Case 7

Acute Left Hemispheric Ischemic Stroke: Comprehensive Stroke Imaging Using Neuro Volume Perfusion CT

By Ramona Finzel and Peter Schramm, MD

Department of Neuroradiology, University of Göttingen, Göttingen, Germany

HISTORY

A 75-year-old female patient with history of arterial hypertension, diabetes mellitus and absolute arrhythmia was admitted to the neurological clinic with symptoms of acute stroke. Two hours prior, the patient had developed an acute, right-sided hemiplegia and a right-sided facial palsy. On physical examination the patient was global aphasic, showed a left-sided eye and head deviation and recurrent emesis (NIHSS 26).*

DIAGNOSIS

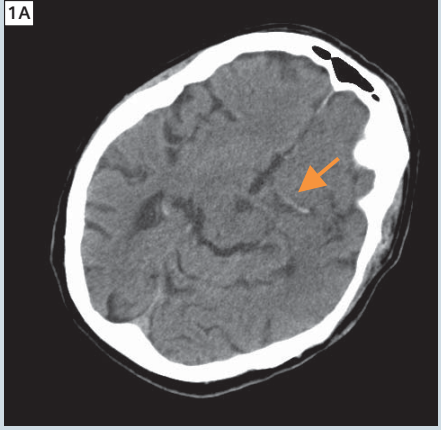
On initial non-enhanced cranial CT (NECT), intracranial hemorrhage and tumor were ruled out. A hyperdense media sign on the left side was visible as an early sign of ischemic stroke (Fig.1A). However, grey and white brain matter appeared normal (Fig. 1B).
Volume perfusion CT (VPCT) indicated large areas of restricted brain perfusion in the left hemisphere. A substantial reduction of values of cerebral blood flow (CBF, Fig. 2A) as well as reduction of cerebral blood volume (CBV, Fig. 2B) were detected in the anterior and middle parts of the left middle cerebral artery (MCA) territory and in parts of the left anterior cerebral artery (ACA) territory.

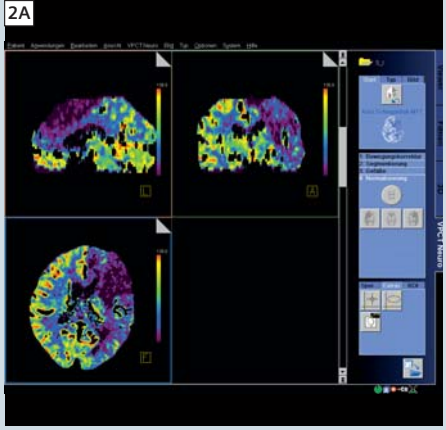
*NIHSS 26 (National Institute of Health Stroke SCORE 26)

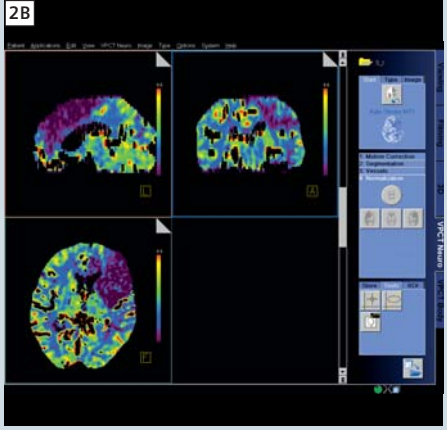
Furthermore, a significant prolongation of the mean transit time (MTT, Fig. 2C) and the time to peak (TTP) in both the complete MCA and ACA territories were found. On CT-Angiography (CTA), occlusion of the main stems of the left MCA (Fig. 3) and ACA were detected. Due to the presence of a large penumbra volume, it was decided to perform intra-arterial thrombolysis and to start a bridging therapy with 20 mg rt-PA immediately. Unfortunately, both thrombolysis therapies were unsuccessful (Fig. 4). Two days later, the follow-up NECT showed the delineation of complete territory infarctions of the MCA and ACA, brain edema and severe midline herniation (Fig. 5).

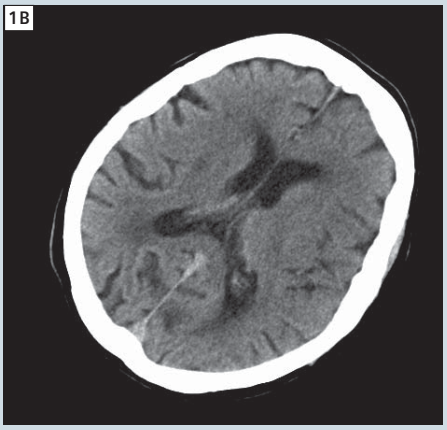
EXAMINATION PROTOCOL

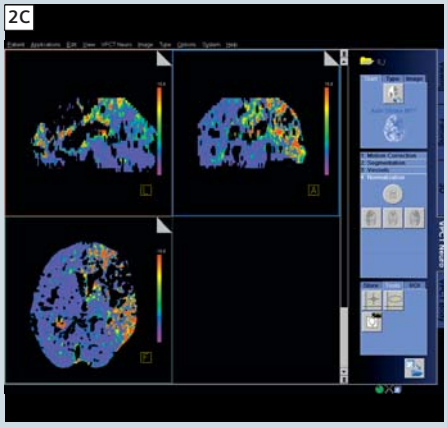
Scanner	*SOMATOM Definition AS+ CT -Perfusion*	*SOMATOM Definition AS+ CTA Vessel analysis*
Scan area	*head*	*head*
Scan length	*96 mm (VPCT)*	*300 mm*
Scan direction	*cranio-caudal*	*cranio-caudal*
Scan time	*40 s, one scan every 1.5 s*	*2.91 s*
Tube voltage	*80 kV*	*120 kV*
Tube current	*200 Eff. mAs*	*120 Eff. mAs*
Scan mode	*Adaptive 4D Spiral*	*Spiral*
eff. dose	*5.2 mSv*	*3.1 mSv*
Rotation time	*0.3 s*	*0.3 s*
Slice collimation	*0.6 mm*	*0.6 mm*
Slice width / Increment	*5 mm / 3 mm*	*1.5 mm / 1 mm*
Reconstruction kernel	*H20f*	*H20f*
Contrast		
Volume / Flow rate	*35 ml Iomeprol 350 @ 5 ml/s* *20 ml NaCl @ 5 ml/s*	*40 ml Iomeprol 350@ 5 ml/s* *25 ml Iomeprol 350@ 2,5 ml/s* *20 NaCl @ 2,5 ml*
Start delay	*4s*	*4s*
Postprocessing	*syngo Volume Perfusion CT – Neuro (VPCT-Neuro)*	*Bolus tracking* *syngo Neuro DSA*

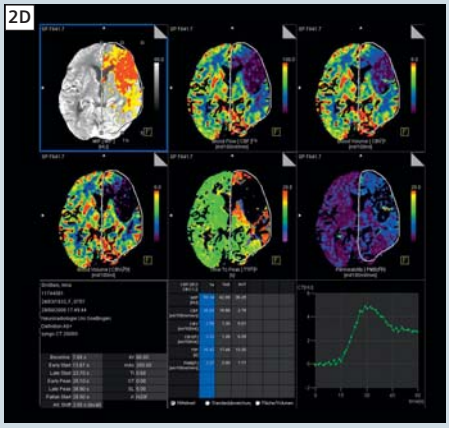












1 A hyperdense media sign on the left side was visible as an early sign of ischemic stroke (Fig.1A, arrow). However, the differentiation of grey and white brain matter appeared normal (Fig. 1B).

2 Volume perfusion CT (VPCT) indicated substantial reduction of values of cerebral blood flow (CBF, Fig. 2A) as well as reduction of cerebral blood volume (CBV, Fig. 2B) were detected in the anterior and middle parts of the left MCA territory and in parts of the left ACA territory. Furthermore, a significant prolongation of the mean transit time (MTT Fig. 2C) could be observed. A large penumbra could be detected (yellow) in regards to a smaller core infarct (red, Fig. 2D). Therefore intra-arterial lysis was indicated.

3 Due to complete stroke assessement the CTA revealed an occlusion of the main stem of the left MCA.

4 Intraarterial thrombolyses failed to open left MCA.

5 Follow-up NECT showed the delineation of complete territory infarctions of the MCA and ACA, brain edema and severe midline herniation.

COMMENTS

With VPCT, analysis of the brain perfusion parameters of the whole brain is possible. Contrary to standard perfusion CT, which allows analysis only of restricted areas of the brain depending on the detector width, even smallest areas of hypo-perfusion can now be analyzed throughout the whole brain with VPCT. Therefore, the advent of VPCT renders important information about the complete volume of tissue at risk of infarction and should be implemented in a comprehensive stroke CT protocol.

Case 8
SOMATOM Definition AS+: Neuro Volume Perfusion CT of Intracerebral Metastatic Disease

By Ramona Finzel and Peter Schramm, MD

Department of Neuroradiology, University of Göttingen, Göttingen, Germany

HISTORY

A 69-year-old female patient with a history of bronchial carcinoma presented to the Department of Neurology with a discrete left-sided, arm-accented, hemiparesis since the evening. She was fully orientated but very cachectic and in poor general condition.

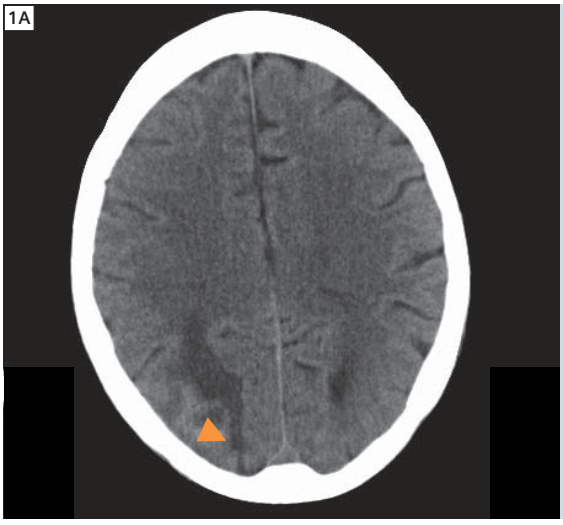
DIAGNOSIS

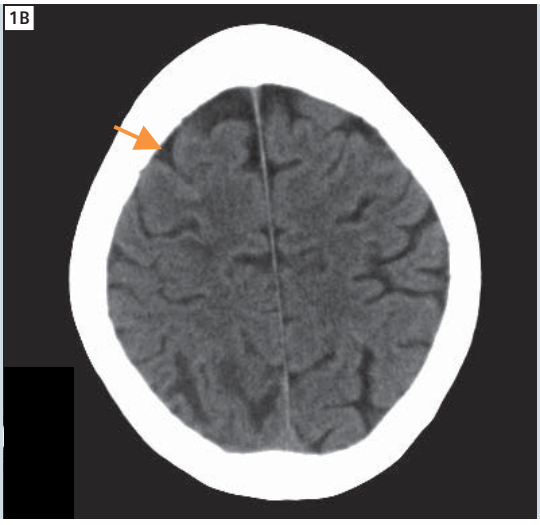
Neuroradiologic examination consisted of a cranial, non-enhanced CT (NECT) scan followed by Volume Perfusion CT (VPCT). NECT revealed a tumor in the subcortical white matter of the right parietal lobe ~~Fig 1A.~~ The tumor showed a rim-like hyperdensity with a central loss of density on NECT and was surrounded by an edema. A second small cortical lesion was visible in the right anterior lobe ~~Fig 1B.~~

Assuming that the patient was suffering from multiple metastasis, we performed VPCT. The calculated permeability maps of VPCT showed multiple lesions with disrupted blood-brain-barrier throughout the whole brain (Figs. 2A–F), indicating the presence of numerous brain metastasis. The lesions showed an elevation of cerebal blood volume (CBV, Fig. 3) and contrast enhancement on the MIP images. In addition, we detected a severe prolongation of the mean transit time (MTT, Figs. 4A-C) and time to peak (TTP) in parts of the right MCA territory. The follow-up MRI examination on the same day visualized various metastasis supra- and infratentorial. In addition, we found subacute ischemic lesions on diffusion-weighted images in the area supplied by the right MCA which were already indicated by the prolongated MTT and TTP on VPCT.

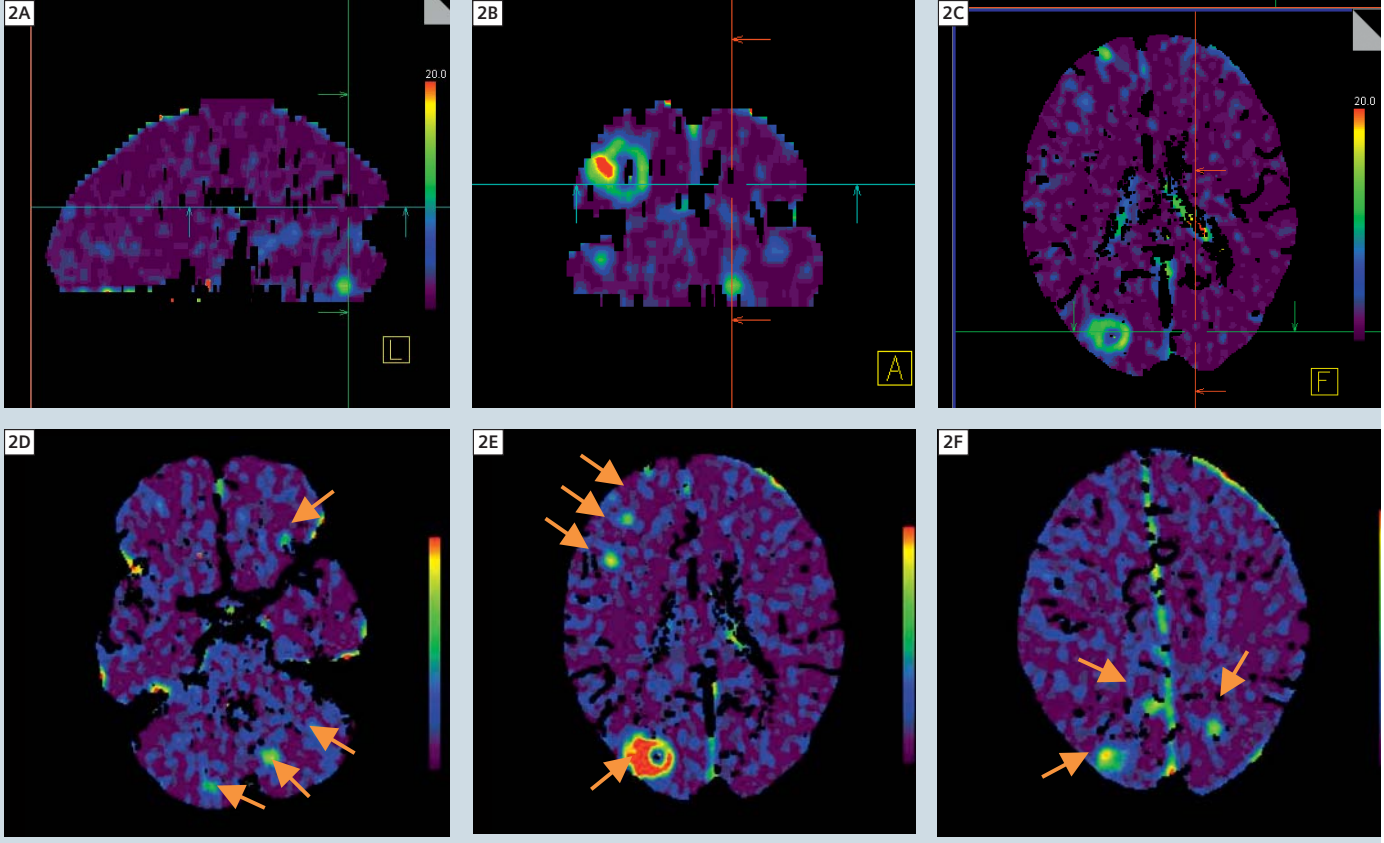
~~COMMENT~~

This case illustrates that VPCT can depict disturbances of the blood-brain-barrier even within smallest lesions that are not visible on NECT. Therefore VPCT is a meaningful method to reveal smallest metastasis within the scope of a CT examination. Further, this example demonstrates the multi-modality of VPCT. Although the examination and the postprocessing were focussed on the assumed diagnosis "tumor", we were able to uncover the supplemental ischemic lesion on the parameter maps.

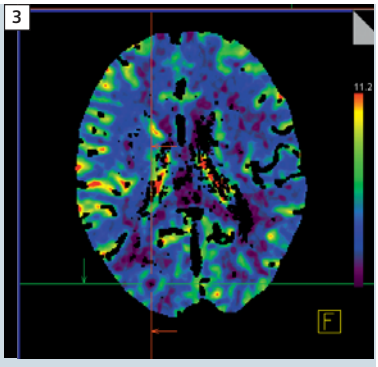




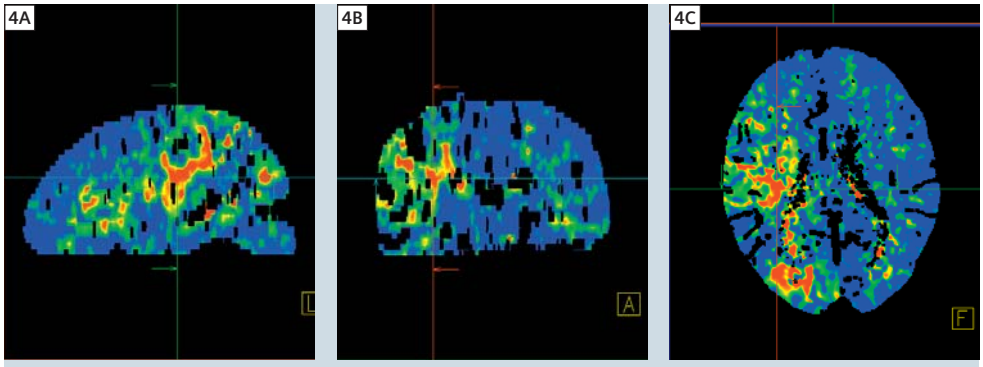
1 ~~(Fig. 1A)~~ NECT revealed a tumor in the subcortical white matter of the right parietal lobe (arrowhead). The tumor showed a rim-like hyperdensity with a central loss of density surrounded by an edema ~~(Fig. 1B).~~ A second small cortical lesion was identified in the right anterior lobe ~~(arrow)~~



2 VPCT showed multiple lesions with disrupted blood-brain-barrier throughout the whole brain (Figs. 2A–F, arrows), indicating the presence of numerous brain metastasis.



3 Additionally VPCT showed an elevation of cerebal blood volume (CBV) of the tumor.



4 3D evaluation of the brain detected an infarct seen as severe prolongation of the mean transit time (MTT) and time to peak (TTP) in parts of the right MCA territory.

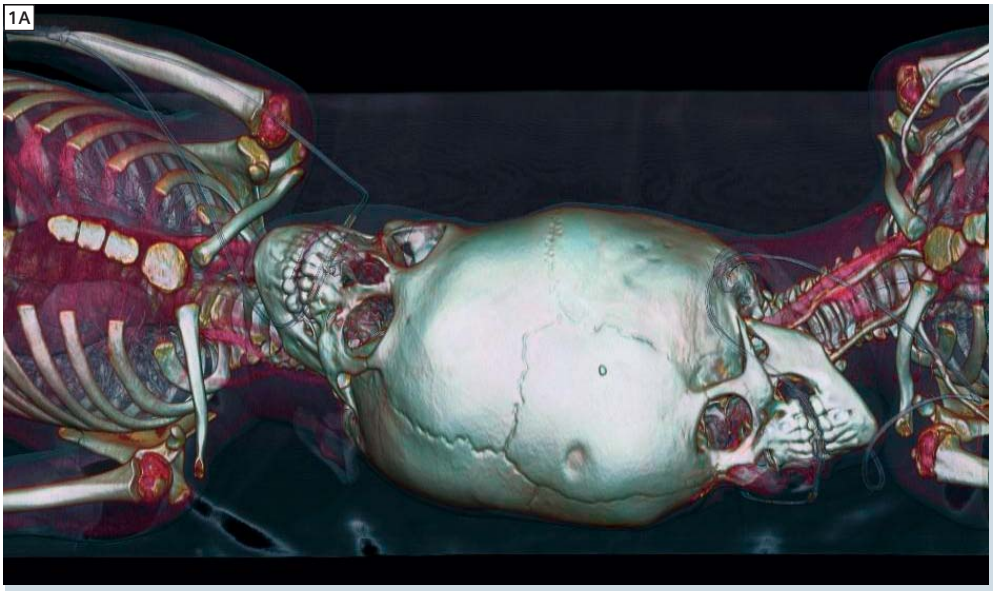
EXAMINATION PROTOCOL

Scanner	*SOMATOM Definition AS+*		
Scan area	*head*	***Spatial resolution***	*0.33 mm*
Scan length	*96 mm (VPCT)*	***Slice width / Increment***	*5 mm & 3,0 mm increment*
Scan time	*40 s, one scan every 1.5 s (27 scans)*	***Reconstruction kernel***	*H20f*
		Contrast	
Scan direction	*cranio-caudal*	***Volume / Flowrate***	*35 ml Iomeprol 350 @ 5 ml/s*
Tube voltage	*80kV*		*20 ml NaCl @ 5 ml/s*
Tube current	*Eff. 200 mAs*	***Start delay***	*4 s*
Scan mode	*Adaptive 4D Spiral*	***Postprocessing***	*syngo Volume Perfusion CT – Neuro (VPCT-Neuro)*
eff. dose	*5.2 mSv*		
Rotation time	*0.3 s*		

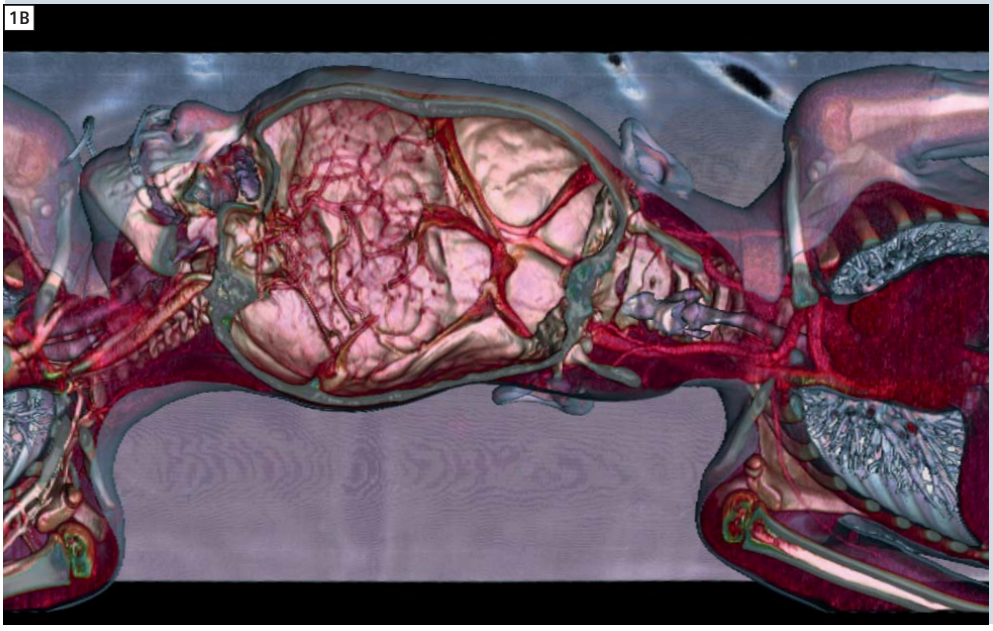
Case 9
Dual Source CT: Visualization of Brain Vessel Connection of Siamese Twins

By Anirudh Kohli, MD, Head

Department of Radiology, Breach Candy Hospital Trust, Mumbai, India



1A Overview with volume rendering technique (VRT) showing the connection of both skulls.



1B Blood-flow through the connected head-vessel system of the conjuncted twins, demonstrated by VRT during administering contrast medium into the artery system of twin 1 (left person). Venous drainage can be found in the brain of twin 2 (right person).

HISTORY

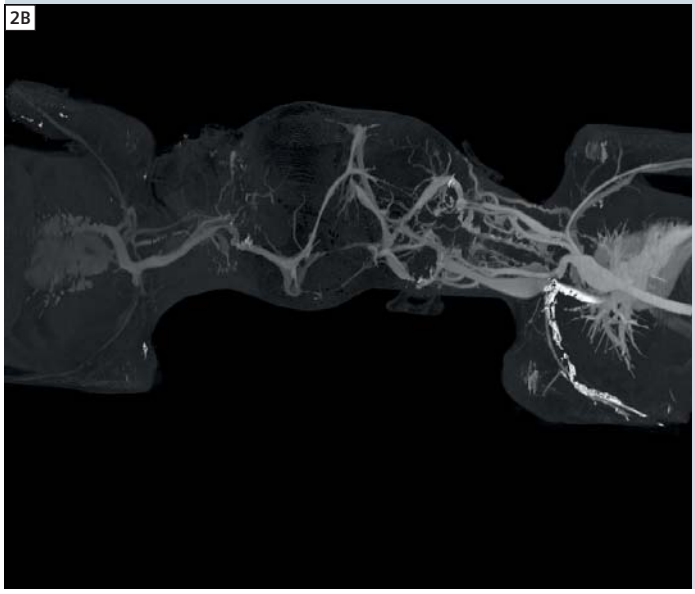
Two children, 3 ½-year-old female twins, fused at the cranium since birth (craniophagus), were transferred to the department of radiology for prearrangement of separation. For the pre-operative diagnosis and surgery planning, a ~~CT angiography~~ was performed to evaluate the vascular communications between the connected brain tissues of both children. The dissection of these communications was the key challenge for the separation procedure. In preparation for the CT scan and for brain vessel visualization, twin one was injected before twin two and finally, both were injected simultaneously.

DIAGNOSIS

The CT imaging revealed both venous communications as well as arterial connections. The arterial communications were well visualized in the superficial cranial branches of the external carotid. The superficial temporal and frontal artery of twin one and the superficial temporal and occipital artery of twin two were found to be communicating. This brain vessel anomaly was recognized to be the reason for volume overload in the brain tissue of twin two, thus resulting in hypertensity.

COMMENTS

The results of the CT imaging provided excellent orientation for the surgical team to prepare a safe separation of the twins.
A CT-Angiography was preferred over an MR-Angiography due to the very short scan time required. This allowed a short sedation time, lowering the sedation risks for the children while concurrently delivering excellent image quality.
With ~~dual energy~~ CT-Angiography, small vascular communications could be visualized that are critical in a pre-operational workup. This information is important to know exactly – before starting a surgery of this difficulty and severity.



2 MIP visualization of vessel-connection: inflow of contrast media into the arteries of twin 1 (left) with drainage via the venous vessel system of twin 2 (right) (Fig. 2A) and vice versa in a second CT-scan afterwards (Fig. 2B).

EXAMINATION PROTOCOL

Scanner	*SOMATOM Definition*
Scan area	*head*
Scan length	*500 mm*
Scan time	*16 s*
Scan direction	*cranio-caudal*
Tube voltage A/B	*140/80 kV*
Tube current A/B	*70/297 quality ref. mAs*
Rotation time	*0.5 s*
Spatial resolution	*0.33 mm*
Slice collimation	*0.6 mm*
Slice width	*0.6 mm*
Kernel	*H10f*

Case 10

A Rare Anomaly of the Middle Cerebral Artery Detected by Three-Dimensional Subtraction CT-Angiography

Jacqui Fielding

Department of Radiology, Angliss Hospital, Upper Ferntree Gully, Melbourne VIC, Australia

HISTORY

A 66-year-old woman with a history of hypertension and recent headaches presented at ~~our~~ hospital with an acute onset of vertigo, fatigue and severe headache. On examination and questioning of the patient, it was found that her mother died at an early age from complications of a cerebral aneurysm. The patient was referred for a brain CT and brain CTA to rule out sub-arachnoid hemorrhage and aneurysm.

DIAGNOSIS

The non-enhanced brain CT shows no sign of subarachnoid bleeding. Using the functionality of digital subtraction CT-Angiography, automatically subtracting a non-contrast from a contrast enhanced study, the complete cerebrovascular tree could be demonstrated and two progressed aneurysms in the middle cerebral arteries could be detected.

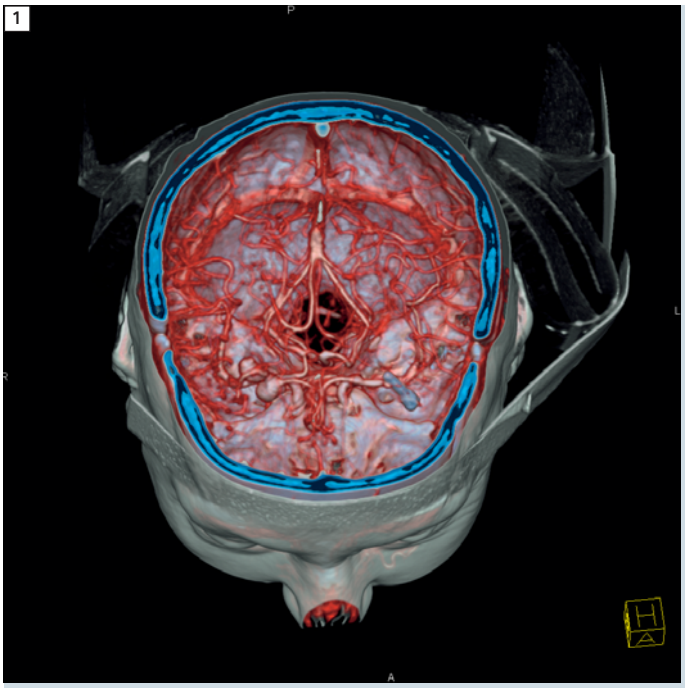
*Duplication of the middle cerebral artery

COMMENTS

In this 66-year-old woman, preoperative angiography and 3-dimensional computed tomography angiography revealed a double aneurysm at the right middle cerebral artery (Circle of Willis). Both aneurysms were clipped and superficial temporal artery-DMCA* anastomosis was performed. She was discharged with no neurologic deficits.

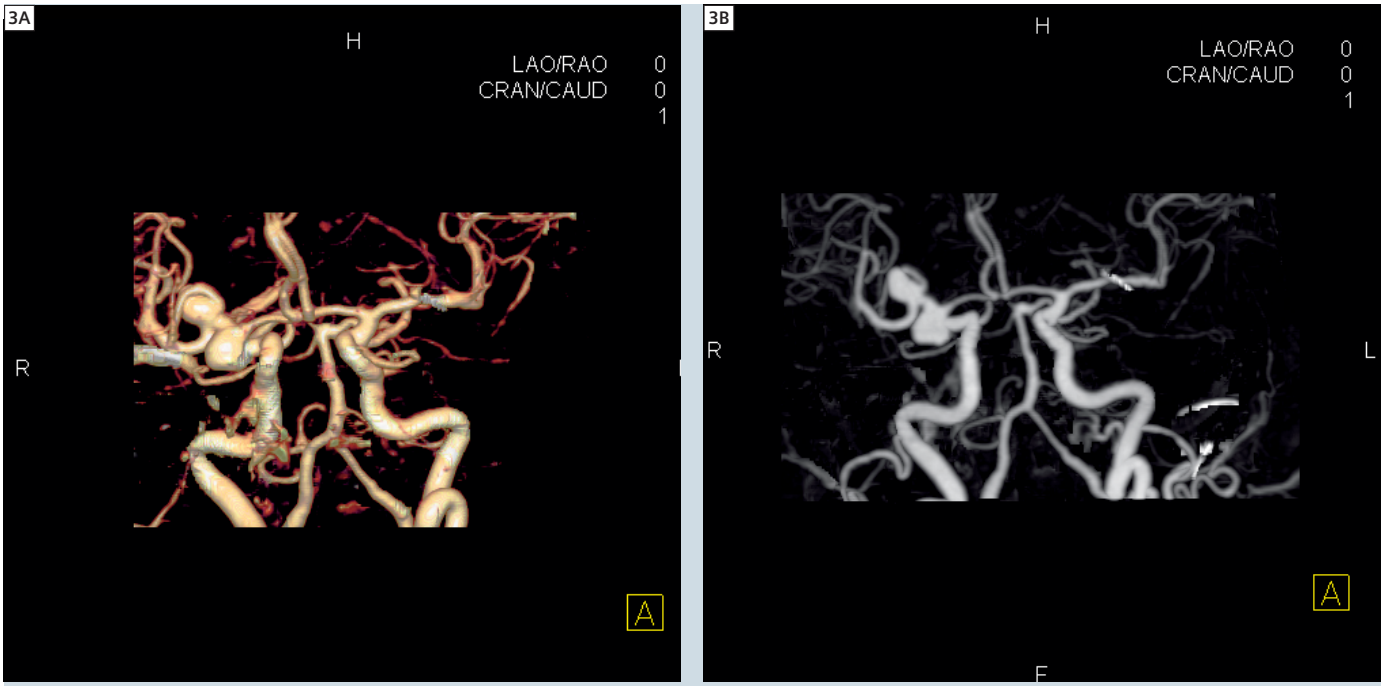
EXAMINATION PROTOCOL

Scanner	*SOMATOM Emotion 16*
Scan area	*Circle of Willis*
Scan length	*80 mm*
Scan direction	*caudo-cranial*
Scan time	*7 s*
Tube voltage	*100 kV*
Tube current	*100 Eff. mAs*
Dose modulation	*CARE Dose off*
$CTDI_{vol}$	*15 mGy*
Rotation time	*0.6 s*
Pitch	*0.8*
Slice collimation	*16 x 0.6 mm*
Slice width	*0.75 mm*
Reconstruction increment	*0.5 mm*
Reconstruction kernel	*H31*
Contrast	*Ultravist 370*
Volume	*50 ml*
Flow rate	*4 ml/s*
Iodine delivery rate	*4 ml/s*
Start delay	*CARE Bolus*
~~***Postprocessing***~~	



1 View into the brain via Volume Rendering Technique (VRT), showing the position of the double aneurysm in the Circle of Willis.

2 Detailed VRT image, showing both ~~aneurisms,~~ located consecutively in an aortic brain vessel.



3 View on the two ~~aneurisms~~ in the Circle of Willis, virtually separated from brain tissue in VRT (Fig. 3A) and in comparison in MIP (Fig. 3B).