego. "Frankly, I was a little surprised at how we were misled by 2D imaging. I learned that we were wrong to feel confident in what we were doing," the radiologist said. "When you treat 80 percent of a tumor, on a 2D image it looks like you have treated it all."

Patients expect carcinomas to be removed down to the very last tumor cell, and as carefully as possible – which indicates a minimally invasive procedure. Likewise, their doctors expect this objective to be reached with 100 percent success. This is why surgeons and radiologists rely on interventional imaging to display every decisive detail from every angle. Artis zeego with *syngo* DynaCT makes it possible to acquire 3D volume images with high-resolution soft-tissue differentiation, which is essential for oncological as well as neuroradiological and abdominal interventions. Doctors can see how much of the carcinoma has been targeted immediately; *syngo* DynaCT with Artis zeego eliminates any false sense of security by ensuring objective results. If only 80 percent of the tumor has been eliminated, doctors can attempt 100 percent success in the same treatment step.

A system for optimizing image-guided therapies

The radiology department of the UVA Medical Center performs around 425,000 examinations per year. Its diagnostic and therapeutic spectrum covers all body areas from head to toe. The department has seven rooms for interventional radiology, one of which is equipped with an Artis zeego, two are used for interventional

"In many ways it has made interventional radiology even more important, because we can offer many of these patients options that are more tolerable than open surgery."

Alan H. Matsumoto, MD,
Department of Radiology,
Medical Center of the University of Virginia (UVA)
in Charlottesville, USA

"The potential of robotics in interventional radiology was very exciting. Everyone was mesmerized seeing the C-arm turning around the patient."

John Fritz Angle, MD,
Department of Radiology,
Medical Center of the University of Virginia (UVA)
in Charlottesville, USA

neuroradiology. Two further Artis zeego are installed in the surgery department. It was here in the 1970s that the innovative doctor and academic Charles Tegtmeyer pioneered minimally invasive therapies (see text box). Over the past 40 years, technological advances mean that as many patients as possible are being given the opportunity for this therapy. The patients who come to the Medical Center in Charlottesville tend to be unhealthy, have a high body mass index (BMI), and suffer from multiple comorbidities. The Artis zeego can support the patient positioning on the table by giving space in the room during patient transfer and supports the resparatory functions of the patient by tilting the table. "In many ways it has made interventional radiology even more important, because we can offer many of these patients options that are more tolerable than open surgery," Matsumoto explains.

When debating which new imaging modality to choose, the priority was clear: Optimizing image-guided therapies. Angle comments, "When we are looking for equipment, first and foremost, the image quality has to be outstanding. This gives us the competence for complex procedures." The goal of the new C-arm system was to enable CT-like images with a large field of view; the C-arm would offer maximum flexibility in the radiology suite, while making procedures much easier for doctors and patients. The objective was to solve a number of problems with a single solution.

A decision was made to choose the Artis zeego. "Siemens picked a piece of technology from another industry that was proven, and applied it to the angiography suite," Angle explains, impressed by the industrial robot that offers unparalleled flexibility in terms of mobility. The innovative technology in the C-arm allows it to be maneuvered around the patient table along six different axes of movement, with a high degree of speed and precision. In its park position, the floor-mounted system can fold back into a compact unit. Since it is not connected to the ceiling in the patient treatment area, the system also meets surgical requirements for hygiene minimally impacting laminar air flow. One of the key features for the UVA interventional radiologists is *syngo* DynaCT Large Volume that covers 45 cm across and 18,5 cm high. This field of view covers large organs, e.g. the liver. Matsumoto explains: "It allows us to see a certain volume in large patients and the entire liver for a possible embolization procedure, or the whole abdomen for the treatment of aortic aneurysm endoleaks." The large 3D volumes are acquired with dedicated protocols for each target area with a scan time starting with only six seconds, which reduces exposure to radiation and increases patient comfort.

Innovation leads to better patient care

The UVA interventional radiologists were among the first worldwide to start using Artis zeego when it was still in the development phase. "The potential of robotics in interventional radiology was very exciting," Angle recalls, "everyone was mesmerized seeing the C-arm turning around the patient." His experiences show how multi-axis mobility has made hybrid interventions significantly easier – and therefore more common. In the same room, for example, interventional radiologists can switch directly from an open stenosis removal to the minimally invasive procedure of opening a constricted area using a balloon catheter. "I think it's a great benefit for the patients," Angle says.

He comments that the imaging is equally impressive: "At the time, that system was absolutely state-of-the-art in quality, and continues to be." When treating the very first patients, the interventional radiologists already noticed the high resolution of the CT-like images. *syngo* DynaCT Large Volume is used every day for planning treatments, as well as for providing a reference for follow-up images.

Precise visualization using Artis zeego is expanding the spectrum of treatments available – such as transarterial

chemoembolization (TACE) for treating inoperable hepatocellular carcinoma, for example. Physicians can now estimate with greater reliability and precision whether the vessel occlusion was reached in its entirety. This is also the case for selective internal radiotherapy (SIRT) with Yttrium-90 microspheres for palliative liver cancer therapy.

A further benefit is the flexible isocenter, which offers a clear advantage for both patient and physician in daily application. Whether the patient table is raised, lowered, or inclined, the flexible isocenter ensures that the target region is always in focus. This saves the team and the patient from troublesome and time-consuming re-positioning – and enables clinicians to continue working in a new position with fewer sequences, less contrast medium, and less radiation.

Confidence and efficiency

In Charlottesville, Artis zeego is employed all along the spectrum of interventional radiology, from the standard to the most complex cases. Working with the robot-guided C-arm increases the confidence of physicians that they will actually achieve what they set out to achieve. When he was on call recently, Angle asked one of the experienced radiology assistants which intervention rooms they should use. The answer? "We use the zeego room. That's the room I can rely on the most." An Artis zeego is not necessary for every angiography suite, but Angle is convinced: "The zeego is a system I cannot imagine being without it. It's extremely useful to have the choice." Alongside the numerous technical advantages of the robot-guided C-arm, it also saves time since Artis zeego accelerates the entire interventional procedure. It is no surprise that even after almost seven years, the UVA interventional radiologists are still so enthusiastic about Artis zeego.

Matthias Manych is a biologist and freelance scientific journalist, editor, and author with a focus on medicine. His work appears primarily in specialist journals, but also in newspapers and online.

Charles J. Tegtmeyer – The winding road to medical innovation

Charles J. Tegtmeyer is now known as one of the fathers of percutaneous transluminal angioplasty (PTA), yet his career path was far from straightforward. His first detour involved studying geology in the early sixties, before later arriving at medicine. His second detour was in 1978 when he was a professor at the University of Virginia; he traveled to Zurich, Switzerland, with fly fishing gear in his luggage. Tegtmeyer hoped to find out more about balloon dilation in PTA and met Andreas Schneider, MD, who was manufacturing special balloons in his garage – and was also an enthusiastic fly fisherman. They decided to exchange equipment, which is how Tegtmeyer ended up taking angioplasty balloons back to Virginia in his luggage. The very same year, he performed the first PTA in kidney arteries and pelvic arteries in the USA. A few years later, he became known as the father of PTA.

Tegtmeyer was also a trailblazer in clinical education. Recognizing the need for specially trained radiology assistants, he founded and directed a postgraduate school for angiography, interventional radiology, and special procedures. "And to this day, 36 years later, and after Tegtmeyer passed away in 1996, we still have this school," Matsumoto says proudly.

Contact

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Changing Traditional Multi-Session TACE Treatment Planning and Follow-up using *syngo* DynaPBV Body

Ronan Ryan, MD, from the Department of Interventional Radiology at St. Vincent's University Hospital (SVUH) in Dublin, Ireland, uses innovative imaging technologies, such as *syngo* DynaCT and *syngo* DynaPBV Body, to improve the clinical efficiency of multi-session transarterial chemoembolization (TACE) treatments.

As advocate of the benefits that *syngo* DynaCT can offer in TACE procedural planning, Ryan routinely relies on a preoperative contrast-enhanced DynaCT run for treatment planning, and a postoperative non-contrasted DynaCT run for endpoint determination. The contrast-enhanced *syngo* DynaCT dataset provides exceptional imaging of the tumor vasculature. This is crucial in assessing tumor progression, including relevant tumor feeders, prior to the intervention. In addition, the non-contrast *syngo* DynaCT dataset helps to verify the distribution of embolic agent and cytotoxic drug within the treated tumor.

For multi-session TACE treatments in particular, *syngo* DynaPBV Body provides the physician with the additional benefit of interval imaging information. This helps to assess residual tumor response. The perfusion imaging is accurate in detecting residual viable tumor and useful in planning further treatments without the need for additional interval imaging.

How do you use *syngo* DynaPBV Body to make assessments in your multi-session TACE treatments?

syngo DynaPBV Body provides information about the location of the residual tumor, its volume, and the vessels supplying it. For multi-session TACE procedures, we now acquire a *syngo* DynaPBV Body of the treated lesion at the end of the procedure and another DynaPBV run at the beginning of the following treatment. A comparison between the post-treatment *syngo* DynaPBV Body data from the previous session with the pre-treatment *syngo* DynaPBV Body data from the following session indicates whether the areas that were well-embolized show recurrence. Seeing tumor enhancement and increased blood volume values in the pre-treatment dataset of the successive session tells me that I would need to treat it in a subsequent session.

How did *syngo* DynaPBV Body change your clinical workflow for TACE treatments?

Previously, we performed diagnostic CT at the beginning in order to plan the number of TACE sessions required for treatment. TACE sessions were planned with approximately four to six weeks interval time and targeted lesions were treated angiographically at each session. Then, four weeks after all of the planned TACE sessions we sent the patient for another diagnostic CT to identify residual enhancing lesions and plan subsequent sessions.

Now, we run *syngo* DynaPBV Body during each TACE session. As a result, during our last planned TACE session, *syngo* DynaPBV Body revealed residual enhancement in the large, dominant index lesion that we had originally treated, as well as other areas of enhancing tumors in the right liver lobe. Thus, we treated the other enhancing lesion first and planned to bring the patient back for an additional session without having to repeat the diagnostic CT. The diagnostic information from *syngo* DynaPBV Body is probably better than that from four-phase CT scans. *syngo* DynaPBV Body gave us the confidence to know exactly what was required at each subsequent step from an interventional standpoint, without the need for additional imaging.

Contact

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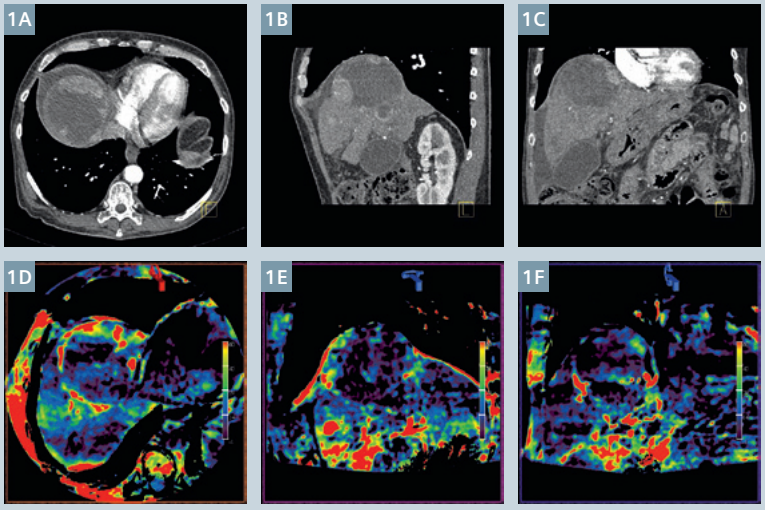
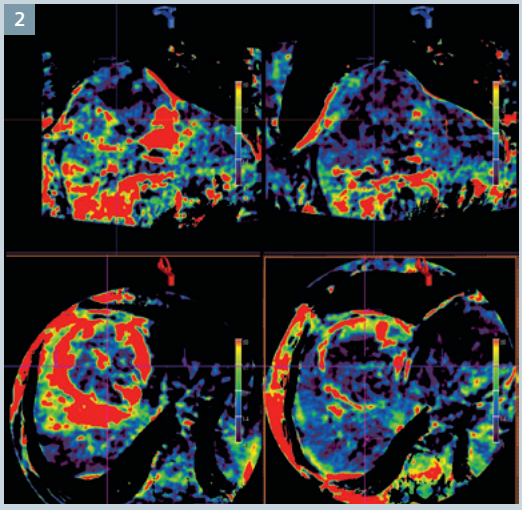
"The diagnostic information from syngo DynaPBV Body is probably better than that from four-phase CT scans. syngo DynaPBV Body gave us the confidence to know exactly what to do at each next step from an interventional standpoint without the need for additional imaging."

Ronan Ryan, MD,
Department of Interventional Radiology, St. Vincent's University Hospital (SVUH) in Dublin, Ireland



1 Comparison of post-interventional *syngo* DynaPBV Body data (lower row) with follow-up four-phase CT imaging to confirm clinical success of treatment.



2 Comparison of pre-interventional (left) with post-interventional *syngo* DynaPBV Body data to confirm technical success of treatment.

Treatment of Hepatocellular Carcinoma using Multiphase Liver Imaging Supported by *syngo* DynaCT

Courtesy of Nishita Kothary, MD, and Kerstin Müller, PhD

Department of Radiology, Stanford University Medical Center, Stanford, United States

Patient History

64-year-old male patient with HCV cirrhosis (Child-Pugh B7) complicated by hepatic hydrothorax, ascites, and hepatocellular carcinoma (HCC). Previously underwent hepatic trans-arterial chemoembolization (TACE) with recurrent disease. Two lesions with arterial enhancement and portal venous washout were observed on the abdominal MR scan in segment IVb and segment VII (largest axial dimension of about 1.4 cm each).

Diagnosis

Recurrent hepatocellular carcinoma (HCC)

Treatment

1. Angiogram and contrast-enhanced multiphase C-arm CT (multiphase *syngo* DynaCT*) from the common hepatic artery.
2. Superselective TACE from the left hepatic artery supplying segment IVb with ethiodized oil.
3. Superselective TACE from the right hepatic artery supplying segment VII with ethiodized oil.
4. Post-TACE, an unenhanced C-arm CT (visualizing the distribution of the embolic agent to the tumors).

Comments

Currently, *syngo* DynaCT is used for guidance during TACE for HCC. At Stanford University Medical Center, the use of multiphase *syngo* DynaCT to predict tumor response after TACE for HCC is being explored. Multiphase *syngo* DynaCT provides early and late phase cone beam CT images, similar to those obtained during late phase CTHA (CT hepatic arteriography). Prior literature has correlated the thickness of the corona with the histologic state of the tumor malignancy [1], and therefore, could potentially be used to predict tumor response.

Protocol

6s DSA scan (4x4 binning).

X-ray delay: 4 s for the contrasted first scan, 36 s for the non-contrasted second acquisition.

Injection protocol: 2 cc/s, 100% contrast, total volume 20 cc (10 s injection duration).

Nishita Kothary, MD

Kerstin Müller, PhD

[1] Kitao A, Zen Y, Matsui O, Gabata T, Nakanuma Y. Hepatocarcinogenesis: Multistep Changes of Drainage Vessels at CT during Arterial Portography and Hepatic Arteriography – Radiologic-Pathologic Correlation. Radiology 2009; 252(2):605-614.

Contact

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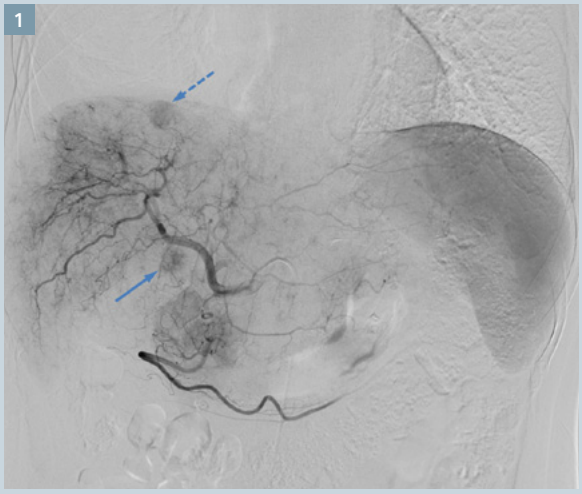
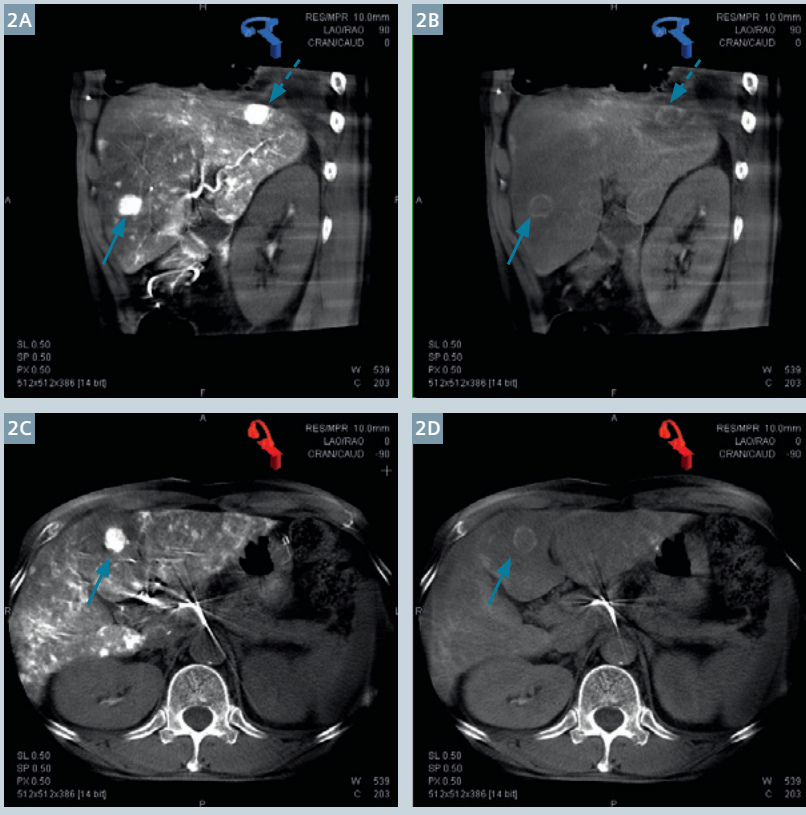
* multiphase *syngo* DynaCT is realized with the commercially available option *syngo* DynaCT

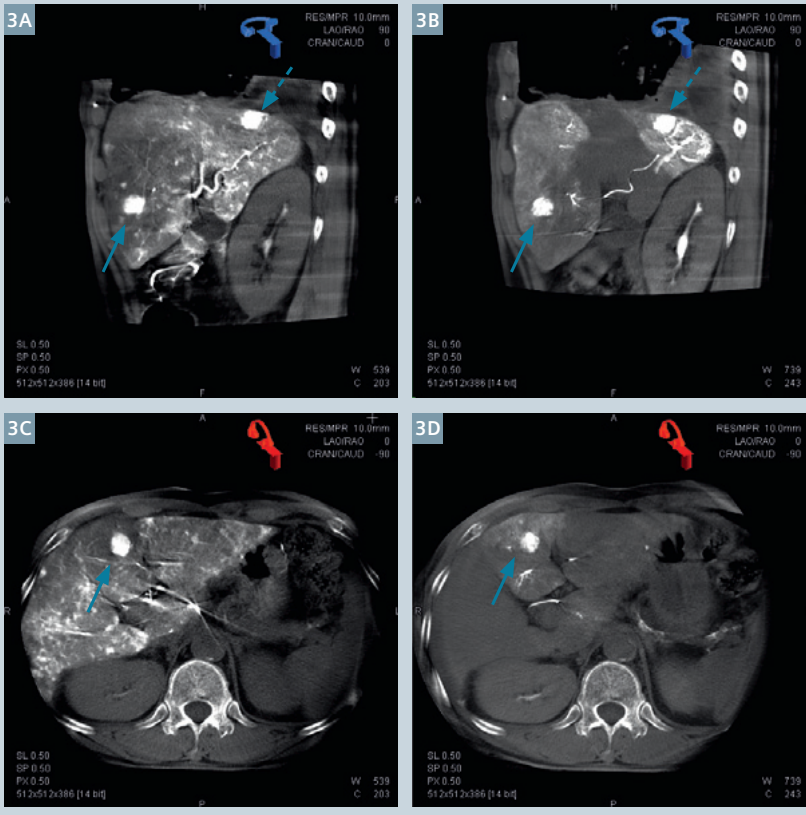


1 Pre-TACE 2D DSA, showing the two tumors in segment IVb (bottom arrow) and segment VII (top arrow).

2 Pre-TACE native reconstruction of the multiphase runs. Early arterial phase (2A, 2C) and late arterial phase (2B, 2D), sagittal (2A, 2B) and axial (2C, 2D).

3 Native reconstruction of early arterial phase pre-TACE (3A, 3C), and unenhanced C-arm CT post-TACE (3B, 3D), sagittal (3A, 3B) and axial (3C, 3D).





"Our goal is to investigate the association between the thickness of the corona, as observed on multiphase syngo DynaCT, and tumor response and prognosis."

Nishita Kothary, MD,
Department of Radiology, Stanford University Medical Center, Stanford, United States

Advanced Procedural Standards and Modern Imaging Technologies are Key to Dose Reduction in Uterine Fibroid Embolization (UFE)

Considerable innovation has been seen in angiographic technologies to improve image quality and reduce radiation dose. The significance of these parameters, however, varies depending on the specific treatment: In uterine fibroid embolization (UFE), the intention clearly is to keep dose at an absolute minimum since the X-ray guided treatment affects an extremely dose-sensitive area of the female body. In addition to the range of dose-reducing measures achievable by an experienced interventional team with a systematic workflow, leading imaging technologies play a critical role in securing minimum dose levels.

Clinical presentation

Severe, prolonged or painful menstrual bleedings are typically observed in patients with symptomatic uterine fibroids. Dependent on size, location, and number, bulk symptoms such as bowel and bladder dysfunction, abdominal protrusion, painful menses, noncyclic pelvic pain, dyspareunia, infertility, and recurrent miscarriage are also observed. Although some patients with uterine fibroids do not report any complaints, symptomatic patients can show severe anemia, relevant impairment of daily activities, and reduced quality of life over years. The incidence of uterine fibroids is published with approximately 70% in white women and 80% in women of African descent. In women between 30 and 50 years, approximately one third of fibroids become clinically relevant.

Treatment options

Various treatment options are available for the treatment of symptomatic uterine fibroids.

Hysterectomy is the radical surgical gold standard and still used in the majority of cases. After treatment, recurrence is almost impossible, and quality of life can be improved; however, blood loss and wound complications are possible.

Laparoscopic myomectomy is a uterine-sparing procedure, although its use in common practice is limited by resources and skills.

Medical therapy with **gonadotropin-releasing hormone analogs** can shrink fibroids and reduce symptoms. Significant adverse effects of suppressing ovarian steroid hormone production are vasomotor symptoms and loss of bone density, which usually limits medical therapy to 6 months.

High-intensity focused ultrasound (HIFU) is a time-consuming technique for percutaneous thermal ablation of individual fibroids in specific locations.

Uterine fibroid embolization (UFE) is an established interventional procedure and independent of size and number of fibroids. The technique has proven technical safety, clinical efficacy, and cost-effectiveness. Positive aspects are the low major complication rate, fast reconvalescence, easy repeatability, and organ maintenance compared with hysterectomy. Compared with medical therapy, the rapid onset and lasting efficacy with low rates of major adverse events are clear advantages. It also offers wide availability as well as low re-intervention rates due to the whole organ treatment approach compared with laparoscopic myomectomy and HIFU.

Interdisciplinary management

At our institution, all patients are evaluated during the team meeting of the Interdisciplinary Fibroid Center. The therapy decision is based on the review of the patient's medical history, evaluation of symptoms, clinical examination, transvaginal ultrasound, and laboratory tests. A specific MRI protocol including angiography and sagittal acquisitions is mandatory to verify the diagnosis, to rule out contraindications (e.g. large pedunculated fibroids) and to plan the UFE procedure (e.g. optimal C-arm angulation). Standardized questionnaires are used to assess outcome and quality of life before and at different time points (1, 6, 12 months) following UFE. Control MRIs should be scheduled for the follow-ups at 1 and 6 months, and also later if clinically indicated (e.g. relapse of symptoms). Furthermore, expert consultation is recommended annually.

Christof M. Sommer, MD,
Katharinenhospital Stuttgart, Clinic for Diagnostic and Interventional Radiology and Interdisciplinary Fibroid Center, Stuttgart, Germany

"The Artis Q Technology – in combination with advanced procedural standards – achieves an impressive dose reduction for patients undergoing uterine fibroid embolization."

Modern tube and detector technologies: Clinical outcome, aspects, and perspective

In our series of 28 symptomatic UFE patients treated with Artis zeego with Q Technology, demographics included a BMI of 28.0±4.5 kg/m² and a total volume of the uterus of 409.3± 328.2 cm³, respectively. The resulting dose-area product for bilateral UFE was 709.2±605.6 cGy*cm² for the fluoroscopy part (with a fluoroscopy time of 11.3±3.1 min) as well as 644.4±348.5 cGy*cm² for the DSA part (with a total number of frames acquired during DSA of 60.5±9.6).

With the Artis Q system family, cutting-edge hardware components in tube and detector technology are carefully matched with intelligent image processing algorithms for imaging at very low dose levels:

X-ray tube: The unique, high-performance GIGALIX tube with flat emitter technology allows for much smaller focal spots to create sharper images than with standard technology. The ability of the tube to provide higher pulse power not only enables reduction of pulse length – thereby reducing motion artifacts – but also permits stronger copper prefiltration for significant reduction of low-energy quanta. High-energy quanta can be reduced because the tube is able to operate at lower voltages due to its increased power, thus maximizing contrast. As a result, the tube is capable of generating an optimal X-ray spectrum, avoiding the portions of the spectrum that apply ionizing radiation to the patient's (and operator's) body without contributing to the image. The Siemens-exclusive Automatic Exposure Control (AEC) fully automatically optimizes 5 variable parameters (tube voltage, tube current, pulse length, focal spot size, copper pre-filtration) according to the angulation and patient's thickness to always minimize patient entrance dose and optimize image resolution. This avoids unnecessary high dose and loss of spatial resolution for thin patients and makes manual adaptation of acquisition parameters unnecessary.

Detector: the actively cooled 16-bit detector with high dynamic range provides better soft tissue resolution and improved Detective Quantum Efficiency (DQE) of 77% implemented by a 36% thicker scintillator layer.

True 16 bit imaging chain: The 16 bit grey value resolution provided by the detector is preserved throughout the entire imaging chain, leading to enhanced soft tissue contrast in 3D imaging.

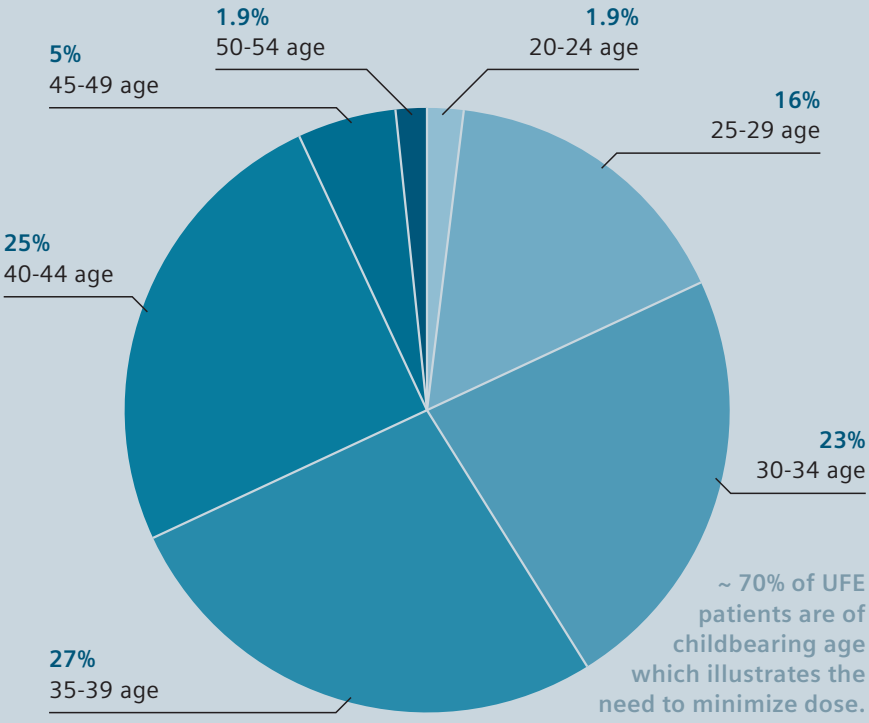
All Siemens angiography systems are delivered with the CARE package (combined applications to reduce exposure) – a set of functions for dose reduction, monitoring and reporting, laying the technical basis for dose awareness and dose-sensitive behavior in the angio operating room.

Standardized procedural steps in a high-volume setting

A summary of the most relevant procedural steps for a typical UFE procedure as performed in Stuttgart hospital is given in the following:

1. **Pre-medication 30 minutes prior to puncture:**
   Intravenous application of 250 mg Prednisolone, 4 mg Ondansetron, 1.25 mg Midazolam, 1 g Novamine and 7.5 mg Piritramide.
2. **Angiography system parameters:**
   Selection of the "low-dose pelvis" preset with low-frequency pulsed-fluoroscopy (4 pulses/s) and a low frame rate for DSA acquisitions (0.5 or 1 image/s).
3. **Maintenance of analgesia:**
   Intravenous application of 15 mg Piritramide over a period of 90 minutes.
4. **Vascular access:**
   Local anesthesia of the right groin with Ultracaine® (e.g. 40 ml Ultracain 1%), percutaneous puncture of the femoral artery, and insertion of a short 5 F sheath.
5. **Catheterization of the left iliac artery:**
   After review of the MRI and under fluoroscopy guidance (field-of-view of 22 cm, collimation, no tube angulation), catheterization of the main stem of the left internal iliac artery applying a 5 F ROC catheter and a soft glidewire with an angulated tip.
6. **Identification of the uterine artery:**
   DSA acquisition (field-of-view of 22 cm, frame rate of 0.5 or 1 image/second, optimal tube angulation with free projection of the origin of the uterine artery according to the MRI (usually 45±5 degrees), contrast material volume of 10-12 ml, contrast material injection rate of 3-5 ml/s).
7. **Reaching the embolization position:**
   Identification of the uterine artery (first anterior branch). After selection of the appropriate frame use overlay technique to catheterize the uterine artery applying a 2.7 F coaxial microcatheter system. Intra-arterial spasmolysis (e.g. 0.5 mg Nitro).
8. **Verification of the embolization position:**
   DSA acquisition (field-of-view of 22 cm, frame rate of 0.5 or 1 image/s, no tube angulation, contrast material volume of 5-8 ml, contrast material injection rate of 1.5-1.8 ml/s). In the case of a prominent collateral to the ovary, the embolization technique needs to be adapted (e.g. deeper catheter position, superselective coil embolization or use of larger microspheres to avoid relevant collateral embolization).
9. **Initiation of block anesthesia (plexus hypogastricus block):**
   After local anesthesia of the skin below the belly in the midline with Ultracaine (e.g. 5 ml Ultracain 1%) and under fluoroscopy guidance

Incidence of UFE



~ 70% of UFE patients are of childbearing age which illustrates the need to minimize dose.

(field-of-view of 22 cm, collimation), positioning of a 21 G Chiba needle at the front of the L5/S1 intervertebral space (in the midline for central blocking or approximately 5 cm lateral of the midline for bilateral blocking). After documentation of the correct needle tip position in two projections (no tube angulation and 90 degree tube angulation), injection of two different medications:
1. 100 mg Bupivacaine-HCL (e.g. 20 ml Carbostesin 0.5%) and
2. 150 mg Ropivacaine-HCL (e.g. 20 ml Ropivacain 7.5 mg/ml).

10. **Embolization:**
Under fluoroscopy guidance (field-of-view of 22 cm, collimation, no tube angulation) flow-mediated injection of biocompatible calibrated microspheres (Embozene Microspheres, CeloNova BioSciences, San Antonio, USA) with a size of 500, 700, and/or 900 µm until stasis. Use of the microsphere size 500 µm only if additional mural adenomyosis had been shown on the MRI prior to procedure. Documentation of stasis (stagnation of flow in the uterine artery for at least 5 seconds).

11. **Documentation of devascularization:**
DSA acquisition 10 minutes after the last particle injection (field-of-view of 22 cm, frame rate of 0.5 image/s, no tube angulation, contrast material volume of 4 ml, contrast material injection rate of 1 ml/s). Definition as the adequate endpoint and surrogate of devascularization as the lack of parenchymal staining and no wash-out of contrast material in the uterine artery for 10 seconds.

12. **Catheterization of the right iliac artery:**
After review of the MRI and under fluoroscopy guidance (field-of-view of 22 cm, collimation, no tube angulation), pushing forward of the 5 F ROC catheter until its tip is located above the aortic bifurcation. After configuration, pulling back the catheter into the main stem of the right internal iliac artery (modified Waldman loop).

13. **Repeat steps 6-8.**

14. **Maintenance of block anesthesia (plexus hypogastricus block):**
After verification of the correct needle tip position and after aspiration, injection of one further medication:
150 mg Ropivacaine-HCL (e.g. 20 ml Ropivacain 7.5 mg/ml).

15. **Vascular access management:**
Removal of catheters, sheath, and needle. Patient receives compression and sterile bandages.

16. **Radiological aftercare:**
Strict implementation of intravenous medication (250 mg Prednisolone, 4 mg Ondansetron (repetitive), 1 g Novamine (repetitive) and 7.5 mg Piritramide (repetitive) daily. Visit twice daily.

Table 1 – Demographics of UFE Patients[1] on Artis zeego with Q Technology

Number of patients (n)	BMI (kg/m²)	Clinical presentation (n)	Total volume of the uterus*(cm³)	Volume of the dominant fibroid* (cm³)
28	28.0±4.5 (21.8-38.4) [26.3-29.6]#	hypermenorrhoe and dysmenorrhoe: 16 hypermenorrhoe: 9 hypermenorrhoe and dyspareunia: 2 hypermenorrhoe and pollakisuria: 1	409.3± 328.2 (105.2-1352.8) [287.8-530.9]#	150.7±180.5 (2.6-720.3) [83.9-217.6]#

1 all patients were treated according to a highly standardized UFE treatment protocol; BMI = body mass index
* determined in accordance with Koh J et al., 2012, Eur J Radiol
# data are mean and standard deviation (minimum-maximum) [95% confidence interval]

Table 2 – Radiation Exposure of UFE Patients[1] on Artis zeego with Q Technology

Fluoroscopy data		DSA data		
Fluoroscopy time (min)	$DAP_{fluoroscopy}$ (cGy*cm²)	Number of DSA acquisitions (n)	Total number of frames acquired during DSA (n)	DAP_{DSA} (cGy*cm²)
11.3±3.1 (5.6-18.8) [10.1-12.4]#	709.2±605.6 (113.6-2883.1) [484.8-933.5]#	7.0±1.3 (5.0-10.0) [6.5-7.4]#	60.5±9.6 (44.0-78.0) [56.9-64.0]#	644.4±348.5 (233.2-2037.7) [515.3-773.5]#

1 all patients were treated according to a highly standardized UFE treatment protocol; DSA = digital subtraction angiography; DAP = dose area product
data are mean and standard deviation (minimum-maximum) [95% confidence interval]

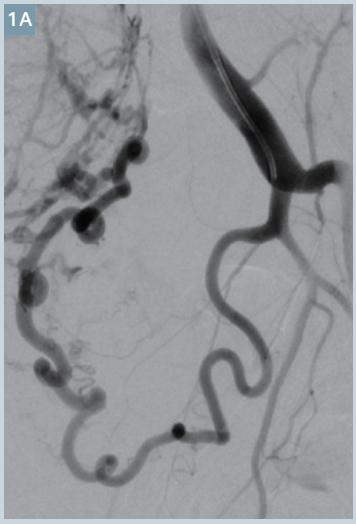
Uterine Fibroid Embolization (UFE)
Supported by Artis zeego with Q Technology

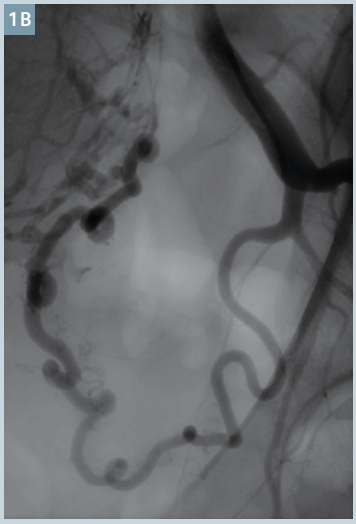
Courtesy of Christof M. Sommer, MD, Katrina Thomas, MD, Patrick Kurz, MD, Michel Klapp Oliger, MD, Stefan Erpenbach, MD, Andreas Hatopp, MD, and Götz M. Richter, MD

Department of Interventional Radiology, Katharinenhospital Stuttgart, Clinic for Diagnostic and Interventional Radiology and Interdisciplinary Fibroid Center, Stuttgart, Germany

Case 1 – Patient of normal weight (BMI of 25.3 kg/m²)

Note: procedural dose area product of 1233.8 cGy*cm²





1 DSA acquisition before UFE in selective position using a 5 F ROC catheter (C-arm angulation with free projection of the origin of the uterine artery; reduction of dose and contrast material by use of pre-interventional MRI for definition of the optimal projection) – delineation of the left uterine artery and the tortuous arteries supplying the fibroids (A subtracted image, B non-subtracted image)

2 DSA acquisition after UFE (no tube angulation) – definition of the embolization endpoint: Lack of parenchymal staining and no wash-out of contrast material in the uterine artery after injection of 5.6 ml Embozene 700 (Embozene Microspheres, CeloNova BioSciences, San Antonio, USA)

Commentary

Advanced procedural standards and the modern tube and detector technologies available in Siemens Artis zeego with Q Technology are key factors in dose reduction. This is of utmost importance since around 70% of UFE patients are in childbearing age. In our UFE patient collective, the dose-area product for fluoroscopy and DSA acquisitions was 1353.5±903.9 cGy*cm² (346.8-4393.8 cGy*cm²) – and therefore well below the recommended average upper threshold of 5000 cGy*cm² (Kröncke T et al., 2015, Fortschr Röntgenstr). In patients with class II obesity (BMI of 35-40 kg/m²), the image quality was also sufficient to catheterize both uterine arteries and to reach the embolization endpoint without complications (at a maximum fluoroscopy time and dose-area product of 18.8 min and 4393.7 cGy*cm², respectively). For UFE, interdisciplinary indication, informed consent, pre-procedural MRI, optimized intra-procedural pain management, adequate embolization materials, and expertise are prerequisites for achieving this new level of radiation dose reduction applying modern tube and detector technologies. From our perspective, not only are young patients and patients with benign diseases the biggest winners of such an approach, but also the core team in the angio operating room.

Contact

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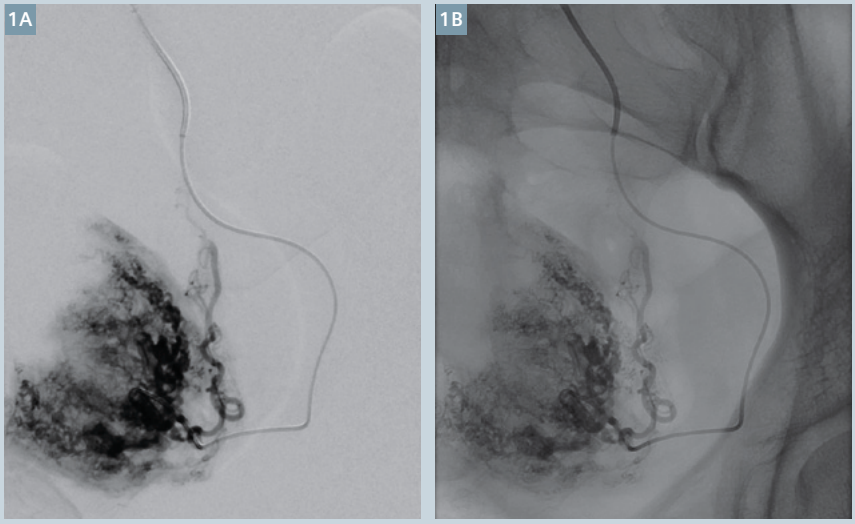
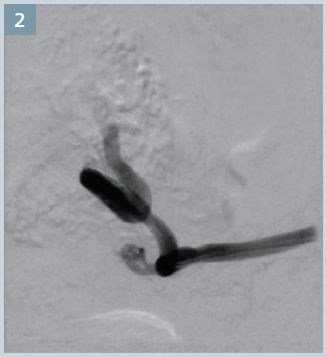
Case 2 – Overweight patient (BMI of 27.8 kg/m²)

Note: procedural dose area product of 1267.4 cGy*cm²



1 DSA acquisition before UFE in superselective position using a 2.7 F microcatheter (no tube angulation) – delineation of the tortuous arteries supplying the fibroids and a collateral to the ovary (A subtracted image, B non-subtracted image)



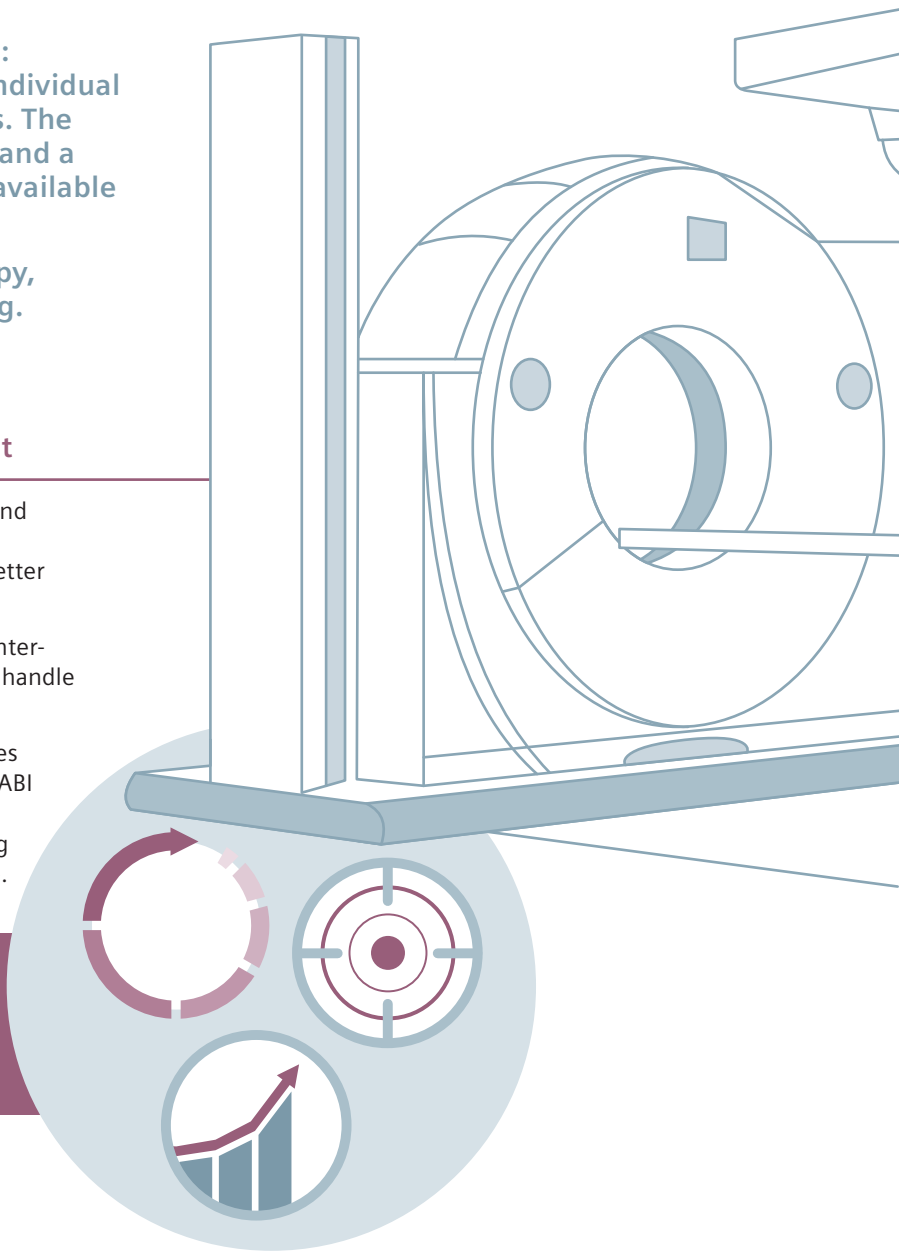
2 DSA acquisition after UFE (no tube angulation) – documentation of the embolization endpoint: Lack of parenchymal staining and no wash-out of contrast material in the uterine artery after injection of 1.7 ml Embozene 900 (Embozene Microspheres, CeloNova BioSciences, San Antonio, USA)

Powerful Interplay MIYABI Angio-CT

Image-guidance technology must address an ever broader range of challenges as demand for minimally invasive treatment keeps growing. The problems interventionalists are now facing can sometimes no longer be optimally taken care of with just one imaging modality.

This is where MIYABI Angio-CT comes in: A hybrid imaging solution in which its individual parts can play to their specific strengths. The combination of an angiography system and a sliding gantry CT makes each modality available exactly when you need it.

This opens up new possibilities in therapy, interventions, and treatment monitoring.



Increased capacity at low operating cost

MIYABI Angio-CT can help speed up routine cases and delivers higher throughput. It also makes complex cases possible (e.g. TACE, RFA) with potential for better reimbursement.

Training costs can be kept to a minimum because interventionalists already know how to operate a CT and handle an angio system.

The smallest configuration of a MIYABI suite requires as little as 5 m x 7.5 m (16.4 ft x 24.6 ft) space. MIYABI Angio-CT thus makes more efficient use of hospital square footage. It can, for example, replace existing angio suites without the need to increase room size.

"Targeting with an extra margin of safety and confidence is key."

David Lacey, MD,
Iowa Methodist Medical Center, Des Moines, USA

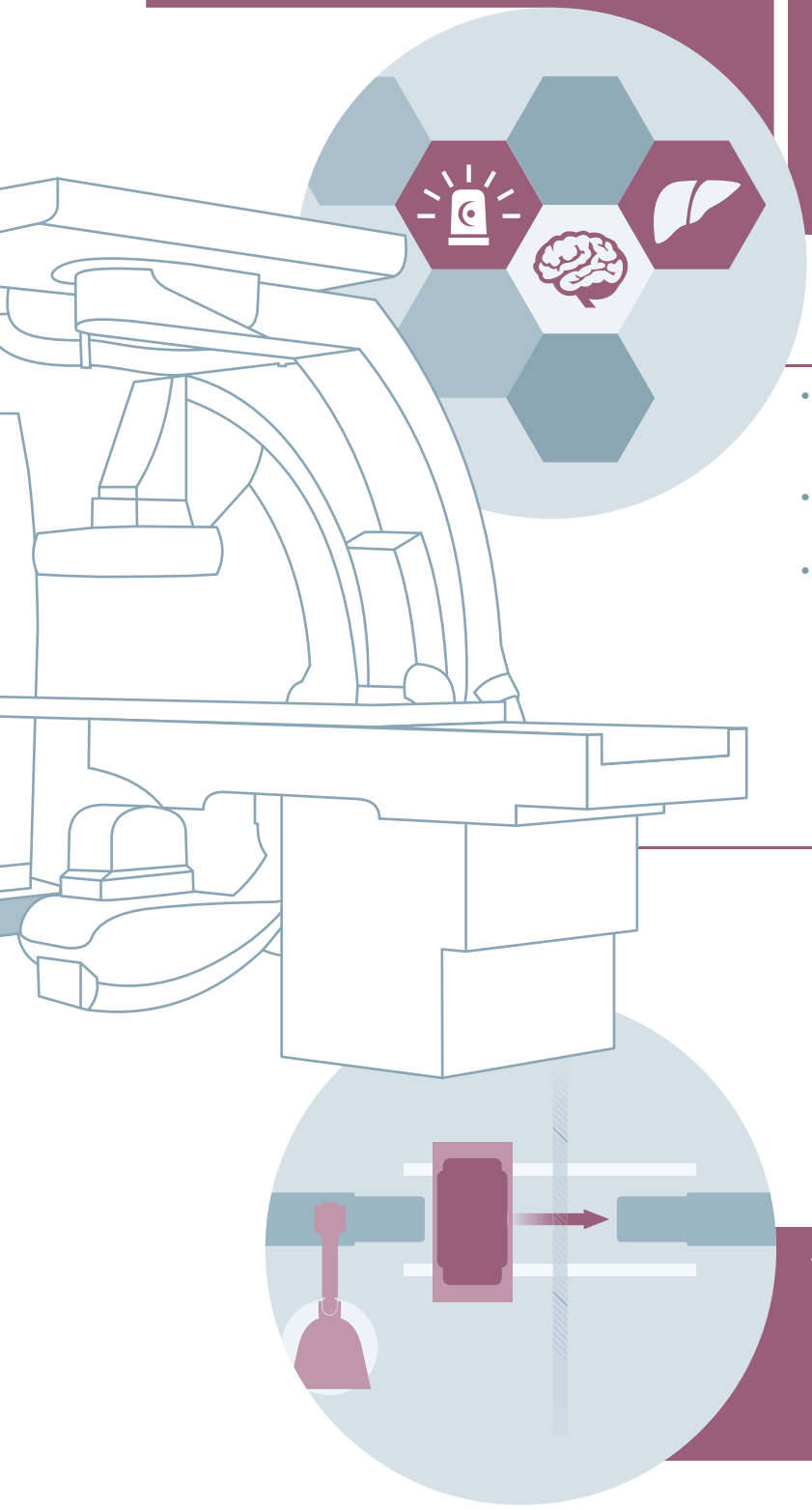
MIYABI Angio-CT is a customized solution and not commercially available in all countries. Due to regulatory reasons the future availability cannot be guaranteed. Please contact your local Siemens organization for further details.

"Having cone beam CT and MDCT in my angio suite allows me to treat hepatocellular carcinoma (HCC) more safely and control, for example, bleedings in treatment of cervical cancer with more confidence."

Hideyuki Takano, MD,
Interventional Radiologist,
Chiba Prefecture Cancer Center, Chiba, Japan

"Cone beam CT has made the IR community aware of the importance of 3D imaging in the angio suite. Now we must build on both 3D and potential 4D imaging during many IR procedures to improve efficacy and safety. We can also begin to seriously tackle the elusive topic of endpoint assessment for interventions like chemoembolization where perfusion imaging may be applicable. Hybrid Angio-CT suites offer the multimodality imaging tools to address the evolving needs of the interventional radiologist going forward."

Michael J. Wallace, MD,
Department Chair ad interim, Interventional Radiology,
University of Texas MD Anderson Cancer Center, Houston, USA



Making routine easy and complex cases possible

- CT angiograms offer conistent breathing artifact-free roadmaps for catheter-based procedures that require vascular guidance.
- In stroke, valuable time can be saved by combining diagnosis with CT and clot retrieval in the same room.
- In trauma, fast whole-body CT scans and rapid image-guided therapy without patient repositioning is key to fast treatment.

Monitoring response and personalizing treatment

MIYABI Angio-CT also brings functional imaging into the interventional suite. With CT perfusion, the tumor response can be directly monitored and the treatment personalized.

TwinBeam Dual Energy offers quantitative iodine maps of tumor contrast retention – which can serve as surrogate marker of treatment response.

One table for both systems allows quick switch of modalities making combined needle-catheter-based interventions quicker and less problematic.

"Since we installed the MIYABI system, we increased our patient volume by 20 percent in three months."

Todd Kranpitz,
Executive Director of Radiology,
Iowa Methodist Medical Center, Des Moines, USA

Artis one: A Truly Universal System

AXIOM Innovations correspondents Robert L. Bard, USA, and Swati Prasad, India, spoke to doctors in Michigan and Kerala about their work with Artis one – the flexible floor system for interventional imaging that covers all clinical needs in interventional radiology, interventional cardiology, and electrophysiology.

Artis one has been on the market for two years and is being used clinically in diverse settings – such as the St. John Macomb-Oakland Hospital in Detroit, Michigan, United States, and the Meditrina Hospital in the state of Kerala, India. Meditrina is a new super-specialty hospital located in the picturesque coastal town of Kollam, an upscale Indian town known for its ability to attract tourists. In a different setting, the St. John Macomb-Oakland Hospital is a suburban community hospital in Detroit, the hub of the American automobile industry – an area recovering from recent economic downturn.

Despite the regional differences, Artis one has been an excellent fit for the needs of both centers. In the multi-specialty context in Kerala, Artis one provides the capability to perform variable procedures using only one piece of equipment that occupies only one small lab. For the high volume of patients at the Detroit hospital, Artis one delivers high quality images to support peripheral, vascular, cardiac, and/or electrophysiological procedures.

Artis one is a truly universal system that provides excellent images and is ideal for routine interventions in a multipurpose cath lab setting at community hospitals, such as St. John in the US, while also having the capability to perform a broad range of procedures in a specialty hospital in a semi-urban area, such as Meditrina in India.

At the St. John Macomb-Oakland Hospital in Detroit, Michigan, USA

The St. John Macomb-Oakland Hospital's status as a community hospital with a multidisciplinary approach creates a demand for throughput-optimized labs capable of covering a broad range of routine procedures in an efficient manner. Lingareddy Devireddy, MD, Medical Director and Chief of Cardiology at St. John, is responsible for bringing the Artis one

to the hospital, making it the first installation in the United States. Devireddy's main concern was to replace outdated, malfunctioning equipment within a small room. Artis one met his needs because of its small footprint which requires only 25 square meters however still provides the flexibility in terms of movement and applications to cover a very broad range of procedures. St. John Hospital has had five months' routine clinical experience with the Artis one when we visited Devireddy and Sohail Akhtar Hassan, MD, Director of Cardiac Electrophysiology Services, to share their experiences in electrophysiology and interventional cardiology.

Both Devireddy and Hassan expressed that they now enjoy a cleaned-up, less hectic environment because of the added space and simplicity. According to Devireddy, "You can pre-program the system to move itself when taking an angiogram," which allows the table and C-arm to move seamlessly and efficiently – "with older systems, moving the table was tough because the cables frequently got stuck. With the Artis one there is no interference and the patient is placed in a precise location." Hassan added, "The positioning is easier with the ability to rotate the C-arm and move it out of the way." The system positioning is fully motorized and requires only the press of a button. The cath lab is less hectic and more efficient because the old system had a habit of breaking down. "We have been using the Artis one for months and it has never been down," Hassan mentioned.

The flexibility of the Artis one has benefitted Devireddy personally because of its flexibility in positioning both the patient and the monitor. Devireddy explained that he has a surgically repaired neck from years of working in traditional cath labs, but now he says, "I no longer have to strain my neck to view the monitor. In terms of the implants, it really helps a lot because the screen is right in front of you, since I do implants using a radial approach from the left side," including univentricular and biventricular internal cardiac defibrillators, and pacemakers. Devireddy added, "There is only one screen and it is easy to move around so if you are doing an implant from the left you can move the screen all the way to the right so that it is right in front of you."

Due to the flexibility of the Artis one, Hassan also noticed that the new system is taking less of a toll on his physical wellbeing. He mentioned, "The biggest change with its implementation is physician fatigue along with, of course, the decreased fluoro and having the display on the same monitor." Hassan feels the controls are well laid out and said that it is much easier to change collimator size, to display different formats, and to decrease fluoro frame rates per second.

Hassan is one of the first electrophysiologists on a worldwide level to use the Artis one for procedures such as leadless pacemaker insertions, ICDs, filters, and ablations. The ability to use it as a hybrid system was particularly attractive because it provides the ability to use the room as an operating room which aids lead extraction. Hassan mentioned the system is very flexible and provides the ability to easily rotate fluoro between the groin and the heart.

Ablations of ventricular tachycardia and atrial fibrillation are safer, according to Hassan, because he can customize the number of frames per second by himself at the table side, which gives him control over the amount of fluoro used – which is considerably less than ablations performed with older equipment. Hassan states, "One of the biggest challenges in the last decade is that the fluoroscopic times were very high with certain procedures. With Artis one we can decrease the frame rate from conventional use of 15 frames per second to 4 frames per second, which is essentially 25 percent of the fluoro which we were giving before for the same procedure."

Lingareddy Devireddy, MD, (left) Medical Director and Chief of Cardiology and **Sohail Akhtar Hassan, MD,** (right) Director of Cardiac Electrophysiology Services at St. John Macomb-Oakland Hospital in Detroit, Michigan, USA

Ablations are routine procedures for electrophysiologists in the United States and their numbers are expected to increase significantly. In 2010 up to 6.1 million patients were diagnosed with atrial fibrillation and these numbers are expected to grow up to 12 million by the year 2050 [1]. The St. John Macomb-Oakland Hospital is preparing for the rush with their new, reliable Artis one.

At the Meditrina Hospital in Kollam, Kerala, India

In tourism parlance, Kerala – a state in south-west India – is known as God's Own Country. It is often figured amongst the world's must-see destinations for its beautiful beaches, spice and tea plantations, and gorgeous backwaters.

Kollam, a coastal city 70 kilometers north of Thiruvananthapuram, Kerala's capital, does not find a mention in India's list of Tier 2 or Tier 3 cities. But it is far ahead of many that are on that list. Endowed with the Ashtamudi Lake, Kollam boasts of not just the backwaters and natural beauty but also of malls and multinational food chains. And now, also a tertiary care hospital – Meditrina Hospital, Kollam. This super-specialty hospital is amongst the first in India to install Siemens Artis one.

"Why do we underestimate smaller cities," questions Prathap Kumar, MD, founder and managing director of the Meditrina group of hospitals. "The future is here, provided that hospitals invest in the best equipment and healthcare services," says 50-year-old Kumar, an interventional cardiologist born in Kollam. The group has set up hospitals in Thiruvanthapuram, Changanessery, Hyderabad, Bhubaneshwar, and Jamshedpur. The 200-bed hospital with over 100 intensive-care units in Kollam was inaugurated in mid-December 2014.

Kumar is confident that investment in high quality equipment like Artis one can be recovered in no time. "Amortization depends on volumes. At Changanessery, I recovered the investment in the cath lab in nine months," he adds.

A large part of Kumar's confidence emanates from certain traits of Kerala's population. The state has the dubious distinction of being the diabetes capital of India, with 20 percent of the population known to be diabetic [2] – compared to India's average of 8 percent. The high prevalence of diabetes, with poor control of blood sugar, blood pressure, and lipids could well explain why Kerala has the highest rate of heart disease in India.

Interestingly, a majority of angioplasties performed by Kumar are on patients in the age group of 35 to 45 years. Despite the high prevalence of heart disease, professionals like Kumar did not have many opportunities in Kollam. With this new hospital, he has taken his dream job to his hometown.

"Patients come to me after visiting other centers. They don't worry about costs," states Kumar, who says that costs matter more in the initial years, when a hospital is trying to establish itself. According to Kumar, Artis one is an excellent high quality system. "Its image quality is a lot better and the motorized gantry makes it very easy to operate," says Seenu, a cath lab technician who has worked with Kumar for the last 12 years.

Kumar is a fan of the CLEARstent Live technology: "While performing an angioplasty, I can see if the stent has expanded well. In other systems, one has to wait for 15 to 20 seconds." Even before its opening in December, the hospital had undertaken 200 procedures using the Artis one, as part of its trial runs. Post the inauguration, the hospital has been undertaking over 140 procedures each month.

Kumar's soft spot for Kollam notwithstanding, it made perfect business sense to invest here. Besides, he has not had trouble finding clinicians,

"Amortization depends on volumes. At Changanessery, I recovered the investment in the cath lab in nine months."

Prathap Kumar, MD,
Managing Director of Meditrina Hospital Kollam, Kerala, India

nurses, and other staff fit to work for a super-specialty hospital.

Kerala is, in fact, a unique state when compared with the other Indian states. For instance, there are far lesser socio-economic disparities between rural and urban areas than in the rest of India [3], and income disparities are a lot smaller here.

Medical tourism in Kerala has not been explored much. "There is huge potential for medical tourism in Kollam." The backwaters that start from Kollam can be a huge draw.

Since Meditrina meets international standards in tertiary care, Kumar has plans to market it as a destination for medical tourism. The hospital has already treated patients from Iraq and Nigeria. But in its initial days, Prathap Kumar wants to focus on the native population.

Kumar's dream does not end with Kollam. He wants to go pan-India. "I will invest in areas with high population density and low healthcare facilities," says Kumar. Next, he is looking to set up hospitals in the states of Jharkhand and Chhattisgarh. And Artis one is an investment that goes along with these plans.

[1] AHA Statistical Update: Heart Disease and Stroke Statistics—2014 Update. A Report from the American Heart Association. Circulation. 2013;129:e28-e292.
[2] http://www.cadiresearch.org/topic/diabetes-indians/diabetes-keralal
[3] http://www.frontline.in/static/html/fl2114/stories/20040716002009000.htm
[4] http://www.tradingeconomics.com/united-states/gdp
[5] http://data.worldbank.org/indicator/NY.GDP.PCAP.CD?page=1
[6] http://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/NationalHealthExpendData/Downloads/Proj2013.pdf
[7] http://www.cdc.gov/workplacehealthpromotion/businesscase/reasons/rising.html
[8] http://en.wikipedia.org/wiki/Economy_of_India
[9] http://www.dnaindia.com/health/report-health-insurance-in-india-still-remains-an-untapped-market-1891509
[10] http://articles.economictimes.indiatimes.com/2013-12-02/news/44657410_1_healthcare-sector-healthcare-delivery-fortis
[11] http://www.ijsrp.org/research-paper-1013/ijsrp-p2234.pdf

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U.S. Healthcare Scenario

Population:
318.9 million

GDP (nominal):
US $ 16,800 billion in 2013 [4]

Per capita income:
US $ 53,042 [5]

Healthcare expenditure:
16% of GDP [6]

Size of the healthcare industry:
Overall, health spending is projected to grow at an average rate of 5.7% for 2013 to 2023, 1.1 percentage points faster than expected average annual growth in the GDP [6].

Rise in cardiac care:
Between 2000 and 2007, healthcare expenditures in the United States increased by 14%. This represents an average of more than US $ 7,400 per person. In 2009, the economic costs of cardiovascular diseases and stroke were estimated at US $ 475.3 billion [7].

India Healthcare Scenario

Population:
1.21 billion

GDP (nominal):
US $ 2.308 trillion [8]

Per capita income:
US $ 1,808 [8]

Healthcare expenditure:
3.9% of GDP (as of 2011) [9]

Size of the healthcare industry:
US $ 78.6 billion in 2012 (up from US $ 45 billion in 2008) [10]. The healthcare industry is growing at a rate of 15% CAGR (compound annual growth rate); and is expected to increase to US $ 158.2 billion by 2017 [10].

Rise in cardiac care:
The rise in middle-class income has led to lifestyle changes, thereby increasing the incidence of coronary heart diseases (which increased from around 27 million in 2000 to 35.9 million cases in 2005 and are estimated to rise to 61 million in 2015) [11].

Image courtesy of John Maniaci – UW Hospital and Clinics

Raising the Bar by Lowering Dose

At a children's hospital in Madison, Wisconsin, doctors are setting new standards in dose reduction with the Artis Q.zen.

By Ron French

Luke Lamers, MD, is director of the catheterization lab in the pediatric cardiology division of the American Family Children's Hospital at the University of Wisconsin in Madison, Wisconsin, USA. Recently, he discussed with AXIOM Innovations his experiences with the Siemens Artis Q.zen, an angiography system with cutting-edge imaging technology that is setting new standards in dose reduction, Lamers says.

Dr. Lamers, tell us about your division.

On the scale of pediatric cardiology divisions, we're on the small size, but we're definitely growing. Before I came here in 2012, there were six physicians, and they weren't doing much intervention in the catheterization lab. So they recruited me to develop the interventional catheterization program. We now have a group of ten pediatric cardiologists. Between catheterization and electrophysiology, we have about 220 cases annually.

What are the challenges specific to pediatric cardiac imaging?

You see everything. From a premature baby to a large adult-size patient. The smallest person we've done a procedure on was a one-kilogram baby. Unlike an adult lab where everyone is 45 to 145 kilograms, we're anywhere from one kilogram to 145-plus kilograms on this imaging system. But of course, you can't just be giving small patients the same radiation dose as the 145-kilogram adult, so that's a challenge to imaging in this field. In my experience prior to the Artis Q.zen, I didn't have much capability to adjust the settings depending on the patient's size. It used to be a one-size-fits-all.

Does the Artis Q.zen offer more options?

This system has a lot of capabilities. It provides options that you can configure and adjust during procedures. Currently we use preprogramed settings for less than six kilograms, six to 20 kilograms, 20 to 40 kilograms, and adults.

Luke Lamers, MD, pediatric interventional cardiologist at the University of Wisconsin, Director of Pediatric Catheterization Services at American Family Children's Hospital in Madison, Wisconsin, USA

Are children more sensitive to dose?

There are more and more studies looking at minimizing dose for pediatric patients in the congenital heart world, specifically for that reason. Children are more sensitive; their tissues are more sensitive and still growing. They have years and years to develop the negative effects of radiation exposure. I would say it's clear that radiation is more of a problem for a baby than for a 60-year-old adult.

Cardiologists and radiologists are trained very differently. In radiology, you really are hammered on the physics of X-rays, and the damaging potential of exposure. In cardiology, you don't get a lot of that; you just learn the imaging and the complex procedures. The more I do this, the more I think: Can I get the same images and yet significantly cut back on dose exposure?

Artis Q.zen is new to the hospital, installed just a year ago. What made you and others at the hospital choose it?

Radiology favored a Siemens system for its cone beam CT capabilities. I'd worked on a Siemens system before and I knew the image quality was going to be good. The more I talked to people, the more it seemed like a good idea. I read about Artis Q.zen and the new technology with the potential to be really pushing the radiation dose, and to begin 3D imaging.

Tell me about the image quality.

All systems provide good image quality. The question is: How much X-ray dose do you need to get that quality? That's where I'm seeing a difference. The image quality is very good at a substantially lower dose than what I'm used to seeing on previous systems.

Can you quantify these dose savings?

We're trying to pull that together to see how much it truly is. Hopefully we'll be publishing our data soon. There are some current benchmarks that have just come out in the literature from the Children's Hospital of Philadelphia, which has a large-volume catheterization lab, stating the radiation dose for six procedures [1]. Among others they are using an Artis zee, whereas we have next-generation technology. We looked at some of our procedures, which we did on Artis Q.zen, and our dose is between 30 and 60 percent less than the figures they are publishing. And once again, the image quality is good.

What other features do you like on Artis Q.zen?

Most catheterization labs have a small X-ray detector, and this one is intermediate in size. This is an advantage in large

"We looked at some of our procedures, ... and our dose is between 30 and 60 percent less than the figures they are publishing [1]."

Luke Lamers, MD,
Director of Pediatric Catheterization Services at the University of Wisconsin's American Family Children's Hospital in Madison, Wisconsin, USA

Image courtesy of John Maniaci – UW Hospital and Clinics

patients, because with a small detector, often you can only see part of the chest, while with this, I can see all of what I want. You can also easily take the anti-scatter grid out of the detector for small patients to decrease dose and improve image quality.

Has 3D imaging with *syngo* DynaCT Cardiac been a help to you?

I had zero previous experience with *syngo* DynaCT Cardiac and Low-dose *syngo* DynaCT before using this system, and we've been using it on a number of cases, learning where it works well and where it doesn't. We've been making some really nice 3D images in the catheterization lab. Even for a cone beam CT 3D reconstruction, the dose is still acceptable. It's not like you're giving the patient a bunch of extra radiation exposure. I was not able to do 3D imaging previously.

Can you recall a specific case in which *syngo* DynaCT Cardiac was a great help?

Yes – a little baby with complex congenital heart disease had had one operation and at the age of 10 months had a catheterization showing narrowing of the pulmonary arteries. Either it was going to need repeat surgery or a treatment in the catheterization lab. Normally, you're in two dimensions, with a frontal and a lateral view. Looking at the pulmonary artery in the right lung, I was thinking of stenting because balloon dilation didn't really make an impact. But then we did the *syngo* DynaCT Cardiac acquisition and rotated the whole pulmonary tree in three dimensions. What we saw was that there were actually two pulmonary artery branches overlapping instead of just a single vessel. So if we had stented one, the other would have been totally occluded, which is pretty much half of the kid's right lung. That would have been a big mistake – and *syngo* DynaCT Cardiac prevented that.

We've done a couple of complex arch interventions where the two-dimensional imaging doesn't really reveal a narrowing, but when you spin it in 3D, you get a sense of the complexity of the narrowing of vessels.

Has Artis Q.zen improved workflow?

Not really, except for patients for which the surgeons requested coronary angiograms and a chest CT preoperatively. Previously this would require two separate procedures. We performed the cone beam CT and coronary angiogram during a single procedure, but it hasn't changed dramatically what we're doing.

How is the spatial and temporal resolution?

Spatial resolution is not a problem, and the definition of wires is not a problem.

You talked about adjustments. How has Siemens supported you in making necessary adjustments to the Artis Q.zen?

There's been amazing feedback. I'm learning a lot from how the applications specialists are adjusting things, and showing us how we can lower dose. So there's been a lot of direct feedback from people who are very well-acquainted with the system to help optimize imaging. Before, I never had this experience of working with applications specialists and pushing the limits of what a system can do. In the process, I'm learning a lot about radiation exposure and the potential of this system.

It sounds like Artis Q.zen has been a positive experience for you, the hospital, and patients.

What we're seeing is a lot lower dose exposure compared to what we saw in the past and one of our main goals is to minimize exposure for pediatric patients, so this is working out very well for us.

[1] Ghelani et al., JACC Cardiovasc Interv. 2014 Sep;7(9):1060-9.

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Precision Rules! Better Prospects for Cardiac Resynchronization

Text: Philipp Grätzel von Grätz | Photos: Detlef Schneider

The success of device therapies in cardiology is critically dependent on the correct placement of cardiac electrodes. At Hospital Wels-Grieskirchen in Austria, CRT devices for heart failure patients are implanted based on 3D visualization of the coronary sinus. This allows for a more accurate positioning of the left-ventricular lead and decreases the risk of therapy failure. It also has the potential to reduce radiation exposure and keep procedure time in check.

Cardiac resynchronization therapy (CRT) is a highly effective treatment to improve both the symptoms and prognosis of patients with chronic heart failure. Established in the early 2000s*, nowadays it is an indispensable treatment option for heart failure patients, says Marcus Ammer, MD, Head of Electrophysiology at Hospital Wels-Grieskirchen in Austria: "CRT improves breathlessness and exercise capacity, but it also reduces hospitalizations and mortality."

Getting in sync

CRT devices increase the efficiency of the pumping heart. They re-coordinate or "resynchronize" the beating of the two cardiac ventricles. To this end, a pacemaker-like device is placed below the skin, and three electrodes are implanted. Two of them are inserted via the subclavian vein into the right atrium and the right ventricle, very similar to what is done in a conventional pacemaker implantation.

The third electrode or "left-ventricular lead" is more complex to put in place. It needs to rest in one of the coronary veins directly adjacent to the wall of the left ventricle. To get there, cardiologists have to locate the coronary sinus in the right atrium, the region where all coronary veins end, and identify the vein that best fits their needs. If the CRT implantation is successful, the two ventricles contract in a more coordinated fashion as a result of the therapy. Cardiac function improves, and heart failure symptoms are alleviated.

Optimal LV lead placement is critical for success

"When we implant a CRT device, we strictly follow European guidelines," says Michael Porodko, MD, who is responsible for the CRT implantation at Hospital Wels-Grieskirchen. "We strongly believe that patients benefit the most from cardiac resynchronization therapy when they are in chronic heart-failure NYHA II – III and present with left bundle-branch block with a QRS-complex width of more than 150 msec." According to international data, these criteria are met in about one in five to one in ten patients with

*Landmark trials include MUSTIC, PATH HF, COMPANION and CARE HF

"CRT improves breathlessness and exercise capacity, but it also reduces hospitalizations and mortality."

Marcus Ammer, MD,
Head of Electrophysiology at Hospital Wels-Grieskirchen in Austria

chronic heart failure. This is a significant number. Taken together, in Europe and the USA, more than 150,000 CRT devices are implanted every year.

However, not every patient benefits. Studies have shown that in three out of ten patients cardiac function does not improve after CRT implantation. "A correct placement of the left ventricular lead is a major factor for a good treatment response," says Porodko. "We know that success rates are highest if the LV lead is placed in the posterolateral part of the left ventricle. And we also know that patients with ischemic heart disease have lower response rates than patients with dilative cardiomyopathy."

Increased accuracy with less radiation dose

At Hospital Wels-Grieskirchen, the electrophysiology department has recently acquired a Siemens Artis Q.zen angiography system with the *syngo* DynaCT Cardiac application for rotational angiography. The system enables patients and operators to benefit from peri-operative 3D visualization of the cardiac anatomy in the angio suite.

The cardiologist and CRT specialist Porodko uses 3D imaging to optimize LV lead placement in CRT implantations. "What we do is to acquire a DynaCT run during CRT implantation in order to obtain a 3D reconstruction of the coronary sinus and its side branches," explains Porodko. The 3D reconstruction of the coronary sinus is superimposed on the live images of the fluoroscopy. "This allows us to identify the most suitable cardiac vein quickly and to place the lead more accurately. Ultimately, this should reduce the risk of non-response."

From a patient perspective, the use of 3D reconstruction imaging of the coronary sinus offers additional benefits beyond the more accurate LV lead placement. "Normally, we would have injected contrast media in the coronary veins at least twice to depict the coronary sinus in different planes in order to get a good impression of the anatomy," says Porodko. With the Siemens *syngo* DynaCT Cardiac application, one injection is enough: "This reduces the amount of contrast media needed, and it can decrease radiation exposure for both patient and cardiologist."

Faster than with the conventional approach

All these benefits come without increasing implantation time. On the contrary: "We are actually faster than with the conventional implantation technique," says Porodko. The main reason for this is a new *syngo* DynaCT Cardiac protocol that was introduced in 2014. Hospital Wels-Grieskirchen was in fact the first hospital worldwide to work with this new protocol. It allows 3D visualization of the morphology of the coronary sinus derived from just one run of the rotational angiography system. This takes no more than five seconds.

Such quick data acquisition is possible because of rapid electric pacing of the right ventricle, explains Ammer: "The rapid pacing prevents the ventricle from beating for exactly the five seconds that are needed for the DynaCT run. We don't need any adenosine and we don't need an ECG trigger." During the rapid pacing, patients don't need to lift their arms above their head anymore and they tolerate the procedure very well. There is a brief decrease in blood pressure, but right after the rapid pacing ends, circulation parameters return to normal. "This works even in patients with severe heart failure," says Ammer. "It is easy to do, since we don't need an additional lead. For the rapid pacing, we use the right-ventricular lead of the CRT system."

Cardiologists all over the world have in fact gained a lot of experience with this temporary electrical silencing of the heart in recent years. Rapid ventricular pacing is well established in transcatheter aortic valve implantations (TAVI), so more and more cardiologists are familiar with it.

Getting higher response rates in CRT treatment

Ultimately, Ammer and Porodko hope that 3D visualization of the coronary sinus will help them to keep the rate

"The DynaCT 3D reconstruction allows us to place the lead more accurately. Ultimately, this should reduce the risk of non-response."

Michael Porodko, MD,
responsible for CRT implantation at Hospital Wels-Grieskirchen in Austria

of non-responders as low as possible. In addition to advanced imaging for increased accuracy in lead placement, patient selection is key for the success of CRT treatment. In recent revisions, guidelines have become increasingly precise about which patients are suitable for CRT treatment. Quadripolar LV leads are another way to increase success rates. They are used routinely at Hospital Wels-Grieskrichen. If electric stimulation can be applied in different sections of the left-ventricular myocardium, the likelihood of a successful resynchronization increases.

According to Porodko: "Achieving high response rates in CRT treatment requires a combination of measures, but imaging is at the core. It allows us to work as precisely, as quickly and as patient-friendly as possible."

Hospital Wels-Grieskirchen

Hospital Wels-Grieskirchen is Upper Austria's largest hospital. Operated by the Franciscans and the Sisters of the Holy Cross, it is among the largest hospitals run by a religious order in Europe. At two sites in Wels and Grieskirchen, there are 1,227 beds. About 78,000 patients are treated in-house every year by 500 medical doctors and 1,200 nurses.

Chronic heart failure and CRT

- The European Society of Cardiology (ESC) estimates that 26 million people worldwide are living with chronic heart failure.[1] The five-year mortality rate is approximately 50%.[2]
- Chronic heart failure is expensive: In the U.S., it amounts for 2% of the total healthcare budget. Annual costs have risen from 24.3 to 39.2 billion US $ between 2003 and 2010.[3]
- Compared with optimal pharmacological therapy, CRT led to a 20% decrease in death or hospitalization.[4]
- The ESC estimates that about 10% of all chronic heart failure patients are candidates for CRT therapy.[5]
- About 33% of CRT patients are non-responders[6]: Neither symptoms nor cardiac ejection fraction improve after the implantation of a device which costs between 5,000 and 15,000 euros.
- Adequate placement of the left-ventricular lead is considered a major factor that contributes to treatment success in CRT therapy.[6]
- 3D visualization of the coronary sinus and integration with real-time fluoroscopy facilitates accurate LV lead placement.[7]

[1] European Society of Cardiology 2014; World Heart Failure Alliance White Paper
[2] Go et al, Circulation 2014, 129:e28-e292
[3] Braunschweig et al, Europace 2011, 13:ii13-ii17
[4] Bristow et al, N Engl J Med 2004, 350:2140-50
[5] European Society of Cardiology Guidelines on cardiac pacing and cardiac resynchronization therapy, Brignole et al, Eur Heart J 2013, 34:2281-2329
[6] Leyva et al, JACC 2014, 64:1047-58
[7] Gutleben et al, Europace 2011, 13:675-82

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

Further Information

www.siemens.com/artis-world
and see CRT case on following page

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Cardiac Resynchronization Therapy
Supported by *syngo* DynaCT Cardiac, *syngo* 3D Roadmap, and *syngo* Dyna4D

Courtesy of Marcus Ammer, MD, and Michael Porodko, MD

Department of Electrophysiology at Hospital Wels-Grieskirchen in Austria

Case Description

3D visualization of the coronary venous system to guide transvenous left-ventricular lead placement during cardiac resynchronization therapy (CRT) device implantation.

Patient History

The patient was a 74-year-old male weighing 95 kg, with a height of 1.85 m and with previously implanted ICD.

Diagnosis

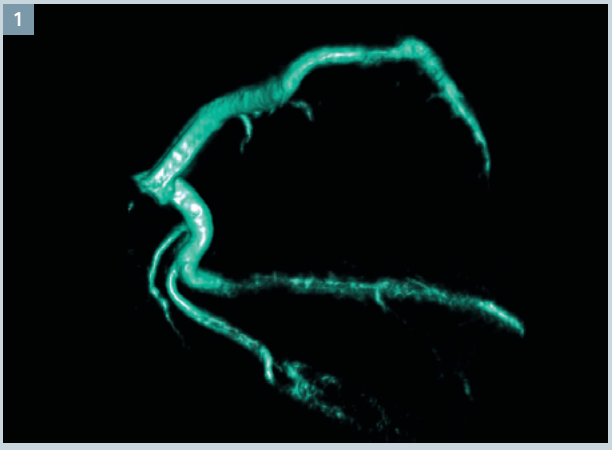
Indication to upgrade the pre-existing implantable cardioverter defibrillator (ICD) to a CRT system with defibrillator backup (CRT-D).

Treatment

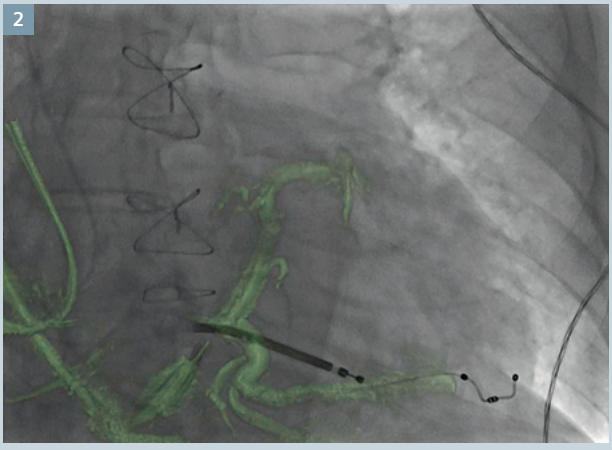
Implantation of a left-ventricular transvenous lead and upgrade to a CRT-D device to allow for biventricular stimulation with defibrillator backup.

Cardiac Resynchronization Therapy

Acquisition Protocol	**5sDCT Card**
Number of Projections:	248
System Dose in µGy/f:	0.36
Increment in Degrees:	0.8 °/f
Injection Protocol	
Catheter Position:	Coronary Sinus
Contrast Medium (CM):	350 mg Iodine/ml
Test Bolus:	w/o
Dilution (CM/Saline):	No
Injection Volume:	7 ml
Injection Rate:	Manual injection with balloon occluder
X-ray Delay:	2 s
Power Injector Used:	No



1 3D reconstruction followed by interactive “punching”.



2 Overlay of 2D and 3D with *syngo* iPilot enhanced functionality.

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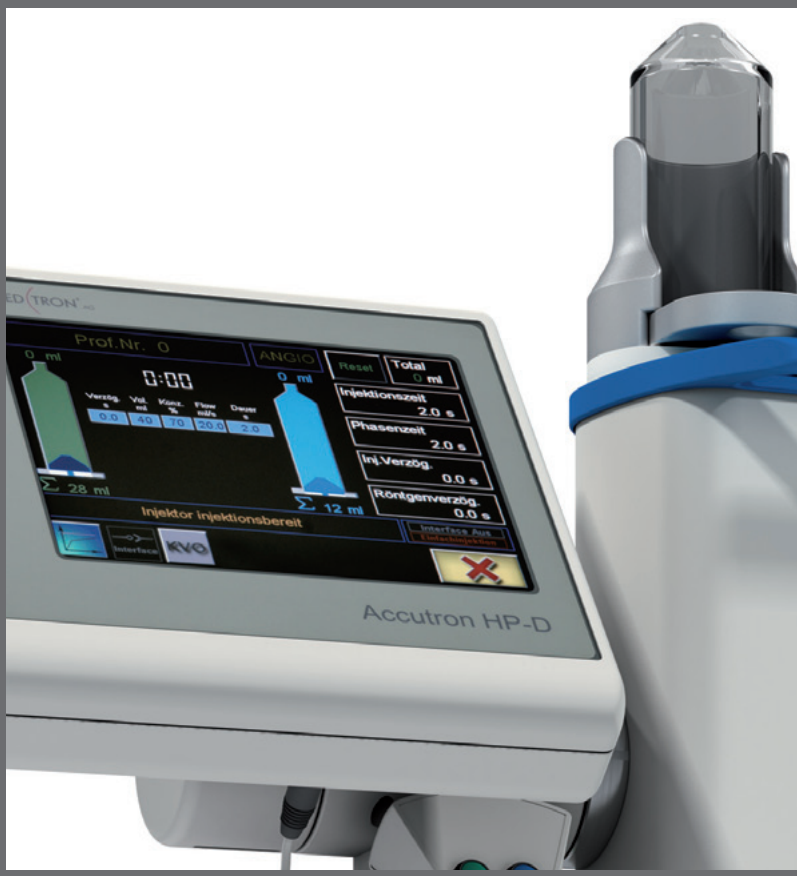

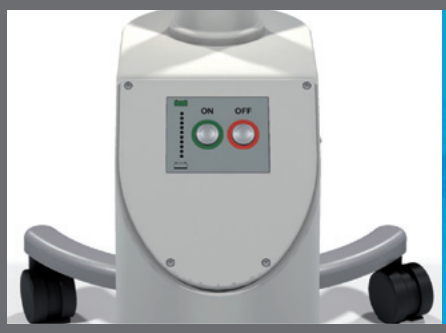

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Supported by non-fluoroscopic electroanatomic catheter tracking

Courtesy of Philipp Sommer, MD, FHRS, FESC, and Simon Kircher, MD

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Introduction

In these cases, we report on two patients with morbid obesity who underwent catheter ablation at our institution for atrial flutter and atrial fibrillation, respectively. In this particular patient cohort, high radiation doses are to be expected for mapping. Ablation is performed solely on the basis of conventional fluoroscopy (and a 3D electroanatomic mapping system in the case of atrial fibrillation). Therefore, it was decided to use a Siemens Artis zee system with integrated MediGuide™ technology (MediGuide™ Technology, St. Jude Medical Inc., St. Paul, MN, USA) for non-fluoroscopic electroanatomic catheter tracking. Previously published clinical trials consistently demonstrated that use of the MediGuide™ platform is associated with a substantial reduction in both fluoroscopy time and radiation exposure in a variety of electrophysiological procedures [1,2,3].

Case 1

Patient history

The first case was a 48-year-old patient with recurrent typical atrial flutter after previous CTI ablation and a BMI of 76 kg/m². Additional risk factors included arterial hypertension, diabetes mellitus type 2, and smoking. Pre-procedural echocardiography did not reveal any relevant structural heart disease.

Diagnosis

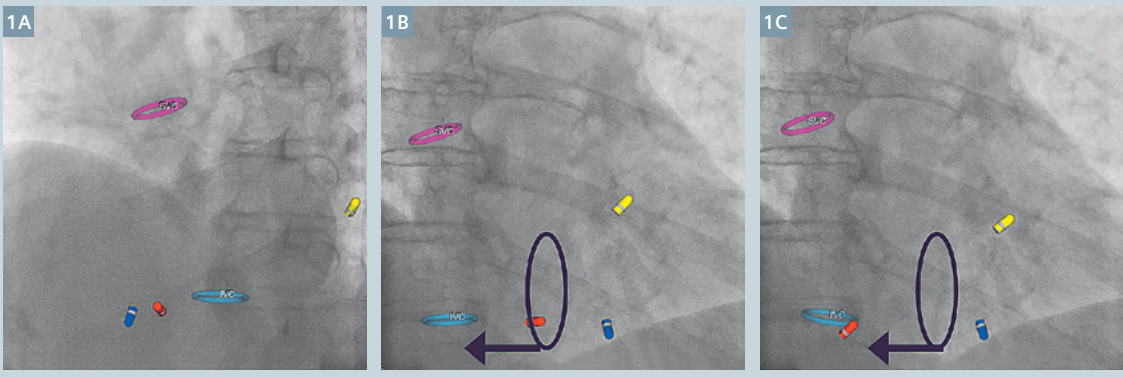
Recurrent typical ("isthmus-dependent") atrial flutter after previous failed CTI ablation with a cycle length of 210 minutes.

Treatment

Sensor-equipped multipolar diagnostic catheters (MediGuide Enabled Livewire™, St. Jude Medical Inc.) were placed in the right ventricular apex (RVA) and the coronary sinus (CS) via the left femoral vein. The diagnosis of typical "isthmus-dependent" flutter was confirmed by entrainment mapping maneuvers. Subsequently, radiofrequency (RF) ablation of the cavotricuspid isthmus (CTI) was performed using an irrigated-tip sensor-equipped ablation catheter (Safire DUO™ Ablation Catheter, MediGuide enabled, St. Jude Medical Inc.) (Fig. 1). After application of 25 RF pulses, complete CTI was achieved. Procedure duration: 60 minutes; fluoroscopy time: 1.7 minutes; radiation dose: 2638 µGym².

Comments

During the first CTI ablation procedure, catheter navigation and mapping were performed solely on the basis of conventional fluoroscopy without the use of the MediGuide™ technology. Procedure duration: 120 minutes; fluoroscopy time: 22.7 minutes; radiation dose: 8109.7 µGym².



1 MediGuide™ screens during ablation of typical atrial flutter. Anatomical markers for superior vena cava (pink) and inferior vena cava (blue); catheter tips for coronary sinus (yellow) and right ventricular apex (blue) and for ablation catheter (red). The ablation catheter is pulled back from tricuspidal annulus (dark blue) to inferior vena cava (dark blue arrow). LAO 46° in 1A; RAO 21° in 1B and 1C.

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Case 2

Patient history

The second patient was a 47-year-old patient with paroxysmal atrial fibrillation and a BMI of 52 kg/m². Prior antiarrhythmic treatment with flecainide and a betablocker has failed to control symptoms. Pre-procedural echocardiography did not reveal any significant structural heart disease.

Diagnosis

Highly symptomatic, drug-refractory paroxysmal atrial fibrillation.

Treatment

The procedure was performed under deep propofol sedation. Sensor-equipped diagnostic catheters were placed in the RVA and the CS (Fig. 2). After transseptal puncture, a 3D geometry of the left atrium and the pulmonary veins was created and subsequently fused with the 3D anatomy of the left atrium acquired by pre-procedural computed tomography scan using a 3D electroanatomic mapping system (Ensite Velocity NavX, St. Jude Medical Inc). Circumferential ablation lines were placed around each pulmonary vein pair to achieve pulmonary vein isolation defined as a bi-directional conduction block. Since significant structural left-atrial alterations could be ruled out by endocardial bipolar voltage mapping, no additional substrate modification was performed. At the end of the procedure, no atrial arrhythmias could be induced during burst-pacing from the CS. Procedure duration: 120 minutes; fluoroscopy time: 1.2 minutes; radiation dose: 827.8 µGym².

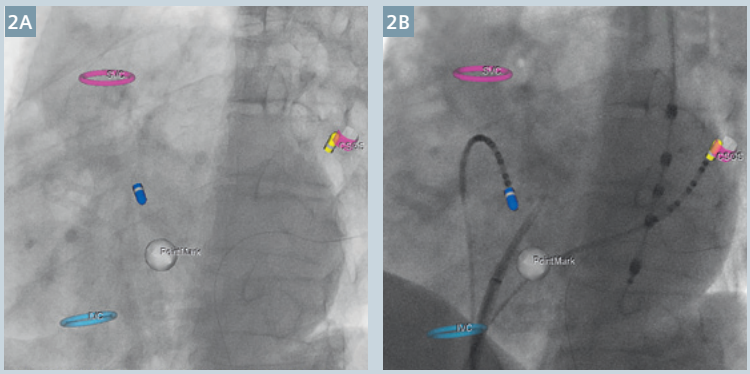
Comments

Application of non-fluoroscopic electroanatomic tracking provided by the MediGuide™ system substantially reduces fluoroscopy time and radiation exposure during different types of catheter ablation procedures. This is especially important in cases with a very high probability of increased radiation doses including patients with significant obesity.

[1] Sommer P, Piorkowski C, Gaspar T et al.: MediGuide in supraventricular tachycardia: initial experience from a multicentre registry. Europace 15(9), 1292-1297 (2013).

[2] Rolf S, John S, Gaspar T et al.: Catheter ablation of atrial fibrillation supported by novel nonfluoroscopic 4D navigation technology. Heart Rhythm 10(9), 1293-1300 (2013).

[3] Richter S, Doering M, Gaspar T et al.: Cardiac resynchronization therapy device implantation using a new sensor-based navigation system: results from the first human use study. Circ Arrhythm Electrophysiol. (5), 917-923 (2013).



2 MediGuide™ screen (2A) compared with live fluoroscopy (2B). Catheter in coronary sinus (yellow) and right ventricular apex (blue) are displayed by non-fluoroscopic catheter visualization. Markers are used for superior vena cava (pink) and inferior vena cava (blue). A marker for fossa ovalis (gray) has been set. Transseptal access can be seen on the right-hand image.

A Winning Team Goes TAVI – Combining Different Imaging Perspectives for Real-Time Insights

Text: **Michele Travierso**

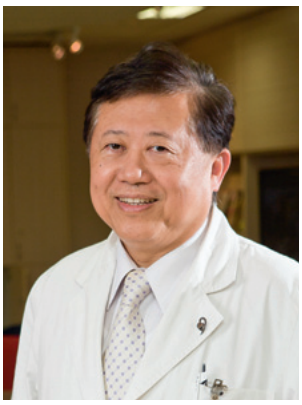
Robotic assisted C-arm systems and 3D transesophageal ultrasound imaging solutions in the operating room are enabling doctors to base their decisions on high-quality data available in real time. AXIOM Innovations met a leading interventional cardiologist and a highly experienced active echocardiographer in Taipei, Taiwan, to find out how they are helping their patients receive improved treatment.

Founded by Soong Mei Ling herself, wife of Chiang Kai-Shek (former president of the Peoples Republic of China), the Cheng Hsin General Hospital – CHGH in Taipei, Taiwan, is a beacon for cardiologists around the region. As the location of the first total artificial heart implantations in Asia, its fame is built on solid foundations. It is also the place where two leading heart specialists, Jeng Wei, MD, and Ming Chon Hsiung, MD, are currently using the latest technology in angiography and 3D echography.

Good teams need good tools

Both Wei and Hsiung spent several years perfecting their education in the U.S. Wei, the interventional cardiologist, and Hsiung, the echocardiographer, work as a team. "I'm his eyes," says Hsiung, as he describes how his guidance is of essence. "He [Wei] needs good eyes. He trusts every word I say." That trust has been built up over decades: Hsiung and Wei have been friends since the early sixties when they were classmates at the National Defense Medical Center, a military medical school. Wei is also an alumnus of NYC's Columbia University. They both want their tools of choice to be as well integrated as the medical team that uses them.

Jeng Wei, MD



Ming Chon Hsiung, MD

Offering highly advanced therapy for heart disease, Wei's preferred system is the Artis zeego. Derived from an industrial robot, the flexible Artis zeego C-arm can be both center stage, delivering high-quality images, or parked out of the way. Due to its positioning flexibility and coverage, Artis zeego can also be used for peripheral vascular surgery. In fact, "you can use it for so many operations," says Wei and therefore use the room in the most efficient way.

Wei's team performs anywhere between 50 to 100 structural heart disease (SHD) interventions per year, many of which are TAVIs (transcatheter aortic valve implantations). "We begin by inserting the TEE probe and then, having exposed the femoral artery, we bring in the Artis zeego to help us guide the device with the valve into the right position. To verify this position we use the TEE". 3D TEE explains Wei, "works by proximity, so it's better for precise valve positioning and detection of leaks." The X-ray and the ultrasound images are different and yet both essential: They can be displayed next to each other, on one large display, or on different monitors.

Wei stresses the advantages of having real-time imaging powers so easily deployable in a hybrid OR. Until recently, he says, "we would have had to move the patient to the catheterization room, but the environment there is not as

sterile as in an operating theater." Wei explains that the setup allows teams to keep the heart-lung machine closer to the patient and does not obstruct patient access. He highlights another benefit: "The positioning memory saves a great deal of time if one needs to move the C-arm and then call it back to where it was."

Real-time imaging

In turn, Hsiung explains how the images he delivers with the help of an ACUSON SC2000 PRIME guide the whole team. "Echos of the True volume TEE probe are fast. With the new probe, unlike with competing ones, we don't have to shut down the respirator to take a look," he says. Each stop and restart of the respirator adds a layer of risk for the patient, however small.

"Usually, it takes about seven beats to get a good image," he continues. "If the patient has arrhythmia, forget it – you cannot get a full picture," Hsiung says. Temperature is also an issue: "Probes from other manufacturers tend to warm up, but the thermal management of ACUSON SC2000 PRIME works very well."

The ACUSON SC2000 PRIME provides yet another advantage: Real-time volume TEE plus color Doppler. Pointing at the image of a pulsating valve on a screen, Hsiung explains how "seeing 3D flow with volume color Doppler helps a great deal". "The red color shows a little regurgitation of the mitral valve."

While TAVIs are less invasive, insurance schemes do not yet cover them: The replacement valves are too expensive. However, having precise placement information in real time, without having to move the patient and considerable extra equipment to a cath room, is a great benefit for the surgical team. Still, the benefits are not just logistical – they translate to cost savings for the service line, if a machine is used effectively. While the valve cost in a TAVI procedure is higher, there are measurable benefits for both convalescents and hospitals. "Patients who haven't had their chests opened can leave the hospital after just four or five days," he states. And what a difference that makes.

The ACUSON SC2000 PRIME

ACUSON SC2000 PRIME True Volume TEE offers various benefits, including precise real-time guidance based on the anatomical information of a true volume scan. Equipped with innovative thermal management, it allows for superior imaging in Doppler mode. The volume color Doppler makes visualizing the residual blood flow possible after a TAVI or a mitral valve clipping. Finally, eSie Valves advanced analysis package allows for easy 1-click measurements before the procedure and immediate verification of planned device size, for aortic and mitral valves.

CLEARstent – Proven Effectiveness for over 85% of Patients

Courtesy of Antônio José Muniz, MD

Department of Cardiology, Santa Casa de Misericórdia de Juiz de Fora, Minas Gerais, Brazil

Study protocol

The strategy of the study was based on the treatment of patients with coronary stenosis of different severities, where quantitative angiographies were applied in three distinct phases: initial, residual and final.

Phase 1
Determination of the initial degree of stenosis.

Phase 2
Treatment of coronary heart disease using the appropriate stent and its expansion at the nominal pressure specified by the manufacturer.

After conventional treatment (without CLEARstent), a new quantitative angiography was performed to quantify the residual stenosis inside the vessel lumen.

Phase 3
In this phase, new reconstructions of the installed prosthesis were performed with CLEARstent, and re-expansions were performed when a residual stenosis was observed. In these cases, high pressure balloons that were shorter than the stent were used, and 12 bars of pressure were applied. A new quantitative angiography was performed and the final result was evaluated.

Results

A total of 43 patients were examined and treated. It was observed that 37 patients did benefit from the use of CLEARstent, as it showed an underexpansion or underdeployment of the implanted stent, which was then treated with post dilatation.

Note: In some cases there was a "step-up", i.e. variation in the diameter of the arteries, due to the use either of re-expansion or vasodilators inherent to the angioplasty procedure.

Final consideration

We observed that with the use of CLEARstent, the prosthesis visualization is enhanced. This allows a better verification of the expansion of the stent and facilitates the execution of a re-expansion. The residual stenosis has successfully been reduced, in other words, it allows the correction of underexpanded stents inside the artery wall.

With this methodology, it was also observed that the CLEARstent tool provides exceptional visualization to perform procedures in bifurcations. In cases where the "Kissing" technique is necessary, it provides precise positioning of the stents preserving the bifurcation angle.

In conclusion, the CLEARstent tool contributes impressively to reducing restenosis caused by incorrect positioning or underexpansion of the stent, once the implant is expanded. Its efficiency is proven by the data shown.

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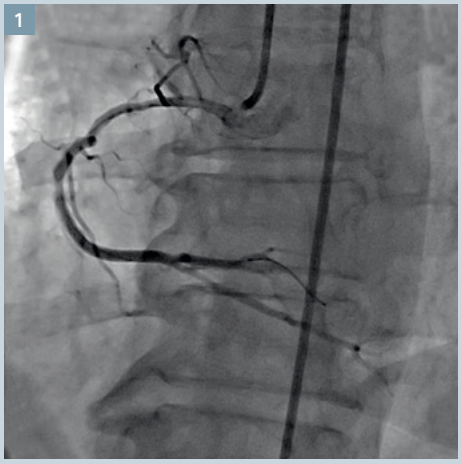
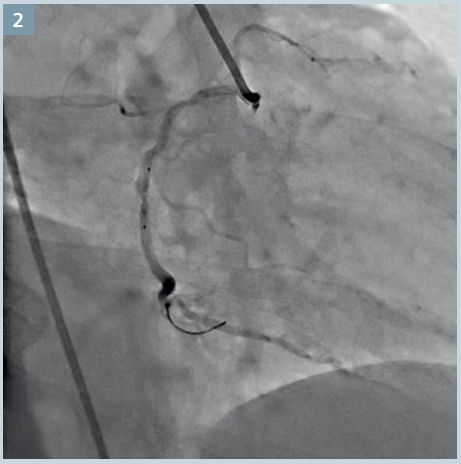
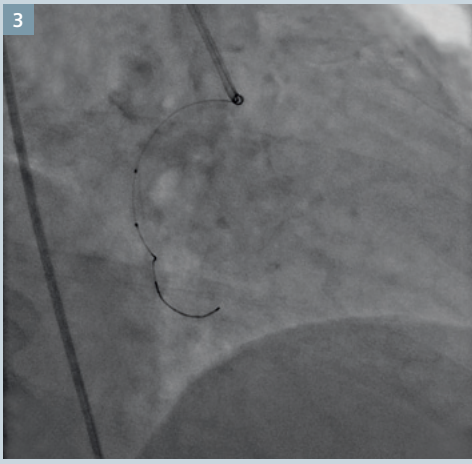


1 Initial angiogram showing a stenosis of the right coronary artery.

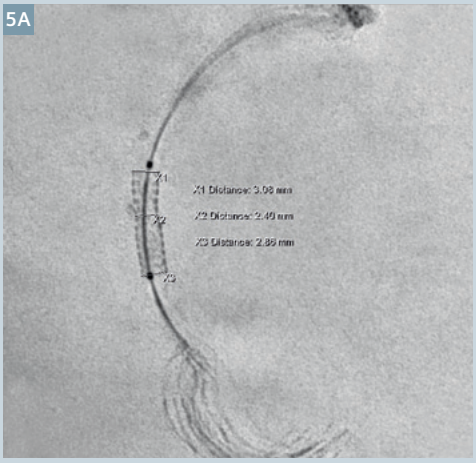


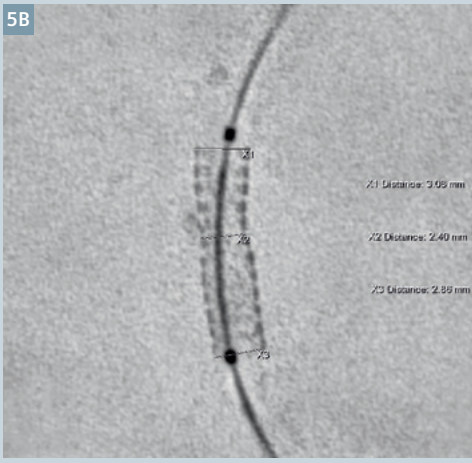
2 Angiogram to check the stent positioning before stent deployment.



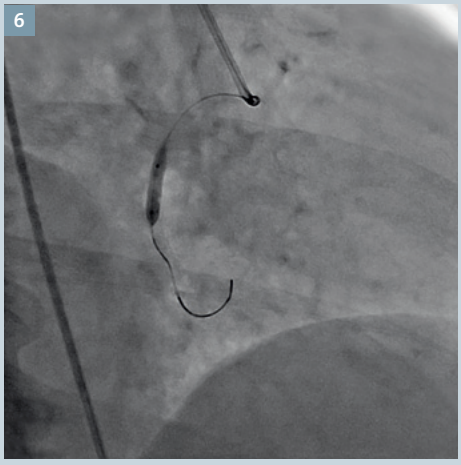
3 CLEARstent acquisition after stent implantation.

4 CLEARstent showing narrowing of the stent in the area of a calcification.



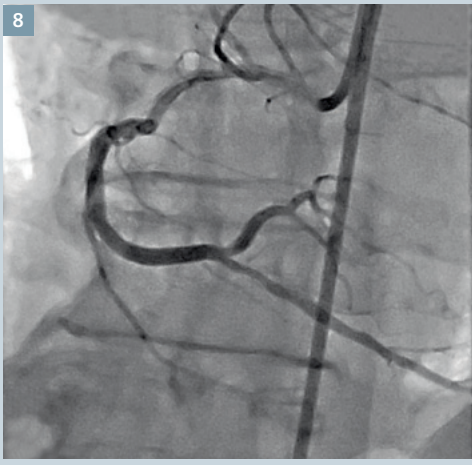


5 Manual measurements at the distal and proximal end of the stent to define the diameter. In addition, a measurement in the region of the underdeployed region.



6 Post dilatation of the underdeployed stent.

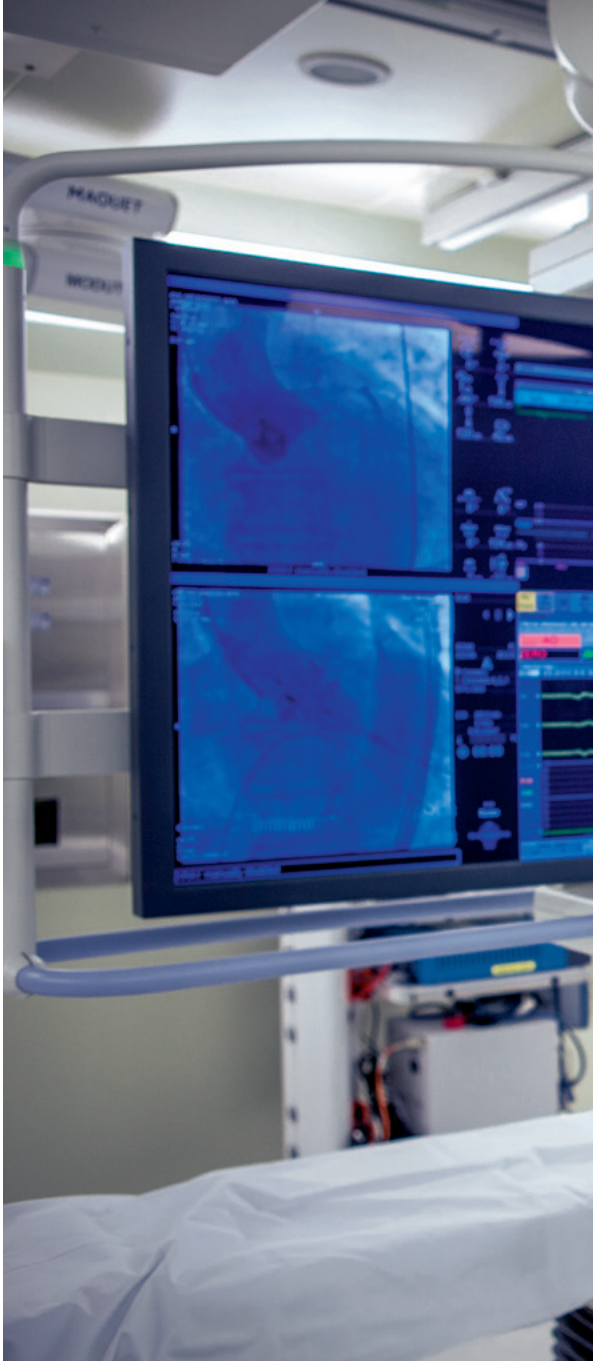
7 CLEARstent showing simultaneuosly the stent enhancement in relation to the contrast-filled vessel.



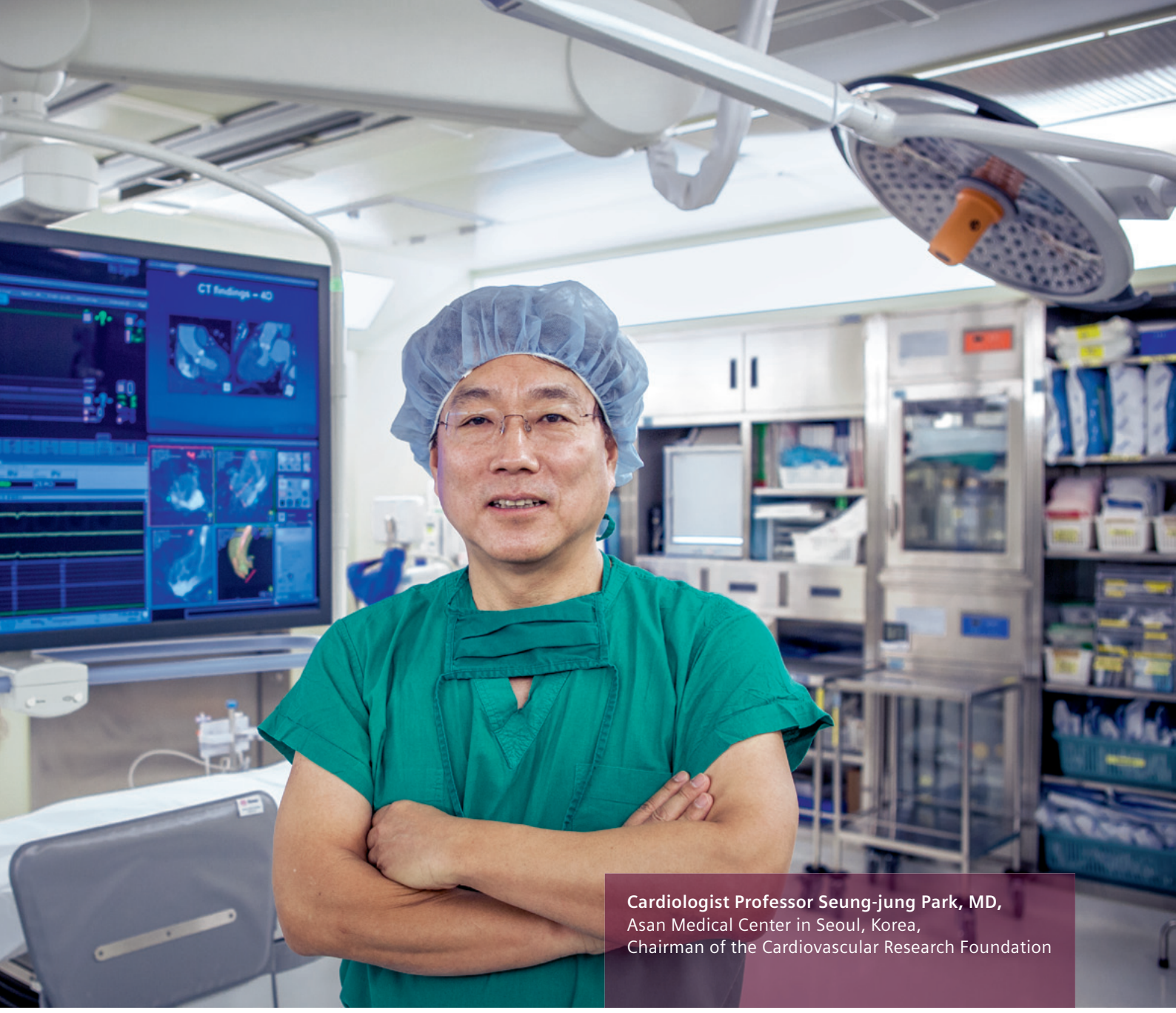
8 Final angiogram.

“Some colleagues called me crazy.”

Text: **Dr. Chul Joong Kim** | Photos: **Thomas Steuer**



In the past decade, two paradigm shifts occurred in the management of patients with coronary artery disease. First, it was acknowledged that only coronary stenoses with hemodynamic significance benefit from revascularization. Previously, many physicians believed that a stenosis grade of >50% was justification for coronary revascularization. The second change relates to treatment of left main coronary disease. Here, interventional revascularization has increasingly become an alternative to bypass surgery. In Seoul we visited one of the visionaries, Korean cardiologist Professor Seung-jung Park, MD. AXIOM Innovations spoke with him about the latest developments in cardiology and how to reassure critical colleagues.



Cardiologist Professor Seung-jung Park, MD,
Asan Medical Center in Seoul, Korea,
Chairman of the Cardiovascular Research Foundation

The fastest way to meet Seung-jung Park would be to have an acute heart attack. When I visit his office at Asan Medical Center in Seoul he greets me in the gown and surgical cap he wears during cardiac interventions. His words and movements have the rhythm of a heartbeat.

When and why did you become internationally known in interventional cardiology?

It was in 2003, when my article "A Paclitaxel-Eluting Stent for the Prevention of Coronary Restenosis" was published in NEJM. This multi-center study involving three Korean heart centers demonstrated that the coronary restenosis rate could be reduced from 27% to 4% when using a paclitaxel-eluting stent instead of a bare metal stent [1].

You have questioned established procedures and introduced new treatments. How has that been acknowledged by your peers?

In the mid-1990s, I performed stenting of the left main (LM) coronary artery, until then a domain of coronary bypass surgery. LM intervention was met with skepticism at the time.

How did you overcome this strong opposition?

At cardiology congresses I discussed this new approach to left main disease with cardiac surgeons. Initially a lot of skepticism was there, as our approach was revolutionary. Some colleagues even called me crazy.

As criticism got louder, the Asan Medical Center temporarily prohibited the procedure. Only later, when further results had been published in the Journal of the American College of Cardiology (JACC), the situation began to turn around and Asan allowed the procedure again. Now, 95% of patients with significant coronary artery stenoses at Asan Medical Center are treated with interventional procedures. I am gathering the results of procedures from leading heart hospitals from all over the world. And in the end, medical guidelines have changed. However, I also became notorious for reducing the size of the cardiac surgical team. (laughs)

What is the next challenge for you?

I am looking for a way to identify those patients with coronary artery stenosis who will not benefit from coronary revascularization. Now, I will be the doctor who downsizes his own cardiology department. However, if that helps patients, it should be done.

Can you elaborate?

A hot topic in interventional treatment of coronary artery disease (CAD) is fractional flow reserve (FFR), and that is my interest these days. In other words, when there is no blood pressure drop distal to a coronary stenosis, there is no indication to perform coronary revascularization, neither percutaneous coronary intervention (PCI) nor coronary artery bypass grafting (CABG). According to literature, this is true in up to 30% of patients. In 2009, I realized that even a high-grade stenosis does not necessarily induce myocardial ischemia in the dependent myocardial segment.

This was an amazing discovery. Approximately one third of those patients whose coronary artery had narrowed by 50-80% showed normal FFR results, which means they did not need coronary revascularization. I also learned that, by contrast, coronary lesions with a low stenosis grade could induce myocardial ischemia, demonstrated by a pathologic FFR value.

So, what did you do with this finding?

I published my findings in 2011. Some colleagues criticized it as “nonsense”. In November 2013, we published a major series in the European Heart Journal (EHI). Observing 5,000 angina pectoris patients revealed that those who did not receive procedures or surgeries based on good FFR results showed much better outcomes than those who received procedures or surgeries only based on stenosis grade.

The number of coronary interventions in your hospital has been reduced by half. Is it because you base your decisions on FFR results?

Correct. We changed the approach to the management of coronary stenosis. Before, we, like all cardiologists all over the world, performed PCI in coronary lesions with >50% stenosis grade. However, nowadays we additionally assess the hemodynamic relevance of such lesions through FFR. And we only perform PCI in lesions demonstrating pathologic FFR.

The Korean innovator in cardiology

Seung-jung Park was named "Doctor of the Year" by the European Association of Cardiovascular Intervention in 2005. In 2008, he was the first Asian cardiologist to receive a Career Achievement Award from TCT. He is now on the editorial boards of four international journals. In addition, he was awarded Korea's Top Scientist Award by the Ministry of Education and Science in 2011. He has been President of Asan Medical Center Heart Institute since 2009 and is currently Chairman of the Cardiovascular Research Foundation.

Park has been using Siemens angiography systems for a long time, introducing the AXIOM dBC and dTC systems in the 2000s and the Artis zee floor-mounted system in the 2010s, frequently applying them in his procedures and achieving remarkable academic outcomes which received international attention. Recently, the Artis zee ceiling-mounted system was installed at Asan Medical Center.

So not all patients with coronary stenosis lower than 50% have to undergo coronary revascularization if FFR results are good?

Exactly. And this is also true for coronary bypass surgery. Examining FFR is a win-win model that maintains health and reduces high medical costs for the patients, as could nicely be demonstrated in the FAME1 study.

This is a change in CAD therapy? Are there any objections?

There certainly could be. FFR is a new diagnostic approach, and the long-term outcome of patients undergoing FFR-guided coronary revascularization needs to be investigated. Two years of results from FAME [2] are very promising.

Since the introduction of transcatheter aortic valve implantation (TAVI), Asan Medical Center has performed increasing numbers of these procedures. Do you consider TAVI to be a game-changer?

TAVI has meanwhile been done in around 80,000 patients worldwide. Numerous clinical studies, such as PARTNER, or registries comprising tens of thousands of patients demonstrated that TAVI is a safe and effective therapeutic option in patients with severe aortic valve stenosis that cannot undergo surgical valve replacement because of too high surgical risk. By the end of 2013, Asan Medical Center, as the first Asian institution, had performed more than 100 TAVI procedures with a 94% procedural success rate. Unlike traditional open heart surgery, which replaces the diseased aortic valves, in TAVI an aortic valve prosthesis is placed via an arterial access route or a transapical access route in the aortic valve region, after the stenosed valve has been destroyed in the first step of the procedure by balloon angioplasty.

Isn't there an overlap between the patients who need TAVI and those who need surgery?

At the moment, when following the guidelines, there is no overlap. The average age of those 100 patients who underwent TAVI at our institution was 78 years. Because of too high risk, open heart surgery was not an option for them. Some patients who underwent TAVI were even in their 90s. TAVI is also performed in our hybrid operating room. The hybrid operating room is a top-notch medical facility incorporating a fully functional cath lab system in a fully functional OR. Now, we are one step closer to being called a global heart center.

[1] N Engl J Med 2003; 348:1537-1545
[2] 1N Engl J Med. 2009;360(3):213-24.

Dr. Chul Joong Kim holds a doctorate in Medicine and a Master's degree in journalism. He is a senior staff writer on medical affairs and health information for Chosun Ilbo, a national daily newspaper, and President of the World Federation of Science Journalists (WFSJ).

Fracture Reduction and Stabilization of Distal Radial Fracture Supported by Artis zeego with Q Technology and *syngo* DynaCT

Courtesy of Professor Olivier Barbier, MD

Department of Orthopedic Surgery, Saint-Luc University Hospital, Brussels, Belgium

Patient History

53-year-old active female who fell on her wrist. She broke her wrist by falling on her extended arm with her entire body weight.

Diagnosis

1. Fracture of the distal radius with dorsal tilt of the articular surface (Fig. 1).
2. Third fragment (posterior ulnar) (Fig. 2).

Planned Treatment

First surgery to be performed in the hybrid operating room with an Artis zeego with Q Technology. A clear goal was to assure proof of concept for high precision imaging and test the workflow.

1. Fracture reduction
2. Stabilization with plate and screws for all the fragments
3. Limited postoperative immobilization through thermoformable (removable) splint at 3 days post-op

Professor Olivier Barbier, MD

Treatment

Surgery started with a preoperative *syngo* DynaCT micro run (Fig. 2) with the arm in a sterile position above the patient's head resulting in CT images with a spatial resolution (voxel size < 0.1 mm) which is superior to standard multislice CT images. (Fig. A)

For the surgical procedure, the arm was then positioned in a lateral extension on an arm board while Artis zeego was completely out of the way. (Fig. B, C)

The advancement of the surgical procedure was controlled with two fluoro shots with the arm in the surgical position.

- The distal part of the anatomic plate is temporarily fixed on the displaced distal part of the radius with K-wires.
- On the lateral radiolucent table, a fluoroscopy (Artis zeego) is performed to control the placement of the plate (Fig. 3).
- The position on the lateral armboard is stored as an individual user position. Therefore, automatic systems that drive to exactly the same position help with the precision and speed needed to acquire images.
- First, the distal part of the plate is fixed with locking screws (in the plate), in the distal fragment of the radius.
- Second, the plate is applied onto the proximal end of the fracture. This manipulation will mobilize the distal fragment, reducing the dorsal tilt.

After all screws had been positioned, another *syngo* DynaCT 3D run was performed. Very interestingly, the rotating 3D reconstruction shows clearly that the reduction is adequate but the posterior ulnar fragment is not fixed with the screws (Fig. D). The ulnar bone was digitally removed from the dataset for better visibility of the radius bone.

Consequently, the images were used to measure the necessary length of the screw required for precise stabilization and the screw was placed. (Fig. E)

A final *syngo* DynaCT showed the successful result with the screws and plate in the exact position and the reduction of the fracture perfectly achieved (Fig. F). Intraoperative 3D imaging clearly improved quality management in the OR and confident patient discharge was enabled as well as secondary surgery avoided.

Contact

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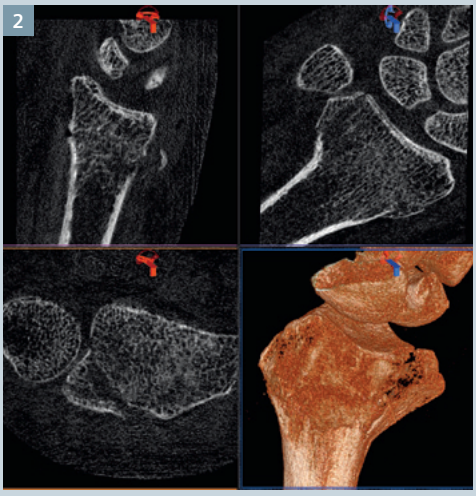
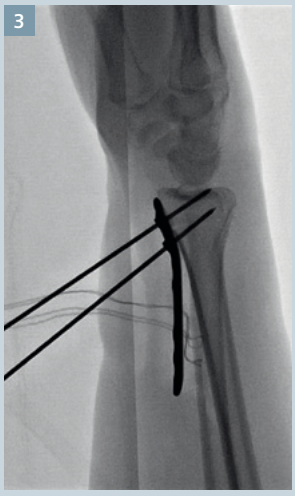
1 Radiographs in the emergency department: A-P view (left) and lateral view (right).



2 Surgery started with a preoperative *syngo* DynaCT micro run showing a third fragment (posterior ulnar).

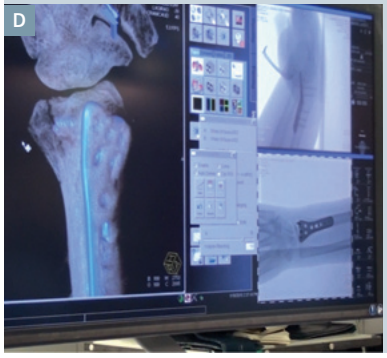


3 The distal part of the anatomic plate is temporarily fixed on the displaced distal part of the radius with K-wires.

A

B

C



D

E

F

Laparoscopic Cryoablation of a Percutaneously Inaccessible Tumor Supported by Artis zeego and *syngo* DynaCT Large Volume

Courtesy of Dogu Teber, MD

Department of Urology, University of Heidelberg, Germany

Patient History

78-year-old female, 85 kg, 165 cm with a medical history including hysterectomy, open cholecystectomy, with approximately 50% stenosis of the external carotid artery, arterial hypertension, and diabetes mellitus. The patient also has a history of renal failure.

In addition, the patient had a large cyst (approximately 3.5 cm in diameter) on the lower pole of the right kidney.

Diagnosis

A regular check-up with ultrasonography revealed a tumor in the right kidney mid-pole. Subsequently, a computed tomography scan confirmed a 3.5 cm x 2 cm x 3 cm tumor. The patient was not reporting any pain in the kidney area.

The CT scan showed a tumor with typical patterns of a hypernephroma. There was no sign of tumor-suspicious lymph nodes or metastases.

Dogu Teber, MD

A tumor was located in the right kidney mid-pole unreachable percutaneously with an ablation procedure. Specifically, the tumor location was ventral, endophytic, hilar, close to vena cava and bowl. Therefore the tumor location precluded percutaneous RF ablation and surgical resection.

Treatment

To treat the tumor, a laparoscopic cryoablation procedure was performed. The patient was positioned in the left lateral decubitus position.

Step 1

The surgeon dissected the kidney laparoscopically and mobilized the kidney. As a result, the tumor became accessible for percutaneously placed cryoablation needles.

Step 2

A large volume *syngo* DynaCT run with intravenous contrast media injection was performed. Due to the patient's obesity and her left side position on the OR table, it was anticipated that the right kidney could not be covered in a standard *syngo* DynaCT dataset. Acquiring a *syngo* DynaCT Large Volume with an intravenous contrast media injection allowed to visualize intraoperatively the whole right kidney with its internal and surrounding vascular structure.

Step 3

In order to see image information from the preoperative CT data relative to the intraoperative patient position, 3D/3D Fusion of preoperative CT data and intraoperative *syngo* DynaCT was performed.

Step 4

Tumor contours were marked using *syngo* 3D Toolbox on the *syngo* X Workplace.

Step 5

Image guidance with *syngo* 3D Roadmap was used to insert the cryoablation needles. Overlaying the three-dimensional contours of the tumor on live fluoroscopy acquired with different C-arm angulations allowed the surgeon to assess how deep the cryo-needles had been placed in the tumor, an information not available in the endoscopic image.

Comments

The procedure proved to be successful with a very positive patient outcome. After six days, at the time of discharge, the creatinine level was back to normal level. At the post-procedural follow-up two months later, no residual tumor was found.

This procedure was performed in a hybrid OR with Siemens Artis zeego. *syngo* DynaCT Large Volume is a unique feature which was essential for the success of this procedure. Conventional hybrid OR systems do not have the possibility to acquire the necessary large patient volume for image guided treatment. Image-guidance tools supported accurate needle placement and needle guidance during the treatment.

Protocol

Imaging protocol

- 16s DR Large Volume
- Scan time: 16 s
- Rotation angle of C-arm: 2 x 220°
- System dose: 0.36 nGy/frame
- Number of frames: 546
- Volume size obtained: 455 mm in diameter and 187 mm in height

Contrast media injection

- Type of injection: intravenous bolus injection
- Volume: 120 ml
- Place of injection: brachial vein
- Injection rate: 4 ml/s
- Delay between injection start and volume acquisition: 45 s

Contact

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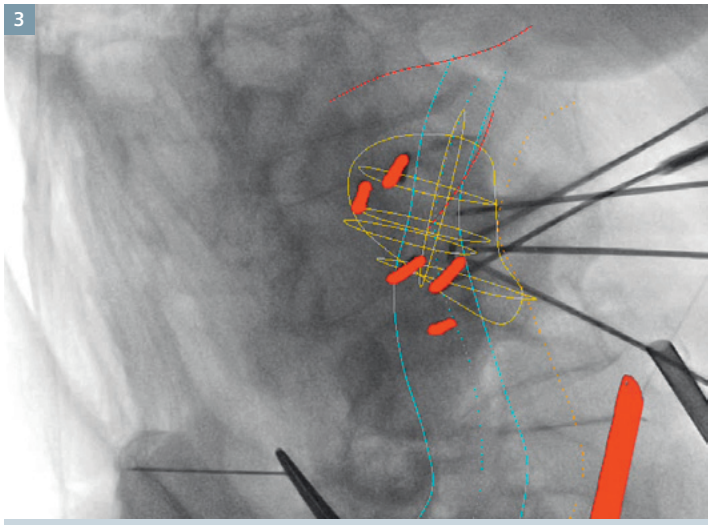
1 Laparoscopic kidney mobilization.

2 Intraoperative *syngo* DynaCT Large Volume run.



3 Image-guided needle placement using *syngo* 3D Roadmap and *syngo* 3D Toolbox.

4 Cryoablation procedure in progress.

A Truly Hybrid Approach: Combining Neurosurgery and Neurointervention

Neurosurgeon Professor Weijan Jiang, MD, has been performing neuro interventions for over 30 years. Since 2012, he has been Vice President of the Second Artillery General Hospital of the Chinese People's Liberation Army and also head of the PLA Stroke Care & Research Center in Beijing, China. The Center is one of the world's leading facilities for cerebral vascular disease and stroke management providing comprehensive diagnostic and therapeutic care for patients with disorders of the cerebral blood vessels. The PLA Stroke Care & Research Center has neuroradiologists and neurosurgeons working together in the hybrid OR with an Artis zeego. The team treats and manages various cerebral vascular diseases. Today, Jiang is in conversation with AXIOM Innovations discussing a unique case performed with Artis zeego in his lab.

Professor Jiang, what procedure did you just perform and why choose the hybrid OR?

Jiang: Today's patient had a giant meningioma and the aim of the procedure was to remove the tumor entirely. The tumor was located in the right temporo-occipital lobe and was very large and highly vascularized. The hybrid OR equipped with an Artis zeego angiography system allowed us to follow a truly hybrid approach: In the same room, we were able to first perform tumor embolization and then switch to open surgery and resect the tumor. This approach largely reduced intraprocedural bleeding and provided great assistance during open surgery. I believe that for giant or deep meningiomas especially, a hybrid approach may become popular for treatment of highly vascularized tumors in the future.

How would you describe your workflow in a hybrid approach?

Jiang: The workflow for this particular case can be broken down into four major steps: First, the Artis zeego angiography system was used to perform a 3D DSA. These data showed detailed information about the feeding arteries to the tumor. In order to see the exact correlation of vessels and tumor, the 3D DSA was fused with preoperative MRI. Second, these arteries were embolized with the help of

Hybrid OR with Artis zeego to provide image guidance during embolization of the tumor prior to surgery.

During open surgery in the hybrid OR, the imaging system is parked away to leave room for the surgical team.

"The hybrid room is designed to combine open and endovascular treatment for neurovascular diseases that could not be treated by intervention or surgery alone, such as complex aneurysms, AVM, DAVF, hypervascular tumors, or chronic carotid occlusions."

Professor Weijan Jiang, MD,
Head of the PLA Stroke Care & Research Center, Beijing, China

syngo 3D Roadmap. In a third step, the team converted to open surgery in the same room without moving the patient to another operating table. With a single press of a button, Artis zeego was moved to a park position away from the table, allowing quick and easy patient access for all staff. The tumor was successfully resected and, finally, we performed post-procedural imaging to ensure the success of the entire procedure.

What are the key factors in adapting to such a hybrid approach?

Jiang: On the one hand, you need to have smoothly operating imaging equipment for a successful outcome, and, on the other hand, excellent teamwork. We need four types of professionals in such cases: nurses skilled in interventional and surgical nursing, anesthesiologist, experienced neurosurgeons, and neurointerventionalists.

What would you recommend to colleagues who are looking to establish a neurosurgical hybrid room?

Jiang: A hybrid room dedicated to neurosurgery should contain an angiographic system that is convenient to use in interventions, but also provides enough space for surgeons to operate. Second, there should be a radiolucent head clamp. In our case, we are using a DORO radiolucent headrest system. We also need surgical devices such as microscopes and intra-procedural EEG, and of course, anesthesia equipment. I believe that the emergent neurosurgical hybrid room is the result of clinical demand. Some neurovascular diseases cannot be treated with either an interventional approach or open surgery. The hybrid room is designed to combine both for certain neurovascular diseases that could not be treated by intervention or surgery alone, such as complex aneurysms, AVM, DAVF, hypervascular tumors, or chronic carotid occlusions.

What are the advantages of robotic-assisted intraoperative imaging in a hybrid OR?

Jiang: Our team here consists of extremely experienced neuro interventionalists and neurosurgeons who have been working together for years now. We have established one of the first neurosurgical hybrid OR in China, equipped with a Siemens Artis zeego angiographic system. In less than one year, we have performed more than 100 hybrid operations in this room, including giant aneurysm, complex DAVF, AVM, hypervascular tumor, and chronic carotid occlusion. The advantage of intra-procedural image guidance is obvious. The Artis zeego provides us with the flexibility we need during our entire workflow. In this case, providing excellent image quality, enabling the detection of the feeding arteries to the tumor and providing the guidance needed during the embolization. During long surgeries, the comfort provided by the way the robotic imaging system adapts to any table movement is something any surgeon appreciates. Also, the possibility of immediate imaging inside the OR to detect any residue is very helpful.

Is radiation dose for patient and staff during the procedure a point of preoccupation?

Jiang: Of course we are cautious about radiation dose during surgery. It is important for patients and staff to maintain lower radiation dose. Siemens CARE&CLEAR helped us to find the right balance between low dose and high image quality. Apart from low dose 2D and 3D DSA, we are also using image fusion to obtain anatomical details and the relationship of lesions. This helps us guide our operation reducing dose while maintaining high imaging quality. For today's procedures, low-dose 3D DSA and also *syngo* DynaCT Low Dose were used to accurately detect the feeding arteries to the tumor and the healthy brain tissue.

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Quality Control when it Counts Most: The World's First Hybrid OR Dedicated to Spine Surgery

Text: **Andrea Lutz**

Operation time cut almost by half, the number of procedures increased by 66 percent in just two years: The decision to build a hybrid OR with a fixed C-arm dedicated solely to spinal surgery has paid off in many respects. As a doctor, Sohei Ebara, MD, believes that the most important effect is the superior clinical outcomes compared with procedures performed in a conventional operating room: "Patients can count on optimal postoperative results. There is no anxious waiting for the post-operative CT scan or deciding how to deal with an imperfectly placed screw. The intraoperative quality control leads to better outcomes and fewer secondary surgeries."

Cervical spine surgery in particular benefits from the new hybrid system, because it is an extremely challenging surgical procedure: The proximity to the central nervous system and the vertebral arteries demands the highest precision in a very confined space – a situation in which intraoperative 3D imaging and precise navigation is key. Artis zeego, a robot-assisted C-arm system, performs a five-second *syngo* DynaCT protocol to obtain a 3D volume in the OR of the actual anatomical situation. The 3D dataset and patient data are automatically transferred to the navigation system within seconds saving considerable time. Then, the imaging system can be moved to a parked position so that the surgeon can begin the guided placement of the screws.

Intraoperative *syngo* DynaCT – for fast and accurate judgment

The combination of intraoperative CT-like imaging and the navigation system provides the surgeon with precise guidance and visualization of the anatomy. When performing lumbar spine surgery, which are the most common cases, Artis zeego provides a large field of view with a 30 x 40 detector. With the option to rotate the detector from landscape to portrait, a larger segment of the spine can be visualized with one image shot. Up to ten vertebral bodies can be shown on just one image and the power generator enables high-quality images to be acquired even in obese patients or where the anatomy is challenging. Ebara resumes: "This system is extremely 'stress-free.' The 3D mode covers a wide range, and we can perform a surgery with fewer 3D scans." And with the intraoperative *syngo* DynaCT, the placement of the screws is verified right in the OR. "Implants that may not be ideally positioned can be corrected immediately," says Ebara.

Easy operation is critical

A specialty of Sohei Ebara and his team is the surgical treatment of scoliosis, a curved three-dimensional deformity of the entire spine. There are various non-surgical treatment options, but surgery is recommended if conservative methods prove insufficient. With the lateral minimally invasive thoracoscopic approach, a new technique,

Shonan Fujisawa Tokushukai Hospital was re-opened after its reconstruction in October 2012 as a key clinical institute in this region. Tokushukai manages 66 hospitals and more than 280 clinical institutes that provide healthcare service in Japan.

A hybrid operating room dedicated to the Spine and Scoliosis Center was installed and equipped with the Artis zeego robotic imaging system, the TruSystem 7500 operating table by Trumpf, and the CURVE navigation system from BrainLab.

Further Information

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developed by Ebara and his team, the thorax is opened through small incisions and an endoscope is used to guide the surgical instruments. Intraoperative imaging plays a decisive role here, because the surgeons lose their tactile sense and natural 3D vision. A *syngo* DynaCT run is performed under sterile conditions and the 3D data is automatically transferred to the navigation system. When the first screws are placed, the instruments need to be visible to the navigation system's camera to achieve the greatest precision. Cross-sectional imaging helps Ebara and his team to decide whether the screws are placed correctly.

Another option is the dorsal approach, where the surgeon follows the placement of the screws on a separate screen of the navigation system using the intraoperative 3D volume. With the help of *syngo* DynaCT Large Volume and the image composing option, the surgeon can visualize the entire spine in a few steps. Any screw that requires repositioning can be adjusted directly in the OR. Ebara explains: "Easy operation is critical. Radiology technologists used to take a long time, especially to compose. And they used to occasionally make acquisition mistakes, but now they can come up with the images in three to four minutes."

The hybrid operating room in Shonan Fujisawa Tokushukai Hospital is the world's first installation dedicated solely to spinal surgery, and it is playing a pioneering role in orthopedic surgery in Japan. Sohei Ebara and his team have improved their efficiency dramatically, but they have never deviated from the well-established principle: safety first.

"Patients can count on optimal postoperative results. (...) The improved intraoperative quality control leads to better outcomes and fewer secondary surgeries."

Sohei Ebara, MD,
Vice President of the Shonan Fujisawa Tokushukai Hospital and Director of the Spine and Scoliosis Center, Japan

Three questions and three answers from Sohei Ebara, MD

What is your general policy for performing surgery?

Naturally, high-level technique is required from the surgeon, but the technology, equipment, and medical instruments should also be as advanced as possible. The most sophisticated technologies should be implemented and developed – such as navigation systems, endoscopes and the evoked spinal cord potential – in order to secure the patient's safety. As a result, we can improve the efficiency and accuracy of our surgeries. In addition, the smaller the scar, the better. That was the motive for developing the anterior orthopedic surgery; but safety can never be sacrificed to the size of scar.

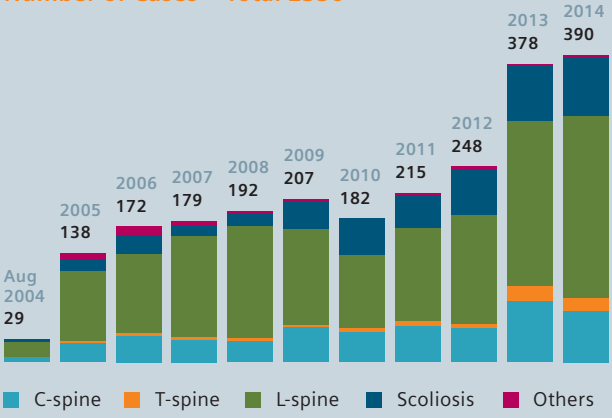
What are the advantages of the anterior orthopedic surgery that you developed?

Initially, we had six to eight incisions 2 cm in size for the 100% endoscopic surgery – but now we are performing surgery that leaves two 7 cm scars along the ribs. The video-assisted thoracoscopic surgery, called hybrid VATS, combines endoscope and direct vision. The advantage of this surgery is that it leaves a much smaller scar than the conventional open surgery. There is also no scar on the back as left with posterior orthopedic surgery. We insert a screw through this scar to support the orthopedic shaft that connects with the outrigger for the orthopedic treatment.

Has the surgical time also been shortened?

Artis zeego has helped, but the number of cases has also increased. In the past, we could only handle one scoliosis surgery per day. Now, with much faster workflows, we can perform one more surgery in addition to the scoliosis procedure, such as lower back or neck. The shorter surgical time is very critical. From four hours to eight hours is a big difference. If it is just three hours, we can even perform one more surgery.

Number of Cases – Total 2330



The Challenge of Excellence: Keeping up with the Rapid Pace of Development in Medical Technology

Text: **Andrea Lutz**

A new industry-trend: Open innovation platforms give companies the opportunity to receive valuable input from experts that will help them solve complex problems. This strategy builds on cooperation and has long been standard in medicine. Established working groups and training centers now offer their expertise online, thus making it globally accessible 24/7 and ensuring that knowledge on the use of new technologies is disseminated, providing for constant growth in experience and refining medical skills further every day.

Medical technology is a dynamic and highly innovative industry. Its vast potential is drawn from the combination of various scientific disciplines. Innovative procedures such as 3D printing in the OR, new methods for three-dimensional design and reconstruction, and the integration of robotics in surgery are just a few of the key topics that require physicians around the world to be very open to sharing experiences at an interdisciplinary level and to engaging in life-long learning. We introduce two institutions that have for many years played an exemplary role in the dissemination of knowledge and experience: IRCAD (Research Institute Against Cancers of the Digestive System) in Strasbourg, with its WeBSurg interactive online university; and the AO Foundation, established in Switzerland as the Arbeitsgemeinschaft Osteosynthese (Association for the Study of Internal Fixation) back in long ago as 1958 and still a pioneer in its field.

Arbeitsgemeinschaft Osteosynthese (AO): Empowering the next generation

The AO Foundation is a nonprofit organization led by an international group of surgeons who specialize in the treatment of trauma. Founded in 1958, today AO fosters one of the most extensive medical networks with more than 12,000 surgeons, operating room personnel, and scientists in over 100 countries. AO institutes deliver value-added products and services to their clinical divisions, surgical network, and partners. Three value statements drive all of their activities: excellence in trauma care, empowering the next generation, transparency and mutual trust. Institute members focus on producing new concepts for improved fracture care, delivering evidence-based decision-making, guaranteeing rigorous concept and product approval, and the timely and comprehensive dissemination of knowledge and expertise. In 2007, AO and Siemens signed an agreement to make digital imaging techniques a standard component of global AO training programs for surgeons. This enables surgeons to improve their level of patient care using the latest medical technology.

Suthorn Bavonratanavech, MD: Education is reducing complications

Suthorn Bavonratanavech, AO President, points out the benefits of the partnership: “As a surgeon, you cannot just listen to the lectures, you also have to use your manual skills, you have to understand

how to use the right tool at the right time. We strive for excellence in the treatment of musculoskeletal injuries and disorders through research and development and clinical investigation."

Asked about the key to delivering the best patient outcomes, Bavonratanavech emphasizes: "We want to continuously improve. Today, we have very good technologies – but because these technologies are always evolving, we cannot stop learning. We persist so that we can deliver the best possible outcomes for our patients. Our main activity is education, because we strongly believe that education not only improves our practice of medicine, it also reduces complications."

Florian Gebhard, MD: We want to increase awareness of the need to protect against radiation exposure

Florian Gebhard is Vice President of AO Trauma in Germany, and he confirms the importance of life-long learning and interdisciplinary exchange for surgeons: "AO is the cradle of modern trauma surgery, so we always want to teach ultra-modern methods and focus on tissue-sparing surgeries." At present there are already courses on computer-aided surgical systems and a webcast on 3D imaging. Yet, AO is also thinking about another issue that is emerging from the trend toward minimally invasive interventions and high-end imaging. Gebhard explains his theory: "The shorter the access paths, the greater our dependence on reliable imaging. That's why we want to increase awareness of the need to protect against radiation exposure during surgery – which means teaching people who attend our training programs how to handle radiation from imaging. It's a very important subject, especially because those of us in AO want to promote the concept of the hybrid operating room."

IRCAD – a center for research and training in partnership with industry

Another site for innovative research and training ideas is within the compound of Strasbourg's University Hospital. The IRCAD minimally invasive surgery training center has acquired an international reputation over the past 20 years. Each year, the Institute welcomes over 4,300 surgeons from 106 countries. A pool of 800 international opinion leaders in their surgical specialties supervise the IRCAD courses, and the Institute has gained fame as a leading research and education organization. The courses involve digestive surgery, urological surgery, vascular surgery, orthopedic surgery, and gynecological surgery. Each session combines theory with live surgeries and hands-on practice in an experimental laboratory. Given the tremendous success of IRCAD's program, founder and President Jacques Marescaux, MD, created branches of the IRCAD in Taiwan and in Brazil, too.

Collaborating to provide customized patient care

Since the foundation of IRCAD, Jacques Marescaux has always geared his work

"You have to understand how to use the right tool at the right time."

Suthorn Bavonratanavech, MD,
AO President, Senior Director
Bangkok Orthopedic Center,
Bangkok Hospital

toward the integration of 3D patient data into tomorrow's operating rooms. Therefore, he encouraged the development of virtual reality and augmented reality combined with robotic-assisted surgery. Today, virtual reality is one of the Institute's most important axes. It translates real data into digital data, which allows a medical scan to be transformed into a virtual 3D clone of the patient. As these simulations become increasingly realistic, surgeons can then prepare for the procedure on the patient's virtual clone. During the intervention, the superimposition of virtual data onto real data (augmented reality) permits a transparent view that should soon allow for the automation of complex surgical movements.

In July 2012, Marescaux's team performed a world premiere of robotic-assisted liver surgery using augmented reality intraoperatively. To Marescaux, augmented reality is the most important advances in patient treatment: "One example is complex pelvic surgery. Surgeons must be able to see the different structures they have to preserve: the urethra, the vessels, and the nerves. In some complex cases, it is impossible to see these three elements. Therefore, we want to have the best image possible of each structure before the operation. The concept of augmented reality makes everything transparent. We need to have an intraoperative imaging system that allows us to see all the details even if the organ moves. I'm sure that if we can demonstrate that it is of benefit to both the patient and the surgeon, it will be mandatory for hospitals to have a hybrid OR."

Accelerating the diffusion of knowledge throughout the world

In order to teach how to best manage this new type of OR, Marescaux organizes interactive courses and has set up an international e-learning website: "All surgeons like new technologies. And the operating room of tomorrow complete with robotics will look like the cockpit of an airplane: There is the robotic system, the 3D visualization, and a lot of screens. You push a button and the technology will do the work for you. It will be very easy. But it will be a challenge for the surgeon to know everything about radioprotection. Today, surgeons don't have enough knowledge about radiation. We want to organize courses to help them understand how to best manage this new kind of OR. WeBSurg provides a platform for that."

WeBSurg is a virtual surgical university. The goal is to provide the surgical community, scientific societies, medical teaching centers, and industries with the world's first online training in surgery, information on the latest surgical breakthroughs, and the ability to chat with surgeons and experts from all over the world. The goal of the scientific founders, Jacques Marescaux, Didier Mutter, MD, Joël Leroy, MD, and Michel Vix, MD, is to accelerate the diffusion of knowledge and technological innovations through-

"The shorter the access paths, the greater our dependence on reliable imaging."

Florian Gebhard, MD,
Vice President, AO Trauma, Germany, Medical Director, Trauma Surgery, Ulm University Hospital

"The combination of imaging and the capacity of the robotic system could actually end up creating the ideal operation."

Jacques Marescaux, MD,
Founder and President of
IRCAD and EITS,
CEO of IHU Strasbourg

out the world in order to offer surgeons and their teams direct access to the latest developments in surgery. At present, WeBSurg has more than 290,000 active members regularly logging on to the website.

Rapid strides on the way to the ideal operation

Taken together, the creation of new medical disciplines, continuous improvement in image quality, and new applications and software solutions mean there is huge capacity for innovation. Jacques Marescaux gazes into the future: "Today, we are still in the prehistory of robotics. Sure, it is more precise, but that's just 'peanuts.' There is another advantage that will change everything: A robot interface can analyze 1,000 signals per second. When you integrate the preoperative image and 3D image guidance with the skill of the surgeon, it will be a huge benefit for the patient." To achieve that, however, the skills of the surgeon have to improve in parallel with the technologies. Another center of collaboration dedicated to achieving just that is the IHU in Strasbourg, which unites private and public research institutions with industry partners. It is a leading research center for biomedical research, medical technology research, patient care, training, and technology transfer in healthcare. The IHU's mission is to develop a new medical discipline that brings together minimally invasive surgery, gastroenterology, and radiology to provide every patient with care that is tailored precisely to his or her needs. A central aspect of this mission is the inclusion and optimization of image guidance in hybrid surgery. In 2012, a ten-year collaboration agreement was concluded between Siemens and Strasbourg IHU. A new building will be fully equipped with Siemens systems.

Asked if we are on the path to the ideal operation, Marescaux has a concrete prediction: "Now, with the 3D images that we get from CT scans, we have the option to do the operation before the operation. It's like producing a movie. You do one minute of the operation – then you stop – do another minute – stop again and put the best parts together. The combination of imaging and the capacity of the robotic system could actually end up creating the ideal operation." But, as he also notes, a robot is only ever as smart as the human that operates it: "We are still in the prehistory of robotics. At the moment, the robot is only improving the surgeon's capability."

Further Information

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New Business Models for Interventional Radiology

Text: **Notker Blechner** | Photos: **Thomas Bernhardt**

In many hospitals, the radiology department is seen only as a service that provides diagnostic information for therapies carried out in other departments. The Klinikum Stuttgart, Germany, has taken a different approach by combining diagnostic and therapeutic radiology in one department with admitting privileges. This model has proved successful, both financially and in terms of patient satisfaction. There is a similar development in the U.S. where new guidelines support interventional radiology as a primary specialty with the right to admit and provide clinical care for patients as well.

Götz Martin Richter, MD, Director of the Center of Radiology at the Klinikum Stuttgart, Germany, is a happy man. "Here I have the responsibility I have always wanted," he is pleased to say.

For several years he worked at another hospital in Germany, where time-consuming and inefficient consultation between departments was a source of real annoyance. "Whenever I wanted to act, I had to go to great lengths to get other departments to agree on what should be done, when and how." Now Richter is performing a variety of procedures for which he is in charge of everything from initial patient consultation and admittance to discharge and clinical follow up.

A more streamlined process between departments

The Klinikum Stuttgart does things differently. Its radiology department performs a wide variety of interventional therapies as well as diagnostic procedures. This combination of diagnostic and interventional radiology and the hospital's strong interdisciplinary approach guarantee that patients needing oncological or surgical observation and care are treated in the conventional way. Those who can be directly referred to IR are then treated by Richter's team alone.

Interventional therapies at the Klinikum Stuttgart range from oncological tumor treatment (TACE, SIRT, thermal ablation)

"The more coding and billing in one place, the better!"

Götz Martin Richter, MD,
Director of the
Center of Radiology at
Klinikum Stuttgart, Germany

to vascular interventions (EVAR, lysis, stenting, special recanalization procedures) and interventional treatment of benign tumors such as uterine fibroids and AV malformations. Richter has become well-known not just in Germany, but also internationally for his use of minimally invasive techniques. He was the first to perform a TIPS procedure in man and one of the first clinicians in Europe to perform EVAR, an interventional procedure where a prosthesis is implanted to repair the aorta. This technique is a minimally invasive alternative to conventional vascular surgery. Richter has also pioneered interventional tumor treatment for cancers such as hepatocellular carcinoma and the management of benign uterine fibroids by embolization.

A department with its own beds

The department's success as a treatment provider is underpinned by its approach to bed management. "We are one of the few radiology clinics in Germany with our own beds," Richter says. The department currently has nine beds. "When I first arrived, there were only three," the radiologist recalls.

The result is that hospital stays are shorter for Richter's patients in Stuttgart. According to Anne Bickelmann, the Center Director for Economics at Klinikum Stuttgart, its patients spend one night fewer in hospital, on average, than patients at facilities without dedicated beds, which have to confer with inpatient wards to decide when patients can be discharged and by whom. "We can keep our beds free for patients who really need them," Bickelmann explains. This serves to optimize patient satisfaction and reduce the amount of time spent in hospital.

Normally, Richter goes through the procedure with patients before the intervention. Afterwards they go home to spend the night. Only on the actual day of the intervention are they admitted and allocated a bed. Following the procedure, the patient stays one or more nights and is discharged the earliest day possible. "At other hospitals the patient has to stay the night before the procedure, as well," Bickelmann explains.

30% lower costs than other hospitals

This holistic approach, giving the department control over its own beds, is already providing financial benefits. In Stuttgart they have seen a marked improvement in cost-effectiveness. "Currently the costs for our own interventional patients are 30% lower than the average for other radiology departments in Germany," Richter explains. This has been achieved largely by deploying staff efficiently and keeping a close eye on infrastructure costs. Since costs have been kept in check, Richter has been able to invest in high-end angiography equipment such as the Siemens unique robot-assisted Artis zeego while maintaining a profit margin of 6%.

The German DRG system

The "Stuttgart model" has been developed in the context of the German diagnosis-related groups (DRG) system, which promotes competition and cost-effectiveness.

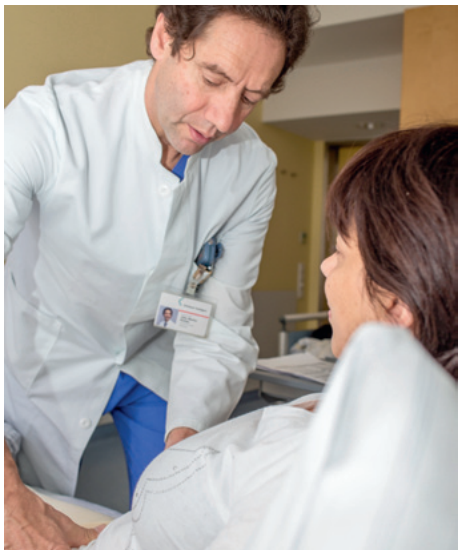
EVAR
Endovascular aortic repair

TIPS
Transjugular intrahepatic portosystemic shunt

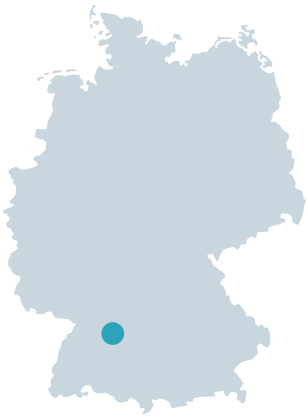
Patient satisfaction exceeds 90%

The success of the Stuttgart model is also reflected in exceptional patient satisfaction rates. Patients find it reassuring that the interventional radiologist treating them is in charge of their care from start to finish. "More than 90% of patients are satisfied with us and say they would recommend us to other people," Richter says.

A survey of women treated interventionally for uterine myomas found that almost 96% were satisfied with the medical care they had received, compared with the national average of 83% for UFE treatment in Germany. That has a great deal to do with the personal approach to care delivery at Klinikum Stuttgart, where the same physician is responsible for the patient before, during, and after interventional treatment.



Stuttgart, Germany



Since 2003, in Germany payments have been calculated on a flat-rate basis, rather than by length of hospital stay. For every illness, a fee for treatment is defined, which is the same for all hospitals. Taking this base rate as the starting point, cases are classified in different groups. For difficult procedures hospitals receive a multiple of the base rate, whereas for straightforward cases they are payed considerably less than the base rate.

A comparison of the so-called case mix index (CMI) of the IR patients in Stuttgart with other hospitals in Germany provides even more impressive evidence of the institution's financial success. Within four years, the CMI value for radiology procedures at the Klinikum Stuttgart has increased by 50% to 1.5. A value of over 1.0 indicates that a hospital is treating more complex cases. Klinikum Stuttgart Center Director for Economics, Anne Bickelmann, attributes this significant increase in CMI to improved returns and the new types of therapy introduced by Richter. This is particularly true for complex interventions such as the treatment of liver tumors with TACE, SIRT and RFA and of benign uterine myomas with UFE. In other words, effecticve patient and cost management are key factors for achieving economic benefit even in complex cases.

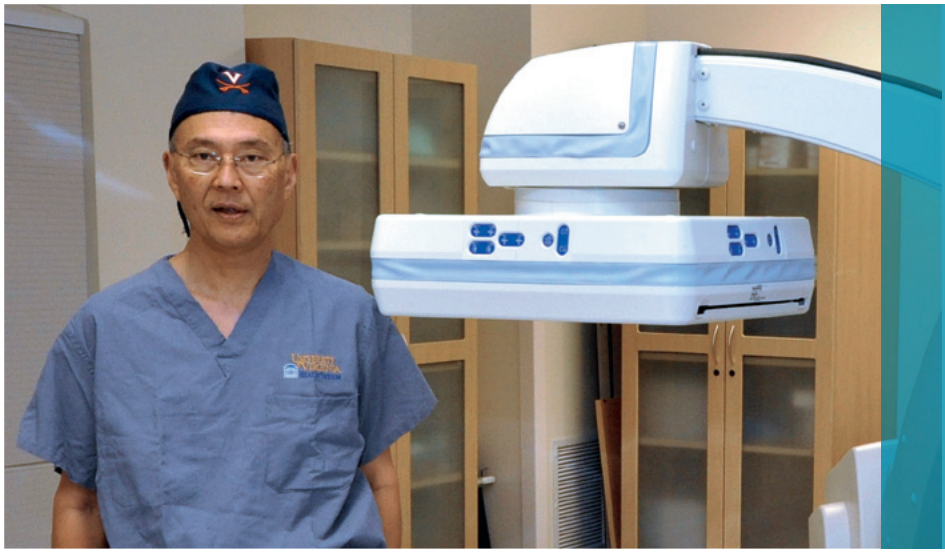
Anne Bickelmann is concerned that the steeply rising costs of the medical technology and devices used in interventional radiology are often "not properly covered by the DRG system". Yet, because Richter and Bickelmann are able to closely monitor costs and do coding and billing at the department level, they are able to offer patients the benefits of state-of-the-art radiology equipment.

Richter and his team are keen to develop their successful approach to bed management. Within an ever-changing healthcare reimbursement landscape, the Stuttgart model of a radiology department with its own beds could assist hospitals financially, as it provides greater transparency in terms of spending and makes it easier to control costs. "We are in a position to expand further and could use more beds," says Richter with a meaningful smile.

A model for other countries

Despite the peculiarities of Germany's healthcare system, Anne Bickelmann is convinced that the model developed in Stuttgart can be replicated abroad. The evolution of radiology from a purely diagnostic tool into a provider of clinical treatment will open up new therapeutic options and care pathways for all hospitals.

Richter agrees that other radiology departments could learn from the "Stuttgart model" that "optimizing processes makes it easier to contain costs and increase treatment success. The more coding and billing in one place, the better." Richter has a dedicated staff member tasked with confirming that the proper DRG coding is assigned to procedures carried out in the radiology department in order to ensure correct invoicing and reimbursement.



"We perform inpatient consultations, operate outpatient clinics, admit and discharge patients, and provide clinical care including medical follow-up."

Alan Matsumoto, MD,
Chair of the Department of Radiology and Medical Imaging at the University of Virginia

Interventional Radiology – New Primary Specialty & Residency

The role of the interventional radiologist is changing in the United States, as well. In 2012, the American Board of Medical Specialties approved Interventional Radiology (IR) as a primary specialty, separate from Diagnostic Radiology (DR). The distinction was based on the unique combination of skills in diagnostic imaging, image-guided procedures, and non-procedural patient care required of interventional radiologists.

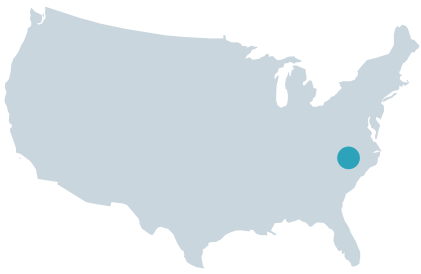
In 2014 the Accreditation Council for Graduate Medical Education (ACGME) approved a dedicated curriculum leading to IR/DR certification by the American Board of Radiology including a dedicated IR residency.

This is good news for interventional radiologists, hospitals, and their patients in that it will standardize the quality of care by setting education benchmarks and requiring physicians to document their qualifications. "In practice, interventional radiologists have had admitting privileges at hospitals like mine since 1991," says Alan Matsumoto, MD, Chair of the Department of Radiology and Medical Imaging at the University of Virginia, "but this recognition of Interventional Radiology as a distinct clinical specialty in the U.S. is a huge opportunity."

Yet interventional radiologists are different. In addition to being imaging and procedural specialists, they are directly involved in patient care. "We perform inpatient consultations, operate outpatient clinics, admit and discharge patients, and provide clinical care including medical follow-up," explains Matsumoto. That makes it all the more important to ensure that the training for young physicians includes critical care rotations, experience with outpatient clinics and inpatient clinical consultations, and the responsibility of admitting and discharging patients.

Not everyone is as excited as Matsumoto about the new status of the discipline. Surgeons may find interventional radiologists vying for business. Certain procedures, such as iliac stenting, can be performed either in an operating room or in an interventional suite. Matsumoto believes we can expect significant changes in care pathways.

Virginia, USA



90% of Matsumoto's patients are classified as outpatients because they leave the hospital the day after treatment. This model is particularly attractive for private and community hospitals in the U.S. where reducing length of stay is key to maintaining cost effectiveness.

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Upcoming Congresses 2016

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
EACTS	Amsterdam, Netherlands	European Association for Cardio-Thoracic Surgery	Oct 03 – 07	http://www.eacts.org/annual-meeting/
TCT	San Francisco, USA	Transcatheter Cardiovascular Therapeutics	Oct 11 – 15	http://www.crf.org/tct/
NASS	Chicago, USA	North American Spine Society	Oct 14 – 17	https://www.spine.org/AM.aspx
CMEF	Wuhan, China	China International Medical Equipment Fair	Oct 18 – 21	http://www.cmef.com.cn
DKOU	Berlin, Germany	Deutscher Kongress für Orthopädie und Unfallchirurgie	Oct 20 – 23	http://dkou.org/2015/startseite.html
AHA	Orlando, USA	American Heart Association	Nov 07 – 11	http://my.americanheart.org/
WFITN	Gold Coast, Australia	World Federation of Interventional and Therapeutic Neuroradiology	Nov 09 – 13	http://wfitn.com.au/
MEDICA	Duesseldorf, Germany	MEDICA	Nov 16 – 19	http://www.medica.de/
Veith Symposium	New York, USA	Annual Symposium on Vascular and Endovascular Issues	Nov 17 – 21	http://www.veithsymposium.org/index.php
APHRS	Melbourne, Australia	Asia Pacific Heart Rhythm Society Scientific Sessions	Nov 19 – 22	http://aphrs2015.com/
RSNA	Chicago, USA	Radiological Society of North America	Nov 29 – Dec 04	http://www.rsna.org/
LTCS	Leipzig, Germany	Latest Techniques in Cardiac Surgery	Dec 03 – 05	http://www.ltcs-leipzig.com/
AO Foundation	Davos, Switzerland	AO Foundation	Dec 06 – 17	https://www.aofoundation.org/
DWG	Frankfurt a. M., Germany	Deutsche Wirbelsäulengesellschaft	Dec 10 – 12	http://www.dwg-kongress.de/
Asia PCR, SingLIVE	Singapore	Asia Pacific Cardiovascular Community	Jan 21 – 23	http://www.asiapcr.com/
STS	Phoenix, USA	The Society of Thoracic Surgeons	Jan 23 – 27	http://www.sts.org/
Arab Health	Dubai, UAE	Arab Health	Jan 25 – 28	http://www.arabhealthonline.com/
Linc Leipzig	Leipzig, Germany	The Leipzig Interventional Course	Jan 26 – 29	http://www.leipzig-interventional-course.com/
Cardio-Rhythm	Hong Kong, China	College of Cardiology and Chinese Society of Pacing and Electrophysiology	Jan 30 – Feb 01	http://cardiorhythm.com/
ISET	Hollywood, USA	International Symposium on Endovascular Therapy	Feb 06 – 10	http://iset.org/
DGTHG	Freiburg, Germany	Deutsche Gesellschaft für Thorax-, Herz- und Gefäßchirurgie	Feb 08 – 11	http://www.dgthg.de/
CADECI	Guadalajar, Mexico	Congreso Anual de Cardiologia Internacional	Feb 19 – 21	http://cadeci.org.mx/w/

Title	Location	Short Description	Date	Contact
ISC	Los Angeles, USA	International Stroke Conference	Feb 17 – 19	http://my.americanheart.org/
AAOS	Orlando, USA	American Academy of Orthopaedic Surgeons	Mar 01 – 05	http://www.aaos.org
ECR	Vienna, Austria	European Society of Radiology	Mar 02 – 06	https://www.myesr.org
EVC	Maastricht, The Netherlands	European Vascular Course	Mar 06 – 08	http://www.vascular-course.com/
EAU	Munich, Germany	European Association of Urology	Mar 11 – 15	http://eaumunich2016.uroweb.org/
CIT	Beijing, China	China Interventional Therapeutics in Partnership with TCT	Mar 17 – 20	http://www.citmd.com/CIT/2016/
IPC	Milan, Italy	International Workshop on Interventional Pediatric and Adult Congenital Cardiology	Mar 19 – 21	http://www.workshopipc.com
LINNC US	New York, USA	Interventional Neuroradiology and Neurosurgery Community	Mar 25 – 26	http://www.linnc.com/
ALICE	Essen, Germany	Advanced Live Interventional Course of Essen	Mar 25 – 27	http://www.alice-the-course.com
China Med	Beiijng, China	International Medical Instruments and Equipment Exhibition	Mar 25 – 27	http://www.chinamed.net.cn/en
DGK	Mannheim, Germany	Deutsche Gesellschaft für Kardiologie – Herz- und Kreislaufforschung e.V.	Mar 30 – Apr 02	http://ft2016.dgk.org/
ACC	Chicago, USA	American College of Cardiology	Apr 02 – 04	http://accscientificsession.acc.org/ACC.aspx
SIR	Vancouver, CA	Society of Interventional Radiology	Apr 02 – 07	http://www.sirweb.org
ASCVTS	Taipei, Taiwan	Asian Society for Cardiovascular and Thoracic Surgery	Apr 06 – 10	http://www.ascvts2016.org/
ITEM	Yokohama, Japan	International Technical Exhibition of Medical Imaging	Apr 14 – 17	http://www.j-rc.org/
Spring CMEF	Shanghai, China	China International Medical Equipment Fair	Apr 15 – 18	http://www.cmef.com.cn
ECIO	Dublin, Ireland	Cardiovascular and Interventional Radiological Society of Europe	Apr 17 – 20	http://www.ecio.org
Charing Cross	London, UK	Vascular and Endovascular Challenges	Apr 26 – 29	http://www.cxsymposium.com/
TCTAP	Seoul, Korea	Cardiovascular Summit	Apr 26 – 29	http://www.summit-tctap.com/2016/
AANS	Chicago, USA	Annual Scientific Meeting, American Association of Neurological Surgeons	Apr 30 – May 04	http://www.aans.org/an16.aspx
HRS	San Francisco, USA	Heart Rhythm Society	May 04 – 07	http://www.heartrhythminternational-grouphousing.org/Home.aspx
DRK	Leipzig, Germany	Deutscher Röntgenkongress	May 04 – 07	http://www.2015.roentgenkongress.de
AUA	San Diego, USA	Annual Meeting, American Urological Association	May 06 – 10	http://www.aua2016.org/
AATS	Baltimore, USA	Annual Meeting, American Association for Thoracic Surgery	May 14 – 18	http://aats.org/annualmeeting/
Spine Week	Singapore	Spine Congress	May 16 – 20	http://www.spineweek.org
EuroPCR	Paris, France	Cardiovascular Course	May 17 – 20	http://www.europcr.com/
LINNC	Paris, France	Interventional Neuroradiology and Neurosurgery Community	May 23 – 25	http://www.linnc.com/
ESTS	Istanbul, Turkey	European Society of Thoracic Surgeons	May 27 – Jun 01	http://www.ests.org

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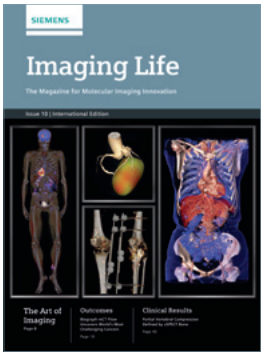

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