

## Morphometric Study of Basilar Artery in the Eastern Indian Population

### Abstract

**Introduction:** The basilar artery (BA) is formed by the fusion of right and left vertebral arteries and divides to form right and left posterior cerebral arteries. This study was done to provide a baseline database regarding length, mid-length diameter, level of origin, and level of termination of BA. **Materials and Methods:** Thirty-eight formalin-fixed brains were obtained from cadavers dissected for undergraduate studies. The external length and the average external diameter of BA were measured by a digital Vernier caliper. Variation in origin and termination of BA was noted using magnifying glass. **Results:** The length and diameter of the BA were  $25.58 \pm 3.57$  mm and  $3.05 \pm 0.41$  mm, respectively. The origin and termination of BA was normal in most cases. In two cases, the origin was above the pontomedullary junction, and in one case, it was below. In two cases, the termination was above the pontomesencephalic junction, and in one case, it was below. **Conclusion:** There was no gender predisposition in length and diameter of the basilar artery. The baseline data established in this study regarding length, diameter, level of origin and level of termination of basilar artery will help neurosurgeons and interventional radiologists to diagnose as well as plan and execute various vascular procedures such as shunting for the treatment of aneurysms and stenosis in the blood vessels of the posterior cranial fossa.

**Keywords:** Anatomy, basilar artery, stroke, variation

### Introduction

Blood supply of brain is quite important for understanding the process and effect of cerebrovascular accidents and other anomalies of brain function. The morphometric data regarding vasculature in Indian population are starting to come up in recent years, but data regarding eastern Indian population have been limited. Hence, we decided to measure the external length and external diameter of the basilar artery (BA) in males and females separately so as to establish a baseline database of eastern Indian population and search for gender predispositions, if any. Our study also aimed to document the levels of formation and termination of BA.

The brain gets its blood supply from two sources, namely, internal carotid system and vertebrobasilar system of arteries. Right and left internal carotid arteries enter the carotid canal and reach the base of the brain. Here, they anastomose with vertebrobasilar system of arteries to form the circle of Willis. The vertebrobasilar system of arteries is formed by right and left vertebral arteries (RVA and LVA). Vertebral artery

ascends through the foramen transversarium of upper six cervical vertebrae and enters the skull through the foramen magnum. The RVA and LVA ascend medially and anteriorly to join each other at the level of the pontomedullary junction (PMdJ) to form BA. BA runs upward and forward in the median groove of pons and divides into two posterior cerebral arteries at the pontomesencephalic junction (PMsJ).<sup>[1]</sup>

### Materials and Methods

We dissected 17 female and 23 male cadavers in Department of Anatomy, SCB Medical College and Hospital, Cuttack, Odisha, India, after obtaining approval from the Institutional Ethical Committee.

The brains were removed according to the standard procedure given in dissection manuals. The brains were thoroughly washed in water to remove the excess preservatives. The arachnoid mater was carefully removed from the base of the brain so as not to disturb any blood vessels. In two female cadavers, while removing the brain, the blood vessels got damaged accidentally, so they were excluded from the study. Hence, we considered only 38 cadaveric brains instead of the originally intended 40 cadaveric brains.

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The formation and termination of BA were identified and noted in relation to PMdJ and PMSJ. BA was considered normal if it formed at PMdJ and terminated at PMSJ. Any variation from this was considered anomalous.

A digital Vernier caliper (Mitutoyo, Japan, accurate to 0.02 mm) was used for measuring the length of BA. The straight basilar arteries were measured by placing one of the prongs at the formation and the other at the termination of BA. The curved basilar arteries were measured indirectly by a nonabsorbable silk suture (Mersilk® suture). First, the suture was placed on the BA to measure the length, and then, it was measured by the caliper to get the length. The external diameter of BA was measured by the Vernier caliper at the formation, at the termination, and midway between the formation and termination. Then, the average of the three values was calculated.

The data were then compiled and were analyzed in a free online statistical analysis software called “QuickCalcs” from www.graphpad.com. The results were then compared with the data of rest of the Indian subcontinent.

## Results

BA was normal in 32 (84.23%) cases, and there were 6 (15.78%) anomalous cases. The level of formation of BA at the pontomedullary junction was in 35 (92.11%) cases, whereas the level of termination at the pontomesencephalic junction was in 34 (89.47%) cases. The details of variation in formation and termination are given in Tables 1 and 2. Figures 1 and 2 show the formation of BA below and above the pontomedullary junction, respectively. Figures 3 and 4 show termination of BA below and above the pontomesencephalic junction, respectively.

In females, the length and diameter of the BA were  $25.97 \pm 4.66$  mm and  $3.13 \pm 0.59$  mm, respectively. In males, the length and diameter of the BA were  $25.32 \pm 2.72$  mm and  $3.01 \pm 0.23$  mm, respectively. The unpaired t-tests were performed but failed to find any gender correlation or predisposition in these values.

**Table 1: Variation in level of formation of basilar artery**

Level of formation	Number of cases (%)
At pontomedullary junction	35 (92.11)
Above pontomedullary junction	2 (5.26)
Below pontomedullary junction	1 (2.63)
Total	38 (100)

**Table 2: Variation in level of termination of basilar artery**

Level of termination	Number of cases (%)
At pontomesencephalic junction	34 (89.47)
Above pontomesencephalic junction	2 (5.26)
Below pontomesencephalic junction	2 (5.26)
Total	38 (100)

The length and diameter of the BA were  $25.58 \pm 3.57$  mm and  $3.05 \pm 0.41$  mm, respectively. The shortest and longest BA in our study were 20.21 mm and 35.23 mm, respectively.



Figure 1: Formation of basilar artery below pontomedullary junction



Figure 2: Formation of basilar artery above pontomedullary junction



Figure 3: Termination of basilar artery below pontomesencephalic junction

**Table 3: Comparison of various dimensions of basilar artery measured by researchers in Indian subcontinent**

Researcher	Number of brains	Length range (mm)	Average length (mm)	Diameter range (mm)	Average diameter (mm)
Kamath <sup>[2]</sup>	100	20-40	31.42	2.5-5.5	3.82
Pai <i>et al.</i> <sup>[3]</sup>	25	24-35	24.9	3-7	4.3
Padmavathi <i>et al.</i> <sup>[4]</sup>	54	25-38	-	-	-
Mamatha <i>et al.</i> <sup>[5]</sup>	20	25-37	28.5	-	-
Iqbal <sup>[6]</sup>	50	18-37	30	2.8-5.1	3.9
Wankhede <i>et al.</i> <sup>[7]</sup>	40	24-36	29.9	3.0-4.0	3.53
Patel <i>et al.</i> <sup>[8]</sup>	60	20.1-42.07	27.76	2.02-4.45	3.36
Present study	38	20.2-35.2	25.58	2-3.9	3.05

**Table 4: Comparison of level of formation of basilar artery by researchers in Indian subcontinent**

Authors	Year	Number of brains	At PMdJ (%)	Below PMdJ (%)	Above PMdJ (%)
Sultana <i>et al.</i> <sup>[9]</sup>	2013	70	67.14	32.86	0
Mamatha <i>et al.</i> <sup>[5]</sup>	2012	20	65	25	10
Wankhede <i>et al.</i> <sup>[7]</sup>	2014	40	62.5	12.5	25
Patel <i>et al.</i> <sup>[8]</sup>	2015	60	88.33	5	6.67
Present study	2016	38	92.11	2.63	5.26

PMdJ – Pontomedullary junction

**Table 5: Comparison of level of termination of basilar artery by researchers in Indian subcontinent**

Author	Year	Number of brains	At PMsJ (%)	Below PMsJ (%)	Above PMsJ (%)
Mamatha <i>et al.</i> <sup>[5]</sup>	2012	20	70	25	5
Wankhede <i>et al.</i> <sup>[7]</sup>	2014	40	50	32.5	17.5
Patel <i>et al.</i> <sup>[8]</sup>	2015	60	95	1.67	3.33
Present study	2016	38	89.47	5.26	5.26

PMsJ – Pontomesencephalic junction



**Figure 4: Termination of basilar artery above pontomesencephalic junction**

## Discussion

The comparison of various studies done in different parts of India and Bangladesh, which is near the eastern part of India and was a part of India, before the year 1947, is given in Tables 3-5.

Kamath in 1981, published data on 100 basilar arteries in south Indian population. Kamath also suggested that these

dimensions of the blood vessels forming circle of Willis might help surgeons assess the feasibility of shunt procedures.<sup>[2]</sup>

Pai *et al.* studied the microsurgical anatomy in 25 cadavers under a microscope and outlined various large and small arteries in the posterior circulation. They described the formation of BA to be at or below the pontomedullary junction. There was no case BA forming above PMdJ. The termination was described as 2–11 mm below mammillary bodies.<sup>[3]</sup>

In 2011, Padmavathi *et al.*<sup>[4]</sup> and in 2012, Mamatha *et al.*<sup>[5]</sup> published data regarding lengths of BA in cadavers from Karnataka, a state in southern part of India. However, both these studies did not take the diameter of the artery.

Iqbal<sup>[6]</sup> published data regarding dimensions of BA in Kerala, another southern state in India.

Wankhede *et al.*<sup>[7]</sup> from Maharashtra and Patel *et al.*<sup>[8]</sup> from Gujarat, both states in western part of India, published the dimensions of BA from cadavers of the same region.

The BA length range of 20.2–35.2 mm in the present study corresponded to the other studies in the Indian scenario.

The blood flow through a blood vessel is higher in shorter and thicker artery as the flow is inversely proportional to



the length and directly proportional to diameter, i.e., fourth power to radius.<sup>[2]</sup> Hence, the dimensions of the BA suggest the volume of blood that is carried by the vessels.

Caplan *et al.*<sup>[10]</sup> in 2005, studied 407 patients with posterior circulation strokes. This study found that extracranial and intracranial vertebral arteries were the most common site for severe occlusive disease followed by BA. The frequency of poor outcome was higher among patients with lesion of BA rather than diseases of intracranial and extracranial vertebral arteries.

In spite of our best efforts, we acknowledge certain limitations in our study. The number of our observations was only 38. Although we started with 40 cadavers, as the dissection method of removing brain is tricky for retaining both vertebral arteries, two specimens had to be discarded. The dissection did not have provision for study on vertebral artery in its entirety. The paucity of cadavers was another hindrance in studying larger number of sample. Variations and hypoplasia were not dealt with so as to keep the study simple.

### Conclusion

The length and diameter of basilar arteries measured showed no gender predispositions. Atherosclerosis, migraine, posterior circulation stroke, and aneurysms are quite common in BA. Neurosurgeons and neurologists require knowledge of BA, its branches, and its variations to understand as well to treat them properly. We are hopeful that this morphological study in the eastern Indian population will help in enriching knowledge regarding the anatomy of BA as well as provide a baseline data regarding the dimensions in eastern Indian population.

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### Conflicts of interest

There are no conflicts of interest.

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