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Original Article

MORPHOLOGICAL STUDY OF THE BASILAR ARTERY IN ADULT HUMAN CADAVERS

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ABSTRACT

Background: The basilar artery is the large median and major artery of the posterior circulation of the brain. Many variations are seen in the basilar artery, majority of them in position, origin and shape of the artery. Many authors have documented various anomalies as well as differences of the anatomy in this area in the Indian population as compared to the Western literature.
Context and purpose of study: Many studies are available on the anterior circulation of the brain i.e. on vessels of the circle of Willis but studies on the posterior circulation are very few. And such studies so far had been done mostly in the American and European races and are mostly based on imaging techniques. Studies in the Indian population have been few. Hence the present study is concentrated on the morphological study of the basilar artery of human adult brain, to show the frequency and type of variations in the morphology of the basilar artery.
Results: The basilar artery most commonly takes origin from the vertebral artery where left vertebral artery is greater in size than the right vertebral artery (72.5%).
Level of formation of the basilar artery is most commonly observed at the ponto-medullary junction (62.5%). Length of the basilar artery varied from minimum 2.4cm to maximum 3.6cm. More commonly artery lies in the range of 2.6-3.0cm (57.5%). Diameter of the basilar artery at origin ranges from 3.2-4.2mm, at mid level from 3-4mm and at termination 3.1-4mm. Level of termination of the basilar artery is more commonly at the mid brain-pons junction (50%). Most of the basilar arteries are of straight type (55%) and next common is bent or curved type (37.5%). Fenestration of 4mm is seen in proximal part of the one basilar artery (2.5%).
Conclusion: Variations of the basilar artery are common. Neurosurgical importance of this study lies during the exposure of the region for different purposes. Knowledge of the vascular variations will increase the success of the surgical procedures and radiological procedures used in interventional radiology.
KEYWORDS: Basilar artery, vertebral artery, level of formation, level of termination, length of basilar artery, diameter of basilar artery.

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INTRODUCTION

The basilar artery, a large median vessel is formed by the union of the vertebral arteries at the mid medullary level and extends to the upper border of the pons. It lies in the pontine cistern and follows a shallow median groove on the ventral pontine surface. The basilar artery is not responsible for the ventral median groove in the pons [1]. The basilar artery is the major artery of the posterior circulation of the brain

which supplies cerebellum, pons, upper medulla oblongata, pineal body, superior medullary velum and tela chorioidea of the third ventricle, internal ear, uncus, parahippocampal gyrus, medial and lateral occipitotemporal gyrus, cuneus and precuneus, visual areas of the cerebral cortex and other structures in the visual pathway, subcortical structures, peduncle and the posterior thalamus, superior and inferior colliculi and medial geniculate body [2].

Many variations in position of arteries of the vertebro-basilar system and the loop formation are quoted in the literature, but the exact cause is not known. Ageing and haemodynamic factors have been postulated as a probable reasons [3]. Anomalies of the vertebrobasilar vessels arise as early embryonic developmental deteriorations. The majority of them are seen in position, origin and shape of the vertebral and or basilar arteries [4].

The microsurgical anatomy of the posterior circulation is very complex and variable. Surgical approaches to this area are considered risky due to the presence of the various important blood vessels and neural structures. Many authors have documented various anomalies as well as differences of the anatomy in this area in the Indian population as compared to the Western literature [5].The knowledge of the variations in the level of origin and termination of the basilar artery, presence of stenosis, aneurysms should be kept in mind by the neurovascular surgeons while performing surgeries on the basilar artery and radiologist during interventional radiology for a better interpretation, diagnosis and treatment. Prior knowledge of possible anatomical variations can prevent inadvertent trauma & bleeding to a very great extent [6].

Many studies are available on the anterior circulation of the brain i.e. on vessels of the circle of Willis but studies on the posterior circulation are very few. Such studies so far had been done mostly in the American and European races and are mostly based on imaging techniques. Studies in the Indian population have been few. Hence the present study is concentrated on the morphological study of the basilar artery of human adult brain, to show the frequency and type of anomalies in the basilar artery.

METHODS

In present study the basilar artery is studied by dissection method [7] in 40 human adult brain specimens from embalmed human cadavers collected from various medical colleges of Maharashtra. Male, female differentiation was not made while collecting the data since numbers of female cadavers was less.

Following parameters were studied:

· Formation of the basilar artery (BA) by the vertebral artery (VA)

· Level of formation in relation to the ponto-medullary junction (P-M junction).

· Level of termination of the basilar artery in relation to the midbrain-pons junction (MB-P junction).

· Length of basilar artery was measured between following points,

i) At the point of formation by union of two vertebral arteries.

ii) At termination where it divides into two posterior cerebral arteries.

· Diameter was measured at three points,

i) At point of formation

ii) Midway

iii) At its termination

The diameter greater than 4.5mm was considered abnormal [8].

Measurements were taken by vernier caliper graduated to measure up to 0.1mm.

RESULTS

Table 1: Variation in formation of the basilar artery.

Formation of Basilar artery	Number of specimens	Percentage
Left VA greater than Right VA (V_0)	29	72.50%
Right VA greater than Left VA (V_1)	9	22.50%
Right VA equal to Left VA (V_2)	2	5%
Right VA hypoplastic (V_3)	0	0%
Left VA hypoplastic (V_4)	0	0%
Total	40	100%

Chi-square test value=29.45, DF=2, P<0.01 (highly significant)

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

Level of formation	Number of specimens	Percentage
At P-M junction	25	62.50%
Above P-M junction	10	25%
Below P-M junction	5	12.50%
Total	40	100%

Chi-square test value=16.25, DF=2, P <0.01 (highly significant)

Table 3: Length of the basilar artery.

Length of the Basilar artery in cm	Number of specimens	Percentage
2.1-2.5	4	10%
2.6-3.0	23	57.50%
3.1-3.5	12	30%
3.6-4.0	1	2.50%
Total	40	100%
Mean ± S.D. (Length of the basilar artery)	2.99 ± 0.29	

Chi-square test value=29, DF=3, P <0.01 (highly significant)

Maximum length of the basilar artery was found to be 3.6cm and minimum length was 2.4cm in specimen studied.

Table 4: Diameter of the basilar artery.

Diameter in mm	Mean ± S.D.	Maximum	Minimum
At Origin	3.63±0.22	4.2	3.2
At Mid level	3.53±0.22	4	3
At Termination	3.60±0.22	4	3.1

Table 5: Variation in the level of termination of the basilar artery.

Level of termination	Specimens	Percentage
At MB-P junction	20	50%
Above MB-P junction	13	32.50%
Below MB-P junction	7	17.50%
Total	40	100%

Chi-square test value=6.35, DF=2, P<0.05 (significant)

Table 6: Variation in the basilar artery.

Variation in the basilar artery	Number of specimens	Percentage
Normal or straight or sagittal	22	55%
Bent or curved	15	37.50%
'S' shaped or tortuous	2	5%
Fenestration or islet formation or segmentation	1	2.50%
Total	40	100%

Chi-square test value=31.4, DF=3, P<0.01 (highly significant)

More number of specimens shows straight type and fenestrated basilar artery was least seen. Fenestration or islet formation or segmentation was seen in 1 specimen (2.5%) and it was present in the proximal part of the basilar artery. Length of fenestration was 4mm (Figure 3).

Fig. 1: Bent or curved type of the basilar artery.

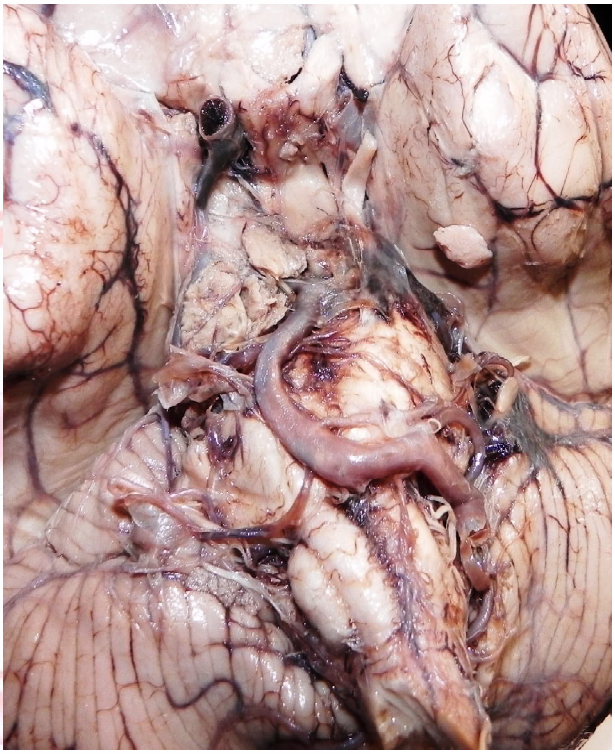

Fig. 2: "S" shaped or tortuous type of the basilar artery.

Fig. 3: Basilar artery with the proximal fenestration.

DISCUSSION

Many variations in position of arteries of the vertebro-basilar system and the loop formation are quoted in the literature, but the exact cause is not known. Variations are noted in the formation of the basilar artery. In the present study (Table 1) and study done by the Padmavathi et al (2011) [6] shows that in majority of specimens larger left vertebral artery and the smaller right vertebral artery contributes to formation of the basilar artery. But Pai et al (2007) [5] found higher number of samples in which right and left vertebral artery were of equal size contributing to the basilar artery formation. Also hypoplastic vertebral arteries were also noted by Vare and Bansal (1970) [9] and Padmavati et al (2011) [6] in their studies. When one vertebral artery is atretic and an atherothrombotic lesion threatens the origin of the other, the collateral circulation, which may also include retrograde flow down the basilar artery, is often insufficient. In this setting, low-flow transient ischemic attacks (TIAs) can occur [10].

Level of formation of the basilar artery was also variable. In present study (Table 2) and study done by Vare and Bansal (1970) [9] majority of cases (65%) shows level of formation were at the ponto-medullary junction. But in contrary to this Songur et al (2008) [11] shows formation below the ponto-medullary junction was more common (67%). While the study done by Padmavati et al (2011) [6] shows almost equal distribution of formation at the ponto-medullary junction (44.4%) and below the ponto-medullary junction (38.9%). Atheromatous lesions can occur anywhere along the basilar trunk but are most frequent in the proximal basilar and distal vertebral segment [10]. The bifurcation regions of the major human cerebral arteries are vulnerable to the formation of saccular aneurysms [12]. So, knowledge of variation in the level of formation of the basilar artery will help in proper approach to the treatment of atheromas and aneurysms.

Length of the basilar artery ranges from 2.4-3.6cms as studied by Pai et al (2007) [5] and in present study (Table 3). Saeki and Rhoton Jr (1977) [13] found length ranging between 1.5-4.0cms, while Lutza (1974) [14] has quoted the average length of 4.84cms, in males 5.05cm and in females 4.46cms. No significant gender difference was found in height, bifurcation or position of the basilar artery in previous studies [15].

Diameter of the basilar artery at its origin was not found quoted in the previous study but in present study mean diameter was found to be 3.63mm (Table 4). Diameter at mid-level was found to be 3.17mm by Smoker et al (1986) [16] and 3.53mm in present study. And diameter at termination was 4.1mm as found by Saeki and Rhoton Jr (1977) [13] and 3.6mm in present study. Previous studies had stated that diameter of the basilar artery differed significantly with gender [15]. The data on the length and diameter of the basilar artery is important for interventional radiologist to perform various endovascular procedures and also to the neurosurgeons to get the proper approach for the surgery.

Level of termination of the basilar artery, the point where it gives its terminal branches which is usually posterior cerebral arteries. Termination at the interpeduncular fossa or the midbrain-pons junction was found in 88% cases by Rand (1978) [17] and in 92% cases by Smoker et al (1986) [16]. Padmavathi et al (2011) [6] found termination at midbrain-pons junction in 44.4% cases, above junction in 29.6% cases and below junction in 38.9% cases. In present study termination was more common at midbrainpons

junction (Table 5).

Variations were seen in the morphology of the basilar artery. Normally the basilar artery has straight or sagittal course but variations which are quoted in the literature include artery bent or curved on one side, fenestrated or partial or segmental duplication, "S" shaped or tortuous, complete duplication. The "S" form cannot be considered a deformity of the old age as it had often been observed in the angiograms of young patients as well [14]. Segmental duplication of the basilar artery, own their clinical interest to the possible association with aneurysms localized at the junctions of the fenestrated segments [18]. Luzsa (1974) [14] has quoted, straight or sagittal type of the basilar artery was found in only 15-20% cases only and fenestrated arteries in 2% cases. Harrigan, Deveikis, Ardelt (2009) [19] has quoted that straight course was found in 45% cases, bent or curved in 35% cases, "S" shaped or tortuous in 20% cases and fenestrated in 1.33% cases. In present study straight course was found in majority of cases (55%), bent type in 37.5%, "S" shaped in 5% and fenestrated in 2.5% cases (Table 6).

CONCLUSION

Variations in the morphology of the basilar artery are common. Knowledge of anatomy of the basilar artery and variations in them is important for dealing with cerebro-vascular diseases which is one of the leading problems of the modern lifestyle. Neurosurgical importance of this study lies during the exposure of the region for different purposes. Knowledge of the vascular variations will increase the success of the surgical procedures and radiological procedures used in interventional radiology.

LIST OF ABBREVIATIONS:

BA- Basilar artery;

VA- Vertebral artery;

P-M junction- Ponto-medullary junction;

MB-P junction- Midbrain-pons junction

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Conflicts of Interests: None

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