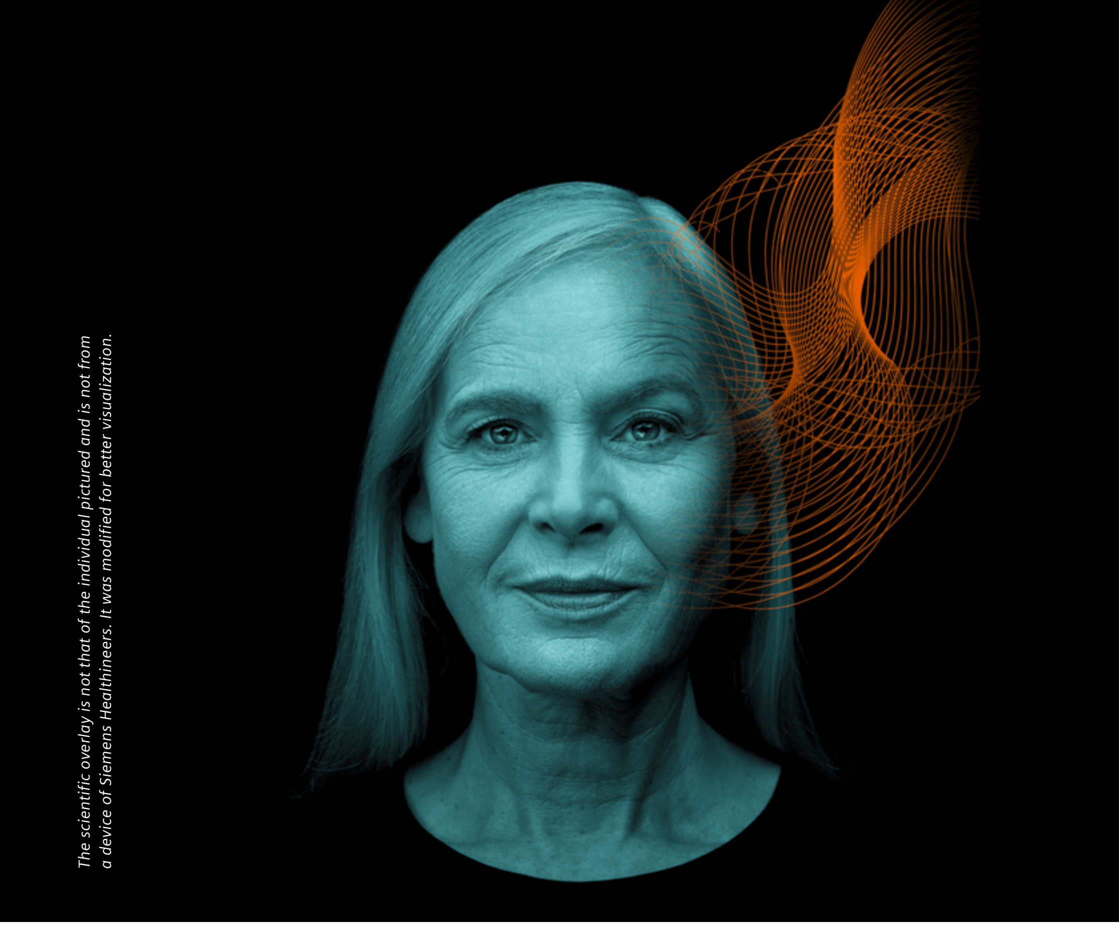

The scientific overlay is not that of the individual pictured and is not from a device of Siemens Healthineers. It was modified for better visualization.

Study Protocol Book

for Artis systems in interventional radiology

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A special word of thanks to our contributors who have kindly shared with us their protocols. We really value their efforts made in detailing their experience and helping colleagues to improve their own clinical practice.

We look forward to hearing your questions, suggestions or feedback. If you have protocols of your own to share, please contact us and keep this valuable forum for and by experts growing.

Sincerely yours,

Angelika Hench,

Showroom manager
Advanced Therapies
Interventional Radiology Marketing

Thank you

We would like to express our sincere gratitude to the following physicians and hospitals, whose contributions made this Application Protocol Book possible:

Renè Chapot, MD,
Hannes Nordmeyer, MD, Ekin Celik, MD,
Interventional Neuroradiology, Alfried Krupp Hospital, Essen, Germany

Wan-You Guo, MD,
Department of Radiology, Taipei Veterans General Hospital, Taiwan

Hiroshi Itokawa, MD, PhD,
Department of Neurosurgery, Kasai Shoikai Hospital, Tokio, Japan

Kiffon Keigher, APN,
Demetrius K. Lopes, MD,
Rush University Medical Center, Chicago, USA

Beverly Aagaard-Kienitz, MD,
Department of Radiology, University of Wisconsin School of Medicine and Public Health, Madison, USA

Jeff McCann, MD, Ronan Ryan, MD,
Department of Interventional Radiology, St. Vincent University Hospital, Dublin, Ireland

Norifumi Nishida, MD,
Yoshinori Takao, MD,
Osaka City University Hospital, Japan

Olivier Pellerin, MD, MSc,
Cardiovascular Radiology Department, Hospital Europeen Georges-Pompidou, Paris, France

Thomas J. Vogl, MD,
Stefan Zangos, MD, Department of Radiology, University of Frankfurt, Germany

Bernhard Meyer, MD, Jan Hinrichs, MD,
Steffen Marquardt, MD,
Institute for Diagnostic and Interventional Radiology, Medical School Hannover, Germany

Ulf Teichgräber, MD, Renè Aschenbach, MD,
Department of Diagnostic and Interventional Radiology, Jena University Hospital, Germany

A.D. Montauban van Swijndregt, MD,
OLVG, Amsterdam, Netherlands

Jianping Gu, MD and Wensheng Lou, MD,
Department of Interventional Radiology, Nanjing No.1 Hospital, China

Peter Mitchell, MD,
Director Neurointervention Service, Department of Radiology, Royal Melbourne Hospital, Parkville, Victoria, Australia

Naoki Kato, MD,
Yuichi Murayama, MD,
The Jikei University School of Medicine, Tokyo, Japan

Jan Gralla, MD, Pascal Mordasini, MD,
Institute of Diagnostic and Interventional Neuroradiology, University Hospital -Inselspital- Bern, Switzerland

Prof. Yuichi Murayama, MD,
Toshihiro Ishibashi, MD, Ichiro Yuki, MD,
Jikeii University School of Medicine, Tokyo, Japan

Andrey Sergeev, MD,
Department of Neurosurgery, The Federal State Budgetary Institution “Almazov National Medical Research Centre” of the Ministry of Health, Russia

Saruhan Cekirge, MD, Isil Saatci, MD,
Department of Interventional Neuroradiology, Koru Hospital, Ankara, Turkey

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

Marios N. Psychogios, MD,
Ioannis Tsogkas, MD,
Department of Diagnostic and Interventional Neuroradiology University Medicine Goettingen, Germany

Bruno C. Odisio, MD,
Department of Interventional Radiology, The University of Texas MD Anderson Cancer Center, Houston, Texas, USA

Pierleone Lucatelli MD, PhD,
EBIR Azienda Ospedaliera Universitaria Policlinico Umberto I, Rome

Eric J Hohenwalter, MD, FSIR,
Sarah White, MD, MS,
Department of Radiology, Division of Vascular & Interventional Radiology, Medical College of Wisconsin, Milwaukee, WI, USA

David Niemann, MD,
University of Wisconsin Hospitals and Clinics, USA

Florian Wolf, MD, Christian Loewe, MD,
Allgemeines Krankenhaus Wien – Medical University Vienna, Austria

Content

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↗ Clinical Specialty Educational Resources

Neurology/ Interventional Neuroradiology

Visualization of collateral vessels for stroke thrombectomy

Courtesy of	J. Gralla, MD, P. Mordasini, MD, Institute of Diagnostic and Interventional Neuroradiology University Hospital – Inselspital – Bern, Switzerland
Supported by	• *syngo* DynaCT Multiphase
System & Software	ARTIS icono VE20, *syngo* Application Software VE2

Patient history
56-year-old patient with a wake-up stroke presenting with hemiparesis on the right side and dysarthria, NIHSS 11.

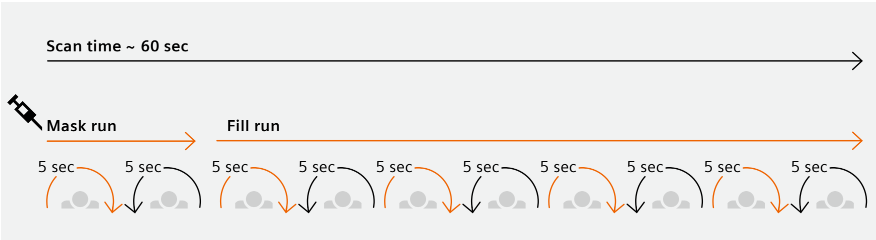
Diagnosis
M1 occlusion on the left side on the basis of an underlying intracranial atherosclerotic stenosis.

Procedure description
Mechanical thrombectomy and stent implantation.

Tips and tricks
syngo DynaCT Multiphase consists of 10 consecutive rotations and results in 10 volumes. Start injection with start of acquisition run. First two volumes required as mask run for potential reconstruction of perfusion maps.* The other 8 volumes are fill runs.

** Third party software required. Calculation of perfusion maps not commercially available yet.*

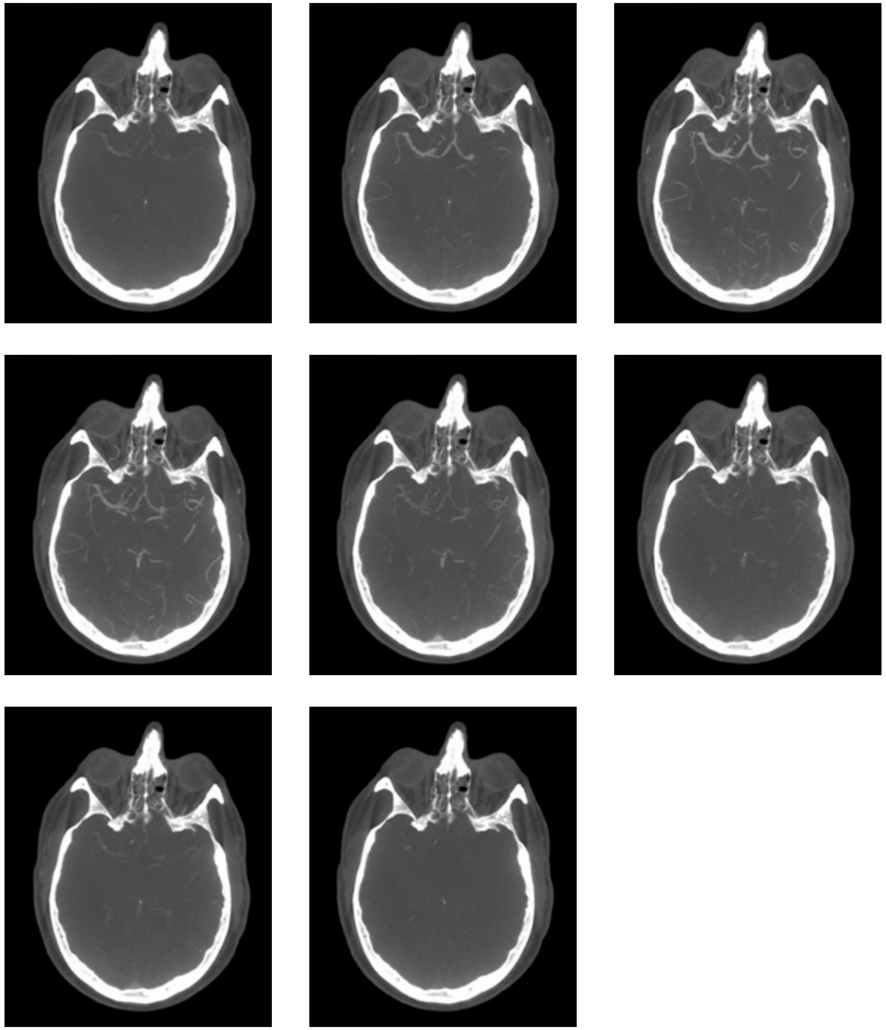
Graphical representation shows workflow including two mask runs



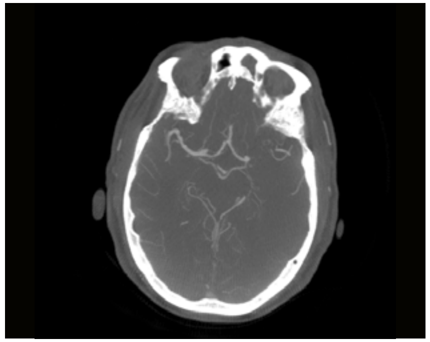
Acquisition protocol	**60sDCT Multiphase**
Injection protocol	
Catheter position	antecubital 18G venous line
Contrast medium	300 mg/mL iodine
Dilution	None
Injection volume	50 mL contrast media followed by 40 mL saline chaser
Injection rate	5 mL/s CM and saline
Duration of injection	18 s
X-ray delay	0 s
Power injector used	Yes

Reconstructions	**For both mask and fill run**
Name	Neuro Perfusion Full HU Auto
VOI size	Full
Slice matrix	512 × 512
Kernel type	HU
Image characteristics	Auto
Reconstruction mode	Nat Fill
Viewing preset	DynaCT Head

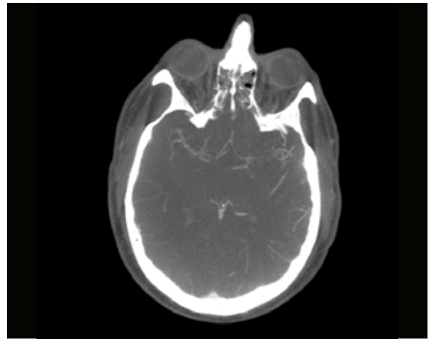
Initial *syngo* DynaCT Multiphase run before thrombectomy



Fill run 1–8, 10 mm MIP slices

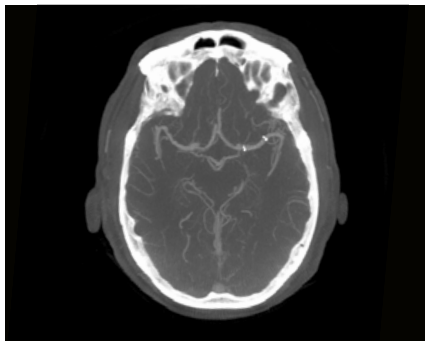


Visualization of M1 occlusion. Fill run 4, MIP 10 mm

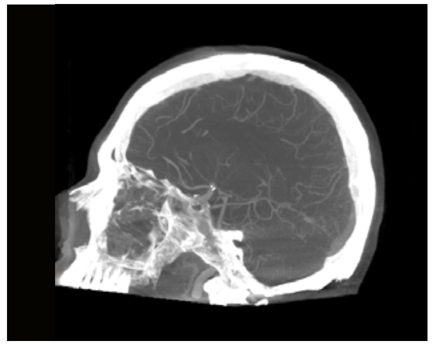


Visualization of potential collaterals in later phase. Fill run 6, MIP 10 mm

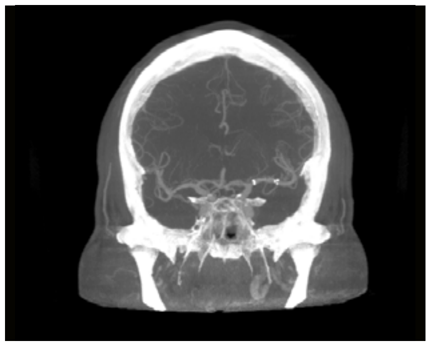
Post-thrombectomy and stent placement



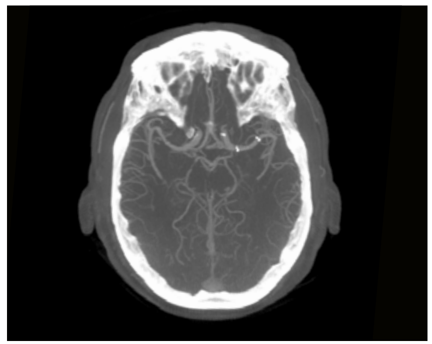
MIP 10 mm transversal



MIP 25 mm sagittal



MIP 25 mm coronal



MIP 25 mm transversal

Thrombectomy in stroke using *syngo* DynaCT Sine Spin

Courtesy of	René Chapot, MD; Ekin Celik, MD; Interventional Neuroradiology, Alfried Krupp Hospital, Essen, Germany
Supported by	*syngo* DynaCT Sine Spin
System & Software	ARTIS icono VE2 with *syngo*, Application Software VE2

Patient history
83-year-old male patient

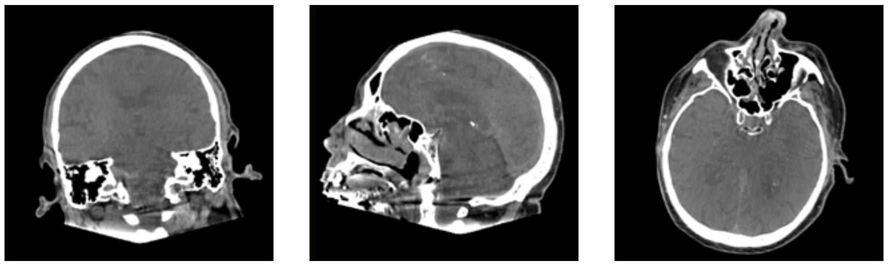
Diagnosis
CTA in another hospital showed an acute occlusion of the left MCA (middle cerebral artery) in the M1 segment.

Treatment
Intracranial thrombectomy with stent retriever under general anesthesia. Thrombectomy in several maneuvers with Solitaire X stent retriever and Tigertriever to reopen the vessel.

General comments
Upon arrival of the patient in our department from the other hospital, the initial CT was 3h old. With a native *syngo* DynaCT Sine Spin, we could check for potential bleeding and demarcation of the infarct before starting thrombectomy. The final *syngo* DynaCT Sine Spin showed a blood-brain barrier disorder, which influences the further treatment of the patient. Severe bleeding would have also been visible.

Tips and tricks
The correct location of the intubation tube is very important for good image quality. Position the ventilation hose from the mouth towards the foot end.

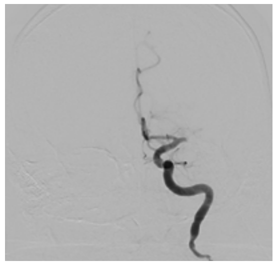
Pre-interventional *syngo* DynaCT Sine Spin



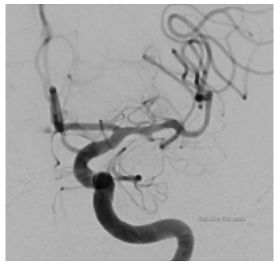
MPR 0.5 mm

Acquisition protocol	**7sDCT Sine Spin - for pre- and post-interventional run**
Injection protocol	
Contrast medium (CM)	N/A
Reconstructions	**Primary**
Name	DCT Head Clear Nat Fill
VOI size	Full
Slice matrix	512 × 512
Kernel type	HU
Image characteristics	Smooth
Reconstruction mode	Nat Fill
Viewing preset	DynaCT Head

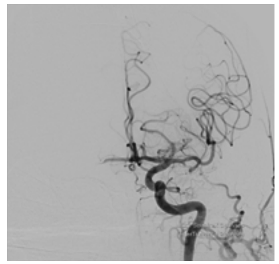
DSA imaging during intervention



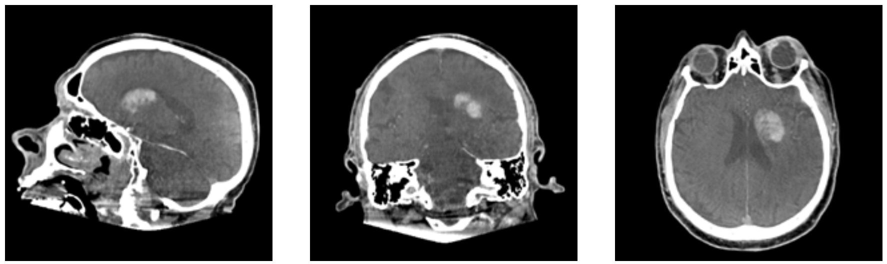
MCA occlusion



After first pass



Post-interventional *syngo* DynaCT Sine Spin



MPR 0.5 mm contrast medium pooling

One-stop-shop management for stroke

Courtesy of	Marios N. Psychogios, MD, Ioannis Tsogkas, MD, Department of Diagnostic and Interventional Neuroradiology University Medicine Goettingen, Germany
Supported by	*syngo* DynaCT
System & Software	Artis Q biplane VD11, *syngo* X Workplace VD10

Patient history
56-year-old male. Right hemiparesis and aphasia with 75-minute onset. No intubation or sedation of the patient.

Diagnosis
Total occlusion of arteria cerebri media.

Treatment
Thrombectomy with SAVE technique.

General comments
Direct admission of the patient to the angio suite for diagnostics and therapy (one-stop-shop management). Check for potential bleeding with the help of *syngo* DynaCT. Carotid bifurcation visible. A native FDCT scan was performed within 15 minutes of the patient arriving at the hospital. After IV injection of contrast media, a biphasic FDCTA scan was performed. We timed the first phase of the FDCTA scan after a bolus-tracked digital subtraction angiography (the contrast agent must be visible in the intracranial internal carotid artery), while the second phase was acquired automatically with a delay of 5 s. The first phase shows the occlusion of the arteria cerebri media. The second phase of the FDCTA scan was used to additionally evaluate late collaterals. An occlusion or relevant stenosis of the proximal internal carotid artery could be excluded with the same acquisition.

Tips and tricks
Very good stabilization of patient's head possible when a head holder is used, even for non-anesthetized patients.

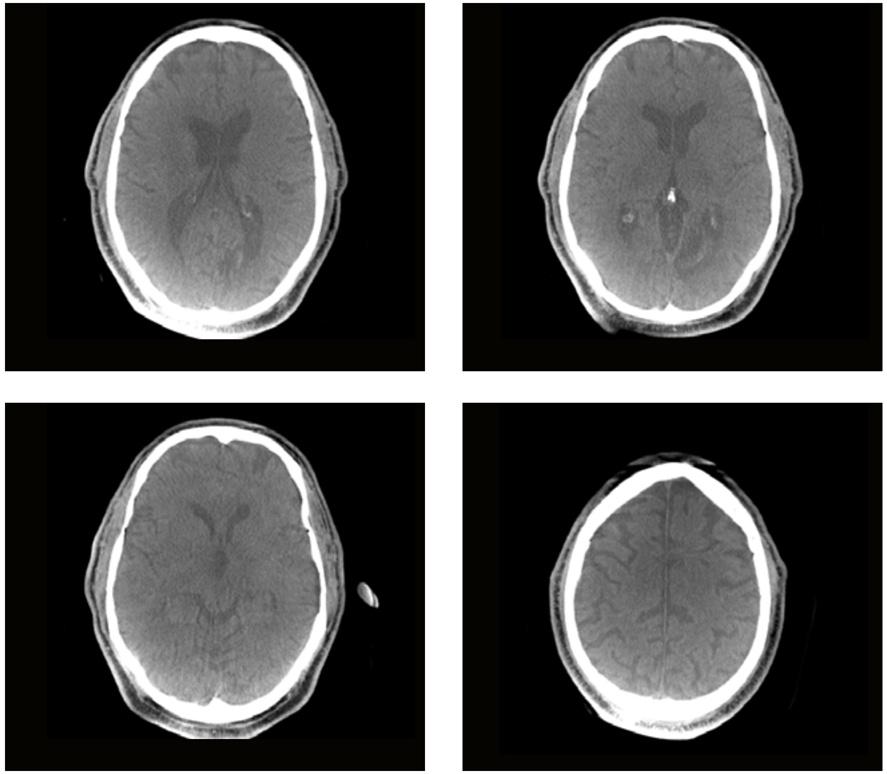
Neuroradiology

Protocol – Part 1

Acquisition protocol	**20sDCT Head Clear 109kV**

Injection protocol	
Contrast medium (CM)	N/A

Reconstructions	**Primary**
Name	DCT Head Clear
VOI size	Full
Slice matrix	512 × 512
Kernel type	HU
Image characteristics	Normal
Reconstruction mode	Nat Fill
Viewing preset	DCT Head



DCT native, check for severe bleeding. 1–4 Thin MPRs from skull base to skull cap

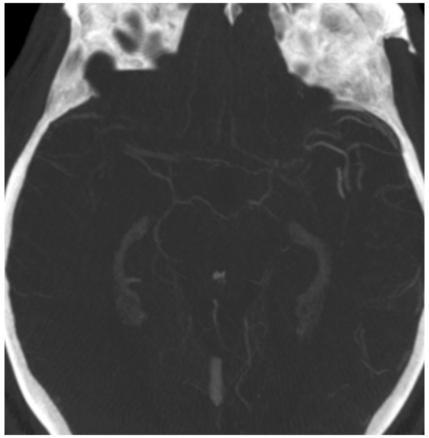
Protocol – Part 2

Acquisition protocol	**10sDCT DSA Head 70kV**

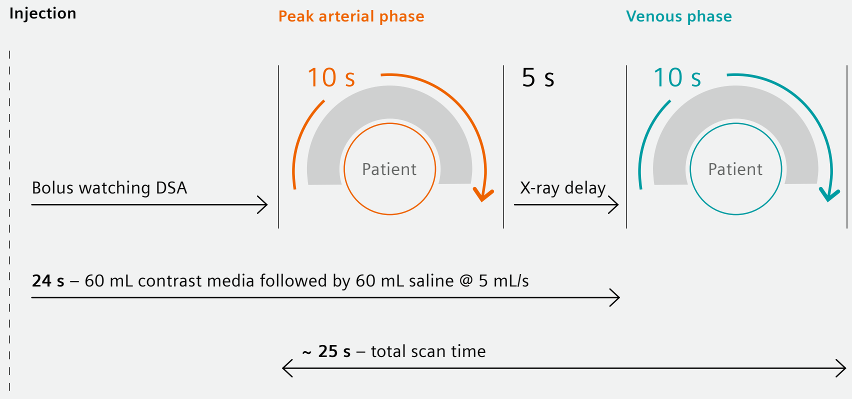
Injection protocol	
Catheter position	Intravenous injection
Contrast medium (CM)	400 mg/mL iodine
Dilution (CM/Saline)	No
Injection volume	60 mL contrast media followed by 60 mL saline chaser
Injection rate	5 mL/s
Duration of injection	12 s for CM + 12 s for saline
X-ray delay	Bolus watching - start first run when contrast agent is seen in the intracranial internal carotid artery. Second run with automatic delay of 5 s.
Power injector used	Yes

Reconstructions	**Primary**
Name	DCT Head Clear for 1st and 2nd rotation
VOI size	Full
Slice matrix	512 × 512
Kernel type	HU
Image characteristics	Normal
Reconstruction mode	Nat Fill
Viewing preset	DCT Head


DCT arterial phase. MCA left occlusion.


DCT delayed phase. Collaterals visible.

Biphasic Flat Detector CT Angiography Protocol



- Total 60 mL (full strength) contrast media at a rate 5 mL/s
- Intravenous injection
- Power injector and angio unsynchronized
- Automatic 10sDCT Head

Mechanical thrombectomy of left MCA occlusion

The individual X-ray delay for *syngo* Neuro PBV IR can be analyzed by *syngo* iFlow.

Courtesy of Prof. Wan-You Guo, MD, Department of Radiology, Taipei Veterans General Hospital, Taiwan

Supported by
- *syngo* DynaCT
- *syngo* Neuro PBV IR
- *syngo* iFlow

System & Software Artis zee biplane VC14, *syngo* X Workplace VB15

Patient history
A 67-year-old man presented with symptoms of acute right hemiplegia of less than 6 hours duration since onset. The patient was taken to CT immediately to exclude hemorrhage with native CT.

Procedure description
Left middle cerebral artery (MCA) occlusion. Noncontrast CT demonstrated a hyperdense MCA sign and excluded intracranial hemorrhage. Flat-detector CT (FDCT) angiography demonstrated the total occlusion of left MCA. A parenchymal cerebral blood volume (*syngo* Neuro PBV IR) map depicted a large area of hypoperfusion in the corresponding left MCA territory, which was similar to the results of multidetector CT perfusion imaging (not shown). After intraarterial mechanical thrombectomy, recanalization of the left MCA was demonstrated by FDCT angiography. A *syngo* Neuro PBV IR map depicted the recovery of CBV values in part of the hypoperfused parenchyma after revascularization.

Revascularization with intra-arterial approach. MCA occlusion could be successfully reopened.

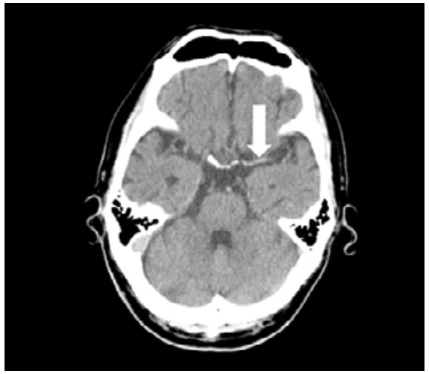
General comments
By combining C-arm rotational acquisition with intraarterial contrast medium injection from the aortic arch, we can obtain
(1) non-contrast *syngo* DynaCT,
(2) a three-dimensional volume of intracranial vasculature (*syngo* DynaCT reconstruction of fill run), and
(3) a *syngo* Neuro PBV IR map.

Related publication
BioMed Research International Volume 2013, Article ID 873614, 7 pages
http://dx.doi.org/10.1155/2013/873614

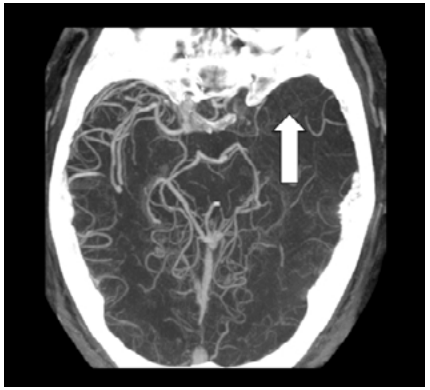
Acquisition protocol	**8s Neuro PBV IR**
Injection protocol	
Catheter position	Aortic arch 4 F pigtail catheter
Contrast medium (CM)	340 mg iodine/mL
Dilution	50%
Injection volume	85 mL
Injection rate	5 mL/s
Duration of injection	17 s
X-ray delay	Individually analyzed with *syngo* iFlow Tmax = 9 seconds for this patient in the superior sagittal sinus
Power injector used	Yes

Reconstructions	**Primary**	**Secondary**
Name	Neuro PBV HU Smooth	DynaCT Head Nat Fill HU[1]
VOI size	Full	
Slice matrix	512 × 512	
Kernel type	HU	HU
Image characteristics	Smooth	Normal
Reconstruction mode	Neuro PBV	Nat Fill
Viewing preset	Neuro PBV	DynaCT Head

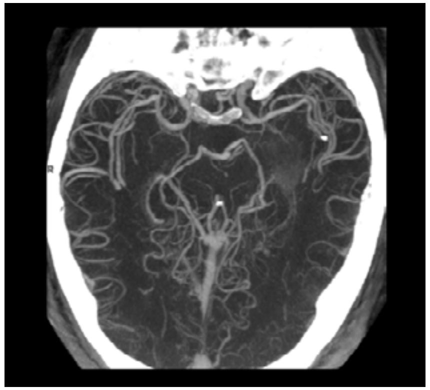
[1] *Reconstruction of the fill run of Neuro PBV 3D acquisition*



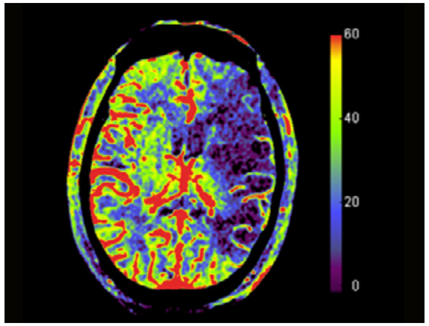
Noncontrast CT demonstrated a hyperdense MCA sign (arrow) and excluded intracranial hemorrhage



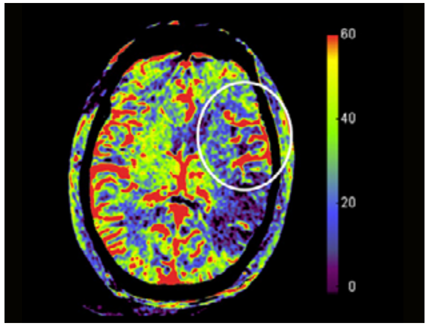
Thick MIP – FDCT angiography demonstrated the total occlusion of left MCA (arrow)



Thick MIP – After intra-arterial mechanical thrombectomy, recanalization of the left MCA was demonstrated by FDCT



A parenchymal cerebral blood volume (*syngo* Neuro PBV IR) map depicted a large area of hypo-perfusion in the corresponding left MCA territory



A *syngo* Neuro PBV IR map depicted the recovery of CBV values (circle) in part of the hypoperfused parenchyma after revascularization

Pipeline flow diverting stent follow-up

Courtesy of	David Niemann, MD, University of Wisconsin Hospitals and Clinics, USA
Supported by	• *syngo* Dyna3D • *syngo* DualVolume
System & Software	ARTIS icono biplane VE20 with *syngo* Applications Software VE2

Patient history
67-year-old female patient.

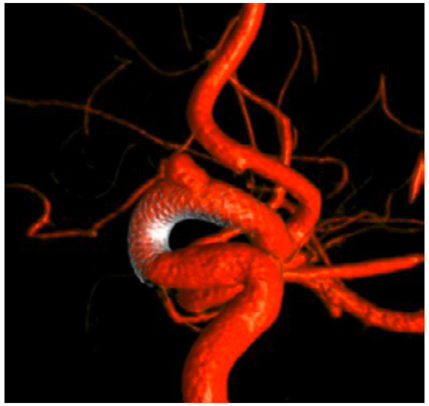
Diagnosis
Ophthalmic aneurysms on right and left side treated with pipeline embolization devices (PEDs)

Treatment
Longitudinal follow-up of implanted pipeline embolization devices (PEDs) using 3D-DSA acquisition and *syngo* DualVolume visualization on ARTIS icono biplane system. Diagnostic angiogram to follow up right ophthalmic aneurysm treated with three PEDs and left ophthalmic aneurysm treated with a single PED. Volumetric imaging acquired on right ophthalmic aneurysm using ARTIS icono. The study shows residual contrast inflow into the right ophthalmic aneurysm and opacification within the extruding vessel, as well as good vessel wall apposition of the three PEDs. Downstream vasculature is wellopacified and no in-stent stenosis is observed.

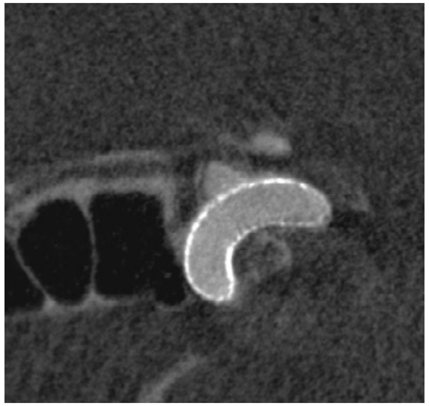
General comments
For the volumetric imaging, we used a 4 s *syngo* Dyna3D run in Twin Spin mode. For the first time, ARTIS icono gives us the ability to perform the 3D run without the need to park the lateral plane.

Acquisition protocol	4sDSA Head
Injection protocol	
Catheter position	Internal carotid artery
Contrast medium (CM)	300 mg/mL
Dilution	None
Injection volume	15 mL
Injection rate	3 mL/s
Duration of injection	5 s
X-ray delay	2 s
Power injector used	Yes

Reconstructions	Primary
Name	Dyna3D DSA Dual
VOI size	Medium
Slice matrix	512 × 512
Kernel type	EE
Image characteristics	Normal
Reconstruction mode	Dual
Viewing preset	3D Dual Volume



Residual aneurysm well visible in VRT, as well as good understanding of stent wall apposition.



In-stent stenosis can be excluded by the MPR image.

One stop management for aneurysmal subarachnoid hemorrhage

Courtesy of	Marios N. Psychogios, MD, Ioannis Tsogkas, MD, Department of Diagnostic and Interventional Neuroradiology University Medicine Goettingen, Germany
Supported by	*syngo* DynaCT
System & Software	Artis Q biplane VD11, *syngo* X Workplace VD10

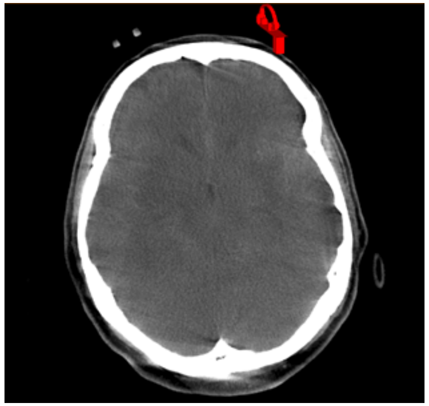
Patient history
62-year-old female patient transferred from a peripheral hospital with an aneurysmal subarachnoid hemorrhage. Direct admission to angio suite and acquisition of a native *syngo* DynaCT, followed by an IV injected DynaCT run to assess the progression and the cause of the bleeding.

Diagnosis
Ruptured aneurysm of the bifurcation of the right middle cerebral artery.

Treatment
Surgical clipping.

General comments
The immediate diagnosis, imaging, and treatment of a ruptured aneurysm is very important and prevents rebleeding. Intrahospital time delays can be avoided if a patient from a peripheral hospital with an aneurysmal hemorrhage depicted on NCCT is transferred directly to the angio suite. The ruptured aneurysm can be reliably depicted on an FDCT angiogram and the DSA can be started without further transfer of the patient. IV *syngo* DynaCT offers an excellent assessment of the aneurysm and adjusted arteries.

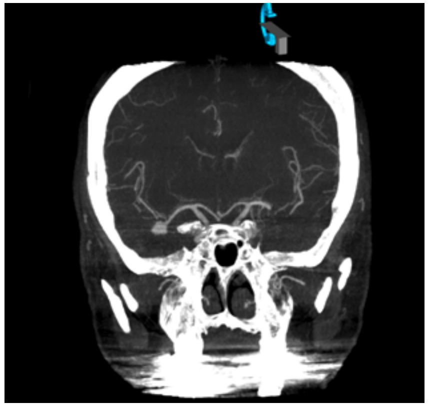
Tips and tricks
Use a headholder to avoid movement when the patient is not sedated.



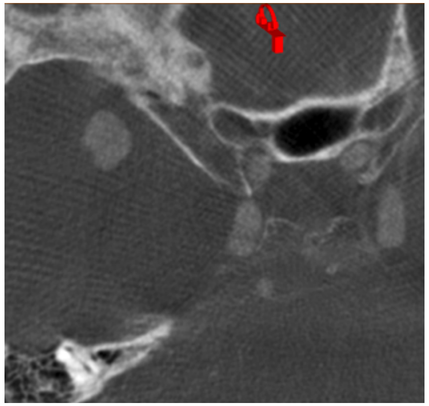
MPR 3 mm axial slice shows subarachnoid bleeding (minor artifacts due to patient motion of not sedated patient)

Acquisition protocol	**10sDCT Head**
Injection protocol	
Catheter position	IV injection
Contrast medium (CM)	400 mg iodine/mL
Dilution	None
Injection volume	60 mL contrast media followed by 60 mL saline chaser
Injection rate	5.0 mL/s
Duration of injection	12 s – 12 s
X-ray delay	bolus tracking with digital subtraction angiography

Reconstructions	**Primary**	**Secondary**
Name	DCT Head Clear	DCT Head Clear
VOI size	Full	Small
Slice matrix	512 × 512	512 × 512
Kernel type	HU	HU
Image characteristics	Normal	Normal
Reconstruction mode	Nat Fill	Nat Fill
Viewing preset	DCT Head	DCT Head



MIP 10 mm frontal slice shows aneurysm and surrounding vessel structure (metal artifacts due to dental implants)



MIP 0.3 mm axial slice shows aneurysm in secondary, small VOI reconstruction

Embolization of an C-ophthalmic artery aneurysm with coil and stent

syngo DynaCT offers excellent spatial resolution allowing visualization of the precise vessel structure before embolization treatment.

Courtesy of	Naoki Kato, MD, Yuichi Murayama, MD The Jikei University School of Medicine, Tokyo, Japan
Supported by	• *syngo* Dyna3D • *syngo* DynaCT Micro • *syngo* Dyna4D
System & Software	ARTIS pheno VE1 with *syngo* Application Software VD2

Patient history
A 54-year-old woman underwent MRI for a headache in 2006. An ophthalmic artery aneurysm was discovered. The size had not changed on followup, but the patient was worried and requested treatment.

Diagnosis
The maximum diameter of the aneurysm was 5 mm. Based on the location of the aneurysm endovascular treatment was recommended. Diagnostic DSA was performed in 2017 and right ICAG (internal carotid artery angiography) revealed that the aneurysm was located at the origin of the ophthalmic artery at the bifurcation of the C2 segment of the ICA. ECAG (external carotid artery angiography) combined with a balloon occlusion test (BOT) did not show collateral flow (i.e., no choroidal blush). To avoid the complication of loss of vision, it was therefore of utmost importance to preserve the ophthalmic artery.

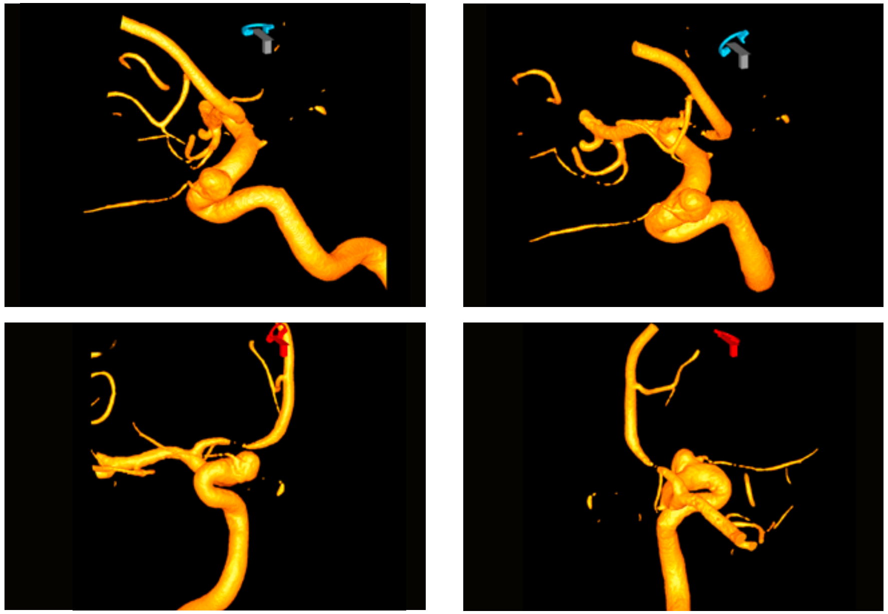
Procedure description
Access was established through the right femoral artery and a catheter was advanced until it reached the left ICA. A 4D DSA scan was then taken to allow the relative location of the catheter to be determined before the stent and coil deployment. To perform the embolization, a stent was deployed to cover the neck of the aneurysm and 10 coils were used to fill the aneurysm. A high filling rate of 35.6% was achieved without sacrificing the ophthalmic artery.

General comments
syngo DynaCT provided excellent spatial resolution and thereby helped to determine the border between the aneurysm and ophthalmic artery. This was important for preserving the patient's visual function. The robotic C-arm can be positioned at any angle to optimize visualization during the procedure. In 3D imaging, the robotic C-arm quickly moves to align with any image position, providing the endovascular surgeons with views from several angles. This is important for the success of the procedure.

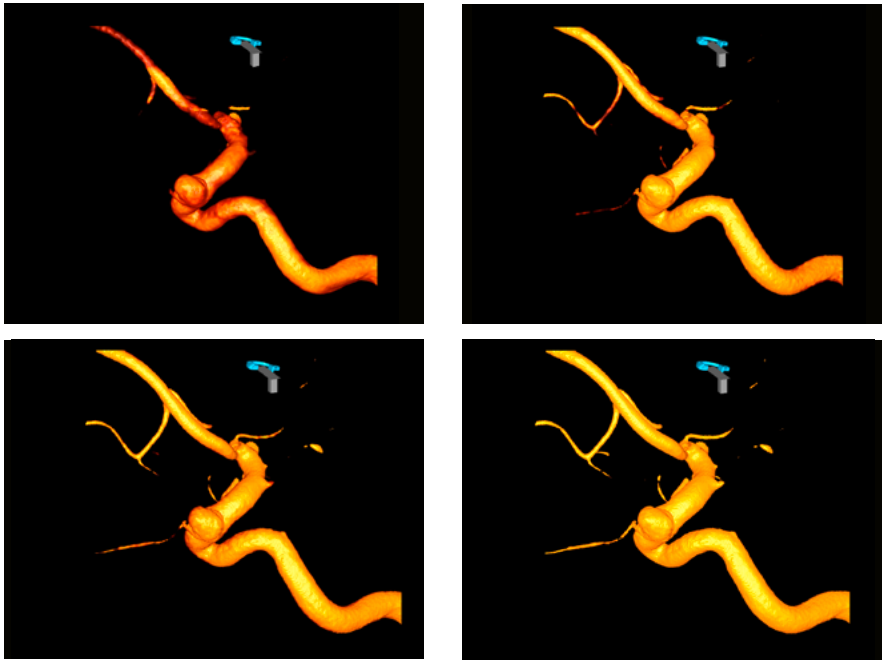
Tips and tricks
3D imaging helps to determine the optimal angle of the C-arm for intraprocedural fluoroscopy, ensuring safe deployment of stent and coil placement.

Acquisition protocol	**6s Dyna4D**
Injection protocol	
Catheter position	Left ICA
Contrast medium (CM)	320 mg/mL
Dilution (CM/Saline)	None
Injection volume	18 mL
Injection rate	3.0 mL/s
Duration of injection	6.0 s
X-ray delay	0 s
Power injector used	Yes

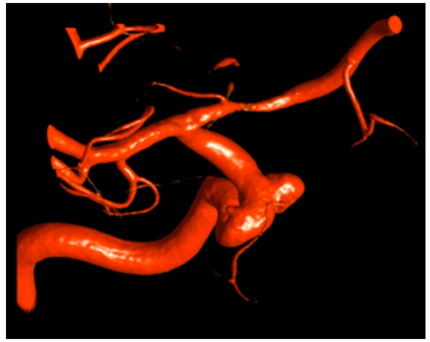
Reconstructions	**Primary**	**Secondary**
Name	Dyna4D arterial	
VOI size	Full	Small for more detailed resolution
Slice matrix	512 × 512	
Kernel type	HU	
Image characteristics	Auto	
Reconstruction mode	Sub	
Viewing preset	Dyna4D	



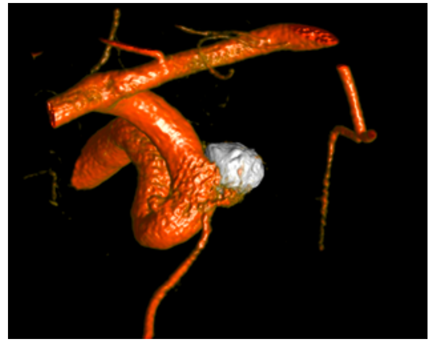
Not only does *syngo* Dyna4D show the morphology from different angles



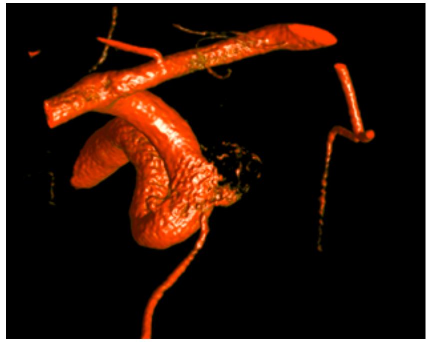
..but also makes it possible to see it at different timepoints



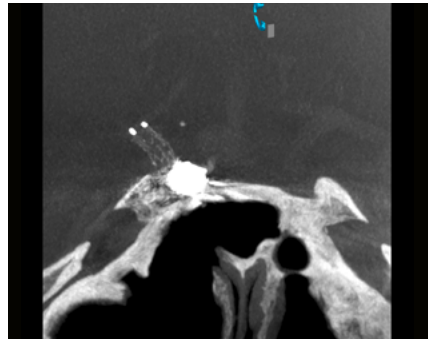
VRT visualization before intervention



Dual volume visualization after intervention



VRT sub-visualization after intervention



syngo DynaCT Micro run, reconstructed with *syngo* DynaCT SMART shows the stent in relation to the coil pack

Flow Diverter Stenting of Large Intracranial Aneurysm

The *syngo* Dyna4D clearly showed how slow the inflow of blood into the aneurysmal structure had become after flow diverter placement, confirming the expected effect.

Courtesy of Yuichi Murayama, MD, Toshihiro Ishibashi, MD, Ichiro Yuki, MD, Jikeii University School of Medicine, Tokyo, Japan

Supported by
- *syngo* Dyna4D
- *syngo* DynaCT Micro

System & Software Artis Q biplane VD11, *syngo* X Workplace VD10

Patient history
60-year-old male patient with large intracranial aneurysm.

Diagnosis
Large intracranial aneurysm located in the cavernous segment of the internal carotid artery. The diameter of the aneurysm at its largest point was 17 mm.

Procedure description
A flow diverter (Covidien Pipeline®) was inserted under general anesthesia according to the general guidelines for flow diverter (FD) treatment in Japan. After initial deployment of the flow diverter, the following 3D acquisitions were performed: A native 20 s DynaCT Micro run in zoom 3 (22 cm) to visualize the metal implant (flow diverter) followed by a 6 s Dyna4D run to obtain information about the vessels' architecture and the flow dynamics. A secondary reconstruction of the DynaCT Micro run was performed, then this volume was fused with the Dyna4D volume.

Based on these images, the physicians concluded that the apposition of the FD to the vessel wall was sub-optimal (see red arrows in the following image) and could lead to thrombo-embolic events in the future. Therefore, they returned and performed a postdilatation of the flow diverter, followed by a second DynaCT Micro run.

The post-dilatation *syngo* DynaCT image was then fused with the available Dyna4D volume (since the patient was under general anesthesia, it was assumed, observed, and confirmed that there was no head motion between the scans).

By displaying the images side by side, the physicians were able to clearly see the achieved improvement in stent apposition: The *syngo* Dyna4D clearly showed how slow the inflow of blood into the aneurysmal structure had become, confirming the expected effect.

General comments
The physicians were impressed by the image quality, the level of detail achieved, and the accuracy of the fusion functionality. The case was very successful, and the physicians unanimously emphasized that the imaging capabilities of the Artis Q system with the PURE® platform enabled them to better visualize the vessels and the device during the procedure and to significantly improve their treatment decisions and outcome.

Tips and tricks
Perform a secondary reconstruction of the DynaCT Micro run with "Sharp" image characteristics to improve visibility of stent struts.

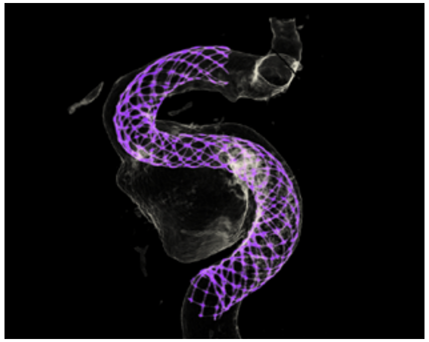
Acquisition protocol	20s DCT Head Micro

Injection protocol	
Contrast medium (CM)	N/A

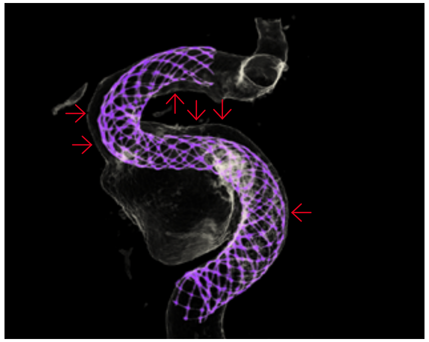
Reconstructions	Primary	Secondary
Name	DynaCT Head Micro	DynaCT Head Micro
VOI size	Full	Full
Slice matrix	512 × 512	512 × 512
Kernel type	HU	HU
Image characteristics	Normal	Sharp
Reconstruction mode	Nat Fill	Nat Fill
Viewing preset	DynaCT Head	DynaCT Head

Neuroradiology

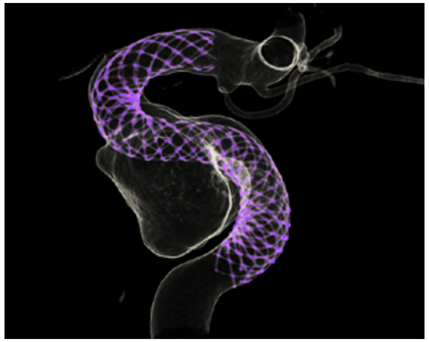
First and second DynaCT Micro run



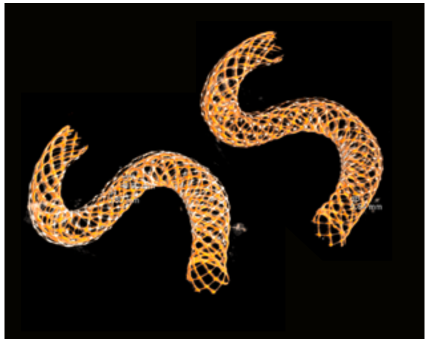
Fused visualization of secondary reconstruction of first DynaCT Micro run with Dyna4D run



Sub-optimal apposition of FD to the vessel wall (red arrows)



After post-dilatation

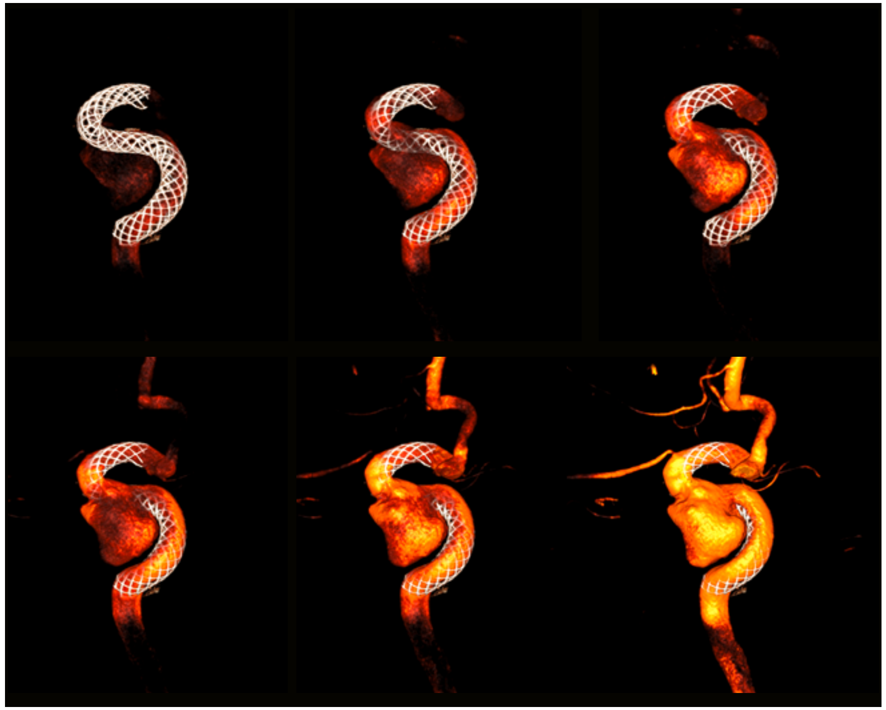


Before post-dilatation in orange, after in white, with measurments showing the shortening and the differences in wall location

Acquisition protocol	**6s DSA Dyna4D Head**

Injection protocol	
Catheter position	Internal carotid artery
Contrast medium (CM)	270 mg iodine/mL
Dilution	None
Injection volume	18 mL
Injection rate	3 mL/s
Duration of injection	6 s
X-ray delay	0 s
Power injector used	Yes

Reconstructions	**Primary**
Name	Dyna4D Sub4D
VOI size	Full
Slice matrix	512 × 512
Kernel type	HU
Image characteristics	Auto
Reconstruction mode	Sub
Viewing preset	Dyna4D



VRT time ranges. Dyna4D volume fused with DynaCT Micro volume, before post-dilatation

Embolization of cerebral AVM

syngo Dyna4D helps us to better understand the vessel structure in AVMs and improves treatment planning.

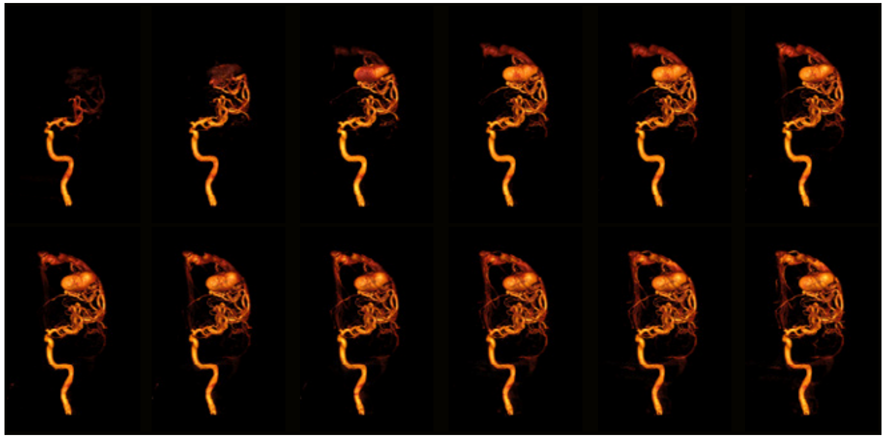
Courtesy of	Renè Chapot, MD, Hannes Nordmeyer, MD, Interventional Neuroradiology, Alfried Krupp Hospital, Essen, Germany
Supported by	*syngo* Dyna4D
System & Software	Artis zee biplane with PURE VD11, *syngo* X Workplace VD10

Patient history
47-year-old male with aphasia and motoric deficiency of right hand due to edema.

Diagnosis
Symptomatic left hemispheric precentral AVM with giant venous aneurysm and brain edema.

Treatment
Multiple endovascular treatments with embolization (Onyx and PHIL).

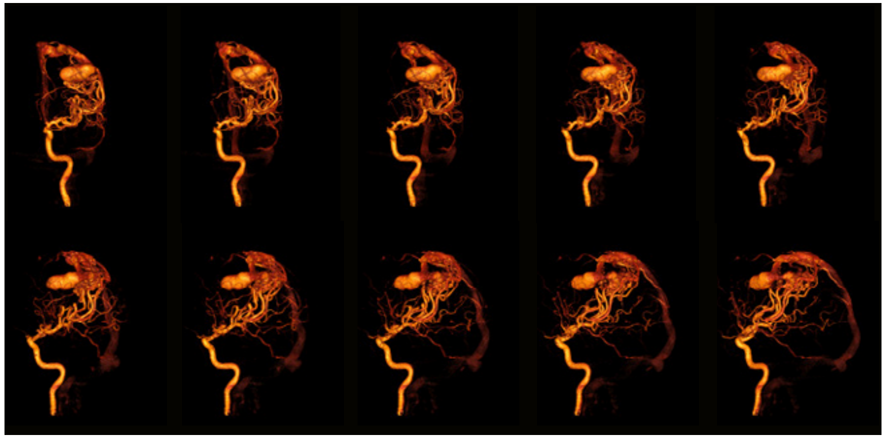
General comments
Normally we make a couple of DSA runs with different angulations of the C-arm to see the feeding vessels in detail and also observe the drainage of the AVM. Thanks to *syngo* Dyna4D this information was readily available after one injection, we could also see the filling and drainage of the AVM in 3D which helped our planning for treatment.



Flow range – *syngo* Dyna4D shows flow patterns in 3D

Acquisition protocol	**6s Dyna4D**
Injection protocol	
Catheter position	ICA extracranial
Contrast medium (CM)	300 mg iodine/mL
Dilution	None
Injection volume	20 mL
Injection rate	3.3 mL/s
Duration of injection	6 s
X-ray delay	0 s
Power injector used	None

Reconstructions	**Primary**
Name	Dyna4D arterial Sub 4D
VOI size	Full
Slice matrix	512 × 512
Kernel type	EE
Image characteristics	Auto
Reconstruction mode	Sub
Viewing preset	Dyna4D



Radial range – *syngo* Dyna4D shows flow patterns in any angulation

AVM treatment planning with *syngo* Dyna4D

syngo Dyna4D was essential in identifying the treatment plan for this patient.

Courtesy of	Peter Mitchell, MD, Director Neurointervention Service, Department of Radiology, Royal Melbourne Hospital, Parkville, Victoria, Australia
Supported by	*syngo* Dyna4D
System & Software	Artis Q biplane with PURE® VD11, *syngo* X Workplace VD10

Patient history

The patient was referred for a cerebral angiogram to assess an arteriovenous malformation that was discovered as an incidental finding.

Procedure description

A 2 cm × 2.3 cm arteriovenous malformation demonstrated in the medial aspect of the posterior temporal lobe on the right side. This is supplied by branches arising from the P2 segment of the right PCS, and drains to the right transverse/s-shaped sinus via veins traversing the tentorium cerebelli. There is a 5 mm × 5 mm aneurysm positioned at the posterior aspect of the nidus (likely venous), best appreciated on the *syngo* Dyna4D volume.

The application of *syngo* Dyna4D provided the following additional information: *syngo* Dyna4D clearly demonstrates that one of the two main arteries (both from P2 segment of the rPCA) are not filling the nidus at all, which is not demonstrated on the DSA images. Out of the one main feeding artery, it is possible to perfectly delineate which of the two “sub-arteries” are supplying the intranidal aneurysm. This allows the interventional team to clearly identify which artery to embolize first.

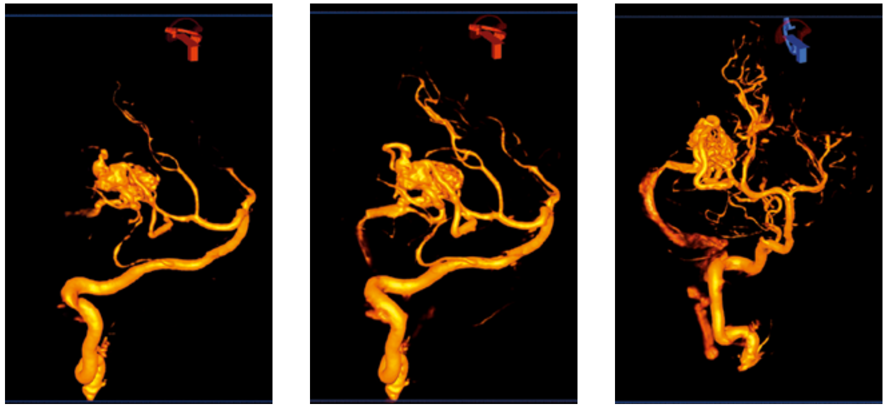
syngo Dyna4D was essential in identifying the treatment plan for this patient. Embolization of the AVM is due to take place later this year.

General comments

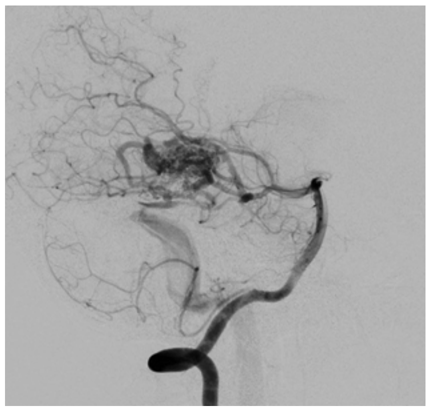
Manipulation of the *syngo* Dyna4D volume allows the clinicians to visualize filling of the AVM in any projection of the 3D model. This results in the most effective planning of the embolization treatment.

Acquisition protocol	12s Dyna4D
Injection protocol	
Catheter position	Vertebral artery
Contrast medium (CM)	240 mg iodine/mL
Dilution	None
Injection volume	20 mL
Injection rate	2.5 mL/s
Duration of injection	8 s
X-ray delay	None
Power injector used	Yes

Reconstructions	Primary
Name	DynaCT Head Nat Fill HU
VOI size	Full
Slice matrix	512 × 512
Kernel type	HU
Image characteristics	Normal
Reconstruction mode	Nat Fill
Viewing preset	DynaCT Head



syngo Dyna4D is used to “untangle” the AVM to perfectly delineate which of the two subarteries are supplying the intranidal aneurysm



DSA image which demonstrates AVM arising from the right vertebral artery

Understanding complex angio architectures of Dural AVF supported by *syngo* Dyna4D

Courtesy of	Ichiro Yuki, MD, Yuichi Murayama, MD, Department of Neurosurgery, Jikei University Hospital, Tokyo, Japan
Supported by	*syngo* Dyna4D
System & Software	Artis Q biplane VD11, *syngo* X Workplace VD10

Patient history
A 67-year-old male presented with diagnosed progressive visual acuity loss. An MR angiogram (MRA) indicated potential dural arteriovenous fistula (dAVF).

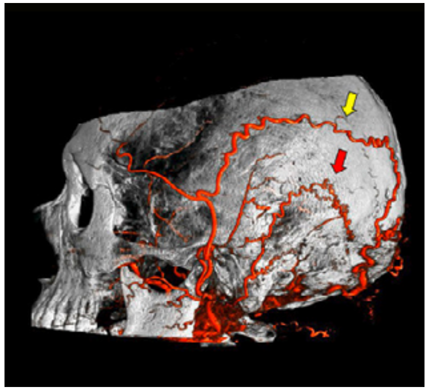
Procedure description
The patient was referred to the endovascular neurosurgery department and underwent a cerebral angiogram. The angiogram revealed a left transverse sigmond sinus dAVF with significant venous reflux into the superior sagittal sinus. Normal draining pattern of left transverse sigmoid sinus was impaired, and it was replaced by the high flow shunting between the multiple arterial branches from the left external carotid arteries and the impaired sinus. After completing the conventional 2D DSA, it was not yet clear whether or not the lesion had "cortical venous reflux", which is decisive in determining the prognosis for the patient. A *syngo* Dyna4D run showed a detailed flow pattern of arteriovenous shunting as well as a correlation between the complex angio architecture and the cranium. The image enables the 3D structure of cortical veins to be distinguished from overlapped vascular structures. A cortical venous reflux was confirmed. The retrograde filling of the contrast in the cortical vein was clearly visible due to the temporal information provided by *syngo* Dyna4D.

Based on the aforementioned image findings, this dAVF was classified as Cognard IIa + B and endovascular treatment was recommended. Transarterial embolization of the feeding artery followed by a transvenous approach and occlusion of the left T-S sinus was performed.

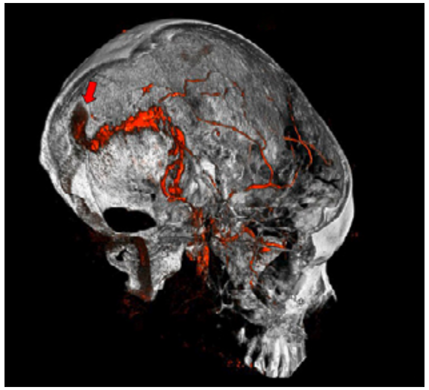
General comments
syngo Dyna4D breaks down the complex angio architecture of the shunting disease into different phases of contrast fillings, and allows to see the direction, speed, and amount of flow in one acquisition. This information is crucial to the treatment.

Acquisition protocol	12s Dyna4D
Injection protocol	
Catheter position	Left carotid artery
Contrast medium (CM)	270 mg iodine/mL
Dilution	None
Injection volume	21 mL
Injection rate	3 mL/s
Duration of injection	7 s
X-ray delay	None
Power injector used	Yes

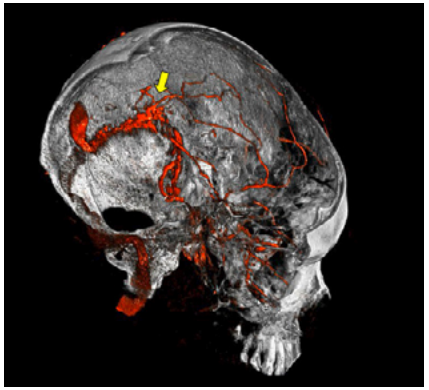
Reconstructions	Primary
Name	Sub4D*Full HU Auto
VOI size	Full
Slice matrix	512 × 512
Kernel type	EE
Image characteristics	Auto
Reconstruction mode	Sub
Viewing preset	Dyna4D
Sub 4D fused with Native Mask Run	



Yellow arrow: superior temporal artery
Red arrow: posterior auricular artery



Left external carotid artery angiogram (ECAG) shows the contrast dye welling up in the left sigmoid sinus, then flowing back to the transverse sinus, and finally to the superior sagittal sinus (red arrow)



Cortical venous reflux was seen at the left occipital lobe near the transverse sigmoid junction (yellow arrow)

Complex spinal AVM

Curative endovascular treatment supported by
4D angiography imaging

Courtesy of Saruhan Cekirge, MD, and Isil Saatci, MD,
Department of Interventional Neuroradiology,
Koru Hospital, Ankara, Turkey

Supported by *syngo* Dyna4D

System & Software Artis zee biplane VD11, *syngo* X Workplace VD20

Patient history

A 27-year-old female presented with progressive weakness. A large spinal arteriovenous malformation (AVM) was diagnosed, affecting both legs, located in the conus medullaris and cauda equina. Since the patient's clinical condition was deteriorating rapidly, a decision was made to perform curative AVM treatment.

Diagnosis

Complex spinal AVM

Procedure description

The spinal AVM was fed by left L1 and L2 radiculomedullary contribution via the posterior and anterior spinal artery. A spinal 4D angiography run was used to assess the AVM nidus and feeder orientation. Within just a few minutes, it was possible to visualize the whole morphology in order to find the ideal working projection to guide the microcatheter into the right position, i.e., the nidus of the AVM. A prolonged intranidal ONYX® injection was administered to completely close the AVM.

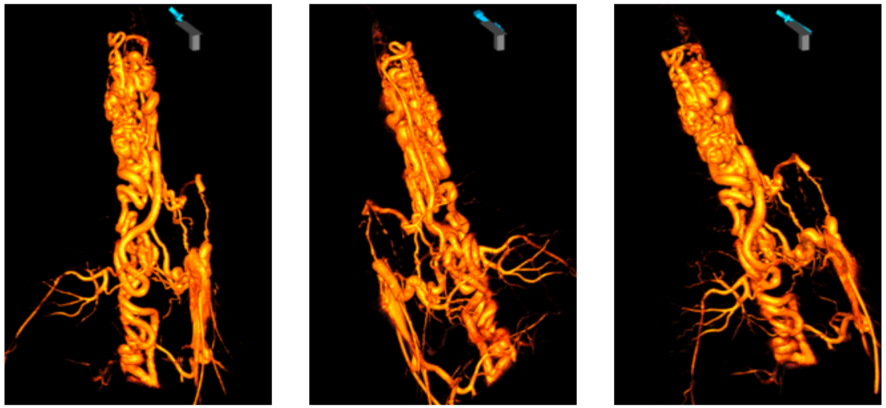
The patient progressively recovered from her symptoms and was able to walk again without assistance.

General comments

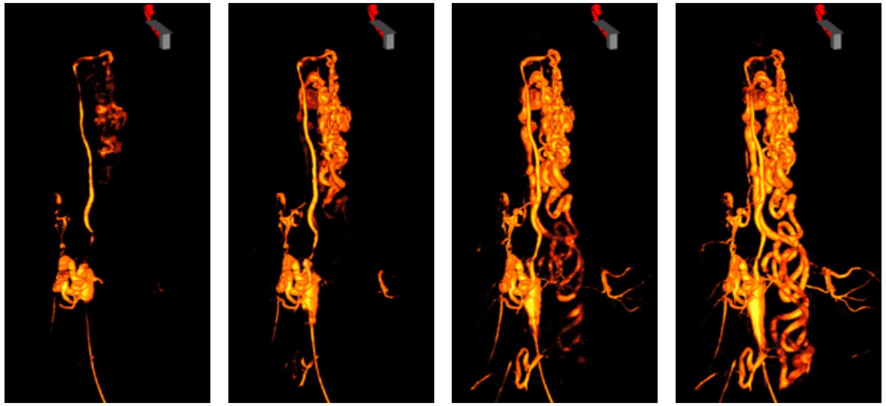
Following on from DSA, 3D angiography, and flat panel CT, we firmly believe that 4D angiography is the next important revolution in the history of angiography. It has the same crucial impact on AVM treatment as 3D angiography had on aneurysm treatment. It enables a very quick and efficient visualization of the disease morphology so that we can treat lesions much more effectively.

Acquisition protocol	**6s Dyna4D**
Injection protocol	
Catheter position	Lumbar artery
Contrast medium (CM)	300 mg iodine/mL
Dilution	None
Injection volume	18 mL
Injection rate	3 mL/s
Duration of injection	6 s
X-ray delay	0 s
Power injector used	Yes

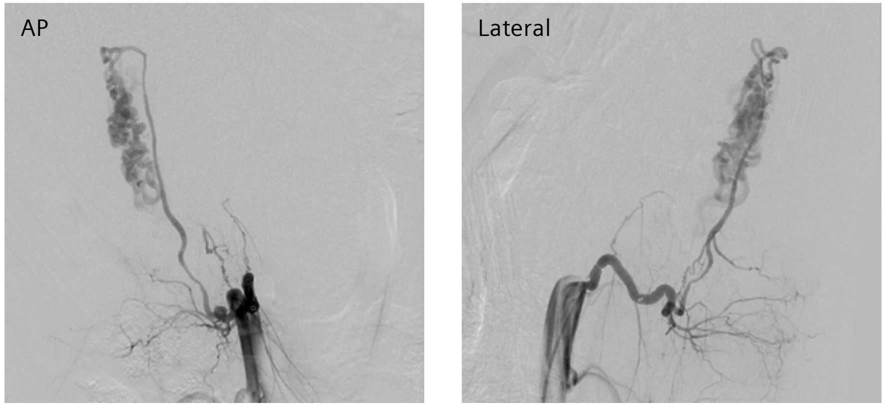
Reconstructions	**Primary**
Name	Dyna4D arterial sub 4D
VOI size	Full
Slice matrix	512 × 512
Kernel type	EE
Image characteristics	Auto
Reconstruction mode	Sub
Viewing preset	Dyna4D



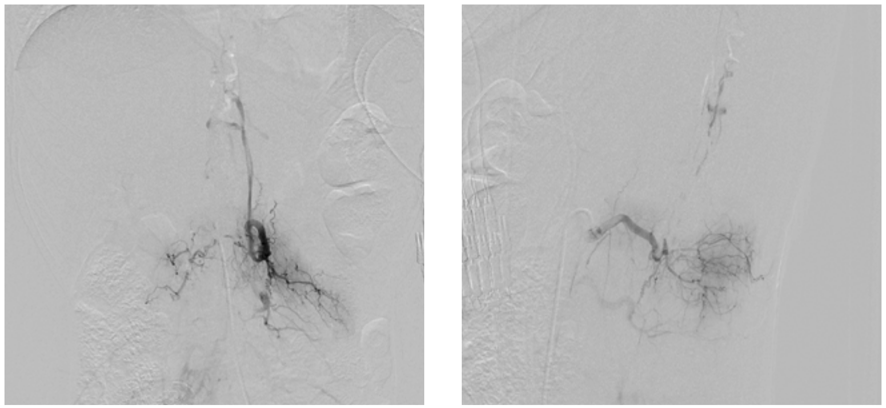
syngo Dyna4D imaging of the spinal AVM was used to find the correct working projection.



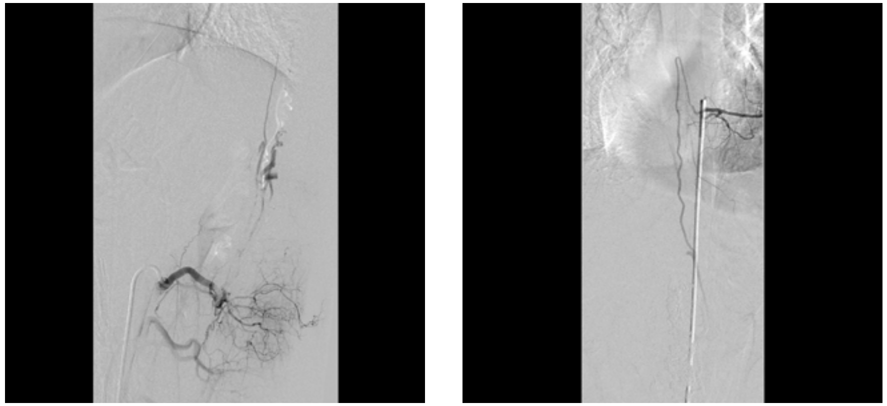
syngo Dyna4D imaging shows AVMs at various time points.



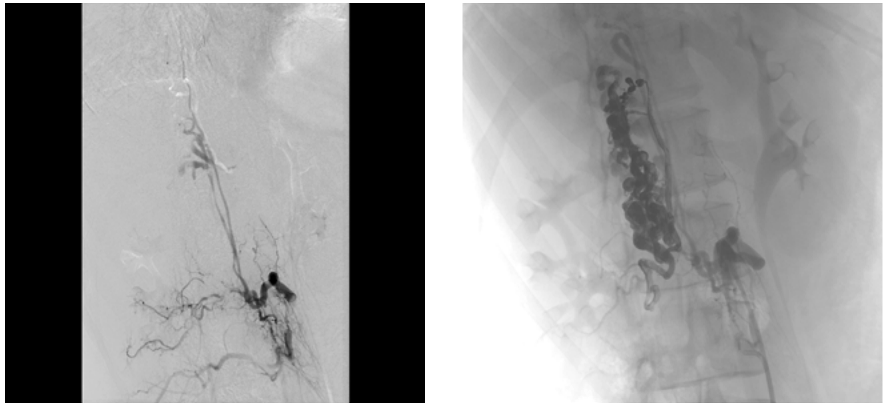
Optimal working projection to verify that there is no occlusion of the anterior spinal artery during gluing



Anterior spinal artery with a contrast media filling from the caudo-cranial direction



Post intervention, images show an occluded AVM and a non-occluded anterior spinal artery, which is still filling with contrast media



Intranidal Onyx® cast after closure of the entire spinal AVM, using embolization, with no complications

Follow-up after bilateral carotid stent placement

syngo DynaCT with IV injection of contrast medium is used for concerns around stent patency, in-stent stenosis, residual filling of aneurysms s/p clipping and/or coiling, and vasospasm.

Courtesy of	Kiffon Keigher, APN, Demetrius K. Lopes, MD, Rush University Medical Center, Chicago, USA
Supported by	*syngo* DynaCT
System & Software	Artis zee biplane VC21, *syngo* X Workplace VB21

Patient history

76-year-old female who developed severe bilateral carotid artery stenosis thought to be primarily related to her history of neck radiation for thyroid disease. Re-stenosis of both carotids seen in CTA. Decision for *syngo* DynaCT with IV injection of contrast medium for improved stenosis evaluation and stent visualization.

Procedure description

A 20sDR DynaCT of the neck region was performed, with a contrast injection through an 18 G IV access in the right antecubital vein, using an X-ray delay of 14 sec. Images were automatically reconstructed on the *syngo* X Workplace and displayed in *syngo* InSpace 3D.

Patient has no new symptoms and no further intervention was recommended with exception of continued dual anticoagulation therapy and stroke risk factor management.

General comments

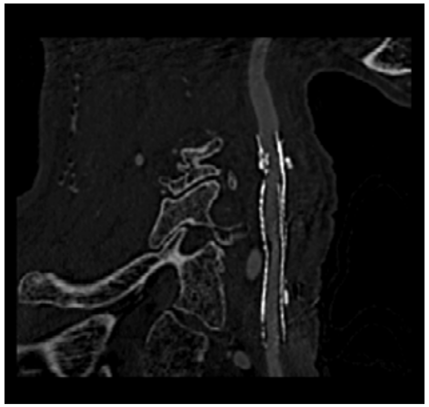
At our institution we are using *syngo* DynaCT with IV injection routinely for patients with the following concerns: stent patency, in-stent stenosis, residual filling of aneurysms s/p clipping and/or coiling, and vasospasm.

Coronal MIP showing bilateral stent placement

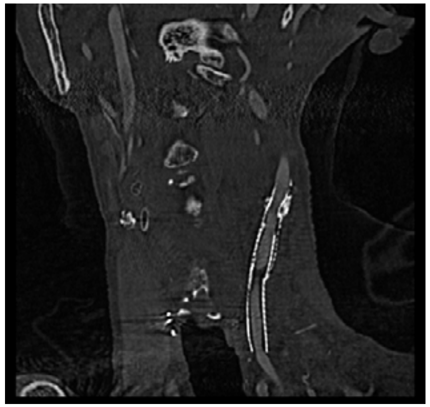
Acquisition protocol	**20sDCT Head 109kV**
Injection protocol	
Catheter position	IV injection; right antecubital vein
Contrast medium (CM)	370 mg iodine/mL
Dilution	None
Injection volume	80 mL
Injection rate	4 mL/s
Duration of injection	20 s
X-ray delay	14 s
Power injector used	Yes

Reconstructions	**Primary**	**Secondary[1]**
Name	DynaCT Head Nat Fill HU	DynaCT Head Nat Fill HU
VOI size	Full	Small
Slice matrix	512 × 512	512 × 512
Kernel type	HU	HU
Image characteristics	Normal	Normal
Reconstruction mode	Nat Fill	Nat Fill
Viewing preset	DynaCT Head	DynaCT Head

[1] *In order to improve the visualization of the stent, a 2nd reconstruction with a small size VOI was performed, using the same parameter as for the initial reconstruction.*



Sagittal MPR demonstrating partial in-stent stenosis (with secondary reconstruction)



Curved MPR demonstrating partial in-stent stenosis (with secondary reconstruction)

Follow-up after stent-assisted aneurysm coiling

We were able to obtain accurate visualization of the parent vessel and verify occlusion of this aneurysm and patency of the stent.

Courtesy of	Kiffon Keigher, APN, Demetrius K. Lopes, MD, Rush University Medical Center, Chicago, USA
Supported by	*syngo* DynaCT
System & Software	Artis zee biplane VC21, *syngo* X Workplace VB21

Patient history
73-year-old female patient. Left middle cerebral artery (MCA) aneurysm that was treated with stentassisted coil embolization in 2005. Because of her history of contrast allergies, we decided to complete a *syngo* DynaCT run with IV injection of contrast medium in the angiography suite for the purpose of improved visualization and monitoring the patient post IV injection.

Procedure description
In 3D rotational angiography we identified that the left MCA aneurysm was completely occluded, status post stenting and coiling. We were able to obtain accurate visualization of the parent vessel and verify occlusion of this aneurysm and patency of the stent. There was no evidence of in-stent stenosis.

The quality of the study was very good, with no evidence of any other abnormalities in the circle of Willis. She tolerated this imaging study without incident and was discharged home. Our plan will be to follow up with this patient in 12 months with repeated imaging study.

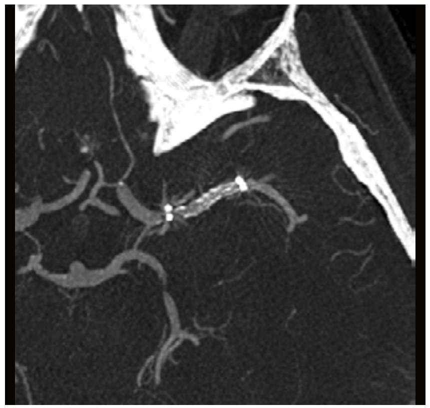
General comments
At our institution we are using *syngo* DynaCT runs with IV injection routinely for patients with the following concerns: stent patency, in-stent stenosis, residual filling of aneurysms s/p clipping and/or coiling, and vasospasm.

VRT (Volume Rendering Technique) of *syngo* DynaCT run with IV injection, visualizing the X stent

Acquisition protocol	**20sDCT Head 109kV**
Injection protocol	
Catheter position	IV injection antecubital vein (18 G) allergy prep medication
Contrast medium (CM)	370 mg iodine/mL
Dilution	None
Injection volume	80 mL
Injection rate	4 mL/s
Duration of injection	20 s
X-ray delay	14 s
Power injector used	Yes

Reconstructions	**Primary**	**Secondary**[1]
Name	DynaCT Head Nat Fill HU	DynaCT Head Nat Fill HU
VOI size	Full	Small
Slice matrix	512 × 512	512 × 512
Kernel type	HU	HU
Image characteristics	Normal	Normal
Reconstruction mode	Nat Fill	Nat Fill
Viewing preset	DynaCT Head	DynaCT Head

[1] *In order to improve the visualization of the stent, a 2nd reconstruction with a small size VOI was performed, using the same parameter as for the initial reconstruction.*



Axial MPR reconstruction outlining full patency of the X stent in the left middle cerebral artery (with secondary reconstruction)

Axial MPR reconstruction showing X stent in the left middle cerebral artery

Follow-up of Aneurysm Clipping Using *syngo* DynaCT with IV Injection

Courtesy of	Peter Mitchell, MD, Department of Radiology, The Royal Melbourne Hospital, Melbourne, Australia
Supported by	• *syngo* DynaCT DSA • *syngo* DualVolume
System & Software	Artis Q biplane VD11, *syngo* X Workplace with *syngo* Application Software VD11

Patient history
Past history of anterior communicating artery clipping (13 years ago), with subsequent elective middle cerebral artery embolization. Small bleb-like aneurysm adjacent to tip of aneurysm clips on DSA.

Diagnosis
Intracranial aneurysms at both the anterior communicating and middle cerebral arteries. Small bleb-like aneurysm for assessment.

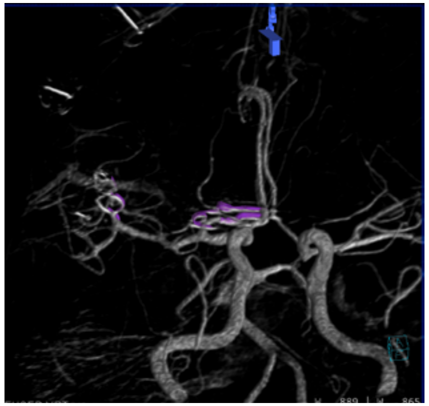
Procedure description
Clip occlusion > 10 years ago, routine follow up showed small new bleb-like aneurysm on DSA. Difficult to identify on MRA. *syngo* DynaCT with intravenous contrast injection in DualVolume mode offered less invasive imaging, able to exclude growth into a true saccular aneurysm, and allowed ongoing surveillance without repeat DSA.

General comments
When alternative non-invasive arterial imaging is limited, due to dense coil and stent packing, or certain types and numbers of clips, *syngo* DynaCT with intravenous contrast injection in DualVolume mode offers a technique that is less impacted by these artifacts, particularly when the clinical area of suspicion is at the base of the previously treated aneurysm.

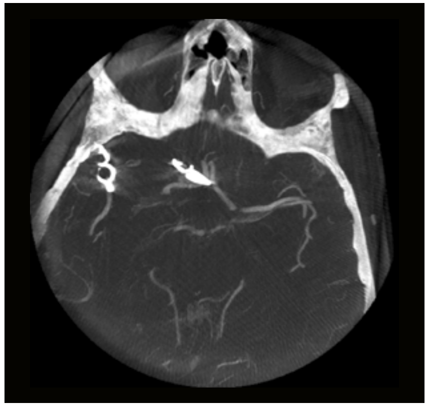
Tips and tricks
- Once the injector is armed, set the 3D protocol to manual mode (injection starts automatically after returning from mask spin)
- Start acquiring the fill run when the carotid artery is displayed on the bolus watch (approx. 8–15 sec)
- Head positioning: symmetrical patient head positioning with strap fixing to reduce patient movement during both spins

Acquisition protocol	**10s DSA DCT Head**
Injection protocol	
Catheter position	IV injection antecubital vein 18 g cannula
Contrast medium (CM)	350 mg iodine/mL
Dilution	None
Injection volume	96 mL
Injection rate	8 mL/s
Duration of injection	12 s
X-ray delay	DSA bolus tracking
Power injector used	Yes

Reconstructions	**Primary**	**Secondary**
Name	DynaCT DSA Dual Head (reconstructs Nat Fill + Nat Mask + Sub volume)	DynaCT DSA Dual Head
VOI size	Full (Nat Fill volume)	Medium (Nat Mask + Sub volume)
Slice matrix	512 × 512	512 × 512
Kernel type	HU (Nat Fill + Nat Mask volume)	EE (Sub volume)
Image characteristics	Auto	Auto
Reconstruction mode	Vasc head	Vasc head
Viewing preset	Dual Volume 2	Dual Volume 2



syngo DualVolume visualization of vessels and clips



Transversal MIP 5 mm

Visualization of clipped aneurysm

DynaCT with intravenous contrast injection is a fast and easy procedure for noninvasive arterial imaging.

Courtesy of	Andrey Sergeev, MD, Department of Neurosurgery, The Federal State Budgetary Institution “Almazov National Medical Research Centre” of the Ministry of Health, Russia
Supported by	• *syngo* DualVolume • *syngo* DynaCT DSA
System & Software	Artis zeego, VC21, *syngo* X-Workplace, VB21

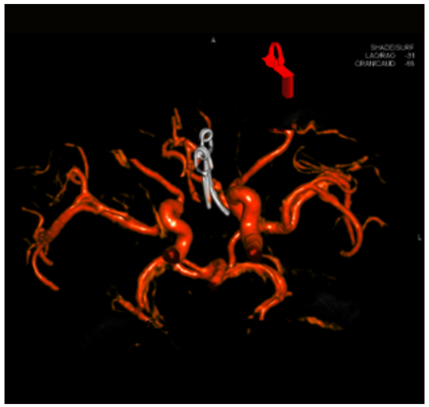
Patient history
Patient hemorrhaged from a giant ACom aneurysm. Urgent admission and surgery was performed the next day.

Diagnosis
Giant aneurysm of the ACom artery. Acute subarachnoid hemorrhage from the aneurysm, Hunt-Hess II.

Procedure description
Acute craniotomy with intrain-tracranial anastomosis A2-A2 and aneurysm clipping.

Intraoperative imaging of cerebral vessels allows neurosurgeons to visualize the effectiveness of clipped aneurysms and patency of bypasses immediately after the surgery.

The injection of the iodine contrast takes place directly after the mask run. We observe the contrast bolus using DSA. As soon as the carotid artery is filled with contrast, we start the robotic C-arm rotation *syngo* DynaCT acquired in Zoom 1 (42 cm) delivers better resolution due to the smaller voxel size compared to *syngo* DynaCT in Zoom 0 (48 cm), and results in better and more detailed visualization of the clips and vessels.

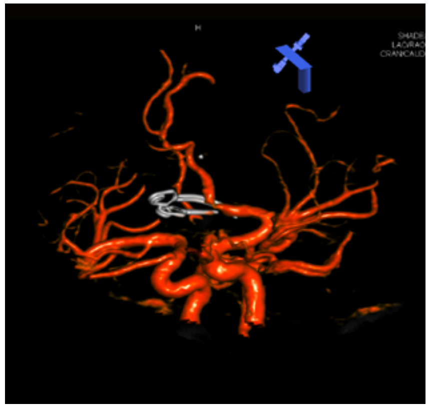


Clipped aneurysm. Intra-intracranial anastomosis A2-A2 with retrograde filling of right A2 vessel (secondary reconstruction)

Acquisition protocol	**10s DSA DCT Head, zoom 42 cm**

Injection protocol	
Catheter position	Cubital vein 18 g
Contrast medium (CM)	370 mg iodine/mL
Dilution	None
Injection volume	100 mL
Injection rate	5 mL/s
Duration of injection	20 s
X-ray delay	DSA bolus tracking
Power injector used	Yes

Reconstructions	**Primary**	**Secondary**
Name	DynaCT Head Nat Fill HU	DynaCT Head Sub MoCo HU
VOI size	Full	Full
Slice matrix	512 × 512	512 × 512
Kernel type	HU	HU
Image characteristics	Auto	Very smooth
Reconstruction mode	Nat Fill	Sub with MoCo (motion correction algorithm)
Viewing preset	Dual Volume 2	Dual Volume 2



3D visualization of the clipped aneurysm (secondary reconstruction)

Transversal MIP with vessels and clips (primary reconstruction)

Follow-up of aneurysm treated with a flow diverter

Cone beam CT with IV injection is a very easy workflow in our daily routine

Courtesy of	Martin Skalej,MD, Department of Neuroradiology University Hospital Magdeburg, Germany
Supported by	*syngo* DynaCT Micro
System & Software	Artis Q biplane VD11, *syngo* X Workplace VD10

Patient history
64-year-old male with two innocent paraophthalmic wide neck aneurysms in the left internal carotid artery.

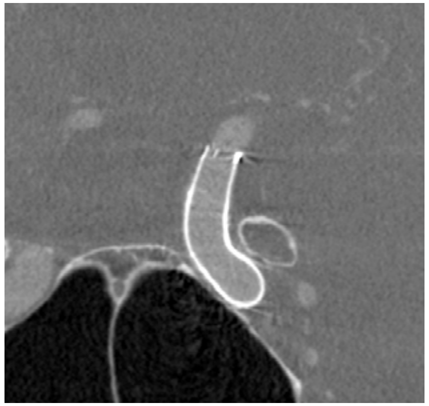
Treatment
Implantation of a flow diverter (Acandis Derivo 4,5 mm × 20 mm) 6 month ago. *syngo* DynaCT Micro acquisition for follow-up of flow diverter treated aneurysm to exclude intimal hyperplasia or in-stent stenosis.

General comments
The follow up of flow diverter placement is easy in our daily routine. There is no need for catheter placement, only IV contrast injection is required. *syngo* DynaCT Micro, with its higher spatial resolution, improves the visualization of the stent.

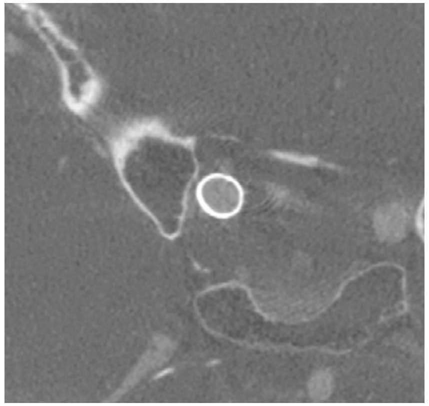
Neuroradiology

Acquisition protocol	**20s DCT Head Micro**
Injection protocol	
Catheter position	IV injection
Contrast medium (CM)	300 mg iodine/mL
Dilution	80%
Injection volume	100 mL
Injection rate	5 mL/s
Duration of injection	20 s
X-ray delay	20 s
Power injector used	Yes

Reconstructions	**Primary**
Name	DynaCT Micro
VOI size	Manual 78 mm × 78 mm × 75 mm
Slice matrix	512 × 512
Kernel type	HU
Image characteristics	Normal
Reconstruction mode	Nat Fill
Viewing preset	DynaCT Head



Implanted flow diverter in the ophthalmic segment of the left ICA lateral: anterior clinoid process, medial: sphenoid sinus, no intimal hyperplasia or in-stent-stenosis



No intimal hyperplasia or in-stent-stenosis

Total ossicular replacement prosthesis (TORP) dislocation

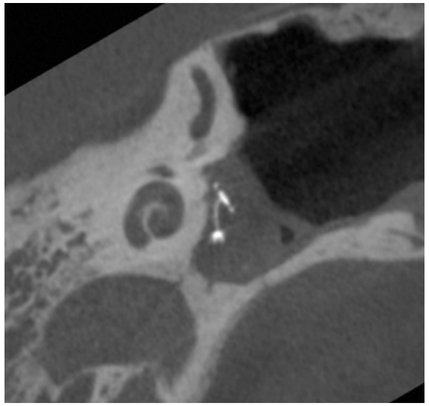
The high spatial resolution of *syngo* DynaCT Micro supports diagnosis of complications after TORP implantations

Courtesy of	Martin Skalej Department of Neuroradiology, MD, University Hospital Magdeburg, Germany
Supported by	*syngo* DynaCT Micro
System & Software	Artis Q biplane VD11, *syngo* X Workplace VD10

Patient history
35-year-old male with known conductive hearing loss; initially benefits after implantation of a total ossicular replacement prosthesis (TORP). After 3 months, he suddenly suffers from hearing loss again.

Diagnosis
TORP dislocation

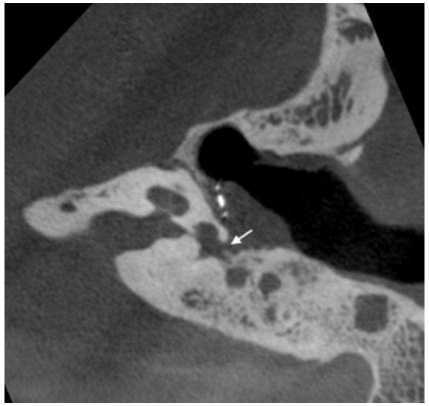
General comments
syngo DynaCT Micro provides higher spatial resolution compared with standard CT images. For the complex anatomy of the inner ear and especially with tiny prosthesis and implants, it helps us to make the right diagnosis.



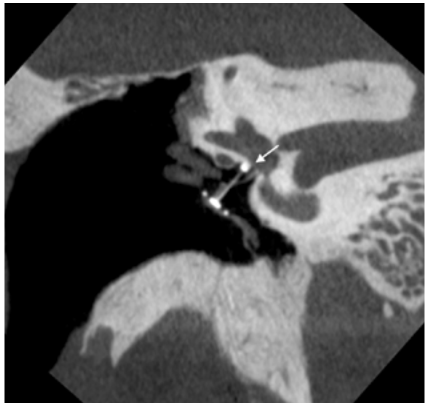
After tympanoplasty type III with titanium total ossicular replacement prosthesis, the tympanum is filled with soft tissue isodense material; the TORP is dislocated and bent

Acquisition protocol	**20s DCT Head Micro**
Injection protocol	
Contrast medium (CM)	N/A

Reconstructions	**Primary**
Name	DynaCT Micro
VOI size	Manual 47 mm × 47 mm × 35 mm
Slice matrix	512 × 512
Kernel type	HU
Image characteristics	Normal
Reconstruction mode	Nat Fill
Viewing preset	DynaCT Head



Dislocated TORP without contact with the oval window (indicated by arrow)



Sample image of a TORP correctly positioned in the oval window (indicated by arrow)

Click here to find more protocols!

↗ Clinical Specialty Educational Resources

Oncology/ Interventional Oncology

Transarterial chemoembolization of HCC

Courtesy of Florian Wolf, MD; Prof. Christian Loewe, MD; Allgemeines Krankenhaus Wien – Medical University Vienna, Austria

Supported by
- *syngo* Embolization Guidance
- *syngo* DynaCT

System & Software ARTIS icono biplane VE2 with *syngo* Application Software VE2

Patient history
68-year-old female patient

Diagnosis
Hepatocellular cancer in liver segment 1. Surgery not possible due to heavy liver cirrhosis.

Treatment
First transarterial chemoembolization (TACE) with TANDEM particles loaded with doxorubicin.

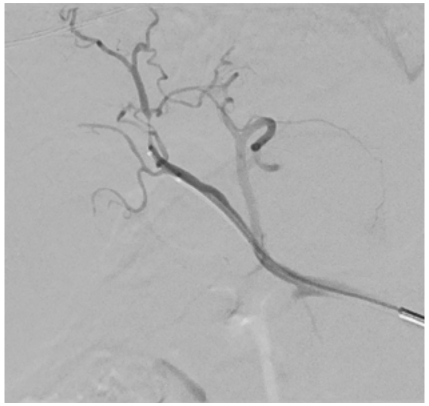
General comments
A lesion in segment 1 is difficult to see in angiography, therefore *syngo* DynaCT is very helpful to visualize the lesion, as well as the feeding arteries. *syngo* Embolization Guidance was used. Simply marking the lesion allows the application to detect all feeding arteries of the tumor. It was then quite visible that the blood supply came from the right hepatic artery. The segmented vessels were overlaid onto live fluoro for better navigation of the microcatheter.

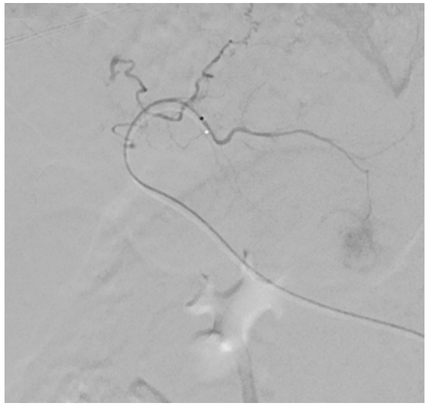
Tips & Tricks
For very high image quality of the *syngo* DynaCT acquisition, good patient cooperation and strict breath-hold are crucial.

Statement
syngo DynaCT is often very helpful for the detection of the lesion. *syngo* Embolization Guidance can help to detect the vessel supply, provides 3D overlay, and can support finding the optimal C-arm angulation.

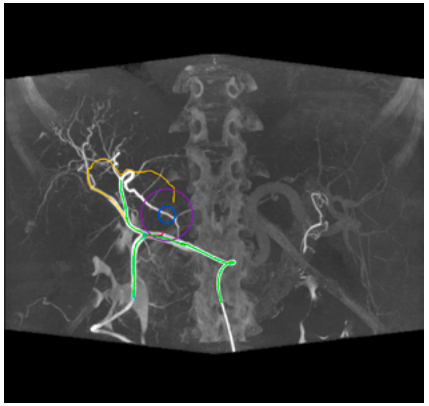
Acquisition protocol	5sDCT Body
Injection protocol	
Catheter position	common hepatic artery
Contrast medium (CM)	300 mg/mL
Dilution	50%
Injection volume	44 mL
Injection rate	4 mL/s
Duration of injection	11 s
X-ray delay	6 s
Power injector used	Yes

Reconstructions	Primary
Name	DCT Body Nat Fill
VOI size	Full
Slice matrix	512 × 512
Kernel type	HU
Image characteristics	Normal
Reconstruction mode	Nat Fill
Viewing preset	DynaCT Body

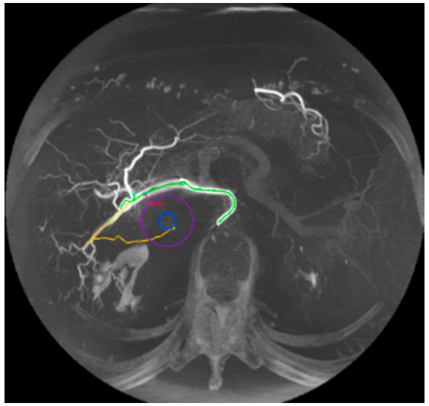

DSA image showing tiny vessel structure


DSA image in treatment position

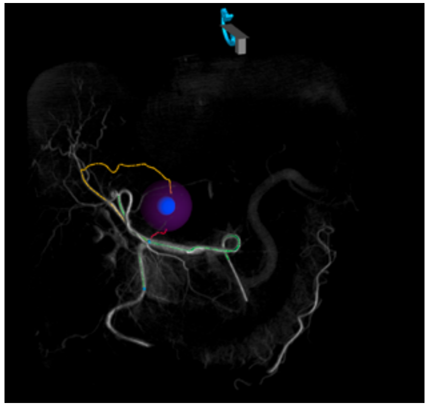
Thin MPRs – Showing hypervascularized lesion in liver segment 1



Thick MPR



Thick MPR



VRT

syngo Embolization Guidance segments feeding vessels to the lesion.
Branching vessels can be added manually.

Transarterial embolization of ependymom metastases in the liver

Courtesy of	Jan Hinrichs, MD Institute for Diagnostic and Interventional Radiology, Medical School Hannover, Germany
Supported by	*syngo* DynaCT
System & Software	Artis pheno VE 10 with *syngo* Application Software VD2

Patient history
60-year-old female patient with history of extraneural myxopapillary ependymoma, initially diagnosed in 2009.

Diagnosis
Liver-, lung- and lymphnode metastases since 2015.

Procedure description
First session of transarterial embolisation of livermetastases with bland embospheres (100–300 µm).

We placed the catheter in the A. mesenterica superior for arteriography and indirect mesentericoportography, followed by arteriography of the celiac trunc.

A cone beam CT run in arterial phase was done with microcatheter placement in the proper hepatic artery.

Embolisation was performed from tumorfeeding branch of the right hepatic artery.

After embolization a final DSA showed a decreased perfusion in the embolized liver arteries.

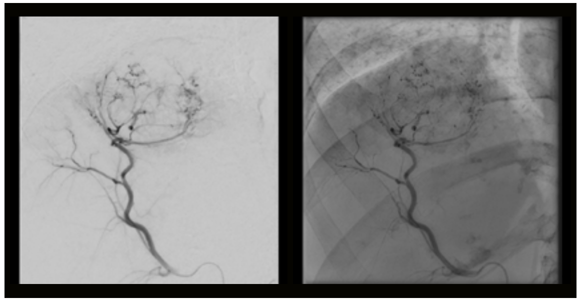
General comments
With the help of the *syngo* DynaCT 3D vessel map, we can ensure the proper position of the catheter for selective embolisation. It enhances the identification of aberrrant vessels, we easily could verify that there are no vessel branches to the bowel or stomach distal to the embolization position.

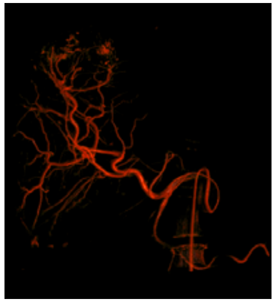
Tips and tricks
To gather best *syngo* DynaCT image quality, proper breathhold of the patient is vital.

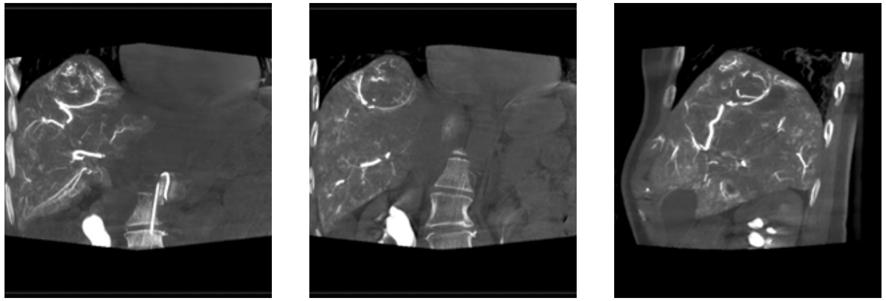
Explain the importance of his cooperation and give breathhold commands understandable and vigorous to the patient.

Acquisition protocol	**5sDCT Body**
Injection protocol	
Catheter position	Microcatheter in proper hepatic artery
Contrast medium (CM)	300 mg iodine/mL
Dilution	60%
Injection volume	24 mL
Injection rate	2.0 mL/s
Duration of injection	12 s
X-ray delay	5 sec
Power injector used	None

Reconstructions	**Primary**
Name	DCT Body
VOI size	Full
Slice matrix	512 × 512
Kernel type	HU
Image characteristics	Normal
Reconstruction mode	Nat Fill
Viewing preset	DynaCT Body


DSA scene in embolisation position


syngo DynaCT VRT visualization


syngo DynaCT imaging MIP 10 mm shows tumor and feeding arteries in axial, coronal and sagital

syngo DynaCT in multiple phases for HCC

syngo DynaCT scanned in two phases would improve the diagnostic performance for HCC and has an advantage in the preoperative diagnosis.

Courtesy of	Norifumi Nishida, MD, Yoshinori Takao, MD, Osaka City University Hospital, Japan
Supported by	*syngo* DynaCT
System & Software	Artis zee VC21, *syngo* X Workplace VB21

Patient history

A 69-year-old male with HCC (hepatocellular carcinoma) and HCV (Hepatitis C virus)-positive hepatic cirrhosis.

The HCC was treated by resection of the caudate lobe 9 years ago, segmentectomy of S6 2 years ago, and several RFA series. HCC recurrence was found by ultra-sonography and dynamic contrast-enhanced CT scan during regular follow-up. Because of this recurrence, the patient was hospitalized for TACE treatment.

Procedure description

Perfusion defect was found in both lobes of the liver using *syngo* DynaCT scanned in two phases. These sites also showed early enhancement and corona enhancement in the second phase using the *syngo* DynaCT scanned in two phases. The patient was diagnosed with HCC multiple recurrence based on these evaluations.

A microcatheter was selectively inserted into left and right hepatic arteries, and then TACE was performed using Lipiodolemulsion and Gelpart.

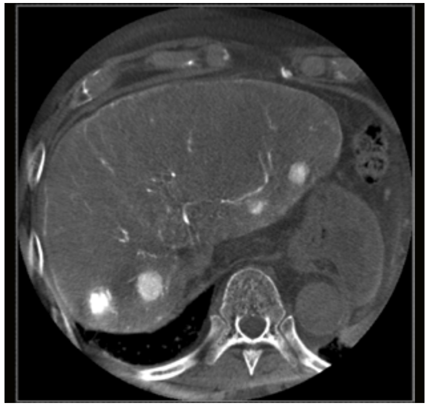
General comment

CT scan during hepatic arteriography for HCC shows both tumor stain in first phase and the corona enhancement in second phase (Radiology 1998 206:161-166. CVIR 2011 34:81–86). Thus this CT scan enables differentiation from an AP shunt which is also densely-stained in the first phase. *syngo* DynaCT scanned in two phases has an advantage in improvement of diagnostic performance for HCC because of its high spatial resolution and precise visualization of corona enhancement in second phase.

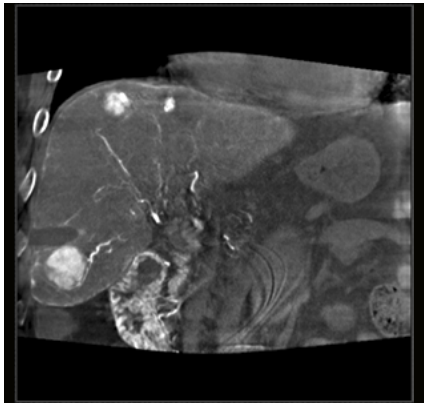
Acquisition protocol	**6sDSA DCT (manual mode)**
Injection protocol	
Catheter position	Common hepatic artery
Contrast medium (CM)	300 mg iodine/mL
Dilution	50%
Injection volume	32 mL
Injection rate	2 mL/s
Duration of injection	16 s
X-ray delay	6s DSA DCT run with manual triggering 1st Phase: 10 s X-ray delay time 2nd Phase: 25 s delay time after the 1st run
Power injector used	Yes

Reconstructions	**Primary**	**Secondary**
Name	DynaCT Body Nat Mask HU Auto	DynaCT Body Nat Fill HU Auto
VOI size	Full	Full
Slice matrix	512 × 512	512 × 512
Kernel type	HU	HU
Image characteristics	Normal	Normal
Reconstruction mode	Nat Mask	Nat Fill
Viewing preset	DynaCT Body	DynaCT Body

1st phase of syngo DynaCT run

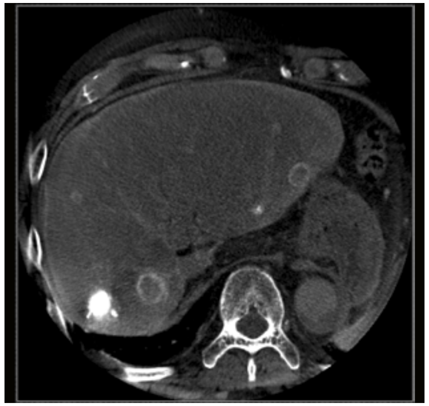


Axial MPR 3 mm

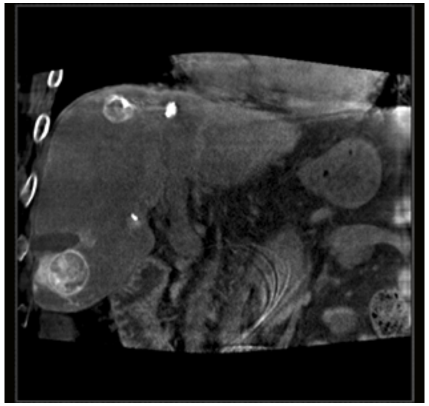


Coronal MIP 20 mm

2nd phase of syngo DynaCT run



Axial MPR 3 mm



Coronal MPR 3 mm

Dual-phase *syngo* DynaCT in liver TACE procedures

Courtesy of	Pierleone Lucatelli, MD, PhD, EBIR Azienda Ospedaliera Universitaria Policlinico Umberto I, Rome
Supported by	Dual-phase *syngo* DynaCT
System & Software	Artis zee ceiling VC21, *syngo* X workplace VB21

Patient history
64-year-old male patient, HCV positive, with known cavernous transformation of the portal vein.

Diagnosis
Typical hypervascular HCC with portal vein cavernomatosis and right portal vein macrovascular invasion.

Treatment
Degradable starch microsphere TACE (DSM-TACE) with epirubicin consisting of two sessions of drug administration for each affected lobe.

Procedure description
In the multistep DSM-TACE protocol (two sessions for each involved liver lobe), a dual-phase CBCT is performed before every session, enabling assessment of the lesion's attenuation.

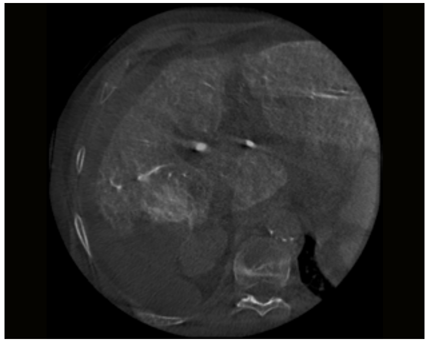
The breath-hold instruction is crucial. A contrast dilution 1:3 is necessary to avoid streak artifacts. The injection should be started before the acquisition in order to maximize liver parenchyma enhancement and must be continued throughout the entire acquisition time.

Only one contrast injection is needed, which is fewer than other 3D protocols. The entire dual-phase imaging process therefore does not increase the amount of contrast media injected.

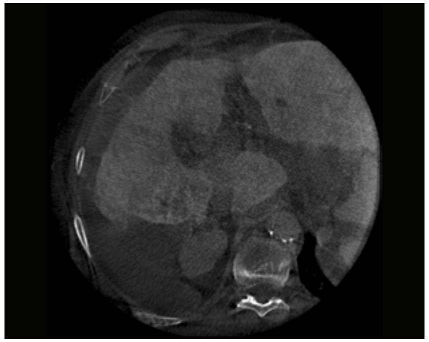
Single injection dual-phase cone beam computed tomography (DP-CBCT) intraprocedural findings correlate with 1 month mRECIST results in the course of degradable starch microsphere TACE (DSM-TACE) for hypervascular HCC and metastatic colorectal cancer (mCRC). [Scientific poster publication CIRSE 2017]

Acquisition protocol	**8s DSA DCT (manual)**
Injection protocol	
Catheter position	Proper hepatic artery
Contrast medium (CM)	350 mg iodine/mL
Dilution	33%
Injection volume	60 mL
Injection rate	4 mL/s
Duration of injection	15 s
X-ray delay	8 s for arterial run 35 s for delayed run
Power injector used	Yes

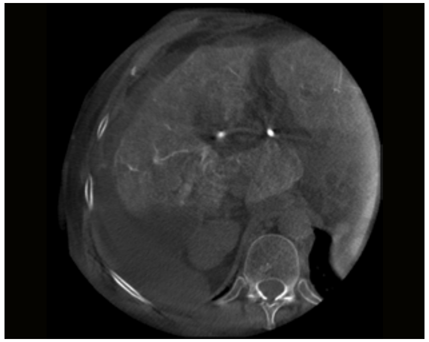
Reconstructions	**For both mask and fill run**
Name	DynaCT Body Nat Fill HU Normal
VOI size	Full
Slice matrix	512 × 512
Kernel type	HU
Image characteristics	Normal
Reconstruction mode	Nat Fill
Viewing preset	DynaCT Body



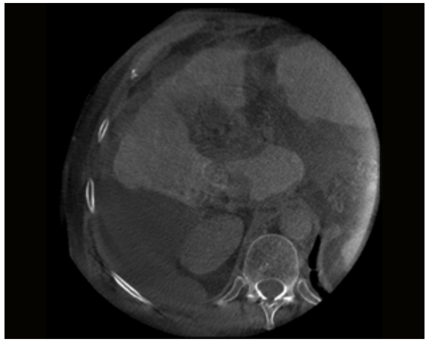
Dual-phase cone beam CT confirmed the lesion – Arterial phase 3 mm MPR



Dual-phase cone beam CT confirmed the lesion – Delayed phase 3 mm MPR



Dual-phase CBCT of second session demonstrated devascularization of the nodule by means of a reduction in the attenuation values – Arterial phase 3 mm MPR



Dual-phase CBCT of second session demonstrated devascularization of the nodule by means of a reduction in the attenuation values – Delayed phase 3 mm MPR

Transarterial chemoembolization of HCC using *syngo* DynaPBV Body

Courtesy of Jeff McCann, MD, Ronan Ryan, MD,
Department of Interventional Radiology,
St. Vincent University Hospital, Dublin, Ireland

Supported by *syngo* DynaPBV Body

System & Software Artis Q ceiling VD10, *syngo* X Workplace VC10

Patient history

51-year-old male with Hep C. Hepatocellular BCLC stage A carcinoma (HCC), which is not amenable to radiofrequency (RF) ablation due to its proximity to the gall bladder. Patient is awaiting liver transplant and recommended for TACE treatment.

Diagnosis

Pre-procedural four-phase CT of the liver measured a maximum of 3.5 cm in length of the segment V HCC lesion. The lesion demonstrated arterial hyperenhancement with portal venous and delayed phase washout centrally consistent with a HCC.

Procedure description

Selective chemoembolization of the 3.5 cm segment V HCC was performed on the patient. The patient tolerated the procedure well and there were no immediate complications.

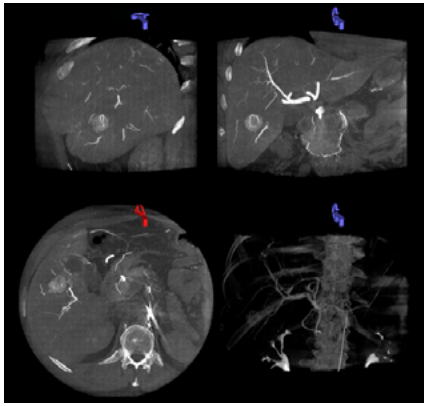
The pre-embolization *syngo* DynaPBV Body showed that the hypervascular tumor in the inferior right lobe derived supply from the segment V artery. Chemoembolization followed by bland embolization of the arterial supply was satisfactory with excellent angiographic response. The post-embolization PBV run confirmed complete treatment by showing no contrast opacification within the tumor. The one-month follow-up four-phase CT liver imaging confirmed results indicated by *syngo* DynaPBV Body.

Tips and tricks

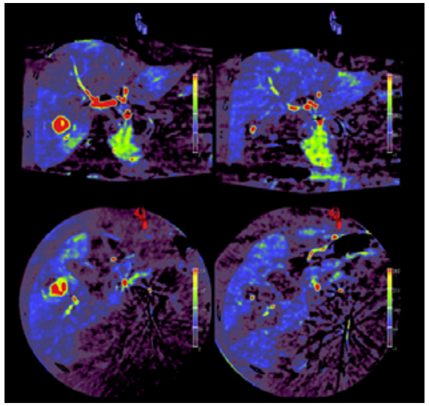
Don't oversedate the patient as patient cooperation with breathing is very important. Arms should be put above the head during *syngo* DynaPBV Body acquisition.

Acquisition protocol	5s DynaPBV Body (automatic)
Injection protocol	
Catheter position	Proper hepatic artery
Contrast medium (CM)	340 mg iodine/mL
Dilution	33%
Injection volume	36 mL
Injection rate	3 mL/s
Duration of injection	12 s
X-ray delay	Manual CM injection started when C-arm finished mask run 7 s acquisition delay as C-arm returns for fill run
Power injector used	Yes

Reconstructions	Primary	Secondary
Name	DynaPBV Body Dual PBV	Reconstruct the Nat Fill run
VOI size	Full	Full
Slice matrix	512 × 512	512 × 512
Kernel type	HU	HU
Image characteristics	Smooth	Smooth
Reconstruction mode	Dual (Sub and Mask)	Nat Fill
Viewing preset	PBV Body	DynaCT Body



Secondary reconstruction of the fill run of the pre-procedural *syngo* DynaPBV Body run gives good visualization of vessel tree (esp. showing the looped tumor-feeding vessel)



Pre- and post-embolization *syngo* DynaPBV imaging to confirm treatment success

Transarterial thoracic chemotherapy using *syngo* Dyna3D HighSpeed

The very short acquisition time of less than 3 s with *syngo* Dyna3D HighSpeed allows acquiring 3D datasets without breathing motion artifacts even in very sick patients.

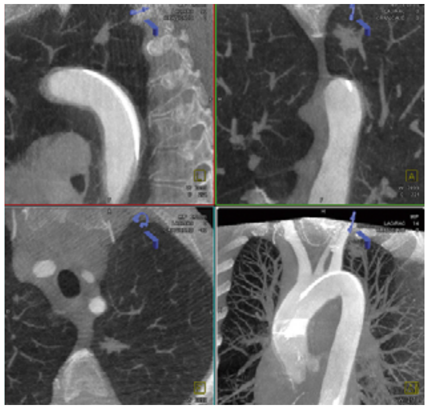
Courtesy of	Thomas J. Vogl, MD, Stefan Zangos, MD, Department of Radiology, University of Frankfurt, Germany
Supported by	*syngo* Dyna3D HighSpeed
System & Software	Artis zeego VC21, *syngo* X Workplace VB21 (Prototype software)

Patient history
61-year-old female. Adenocarcinoma of the lung, recurrent tumor after surgery, radiation therapy and systemic chemotherapy. Actual third line therapy protocol.

Diagnosis
No systemic metastases, local intrapulmonary infiltration.

Procedure description
Transarterial thoracic chemotherapy with a mix of Mitomycin, Gemcitabine and Cisplatin injected in the ascending aorta performed after using the *syngo* Dyna3D HighSpeed protocol.

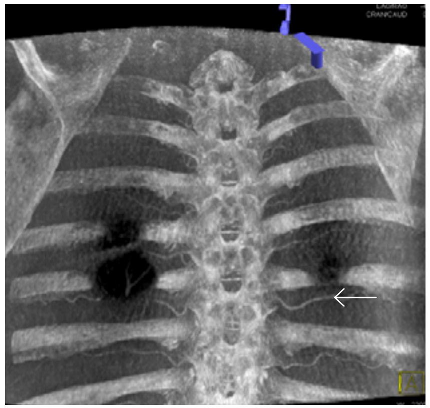
General comments
syngo Dyna3D HighSpeed allowed performing the 3D acquisition with only 25 mL of contrast and helped to save nearly 30% contrast media compared to a regular 5 s protocol. (A regular 5 s protocol would have required a 7 s injection protocol, resulting in a total volume of 105 mL with 35 mL of contrast).



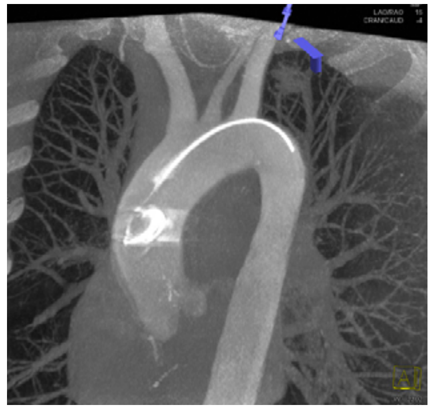
MIP 6 mm – The presented images show very good and sharp delineation of pulmonary arteries and their small branches.

Acquisition protocol	**3sDR HighSpeed**
Injection protocol	
Catheter position	Ascending aorta
Contrast medium (CM)	350 mg iodine/mL
Dilution	33%
Injection volume	75 mL
Injection rate	15 mL/s
Duration of injection	5 s
X-ray delay	2 s
Power injector used	Yes

Reconstructions	**Primary**
Name	DynaCT Body Nat Fill HU
VOI size	Full
Slice matrix	512 × 512
Kernel type	HU
Image characteristics	Normal
Reconstruction mode	Nat Fill
Viewing preset	DynaCT Body



Coronar MIP 29 mm – Visualization of intercostal arteries (white arrow).



Thick MIP – Visualization of pulmonary arteries with the tumor.

Combined embolization and ablation in an angio-CT interventional suite

Combining CT and angiography systems not only has the potential to enable these complex combined techniques, but also to take existing interventional therapies to a new level.

Courtesy of	Bruno C. Odisio, MD, Department of Interventional Radiology, The University of Texas MD Anderson Cancer Center, Houston, Texas, USA
Supported by	• *syngo* 2D/3D Fusion • *syngo* Embolization Guidance • *syngo* 3D Roadmap
System & Software	Angio-CT with Artis Q ceiling + SOMATOM Definition Edge (128 slices)

Patient history

59-year-old male with metastatic colorectal cancer to spleen.

Diagnosis

The patient was previously diagnosed with metastatic colorectal cancer to the liver and was successfully treated using CT-guided liver ablation. A new metastasis measuring 1.9 cm was found in the superior aspect of the spleen (Fig. 1). This was treated with percutaneous CT-guided microwave ablation and with a pre-ablation superselective embolization of the feeder vessels to the tumor in order to reduce the risk of bleeding.

Procedure description

A catheter was placed in the splenic artery guided by fluoroscopy and DSA was obtained (Fig. 2a). An intraarterial CT scan with contrast administration was acquired of the splenic artery to map out the tumor feeder vessels.

Multiplanar reformatted (MPR) images from the intra-arterial CT scan clearly illustrated the hypovascular tumor and the vessels supplying the splenic segment harboring the target tumor (Fig. 2b), which were not visible on planar DSA images.

After delineating the feeder vessels, superselective catheterization of the splenic artery branch supplying the area of interest was performed successfully, and the target feeding branches were embolized. (Figs. 2c–2d). Following the embolization, microwave ablation under CT guidance was performed. In general, the spleen is prone to bleeding due to its rich vascularity. Therefore,

femoral access was maintained throughout the ablation procedure to mitigate bleeding under angiography where needed. An initial noncontrast CT scan was acquired to plan the ablation needle path.

Prior to inserting ablation probes, hydrodissection of the perisplenic space with separation of the splenic flexure of the colon was performed successfully under CT guidance. Two microwave antennas were inserted under CT guidance, and microwave ablation was performed. Immediately after the removal of the ablation probes, the patient became tachycardic and hypotensive. A DSA was therefore acquired to exclude any bleeding. Intraarterial contrast-enhanced CT imaging, also performed toward the end of the ablation procedure, confirmed the ablation margins and indicated no bleeding from the ablation (Fig. 3).

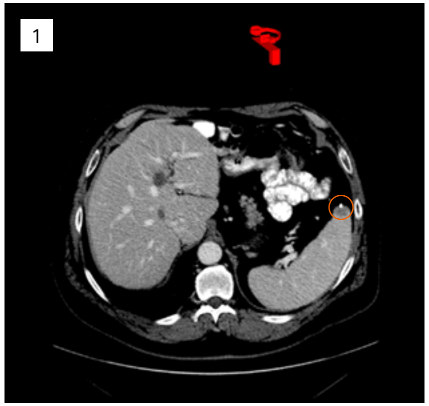
General comments

Since embolization is an intra-arterial therapy, it is traditionally performed in an angiography suite, while ablation, a percutaneous procedure, is performed using CT or ultrasound imaging. However, the combination of a CT scanner and angiography system allowed us to perform these two procedures in the same setting and with successful interplay of the technical and imaging information between the two procedures. For example, intraarterial CT imaging was used to accurately identify the vessels feeding the splenic segment harboring the tumor during the embolization procedure under angiography imaging. Similarly, immediate post-ablation assessment of potential bleeding and ablation margins was performed using DSA and CT imaging acquired with intraarterial access. As a safety measure, CT-guided hydrodissection was performed to avoid ablation of critical structures, and femoral access was maintained for angiographic detection and embolization of possible bleeding.

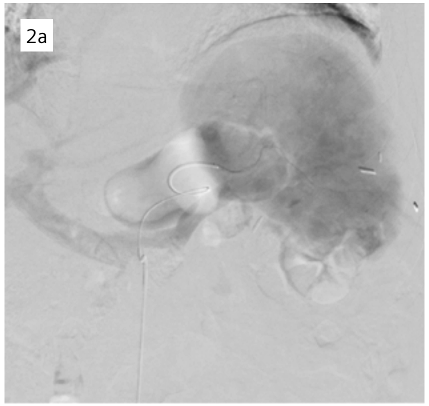
Acquisition protocol	Abdominal CT Scan
Tube voltage	120 kV
Tube current	233 mAs
Rotation speed	0.5 s
Gantry tilt	0°
Slice thickness	0.5 mm

Reconstructions	Primary
Name	MPR Reformation
Slice thickness	0.8 mm
Slice matrix	431 × 431
Kernel type	I40

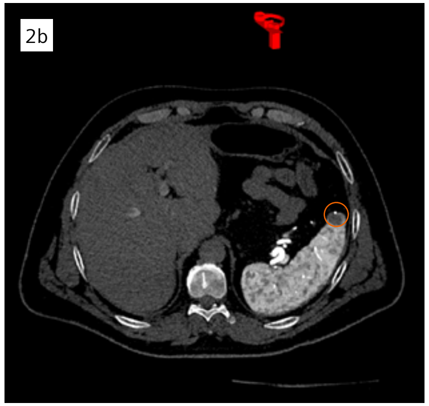
Injection protocol	
Catheter position	Splenic artery
Contrast medium (CM)	350 mg iodine/mL
Dilution	None
Injection volume	42 mL
Injection rate	3.0 mL/s
Duration of injection	14 s
X-ray delay	0 s
Power injector used	Yes



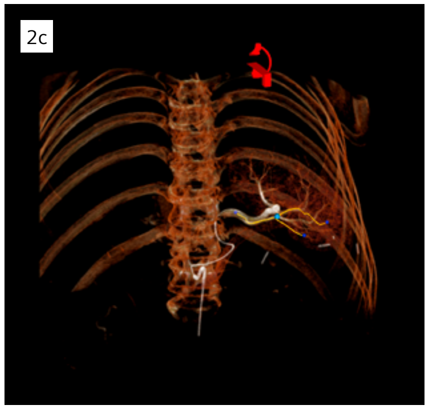
Diagnostic CT scan showing metastasis to spleen



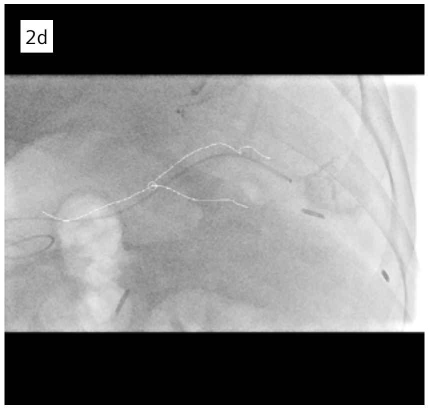
Planar DSA to depict splenic vasculature



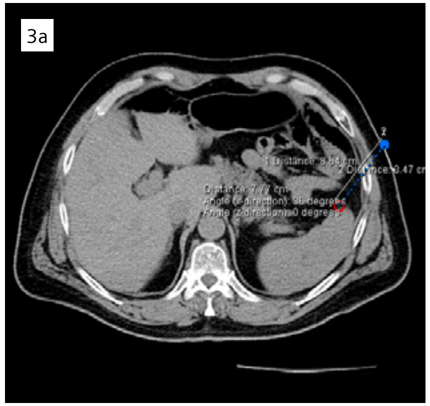
Axial slice of intra-arterial CT image showing splenic lesion



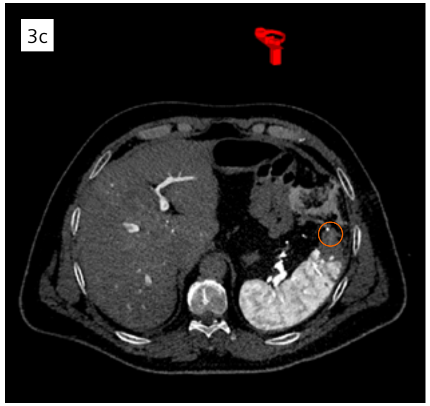
Identification of tumor vessels using *syngo* Embolization package

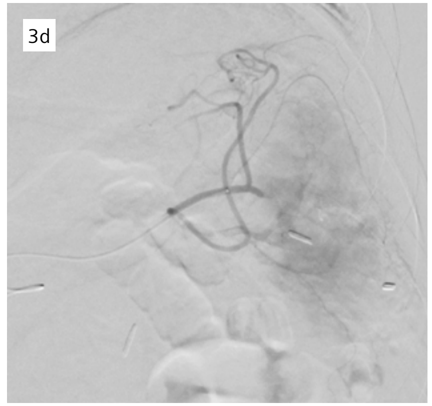


Fluoroscopic image of the point of embolization, vessel path overlaid from intra arterial CT scan

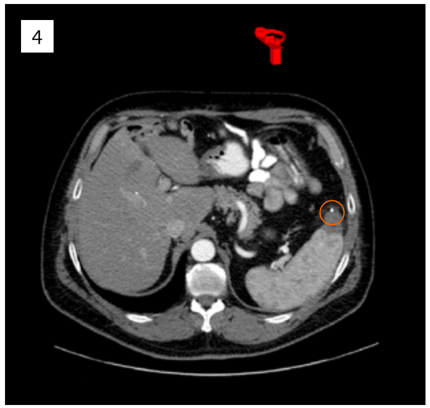


Axial slices showing the path planning on CT images (3a) and the ablation probe (3b)





Immediate post-ablation intra-arterial CT highlighting the ablation margin (3c). Immediate post-ablation DSA confirming no evidence of bleeding (3d)



Follow-up CT imaging showing successful ablation of the splenic metastasis

Click here to find more protocols!

↗ Clinical Specialty Educational Resources

Vascular/ Interventional Radiology

Prostate artery embolization

Courtesy of	Prof. Florian Wolf, MD; Prof. Christian Loewe, MD; Allgemeines Krankenhaus Wien – Medical University Vienna, Austria
Supported by	• *syngo* Embolization Guidance • *syngo* DynaCT
System & Software	ARTIS icono VE2 with *syngo* Application Software VE2

Patient history
75-year-old male. Benign prostate hyperplasia.

Diagnosis
Lower urinary tract symptoms (LUTS)

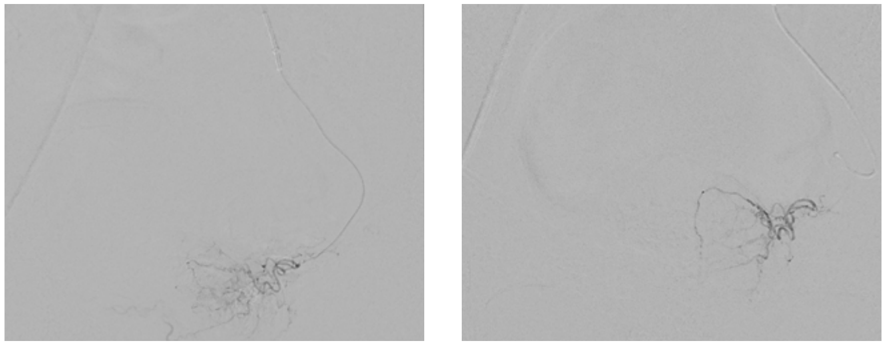
Treatment
Urologist offered transurethral resection of the prostate, but patient decided for interventional prostate artery embolization (PAE).

Selective catheterization of left and right prostate lobe separately with the help of *syngo* DynaCT acquisition and using *syngo* Embolization Guidance.

Superselective *syngo* DynaCT was done to rule out unwarranted embolization of neighboring structures.

Embolization of the prostate lobes with Embozene 250 µm microspheres.

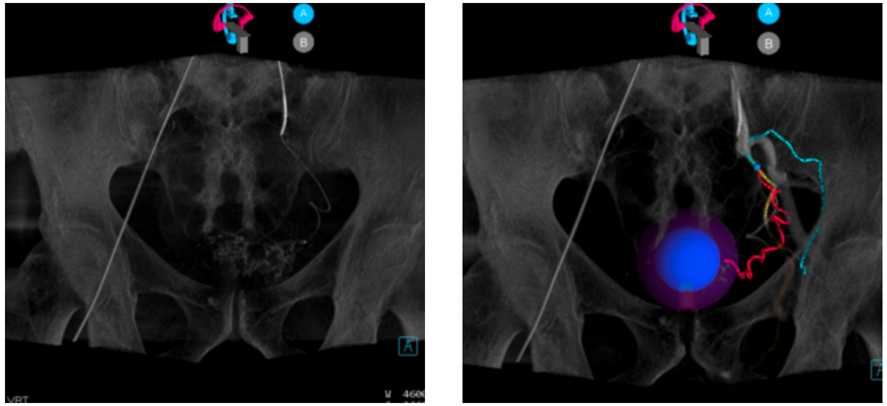
General comments
"*syngo* Embolization Guidance is a one-click tool that can help us to find and navigate to the prostate artery faster, especially for our relatively inexperienced interventionalists. The superselective DynaCT at the location for the embolization helps us to make the procedure safer."



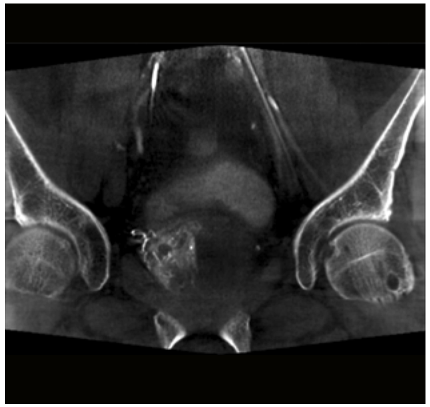
Selective catheterization of feeding vessel

Acquisition protocol	4sDCT Body Care
Injection protocol	
Catheter position	below aortic bifurcation
Contrast medium (CM)	300 mg/mL
Dilution	50%
Injection volume	5 mL
Injection rate	1 mL/s
Duration of injection	5 s
X-ray delay	1 s
Power injector used	No

Reconstructions	Primary
Name	DCT Body Nat Fill Full
VOI size	Full
Slice matrix	512 × 512
Kernel type	HU
Image characteristics	Normal
Reconstruction mode	Nat Fill
Viewing preset	DynaCT Body



VRT, *syngo* Embolization Guidance showing feeder vessel, branching vessels added manually



MPR 5 mm, verification of treatment position

Visualization of prostate arteries

Courtesy of	Bulat Sharafutdinov, MD, Edgar Gaziev, MD, Clinics of Kazan University, Kazan city, Russia
Supported by	• *syngo* Embolization Guidance • *syngo* DynaCT • *syngo* 3D Roadmap
System & Software	Artis Q floor VD11, *syngo* X Workplace VD10

Patient history

A 50-year-old man with benign prostate hyperplasia and acute urinary retention was referred for prostate artery embolization. He had been experiencing lower urinary tract symptoms for nearly three years and had been treated medically with no clinical improvement.

Diagnosis

Benign prostate hyperplasia and acute urinary retention.

Procedure description

With the catheter positioned in the abdominal aorta above the bifurcation, we got perfect visualization of the prostate and supplying vessels from both the left and right side. With the help of *syngo* Embolization Guidance we obtained a map of supplying vessel that was used during embolization. Successful vascular occlusion was then accomplished with microspheres (300–500 mm in size) for embolization.

General comments

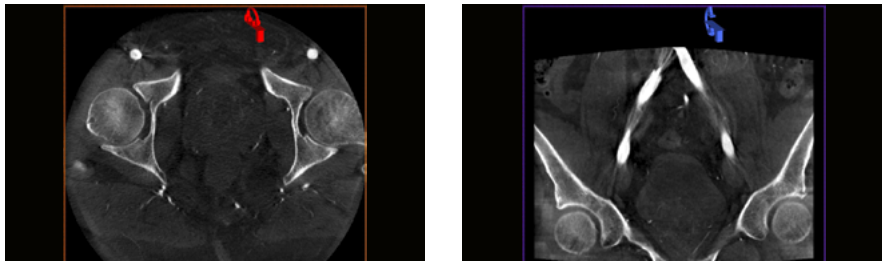
syngo Embolization Guidance with arterial contrast injection facilitates selective prostate artery catheterization, which has the potential to reduce dose and contrast medium. We marked the distal point of the prostatic artery and the proximal internal artery. *syngo* Embolization Guidance automatically creates the track between the two points, which can be overlaid to the live fluoro images.

Tips and tricks

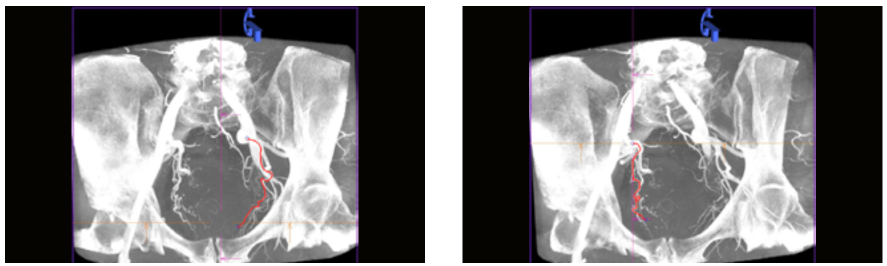
First, the power injector was readied. An injection protocol with an X-ray delay was chosen to get good visualization of the iliac arteries and prostate. 6s DynaCT Body acquisition protocol was used. The injector is triggered by the system and, according to the injection protocol, the C-arm starts DynaCT rotation with a 7 s delay.

Acquisition protocol	**6sDCT Body**
Injection protocol	
Catheter position	Pigtail 5F; abdominal aorta above bifurcation
Contrast medium (CM)	350 mg iodine/mL
Dilution	None
Injection volume	65 mL
Injection rate	5 mL/s
Duration of injection	13 s
X-ray delay	7 s
Power injector used	Yes

Reconstructions	**Primary**
Name	DynaCT Body Nat Fill HU
VOI size	Full
Slice matrix	512 × 512
Kernel type	HU
Image characteristics	Auto
Reconstruction mode	Nat Fill
Viewing preset	DynaCT Body



Visualization of prostate on 2 mm axial and coronal MPRs.



75 mm MIPs (left and right side) with vessel trajectory identified by *syngo* Embolization Guidance.

Prostatic artery embolization

A *syngo* DynaCT run in low-dose setting is sufficient quality as the soft tissue information is available from pre-interventional MRI. No *syngo* DynaCT run with higher dose needed.

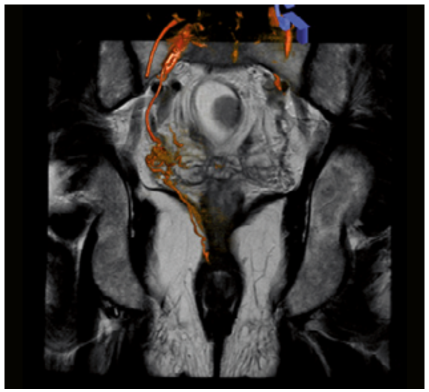
Courtesy of	Olivier Pellerin MD, MSc, Cardiovascular Radiology Department, Hospital Europeen Georges-Pompidou, Paris, France
Supported by	• *syngo* DynaCT • *syngo* InSpace 3D/3D Fusion • *syngo* iPilot enhanced • *syngo* Embolization Guidance
System & Software	Artis zee ceiling VC21, *syngo* MMWP VE52

Patient history
66-year-old man; benign prostate hyperplasia with major dysuria.

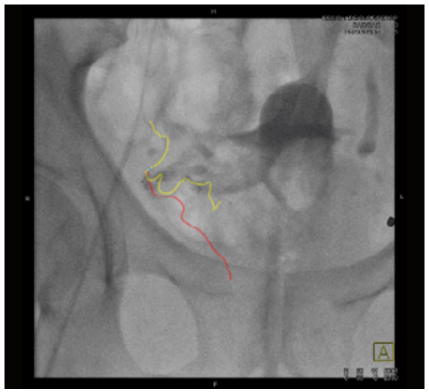
Diagnosis
Prostate volume 90 cm³ PSA < 3.

Treatment
Embolization of benign prostate hyperplasia.

Tips and tricks
Fusion of MRI data can save dose, because a *syngo* DynaCT run in lowdose setting is sufficient. *syngo* Embolization Guidance provides guidance to the target vessel, thus saving time, contrast media and fluoro time as well as dose.

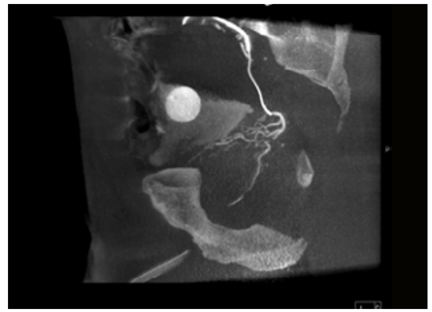


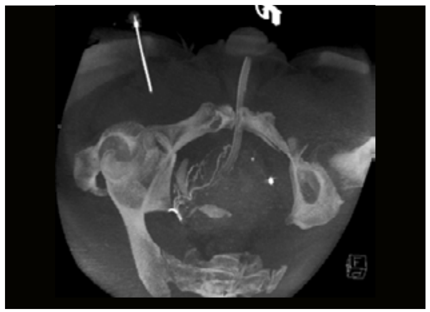
MRI image fused with *syngo* DynaCT volume (low-dose setting). Visualization in embedded MPR mode



Store fluoro with *syngo* iPilot overlay of *syngo* Embolization Guidance centerlines. Protocol: Fluoro normal

Acquisition Protocol 5sDCT	Body Care
Injection protocol	
Catheter position	Prostatic Artery
Contrast medium (CM)	350 mg Iodine/mL
Dilution (CM:Saline)	50%
Injection volume	5 mL
Injection rate	~1 mL/s
Duration of injection	5 s
X-ray delay	None
Power injector used	None
Reconstructions	**Primary**
Name	DynaCT Body Nat Fill
VOI size	Full
Slice matrix	512 × 512
Kernel type	HU
Image characteristics	Normal
Reconstruction mode	Nat Fill
Viewing preset	DynaCT Body





Thick MIP 48 mm – Frontal, sagittal and transversal view of pelvic vessels out of *syngo* DynaCT volume (low-dose setting)

Endoleak Type IIb Treatment Supported by *syngo* Needle Guidance

Using the pre-procedural CT scan fused with the *syngo* DynaCT helped to precisely plan the needle path to the nidus of the endoleak.

Courtesy of	Steffen Marquardt, MD, Institute for Diagnostic and Interventional Radiology, Hannover Medical School, Germany
Supported by	• *syngo* DynaCT • *syngo* 3D/3D Fusion • *syngo* Needle Guidance
System & Software	ARTIS pheno VE10 with *syngo* Application Software VD2

Patient history
An 82-year-old male patient with abdominal aortic aneurysm was treated with endovascular aortic repair (EVAR) two years ago.

The patient presented with ongoing enlargement of the aneurysm sac and a type II endoleak, fed by lumbar arteries.

The inferior mesenteric artery was occluded with coils one year ago, and so the patient was scheduled for embolization of the endoleak by direct aneurysm sac puncture.

Diagnosis
Persistent type IIb endoleak after EVAR treatment.

Procedure description
Embolization of the endoleak with Onyx® following coil embolization of branching lumbar arteries. To plan the direct puncture of the aneurysm sac, we registered the *syngo* DynaCT volume with the pre-procedural CT scan volume. Then we used *syngo* Needle Guidance to plan the needle path. To verify the correct needle position before treatment, we used a DynaCT run in slab mode. The smaller volume of the collimated 3D acquisition provided enough information with a lower dose.

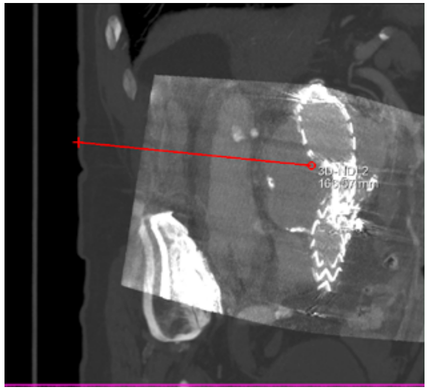
General comments
syngo Needle Guidance provides a graphical overlay of the planned needle path on live fluoro during needle placement for all C-arm angulations.

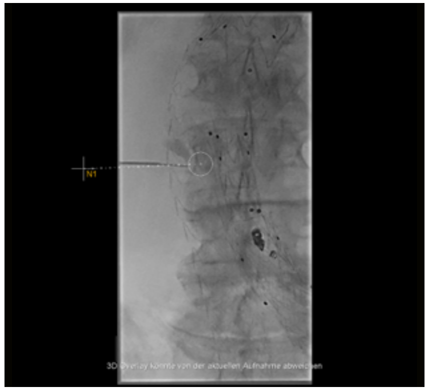
Tips and tricks
No additional contrast injection was needed for the DynaCT run when registering the preprocedural CT volume.

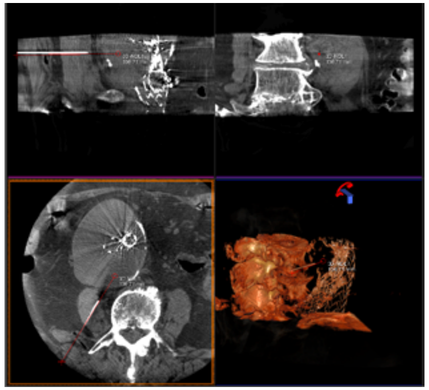
Acquisition protocol	**5sDCT Body**
Injection protocol	
Contrast medium (CM)	None

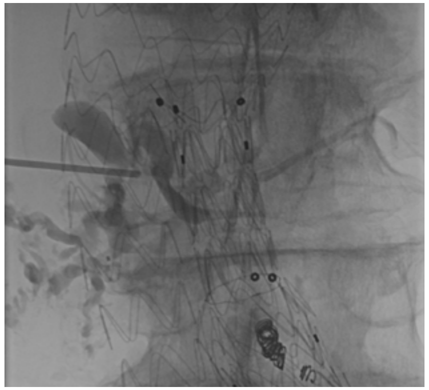
Acquisition protocol	**5s DCT Body in slab mode**
Injection protocol	
Contrast medium (CM)	None
Collimation	Collimation to 9 cm craniocaudal extension

Reconstructions	**For both DynaCT runs**
Name	DynaCT Body Nat Fill
VOI size	Full
Slice matrix	512 × 512
Kernel type	HU
Image characteristics	Normal
Reconstruction mode	Nat Fill
Viewing preset	DynaCT Body


Planning of needle path (CT volume fused with DynaCT volume)


Fluoro image with graphical overlay of planned needle path


Verification of needle position using a collimated DynaCT run


Verification of needle position in nidus of endoleak

syngo DynaCT of the pulmonary arteries

syngo DynaCT can provide additional information about chronic embolism by depicting web stenoses and occlusions.

Courtesy of	B. Meyer, MD, Institute for Diagnostic and Interventional Radiology, Medical School Hannover, Germany
Supported by	*syngo* DynaCT
System & Software	Artis Q ceiling VD10, *syngo* X Workplace VC10

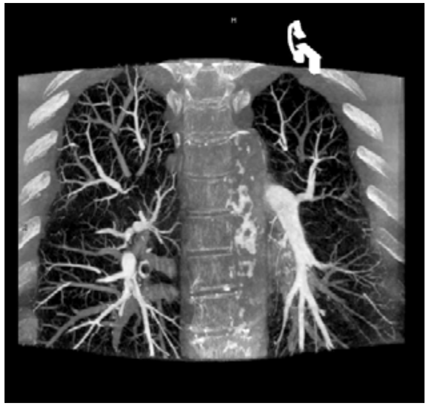
Patient history
Patient with history of recurrent pulmonary embolism and chronic thromboembolic pulmonary hypertension (CTEPH). Pulmonary angiogram and *syngo* DynaCT were acquired for diagnostic work-up.

Diagnosis
CTEPH with perfusion defects and web stenoses mainly in the right lung.

Treatment
Diagnostic workup.

General comments
Pulmonary angiograms are still the established gold standard for diagnostic workup in patients with CTEPH. *syngo* DynaCT can provide additional information about chronic embolism by depicting web stenoses and occlusions.

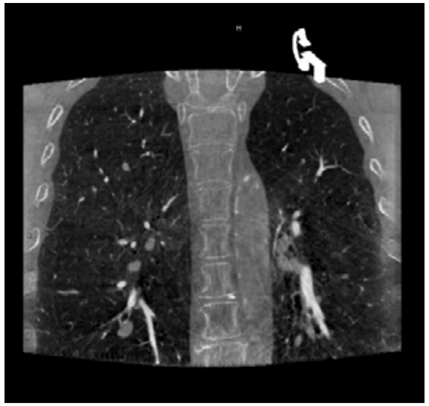
Tips and tricks
Selective *syngo* DynaCT imaging can be performed in case of insufficient contrast using a central catheter position.


Thick MIP 23 mm – Web stenosis in lower right lobe (white arrow)

Acquisition protocol	**6sDCT Body**
Injection protocol	
Catheter position	Central catheter position
Contrast medium (CM)	300 mg iodine/mL
Dilution	70%
Injection volume	60 mL
Injection rate	8 mL/s
Duration of injection	7.5 s
X-ray delay	1.5 s
Power injector used	Yes

Reconstructions	**Primary**
Name	DynaCT Body Nat Fill HU
VOI size	Full
Slice matrix	512 × 512
Kernel type	HU
Image characteristics	Normal
Reconstruction mode	Nat Fill
Viewing preset	DynaCT Body


Thick MIP 23 mm – Small Web stenosis in left lobe (white arrow)


Thin MPR

Balloon angioplasty in CTEPH

For *syngo* iFlow no separate DSA runs are necessary

Courtesy of	Jan Hinrichs, MD, Institute for Diagnostic and Interventional Radiology, Hannover Medical School, Germany
Supported by	*syngo* iFlow
System & Software	ARTIS pheno VE1 with *syngo* Application Software VD2

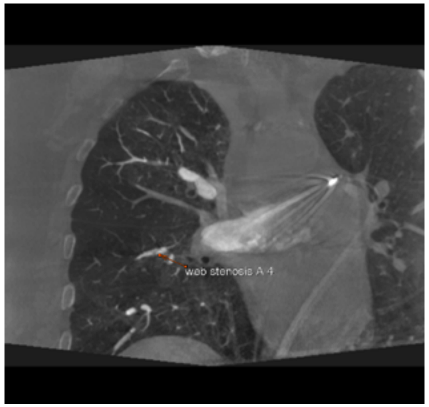
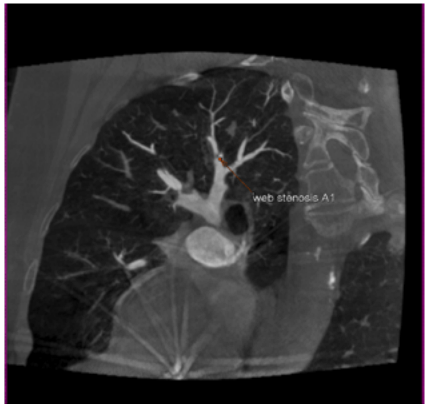
Patient history
74-year-old female patient with history of recurrent pulmonary embolism and chronic thromboembolic pulmonary hypertension (CTEPH).

Diagnosis
CTEPH with perfusion defects.

Treatment
In the third balloon angioplasty procedure, we focused on the right middle and right upper lobe.

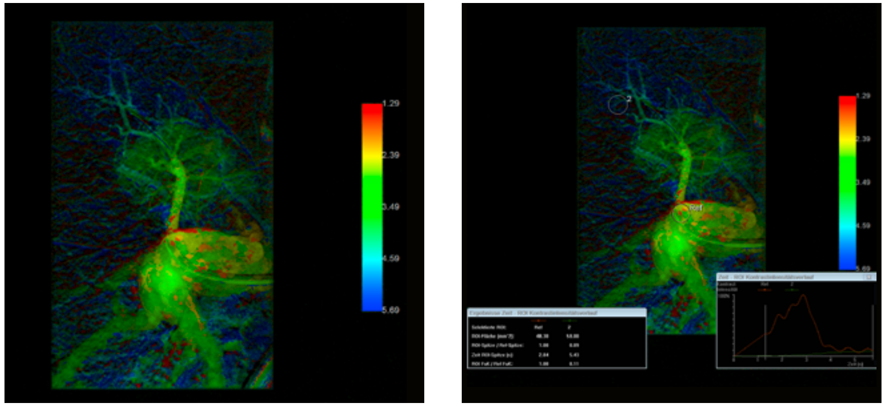
General comments
With *syngo* iFlow we were able to visualize the improvement of peripheral filling of the treated vessels. ROIs create contrast concentration versus time curves.

Tips and tricks
For the use of *syngo* iFlow, 4 F/s DSA run is sufficient. No separate DSA runs are necessary. Coordinate timing of injection for direct pre- and posttreatment comparison.

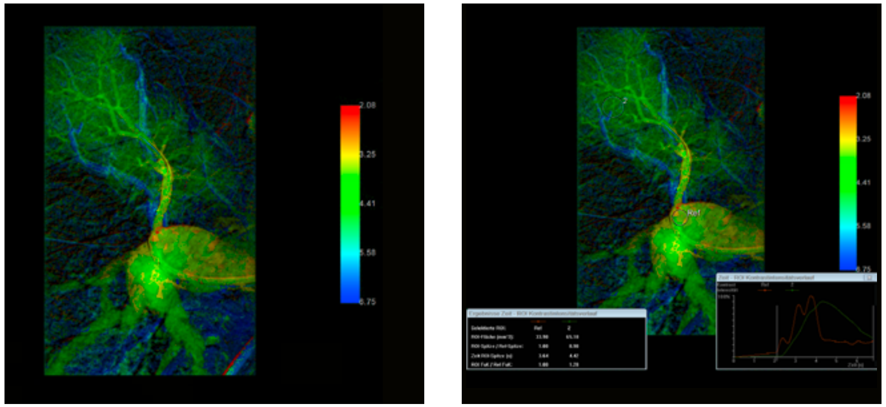



Web stenoses visible on *syngo* DynaCT images

Acquisition protocol	**DSA 4 F/s ~27 frames**
Injection protocol	
Catheter position	Upper right lung lobe artery
Contrast medium (CM)	300 mg iodine/mL
Dilution	60%
Injection volume	8 mL
Injection rate	Hand injection
Duration of injection	7 s
X-ray delay	Injection starts right after mask image
Power injector used	None



syngo iFlow before angioplasty



syngo iFlow after angioplasty visualizes the improvement of peripheral blood flow

syngo DynaCT 360 with IV injection used for TIPS planning

A non-invasive contrast-enhanced (intravenous injection) *syngo* DynaCT was deemed as the best choice due to the lack of previous conventional CT.

Courtesy of	Ulf Teichgräber, MD, Renè Aschenbach, MD, Department of Diagnostic and Interventional Radiology, Jena University Hospital, Germany
Supported by	*syngo* DynaCT 360
System & Software	Artis zeego with Q technology VD10, *syngo* X Workplace VC10

Patient history
48-year-old female patient; liver cirrhosis.

Diagnosis
Ascites and portal hypertension with esophageal varices and bleeding.

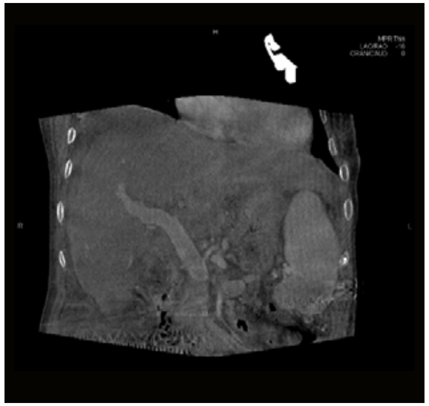
Treatment
TIPS procedure.

General comments
Portal vein patency is crucial for TIPS procedure. Due to a missing preprocedural contrast enhanced CT study, a *syngo* DynaCT 360 with intravenous contrast injection was performed to evaluate patency of portal vein.

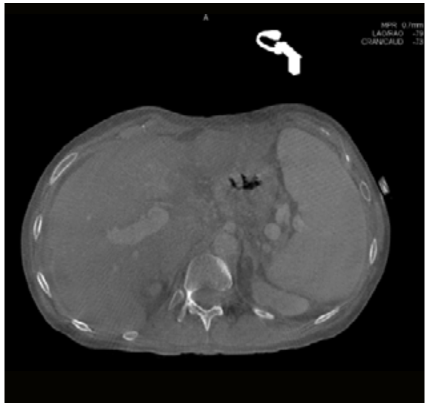
Tips and tricks
syngo DynaCT 360 offers more coverage compared to conventional cone-beam CT to evaluate portal vein, hepatic vein and other vascular structures in the abdomen.

Acquisition protocol	**6s Large Volume 360°**
Injection protocol	
Catheter position	Antecubital vein
Contrast medium (CM)	370 mg iodine/mL
Dilution	None
Injection volume	80 mL
Injection rate	3 mL/s
Duration of injection	26.6 s
X-ray delay	40 s
Power injector used	Yes

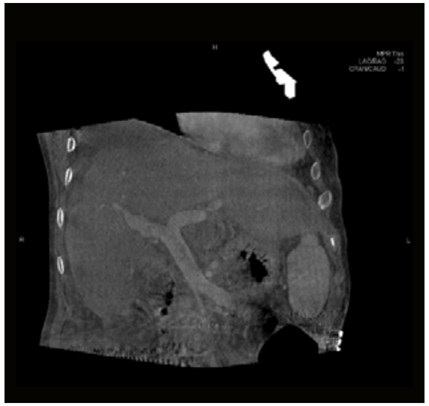
Reconstructions	**Primary**
Name	DynaCT Body Nat Fill HU
VOI size	Full
Slice matrix	512 × 512
Kernel type	HU
Image characteristics	Normal
Reconstruction mode	Nat Fill
Viewing preset	DynaCT Body



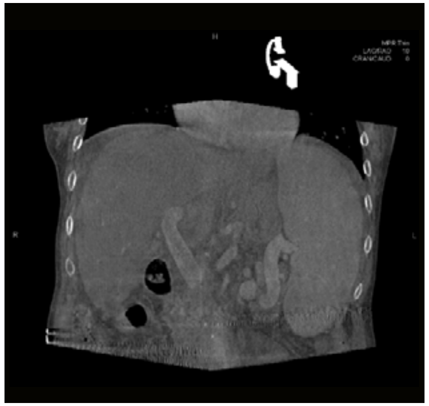
MPR thin coronal portal vein[1]



MPR thin axial right portal vein[1]



MPR thin coronal portal vein[1]



MPR thin coronal splenic vein and collaterals[1]

[1] *Artifacts visible due to ruler taped to patient skin.*

TIPS placement facilitated by CO_2 *syngo* Dyna3D and guided by *syngo* Toolbox

Anything that can help guide the portal vein puncture has the potential to reduce procedure dose and the number of punctures needed.

Courtesy of	Eric J Hohenwalter, MD, FSIR, Sarah White, MD, MS, Department of Radiology, Division of Vascular & Interventional Radiology, Medical College of Wisconsin, Milwaukee, WI, USA
Supported by	• *syngo* Dyna3D • *syngo* Toolbox • *syngo* 3D Roadmap
System & Software	Artis zee ceiling VC21, *syngo* X Workplace VB21

Patient history
A 60-year-old female with nonalcoholic steatohepatitis (NASH) cirrhosis and refractory ascites.

Diagnosis
The patient was transferred to the Interventional Radiology Department for transjugular portosystemic shunt (TIPS) insertion.

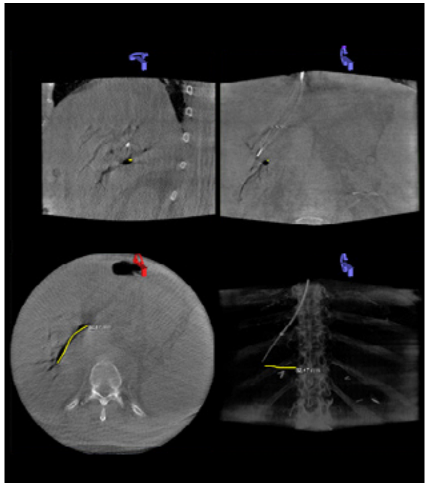
Procedure description
The right hepatic vein was selected via right transjugular vein access. Hepatic venography was performed, demonstrating a normal confluence of the hepatic veins. Wedged CO_2 portal *syngo* Dyna3D venography was then performed with images showing normal portal venous anatomy. A target was chosen within the right main portal vein, near the main portal vein bifurcation and marked using *syngo* Toolbox. These graphics were overlaid on live fluoroscopy for intraprocedural guidance. Surgical clips were also marked with *syngo* Toolbox to monitor liver motion and misregistration due to respiration or patient movement. A Colapinto needle was placed using the overlaid portal vein marking as a reference, followed by a glidewire. After the DSA portography acquisition, the GORE® VIATORR® stent was deployed.

General comments
One of the most difficult aspects of performing a TIPS is the portal vein puncture. Anything that can help guide this puncture has the potential to decrease the procedure time, fluoro time, and, most importantly, decrease the number of punctures needed. *syngo* Toolbox was extremly helpful in this case.

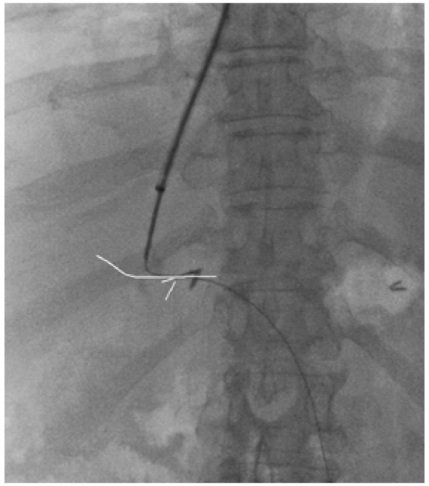
Tips and tricks
Typically, a 2D CO_2 portogram is performed – standard of care for TIPS cases – prior to the 3D acquisition to confirm that the portal veins will fill, and to avoid the additional radiation if they do not. Reasons for inadequate portal vein opacification include hepatic venous collaterals and inadequate balloon inflation. The CO_2 injection is timed to be coincident with C-arm motion rather than with the spin “trigger”. The acquisition is triggered first and the injection of CO_2 is then administered when the C-arm begins to move. The reason for this is that it is difficult to keep the veins opacified for 5 seconds if the injection is started too early using a 60 mL syringe.

Acquisition protocol	**5sDR Body**
Injection protocol	
Catheter position	Proximal right hepatic vein
Contrast medium (CM)	CO_2
Dilution	None
Injection volume	60 mL
Injection rate	Manual injection
Duration of injection	5 s
X-ray delay	None (injection is coincident with start of C-arm rotation)
Power injector used	None

Reconstructions	**Primary**
Name	3D Body Nat Fill HU
VOI size	Full
Slice matrix	512 × 512
Kernel type	HU
Image characteristics	Normal
Reconstruction mode	Nat Fill
Viewing preset	DynaCT Soft Tissue

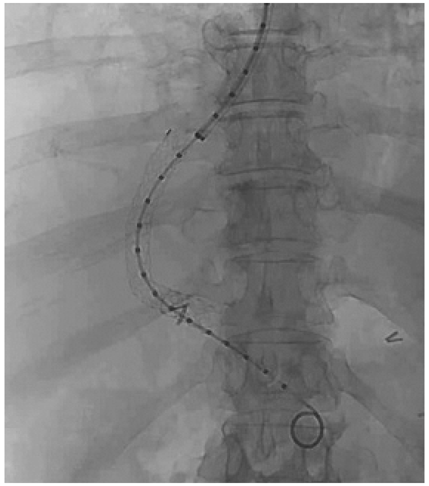


CO_2 *syngo* Dyna3D showing the portal vein and *syngo* Toolbox graphics (yellow)



AP fluoroscopy image showing the *syngo* Toolbox overlay after successful portal vein access

Conventional portal venogram



Non-subtracted image from a DSA acquisition showing the successfully deployed TIPS stent

syngo Dyna3D DSA imaging of right hip after surgery

A *syngo* DualVolume visualization was used to show vessels in relation to the anatomical structures to find the bleeding.

Courtesy of	A.D. Montauban van Swijndregt, MD, OLVG, Amsterdam, Netherlands
Supported by	*syngo* Dyna3D
System & Software	Artis Q ceiling VD10, *syngo* X Workplace VC10

Patient history
Arterial bleeding after Gamma nail insertion in right hip.

Diagnosis
Immediately after surgery there was swelling of the upper leg. Deep femoral artery bleeding was suspected. CT angio showed a blush in muscle and the patient was transferred to the angio suite for exact localization of the bleeding and further treatment.

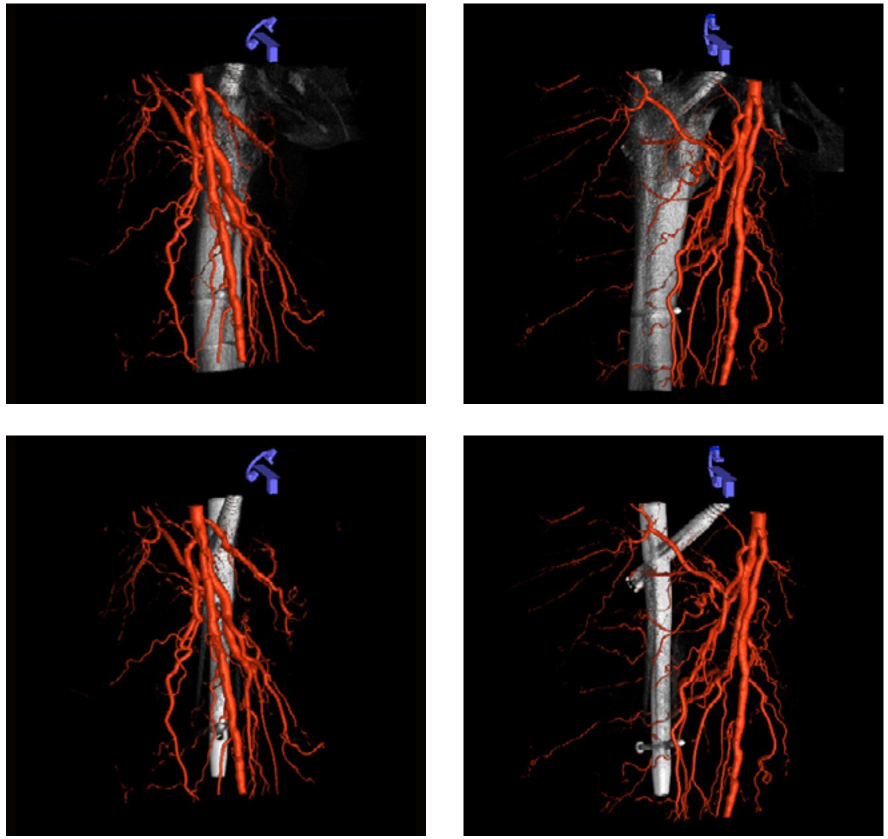
Procedure description
A *syngo* Dyna3D DSA run was performed and after fully automized reconstruction of all volumes, visualized in *syngo* DualVolume mode to show vessels in relation to the anatomical structures to find the bleeding. The bleeding had stopped in the meantime, so treatment was not necessary.

General comments
Due to the metal artifacts of the Gamma nail we decided for a high-contrast Dyna3D DSA run, rather than using a soft-tissue *syngo* DynaCT run.

This turned out to be a nice 3D volume, and even nice MPR views of the bony tissue.

Acquisition protocol	**5sDSA Body**
Injection protocol	
Catheter position	Selective in arteria iliaca communis
Contrast medium (CM)	270 mg iodine/mL
Dilution	None
Injection volume	24 mL
Injection rate	4 mL/s
Duration of injection	6 s
X-ray delay	1 s
Power injector used	Yes

Reconstructions	**Primary**
Name	Dyna3D DSA Dual Body
VOI size	Full
Slice matrix	512 × 512
Kernel type	EE for sub volume/ HU for mask volume
Image characteristics	Auto
Reconstruction mode	Dual
Viewing preset	DualVolume



syngo DualVolume – Combines the reconstruction of mask run with the subtracted reconstruction to show vessels in relation to bones in any angulation

Peripheral angiography using CO_2

Artis zeego with variable isocenter is very helpful in CO_2 cases as it travels easily along the tilted table.

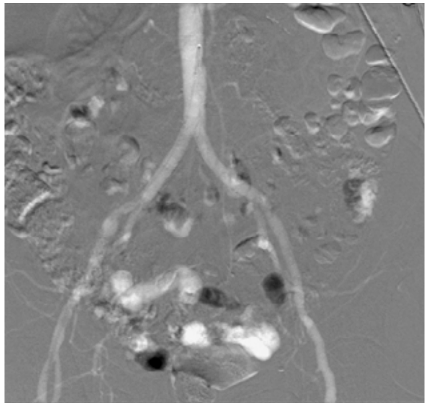
Courtesy of	Ulf Teichgräber, MD, Renè Aschenbach,MD, Department of Diagnostic and Interventional Radiology, Jena University Hospital, Germany
Supported by	CO2 evenflow
System & Software	Artis zeego with Q technology VD10, *syngo* X Workplace VC10

Patient history
74-year-old female patient. Occlusive peripheral artery disease. Patient did not want bypass surgery. Renal insufficiency Grade III (severely limiting the use of contrast media).

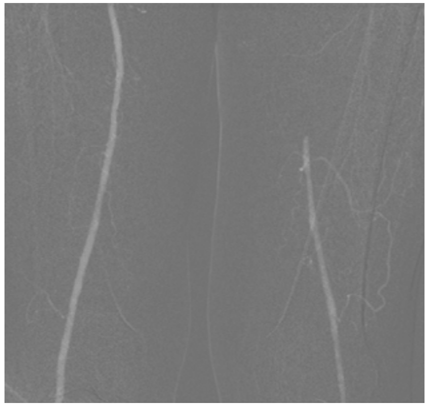
Diagnosis
Fontaine IIb. Left superficial femoral artery is occluded in the proximal third and there is distal filling via collaterals.

Treatment
Laser atherectomy followed by PTA with drug-eluting balloon. VIABAHN stent graft placed.

General comments
CO_2 evenflow acquisition technique provides high image quality. High k-factor creates more homogeneous, bubble-free visualization of vessels.



Min OPAC – Iliac arteries

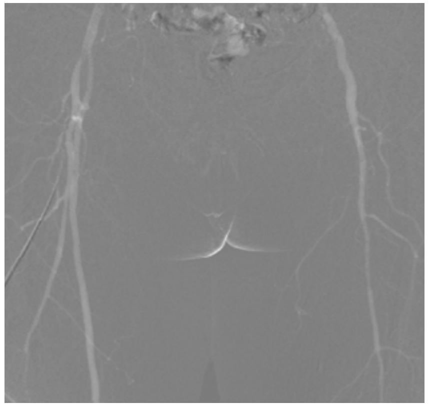


Min OPAC – Vessels below occlusion show collateral filling

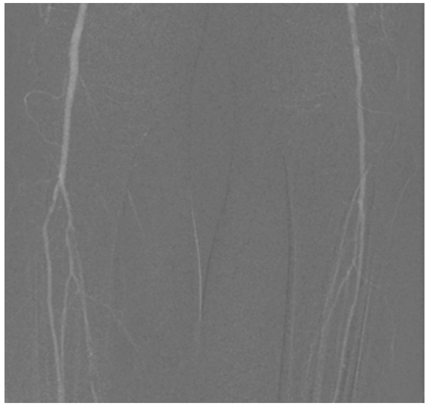
Acquisition protocol	DSA CO_2 Evenflow
Frame rate	7.5 f/s (higher frame rate, low dose/f, high k-factor)
Length of sequence	20 s max

Injection protocol	
Catheter position	Distal abdominal artery
Contrast medium (CM)	CO_2 1.3 bar
Dilution	None
Injection volume	80 mL for each angiography step/for intervention 20 mL CO_2
Injection rate	Manual
Duration of injection	Manual
X-ray delay	Injection starts right after mask selection (~4th frame)
Power injector used	Optimed CO_2 system

Image Postprocessing	
Pixel Shift	Automatic
Min OPAC	Yes



Min OPAC – Femoral arteries



Min OPAC – Occlusion in left superfic. femoral artery

Real-time assessment of revascularization of peripheral vascular disease

The functional information gathered by *syngo* iFlow was very valuable for choosing the right treatment strategy for the next step.

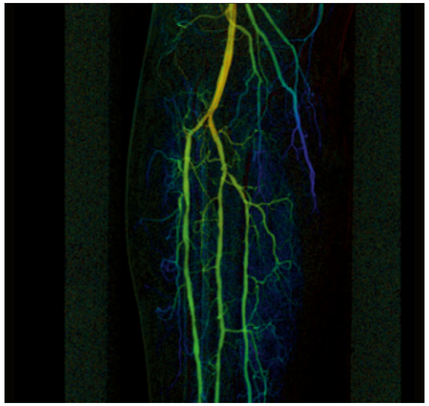
Courtesy of	Jianping Gu, MD, Wensheng Lou, MD, Department of Interventional Radiology, Nanjing No. 1 Hospital, China
Supported by	*syngo* iFlow
System & Software	Artis zee VC14, *syngo* X Workplace VB21

Patient history
A 75-year-old male patient with 8-year history of hypertension suffered from low extremity arterial occlusive disease. Implantation of a stent 3 years prior, presenting with severe pain and numbness in his right lower limb.

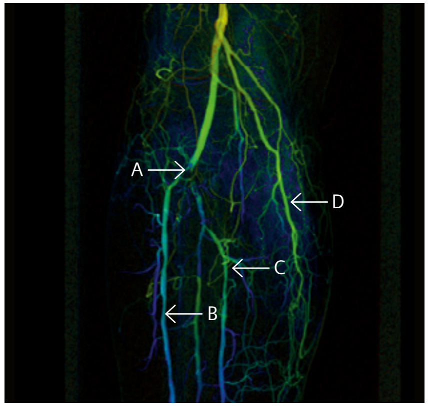
Diagnosis
The middle and upper segments of the right superficial femoral artery were occluded, while the lower segment still showed sufficient perfusion due to collateral flow. The popliteal, peroneal, anterior tibial, and posterior tibial arteries were not obstructed but presented with localized plaque formations. A severe stenosis existed at the bifurcation of the posterior tibial artery.

Treatment
A balloon dilatation and subsequent thrombolysis therapy were performed at the upper segment of the right superficial femoral artery. 2 stents (6x150 mm, Protege, EV3) were implanted into the right superficial femoral artery to reopen the vessel.

Acquisition protocol	**DSA 2 f/s**
Injection protocol	
Catheter position	Not specified
Contrast medium (CM)	320 mg iodine/mL
Dilution	None
Injection volume	8 mL
Injection rate	3 mL/s
Duration of injection	2.6 s
X-ray delay	None
Power injector used	Yes

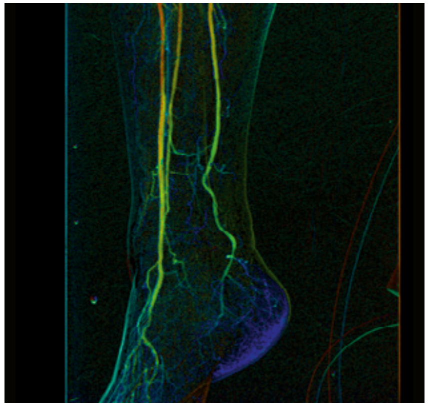


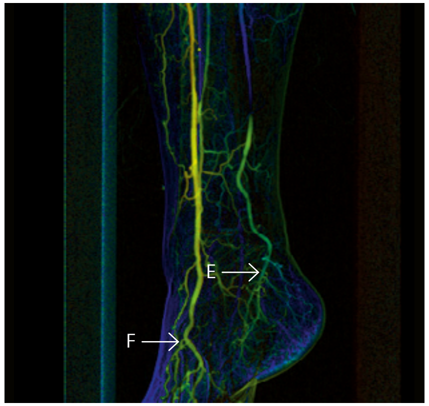
syngo iFlow image before treatment of the stenosed superficial femoral artery



During stenting of the superficial femoral artery an occlusion of the popliteal bifurcation was caused by an embolus (A)

syngo iFlow shows the hemodynamic changes in the distal vessels. Time-to-peak (TTP) analysis based on the *syngo* iFlow images showed an increased flow in a collateral branch (D) ↓ 2.5 s. At the same time blood flow within the anterior (B) ↑ 2.5 s and posterior tibial arteries (C) ↑ 1.5 s slowed down





TTP shows that (E) the blood flow in the malleolar artery was almost the same as before (TTP ↑ 0.5 s) and that (F) the blood flow in the dorsalis pedis artery was improved (TTP ↓ 3.5 s)

syngo iFlow measurement shows improved distal blood flow after intervention despite the embolus

Click here to find more protocols!

↗ Clinical Specialty Educational Resources

Orthopedic

Arthrography of lunatomalacia of the right wrist using *syngo* DynaCT Micro

Courtesy of Jan Hinrichs, MD Institute for Diagnostic and Interventional Radiology, Hannover Medical School, Germany

Supported by *syngo* DynaCT Micro

System & Software Artis pheno VE 10, *syngo* Appplication Software VD2

Patient history
27-year-old female with grade 4 lunatomalacia of the right wrist with chronic pain. Radial shortening surgery performed in 2015.Diagnosis Benign prostate hyperplasia and acute urinary retention.

Procedure description
Arthrography of right wrist for diagnostic workup. Detailed imaging of the articular cartilage.

Injection of iodine contrast in the distal radioulnar joint, the midcarpal row, and the radioulnar joint following fluoroscopy guided puncture.

syngo DynaCT Micro cone beam CT (CBCT) scan in Zoom 3.

Known grade 4 lunatomalacia with destruction of os lunatum.

Incomplete filling of the radiocarpal joint, most likely due to adhesions of the joint in the ulnar parts.

General comments
The high spatial resolution of *syngo* DynaCT Micro allows us to visualize all anatomical structures of the human wrist in detail.

It is easy to diagnose cartilage damage or pathologies in the bony structures.

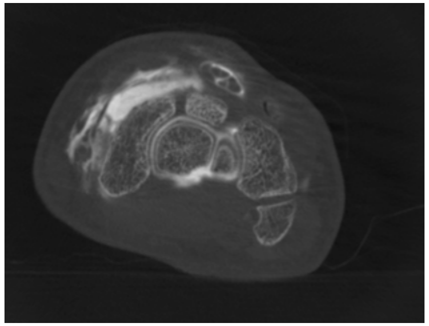
Tips and tricks
To acquire a CBCT scan of the wrist, special positioning of the patient is necessary.

The patient should lie in a prone position with the arm extended overhead ("Superman" position) and the other arm down alongside the trunk.

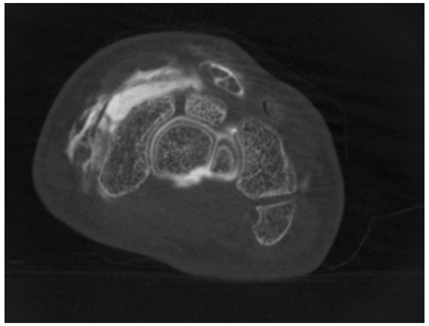
Acquisition protocol	**6sDCT HeadMicro (Zoom 3)**	
Injection protocol		
Catheter position	Intraarticular	
Contrast medium (CM)	300 mg iodine/mL	
Dilution (CM/Saline)	N/A	
Injection volume	8 mL	
Reconstructions	**Primary**	**Secondary**
Name	DCT Head Clear	DCT Head Clear
VOI size	Manual	Manual
Slice matrix	512 × 512	512 × 512
Kernel type	HU	HU
Image characteristics	Normal	Sharp
Reconstruction mode	Nat Fill	Nat Fill
Viewing preset	DCT Head	DCT Head

Coronal MPR – primary reconstruction

Coronal MPR – secondary reconstruction



Axial MPR – primary reconstruction



Axial MPR – secondary reconstruction

Overview of Advanced Applications

3D/Advanced 3D	
syngo Dyna3D	performs a rotation around the patient, acquiring from different angles.
syngo Dual Volume	Simultaneous visualization of dual-volume imaging (e.g. stent and contrast-enhanced vessels).
syngo DynaCT	the C-arm rotates around the area of interest, which is placed in the isocenter. The dedicated enhanced cone-beam reconstruction algorithms reconstructs a low-contrast three-dimensional image, visualizing soft tissue.
syngo Dyna4D	With this rotational aquisition a virtually unlimited number of DSA runs at no additional dose and contrast medium is provided. You can now see flow patterns in 3D.
syngo Dyna3D HighSpeed*	Provides a fast high contrast 3D protocol of less than 3 s, repre-sented with reduced motion artifacts and less contrast media.
syngo DynaCT Large Volume**	By rotating twice around the patient with a small shift of the C-arm, ARTIS pheno is able to cover a larger field of view than a standard *syngo* DynaCT protocol.
syngo DynaCT 360**	Provides a fast large-volume acquisition protocol in only six seconds. This protocol rotates the C-arm by 360 degrees once along an elliptical path.
syngo DynaCT Micro	Provides high spatial resolution 3D imaging, by using each detector pixel. 40 % higher resolution compared to a standard *syngo* DynaCT
syngo DynaPBV Body	is an imaging protocol specifically designed for the abdomen and provides functional information before and after interventional therapy.
syngo DynaPBV Neuro	are 3D functional imaging acquisition protocols that provide physiological information of the patient intraoperatively.
syngo DynaCT Sine Spin	*syngo* DynaCT Sine Spin helps neuroradiologists to detect bleedings in the interventional suite, especially when imaging the basal part of the brain and close to the skull.
syngo DynaCT Multiphase	*syngo* DynaCT Multiphase makes it possible to visualize collateral vessels with time-resolved DynaCT, depicting up to 10 different time points within a period of 60 seconds.

* *only possible with Artis zeego, ARTIS pheno or ARTIS icono systems*
** *only possible with Artis zeego or ARTIS pheno systems*

Advanced tools and workflows	
syngo 3D Roadmap	superimposes 3D objects and/or the 3D image colorcoded on top of the live X-ray. It provides real-time guidance to the physician.
syngo Fusion package	With the *syngo* Fusion package pre-procedural images from CT, MR and PET-CT can be imported and fused to live fluoroscopy.
syngo 2D/3D Fusion	only two fluoro projections are required to easily fuse 3D volumes from other imaging modalities for live image guidance.
syngo3D/3D Fusion	aligns two 3D volumes from the same or different modality. Any *syngo* DynaCT or *syngo* Dyna3D image can be fused with datasets from e.g., CT, MR or PET.
syngo Toolbox	is a generic application to interactively mark anatomical structures of interest in a 3D volume, e.g. a *syngo* DynaCT image, using points and lines.
syngo DynaCT SMART	This Streak Metal Artifacts Reduction Technology reduces metal artifacts through a secondary reconstruction.
syngo Needle Guidance	the operator can plan a needle-based procedure in a 3D volume by specifying a target and multiple trajectories for needles or any other rigid instruments.
syngo Embolization Guidance	is an application for advanced embolization planning and guidance.
syngo iFlow	*syngo* iFlow allows the visualization of a DSA run in one single image by color-coding time and intensity of maximum opacification.
syngo 3D Stenosis Measurement	allows analyzing a 3D segment in a 3D volume and calculates all relelvant data of a stenosis (minimum diameter, maximum diameter, and area of the vessel's stenosis cross-section)
syngo 3D Aneurysm Guidance Neuro	With three simple mouse clicks, a cerebral aneurysm and its parent vessels are segmented and provides you with all the relevant data of an aneurysm (parent vessel dimensions, volume, ostium, etc.)
syngo Neuro Virtual Stent	is a planning tool that provides a 3D virtual intracranial stent.

For more information about our Artis and Workplace Applications visit us online at:
siemens-healthineers.com/angio

Contact
Angelika.Hench@siemens-healthineers.com

Find more study protocols and valuable information online:

↗ Clinical Specialty Educational Resources

Siemens Healthineers Headquarters
Siemens Healthcare GmbH
Henkestr. 127
91052 Erlangen, Germany
Phone: +49 9131 84-0
siemens-healthineers.com

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