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Study Protocol Book

for ARTIS systems in
Interventional Neuroradiology

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Dear Reader,

In neurointerventional radiology, sharing clinical expertise is key to advancing patient care, procedural excellence, and innovation. When experienced specialists exchange insights, practical approaches, and decision-making strategies in complex cerebrovascular cases, the entire neurointerventional community benefits.

Our Study Protocols series has been developed to provide precisely this platform for peer-to-peer knowledge sharing — by experts, for experts. These protocols offer you practical guidance, workflow recommendations, and relevant real-world experience across a range of neurointerventional procedures and imaging strategies.

Our aim is to support your entire team by enhancing daily clinical workflows, strengthening procedural confidence, and developing neurointerventional practice. The protocols also serve as a valuable reference for routine and complex clinical scenarios alike.

We sincerely thank all the contributors who generously shared their protocols, expertise, and clinical experience.

If you'd like to contribute your own protocols or clinical insights, please contact us.

Best wishes,

Angelika Hench,

Customer Excellence
Advanced Therapies

Thank you

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

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Content

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Neuro interventions

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.

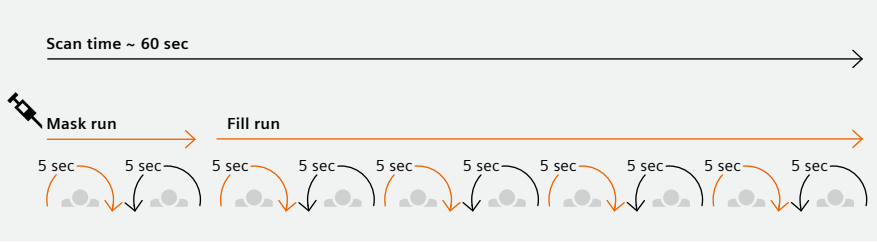
Diagnosis
M1 occlusion on the left side on the basis of an underlying intracranial atherosclerotic stenosis.

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.

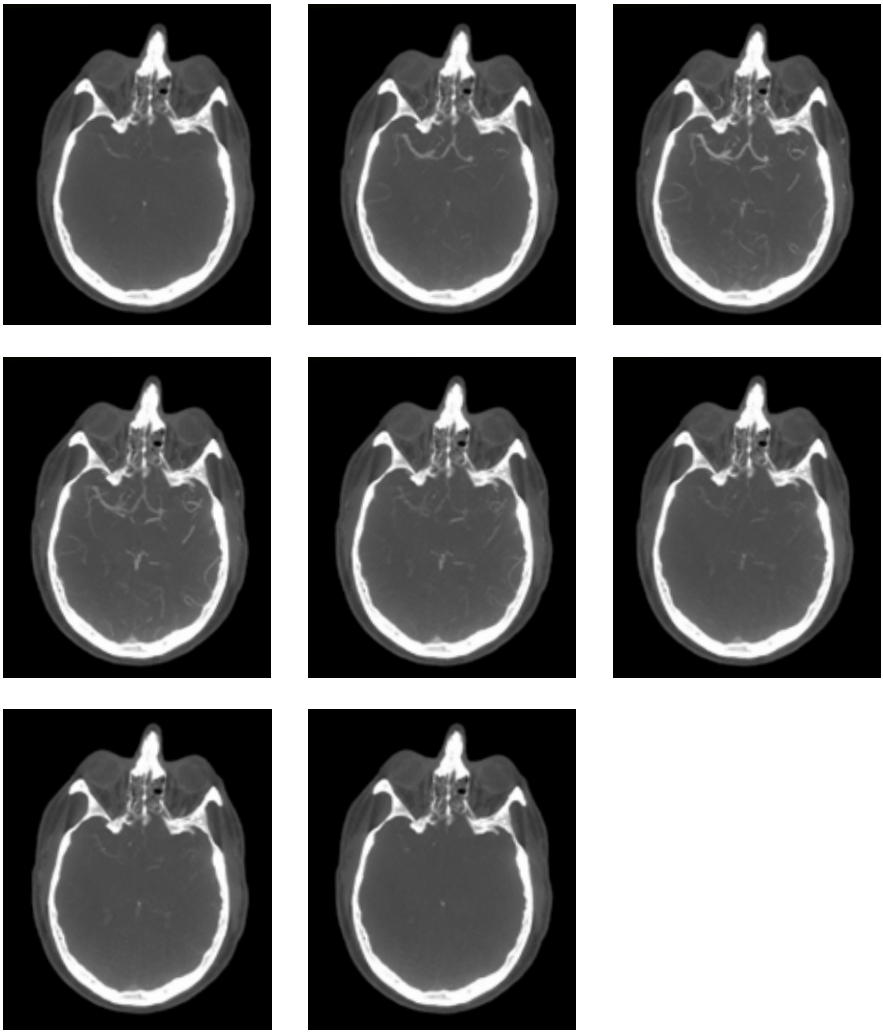
** Third party software required.*

Graphical representation shows workflow including two mask runs

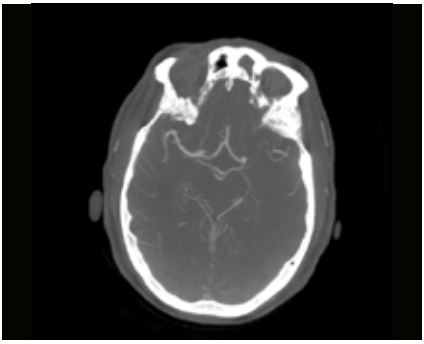


Acquisition protocol	**60sDCT Multiphase**
Injection protocol	
Catheter position	antecubital 18G venous line
Contrast medium	300 mg/mL iodine
Dilution	None
Injection volume	50 mL contrast media followed by 40 mL saline chaser
Injection rate	5 mL/s CM and saline
Duration of injection	18 s
X-ray delay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

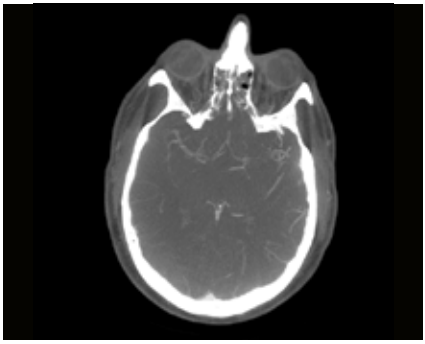
Initial *syngo* DynaCT Multiphase run before thrombectomy



Fill run 1–8, 10 mm MIP slices

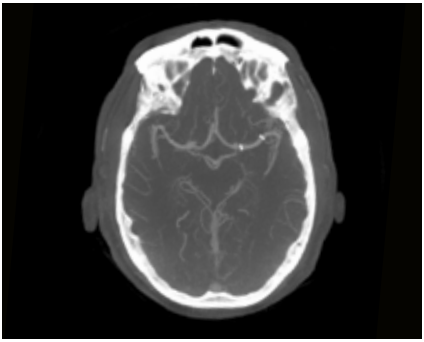


Visualization of M1 occlusion. Fill run 4, MIP 10 mm

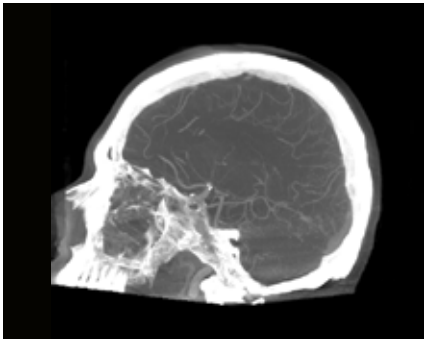


Visualization of potential collaterals in later phase. Fill run 6, MIP 10 mm

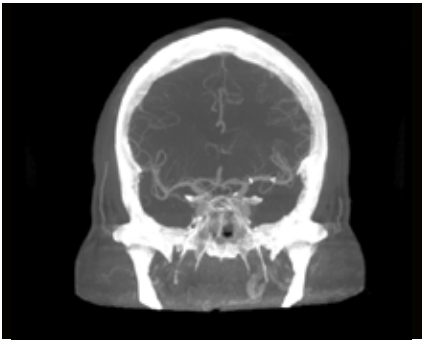
Post-thrombectomy and stent placement



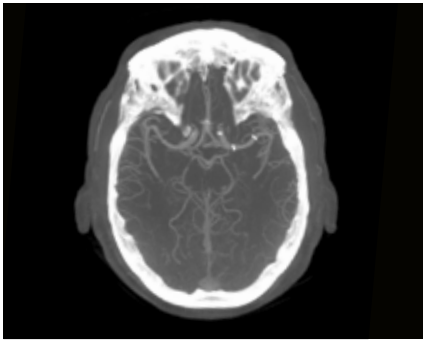
MIP 10 mm transversal



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

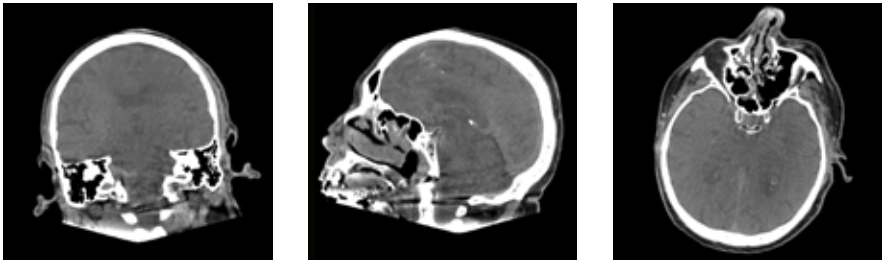
Diagnosis
CTA in another hospital showed an acute occlusion of the left MCA (middle cerebral artery) in the M1 segment.

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

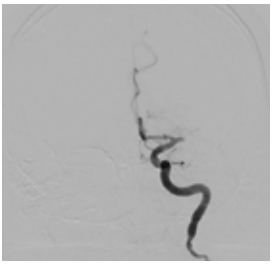


MPR 0.5 mm

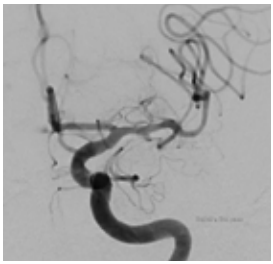
Acquisition protocol	7sDCT Sine Spin - for pre- and post-interventional run
Injection protocol	
Contrast medium (CM)	N/A

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

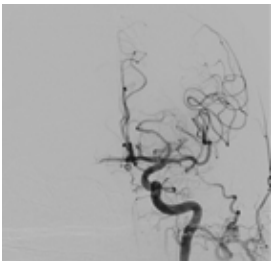
DSA imaging during intervention



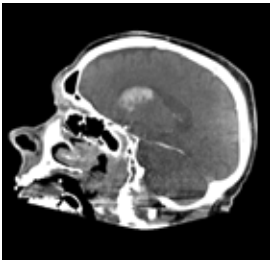
MCA occlusion

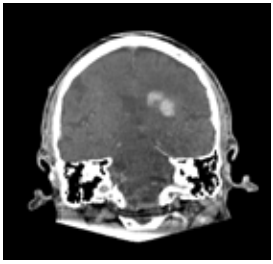


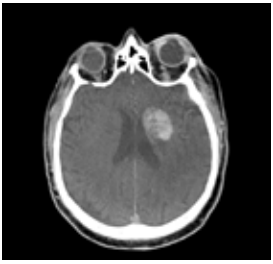
After first pass



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.

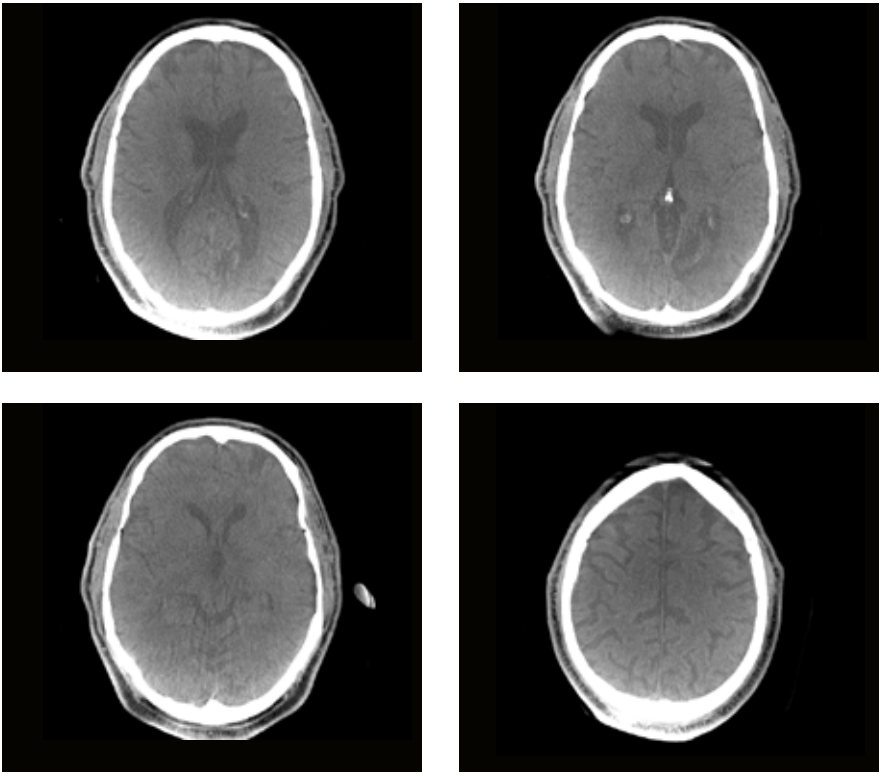
We timed the first phase of the FDCTA scan after a bolus-tracked digital subtraction angiography (the contrast agent must be visible in the intracranial internal carotid artery), while the second phase was acquired automatically with a delay of 5 s. The first phase shows the occlusion of the arteria 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.

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



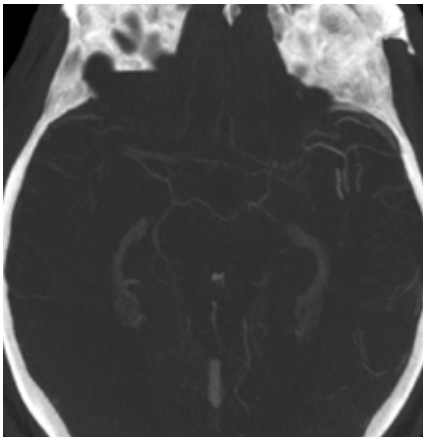
DCT native, check for severe bleeding. 1–4 Thin MPRs from skull base to skull cap

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

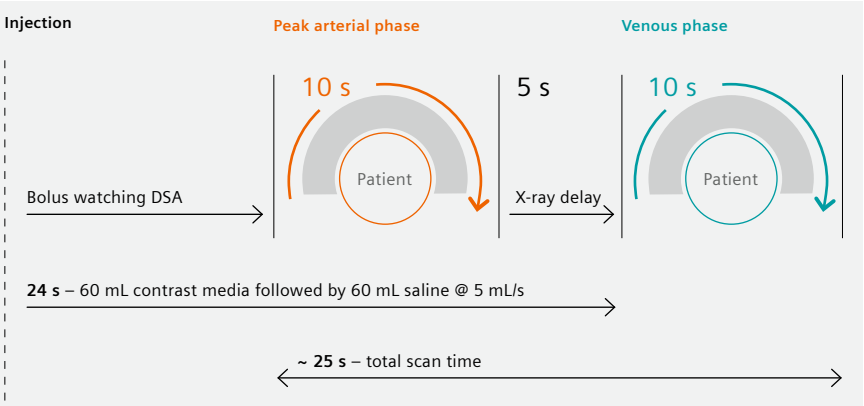
Reconstructions	**Primary**
Name	DCT Head Clear for 1st and 2nd rotation
VOI size	Full
Slice matrix	512 × 512
Kernel type	HU
Image characteristics	Normal
Reconstruction mode	Nat Fill
Viewing preset	DCT Head

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

Large vessel occlusion of the left MCA

Courtesy of	Rahul Kumar, MD GS Neuroscience Clinic, Patna, Bihar, India
Supported by	*syngo* Dyna3D, *syngo* DualVolume
System & Software	ARTIS icono biplane VE20 with *syngo* Application Software VE20

Patient history
A 48-year-old male presented with transient weakness (complete hemiparesis). Stroke onset 13 hours ago.

Diagnosis
CT images showed a large vessel occlusion in the left middle cerebral artery (MCA).

Treatment
The patient was immediately transferred to Angio for a thrombectomy procedure. The occlusion of the left MCA was confirmed in DSA imaging. After acquiring *syngo* Dyna3D runs from both sides, it was found that the MCA occlusion was resolved by collateral filling. The patient's stroke symptoms improved immediately. It was decided not to proceed with the thrombectomy procedure.

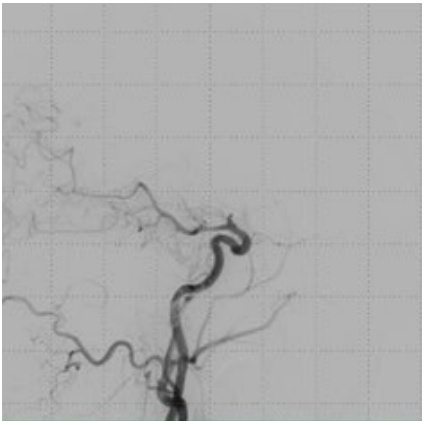
General comments
syngo Dyna3D/3D Fusion can achieve a good overview of the 3D volumes injected from either side.

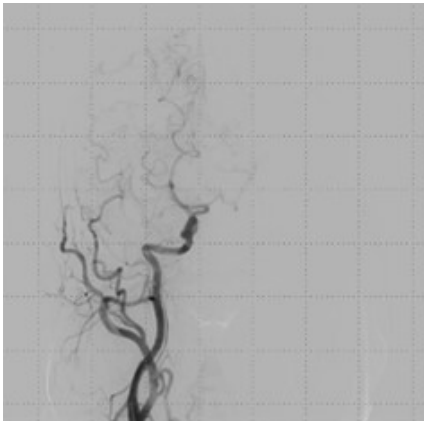
Tips and tricks
It is essential to use an X-ray delay to ensure constant filling of the complete vessel structure. Ensure that the patient's head is properly fixed. If the patient is not sedated, inform them about the procedure steps to ensure maximum cooperation and avoid movement during the 3D runs.

Acquisition protocol	4s DSA Dyna3D Head for both sides
Injection protocol	
Catheter position	Common carotid artery
Contrast medium (CM)	300 mg/mL
Dilution	100%
Injection volume	18 mL
Injection rate	3 mL/s
Duration of injection	6 s
X-ray delay	2 s
Power injector used	Yes

Reconstructions	Primary	Secondary
Name	3D Head Sub Full	3D Head Nat Fill Full
VOI size	Full	Full
Slice matrix	512 x 512	512 x 512
Kernel type	EE	HU
Image characteristics	Auto	Auto
Reconstruction mode	Sub	Nat
Viewing preset	3D Angio	3D Angio

DSA

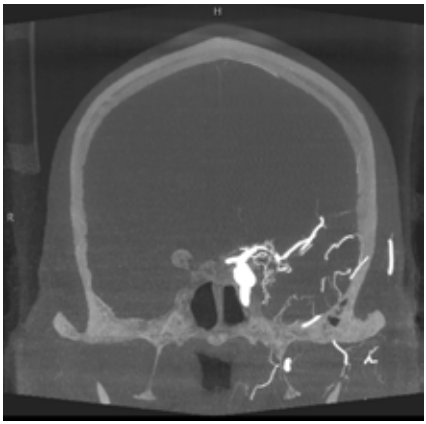


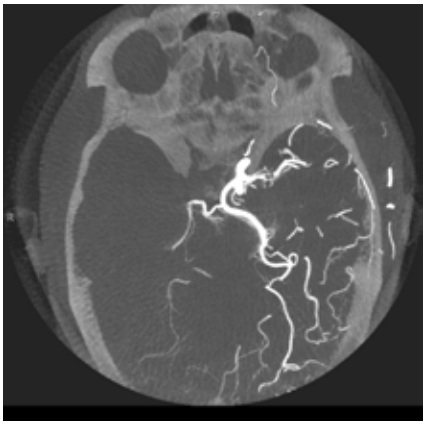


Completely occluded left MCA.

MIP

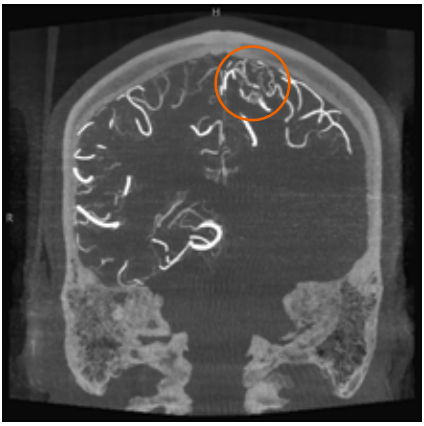
Injection in right common carotid artery.





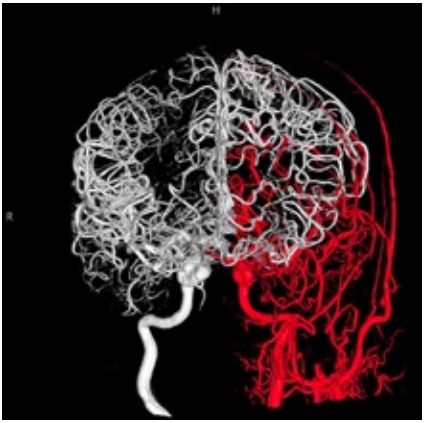
Injection in left common carotid artery.

MIP



Demonstration of the leptomeningeal collaterals.

VRT



syngo DualVolume visualization after *syngo* 3D/3D Fusion of both 3D runs.

Mechanical thrombectomy of left MCA occlusion

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

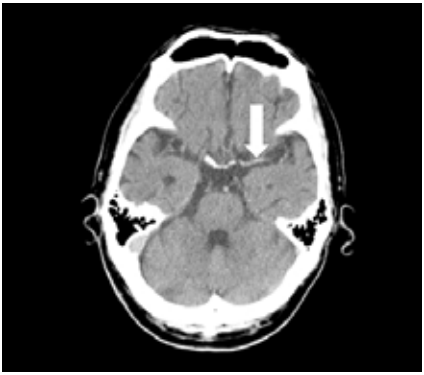
By combining C-arm rotational acquisition with intraarterial contrast medium injection from the aortic arch, we can obtain
(1) non-contrast *syngo* DynaCT,
(2) a three-dimensional volume of intracranial vasculature (*syngo* DynaCT reconstruction of fill run), and
(3) a *syngo* Neuro PBV IR map.

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

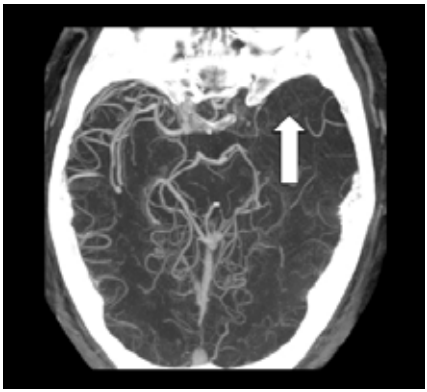
Acquisition protocol	**8s Neuro PBV IR**
Injection protocol	
Catheter position	Aortic arch 4 F pigtail catheter
Contrast medium (CM)	340 mg iodine/mL
Dilution	50%
Injection volume	85 mL
Injection rate	5 mL/s
Duration of injection	17 s
X-ray delay	Individually analyzed with *syngo* iFlow Tmax = 9 seconds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

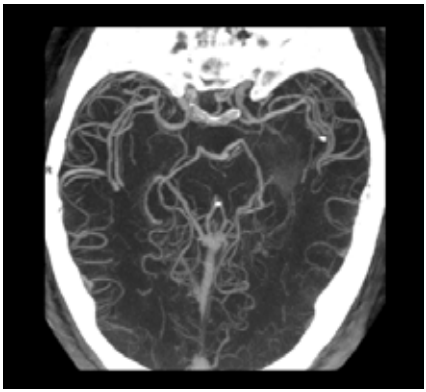
[1] *Reconstruction of the fill run of Neuro PBV 3D acquisition*



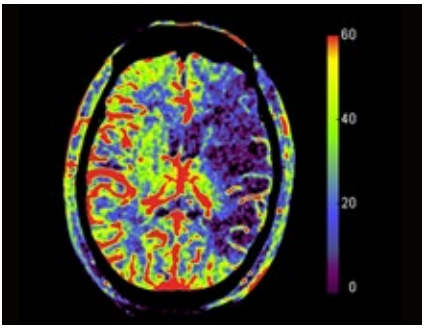
Noncontrast CT demonstrated a hyperdense MCA sign (arrow) and excluded intracranial hemorrhage



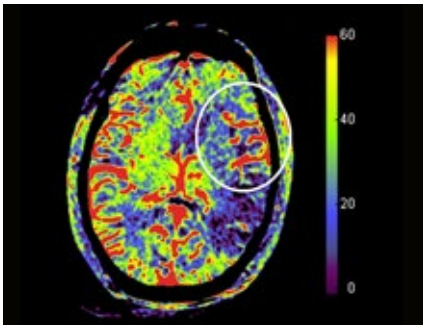
Thick MIP – FDCT angiography demonstrated the total occlusion of left MCA (arrow)



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 hypoperfusion 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

Visualization of pontine hemorrhage in *syngo* DynaCT Micro

Courtesy of	Rahul Kumar, MD GS Neuroscience Clinic and Research Centre Pvt. Ltd. Patna, Bihar, India
Supported by	*syngo* DynaCT Micro
System & Software	ARTIS icono biplane VE20 with *syngo* Application Software VE20

Patient history
A 32-year-old male patient presented with early acute stroke symptoms of vertigo, dizziness, and severe imbalance. He was to be diagnosed with a central pontine hematoma.

Diagnosis
The native computed tomography (CT) revealed bleeding in the brain stem. It was decided to perform a DynaCT scan with contrast media injection to better understand the involved vascular structures. The cone beam CT angiography shows the hematoma cavity, which is seen as an avascular zone in the pontine tectum. More interesting is the beading seen on the para-median perforators that are the homologous vessels to the sulco commisurals in the spinal cord.

Treatment
The patient was found to have elevated homocysteine levels. We decided for conservative treatment and he was medicated appropriately. The patient has responded very well to the medication. A follow-up CT scan showed complete resorption of the hemorrhage.

General comments
"The *syngo* DynaCT Micro image showing the beading of the vessels is probably the singular most impressive image yet."

Tips and tricks
Adequate and continuous contrast filling must be maintained throughout the scan. The use of diluted contrast medium is recommended, as high contrast concentrations can generate beam-hardening artifacts, potentially obscuring small vascular structures.

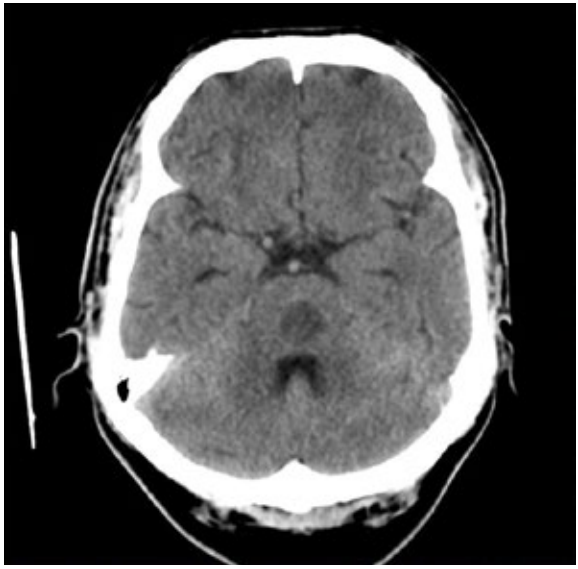
Acquisition protocol	**14s DCT Head Micro**
Injection protocol	
Dilution	33–35%
Injection volume	63–84 mL
Power injector used	Yes
Injection rate	3–4 mL/s
Duration of injection	21 s
X-ray delay	7 s
Catheter position	Vertebral artery

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

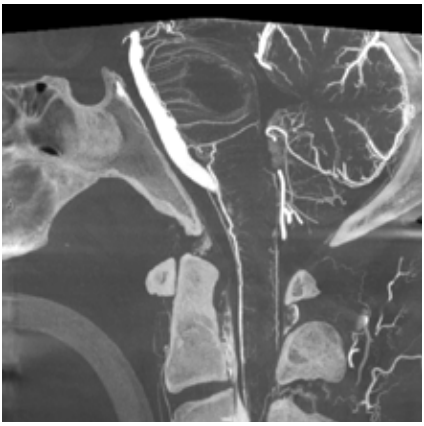
CT Head

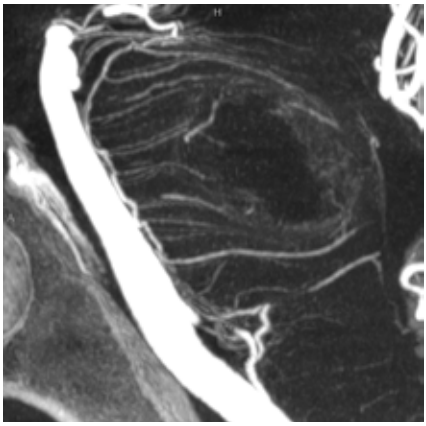
Hemorrhage is visible.

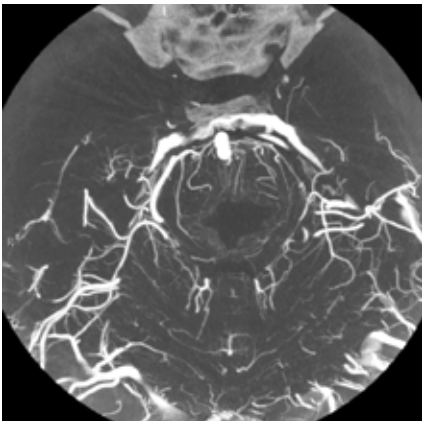
CT Head follow-up



DCT Micro







The hematoma cavity is seen as an avascular zone in the pontine tectum. Zoomed image illustrates beading of vessels.

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

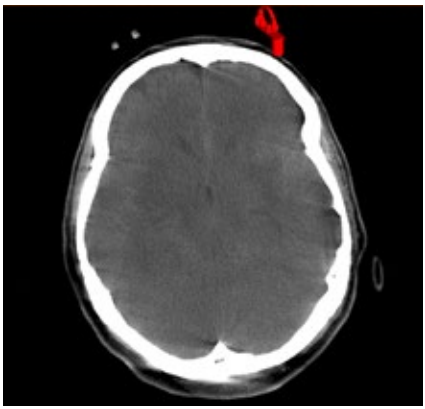
Patient history
62-year-old female patient transferred from a peripheral hospital with an aneurysmal subarachnoid hemorrhage. Direct admission to angio suite and acquisition of a native *syngo* DynaCT, followed by an IV injected DynaCT run to assess the progression and the cause of the bleeding.

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.

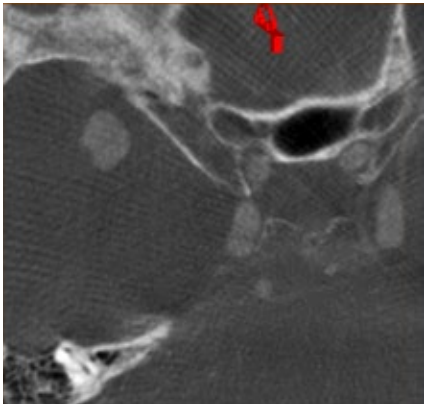


MPR 3 mm axial slice shows subarachnoid bleeding (minor artifacts due to patient motion of not sedated patient)

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

Flow diverter placement in a subarachnoid hemorrhage case supported by 'SuperDyna' imaging technique

Courtesy of	St Vincent's Hospital Radiology Department, Melbourne, Australia
Supported by	*syngo* Dyna3D, *syngo* 3D/3D Fusion, *syngo* DynaCT
System & Software	ARTIS icono biplane VE40A with *syngo* Application Software VE40C

Patient history
60-year-old male patient with a known subarachnoid hemorrhage (grade 2) of unclear origin. Sudden drop in Glasgow Coma Score – query aneurysm/malformation

Diagnosis
Right internal carotid artery blister aneurysm

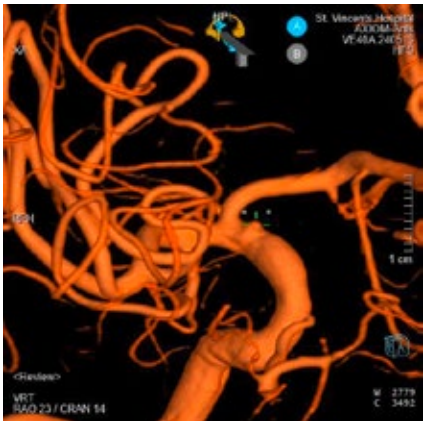
Treatment
A diagnostic cerebral angiogram was performed. A blister aneurysm evident on the right internal carotid artery (ICA) was confirmed by performing a 4 s Dyna3D DSA spin with the injection of contrast media using a catheter in the right ICA. Two flow diverter stents were then inserted to cover the parent vessel of the blister aneurysm (5.0 x 21/14 mm and 5.0 x 15/9 mm). Typically, two or more flow diverters are needed to treat blister aneurysms specifically.

After the deployment of both stents, a selective diagnostic angiogram was performed using a catheter in the right ICA. Then a native 8 s DynaCT run was performed. In a secondary reconstruction this volume was refined with a small VOI to increase spatial resolution. Persistent filling of the right ICA blister aneurysm without significant change in size or appearance could be seen. By fusing the subtracted reconstruction volume of the initial 4 s Dyna3D run, and the refined volume of the 8 s DynaCT run the patency of the two stents was visualized in significant detail, providing a crucial diagnosis.

Tips and tricks
Proper preparation of the patient is crucial – a head holder and head strap/sponges are essential to prevent patient movement during the procedure. This must be considered prior to creating the sterile procedure field.

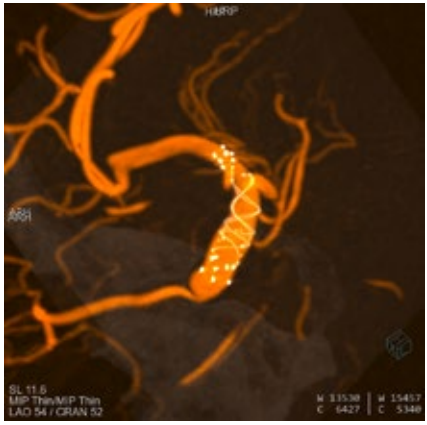
Acquisition protocol	**4s DSA Dyna3D Head**
Injection protocol	
Catheter position	Right ICA
Contrast medium	240 mg iodine/mL
Dilution	100%
Injection volume	16 mL
Injection rate	4.0 mL/s
Duration of injection	4 s
X-ray delay	1 s
Power injector used	Yes
Acquisition protocol	**8 s DCT Head 109 kV**
Injection protocol	NA

Reconstructions	**Primary**	**Secondary**
Name	DynaCT Head Clear	DynaCT Head Clear
VOI size	Full	Small
Voxel size	0.5 mm	0.11 mm
Slice matrix	512 x 512	512 x 512
Kernel type	HU	EE
Image characteristics	Normal	Sharp
Reconstruction mode	Nat Fill	Nat Fill
Viewing preset	DynaCT Head	DynaCT Head

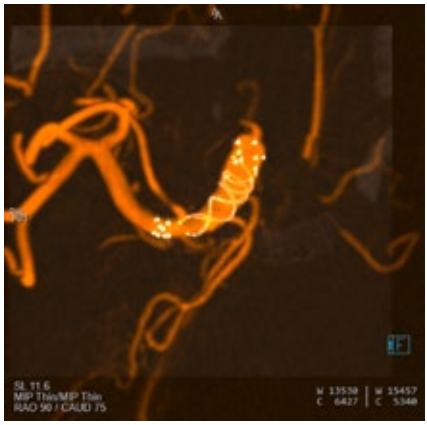


Subtracted reconstruction of 4 s Dyna3D run visualized in VRT mode, depicting presence of right ICA blister aneurysm (shown with 3D marker)

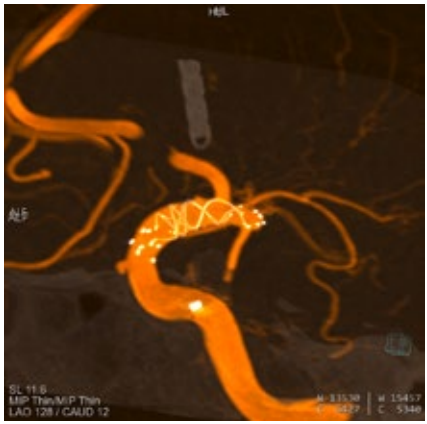
Flow diverter placement in subarachnoid hemorrhage case supported by 'SuperDyna' imaging technique



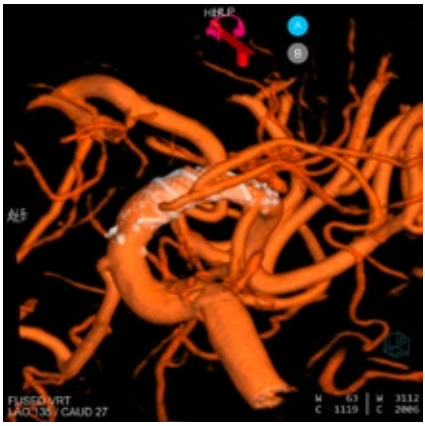
MIP thin in alignment with stents



MIP thin in alignment with stents

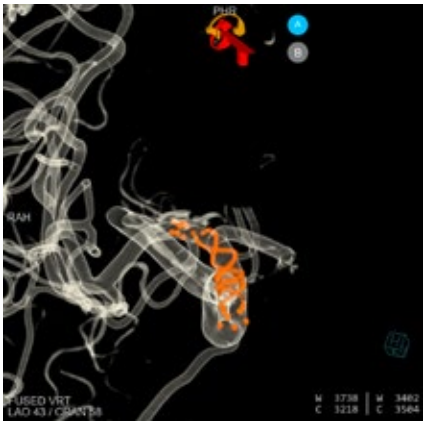


MIP thin in alignment with stents



Dual volume visualization in VRT mode

Dual volume visualization in VRT mode
Dual volume visualization with translucent color preset



Dual volume visualization in VRT mode
Dual volume visualization with translucent color preset

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.

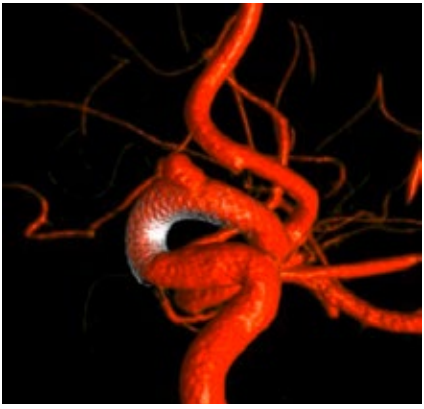
Diagnosis
Ophthalmic aneurysms on right and left side treated with pipeline embolization devices (PEDs)

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.

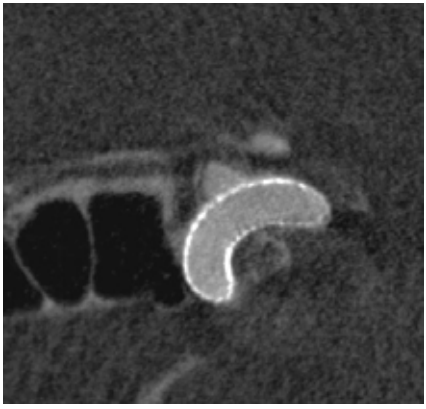
General comments
For the volumetric imaging, we used a 4 s *syngo* Dyna3D run in Twin Spin mode. For the first time, ARTIS icono gives us the ability to perform the 3D run without the need to park the lateral plane.

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.

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

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.

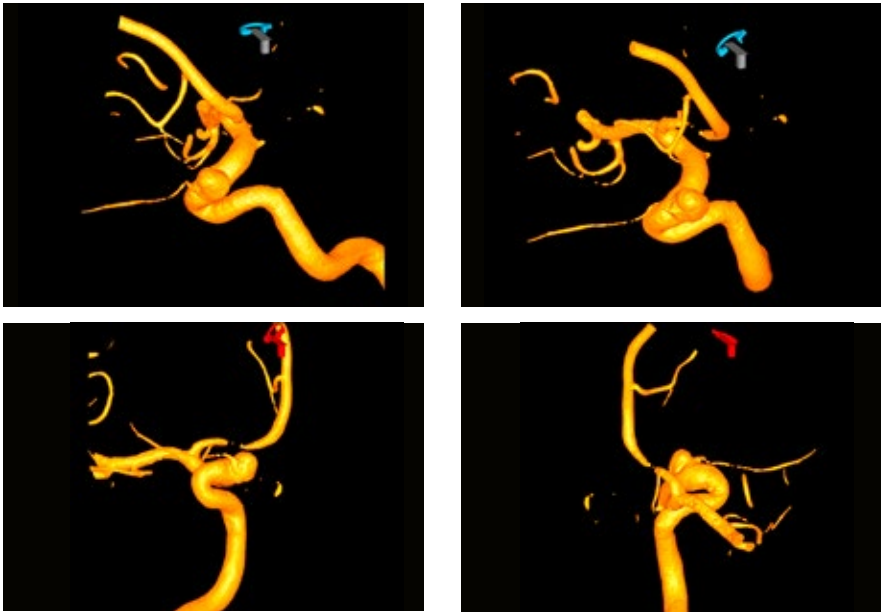
General comments
syngo DynaCT provided excellent spatial resolution and thereby helped to determine the border between the aneurysm and ophthalmic artery. This was important for preserving the patient's visual function. The robotic C-arm can be positioned at any angle to optimize visualization during 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.

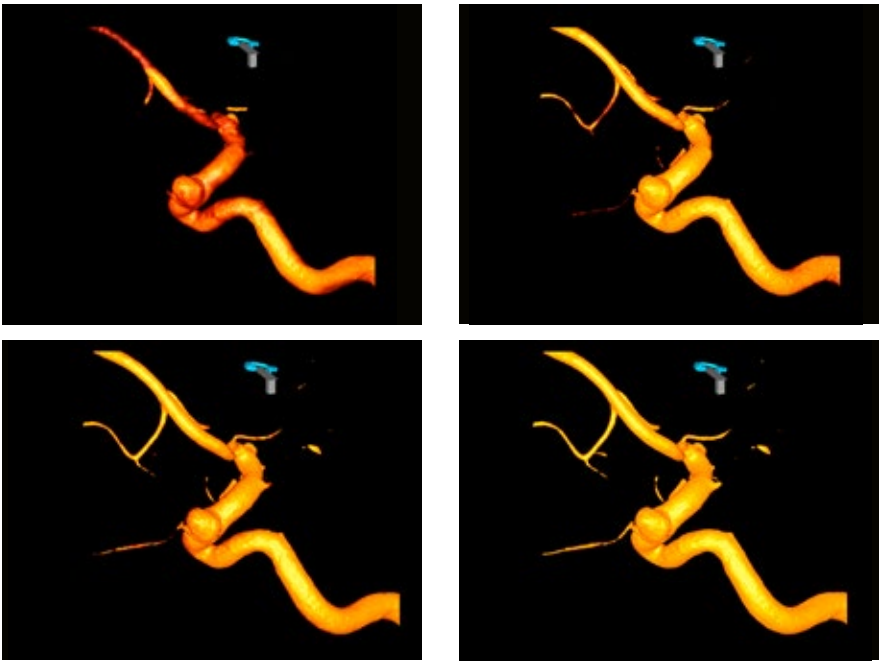
Tips and tricks
3D imaging helps to determine the optimal angle of the C-arm for intraprocedural fluoroscopy, ensuring safe deployment of stent and coil placement.

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

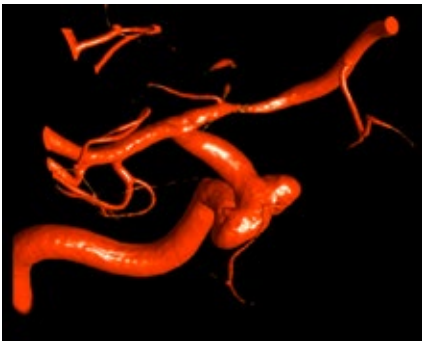
Reconstructions	**Primary**	**Secondary**
Name	Dyna4D arterial	
VOI size	Full	Small for more detailed resolution
Slice matrix	512 × 512	
Kernel type	HU	
Image characteristics	Auto	
Reconstruction mode	Sub	
Viewing preset	Dyna4D	



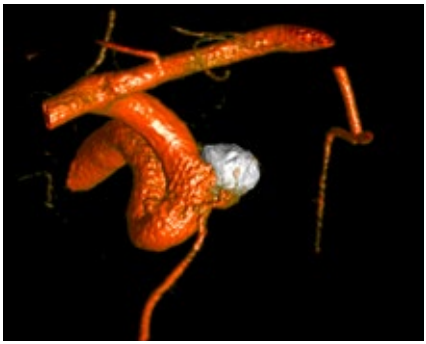
Not only does *syngo* Dyna4D show the morphology from different angles



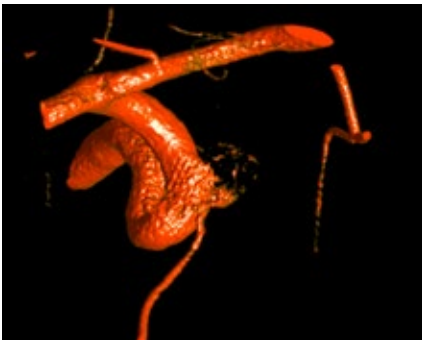
..but also makes it possible to see it at different timepoints



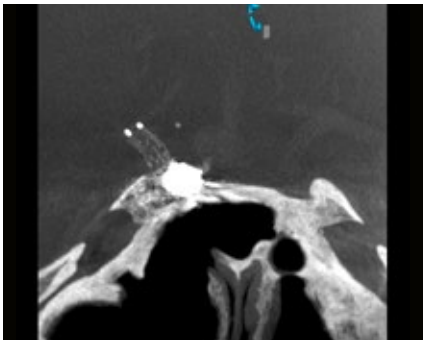
VRT visualization before intervention



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

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.

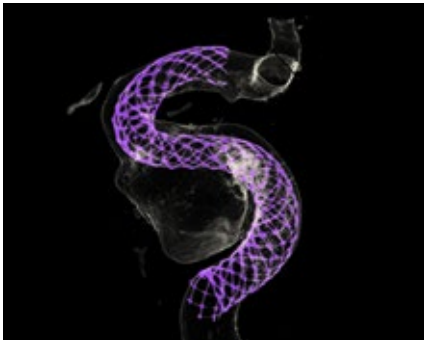
General comments
The physicians were impressed by the image quality, the level of detail achieved, and the accuracy of the fusion functionality. The case was very successful, and the physicians unanimously emphasized that the imaging capabilities of the Artis Q system with the PURE® platform enabled 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.

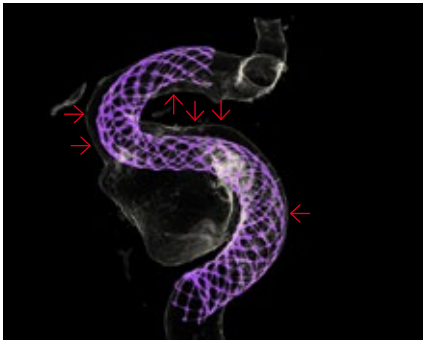
Acquisition protocol	**20s DCT Head Micro**
Injection protocol	
Contrast medium (CM)	N/A

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

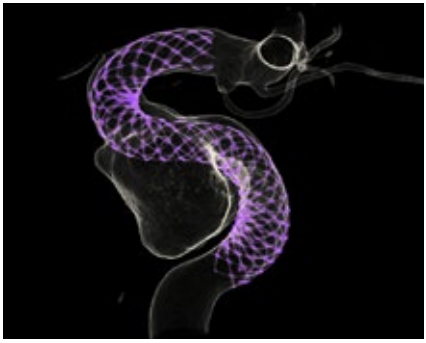
First and second DynaCT Micro run



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



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

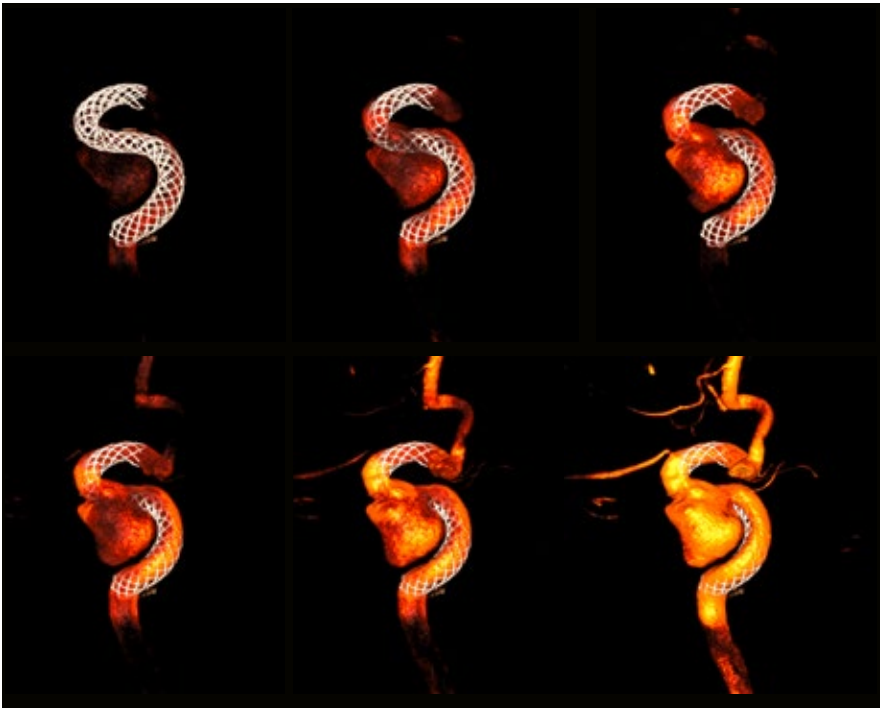


After post-dilatation

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

Large frontal AVM embolization using *syngo* 3D/3D Fusion technique

Courtesy of	René Chapot, MD, Interventional Neuroradiology, Alfried Krupp Hospital, Essen, Germany
Supported by	*syngo* Dyna3D, *syngo* 3D/3D Fusion
System & Software	ARTIS icono biplane VE30 with *syngo* Application Software VE30

Diagnosis
Large frontal arteriovenous malformation (AVM), fed by the right internal carotid artery (ICA).

Treatment
Liquid embolization

General comments
The complicated vessel structure in an AVM is not easy to understand. MPR images make it easier to differentiate arteries from veins and the nidus. We use a technique, which we call "6D", it consists of two fused color-coded 3D DSA runs. The understanding of the vessels comes from looking at the fused thin-slice MPRs in dedicated color presets, one blue and one orange. The benefit of this fusion technique is the ability to look inside the AVM and see which part comes from which artery (with one 3D volume in blue and one in orange) and where the veins are. Thanks to the color coding and the mix of orange and blue, the veins appear whitish.

Procedure workflow
In addition to regular DSA scenes, a first 3D DSA run is achieved using an injection from the right ICA.
This shows the territory of the middle cerebral artery (MCA) and the anterior cerebral artery (ACA).

Venous filling must be achieved from the beginning of the rotation. This requires a certain X-ray delay.

The second 3D DSA run is done from the left carotid artery and depicts the ACA.

***syngo* 3D/3D Fusion workflow**
- Load the first 3D DSA reconstructed dataset, use the blue color preset.
- Load the second 3D DSA dataset, use the orange color preset (dedicated color presets are required).
- Confirm "Load fused" in the pop-up window.
- Scroll through the MPRs to precisely see which vessel comes from the MCA and which from the ACA.

- Switch from coronal to sagittal view to better understand the main AVM vein. The course can be followed by scrolling through until the sagittal sinus is visible.

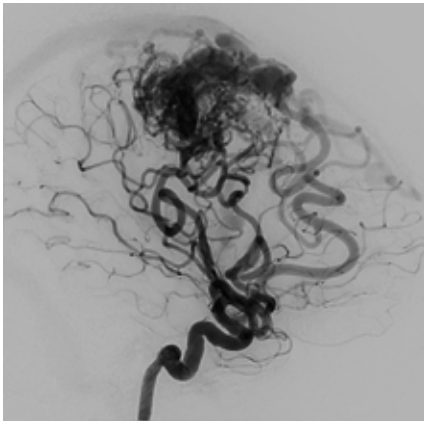
Tips & Tricks
To achieve optimal image quality in the 3D volumes, it is necessary to fix the head (a dedicated head-holder with fixation straps is recommended) and prevent any patient motion.

Statement
"6D" is a major step forward in understanding the AVM anatomy and defining the treatment approach – whether to start the embolization from the arteries or the veins.

Acquisition protocol	**4 s DSA Head Micro (for both runs)**
Injection protocol	
Catheter position	1) right ICA; 2) left ICA
Contrast medium	300 mg/mL
Dilution	70%
Injection volume	40 mL
Injection rate	~5 mL/s
Duration of injection	~8 s
X-ray delay	~3 s
Power injector used	Hand injection; start injection during back rotation, when C-arm passes AP position.

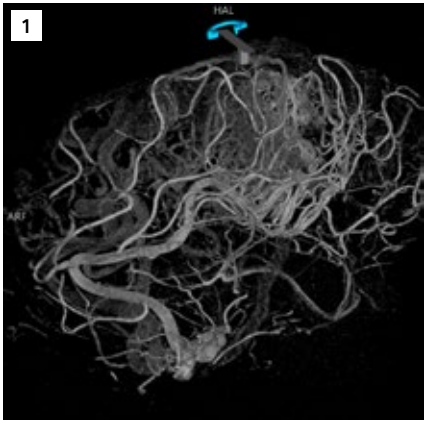
Reconstructions	**Primary**	**Secondary**
Name	3D Head Sub Full Normal	3D Head Sub Full Normal
VOI size	Full	Full
Slice matrix	512 x 512	512 x 512
Kernel type	EE	EE
Image characteristics	Normal	Normal
Reconstruction mode	Sub	Sub
Viewing preset	6D blue	6D orange

DSA

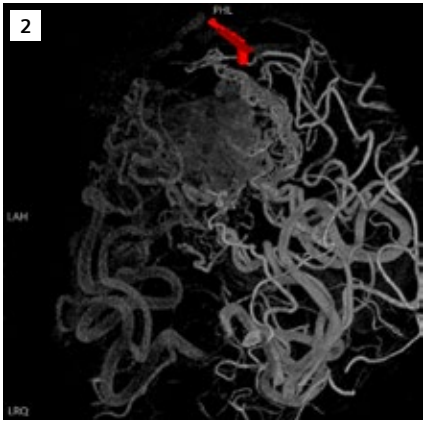


DSA image of AVM in lateral view.

VRT



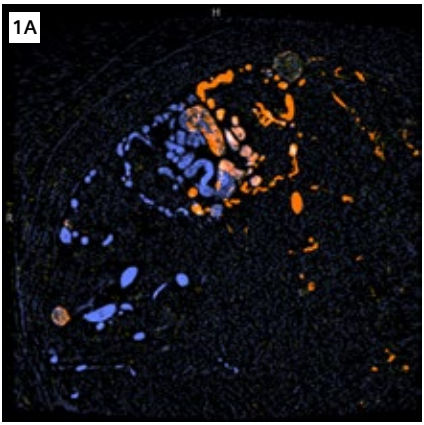
VRT 1: Injected in right ICA



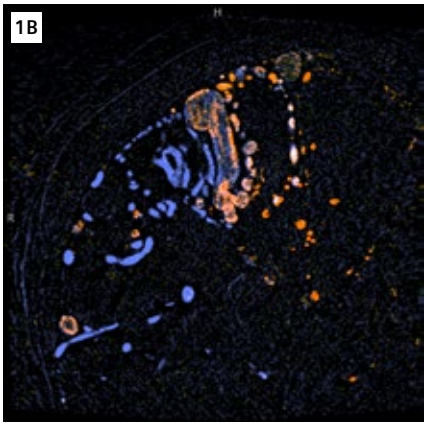
VRT 2: Injected in left ICA

VRT visualization of each 3D run.

MPR

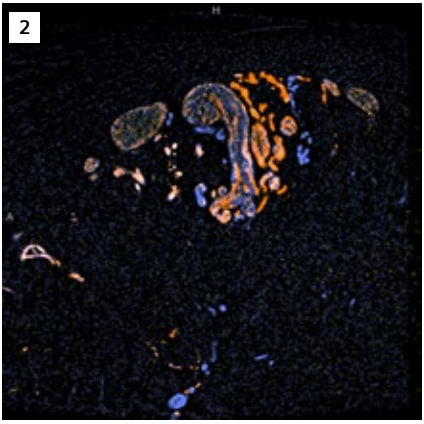


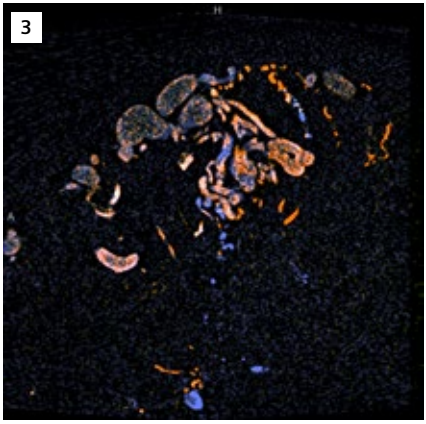
Arteries coming from the ACA are displayed in orange; those from the MCA are in blue.



As the vein is fed by two compartments (with the vessels from the ACA in orange, and the MCA in blue), it appears whitish.

Coronal MPR slice showing AVM in *syngo* 3D/3D Fusion.





In the sagittal MPRs, you can easily follow the course of the common vein.

High-flow dural fistula treatment decision supported by *syngo* iFlow

Courtesy of	Rahul Kumar, MD GS Neuroscience Clinic and Research Centre Pvt. Ltd. Patna, Bihar, India
Supported by	*syngo* Dyna3D, *syngo* iFlow, *syngo* DualVolume, *syngo* DynaCT Micro
System & Software	ARTIS icono biplane VE21 with *syngo* Application Software VE21

Patient history
A 45-year-old male patient presented with progressively worsening sensorium and obtundation over the preceding 18 months. He was being treated as a case of cortical venous sinus thrombosis. Clinically, he had no lateralizing deficits, but had mild neck stiffness and bilateral papilledema. A lumbar puncture showed increased ICP: 310 mm of water.

Diagnosis
An MRI was performed and showed features suggestive of intracranial venous hypertension, and multiple flow voids in the region of the left lateral sinus. A conventional catheter angiogram was performed.

DSA revealed a high-flow dural fistula in the region of the left transverse and left sigmoid sinuses, supplied by the left occipital artery, the left posterior cerebral artery, and the left meningo-hypophyseal trunk.

Treatment
Endovascular embolization was performed, and complete exclusion of the fistula was seen in the immediate postprocedural runs. However, the venous drainage, though better angiographically, was still showing slowing.

The dilemma was whether to continue embolization, do a thrombectomy of the chronically occluded sinuses, or just terminate the procedure and do further medical management.

This is where the *syngo* iFlow application came to our rescue. Based on this analysis, the procedure was completed and no further intervention was done.

Clinically, the patient's condition metamorphosed completely within 72 hours of the procedure.

To check the patient's progress, another angiogram was done two weeks after the procedure.

The *syngo* iFlow application showed further shortening of the transit time across the brain, paralleling the clinical improvement. The crux of this case was the slow flow of the venous blood through the medullary venous system of the brain because of the relatively higher pressure in the superior sagittal sinus, as a result of the dural fistula. Once the fistula is eliminated, theoretically there should be an increase in the venous flow velocity across the brain parenchyma, thus shortening the transit time of blood through the brain.

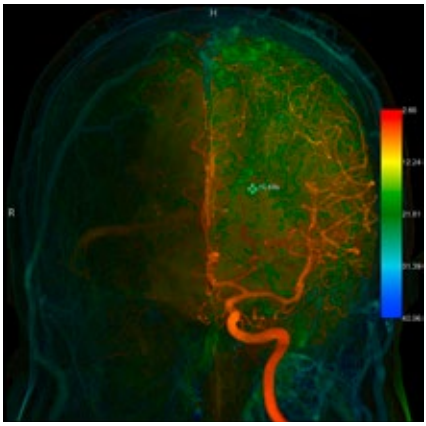
General comments

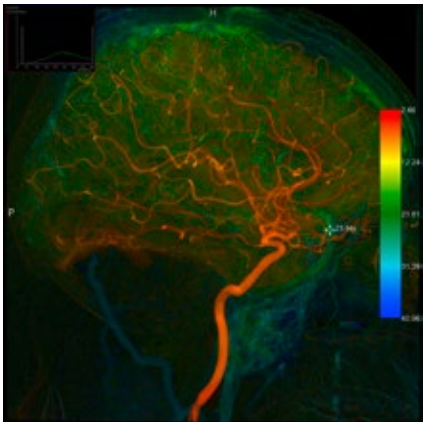
The treatment decision and progress was supported strongly by the information obtained from *syngo* iFlow.

Protocol – Part 1

Acquisition protocol	**DSA VFR**
Framerate	2 F/s for 20 frames – 1 F/s for 29 frames
Slice matrix	2k live imaging
Zoom	32 cm
Injection protocol	
Contrast medium (CM)	300 mg iodine/mL
Dilution	100%
Injection volume	n.a.
Power injector used	Hand injection
Injection rate	3 mL/s
Duration of injection	n.a.
X-ray delay	n.a.
Catheter position	Common carotid artery

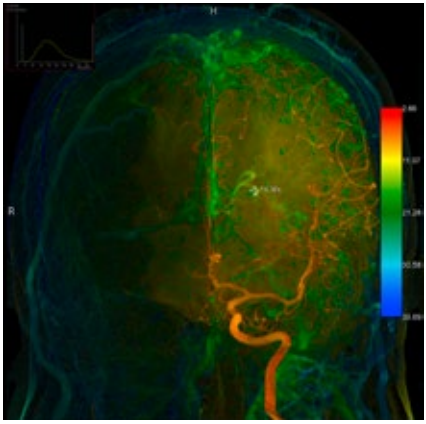
syngo iFlow before treatment

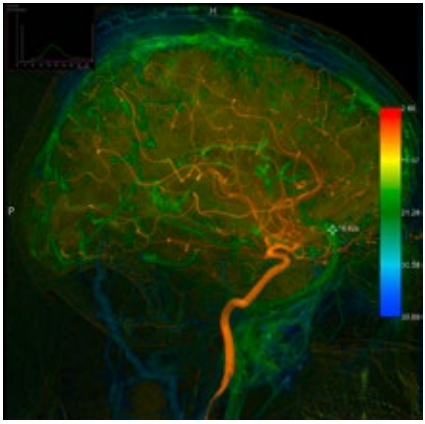




The blood took 19.68 seconds to reach the internal cerebral vein, and 23.94 seconds to reach the superficial middle cerebral vein before the fistula was closed.

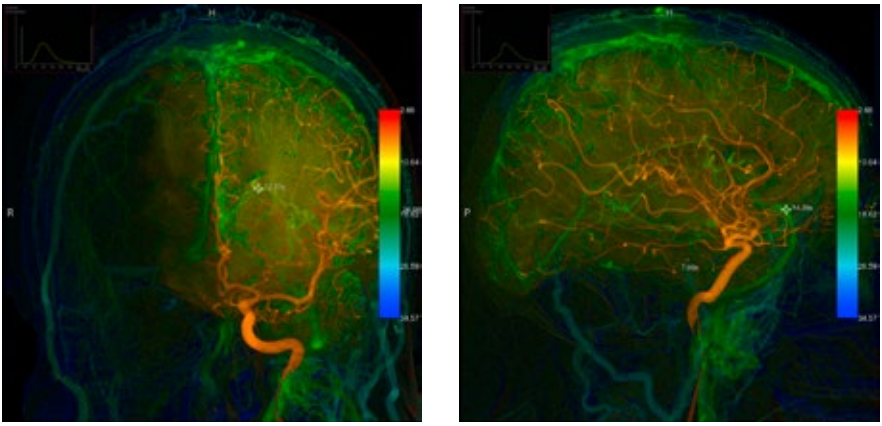
syngo iFlow immediately after treatment





Post-embolization, the blood took 14.36 seconds to reach the internal cerebral vein, and 18.62 seconds to reach the superficial middle cerebral vein immediately after the fistula was closed.

syngo iFlow two weeks after treatment



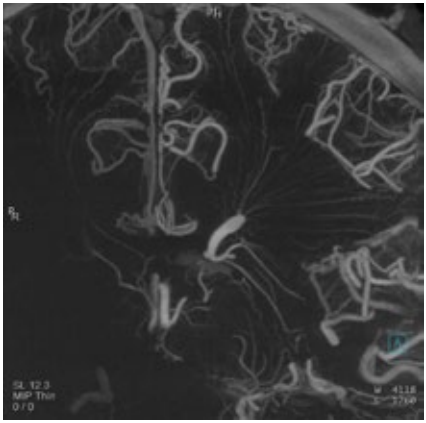
Post-embolization at the two-week interval, the blood took 12.23 seconds to reach the internal cerebral vein, and 14.36 seconds to reach the superficial middle cerebral vein.

Protocol – Part 2

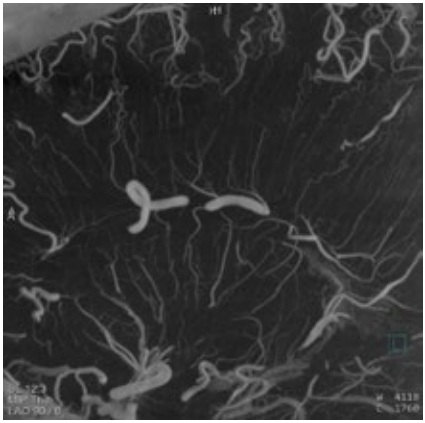
Acquisition protocol	**14 s DCT Head Micro**
Injection protocol	
Contrast medium (CM)	300 mg iodine/mL
Dilution	33–35%
Injection volume	63–84 mL
Power injector used	Yes
Injection rate	3–4 mL/s
Duration of injection	21 s
X-ray delay	7 s

Reconstructions	
Name	DCT Head
VOI size	Full
Slice matrix	512 x 512
Kernel type	HU
Image characteristics	Sharp
Reconstruction mode	Nat
Viewing preset	DynaCT Head

syngo DynaCT Micro



Frontal view 12 mm MIP



Sagittal view 12 mm MIP

Showing the congested, worm-like structures of the deep medullary veins.

Protocol – Part 3

Acquisition protocol	**4 s DSA Head**
Injection protocol	
Contrast medium (CM)	300 mg iodine/mL
Dilution	100%
Injection volume	18 mL
Power injector used	Yes
Injection rate	3 mL/s
Duration of injection	6 s
X-ray delay	2 s

Reconstructions	**Primary**	**Secondary**
Name	3D Head Sub Full	3D Head Mask Full
VOI size	Full	Full
Slice matrix	512 x 512	512 x 512
Kernel type	EE	HU
Image characteristics	Normal	Normal
Reconstruction mode	Sub	Nat
Viewing preset	3D Head Dual	3D Head Dual

syngo Dyna3D DualVolume

AP view

Lateral view

Visualization of vessel structure in relation to embolic material in dual volume mode.

Embolization of cerebral AVM

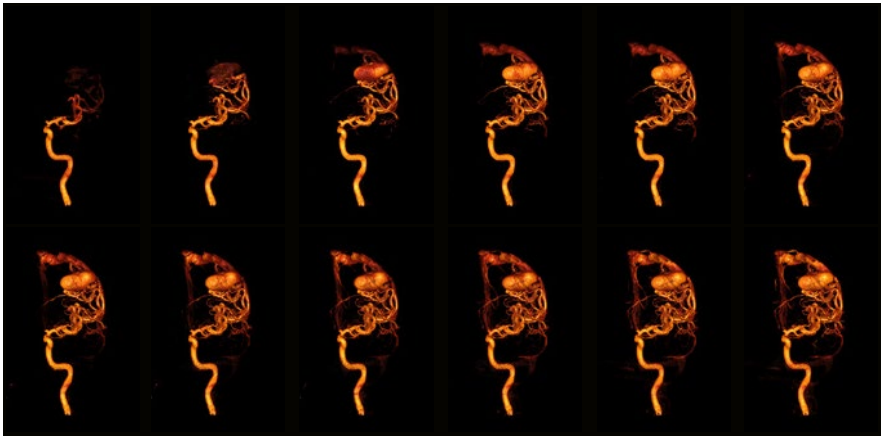
Courtesy of	Renè Chapot, MD, Hannes Nordmeyer, MD, Interventional Neuroradiology, Alfried Krupp Hospital, Essen, Germany
Supported by	*syngo* Dyna4D
System & Software	Artis zee biplane with PURE VD11, *syngo* X Workplace VD10

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).

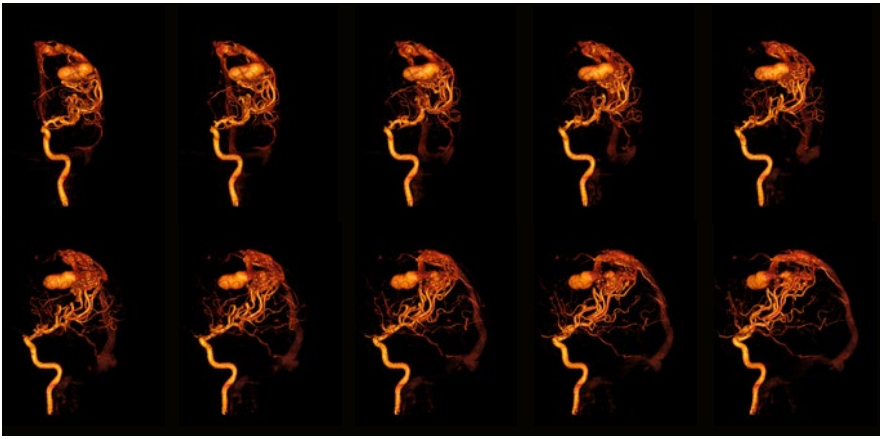
General comments
Normally we make a couple of DSA runs with different angulations of the C-arm to see the feeding vessels in detail and also observe the drainage of the AVM. Thanks to *syngo* Dyna4D this information was readily available after one injection, we could also see the filling and drainage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

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.

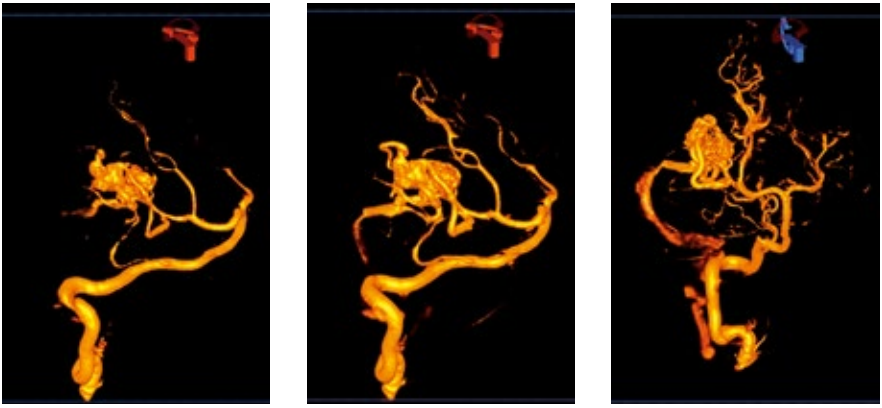
Out of the one main feeding artery, it is possible to perfectly delineate which of the two "sub-arteries" are supplying the intranidal aneurysm. This allows the interventional team to clearly identify which artery to embolize first.

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

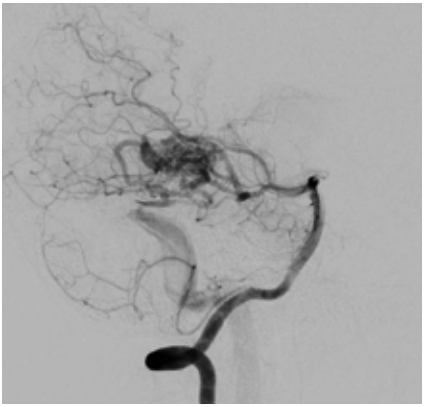
General comments
Manipulation of the *syngo* Dyna4D volume allows the clinicians to visualize filling of the AVM in any projection of the 3D model. This results in the most effective planning of the embolization treatment.

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).

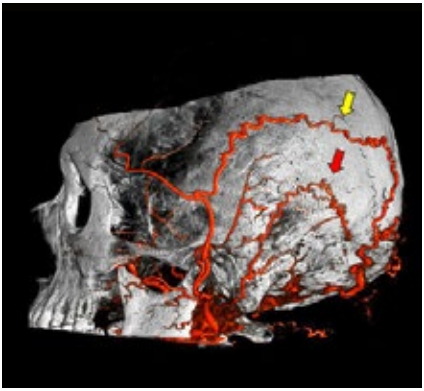
Procedure description
The patient was referred to the endovascular neurosurgery department and underwent a cerebral angiogram. The angiogram revealed a left transverse sigmond sinus dAVF with significant venous reflux into the superior sagittal sinus. Normal draining pattern of left transverse sigmoid 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 trans-venous approach and occlusion of the left T-S sinus was performed.

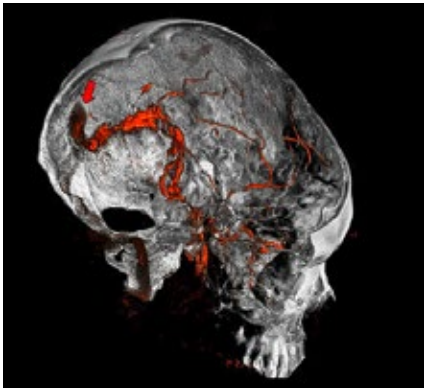
General comments
syngo Dyna4D breaks down the complex angio architecture of the shunting disease into different phases of contrast fillings, and allows to see the direction, speed, and amount of flow in one acquisition. This information is crucial to the treatment.

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

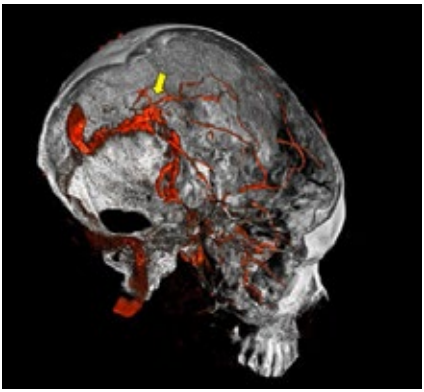
Reconstructions	Primary
Name	Sub4D*Full HU Auto
VOI size	Full
Slice matrix	512 × 512
Kernel type	EE
Image characteristics	Auto
Reconstruction mode	Sub
Viewing preset	Dyna4D
Sub 4D fused with Native Mask Run	



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)

Follow-up after bilateral carotid stent placement

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.

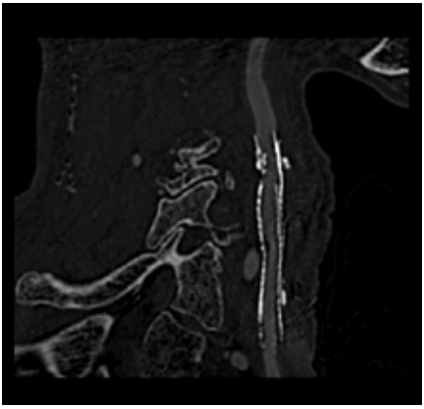
General comments
At our institution we are using *syngo* DynaCT with IV injection routinely for patients with the following concerns: stent patency, in-stent stenosis, residual filling of aneurysms s/p clipping and/or coiling, and vasospasm.

Coronal MIP showing bilateral stent placement

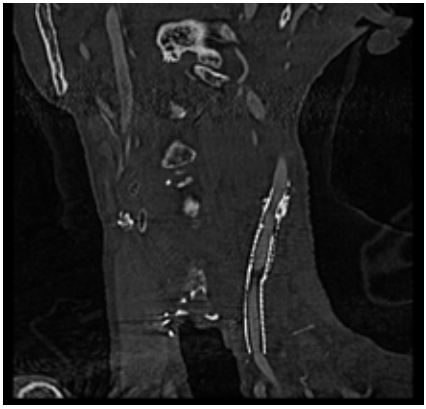
Acquisition protocol	20sDCT Head 109kV
Injection protocol	
Catheter position	IV injection; right antecubital vein
Contrast medium (CM)	370 mg iodine/mL
Dilution	None
Injection volume	80 mL
Injection rate	4 mL/s
Duration of injection	20 s
X-ray delay	14 s
Power injector used	Yes

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

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.

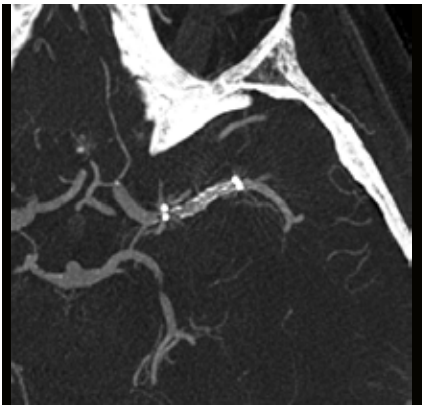
General comments
At our institution we are using *syngo* DynaCT runs with IV injection routinely for patients with the following concerns: stent patency, in-stent stenosis, residual filling of aneurysms s/p clipping and/or coiling, and vasospasm.

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

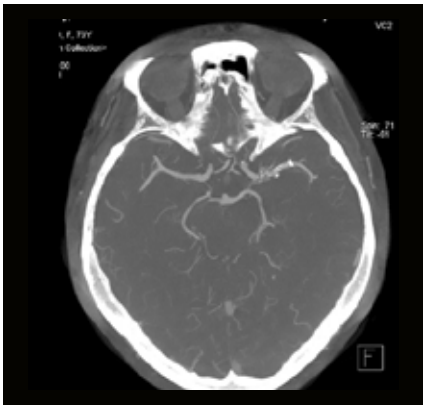
Acquisition protocol	**20sDCT Head 109kV**
Injection protocol	
Catheter position	IV injection antecubital vein (18 G) allergy prep medication
Contrast medium (CM)	370 mg iodine/mL
Dilution	None
Injection volume	80 mL
Injection rate	4 mL/s
Duration of injection	20 s
X-ray delay	14 s
Power injector used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

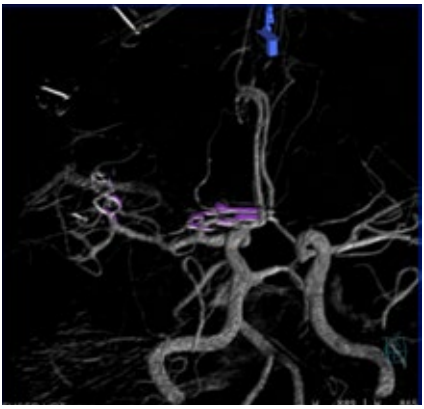
Procedure description
Clip occlusion > 10 years ago, routine follow up showed small new bleb-like aneurysm on DSA. Difficult to identify on MRA. *syngo* DynaCT with intravenous contrast injection in DualVolume mode offered less invasive imaging, able to exclude growth into a true saccular aneurysm, and 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.

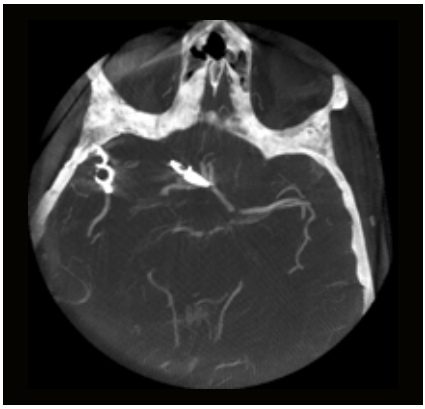
Tips and tricks
- Once the injector is armed, set the 3D protocol to manual mode (injection starts automatically after returning from mask spin)
- Start acquiring the fill run when the carotid artery is displayed on the bolus watch (approx. 8–15 sec)
- Head positioning: symmetrical patient head positioning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

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.

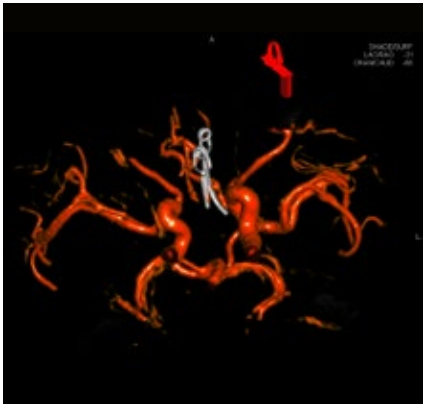
Diagnosis
Giant aneurysm of the ACom artery. Acute subarachnoid hemorrhage from the aneurysm, Hunt-Hess II.

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.

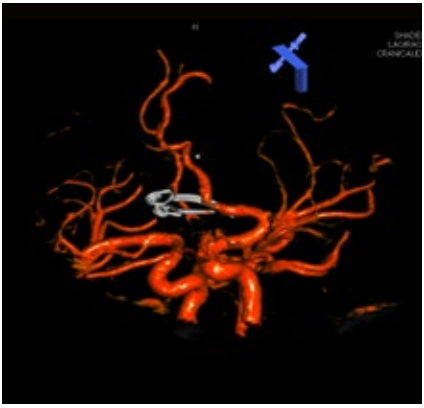
General comments
DynaCT with intravenous contrast injection is a fast and easy procedure for noninvasive arterial imaging.



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

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.

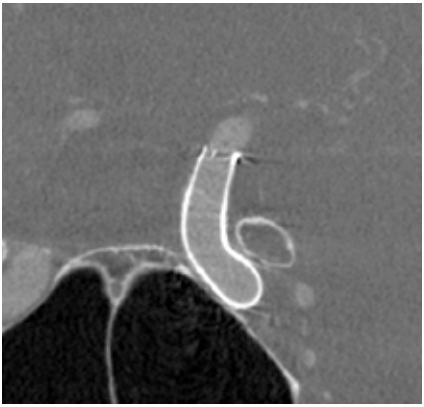
Treatment
Implantation of a flow diverter (Acandis Derivo 4,5 mm × 20 mm) 6 month ago. *syngo* DynaCT Micro acquisition for follow-up of flow diverter treated aneurysm to exclude intimal hyperplasia or in-stent stenosis.

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

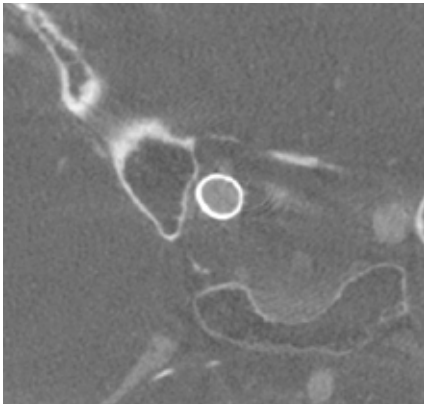
The follow up of flow diverter placement is easy in our daily routine. There is no need for catheter placement, only IV contrast injection is required. *syngo* DynaCT Micro, with its higher spatial resolution, improves the visualization of the stent.

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

Transradial embolization of the middle meningeal artery for chronic subdural hematoma

Courtesy of	Riitta Rautio, MD, Head of Interventional Radiology, TYSK, Turku University Hospital, Turku, Finland
Supported by	*syngo* DynaCT
System & Software	ARTIS icono biplane VE30 with *syngo* Application Software VE30

Patient history
A 79-year-old female patient fell down two weeks ago and thereafter suffered from gradual loss of balance and mild hemiparesis. She currently smokes and has a coronary bypass in her history. Ticagrelor 90 mg x 2 and ASS 100 mg x 1 after recent coronary intervention.

Diagnosis
Chronic subdural hematoma discovered on the right side in native CT imaging.

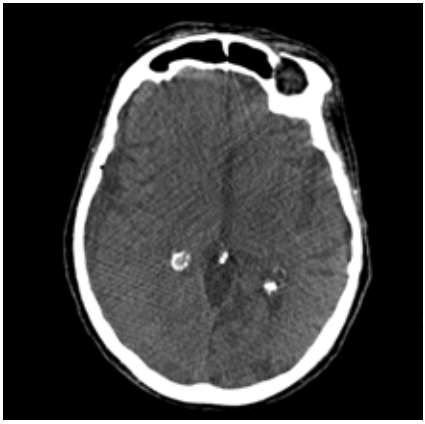
Treatment
Subdural hematoma evacuation was performed with burr hole technique by the Neurosurgeons in the OR theater due to the large mass effect and midline shift. Continuation of antithrombotic medication was required due to the patient's previous coronary intervention. Middle meningeal artery embolization with Onyx was performed two weeks after evacuation.

General comments
A native flat-detector CT scan is performed before the intervention to check the size of the existing subdural hematoma (images 1–3).

Aortic arch tortuosity increases with age and can make transfemoral procedures longer and complicated. A transradial procedure allows early ambulation and discharge for suitable patients.

The procedure starts by positioning the patient's arm in the radial support on the angiography table, with the

Figure 1



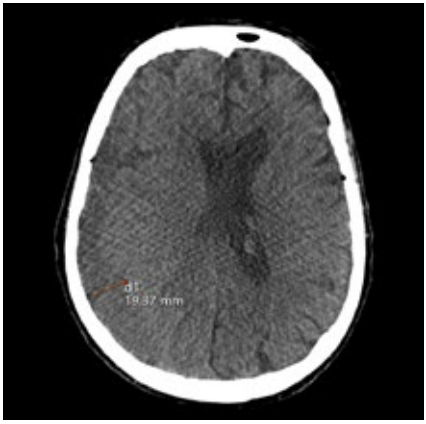
flat detectors ready for radial approach (image 4). The change to biplane neuro imaging uses a preset system position with a very smooth transition (images below).

Tips and tricks

A head holder allows good stabilization of the patient's head if the patient is awake during the procedure. When using liquid embolics that contain tantalum for opacity, the empty tantalum roadmap reliably shows the forward penetration of the embolic agent. We are using roadmap presets, which use an X-ray spectrum optimized for the imaging characteristics of the material, in our case tantalum for Onyx, to achieve the best image contrast with the lowest possible dose (Structure Scout).

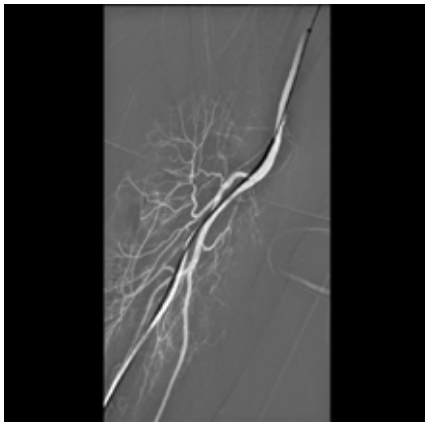
Acquisition protocol	**7sDCT Sine Spine**
Injection protocol	
Catheter position	n.a.

Reconstructions	**Primary**
Name	DynaCT Head Clear Nat Fill
VOI size	Full
Slice matrix	512 x 512
Kernel type	HU
Image characteristics	Smooth
Reconstruction mode	Nat Fill
Viewing preset	DynaCT Head

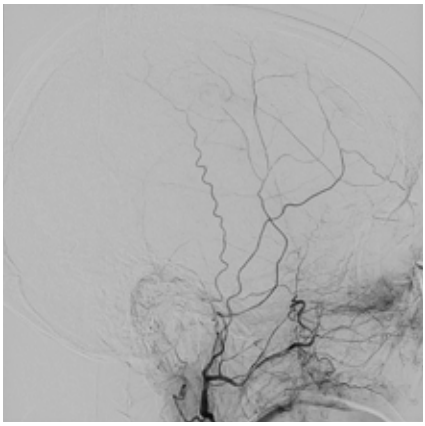


Native *syngo* DynaCT Sine Spin to visualize the size of the hemorrhage

Figure 2

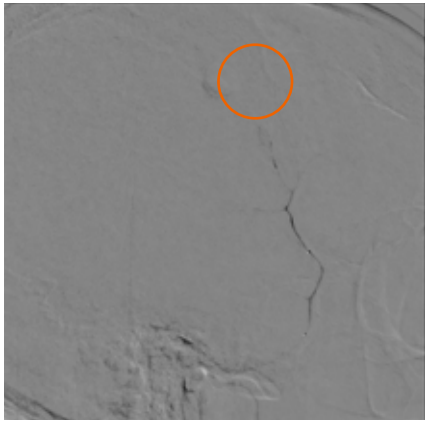


DSA radial approach

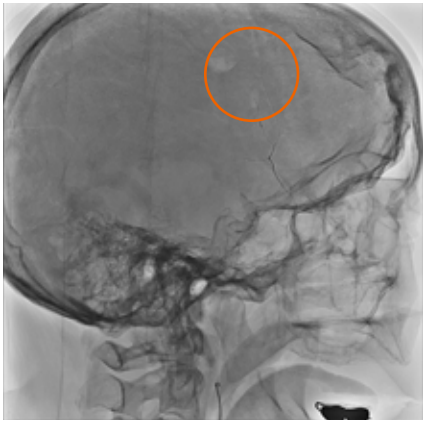


Neuro DSA imaging using a variable frame rate protocol (4/2/1)

Figure 3

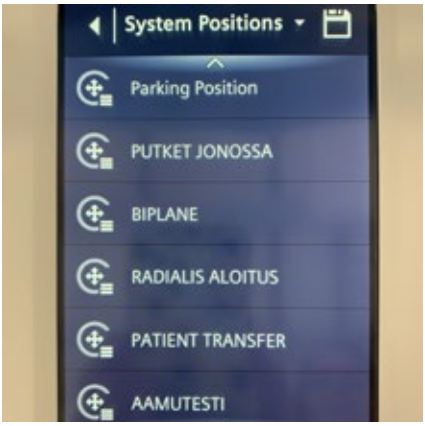


Empty roadmap image (subtracted roadmap with tantalum settings) to watch the inflow of the liquid embolic material



Native single shot after embolization

Radial access setting



With the help of stored system positions, changing from radial access position to biplane imaging position is fast and easy

System position for biplane imaging

syngo DynaCT of petrous bones to visualize cholesteatoma

Courtesy of	Tobias Struffert, MD, Universitätsklinikum Giessen, Germany
Supported by	*syngo* DynaCT Head
System & Software	ARTIS icono biplane VE2 with *syngo* Application Software VE2

Patient history
Male patient, who presented with hearing impairment.

Diagnosis
Cholesteatoma of the left ear.
A cholesteatoma is a destructive and expanding growth consisting of keratinizing squamous epithelium in the middle ear and/or mastoid process. The reconstructed *syngo* DynaCT volume shows eroded ossicles, liquid-filled mastoid cells, and swollen intima in the meatus externa.

Treatment
Surgical intervention to remove the cholesteatoma.

General comments
The 8s DCT Head acquisition protocol has the advantage of acquiring both sides at once. Collimate top-down for the desired ROI. A secondary reconstruction of left and right petrous bone separately provides a very high spatial resolution. With this approach, the expansion of the cholesteatoma and related erosions were nicely depicted.

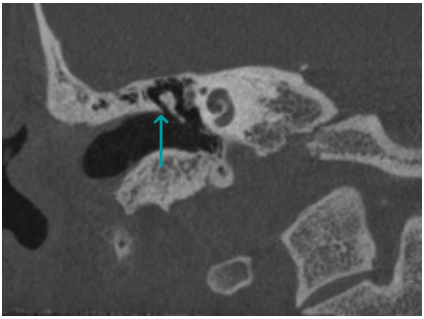
The approach is requested by our neurosurgeons and enhances their confidence during surgery.

Tips & Tricks:
Explain the short procedure to the patient and the need to lie still during the rotation of the system. Ensure proper positioning of the patient and fixation of the head to achieve optimal image quality.

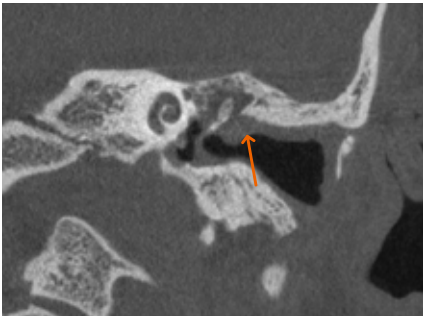
Acquisition protocol	**8sDCT Head** **Collimated (top-down) for the desired ROI**
Injection protocol	
Contrast medium (CM)	no contrast
Test Bolus	n.a.

Reconstructions	**Secondary. Reconstruct left and right petrous bone separately.**
Name	DynaCT Head
VOI size	Manual; adjust VOI size to reach slice thickness of 0.15–0.17 mm
Slice matrix	512 x 512
Kernel type	HU
Image characteristics	Sharp
Reconstruction mode	Nat
Viewing preset	DynaCT Head

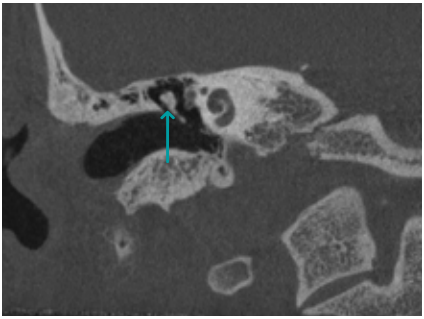
Coronal MPR



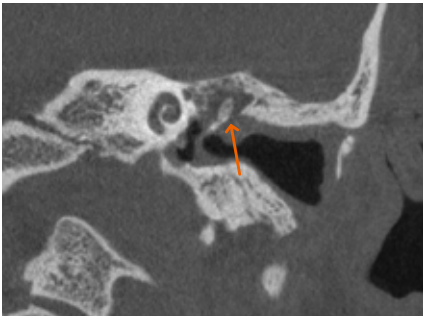
Petrol arrow shows attic sporn on healthy right petrous bone.



Orange arrow shows eroded attic sporn with thickened intima in meatus externa.

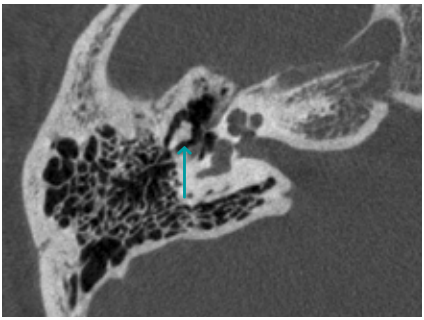


Petrol arrow shows normal anatomy of malleus.

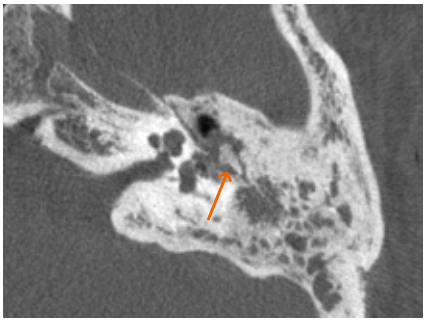


Orange arrow shows destructed malleus.

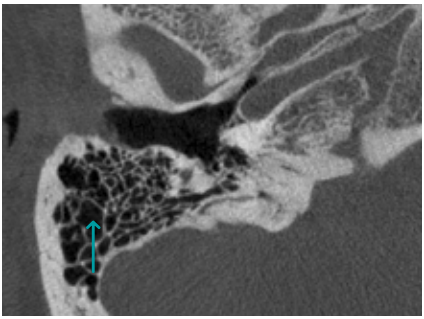
Axial MPR



Right incus in healthy structure.



Left incus shows erosion due to the cholesteatoma.



Petrol arrow shows normal pneumatized mastoid cells.

Orange arrow shows liquid-filled mastoid cells. Yellow arrow shows thickened intima of the meatus externa.

Total ossicular replacement prosthesis

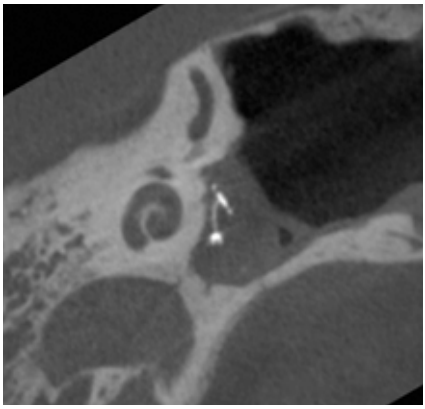
The high spatial resolution of *syngo* DynaCT Micro supports diagnosis of complications after TORP implantations

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

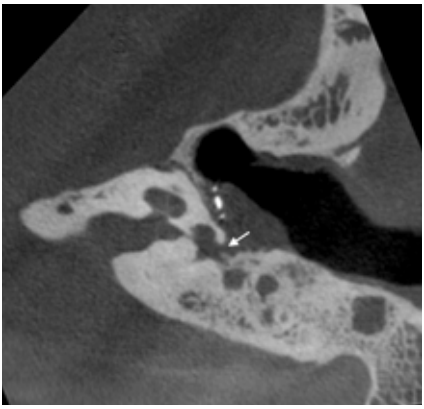
General comments
syngo DynaCT Micro provides higher spatial resolution compared with standard CT images. For the complex anatomy of the inner ear and especially with tiny prosthesis and implants, it helps us to make the right diagnosis.



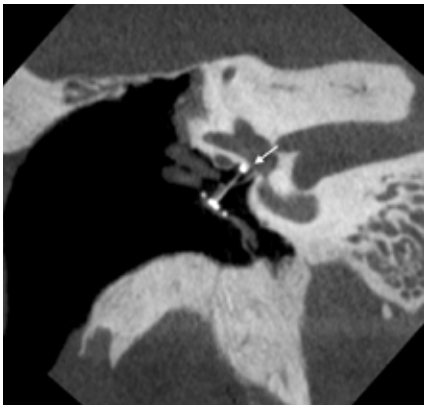
After tympanoplasty type III with titanium total ossicular replacement prosthesis, the tympanum is filled with soft tissue isodense material; the TORP is dislocated and bent

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)

Overview of Advanced Applications

3D/Advanced 3D	
syngo Dyna3D	performs a rotation around the patient, acquiring from different angles.
syngo Dual Volume	enables simultaneous visualization of dual-volume imaging (e.g., stent and contrast-enhanced vessels).
syngo DynaCT	offers dedicated, enhanced cone-beam reconstruction algorithms that reconstruct a low-contrast, three-dimensional image of soft tissue. The C-arm rotates around the area of interest at the isocenter.
syngo Dyna4D	is a rotational acquisition that delivers a virtually unlimited number of DSA runs with no additional radiation dose or contrast medium. Allows you to see flow patterns in 3D.
syngo DynaCT HighSpeed	Provides a fast high contrast 3D protocol of less than 3 s, represented with reduced motion artifacts and less contrast media.
syngo DynaCT Micro	provides high spatial resolution 3D imaging by using each detector pixel for 40 percent higher resolution compared with a standard *syngo* DynaCT.
syngo DynaPBV Neuro	enables 3D functional imaging acquisition protocols that deliver physiological information about the patient intraoperatively.
syngo DynaCT Sine Spin	helps neuroradiologists to detect bleeds in the interventional suite, especially when imaging the basal part of the brain and areas close to the skull.
syngo DynaCT Multiphase	enables visualization of collateral vessels with time-resolved DynaCT, depicting up to 10 different timepoints within a period of 60 seconds.

Advanced tools and workflows

syngo 3D Roadmap	superimposes 3D objects and/or the 3D color-coded image onto the live X-ray image for real-time guidance.
syngo Biplane 3D Roadmap	superimposes 3D objects and/or the 3D color-coded image onto the live X-ray image in both planes for real-time guidance.
syngo Fusion package	allows preprocedural images from CT, MR, and PET-CT to be imported and fused to live fluoroscopy.
syngo 2D/3D Fusion	requires just two fluoro projections to fuse 3D volumes from other imaging modalities for live image guidance.
syngo3D/3D Fusion	aligns two 3D volumes from the same or a different modality. Any *syngo* DynaCT or *syngo* Dyna3D image can be fused with datasets from CT, MR, or PET, for example.
syngo Toolbox	uses points and lines to interactively mark anatomical structures of interest in a 3D volume, e.g., a *syngo* DynaCT image. It is a generic application.
syngo DynaCT SMART	reduces metal artifacts through secondary reconstruction (streak metal artifacts reduction technology).
myNeedle Companion	allows the operator to plan a needle-based procedure in a 3D volume by specifying a target and multiple trajectories for needles or other rigid instruments.
myEmbolization Guide	supports advanced embolization planning and guidance.
syngo iFlow	allows the visualization of a DSA run in one single image through color-coding of time and intensity of maximum opacification.
syngo 3D Stenosis Measurement	allows analysis of a 3D segment within a 3D volume and calculates all data relevant to a stenosis (minimum diameter, maximum diameter, and cross-section of stenosis).
syngo 3D Aneurysm Guidance Neuro	enables segmentation of a cerebral aneurysm and its parent vessels with three simple mouse clicks, providing all data relevant to an aneurysm (parent vessel dimensions, volume, ostium, etc.).
syngo Neuro Virtual	is a planning tool that provides a 3D virtual intracranial stent.

For more information about ARTIS and Workplace applications in Interventional Neuroradiology visit us online at:

siemens-healthineers.com/angio/interventional-radiology/clinical-specialities/neuroradiology

Notes

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Notes

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