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MRI and MR angiography of persistent trigeminal artery

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Abstract We describe the MRA and MR angiography (MRA) features of persistent trigeminal artery (PTA) found incidentally in eight patients, with special attention to its origin, site and course. The different patterns of posterior communicating arteries were also noted. The PTA were shown on sagittal, coronal and axial MRI and on MRA. In four cases, the PTA arose from the lateral aspect of the intracavernous internal carotid artery, ran caudally, passing round the bottom of the dorsum sellae to join the basilar artery. In the other four cases, it arose from the medial aspect, ran caudally through the sella turcica and pierced the dorsum sellae to join the basilar artery. The posterior communicating arteries were present unilaterally in five cases and bilaterally in one, and absent bilaterally in two. Identification of a PTA with a trans-sellar course is crucial if a trans-sphenoidal surgery is planned.

Key words Artery, trigeminal · Arteries, anomalies · Magnetic resonance imaging · Magnetic resonance angiography

Introduction

The trigeminal artery is the most common primitive carotid-basilar anastomosis to persist in adulthood. The angiographic patterns of persistent trigeminal artery (PTA) are well-known but the exact relationships of the PTA with the surrounding structures cannot be appreciated on angiographic images. Using high-resolution MRI and MR angiography (MRA), we demonstrated in vivo the origin, the course and relationships of the PTA.

Materials and methods

We found eight patients (4 males, 4 females, age 7–64 years) to have a PTA. In 6 cases, the PTA was identified on arteriography performed for transient ischaemic attack (1 case), stroke (1), headaches (1), intracerebral haemorrhage (2) or venous malformation of the scalp (1). In these patients high-resolution MRI and/or MRA was then performed. In two other cases, PTA was demonstrated on high-resolution MRI of the sellar region performed to investigate a pituitary macroadenoma after trans-sphenoidal surgery or to examine a child presenting with precocious puberty; arteriography was not performed in these patients.

All the MRI examinations were conducted at 1.5 T. High-resolution MRI studies included sagittal (6 cases), axial (6) and coronal (1) spin-echo (SE) T1-weighted images: TR 500 TE 14 ms, 3 acquisitions, 300 × 512 matrix, 240 mm field of view (FOV), 3-mm section thickness. Coronal (1 case) and sagittal (2) fast SE T2-weighted sequences were also performed: TR 5000 TE 90 ms, 2 acquisitions, 288×512 matrix, 260 mm FOV, 3-mm section thickness. In all cases, MRA was performed with a 3D-FISP sequence (TR 40, TE 8 ms, flip angle 15°, imaging slab 50–60 mm thick, 64 partitions, 256 × 512 matrix size). The MRA source images were carefully analysed, then the data were postprocessed with a maximum intensity projection (MIP) algorithm to obtain 2D projections.

Results

A PTA was observed on the right side in five cases and on the left in three, as a flow void on T1- and T2-weighted images. In all cases, the MRA source images provided better delineation of the course of the PTA

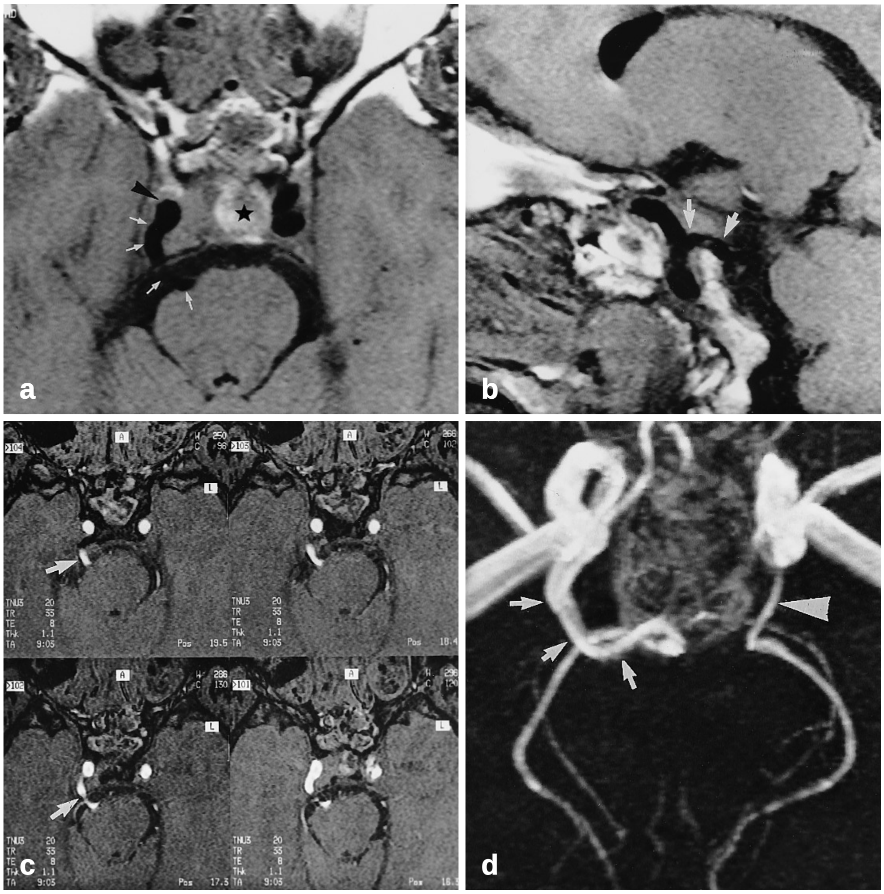


Fig. 1 a–d A 52-year-old female examined 48 h after haemorrhagic trans-sphenoidal surgery for a nonsecreting pituitary macroadenoma. **a** Axial T1-weighted image. Persistent trigeminal artery with laterosellar course *(small white arrows)*. Intracavernous internal carotid artery *(arrowhead)*. Surgical packing of the pituitary fossa *(star)*. **b** Right parasagittal T1-weighted image demonstrating the origin of the persistent trigeminal artery *(arrows)* from the intracavernous internal carotid artery. **c** MRA. Axial source images. The laterosellar course of the persistent trigeminal artery is well shown *(arrows)*. **d** MRA. Axial MIP of the circle of Willis. Persistent trigeminal artery with laterosellar course *(arrows)*. Left posterior communicating artery *(arrowhead)*

than the T1-weighted images. In four cases, the PTA arose from the lateral aspect of the intracavernous internal carotid artery, then ran caudally and passed round the bottom of the dorsum sellae. After a short cisternal course, medial to the trigeminal nerve, it joined the basilar artery (Fig. 1). In the other four cases, the PTA arose from the medial aspect of the siphon and ran caudally within the pituitary fossa, in close contact with the gland. It then, ascended sharply to pierce the dorsum sellae, passed across the ambient cistern and joined the basilar artery (Figs. 2, 3).

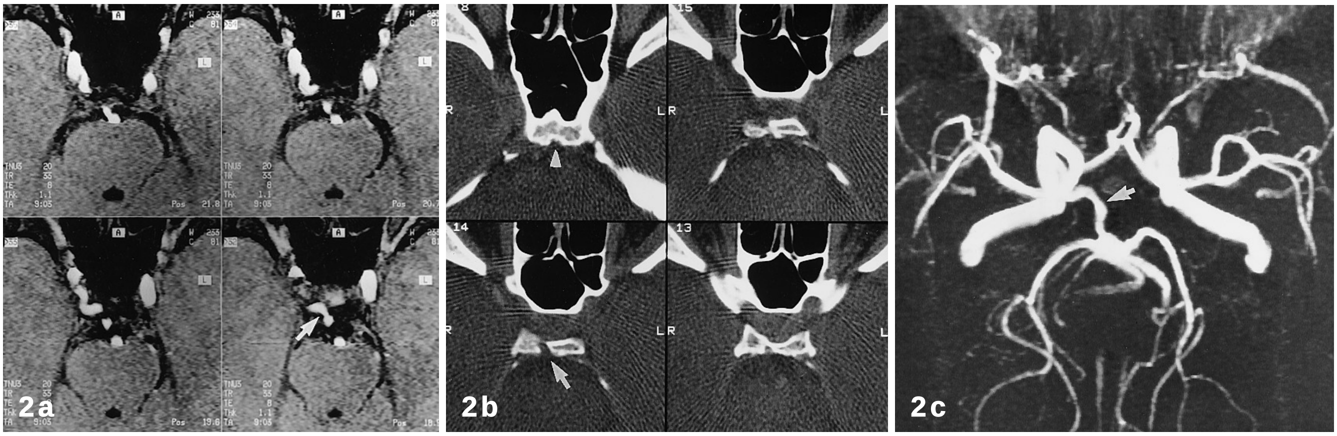
The PTA ranged from 1.7 to 4 mm in diameter. The posterior communicating arteries (PCommA) were identified on MRA. They were present bilaterally in one case and unilaterally in five, contralateral to the PTA in four cases and ipsilateral in one; there was no PCommA on either side in two cases.

Discussion

The prevalence of the PTA ranges from 0.1 to 1 % according to autopsy and angiographic studies [1, 2]. It originates from the internal carotid artery, proximal to the meningohypophyseal trunk, at the point where it leaves the carotid canal and penetrates the cavernous sinus. Anatomical and radiological studies have shown variations in its course [3–9]. The usual course is from the posterolateral wall of the internal carotid artery to the posterior dural surface of the cavernous sinus, where it lies medial to the ophthalmic branch of the trigeminal nerve and grooves the dorsum sellae. In other cases, the PTA originates from the posteromedial aspect of the internal carotid artery and has an intrasellar course in close contact with the pituitary gland. The artery ascends from the sellar floor and pierces the dorsum sellae. Only five cases of PTA with an intrasellar course have been previously documented on MRI [4–7].

The two variants could have different embryological origins. The so-called PTA with an intrasellar course could, in fact, be the persistent primitive maxillary artery in its intracavernous portion. This artery is an embryonic vessel which originates from the medial surface of the C5 portion of the carotid siphon; it supplies the posterior pituitary and anastomoses with the contralateral primitive maxillary artery.

Asymmetry of the circle of Willis with aplasia or hypoplasia of the PCommA has been reported as the most



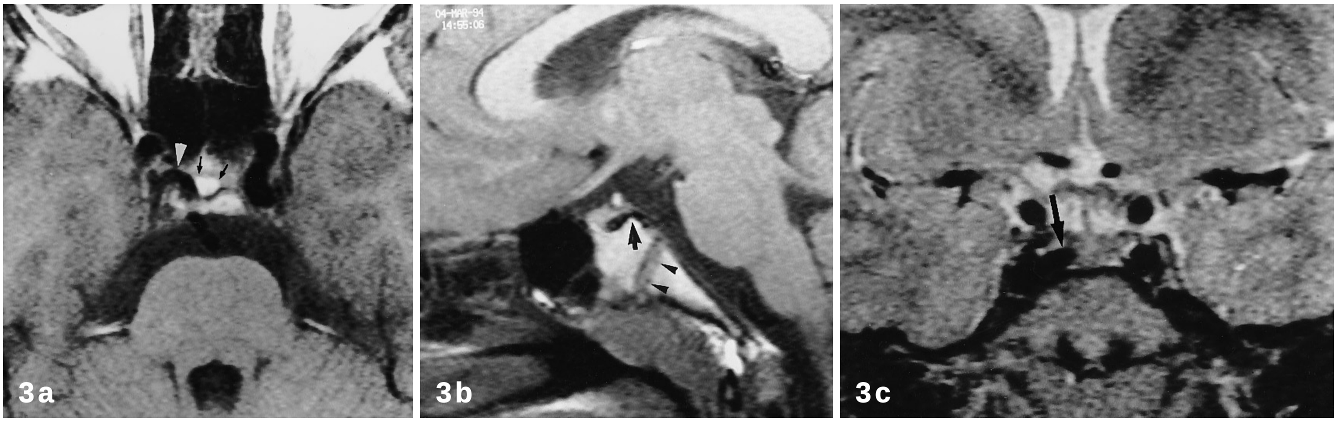


Fig. 2 a–c A 23-year-old woman with headaches. **a** MRA. Axial source images showing on the right a tortuous intrasellar persistent trigeminal artery piercing the dorsum sellae *(arrow)*. **b** Axial CT. The artery grooves the inferior part of the dorsum sellae *(arrowhead)*. At the midsellar level, the canal for the trigeminal artery in the dorsum sellae is clearly identified *(arrow)*. **c** MRA. Axial MIP of the circle of Willis. Medially located persistent trigeminal artery *(arrow)*

Fig. 3 a–c A 7-year-old boy examined for precocious puberty. **a** Axial T1-weighted image. The intrasellar persistent trigeminal artery *(arrowhead)* is in close contact with the pituitary. The posterior lobe *(arrows)* seems slightly compressed on the right. **b** Right parasagittal T1-weighted image. The persistent trigeminal artery pierces the inferior part of the dorsum sellae *(arrow)*. Spheno-occipital synchondrosis *(arrowheads)*. **c** Coronal T2-weighted image demonstrating the intrasellar course of the artery *(arrow)*

common abnormality associated with a PTA [10]. Demonstration of a proximal hypoplastic basilar artery below the abnormal communication, with enlargement above, has been considered an ancillary sign of PTA [11]. There are reports of 16 cases of aneurysm of a PTA, associated in one case with a thrombosed aneurysm of the vertebrobasilar system, [12].

There is usually no clinical correlate of the presence of a PTA. Demonstration of a PTA can, however, have clinical significance: paradoxal ischaemic lesions in the vertebrobasilar territory can occur in case of occlusive disease or embolic lesion of the internal carotid artery. Failure to recognise an intrasellar PTA could result in massive haemorrhage during trans-sphenoidal surgery for pituitary adenoma.

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BOOK REVIEW

Harris, J. H., Jr., Mirvis, S. E.: The Radiology of Acute Cervical Spine Trauma, 3rd ed. Williams & Wilkins 1996. ISBN 0-683-03929-6, hardcover, £ 80.00.

I have in my possession the first edition of this splendid book, first published in 1978. To someone who has been a neuroradiologist for a quarter of a century, its appearance 18 years ago was a godsend. Many are the times, pre-Harris, that I have sat with a metaphorical cold towel around my sweating brow trying to interpret complex cervical trauma cases with my neurosurgical colleagues demanding instant answers. Read Harris and all becomes transparently clear.

In the preface to the first edition Dr. Harris says “This work was born of the frustration engendered by the lack of a ready source of reference for assistance in the evaluation of acute cervical spine injuries, as encountered in a busy general practice of radiology. It is designed to ameliorate similar frustrations which might be experienced by other radiologists, orthopaedic and neuro surgeons, emergency physicians and others involved in the diagnosis and management of patients with acute cervical spine injury.” It does.

I now know that I am not alone in thinking that trauma to the cervical spine is complex and worrying. In the foreword to the 3rd edition Theodore Keats states that “I have always considered the cervical spine to be one of the most difficult and challenging anatomies to image and analyse radiographically.” It is.

The first edition had 116 pages including the index, the new 3rd edition has 512. There has been considerable expansion and new concepts on the mechanism of cervical spine trauma have been included and CT images used where relevant. A section on MRI has been added which makes valid points and is very good. I do, though, wonder why it is still necessary to have 25 pages of MR physics and artefacts when this is available in so many other books and journals. There are of course mistakes; in a section on imaging techniques and choice of procedures a table suggests that CT is not indicated in, amongst others, bilateral interfacetal dislocation, whereas in the text it is recommended. My own practice would be to do CT in case associated fractures of the facet joints make closed reduction difficult or impossible. A figure showing a suggested algorithm of imaging steps is too small for your presbyopic reviewer and some of the abbreviations are uninterpretable. Don’t let this put you off; it is a very good book.

Buy it. It only costs £ 80.00 and may save you or your hospital many thousands, even hundreds of thousands of pounds if you read, mark, learn and inwardly digest [1] its content.

R. M. Paxton, Plymonth

Reference

1. Collect for the Second Sunday in Advent