Cerebellar Arteriovenous Malformation – Complicated by Active Bleeding?

By Wuchao Li, MD; Rongpin Wang, MD; Hui Song, MD; Chong Tian and Xing Ming
Department of Radiology, Guizhou Provincial People's Hospital, Guiyang, P. R. China

History

A 17-year-old female patient, suffering from an acute onset of a severe headache for the past 24 hours, was admitted to the emergency department. She neither had neurological symptoms, such as nausea, vomiting or confusion, nor a recent history of trauma. Physical examination revealed a decreased muscle tone in the right lower limb. An immediate cerebral non-contrast CT examination showed a hematoma with peripheral edema in the left cerebellar hemisphere (Fig. 1a). A Dual Energy CT (DECT) was requested to further investigate the cause of the hematoma and to rule out active bleeding.

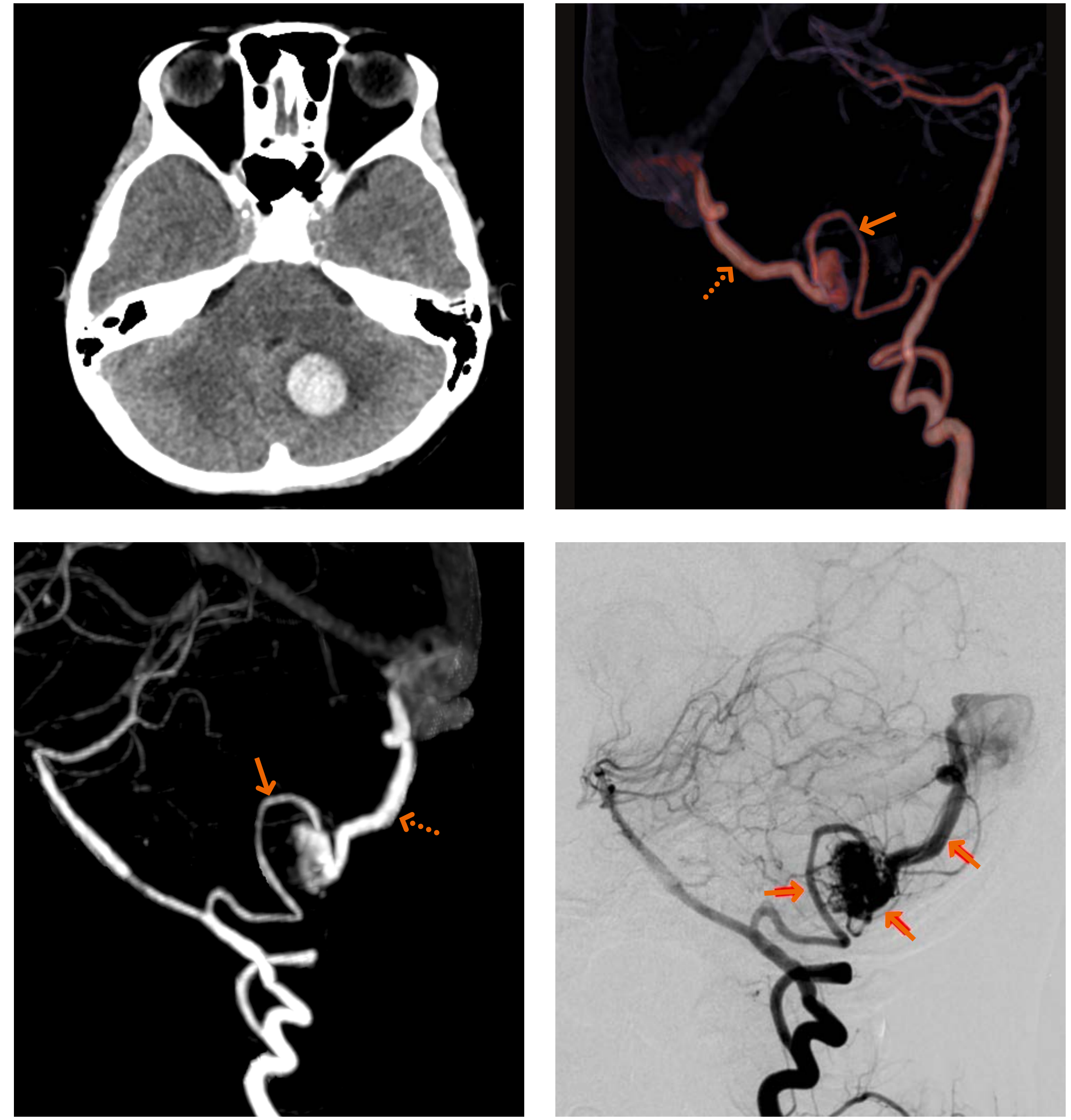
Diagnosis

DECT angiography (CTA) images showed malformed vessels in the area of the left cerebellar hematoma, measuring approximately 10 mm × 6 mm × 10 mm in size. An anomalous feeding artery, arising from the posterior inferior cerebellar artery, and an enlarged vein draining into the torcular herophili were revealed (Figs. 1b and 1c). These findings suggested an arteriovenous malformation (AVM). DE Virtual

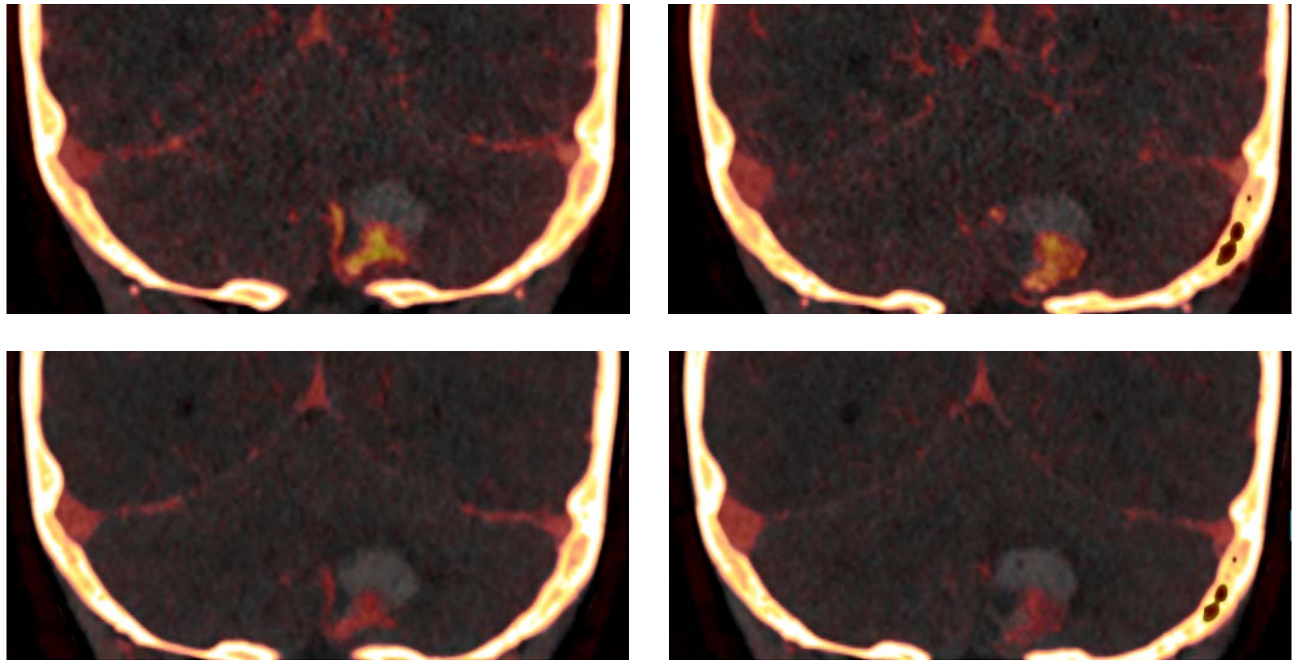
Examination Protocol

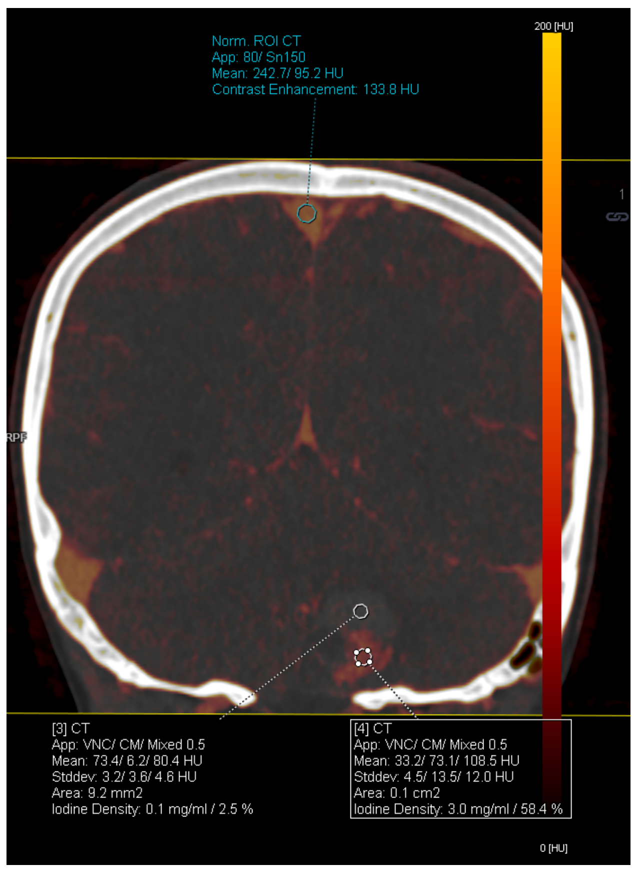
Scanner	**SOMATOM Force**	
Scan area	Head&Neck	Head
Scan mode	Dual Energy	Dual Energy
Scan length	299 mm	133 mm
Scan direction	Caudo-cranial	Caudo-cranial
Scan time	1.9 s	5 s
Tube voltage	80 / Sn150 kV	80 / Sn150 kV
Effective mAs	72 / 56 mAs	205 / 150 mAs
Dose modulation	CARE Dose4D™	CARE Dose4D™
$CTDI_{vol}$	3.76 mGy	21.44 mGy
DLP	130 mGy cm	331 mGy cm
Effective dose	0.4 mSv	1.02 mSv
Rotation time	0.25 s	0.5 s
Pitch	0.7	0.7
Slice collimation	192 × 0.6 mm	64 × 0.6 mm
Slice width	1 mm	1 mm
Reconstruction increment	0.7 mm	0.7 mm
Reconstruction kernel	Qr40	Qr40
Contrast	370 mg/mL	–
Volume	30 mL	–
Flow rate	5 mL/s	–
Start delay	Bolus tracking with 100 HU in the aortic arch + 2s	30 s after CTA scan

1a 1b 1c 1d



1 An axial image (Fig. 1a) shows a hematoma with peripheral edema in the left cerebellar hemisphere. VRT (Fig. 1b), and MIP (Fig. 1c) images reveal an anomalous feeding artery (arrows) arising from the posterior inferior cerebellar artery, the malformed vessels, and an enlarged vein (dashed arrows) draining into the torcular herophili. A DSA image (Fig. 1d) confirmed the CT finding.





2 DE virtual unenhanced images acquired in the arterial phase (Figs. 2a and 2b) and in the later phase (Figs. 2c and 2d) show irregular contrast enhancement around the malformed vessels, implying active bleeding.

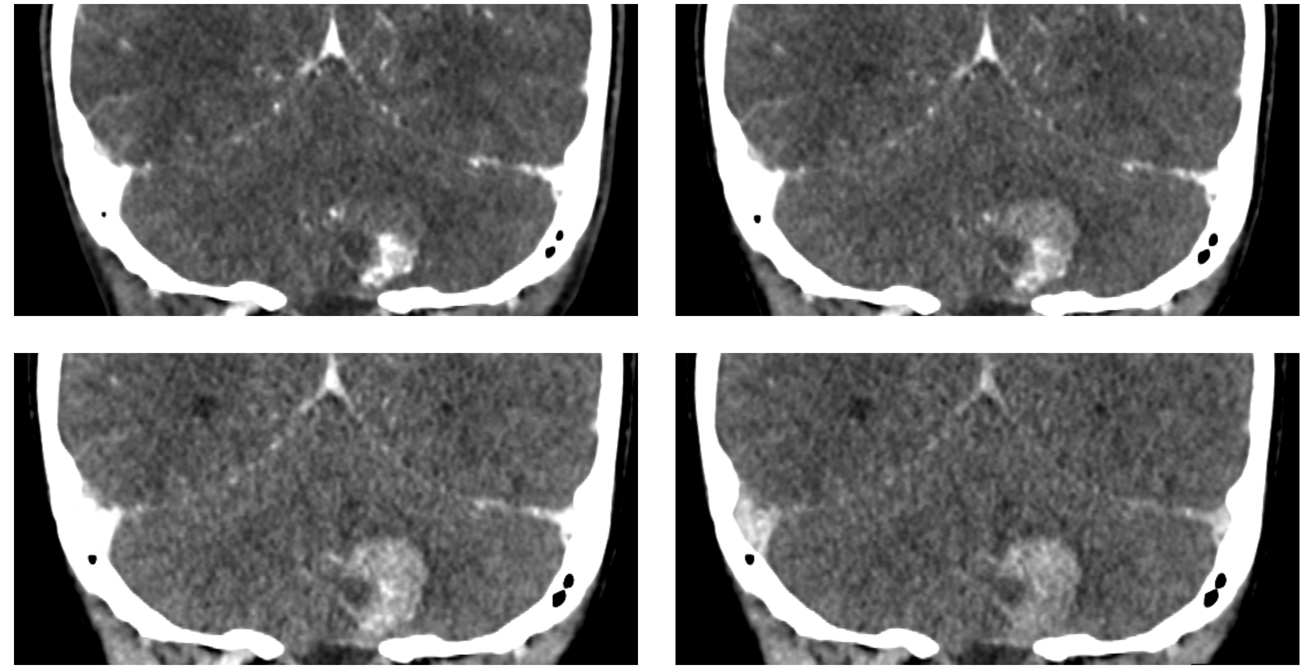
3 The evaluation of the iodine concentration in the suspicious active bleeding area (ROI 4) and in the hematoma (ROI 3) shows a significant difference. An ROI (in blue) is also placed in the sagittal sinus for normalization.

Unenhanced (Figs. 2 and 3) and Monoenergetic Plus (Fig. 4) images showed irregular contrast enhancement around the malformed vessels, implying active bleeding.

The CT findings of a cerebellar AVM were confirmed by digital subtraction angiography (DSA) (Fig. 1d) in subsequent interventional therapy.

Comments

An AVM, consisting of a congenital abnormal tangle of blood vessels without capillaries,[1] is a significant cause of intracranial hemorrhage in young adults.[2] DSA has been the golden standard for the diagnosis of AVMs due to its high temporal and spatial resolution.[3]



4 DE Monoenergetic Plus images displayed at 40 keV (Fig. 4a), 70 keV (Fig. 4b), 90 keV (Fig. 4c) and 120 keV (Fig. 4d) energy levels show significant differences in the image contrast. The enhancement and its differences in the malformed vessels and in the active bleeding areas are significantly improved at 40 keV.

Although therapy decision heavily relies upon DSA results, DECT angiography has increasingly gained importance for initial diagnostic work-up, since it is able to display high quality images of the feeding arteries and draining veins, using *syngo*.CT DE Direct Angio. This feature can support to differentiate hemorrhages from contrast agent and as well can quantify the iodine uptake using *syngo*.CT DE Virtual Unenhanced. This helps to increase the diagnostic confidence of the physician when active bleeding in the hematoma needs to be clarified. Furthermore, images can be displayed at energy levels between 40 and 190 keV and image contrast can be significantly enhanced at lower energy levels using *syngo*.CT DE Monoenergetic Plus. Hereby, the differentiation between the hematoma and the active bleeding areas can be greatly improved. All applications are performed in an automated workflow.

The three dimensional features of AVMs including feeding artery, malformation vascular mass and draining vein, can be clearly demonstrated and highlighted by volume rendering technique (VRT). In addition, DECT images can clearly demonstrate variable imaging characteristics such as the relationship between an AVM and the surrounding cerebral structures. This is crucial for treatment planning and for prognosis prediction.[4] Therefore, DECT can serve as a rapid and reliable diagnostic approach for identifying an underlying AVM complicated by active bleeding. ●

References

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