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MORPHOLOGICAL STUDY OF THE VERTEBRAL ARTERIES IN ADULT HUMAN CADAVERS

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ABSTRACT

Background: Missing anatomical variations in the vertebrobasilar system can lead to catastrophic sequel in surgeries like atlanto axial screw fixation and anterior cordectomy etc. The aim of the present study was to examine the vertebral arteries in south Indian population.

Materials and Methods: This study was conducted in the Department of Anatomy, Vydehi institute of medical sciences, Bangalore. Intracranial parts of vertebral arteries were studied in 20 human adult brain specimens of both genders obtained from embalmed human cadavers. Diameters of the intracranial part of vertebral arteries of were measured using a digital verniers caliper.

Results: All the vertebral arteries originated from the first part of subclavian artery. There was no difference in the course of Right and left vertebral arteries. Later both the vertebral arteries joined to form the basilar artery most commonly at the pontomedullary junction. The intracranial part of Left vertebral artery was greater in size than the right vertebral artery in most of the specimens. However one specimen showed the presence of left hypoplastic vertebral artery and therefore the right vertebral artery was the main contributing artery in the formation of basilar artery.

Conclusion: Understanding and reporting of the anatomical variations of vertebral arties is essential to create awareness that can aid in various surgical and radiological procedures.

KEY WORDS: Subclavian Artery, Vertebral Artery, Pontomedullary Junction, Basilar Artery Left Hypoplastic Vertebral Artery.

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INTRODUCTION

The vertebral arteries which originate from the first part of subclavian arteries unite to form the basilar artery are the primary blood supply for infratentorial brain structures such as mesencephalon, cerebellum, pons and medulla oblongata. According to classical descriptions, the vertebral artery arises from the superior aspect of the first part of suclavian artery, passes through the foramina of all cervical transverse terminal except the seventh, then curves medially behind the lateral mass of atlas, and then enters the cranium via the formen magnum. At the lower pontine border, it joins its fellow of opposite side to form the basilar artery [1].

Vertebral artery is classically divided into 4 segments. First segment starts from its origin on first part of subclavian artery to the C6 transverse foramina. The second segment is from C6 to C2 transverse foramina. Third segment is from C2 to foramen magnum. Fourth from foramen magnum to vertebra basilar junction. Both the right and left vertebral artery merge to form the single midline basilar artery in a complex called the vertebrobasilar system, which supplies blood to the posterior part of the circle of Willis and thus to significant portions of the brain [2].

Congenital variations in the vertebral arteries are frequently encountered in routine cadaveric dissections and during imaging procedures. The commonly encountered variations include abnormal origin, asymmetrical vertebral arteries, duplication of arteries, fenestration of arteries and hypoplastic vertebral artery [3-5]. The knowledge about the variations of the vertebrobasilar arterial complex is important for surgeons operating at the skull base, craniocervical junction, cervical region and for clinicians interpreting the imaging of this region.

Vertebral artery hypoplasia has been known to be associated with regional hypoperfusion and complex neurovascular consequences that can lead to vestibular neuronitis and migraine pathogenesis [5]. Vertebral artery hypoplasia is also found to be a contributing factor of acute ischemic stroke, especially in posterior circulation territories [6]. Therefore, this study was undertaken to find the variations in the vertebral arteries.

MATERIALS AND METHODS

This study was conducted in the Department of Anatomy, Vydehi institute of medical sciences, Bangalore. Intracranialpart of vertebral arteries were studied in 20 human adult brain specimens of both genders obtained from embalmed human cadavers. The site of origin and termination of vertebral arteries were noted. Diameters of the intracranial part of vertebral arteries of were measured. The measurements were taken using a digital verniers caliper.

RESULTS

Table 1: Comparison between the right and left vertebral artery.

	Number of specimens	Percentage
Left VA greater than Right VA	15	75%
Right VA greater than Left VA	3	15%
Right VA equal to Left VA	1	5%
Right VA hypoplastic	0	0%
Left VA hypoplastic	1	5%
Total	20	100%

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

Level of formation of basilar artery	Number of specimens	Percentage
At P-M junction	13	65%
Above P-M junction	5	25%
Below P-M junction	2	10%
Total	20	100%

Table 3: Diameter of the intracranial part of vertebral artery.

	Right	Left	p value
Diameter in mm	3.12 ± 0.08	3.64 ± 0.04	<0.01

Fig. 1: Showing left hypoplastic vertebral artery.

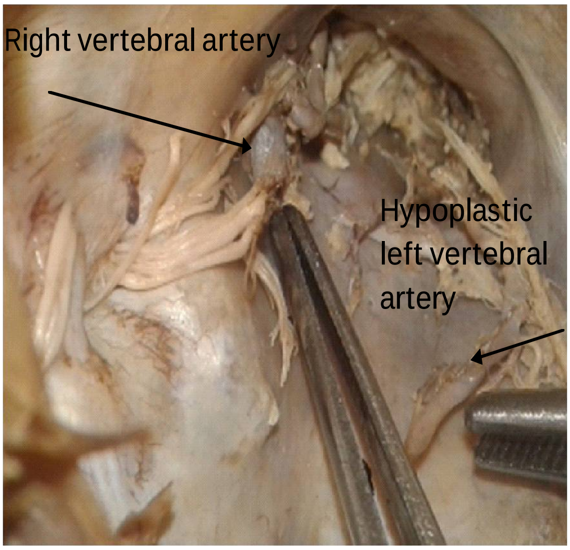
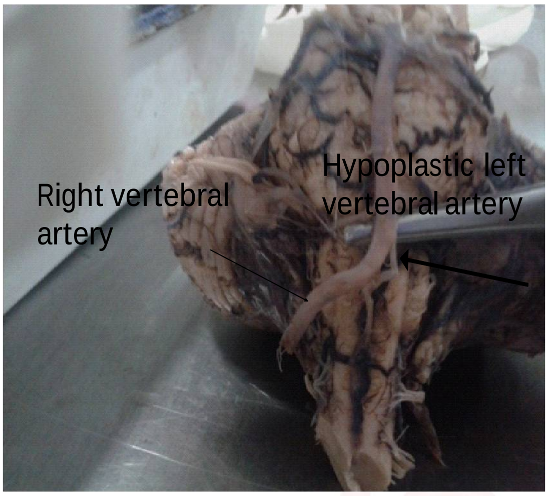


Fig. 2: Showing left hypoplastic vertebral artery.



The vertebral artery commonly took origin from the first part of subclavian artery. There was no difference in the course of right and left vertebral arteries. In the cranial cavity left vertebral artery was greater in size than the right vertebral artery in 75 % of the specimens (Table 1). Level of formation of the basilar artery was observed at the ponto-medullary junction in 65% of the specimens (Table 2). Mean diameter of the right vertebral artery was 3.12 ±0.08 mm while that of left vertebral artery was 3.64±0.04mm and the difference was statistically significant (p value <0.01) (Table 3).

However among them, a left hypoplastic vertebral artery was found in an aged male cadaver (Fig. 1 & 2). It originated from subclavian artery to enter the foramen transversarium at the level of the 6^{th} cervical vertebrae. Then it proceeded superiorly in the transverse foramina of the rest of cervical vertebrae. After it had passed through the transverse foramina of C1, it travelled across the posterior arch of C1 and through the suboccipital triangle before entering the foramen magnum. Inside the skull, it was about 0.8mm in diameter in the cranial cavity and joined the right vertebral artery a little below the pontomedullary junction to form the basilar artery. This abnormality was seen only on the left side. The right vertebral artery with diameter of about 4mm itself was majorly forming the basilar artery. Alongside a punched out lesion of the cerebrum of the right side in the temperoparietal region was also found indicating a haemodynamic imbalance resulting in a stroke with post gliosis after an infarct episode.

DISCUSSION

The anomalies in blood vessels are due to unusual paths, persistence of obliterated vessels, disappearance of vessels and incomplete development. The embryogenesis of vertebral artery takes place between 32 and 40 days of development. At the 4mm embryo stage, there are seven intersegmental arteries that arises dorso laterally from dorsal aorta. At the 7-12mm stage vascular connections between them exist. In the cervical region, the vertebral artery develops as a composite vessel and develops from following sources: first part, which extends from subclavian artery to foramen transversarium of C6 vertebra, develops from dorsal ramus of spinal branch of seventh intersegmental artery. Second part, extending from the foramina tranversarium of C6 vertebra to first cervical vertebra develops from enlargement of post costal anastomosis with the consequent regression of the stems of the upper six intersegmental arteries. Third part that rests on the posterior arch of atlas is derived from the spinal branch of first cervical intersegmental artery. Fourth part, owes its development from the preneural division of the spinal branch of first cervical inter segmental artery.

Frequent variation in the origin and few cases of unusual courses has been reported. Vertebral arteries have been reported to be arising from common carotid artery, brachiocephalic artery, or sometimes directly from arch of aorta only [7]. Cases of vertebral artery in cervical part taking a retrooesophageal course have also been reported. However in our study, we did not note any variation in origin or course of these arteries. Akar ZC et al studied the intracranial course of vertebral artery and described that the right vertebral arteries were larger in dimensions than the left [8]. In our study we found that left sided vertebral arteries were larger than the right. Anjuman sultana et al in their study on site of formation of basilar artery found that in 72.29% cases the basilar artery formation was at pontomedullary junction while 35.79% showed basilar artery formation below pontomedullary junction and there was no basilar artery formation above the pontomedullary junction [9]. In this study, 65% of the specimens had the basilar artery formation at pontomedullary junction, 25% above the pontomedullary junction and 10% below the pontomedullary junction. Congenital vertebral artery hypoplasia is an uncommon embryonic variation of posterior circulation. It was described as early as in the 19th century [10]. It has been found to have a frequency of 2-6%. Katsanos et al described the prevalence of vertebral artery hypoplasia to a range of 1.9% to 11.6% [11]. This study showed an incidence of 5% for hypoplastic artery.

Chuang YM et al described operational definitions of vertebral artery hypoplasia which vary between diameters of < 2 to < 3 mm, or an asymmetry ratio of equal or greater than 1:1.7 [10]. Jeng, yip pk et al indicated that right sided vertebral artery hypoplasia is twice as more common than left sided vertebral artery hypoplasia [12]. Caplan baker et al were first to notice that smaller of paired arteries are more likely to occlude and raised the question if the congenital hypoplastic arteries are by nature more prone to occlusion [13]. Katsanos et al described that along with the size of the artery there must be an interaction with the blood pressure, constituents of the blood, and the rheology and physics of blood flow and that small diameter arteries are more vulnerable to low flow velocity and prothrombotic and atherosclerotic factors [11].

The left vertebral artery is usually larger and carries more blood which was true in this study. Clinically, this may lead to altered hemodynamics. According to Blickenstaff KL et al., the incidence of congenital atresia or hypoplasia of the left vertebral artery is 3.1%, and of the right vertebral artery is 1.8% [14].

Campos D described hypoplasia of the right vertebral artery in a 70 years old male cadaver. Park JH et al investigated the frequency and clinical relevance of hypoplastic vertebral artery in patients with ischemic stroke with or without vertebral artery territory and in normal healthy people. They found that 35.2% of the cohort had bilateral hypoplastic vertebral artery. Patients with posterior circulation strokes had a higher rate of hypoplastic vertebral artery than those with anterior circulation strokes [5].

Katsanos AH et al published a review on the relationship between a hypoplastic vertebral artery and posterior circulation cerebral ischemia. They found that ultrasound studies reveal the reduced blood flow in the hypoplastic vertebral artery may result in local cerebral hypoperfusion and subsequent focal neurological symptomatology. That risk of cerebral ischemia is related to the severity of the hypoplasia [11].

Thierfelder KM et al studied the perfusion in the posterior inferior cerebellar artery territory in the patients with vertebral artery hypoplasia in the absence of manifest posterior circulation ischemia. They found that vertebral artery hypoplasia is a frequent vascular variant that can lead to a relative regional hypoperfusion in the posterior inferior cerebellar artery territory [15].

Orino et al described a 36 year old male with locked in syndrome due to brainstem infarction whose cerebral angiography revealed hypoplasia bilateral vertebral arteries, a persistence of right primitive trigeminal artery, and retrograde blood flow of basilar artery from the posterior trigeminal artery [16].

CONCLUSION

Anatomical variations in the vertebrobasilar system are frequently reported which if missed can lead to catastrophic sequel in surgeries like atlanto axial screw fixation, anterior cordectomy, repair of aneurysms, vertebral endarterectomy , excision of craniocervical junction masses etc. Hence, understanding and reporting of the same is essential to create awareness that can aid in various surgical and radiological procedures.

Conflicts of Interests: None

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