



# Fenestrated P1 segment of posterior cerebral artery, partly duplicated posterior communicating artery

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## Abstract

**Purpose** Anatomic variations at the junction of primitive internal carotid and basilar arteries are exceedingly rare. We aimed at reporting such rare variants involving the posterior communicating artery (PCoMA) and the P1 segment of posterior cerebral artery (PCA).

**Methods** The circle of Willis was dissected in an adult cadaver after removal of the cranial vault and cerebral hemispheres.

**Results** The basilar end was rotated axially to the right. The P1 segment of the right PCA was fenestrated and occupied the interpeduncular fossa. The right PCoMA passed over the oculomotor nerve to join the anterior arm of the P1 fenestration. On the opposite side, the PCoMA coursed supero-medially to the oculomotor nerve and it had a partly duplicated posterior end, with two arms, medial, larger, and lateral, thinner, inserting successively into the left PCA.

**Conclusion** Extremely rare anatomic variations of the circle of Willis should not be ignored when endovascular or microneurosurgical specific approaches are intended.

**Keywords** Circle of Willis · Internal carotid artery · Basilar artery · Cerebral artery · Arterial fenestration · Arterial duplication

## Introduction

Fenestrations are vascular variations that begin with a common vascular tube, then split into two parallel luminal channels which further rejoin distally [5]. The prevalence of fenestration of the posterior cerebral artery (PCA) is seemingly very low (0.34%) and is primarily observed in its P1 (precommunicating) segment [8], i.e. the segment from its origin to the insertion of the posterior communicating artery (PCoMA). There have only been a handful of cases in the literature to report fenestrations of the P1 segment of the PCA [5].

Trandafilović et al. brought evidence of prenatal and postnatal anatomic variations of PCoMA [7]. The authors distinguished fenestrations from duplications and classified duplications as partial and total [7].

The anatomical variant presented here was identified following an educational dissection of the base of the skull.

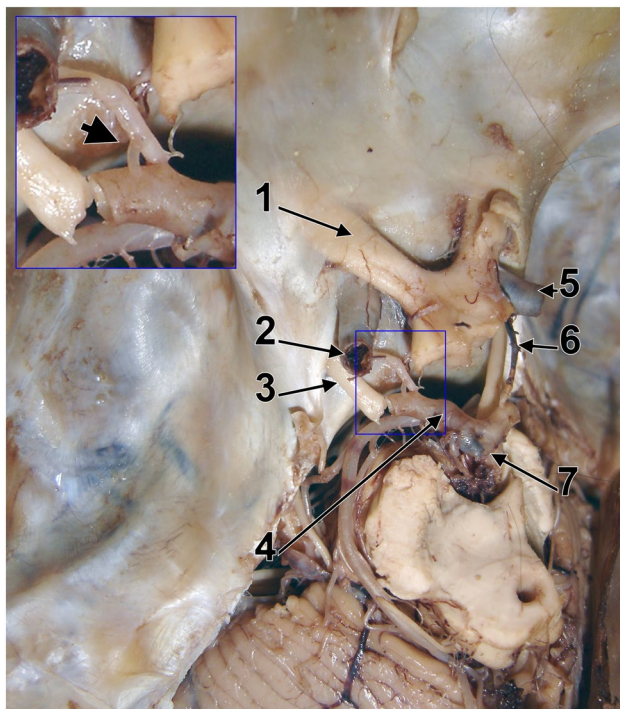
## Anatomic variation

A human adult cadaver of a Caucasian 58-year-old male with sudden cardiac death was dissected for presentation to students. During the dissection targeting the pontocerebellar angles, the cranial vault was removed, then the cerebral hemispheres, thus being accessed the skull base. Dissection within the tentorial notch revealed rare anatomic variants of the posterior part of the circle of Willis (Fig. 1).

The basilar end was found sending bilaterally the PCAs that were further joined to ICAs by the PCoMAs. Immediately inferior to the PCAs origins from the basilar end were found those of the superior cerebellar arteries; on each side the oculomotor nerves coursed between the PCAs and the superior cerebellar arteries. The left and right posterior sides of the circle of Willis were morphologically and topographically asymmetrical. The basilar end was displaced to the left, and rotated axially to

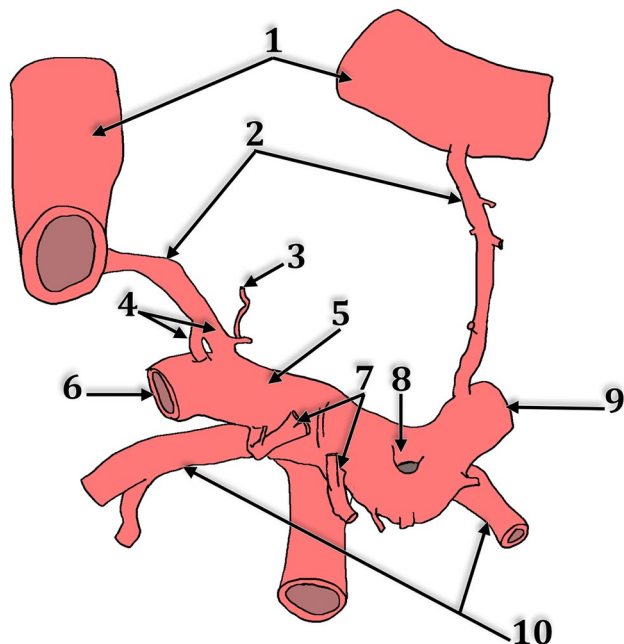
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**Fig. 1** Endocranial skull base dissection after removal of the cerebral hemispheres. Left postero-superior view. 1—Optic nerve; 2—left internal carotid a; 3—oculomotor nerve; 4—basilar artery bifurcation; 5—right internal carotid artery; 6—right string-like posterior communicating artery; 7—annular fenestration of the pre-communicating segment of the right posterior cerebral artery. In inset is digitally magnified the left posterior communicating artery of which posterior end is duplicated (arrowhead)

right. Consequently, the P1 segment of the right PCA was directed postero-laterally, thus occupying the interpuncular fossa. The P1 segment of the left PCA was directed slightly antero-laterally, on the anterior side of left cerebral peduncle. Therefore, the right PComA was longer than the left one. The right PComA coursed supero-medially to the oculomotor nerve to join the right PCA superior to that nerve. The left PComA was supero-medial to the oculomotor nerve on that side. Two double arterial trunks were found, as follows. The P1 segment of the right PCA was fenestrated. That fenestration was transversal, with a posterior and an anterior arm. From the posterior arm of that fenestration left thalamoperforating branches. On the opposite side the P1 segment was also sending off a thalamoperforating branch. The left PComA posterior end divided into two arms, medial and lateral, that joined successively the left PCA. The medial one was larger and sent off a branch for the optic tract. This left variant was regarded as an incomplete posterior duplication of PComA (Fig. 2).



**Fig. 2** Diagram of the arterial morphology of the posterior circle of Willis. Left postero-superior view. 1—Internal carotid arteries; 2—posterior communicating arteries; 3—branch of optic tract; 4—duplicated posterior end of left posterior communicating artery; 5—P1 segment of left posterior cerebral artery; 6—P2 segment of left posterior cerebral artery; 7—thalamoperforating arteries; 8—fenestrated P1 segment of right posterior cerebral artery; 9—P2 segment of right posterior cerebral artery; 10—superior cerebellar arteries

## Discussion

Alpers found the “duplication or forking” of the PComA in 2/350 (0.57%) circles of Willis and reported it in a paper solely based on diagrams [1], being quoted for that variant in Bergman’s Encyclopedia of Human Anatomic Variation [2]. In an anatomical study of the prenatal and postnatal PComA the fenestration of this artery was found only in foetal specimens [7]. For these, a prevalence of 0.34% was calculated [7]. The partial duplication of the PComA is rare, in 0.86% of cases being found at the origin of the PComA and in 1.21% at the PCA-PComA junction [7]. Several reports of PComA fenestration in the literature were criticised as they do not present fenestrations, but partial duplications of the PComA [7]. Fenestrations of PCA are also exceedingly rare [6, 10]. P1 segment anomalies were found in just 3% of cases of which in just one case was found a duplicated P1 segment [3]. Both P1 and P2 segments of PCA could present fenestrations [6].

Uchino reported in 2013 a duplicate origin of PComA from the supraclinoid ICA [9]. As the authors documented, previous such morphologies were reported as fenestrations [9]. The authors regarded that anatomical variation

as resulted from the persistence of branches emerging the caudal division of the primitive ICA during development [9]. As the PComA results from the caudal branch of the primitive ICA [4], a duplicated posterior end of PComA could result from an altered embryological fusion of the primitive ICA and BA. As we found on one side distal duplication of PComA and on the opposite side a fenestrated P1 segment of PCA, the defectuous primitive ICA-to-BA embryological fusion could be equally reasonable speculated.

In conclusion, extremely rare anatomic variations of the circle of Willis should not be ignored when endovascular or microneurosurgical specific approaches are intended.

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**Data availability** The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

## Declarations

**Conflict of interest** The author has no conflict of interests to declare.

**Ethical statement** The research was conducted ethically in accordance with The Code of Ethics of the World Medical Association (Declaration of Helsinki).

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