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CT angiography of intracranial aneurysms related to arteriovenous malformations: a cautionary tale

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Abstract Computed tomographic angiography (CTA) has a high sensitivity and specificity for the detection of intracranial aneurysms and is increasingly used as the primary imaging modality in the investigation and pretreatment planning of patients presenting with acute subarachnoid haemorrhage. We present two cases in which CTA failed to demonstrate arteriovenous malformations associated with intracranial aneurysms.

Keywords Angiography · Arteriovenous malformation · Computed tomography · Subarachnoid haemorrhage

Introduction

The advent of multidetector row technology has led to considerable progress in the field of computed tomographic angiography (CTA) in the detection and characterization of intracranial aneurysms [1]. As a result, an increasing number of departments are relying on CTA for pretreatment planning when intracranial aneurysms are demonstrated. We report two cases in which CTA accurately identified very small aneurysms but failed to identify the associated arteriovenous malformation (AVM).

Case reports

Case 1

A 68-year-old woman presented to her local hospital with a 12-h history of severe right-sided headache, vomiting and collapse. Computed tomography (CT) showed diffuse subarachnoid haemorrhage (SAH) and CTA with three-dimensional reconstructions of the intracranial circulation demonstrated an aneurysm of the distal left posterior inferior cerebellar artery (PICA) (Fig. 1a). Intra-arterial digital subtraction angiography (IADSA) performed 24 h later showed the aneurysm arising from the retrotonsillar segment of the left PICA, which supplied a small peripheral left cerebellar AVM (Fig. 1b). CT suggested that the aneurysm was responsible for the haemorrhage. The aneurysm was successfully embolized with a single injection of histoacryl with partial embolization of the nidus (Fig. 1c).

Case 2

A 72-year-old man presented 1 h after onset of an acute, severe occipital headache. CT demonstrated acute SAH, predominantly within the posterior cranial fossa. CTA revealed a 2 mm diameter aneurysm arising from the right side of the distal basilar artery (Fig. 2a,b). No other vascular abnormalities were shown. IADSA prior to endovascular treatment showed the aneurysm arising from an abnormally large branch of the basilar artery,

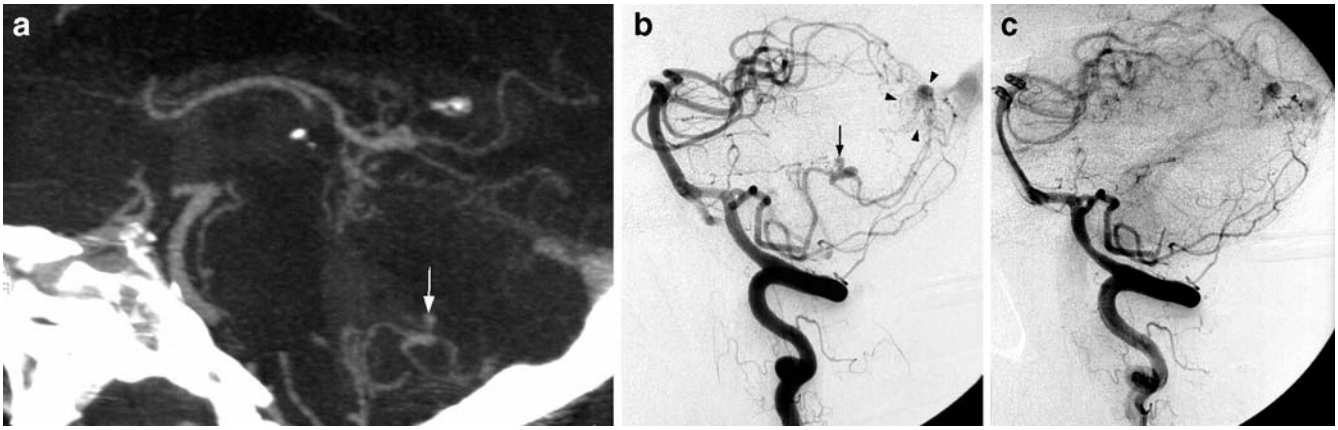


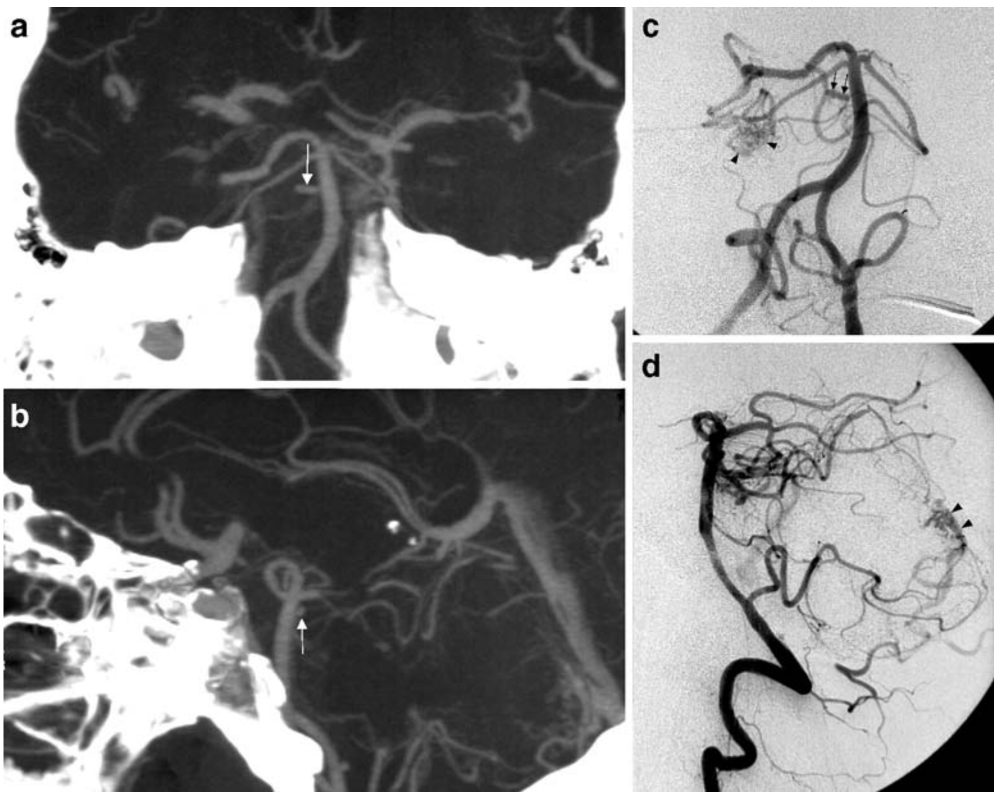
Fig. 1 **a** Sagittal CTA reconstruction showing an isolated distal left PICA aneurysm (*arrow*). **b** Lateral projection, left vertebral angiogram, demonstrates a small peripheral AVM (*arrowheads*) supplied by the left PICA. The associated distal PICA aneurysm is shown (*arrow*). **c** Angiogram after histoacryl embolization showing complete aneurysm occlusion and partial AVM occlusion

supplying a small AVM closely related to the right transverse sinus (Fig. 2c,d). Imaging suggested that the aneurysm was responsible for the haemorrhage. The parent vessel proved too small for the introduction of a microcatheter, precluding attempted coiling of the aneurysm. The use of liquid embolic agents was considered potentially harmful owing to the proximal location of the aneurysm. Surgery in this area was also considered too risky and the patient was therefore managed conservatively. He made a good recovery and remains well.

Discussion

1Single-slice CT (SSCT) angiography has been reported to detect intracranial aneurysms with sensitivities in the range 67–100% and an accuracy of 90% [2, 3]. This technique is significantly more sensitive at detecting aneurysms larger than 2 mm in diameter (95% sensitivity). With aneurysms less than 2 mm in diameter, sensitivity falls to 53% (CI 44–62%) [1, 3]. SSCT angiography also performs poorly in detecting aneurysms adjacent to bone or where there is

Fig. 2 **a**, **b** Coronal and sagittal CTA reconstructions showing a 2 mm diameter aneurysm arising from the right side of the distal basilar artery (*arrows*) below the superior cerebellar artery. There is no evidence of an associated AVM. **c**, **d** Frontal and lateral projections, left vertebral angiogram, show the aneurysm arising from a dilated perforating branch of the basilar artery (*arrows*) which supplies a peripheral AVM (*arrowheads*)



considerable vessel overlap such as the paraclinoid region and the terminal internal carotid artery segments [1]. Multislice CT (MSCT) angiography, now widely available, circumvents most of these limitations by allowing acquisition of thinner, overlapping slices and enabling more reliable imaging during peak arterial opacification, avoiding venous contamination and thereby improving the quality of 2D and 3D reconstructions [1]. In a comparative study of 50 patients investigated with both CTA and IADSA, Wintermark et al. [1] found that MSCT angiography detected aneurysms greater than 2 mm in diameter with a sensitivity of 94.8%, a specificity of 95.2% and an accuracy of 94.9%; inter-observer agreement was high, at 98%. Like other investigators, they found 2 mm to be the apparent cut-off size below which the sensitivity of CTA was significantly lower—approximately 50% [1]. In a computer simulation and meta-analysis, van Gelder [3] reported that CTA should be able to demonstrate all aneurysms larger than 7 mm in diameter.

In the cases reported here, the aneurysms demonstrated were approximately 2 mm in diameter and were confirmed as the source of haemorrhage based on the distribution of blood on CT. The characteristics of the aneurysms required to allow treatment planning were adequately demonstrated in both cases; however, CTA failed to identify that these aneurysms were associated with AVMs.

CTA has previously been shown to provide valuable information regarding the size, site, orientation and patterns of feeding arteries and draining veins of known AVMs prior to stereotactic radiosurgical treatment [4]. In a report of 86 patients imaged with CTA following non-traumatic intracranial haemorrhage, Sasiadek et al. [5] identified six AVMs on CTA; however, two were shown to be false-positives at IADSA or surgery. The AVMs in our cases were small and lay peripherally in the posterior cranial fossa, which made them difficult to detect. Our technique was also optimized for demonstration of the arterial phase of enhancement with minimal venous contamination, whereas optimal demonstration of venous drainage patterns of AVMs requires a longer time-delay before image acquisition. IADSA, on the other hand, provides dynamic information and is currently regarded as the reference examination for AVM demonstration [5, 6].

The association of AVMs with intracranial aneurysms is well recognized [6–9]. The aneurysms may be within the AVM nidus or on the feeding arteries (flow-related), or may be coincidental and unrelated to the AVM [6, 8, 10, 11]. The reported frequency of AVM-related aneurysms varies from 2.7% to 58% [6, 9, 12] depending on the quality of the angiography, interpretation of the angiograms and whether superselective angiography is performed. Intranidal aneurysms may be difficult to distinguish from post-haemorrhagic pseudoaneurysms within the nidus and this may, in part, explain some of the discrepancies in the reported incidence of intranidal aneurysms [6, 13].

The risk of AVM haemorrhage is significantly higher in patients with associated aneurysms [6, 9, 14]. Where aneurysms exist in association with AVMs, they are more likely to rupture if they lie peripherally on the feeding artery [8, 9, 15]. The risk of rupture is also higher for aneurysms related to infratentorial AVMs [8]. In general, the AVM appears to be as likely to rupture as the associated aneurysm [6, 16]. However, in both our cases the aneurysm was responsible for the haemorrhage. This concurs with the experience of Westphal and Grzyska [8] and Batjer et al. [15] who found the aneurysms significantly more likely to be the bleeding source.

Treatment strategies for combined lesions presenting with haemorrhage require a thorough understanding of the AVM and associated aneurysms. Where the aneurysm is deemed to have ruptured, or where it is unclear which lesion has bled, the strategy would be to exclude the aneurysm from the circulation first and then treat the AVM [8–10]. Treatment of both lesions at the same time can often be achieved using endovascular techniques. The failure of CTA to demonstrate an associated AVM leads to an incomplete understanding of the lesion, resulting in inappropriate treatment planning. It would therefore be advisable in all cases where an AVM is suspected, or where aneurysms are demonstrated in a distal or unusual location such as the posterior cranial fossa, for complementary IADSA to be performed prior to any treatment planning.

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