Anomalies of the posterior communicating artery and their potential clinical significance

KRISHNA KUMAR BISARIA, M.S.(ANAT.), M.S.(OPHTHALMOL.), D.O.M.S.
Department of Anatomy, King George's Medical College, Lucknow, Uttar Pradesh, India

This study of the posterior communicating artery (PCoA) in 126 cranial cavities of adult cadavers revealed some hitherto unreported anomalies. These included: the origin of one PCoA from the ophthalmic artery inside the optic canal; the presence of three PCoA's on one side; the occurrence of two posterior cerebral arteries of different origin on one side; and the existence of junctional dilatations at both ends of a PCoA. Junctional dilatation at the commencement of the artery was seen in 6.3% of cases. More common anomalies were a fetal type of posterior cerebral artery in 31.7% and macroaneurysmal dilatation of the PCoA in 39.7% of cases. The presence of multiple arteries makes possible normal circulation in cases involving obstruction to any one of them. The junctional dilatation or dilatation of any other part of the PCoA, if pre-aneurysmal, may leak or rupture to produce subarachnoid hemorrhage. Arteries pressing on the oculomotor nerve may produce diplopia, and those compressing the optic chiasm and tracts may cause visual defects.

**Key Words**
- cerebral artery
- vascular anomaly
- posterior cerebral artery
- posterior communicating artery
- aneurysm
- anatomical study

The anomalies of the posterior communicating artery (PCoA) have been described by many workers. Anson and Maddock,1 Gardner, et al.,6 and Stopford13 have reported that one or more PCoA's may be absent. Riggs and Rupp,9 in a study of 994 specimens, found reduced caliber of the PCoA in 214 instances, and commented that potential restriction of circulation may exist between the carotid and vertebrobasilar channels. Saeki and Rhoton10 found a hypoplastic PCoA in 32% of their specimens and fetal configuration of the posterior cerebral artery (PCA) in 22%. They pointed out that the absence of either is rare.

The present study of the PCoA deals particularly with very rare anomalies not reported before, and discusses their possible clinical significance.

**Materials and Methods**

The cranial cavities of 126 adult cadavers were examined after preparation of the specimens. The skull cap was removed, the dura mater was incised, and the frontal lobes of the cerebral hemispheres were first pulled up and then pushed gently back. The optic chiasm was cut and the internal carotid arteries were dissected in such a way that the origin of the PCoA remained intact. A transverse incision was made in the midbrain at the level of the tentorial notch, taking care not to damage the PCoA and the PCA. The PCoA was exposed, and its origin, termination, length, diameter, relationship to other structures, number, and abnormal dilatations were carefully noted.

**Observations**

In 110 cranial cavities the PCoA originated from posteromedial surfaces of the internal carotid arteries on both sides (Figs. 1 and 3), in 12 cavities from the posteromedial surface on one side and posterior on the other (Fig. 2), in two specimens from the posterior surface on both sides (Figs. 4 and 5), and in one case from the medial surface on both sides. In one subject a thread-like right PCoA arose from the lateral surface of the ophthalmic artery in the optic canal (Fig. 6).

In 116 cranial cavities the PCoA's terminated in the PCA bilaterally, and in 10 subjects unilaterally with the PCoA absent on one side (Fig. 7). In one of these 10 specimens, there were two PCA's on the left: the left PCoA terminated in one, and the other, arising from the basilar artery, was hypoplastic (Fig. 8). This subject also had a single right PCA. The larger PCA on the left side showed a mulberry-like dilatation at its origin.

The PCoA's ranged in length from 7.0 to 25 mm and in diameter from 0.5 to 4 mm. Marked difference in the diameter of the two arteries was noted in 48 cranial...
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FIG. 1. Specimen showing approximately symmetrical posterior communicating arteries (PCoA's) arising from the posteromedial surfaces of the internal carotid arteries. A junctional dilatation (arrowhead) and the neck of a funnel-shaped dilatation (arrow) are seen at the termination of the right PCoA.

cavities (Figs. 2, 5, and 6), and the diameters were approximately equal in 68 specimens (Figs. 1 and 3). In the 10 cranial cavities where only a single PCoA was present the diameter ranged from 2 to 3 mm.

In 100 cranial cavities the PCoA lay medial to the oculomotor nerve but under the optic chiasm and the optic tract (Fig. 9). In the remaining 26 specimens, a portion of the artery was lying over the oculomotor nerve (Figs. 1, 2, and 5).

In 25 cranial cavities, the left PCoA ranged in diameter from 3 to 4 mm, and in all these cases it took the place of the PCA which was connected with the basilar artery by a small artery (Fig. 2). In these specimens, the opposite PCoA had a diameter of 1 to 2 mm. In 15 cranial cavities the right PCoA ranged from 2.5 to 4 mm in diameter and terminated in the PCA, and was also connected to the basilar artery by a small artery (Fig. 5). In these cases, the opposite artery had a diameter of 1 to 2 mm. In 76 cranial cavities, both PCoA's were of nearly equal size and terminated in the PCA (Figs. 1, 3, 4, and 9). Their diameter ranged from 0.5 to 3 mm.

Funnel-shaped junctional dilatation was observed in eight specimens: bilateral at the origin of the PCoA in two instances, unilateral in five, and at both ends of an artery in one case (Fig. 1). In one specimen, the PCoA showed a mulberry-shaped aneurysm at its origin (Fig. 8), and in another ectasia of the medial wall (Fig. 6). In 50 of the specimens, PCoA's with a diameter of 1 to 2.5 mm showed macroaneurysmal dilatations from other sites (Figs. 3 and 5). These malformations were either fusiform in shape (Fig. 5) or showed ectasia of one of their walls (Figs. 2 and 4).

In one cranial cavity there were three PCoA's connecting the internal carotid artery with the PCA (Fig. 4). The intermediate artery again divided into two before joining the PCA. The medial artery showed ectasia of its lateral wall at two sites.

Discussion

This study deals with the PCoA only, so these vessels were preserved in the cranial cavity when the specimens were prepared in order that their relationship with other structures could be studied. In a majority of cases the artery originated from the posteromedial surface of the internal carotid artery and ran medial to the oculomotor nerve under the optic chiasm and tract. In a few cases it lay partly over the oculomotor nerve, but in none of the cranial cavities did it course lateral to the nerve. Gibo, et al., mentioned that if the configuration of the PCA was of the fetal type, the artery coursed...
either above or lateral to the oculomotor nerve. In this study, 31.7% of cases showed fetal configuration of the PCA, in 60.3% of cases the PCoA's were bilateral and approximately equal in diameter, and in 8% the PCoA was absent on one side. We found no case in which both PCoA's were absent. The diameter of the PCoA ranged from 0.5 to 4 mm (average 2.6 mm) and the length varied from 7 to 25 mm (average 10 mm).

Previously unreported findings included: 1) a PCoA which arose from the ophthalmic artery; 2) the occurrence of two PCA's with different origins on the same side; and 3) the presence of three PCoA's on one side. Chambers, et al.,\(^2\) reported a case with an anterior communicating artery aneurysm and an anomalous artery, which was a PCA branch arising from the internal carotid artery itself. The presence of two PCA's and three PCoA's on one side in two different cranial cavities would maintain normal blood supply if any one of them is obstructed.

Funnel-shaped junctional dilatation of the PCoA was found in 6.3% of cases. In one cranial cavity, in addition to the junctional dilatation at the commencement of the artery, there was also a funnel-shaped dilatation at its terminal end. This finding is contrary to statements made by many workers\(^5,7,10-12,14\) that junctional, funnel-
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Fig. 6. *Left:* Specimen showing the thread-like right posterior communicating artery (PCoA, *arrow*) emerging from the optic canal. There is a bulge on the medial wall of the left PCoA (*arrowhead*) at its origin. *Right:* Diagram showing the right PCoA (*arrow*) arising from the lateral surface of the ophthalmic artery after the roof of the optic canal has been removed.

Fig. 7. Specimen with total absence of a left posterior communicating artery.

Fig. 8. Specimen showing two left posterior cerebral arteries (PCA's). One of these (*large arrow*) is replacing the posterior communicating artery, and has no communication with the other left PCA (*small arrow*) which is thread-like and is a normal branch of the basilar artery. A mulberry-shaped aneurysm (A) is seen at the point where the large PCA originates from the internal carotid artery.
shape, or infundibular dilation or infundibular widening is present at the point of origin of the PCoA from the internal carotid artery. Chase\(^1\) suggested that the gross anomalies of the circle of Willis may be accompanied by structural defects in the wall of the vessel. Fox, et al.,\(^5\) stated that the danger of considering such a dilatation as an aneurysm is great, because it may produce subarachnoid hemorrhage on rupture. Stehbens\(^1\) commented that the funnel-shaped dilatation probably represents a stage in the development of an aneurysm. Matas\(^8\) did not mention the presence of an aneurysm of the PCoA in his series. Apart from junctional dilatation, dilatation in other parts of the PCoA was seen in 39.7% of our specimens, which is a very high incidence. They were mostly fusiform in shape and a few showed ectasia of the arterial wall. Dilatations were found in the arteries with a diameter less than 2.5 mm. Such dilatations could be considered dangerous if they are thought to be pre-aneurysmal, in which case they may leak or rupture and produce subarachnoid hemorrhage. Those compressing the oculomotor nerve may produce diplopia, and pressure on the optic chiasm or tract may result in visual disturbances.

**References**


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Address reprint requests to: Krishna Kumar Bisaria, M.S., D.O.M.S., Department of Anatomy, King George’s Medical College, Lucknow, Uttar Pradesh, India.