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A STUDY ON ANATOMICAL AND MORPHOLOGICAL VARIATIONS OF THE ORIGIN OF LEFT VERTEBRAL ARTERY FROM THE ARCH OF AORTA

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ABSTRACT: The anatomic and morphologic variations of the left vertebral artery are significant for diagnostic and surgical procedures in the head and neck region. This study was conducted on 30 cadavers (Male-25, female-5) during routine dissection in the Department of Anatomy. Origin, course and termination of left vertebral artery from the arch of aorta were observed. Diameters at various level (1st, 2nd, 3rd & 4th part) and length of the prevertebral part of left vertebral artery were measured. Results showed, the average diameter of left vertebral artery that took origin from arch aorta was 5.4mm and average length of prevertebral part of left vertebral artery is about 7.2 cm. The narrowest part of the left vertebral artery was 2nd part and its average diameter was 4.7mm. These measurements are helpful in identifying the difficulties in catheterization and angiographic studies.

KEYWORDS: vertebral artery, arch of aorta, cervical vertebra, variation.

INTRODUCTION: Variations in the branching pattern of aortic arch are due to variations in the extent of the fusion and absorption of some of the aortic arches into the aortic sac.^[1] The unusual origin of left vertebral artery (LVA) is often from the aortic arch between the left common carotid artery and the left subclavian artery.^[2] Normally, the vertebral artery arises from the superoposterior aspect of the first part of the subclavian artery. It passes between longus colli and scalenus anterior muscle, behind the common carotid artery and the vertebral vein through the foramina in the transverse processes of all of the cervical vertebrae except the seventh, curves medially behind the lateral mass of the atlas and enters the cranium via the foramen magnum. At the lower pontine border it joins its fellow to form the basilar artery.^[3] In the present study, the origin, course, developmental origin, diameters at various level and clinical significance of the left vertebral artery from the arch of aorta have been discussed.

MATERIALS AND METHODS: This study was conducted on 30 cadavers (Male-25, female-5) during routine dissection in the Department of Anatomy. The thoracic cavity was opened by cutting through the costochondral junctions and removing the sternum and costal cartilages. The lungs and pleura were removed, superior vena cava and brachiocephalic veins cleared then pericardium opened to expose heart and ascending aorta. Nerves and connective tissues were removed to expose the branches of the aortic arch. Origin, course and termination of left vertebral artery were observed. Diameter at various levels (1st, 2nd, 3rd & 4th part) (By using Vernier caliper) and length of the prevertebral part of left vertebral artery were measured. Photographs of the variant origin of the left vertebral artery was taken using digital camera (Canon – 16.0 megapixels)

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RESULTS:

Cadaver no.	Passing through	Left vertebral artery					
		Prevetebral length (cm)	1 st part Diameter (mm)	2 nd part Diameter (mm)	3 rd part Diameter (mm)	4 th part Diameter (mm)	Average Diameter (mm)
1.	C5	7.2	5.6	4.2	4.5	4.8	4.8
2.	C5	6.6	6.4	5.4	5.8	5.0	5.7
3.	C4	7.8	6.2	5.0	6.0	5.2	5.6

Table 1: Various measurements of left vertebral artery from three cadavers

Among 30 cadavers, origin of left vertebral artery from arch of aorta was observed in 3 cadavers. In all the three cadavers (fig. 1, 2), it originated from arch of aorta in between the left common carotid artery and the left sub clavian artery and in two cadavers it passed through transverse foramen of C5 vertebra but in one case it was passing through C4 vertebra. The maximum length of the prevertebral segment was 7.8cm. The average diameter of left vertebral artery that took originated from arch of aorta was 5.4mm. we observed the average minimum diameter was measured in the second part of the left vertebral artery i.e. around 4.7mm and the average maximum diameter was in first part, measured around 6.1mm.

Fig. 1: Showing origin of left Vertebral artery from the arch of aorta

- BCT- Brachiocephalic trunk.
- LCCA- Left common carotid artery.
- LVA- Left vertebral artery.
- LSA- Left subclavian artery.

Fig. 2: Showing origin of left vertebral artery from the arch of aorta

- BCT- Brachiocephalic trunk.
- LCCA- Left common carotid artery.
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DISCUSSION: The vertebral artery is classically described as first branch of the subclavian artery. Multiple variations in the origin of the vertebral artery have been reported in the literature, such as it can arise from the aortic arch, the common carotid or the internal carotid arteries.^[4] The LVA varies in origin more than the right. A case of bilateral anomalous origin of the vertebral artery from the aortic arch is also reported.^[5]

Most frequently (2.4-5.8%) the LVA arises directly from the aortic arch between the left common carotid artery and left subclavian artery.^[5,6] Jayanthi, et al. stated that the frequency of origin of the LVA from the aortic arch is in the range of 1–3% of cases and normal three-branched arrangements of the aortic arch are reported in 64.9% of cases.^[1] According to Sumit et al, out of 75 cadavers 58 (77.3%) were having the normal three branched arrangements but, the origin of LVA from aortic arch was found in 6 cadavers (8%). It is coming under Adachi's classification type III.^[7] Nurcan et al, have observed the diameter of the LVA at its origin was 5.51 mm and the diameter of the RVA was 4.54 mm. But both were entered through the transverse foramen of the C6 vertebra.^[8]

Beata et al, have reported that the two vertebral arteries are usually unequal in size; the left is frequently larger than right one. The diameter of the LVA was 6 mm and it entered through C3 foramen transversarium.^[9] But Kubikova et al, have stated that the LVA usually enters the sixth cervical foramina transversaria (88%).^[10] only in 5–7% cases the left vertebral artery will enter seventh or fifth cervical vertebra.^[11] In contrast to the above said statement Adachi (66.66%) and Yamaki (43.3%) have observed that the LVA commonly enters through C5 foramina transversarium.^[10] Paniker et al have said that the diameter of left vertebral artery at its origin was 3.1 mm as compared to that of the right, which had a diameter of 6.5 mm at origin.^[12] But Haifa et al, have observed that the mean diameter of the LVA was 5.5 mm.^[13]

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Compared with the above mentioned literatures, in the present study, from three cadavers, it originated from arch of aorta in between the left common carotid artery and the left subclavian artery and in two cadavers it passed through transverse foramen of C5 vertebra. This is consistent with Adachi and Yamaki's findings. But in one case it was passing through C4 vertebra. The maximum length of the prevertebral segment was 7.8cm. The average diameter of left vertebral artery that took originated from arch of aorta was 5.4mm. This finding was consistent with findings in Haifa et al. study. we observed the average minimum diameter was measured in the second part of the left vertebral artery i.e. around 4.7mm and the average maximum diameter was in first part, measured around 6.1mm. These measurements are helpful in identifying the difficulties in catheterization and angiographic studies.

Anatomical and morphological variations of the vertebral artery are of great importance in surgery, angiography, and all non-invasive procedures.^[13] Anomalous vertebral artery origins also represent a potential pitfall at diagnostic cerebrovascular imaging. One or both vertebral arteries may be wrongly assumed to be occluded or diseased, either by eluding catheterization during angiography or by lying outside the region of interest during noninvasive studies such as CT angiography, MR angiography, or Doppler sonography.^[5] According to the literature, most patients with anatomic variation of the left vertebral artery are clinically asymptomatic. Some patients complained of dizziness, but this was thought to have no association to the anomalous origin of the left vertebral artery.^[9]

The most frequent pathology affecting the extracranial vertebral artery is atherosclerosis. The commonest site of which, according to Fischer et al. is at the origin of vessel from subclavian artery.^[8] A variant origin of vertebral artery of this kind may favour cerebral disorders because of alterations in cerebral haemodynamics.^[14,15] Although overall incidence of variant origin of prevertebral segment of vertebral artery is very low, it is extremely important to be aware of these complications in such patients.^[15] Vertebral artery anomalies can cause ischemia as well as infarction of the brain stem and cerebellum if the vertebro-basilar axis is left dominant and communication at the arterial circle of Willis is poor.^[2] Anomalous origins may lead to altered haemodynamics and predispose the patient to intracranial aneurysm formation. Endovascular therapy of intracranial aneurysms can be performed before they present clinically as subarachnoid hemorrhages.^[16]

Embryological Origin: The intersegmental arteries are 30 or more branches of the dorsal aorta. They originate from the branchial aortic system. Initially the vertebral artery emerges being formed by the longitudinal anastomosis of the cervical segmental arteries. Usually the first part of vertebral artery develops from proximal part of dorsal branch of seventh cervical intersegmental artery proximal to postcostal anastomosis. The second part is derived from longitudinal communications of the postcostal anastomosis.^[5] In the present case, the left sixth dorsal intersegmental artery might have persisted as the first part of vertebral artery hence Left vertebral artery was arising from arch of aorta.

CONCLUSION: Knowledge of potential vertebral artery origin variants appears to be mandatory for planning aortic arch surgery or endovascular interventions. Surgeons must be aware of possible variations of the major arteries and be able to identify them. This is very important for appropriate invasive techniques in order to achieve desired objectives and to avoid major complications especially during vascular surgery.

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