Surgical and Radiologic Anatomy (2019) 41:703–705
https://doi.org/10.1007/s00276-019-02209-8

ANATOMIC VARIATIONS

Replaced posterior cerebral artery (PCA): origin of all branches of the PCA from the anterior choroidal artery diagnosed by MR angiography

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Received: 29 September 2018 / Accepted: 20 February 2019 / Published online: 3 April 2019

Abstract
We present a rare variant of the right posterior cerebral artery (PCA), recently named "replaced PCA," that demonstrates the origin of all its branches from the right anterior choroidal artery (AChA) on magnetic resonance (MR) angiography. In this variation, the right posterior communicating artery (PCoA) is hypoplastic and resembles the transposition of the AChA and PCoA. Detection of such rare arterial variations on MR angiographic images requires careful review of images, including source images, and partial maximum-intensity-projection images aid their identification.

Keywords Anterior choroidal artery · Cerebral arterial variation · Magnetic resonance angiography · Posterior cerebral artery · Posterior communicating artery

Introduction

Rarely, the anterior choroidal artery (AChA) is hyperplastic and gives rise to a branch of the posterior cerebral artery (PCA) [1, 6]. The reported prevalence of this variation is 2.3% on catheter angiography [7] and 0.55% on magnetic resonance (MR) angiography [8]. Extremely rarely, all branches of the PCA arise from the AChA, a variant recently named "replaced PCA" [8].

We present a case of this extremely rare variation that was diagnosed by MR angiography.

Case report

A 76-year-old woman with acute right thalamic hemorrhage transferred from a general hospital to our institution for further evaluation and possible treatment.

Five days after the onset of symptoms, the patient underwent cranial MR imaging and MR angiography in our institution using a 3-tesla scanner (Ingenia 3.0T, Philips Medical Systems, Best, The Netherlands) to evaluate the cause of the hemorrhage. MR imaging showed acute hematoma in the right thalamus and ventricular system (Fig. 1). MR angiography was obtained using a 3-dimensional phase-contrast (3D-PC) technique to avoid signals from the hematoma that contained methohemoglobin. Parameters of the 3D-PC MR angiographic protocol were: repetition time, 7.11 ms; echo time, 3.40 ms; 8° flip angle; velocity encoding, 45 cm/sec; field of view, 18.11 × 18.11 cm; and slice thickness, 0.50 mm.

Maximum-intensity-projection (MIP) MR angiographic images showed no vascular lesion relating to the hematoma but did depict the proximal right PCA in a high position (Fig. 2). Partial MIP images of the right carotid system (Fig. 3) demonstrated both infundibular dilatation at the origin of the PCoA and marked hyperplasia of the AChA that supplied all branches of the PCA. An axial reformatted source image (Fig. 4) showed the hyperplastic AChA arising just proximal to the tip of the internal carotid artery (ICA).

The patient underwent no further imaging; the hematoma was treated conservatively; and the hydrocephalus was treated surgically with endoscopic third ventriculostomy 14 days after symptom onset with good clinical course.

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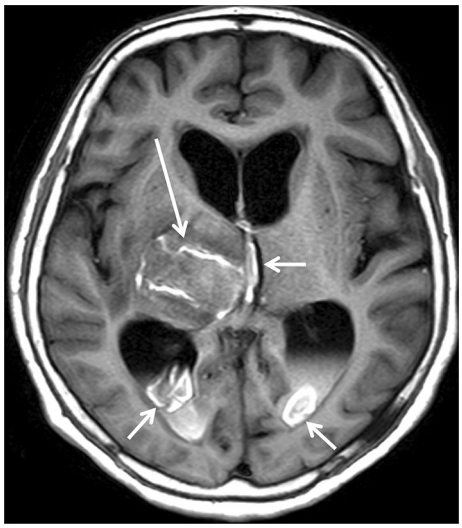

Fig. 1 Magnetic resonance (MR) imaging obtained using a 3-tesla scanner. T_1-weighted image of the basal ganglia/thalamus shows peripherally hyperintense large mass in the right thalamus (long arrow), which indicates acute hematoma. Hematoma was also seen in the third ventricle and bilateral posterior horns of the lateral ventricle (short arrows)

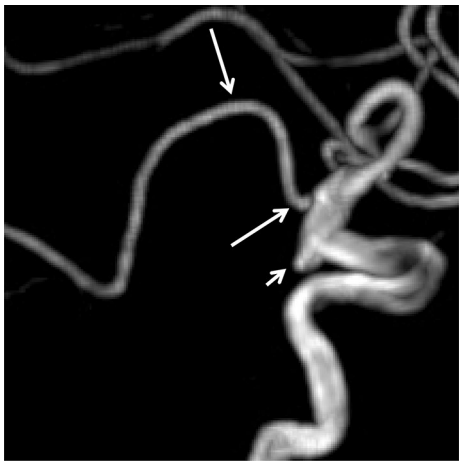

Fig. 3 Lateral partial maximum-intensity-projection (MIP) image of the right carotid system clearly shows aplasia of the posterior communicating artery (PCoA) and infundibular dilatation at its origin (short arrow). The fetal-type PCA arises distally and takes a more cephalad course that resembles the course of the cisternal segment of the anterior choroidal artery (AChA) (long arrows). Although the ventricular segment of the AChA cannot be identified, we diagnosed that the AChA is supplying all branches of the PCA, which indicates this is a "replaced PCA."

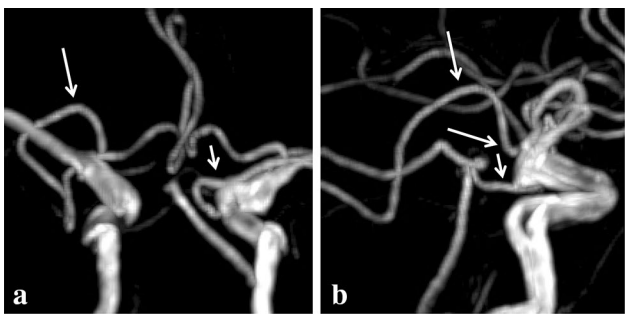

Fig. 2 **a** Anteroposterior (AP) and **b** lateral projections of magnetic resonance (MR) angiography show bilateral fetal-type posterior cerebral arteries (PCAs) and the high position of the proximal right PCA (long arrows). The left PCA takes a normal course (short arrows)

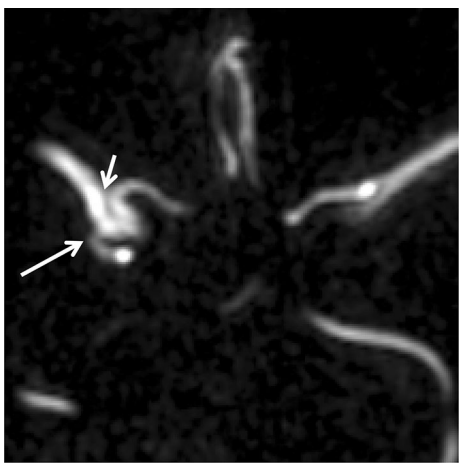

Fig. 4 An axial reformatted source image shows the hyperplastic anterior choroidal artery (AChA) (long arrow) arising just proximal to the tip of the internal carotid artery (ICA) (short arrow). The ventricular segment of the AChA cannot be identified even on source images (not shown)

Discussion

The PCoA and AChA arise from the supraclinoid segment of the ICA, and the AChA generally originates distal to the origin of the PCoA [2]. However, the small diameter of the AChA may frequently prevent its identification on MR angiography because of the low spatial resolution of this modality. The PCoA arises from the supraclinoid ICA and anastomoses with the PCA at the P1–P2 junction; the P1 segment of the PCA is frequently hypoplastic (the so-called fetal-type PCA), as on our patient's left side; the PCoA is also frequently hypoplastic; and the origin of the PCoA is frequently dilated (the so-called infundibular dilatation), as on our patient's right side. This variation is distinguished from an aneurysm at the ICA–PCoA junction by its triangular shape with no neck, maximum diameter smaller than 3 mm, and origin of the PCoA from its apex.

According to Padget [5], most adult arteries in the head region are recognizable in a Stage 5 embryo of 16–18-mm

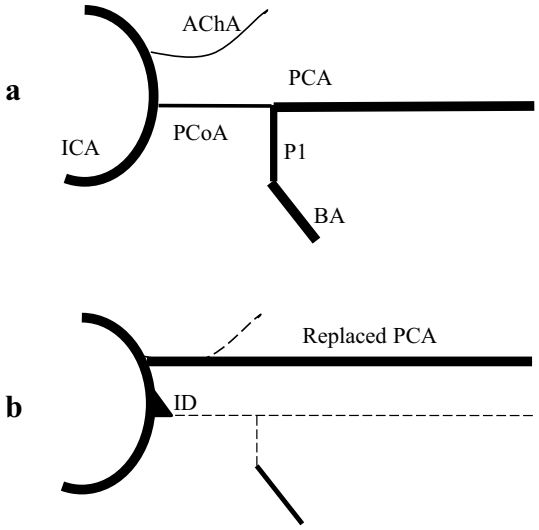

Fig. 5 Schematic illustrations of **a** normal subject and **b** this patient (modified from Ref. [8]). *AChA* anterior choroidal artery, *BA* basilar artery, *ICA* internal carotid artery, *ID* infundibular dilatation, *PCA* posterior cerebral artery, *PCoA* posterior communicating artery, *P1* P1 segment of the PCA

length, and the circle of Willis is complete in a Stage 6 embryo of 20–24-mm length. Arterial variants may develop from failure of fusion or abnormal fusion during these early embryonic stages.

Anastomosis between the AChA and superior branches of the proximal part of the post-communicating segment of the PCA has been reported in a microsurgical anatomic study [3], and rarely, a large AChA gives rise to a branch of the PCA, a variation called hyperplastic AChA [6, 7]. The PCA usually has 4 major cortical branches—the anterior temporal artery, posterior temporal artery, calcarine artery, and parietooccipital artery—and most frequently, the temporal branches of the PCA arises from the AChA, a variant recently named "accessory PCA" [8].

In our patient, all the branches of the PCA arose from the AChA. Figure 5 presents a schematic illustration. Unfortunately, MR angiography did not depict the ventricular segment of the right AChA. If digital subtraction angiography was performed, the tiny distal AChA might be confirmed. This variation may be misdiagnosed as transposition of the AChA and PCoA [1, 4], can be regarded as a variant PCA, and was recently described as "replaced PCA" [8].

Conclusion

We report an extremely rare case of "replaced PCA," in which all branches of the PCA arose from the AChA, that was diagnosed by MR angiography. This variation may be misdiagnosed as transposition of the AChA and PCoA.

Careful review of MR angiographic images that include source images is important to detect rare arterial variations, and partial MIP images are useful for the identification of these anomalous vessels on MR angiography.

Acknowledgements We thank Rosalyn Uhrig, M.A. for her editorial assistance in the preparation of this manuscript.

Author contributions AU carried out the study design and drafting of the manuscript. AU, TK and HK performed data acquisition and made a critical review of the manuscript. All authors have read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest We declare that we have no conflict of interest.

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