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Original Research Article

VARIATIONS IN THE ORIGIN OF VERTEBRAL ARTERIES – A CADAVERIC STUDY

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ABSTRACT

Background: The vertebral arteries originate from the first part of subclavian artery on both sides. Knowledge of anomalies in the origin of vertebral arteries is essential while planning aortic surgeries and endovascular procedures. Commonest variant in literature is the left vertebral artery arising directly from the aortic arch. The aim of this study was to identify any variations present in the origin of vertebral arteries. **Materials and Methods:** Twenty five embalmed cadavers were obtained from the Department of Anatomy, Kallakurichi Medical College. The lower neck and thoracic region were dissected, aortic arch with its branches were exposed completely. Any variations in the origin of vertebral arteries on left and right sides were identified and photographed. **Result:** Normal origin of vertebral arteries were noted in 23 cases (92%). In 2 cases (8%) the left vertebral artery arose directly from the Aortic Arch, between left subclavian artery and left common carotid arteries. There were no anomalies noted on the right side. **Conclusion:** Anatomical variants of vertebral arteries might pose difficulties during surgical interventions on the aortic arch. Hence identification of these anomalies using imaging studies would be useful to prevent iatrogenic damage and avoid complications.

INTRODUCTION

The vertebral artery arises from the superoposterior aspect of the first part of the subclavian artery. It passes through the foramina in the transverse processes of all the cervical vertebrae except the seventh , curves medially behind the lateral mass of the Atlas and enters the cranium via the foramen magnum.[1]

Multiple variations involving the origin of vertebral arteries have been reported in literature. Its aberrant origin is variable and can arise from aortic arch, common or internal or external carotid arteries.[2] Commonest variation is the left vertebral artery arising directly from the Aortic Arch between the left common carotid and left subclavian artery with a prevalence of 2.4 – 5.8 %.[3] In contrast, an aortic origin of the Right vertebral artery is rare.[4] A bilateral Aortic Arch origin of vertebral artery represents an exceptional anatomical variant.[5]

These variations are mostly asymptomatic and are incidental findings. But it is important for clinicians to be aware of them as they may interfere with angiographic or surgical procedures on the aortic arch. An aortic arch surgery might be complicated by ischaemic issues, which can be caused by unrecognized variation of its vascular anatomy.[6] Some are known to cause tracheo oesophageal obstructive symptoms such as dysphagia or stridor.[7] The anomalous vertebral artery origin may be an independent risk factor for arterial dissection, the longer extracranial course may lead to increased vulnerability of the vessel wall to shear stress resulting in intimal tear and dissection.[8]

MATERIALS AND METHODS

Twenty five formalin fixed cadavers used for routine dissection of first MBBS students were obtained from Department of Anatomy, Government Medical College, Kallakurichi. The lower neck and thoracic region were dissected and Arch of Aorta with all its branches were exposed completely. The site of origin of right and left vertebral arteries were noted. Any variations in their origin were identifed and photographed.

RESULTS

Out of 25 cadavers, in 23 cases (92%) vertebral artery had a normal origin from the first part of subclavian artery on both sides. In 2 cases (8%) the left vertebral artery originated directly from the aortic arch

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between left subclavian artery and left common carotid arteries. In both the cases, the vertebral artery ascended and entered foramen transversarium of the C6 cervical vertebrae. The right vertebral artery had a normal origin from the first part of right subclavian artery in all the 25 cadavers. There were no variations noted on the right side.

Figure 1: Left vertebral artery arising from Arch of aorta

Figure 2: Left vertebral artery from aortic arch entering C6 cervical vertebra

Figure 3: Only internal thoracic artery and thyrocervical trunk arising from first part of subclavian artery on the left side

DISCUSSION

The prevalence of left vertebral artery arising from Arch of aorta ranges between 0.68 – 5.8% based on the previous studies. In our study, the frequency of left vertebral artery arising from aortic arch was found to be 8%.

Adachi was the first to classify anomalies of vertebral arteries .The above variations of left vertebral artery arising as a fourth branch from the aortic arch belongs to Adachi Type C classification.[9]

Evan .H.Einstein et al reported in his study, that the incidence of left vertebral artery arising from aortic arch is 14.8%.[10] In a study by Dr. Shylaja DK et al the overall incidence of the above variation was observed to be 6.7%.[11] Kartik Bhatia et al in their study of South Australian population, reported an incidence of 7.41% where the left vertebral artery originated from the aortic arch.[12]

COMPARISON OF STUDIES SHOWING INCIDENCE OF LEFT VERTBRAL ARTERY ARISING FROM AORTIC ARCH

S.NO	STUDIES	INCIDENCE (%)
1	Adachi(1928)[9]	5.4%
2	Daseler EH (1959)[13]	4.25%
3	Argenson et al (1980)[14]	5.8%
4	Vorster et al (1998)[15]	5%
5	Yamaki et al (2006)[16]	5.8%
6	Uchino et al (2013)[17]	4.1%
7	Tetiker et al (2014)[18]	3.8%
8	Woraputtaporn et al (2019)[19]	5.3%

Numerous case reports have also reported the above variation. Ecc.Onrat et al,[20] Eleni Pater et al,[21] Nagendra Singh et al,[22] and Magda Eldomiaty et al23 have all published case reports identifying the anomalous origin of left vertebral artery from the aortic arch.

In our study, there were no anomalies noted on the right side. In all the cadavers, the right vertebral

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artery originated from the first part of the subclavian artery. Although variants of the right vertebral artery is relatively rare, there are studies done previously which have observed this variation. Umar Abid Saeed et al,[24] in his study observed 3 cases of aberrant right vertebral artery arising as the last branch from the arch of aorta. Lemke et al,[3] in his study noted that the right vertebral artery had origin from the right common carotid artery with a concomitant anomalous right subclavian artery origin as last branch of the aortic arch.

In our study variations were present on the left side only. No bilateral variations were noted. But bilateral aortic arch origin of vertebral arteries have also been reported in literature. In a study of Sait Albayram et al,[4] he observed that both vertebral arteries arose directly from the aortic arch between the left common carotid and left subclavian artery , which was a rare variation . Goray VB et al,[25] noted in his study that both vertebral arteries originated as additional branches of the aortic arch.

In a study by Aprajita Sikka et al,[26] bilateral variation was noted. Left vertebral artery took origin from arch of aorta and right vertebral artery took origin from right subclavian artery.

In the study by Aprajita Sikka et al,[26] the left vertebral artery which originated from aortic arch entered the foramen transversarium of C4 vertebra. The right vertebral artery which originated from right subclavian artery entered the C3 cervical vertebra. In a radiological study by Chia Ying Lin et al,[27] 80.4% of left vertebral arteries with variant origin from aortic arch entered the C5 transverse foramen.

In another radiological study by Xueting Yi et al,[28] ,they observed that in 2.47% and 4.71% of studied cases the vertebral artery entered C4 and C5 transverse foramen respectively. Hence studies done previously have confirmed that when vertebral arteries arose from the aorta, there was a significant higher rate of anomalous entrance level (C4 or C5) to normal C6 entrance level.

In our present study in the 2 cases of variant origin of left vertebral artery, the artery ascended up and entered the foramen transversarium of C6 cervical vertebrae.

Identifying the high level of vertebral artery entrance is crucial prior to operation, due to lack of bony protection. The abnormal course of extradural vertebral artery may complicate corpectomy, foraminotomy and percutaneous nerve block causing arterial laceration or pseudoaneurysm formation.[29,30]

Vascular variation can cause changes in blood flow and thus may increase the chances of aneurysm formation in the vertebrobasilar system of the body.[31] If the vertebral arteries are not identified in their normal position, this finding may be misinterpreted as the vessels being congenitally absent. This information is important for vascular or cardiovascular surgical planning.[32]

In live patients the diagnosis of an aberrant vertebral artery can easily be made out with color Doppler, in addition, other modalities can achieve cerebrovascular imaging such as chest and neck vessels angiography or magnetic resonance imaging and CT angiography.[33,34]

CONCLUSION

In our present study, the left vertebral artery originated from the aortic arch in 2 cases[8%].No anomalies were noted on the right side. Knowledge of variations in the origin of vertebral arteries is clinically relevant because such variants are more prone for vascular pathologies. Anomalous origin of vertebral arteries may complicate surgeries on the aortic arch and endovascular procedures. Surgical procedures that requires exposure of vertebral arteries include aneurysm repair, excisions of craniocervical tumours, vertebral endarterectomy and cervical spine surgeries. With respect to individual variations,a thorough knowledge of vertebrobasilar variations may improve the outcome of skull base and other head and neck operations and aid in the intepretation of imaging35. It can cause changes in cerebral haemodynamics leading to cerebrovascular complications. Without a thorough understanding of anomalous origins and course of vertebral arteries, angiography can be difficult or impossible.

CT angiography is the principal imaging modality for assessment of vascular anomalies now a days due to high spatial resolution and widespread availability.In recent years DECT [dual energy computed tomography] is becoming a non invasive and reliable tool to diagnose vascular anomalies in head and neck regions.

Preop assessment and screening of patients undergoing neck and chest surgeries using imaging studies like CT and MR Angiograms for possible vertebral artery variations is hereby recommended. It is important for clinicians to be aware of variations of vertebral arteries while planning diagnostic or interventional angiographies.

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