

## A MORPHOLOGICAL STUDY OF BASILAR ARTERY AND ITS VARIATIONS IN THE LOCAL POPULATION

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### ABSTRACT

**Background:** Atherosclerosis of cerebral arteries particularly basilar artery has become common today. The atherosclerosis of BA can lead to loss of memory, depression and also cerebrovascular accidents. Variations of the BA are main cause in the occurrence of cerebrovascular diseases.

**Context and purpose of study:** The knowledge of occurrence of variation of BA can help in early diagnosis and successful surgical intervention. Most of the western studies are mainly based on the radiology. An anatomical morphological study of BA and variations will enhance the existing knowledge of BA.

**Results:** The average length of BA is 26.7 mm (with the range of 17.4 mm to 45mm) and the mean diameter is 3.8 mm (with the range of 2.1mm to 5.2 mm). The mean angle of formation is 58.6° (with the range between 45° to 70°). In 80% of the specimens the level of formation is normal i.e. at the pontomedullary junction. The position of termination is normal in 75% of specimens i.e. at the pons midbrain junction.

**Conclusion:** Variations of BA are common both in respect of angle of formation and termination of BA into branches. Knowledge of the vascular variations will increase the success of the surgical procedures and radiological procedures used in the treatment of vertebro-basilar cerebrovascular pathology.

**KEY WORDS:** Basilar artery, vertebral artery, level of formation, level of termination, length of basilar artery, diameter of basilar artery.

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### INTRODUCTION

The brain is the foremost vital organ of the body and its nourishment is the utmost important function of the heart. Any deficiency in its blood supply can lead to morbidity and mortality. The brain receives blood supply from the terminal branches of right and left internal carotid artery (ICA) and the basilar artery (BA). An anastomotic circle of brain vessels is formed at the base of the brain called circle of Willis to ensure conti-

nity of blood supply to the brain. The circle of Willis is formed by the branches of right and left ICA joining with the right and left posterior cerebral arteries (PCA), which are the branches of BA.

The BA is formed by the union of right and left vertebral arteries (VA) at the junction of medulla with pons. After its formation it runs in the basilar sulcus to the upper border of pons. At the

upper border of pons the BA terminates by giving right and left PCA. The BA contributes to the posterior circulation of the brain. The anatomical variations of the BA can cause loss of memory and depression besides causing transient ischemic attacks, atherosclerosis and cerebral infarction based on its area of blood supply.

Besides, BA is the favoured site of atherosclerosis among the intracranial vessel [1]; we studied the morphology the BA in the local population of Andhra Pradesh.

## MATERIALS AND METHODS

The study is conducted on 33 adult brain specimens. The specimens are obtained during the routine dissection for the MBBS and BDS students at NRI institute of Medical Sciences, Visakhapatnam, Andhra Pradesh. The embalmed brain specimens are dissected to expose the level of formation and termination of BA which included the dissection of VA and PCA and PCoA. The length and diameter of BA are measured with vernier callipers graduated to measure up to 0.1mm and the angle of formation is measured by using the protractor. The level of BA formation and termination and the angle of formation are recorded. Any variations observed are recorded in detail, photographed and the data obtained is tabulated.

## RESULTS

In our study the average length of BA is 26.7 mm (with the range of 17.4 mm to 45mm) and the mean diameter is 3.8 mm (with the range of 2.1mm to 5.2 mm). The mean angle of formation is 58.6° (with the range between 45° to 70°). In 80% of the specimens the level of formation is normal i.e. at the pontomedullary junction. The caudal formation and rostral formation are 10% each. The position of termination is normal in 75% of specimens i.e. at the junction of pons with midbrain; caudal termination is in observed 15% and the rostral termination in 10%.

Further in our study two specimens showed a complex of variations. These variations in these two specimens are recorded in detail and photographs obtained.

In one specimen it is observed that the length of BA is 45mm and the diameter is 5mm. This

BA is observed to be curved with its convexity towards the right side. The VA forming this BA is having the following; left VA is having a diameter of 6.2 mm whereas the right VA measured only 2mm. They joined at an angle of 45 degrees at the pontomedullary junction. The BA appeared as an extension of left VA. The left VA and BA together made a curve to the right. The anterior spinal artery was formed unilaterally from the undersized right VA. The specimen is shown in the Fig 1.

**Fig. 1:** Showing narrowed Right VA and unusually wide left VA. The left VA and BA are making a curve to the right. The anterior spinal artery is taking origin from right VA.



**Fig. 2:** showing origin of right PCA from right ICA and continuation of BA as left PCA . The left PCoA is present.



In another specimen it is observed that BA continued as the left PCA .The posterior communicating artery (PCoA) is present on the left side. The right PCA has taken origin from ICA with no connection with the BA. The right

VA is slender. Further in this brain specimen the left anterior cerebral artery (ACA) continued as single unilateral A2 segment of ACA after it is joined by slender right ACA. The specimen is shown in the Fig 2.

## DISCUSSION

Variation in the BA is observed in our study. The variation in the length and position of BA are attributed to the aging and hemodynamic factors [2]. The reason for the branching pattern is congenital with embryological explanations consequent to them [3].

The average length of BA in our study is 26.7 mm. The table I give comparison of length of BA as reported by different studies. The results of our study are similar to those reported.

**Table 1:** A review of studies on the basilar artery.

Sl no	Study year	No of specimens	Length of BA (mm)
1	Adachi (1928)	83	25-30
2	Busch et al (1966)	1000	33.3
3	Saeki and Rhoton (1977)	50	15-40
4	Kamath (1979)	100	22-45
5	Padmavathi et al (2011)	54	25-38
6	Hosapatna Mamatha et al (2012)	20	27-35
7	Present study (2018)	33	17.4-45

The mean diameter of BA in our study is 3.8mm. The diameter greater than 4.5mm is considered abnormal [4]. The mean diameter of BA was 3.17mm according to Smoker et al. [5] and 4.1mm as found by Saeki and Rhoton Jr [6].

The angle of formation of BA according to Clarke et al ranged from 70° to 90°, according to Padmavathi et al it was 50° to 90°. According to Hosapatna Mamatha et al the angle of formation for BA was 45° to 70°. And our study results are similar to Hosapatna Mamatha et al.

The level of formation of the BA is observed to be highly variable. According to Harish A. Wankhede et al. [7] and Vare and Bansal [8] the level of formation at the ponto-medullary junction was 65%. In the present study the level of formation at the ponto-medullary junction is 80%.

The level of termination at the midbrain-pons junction was found to be 88% by Rand [9] and 92% by Smoker et al [5]. In the study of 160 specimens, Stopford et al found that BA terminated

normally in 156 specimens. In present study termination at midbrain-pons junction is 75%.

The BA develops from the fusion of bilateral longitudinal channels at the base of the brain. These bilateral longitudinal channels establish connections with the right and left caudal division of ICA cranially and the VA caudally before fusion. The caudal division of ICA differentiates into the PCoA and the stem of PCA. The PCA arising from ICA in adults is considered to be due to persistence of foetal arrangements of vessels.

Akar et al. [10] studied VA and its branches. The unilateral narrowing of the VA is not mentioned in their studies. Grand et al. [11] made a study about the microvascular anatomy of brains to develop anatomical guidelines for aneurism surgery in the region of the vertebro-basilar junction. The unilateral narrowing of the VA was also not mentioned in their study. Lang [12] reported rare variation of VA. In this variation the VA of the right side had a narrow diameter of 0.9 mm. The left VA was unusually wide 5.5 mm and it had a bend to the left side.

A similar variation as our first reported variation was reported by Eray Tuccar et al. In their specimen the diameter of left VA measured 1.1mm and the right 5.5mm. The BA was formed at pontomedullary junction. The right VA and BA made a curve to the left. The anterior spinal artery was formed unilaterally from the undersized left VA [13].

Govsa et al. [14] in their investigation to extend the knowledge of the origin of the anterior spinal artery examined 80 brains of human cadavers and found that unilateral origin of the anterior spinal artery was found in 9 specimens (11.3 %). In a similar study Rodriguez-Baeza et al. [15] carried out their study using 31 human cadavers and the unilateral origin was 9.7 %.

Macchi et al. reports the possibility of origin of PCA from ICA is about 13%, and also mentions that there are hardly any other reports of origin of PCA from ICA. They further observed that in about 2% of cases, where absence of a PCoA was associated with the origin of PCA from ICA [16].

A similar variation as our reported second variation was reported by Mohandas K. G. Rao et al.

They further observed that, to the best of their knowledge, there were no reports of origin of PCA as a continuation of the BA [17].

## CONCLUSION

The morphology of BA in the local population is highlighted in the present study. The study reveals that variations are common in BA. There is increasing evidence that there is a relation between the angle of formation and branching with the development of atherosclerosis. The study will be of help to the radiologists and neurosurgeons in the correct diagnosis and treatment of the patients with various cerebrovascular diseases.

## ABBREVIATIONS

**BA-** Basilar artery

**VA-** Vertebral artery

**PCA-** Posterior cerebral artery

**ICA-** internal carotid artery

**PCoA-** Posterior communicating artery

**Conflicts of Interests: None**

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