Section: Anatomy

Original Research Article

THE ANATOMIC VARIATIONS OF THE POSTERIOR COMMUNICATING ARTERY: A CADAVERIC STUDY

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Abstract

Background: The posterior communicating artery is important artery for neurosurgeons. It is arises from the postero-medial wall of the Internal carotid artery, sweeps backward and slightly medial above the oculomotor nerve to join the posterior cerebral artery. Increased incidence of microsurgical operations in the areas in recent days that are supplied by posterior communicating artery requires better understanding about anatomic variations and may be helpful to vascular surgeons. The aim is to study the anatomic variations of the posterior communicating artery like their origin length, Fetal type and perforators arising from posterior communicating artery and posterior cerebral artery in south Indian cadavers. **Materials and Methods:** This study done in 50 formalin fixed human brains obtained from routine dissection from cadavers with 10x magnification. Their origin, length, type, perforators from the arteries for both sides, totally 100 posterior communicating arteries noted and photographed for documentation. **Result:** All the posterior communicating artery arose from the internal carotid artery except two hemispheres where it was absent. The mean length was 13.3mm. Normal type of PCoA was found in 88 hemispheres, fetal type was found in 10% and another 2 hemispheres it was absent. All the type of posterior communicating artery was gave 3-11 perforators even fetal type, but one posterior cerebral artery does not give any perforators on left side and single large perforator originate from right side and supply both sides. **Conclusion:** The knowledge of anatomical variations in the posterior communicating arteries is important to neurosurgeons in order to keep neurological damages to minimum, during treatment of arteriovenous malformations, aneurysms and in interventions of posterior part of the circle of Willis.

INTRODUCTION

Sir Thomas Willis, in 1664 described Circle of Willis, a large arterial anastomosis, which unites the internal carotid and vertebrobasilar systems and lies in subarachnoid space within the interpenduncular fossa. Circle of Willis formed by two anterior cerebral arteries arise from the anterior part, two middle cerebral arteries from the anterolateral parts, and two posterior cerebral arteries from the posterior part of the arterial circle.[1]

In upper border of pons, basilar artery divides into two posterior cerebral arteries.[2] These vessels pass laterally and backward over the crus cerebri and receive anastomoses from the Posterior communicating artery. Surgical nomenclature divides the Posterior Cerebral artery into 3 segments: P1 - from the basilar bifurcation to origin of the posterior communicating artery. P2 - from the origin of posterior communicating artery to the portion in peri- mesencephalic cistern. P3 - this segment runs in the calcarine fissure.[1] Several small ganglionic branches which arise from the beginning of Posterior Cerebral artery and Posterior communicating artery pierce the posterior perforated substance, and they are called posteromedial central branches.

The Posterior communicating artery originate from the posteromedial surface of Internal Carotid artery (ICA) and passes medially and inferiorly, through

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the membrane of Liliequist, and joins Posterior Cerebral artery at the junction of P1 and P2 segment. Perforating branches from Posterior communicating artery supply optic chiasm and tract, mamillary body, tuber cinereum, subthalamus, posterior hypothalamus and anterior and ventral parts of the thalamus.[3] Occlusion of the Posterior communicating artery or its branches causes hemiballismus and thalamic syndrome.

In normal type, the lumen of the Posterior communicating artery (PCoA) is less than lumen of the Posterior Cerebral artery (PCA) of the same side. In fetal type, the size of PCoA is larger than the PCA, due to failure of regression of PCoA and P1 segment remains hypoplastic. ICA supplies PCA area through fetal type of PCoA.[4] 17.1% of the intracranial aneurysms are generally located near the origin the PCoA.[5] In addition, the artery may be involved in cases of, arteriovenous malformations or intracranial tumors. The diagnostic evaluation of Posterior communicating artery is required in order to obtain knowledge of the anatomy of this vessel, therefore we decided to examine their origin, length, type of the Posterior communicating artery and perforators from PCoA and P1 segment of the PCA in detail.

MATERIALS AND METHODS

50 adult human brains aged from 18 to 80 years without regard to sex obtained from routine dissection at Thanjavur Medical College, were used for dissecting the posterior communicating arteries. This study was done in Department of Anatomy, Government Thanjavur Medical college, Thanjavur in the period of July 2011 to Dec 2013. Institutional ethical clearance was obtained before commencement of study. The specimens were removed from the cadaver as described in Cunningham's manual of practical anatomy,[6] and they were fixed in 10% formalin. After complete fixation of the specimen, the arachnoid mater was carefully removed to expose the vessels at the base of the brain. The origin, length, type of posterior communicating artery, perforating arteries from PCoA, PCA noted with 10x magnification. The most representative specimens were photographed with the Nikon digital camera.

RESULTS

One 100 posterior communicating artery were studied from their origin. In all the hemispheres, posterior communicating artery was constantly arose from the Internal carotid artery. Out of 100 PCoA, 98 arteries arose from the ICA and in 2 hemispheres arteries were absent on right side [Figure 1]. The length of PCoA from its origin to the union with the posterior cerebral artery was 13.33mm. Minimum length was 7mm and maximum length was 19mm found [Table 1]. In 100 hemispheres fetal type of PCoA was found [Figure 2] in 10% (on the right side 7, left side 3) [Table 2]. All fetal type arteries were found in unilaterally. Normal type of PCoA was found in 88 hemispheres and another 2 hemispheres posterior communicating artery was absent.

The posteromedial perforators arose from all the 98 posterior communicating arteries [Table 3 & Figure 3]. But all the posterior cerebral arteries give posteromedial perforators except one right posterior cerebral artery doesn't give any perforators [Figure 4].

Figure 1: Posterior communicating artery absent on right side

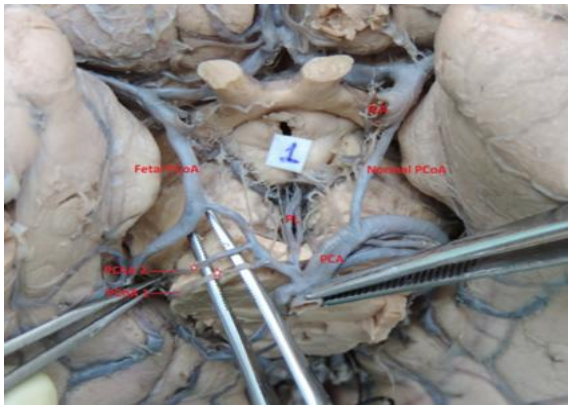

Figure 2: Fetal Type of Posterior communicating artery on right side

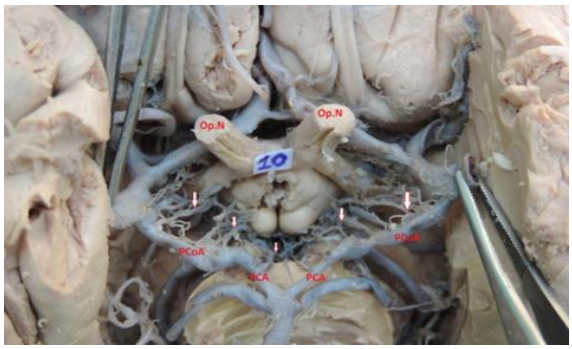

Figure 3: Postermedial perforators from PCA, PCoA

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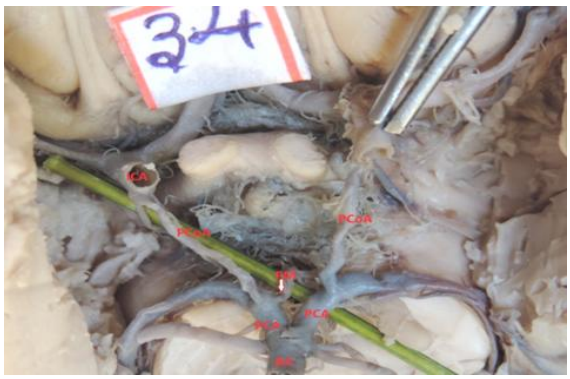

Figure 4: Postermedial perforators absent on left side of the posterior cerebral artery

Table 1: Length of Posterior communicating arteries.

S. No	Name of the Arteries	Mean length of arteries (mm)	Standard deviation	Range (mm)
1	Right PCoA	13.11	3.69	7-19
2	Left PCoA	13.55	2.84	8-19

Table 2: Type of posterior communicating artery

S. No	Type of PCoA	Right	Frequency (Right)	Left	Frequency (Left)	Total Percentage
1	Fetal	7	14%	3	6%	10%
2	Adult	41	82%	47	94%	88%
3	Absent	2	4%	-	-	2%

Table 3: Site of origin of Posteromedial central Perforators

S. No	Site of origin	No. of Specimens	Frequency	Total Frequency
1	Right PCoA	48	100%	
2	Left PCoA	50	100%	100%
3	Right P1 segment	50	100%	99%
4	Left P1 segment	49	98%	

DISCUSSION

The embryogenesis of the cerebral vascular system begins at approximately 5 weeks of gestation. At 5th week of human development (4-5 mm embryo), the primitive internal carotid arteries arise from the 3rd aortic arches. At the base of the optic vesicle, the internal carotid bifurcates into cranial and caudal division. The cranial division gives rise to anterior cerebral arteries, middle cerebral arteries, anterior choroidal arteries, the stem of primitive olfactory artery remains as a small striate branch of anterior cerebral artery. The caudal division which gives rise posterior communicating artery, stem of the posterior cerebral arteries.[7] The rest of PCA develops from the stem of Posterior Choroidal artery which is annexed by caudally expanding cerebral hemisphere, and its distal portion becoming a chroidal branch of PCA. In embryonic life, posterior communicating artery continues as posterior cerebral artery, but in adults posterior communicating artery leaves the basillary system. If the PCoA smaller than PCA it is referred to adult type of artery. Persistence of the fetal type of posterior circulation, where P1 segment of posterior cerebral artery was smaller than posterior communicating artery.

Yasargil et al reported adult type of artery present in 67.5% cases and fetal type in 24.5% and equal representation in 8% of cases.[8] Robert W. Rand (1985) reported fetal type PCoA in 22% of cases.[9] Ronald A. Bergman (1995) reported fetal type circulation on right side as 5.5%, on left side as 4.5%, and on two sides in 2%. Aysun et al stated that fetal type of PCoA was found in 26.6% of cases.[10]

In the present study fetal type of posterior communicating artery was seen in 10% of the hemispheres (on right side14%, on left side 6%), adult type present in 88% of the hemispheres and PCoA was absent in 2% of the hemispheres. Here in all hemispheres fetal type artery was unilateral. The relation oculomotor nerve and PCoA is important to neurosurgeons, because during operations it can easily be used to find the artery. In present study in foetal type, artery was located on the superior and lateral side of the nerve. The incidence of anomalies of fetal type of artery is higher with cerebral aneurysms than in other groups.[11]

Aysun et al stated that the average length of PCoA 11.94 mm.[10] SB Pai et al stated that the average length of the PCoA was 11.88 mm on left side and 12.13 mm on right side.[12] Sylvia Kamath et al stated that the length of right PCoA was 1.35 + 0.34 cm and left PCoA was 1.33 + 0.33 cm.[13] In the present study mean length of PCoA on right side was13.11 + 3.69 mm and on left side was 13.55 +

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2.84mm.These observations were nearer to the findings of Sylvia Kamath et al.

Normally posteromedial perforators arise from the PCoA and P1 segment of the PCA. According to Arnald et al 96% of specimens gave perforators, 4% (2 from P1segment) gave no perforating branches.[14] According to Robert W. Rand, 92% of specimens of PCA gave perforators, 8% (4 from P1segment) gave no central branches. 4-12 central branches originated along the course of the PCoA. According to Aysun et al 4-9 central branches originated from posterior communicating artery. In present study all P1 segments on right side had perforators, but on left side 1% (one P1 segment) had no perforating branches. In this hemisphere single large perforator originate from right side and supply both sides. In this study all posterior communicating artery had perforators except in 2 specimens, where PCoA was absent on the right side. Gabrovsky,[15] said that the posterior 1/3 of the posterior communicating artery is the area where the risk of perforating branch damage is least in intra-operative division. Branches of the posterior communicating artery can be injuried during surgical interventions of tumors of the parasellar region, aneurysms and hypophysis tumors. Diabetes insipidus, Hypothalamic disturbances, somatostatic symptoms and movement disordesrs can be encountered following injury to these branches.

Limitation(s)

This study was done on the human cadavers. It can be extended to intra-operative and radiological studies to obtain further results and conclusions.

CONCLUSION

Transection of a hypoplastic PCoA has been recommended to gain access to basilar bifurcation aneurysms, on the assumption that they have fewer branches and brain less dependent on them. But fetal type of artery gave origin to the same number and size of perforating arteries, like adult type of artery. Thus hypoplastic segments should be handled with care and divided to aid in exposure of the basilar bifurcation only after careful consideration. Detailed knowledge of the anatomic variations of posterior communicating artery is very important during surgical intervention on the circle of Willis and helps the neurosurgeons to construct a safe micro dissection plan.

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