

# A Anatomical Study on Relationship Between Posterior Cerebral Artery and Posterior Communicating Artery

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## ABSTRACT

**Background and Objectives:** A anastomotic ring called Circle of Willis, which is formed by the internal carotid and vertebrobasilar systems is one of the greatest anastomosis of human body. It slows down the blood before it reaches the brain and helps in collateral circulation. Anatomic study reveals the variation in the pattern and calibre of vessels which make up the circulus arteriosus. The variations in calibre occurring in the posterior communicating artery and posterior cerebral artery are not uncommon.

**Methodology:** A total of 45 brain specimens were collected, cleaned and dissected. A careful examination of the specimens was done to check for variations arterial components of the Circulus Arteriosus. The calibre of the pre commu-

nicating (P1) segment of posterior cerebral artery and the posterior communicating artery (PCoA) were carefully recorded.

**Results:** The posterior part of the Circle of Willis was more anomalous and the posterior communicating artery was the most anomalous segment. The fetal configuration of PCoA was found in 20% of the cases. An inverse relationship was found in the components of the posterior part of the circle, between PCoA and P1 segment on the ipsilateral side. Anomalies in the formation of Circulus Arteriosus may predispose to stroke. The neurosurgical importance of this study lies during the exploration of the region for different purposes. Knowledge of the vascular variations will increase the success of the procedure.

**Key Words:** Posterior communicating artery, Posterior cerebral artery, Circle of willis

## INTRODUCTION

A thorough knowledge of anatomy Circulus Arteriosus is important for neurosurgeons and anatomists; Circulus Arteriosus is the arterial anastomotic ring which is formed by Carotid and Vertebro – basilar systems. The Posterior Communicating Arteries are two in number and arise from the internal carotid arteries on either side. On both the sides they run backwards, above the oculomotor nerves and anastomose with the posterior cerebral artery of their respective side to close the arterial circle and form the Circulus Arteriosus. The Basilar artery extends superiorly from its origin near the ponto-medullar junction to its terminal bifurcation into a pair of posterior cerebral arteries. The Posterior Cerebral Artery passes lateral and parallel to the superior cerebral arteries of both sides where it receives the posterior communicating branch of the internal carotid. The part of the posterior cerebral artery before this communication is called the P1 segment (pre-communicating or Horizontal) and the part after this communication is called the P2 segment (Post-communicating or Ambient). The appreciation of morphological variations of Circulus Arteriosus still has its place inspite of tremendous advances in technology for the study of anatomy in situ, through computerized

tomographical angiography or magnetic resonance angiography. In the present study, an attempt has been made to study the anatomic variations in the posterior cerebral artery and posterior communicating artery in the formation of Circulus Arteriosus.

## OBJECTIVES

1. To the study the anatomical variations of the posterior part of Circulus Arteriosus.
2. To study the variations of Posterior Cerebral Artery.
3. To study the variations of Posterior Communicating Artery.
4. To obtain information about the relationship between the variations of the posterior cerebral artery and posterior communicating artery in the formation of Circulus Arteriosus.

## METHODOLOGY

45 formalin embalmed brains were studied during the period of five years, in the dissection Halls JJM Medical College, Davangere and MVJ Medical College, Hoskote, India. The for-

mation and branches of circulus arteriosus was observed with the aid of a magnifying lens by removing the arachnoid mater carefully in the interpeduncular cistern. Posterior cerebral artery was traced from its origin to the termination, posterior communicating artery was also observed. The variations encountered were noted. And the photograph of the best observed anomalous Circulus Arteriosus was taken.

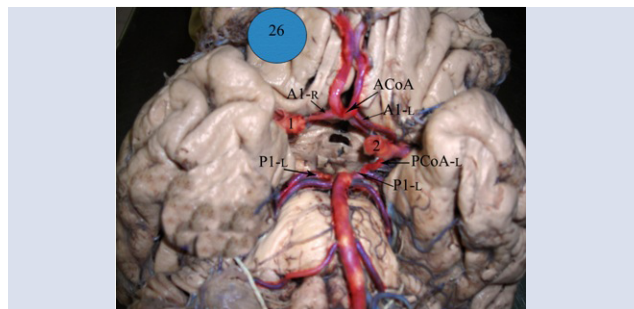
## RESULTS

### Circulus arteriosus: Posterior part

In the present study, out of 45 brain specimens, it was found that the circle of Willis was complete in 76.66% of the cases and incomplete in 23.34% of the cases. The posterior part of the circulus arteriosus was incomplete 16.66%. [Table/Fig-1] shows the Average Lengths and External diameters of the Basilar artery, Pre-communicating (P1 Segment) of Posterior cerebral artery and Posterior Communicating Artery (PCoA). [Table /Fig 2] shows the Circulus Arteriosus with absent PCoA, [Table /Fig 3] shows the Circulus Ateriosus with hypoplasia of P1 segment.

Name of the arterial segment	Length [mm]		Diameter [mm]	
	Right	Left	Right	Left
BA	-		3.47±0.65	
P1	7.96±2.30	7.93±2.96	2.04±0.52	2.25±1.05
PCoA	14.22±2.90	14.47±2.85	1.06±0.80	1.06±0.76
ICA	-		3.61±0.81	3.86±0.78

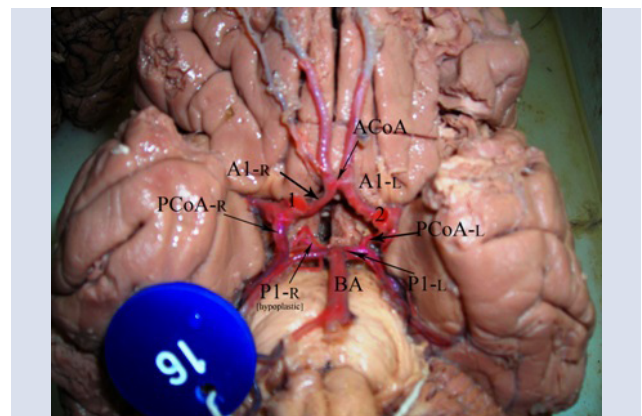
[Table/Fig-1]: Average Length and External Diameters of the components of posterior part of Circulus Arteriosus



[Table/Fig-2]: Circulus Arteriosus with Absent PCoA on right

### Basilar artery (BA)

In the present study, the average external diameter at the bifurcation of the basilar artery was found to be  $3.4 \pm 0.11$  mm. The terminal bifurcation of the artery was found to be equal in 26 of the cases (86.66%) and unequal in 4 cases (13.33%). Out of the 4 cases, in one case (3.33%), an unequally bifurcating basilar artery was found and the artery continued as the right PCA & left PCA in 3 cases (10%).

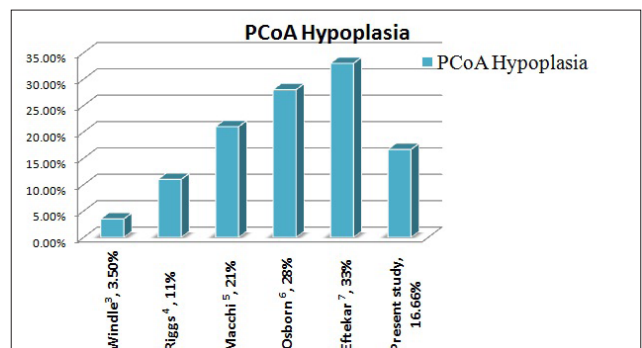


[Table/Fig-3]: Circulus Arteriosus with hypoplastic P1 segment on right

## DISCUSSION

### Posterior communicating artery [PCoA]

In the present study, the artery was found to be present in 86.66% and the average length of the artery was found to be  $14.22 \pm 2.90$  mm on the right side and  $14.47 \pm 2.85$  mm on the left. The average external diameter of the artery was found to be  $1.06 \pm 0.80$  mm on right side and  $1.06 \pm 0.76$  mm on the left. Studies of Kamath S states the PCoA average external diameter on right to be  $5 \pm 0.7$  mm; on left to be  $4 \pm 0.7$  mm; average length of PCoA on the right to be  $13.50 \pm 3.4$  mm and on the left to be  $13.3 \pm 3.3$  mm [1]. Orlandini et al., mentions mean values for the length of PCoA to be  $13.7 \pm 3.5$  mm in the right and  $13.3 \pm 3.5$  mm in the left [2]. The PCoA on the right side was observed to be more anomalous when compared to the left side, the PCoA was found to be absent in 13.3% of the cases; 10% on right side 3.33% on left. Both PCoA were hypoplastic in 16% of the cases. Hypoplastic PCoA-R was seen in 23% and hypoplastic PCoA-L was seen in 6.66%. Each of the PCoA continued as PCA proper on the ipsilateral side. PCoA arising from basilar artery was seen in 4.44%. [Table/Fig-4] shows comparisons of the Hypoplasia of the PCoA segment with that of the other workers.

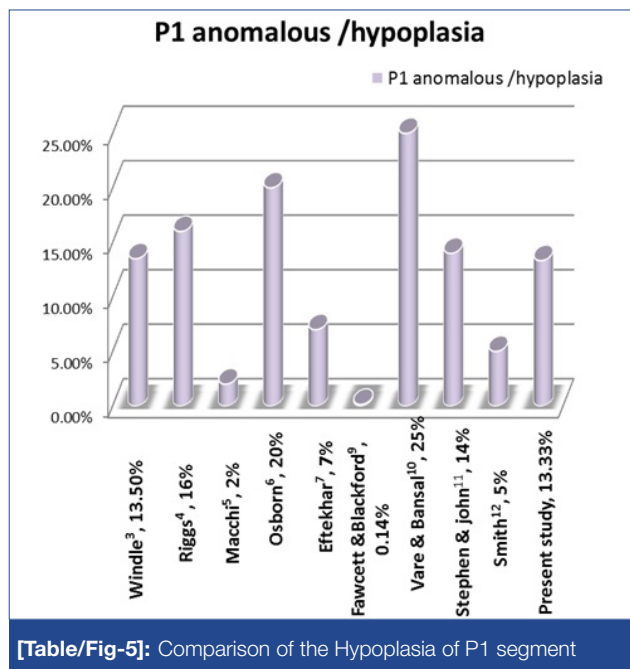


[Table/Fig-4]: Comparison of Hypoplasia of PCoA Segment

### Posterior Cerebral Artery (P1 Segment)

In the present study, the pre-communicating artery (P1 Segment) was present in 41 of the cases (91.11%) and absent in 4 cases; Out of the 4 cases, 2 cases, one each on the right and left side respectively. The average length of the P1 segment in the present study was found to be  $7.96 \pm 2.30$  mm on right side and  $7.93 \pm 2.96$  mm on the left; and the average external diameter of the P1 segment was found to be  $2.04 \pm 0.52$  mm on the right side and  $2.25 \pm 1.05$  mm on the left. Windle studies also show normal P1 segment in 86.5% of the cases [3]. Luzsa illustrates the average length of P1 segment ranging from 1.2 - 2.2 mm similar to the present study finding where the average length was found to be 2 mm [8]. According to Kamath S the average length on the right side for P1 segment is  $6.8 \pm 2.7$  mm and on the left  $6.9 \pm 3.1$  mm. The average external diameter is  $2.1 \pm 0.7$  mm on the right and  $2.2 \pm 0.6$  mm on the left [1]. Orlandini et al., also mentions mean values for P1 segment on the right being  $7.7 \pm 2.6$  mm and  $8.1 \pm 2.9$  mm on the left [2].

In the present study, the artery was hypoplastic in 13.5% of the cases. The artery originated from the terminal bifurcation of the basilar artery in 39 (86.5%) cases. In 6 cases (13.5%) the artery originated from ICA, 3 cases on each side accounting for 6.66% each; [Table/Fig-5] shows the comparisons of Hypoplasia of the P1 segment with other workers.



[Table/Fig-5]: Comparison of the Hypoplasia of P1 segment

In the present study, fetal/embryonic configuration of PCoA where the diameter of P1 segment is smaller than PCoA was found in 20% of the cases. Overbeeke et al., study shows fetal configuration of the PCoA in 14% [13]. Yasargil reported

32.5% of fetal PCoA [14]. Osborn reports fetal origin of PCoA in 20-30% [6]. Van Raamt et al, mentions fetal origin of PCoA in 29% of the cases [15]. Caplan illustrates 24% of the fetal configuration of PCoA [16]. Studies of Hussain shows the percentage of the fetal configuration PCoA was about 15% in Jordanians [17].

In the present study, an inverse relation was seen in the external diameter of PCoA and P1 segment on the ipsilateral side 73.3% of the cases showed an inverse relationship on the right and 76.7% on the left. After subjecting the data to statistical analysis it was found that PCoA and P1 segment were inversely correlated and statistically significant  $r = -0.595$   $p = 0.002$  (correlation significant @ 0.05 i.e.,  $p = 0.05$ ) on right, on the left  $r = -0.307$   $p = 0.045$ . Study of Kamath S also inverse correlation between PCoA and P1 segment  $r = -0.575$ ,  $p < 0.001$  for right and  $r = -0.485$ ,  $p < 0.001$  for left side [1]. Studies of Hoksbergen et al., shows PCoA diameters were found to correlate negatively ( $r = -0.5$ ,  $P = 0.01$ ) to the diameters of their accessory P1 segments [17]. Similar findings have been noticed Hussain [18]. It is evident that there is existence of an inverse relation between PCoA and P1 segment.

### CONCLUSION

It was found that the posterior part being more anomalous & variant, the posterior enjoys more blood supply when compared to the anterior part. There exists an inverse relations between Posterior cerebral artery [P1] and Posterior Communicating artery which was also observed among the other workers Kamath S, Orlandini et al., Hoksbergen et al., Hussain [1, 2, 17, 18] Thorough knowledge of the anatomy and awareness of the variations and anomalies of these arteries are of clinical and scientific importance in dealing with lesions involving these arteries and their branches The anomalies in formation of Circle of Willis especially the posterior part of the anastomotic ring are more common. This study in the scope neurosurgical importance is attempt to enhance knowledge of the vascular variations which will not only increase the success of the procedure and also keeps inadvertent vascular traumas during surgeries at bay.

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