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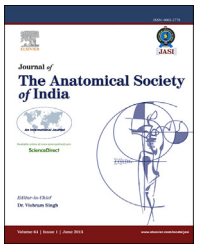

Original Article

Morphometry of basilar artery in population of Gujarat

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ARTICLE INFO

Article history:
Received 17 June 2014
Accepted 1 April 2015
Available online 22 April 2015

Keywords:
Morphometry
Basilar artery
Variation
Stroke

ABSTRACT

Introduction: The basilar artery is a large median vessel responsible for supplying various parts of the brain. The aim of this study was to observe, record and compare variations in basilar artery regarding its length, mid length diameter, level of origin and level of termination.

Method: Sixty human formalin fixed brain specimens obtained from cadavers donated for the study purpose were under examination in the Dept. of Anatomy, Gov. Medical College, Baroda. The process was undertaken according to the dissection method as per the Cunningham manual. The variation in length and diameter of basilar artery was noted using Digital Vernier calipers. Variation in origin and termination of basilar artery was noted using magnifying glass.

Results: Variation in basilar artery diameter found ranged from min 2.02 mm to max 4.45 mm. Variation in length found ranged from min 20.1 mm to 42.02. In most of the cases basilar artery origin and termination was normal. In 4 cases origin was above the Ponto-Medullary junction and in 3 cases it was below. In 2 cases termination was above the Ponto-Mesencephalic junction and in 1 case it was below.

Discussion: This observation highlight the variations in morphological aspects of the basilar artery, the knowledge of variations would help neurosurgeons safely diagnose, as well as plan and execute vascular bypass and shunting procedures for the treatment of stenosis, aneurysms and arteriovenous malformations in the posterior cranial fossa.

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http://dx.doi.org/10.1016/j.jasi.2015.04.003

1. Introduction

Human brain and its complex vascular network may be viewed as a "three pound biological computer". It is composed of billions of specialized cells and circuits which make it the most vital organ in the human body. It is richly supplied with blood vessels which provide oxygen and other essential nutrients. There may be variations in typical configuration. Vessels generally vary in caliber; often they are hypoplastic, duplicated or even absent.[1]

The basilar artery is formed by the union of two vertebral arteries at the Ponto-Medullary junction. The artery terminates by dividing into two posterior cerebral arteries just after passing superior to the two Oculomotor nerves at the Ponto-Mesencephalic junction[2] (Fig. 1).

Several studies have shown that these variations play an important role in the development of cerebrovascular diseases.[3]

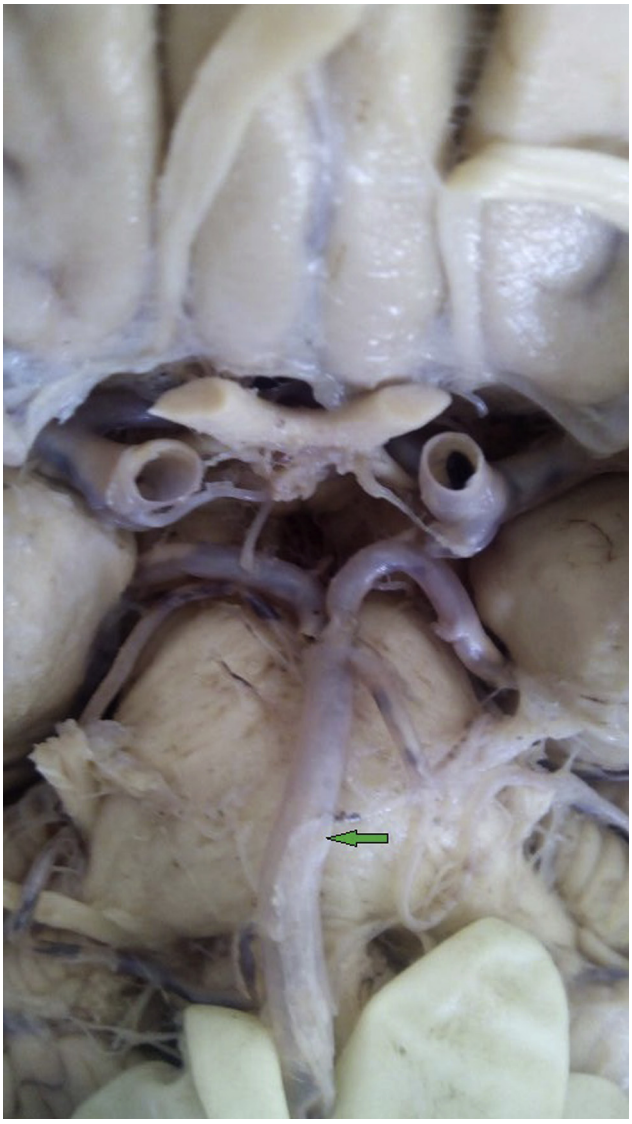

Fig. 1 – Normal basilar artery. Basilar artery normal variant (Green arrow).

Cerebrovascular diseases are the leading illness affecting the modern world with a high mortality rate. The posterior circulation of the brain consists of vertebrobasilar system, shows a high incidence of anomalies in the form of hypoplasia, fenestrations and asymmetry of the vessels, which precipitate the development of vertebrobasilar insufficiency and posterior circulation stroke. A detailed knowledge of the vertebrobasilar variants is essential in the diagnosis, treatment as well as in educating the patients suffered from posterior circulation stroke.[4]

Basilar artery related clinical condition such as posterior circulation stroke, migraine, aneurysm, atherosclerotic changes are very common throughout the world. Knowledge of anatomy of the basilar artery and its branches are necessary for neurosurgeons, neurologists for proper diagnoses and treatment of cerebrovascular diseases, aneurysm, tumor, epilepsy, migraine and other form of vascular anomalies.[5]

The surgical importance lies in its application during the exposure of the basilar artery and a thorough knowledge of the vascular variants will increase the success of the procedure. The inference obtained from this work is also useful for the sonologists in improving their diagnostic skills and for anatomists in enhancing their knowledge in teaching.

Various types of variations exist in different populations, but the variations of the basilar artery in Indian population have been reported only by few authors previously, based on cadaveric analysis. The present study is aimed to analyze the size, asymmetry and anomalies of the basilar artery.

2. Materials and methods

Sixty human formalin fixed brain specimens obtained from cadavers donated for the study purpose were under examination in the Dept. of Anatomy, Gov. Medical College, Baroda and other Medical Colleges of Gujarat from April 2013 to March 2014.

The study was approved by Scientific Review Committee and Ethical Committee (IECHR, Medical College Baroda & SSG Hospital).

The brain was removed by dissection method mentioned in Cunningham Manual of Practical Anatomy.[6] Dissections were done by Assistant Professor of Anatomy Department. Before dissection, the specimen was washed in running tap water for half an hour. The arachnoid and pia mater over the pons, medulla oblongata and the interpeduncular cistern was removed carefully in order to expose and visualize the basilar artery and its branches with the post part of circle of Willis.

In situ examination of the formation, termination, branches and the length was carried out. The dimensions of the component vessels were measured using Digital vernier calipers (sensitivity: 0.1 mm). Site of formation and termination of basilar artery were examined carefully by hand magnifying glass and noted. We focused on the basilar artery. The results obtained were recorded and tabulated.

Water was removed from the dependent areas and the grooves using filter paper.

Inclusion criteria: Undamaged specimens of the brain with intact circulas arteriosis and basilar artery.

Exclusion criteria: Damaged circulus arteriosis.

3. Results

Basilar artery was normal in 58 circles (96.67%). Anomalies were found in 2 cases (3.33%). The larger division (thickness 4.45 mm) occupied the basilar sulcus while the smaller one (thickness 2.01 mm). The vertebral arteries in this case were unequal in size. The mean length of basilar artery was 27.76 mm. Minimum length was 20.1 mm and maximum length was 42.02 mm. Mean diameter of basilar artery was 3.36 mm. Minimum diameter was 2.02 mm and Maximum diameter was 4.45 mm (Table 1).

The origin of basilar artery was at the Ponto-Medullary junction in 53 circles. In 4 circles (6.67%), it was above Ponto-Medullary junction and in 3 circles (5%) it was below the Ponto-Medullary junction (Table 2). The basilar artery terminated at the Ponto-Mesencephalic junction in 57 circles (95%), in 2 circles (3.33%) it was above the level of Ponto-Mesencephalic junction and in 1 case (1.67%) it was below the level of Ponto-Mesencephalic junction (Table 3).

Vertebral artery: Bilateral symmetrical vertebral arteries were encountered in 58 circles. Asymmetry was observed in 2 circles. Hypoplastic vertebral artery with curved course of basilar artery was seen in 1 brain (Fig. 2). As it was difficult to find out intact vertebral arteries we can't measure the diameter and length of all vertebral arteries.

4. Discussion

A wide range of variability, with regard to length, position, origin and termination was seen in the basilar arteries examined in our study. Variations in the length and position of basilar arteries can be attributed to aging and hemodynamic factors, variations in branching pattern are mostly congenital in origin, with embryological explanations behind them.

Idowu et al also observed that the diameter of the basilar artery was relatively constant throughout its course except for the widening at its terminal bifurcation. These terminal widenings/expansions were probably in the form of minor variants of the above mentioned dolichoectasia. They also stated that the basilar artery extends from the lower to the upper border of the cisterna pontis in 98% of the brains; and early bifurcation at the mid pontine region in 2% of the cases. It terminates at the Ponto-Mesencephalic junction by running a straight course in 60% of the cases, convex to the right in 18% and convex to the left in 18% of the cases and forming a loop in 4% of the cases.[7]

Over the past 50 years, interventional radiology & many revascularization procedures like Transluminal angioplasty, vascular shunt & Bypass surgeries have greatly advanced and are being performed for various diseases of the basilar artery.[8]

Table 1 – Average dimension of basilar arteries.

Length	(mm)	Diameter	(mm)
Average	27.76	Average	3.36
SD	4.51	SD	0.697
Range	20.1–42.02	Range	2.02–4.45

Table 2 – Variation in the level of formation of the basilar artery.

Level of formation	No of cases	Percentage
At Ponto-Medullary junction	53	88.33%
Above Ponto-Medullary junction	4	6.67%
Below Ponto-Medullary junction	3	5%
Total	60	100%

Variations in the circle of Willis correlate significantly with relative contributions by the flow rates of the bilateral internal carotid and basilar arteries.[9]

In our study mean length of the basilar arteries was 27.76 (range 20.1–42.02) mm. In a recent study, Padmavathi et al reported an average length of 25–38 mm.[2] A study was performed on 20 brain specimens at Kasturba Medical College said that in most specimens, the mean length of the basilar arteries was 28.5 ± 2.8 (range 25–37) mm, with the basilar arteries in specimen 4 measuring nearly 37 mm.[10] Saeki & Rhoton et al shown length variation 15–40 mm with 50 specimens.[11] The present study results for average length and diameter of basilar artery were similar to other study results (Table 4).

Pai et al studied on 25 cadaveric specimens, and found the commonest site of formation of basilar artery at the Ponto-Medullary junction, and the 2nd commonest site of formation of basilar artery below Ponto-Medullary junction.[12] Padmavathi et al study of 54 cases showed that in 24 cases (44.4%) basilar artery formation was at Ponto-Medullary junction, in 9 cases (16.7%) it was above the level of Ponto-medullary junction. In 21 cases (38.9%) it was below the Ponto-Mesencephalic junction. While present study results conclude in 53 cases (86.9%) formation was at the Ponto-Medullary junction. 4 cases (6.6%) it was above the level of Ponto-Medullary junction, in 3 cases (4.9%) it was below the Ponto-Mesencephalic junction. It suggests higher possibilities of variation in formation of basilar arteries.

A study of 54 cases showed that in 24 cases (44.4%) basilar artery termination was at Ponto-Mesencephalic junction, in 16 cases (29.6%) it was above the level of Ponto-Mesencephalic junction as rostral as 10 mm above. In 14 cases it was below the Ponto-Mesencephalic junction as caudal as 4 mm.[2] While in current study result shows that 58 cases (95.1%) basilar artery termination was normal, in 2 cases (3.3%) it was above the level and 1 case (1.6%) it was below the Ponto-Mesencephalic junction.

Chaturvedi et al had suggested that hypoplastic basilar artery might be a predisposing factor for ischemic stroke and the mean age of all cases was 49.8 out of 4000 cases he has examined.[13]

Table 3 – Variation in the level of termination of the basilar artery.

Level of termination	No of cases	Percentage
At Ponto-Mesencephalic junction	57	95%
Above Ponto-Mesencephalic junction	2	3.33%
Below Ponto-Mesencephalic junction	1	1.67%
Total	60	100%

Table 4 – Average dimensions of basilar artery as reported in literature.

Name of the author	Length of the basilar artery		Diameter of basilar artery	
	Range (mm)	Average (mm)	Range (mm)	Average (mm)
Idowu et al[7]	20–40	31.42	2.5–5.5	3.82
Iqbal S.[4]	18–37	30	2.8–5.1	3.9
Present study	20.1–42.07	27.76	2.01–4.45	3.36

Stopford found that the basilar artery had bifurcated at the upper border of pons in 97.5% of the specimens and below this level, i.e., at the upper pons in the remaining 2.5% of the cases.[14]

As we have included specimens from different medical colleges of Gujarat the result is good representative of Gujarat population.

Fig. 2 – Abnormal variant of basilar artery. Abnormal variant, right hypoplastic vertebral artery (Orange arrow) and curved course of basilar artery (Green arrow).

The end results of the variation of the basilar artery in this study was not a true reflection of the general population in the frequency of the vertebrobasilar anomalies, because our data were limited to only 60 adult cadaveric brains without any neurological diseases. In addition our sample group was so small and Indian origin; it may also limit generalizations of these variations based on our study results. The inference of this study will inform neurosurgeons, sonologists and patients about the potentially vulnerable vertebrobasilar circulation and further autopsy, angiographic, and magnetic resonance imaging analysis were needed to augment these clinical implications.

5. Conclusion

Cerebrovascular diseases are one of the leading problems in modern medicine with high incidence of mortality rate. The vertebrobasilar system which supplies one fourth of the brain shows a high incidence of variations in the form of hypoplasia, fenestrations and asymmetrical configuration. These variations increase the risk of vertebrobasilar ischemia and posterior circulation stroke. Our study was conducted to analyze the size, asymmetry and variation of the basilar artery, using 60 adult cadaveric brains. The result showed that much variation is seen in diameter and length of basilar artery plus origin and termination of the arteries.

Conflicts of interest

All authors have none to declare.

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