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A RARE CASE REPORT OF THE BOVINE AND LEFT VERTEBRAL VARIANT OF THE ARCH OF AORTA.

Clinical Anatomy

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ABSTRACT

The arch of aorta, a continuation of ascending aorta gives of three main branches, the brachiocephalic trunk, left common carotid artery and left subclavian artery. During routine dissection as part of undergraduate medical teaching in the Department of Anatomy, Government Medical College Kottayam, a rare variation of arch of aorta was noticed. In this cadaver, there was a common origin of the brachiocephalic trunk and left common carotid artery (Bovine variant) and the left vertebral artery was arising directly from arch of aorta. Variations of the arch of aorta comprise a group of entities that may be either asymptomatic or associated with other congenital cardiac defects. A broad spectrum of pathologies and surgical procedures is often linked with these variations hence; the arch of aorta is a key area to be reviewed for its variant anatomy.

KEYWORDS

arch of aorta, brachiocephalic trunk, left common carotid artery, left vertebral artery.

INTRODUCTION

The description of the normal and variant anatomy of the arch of aorta and its branches dates back to Vesalius (1543), Cruveulhier (1837), Tiedemann (1822), Bourgery (1836), Quain (1844), Dubrueil (1847), Heitzmann, (1885), Le Double (1901), Parsons (1902) and other eminent commentators, whose works describe various arrangements of aortic arch branches.[1] The arch of aorta, arch artery of left fourth pharyngeal arch, is the continuation of ascending aorta. It ascends to the mid-level of the manubrium sterni and curves around the hilum of the left lung. Posteriorly, it descends to the left of body of the fourth thoracic vertebra and continues as the descending thoracic aorta. The convex aspect of the arch of aorta gives of three branches, from right to left: the brachiocephalic trunk (innominate artery), the left common carotid and left subclavian artery. The brachiocephalic trunk further divides into the right subclavian artery and the right common carotid artery.

The vertebral artery arises from the first part of subclavian artery and is divided into four segments-preforaminal segment, foraminal segment, extradural or extraspinal segment and intradural or intracranial segment.[2] The arch of aorta is known for its variations because of the complex embryological origin. Variations associated with vertebral artery include variations in origin and termination, abnormal levels of entry into the transverse foramen, duplications, fenestrations, loops and the presence of rete vertebralis.[3] Accurate knowledge of such variations is crucial for both radiologist and surgeons.

Case Report

The variation was observed in a formalin- fixed male cadaver during the routine dissection of thorax for undergraduate medical students in the Department of Anatomy, Government Medical College Kottayam. The dissection was carried out as per Cunninghams Manual of Practical Anatomy, Volume 2.

After opening the anterior thoracic wall, fat and the pericardium covering the ascending aorta were removed. The veins were displaced to expose the arch of aorta with its branches. A variation in the branching pattern of the arch of aorta was noted. From right to left, the branches were: a common origin of brachiocephalic trunk and left common carotid artery, the left vertebral artery and the left subclavian artery.

The common origin was located anterior to the trachea. After its origin, the left common carotid artery crossed anterior to the trachea and coursed towards the left. The brachiocephalic trunk bifurcated into right common carotid and right subclavian artery.

The left vertebral artery arose directly from the arch of aorta between the common origin and the left subclavian artery. It ascended vertically through the left scalenovertebral triangle and entered the foramen transversarium of sixth cervical vertebra. The right vertebral artery had a normal origin from the first part of right subclavian artery. The further course of all branches was unremarkable.

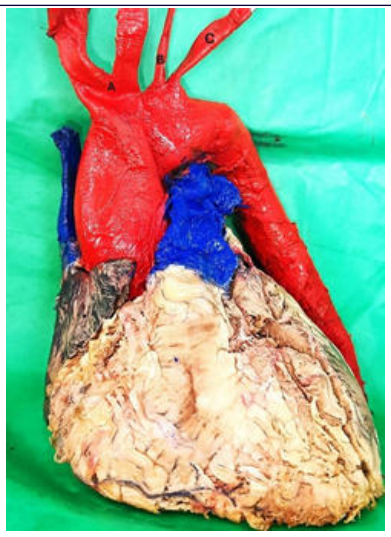

Figure 1: Bovine and left vertebral variant of the arch of aorta A: common origin of brachiocephalic trunk and left common carotid artery B: left vertebral artery C: left subclavian artery.

DISCUSSION

Description of variant branching patterns of arch of aorta dates back to the 1500s. Popieluszko et al. based on a meta-analysis, proposed a classification system consisting of seven types - Type 1: normal three vessel branching pattern. Type 2: Bovine arch: from right to left, branches are a common trunk giving rise to the brachiocephalic trunk and the left common carotid artery, followed by the left subclavian. Type 3, left vertebral variant: from right to left, the branches are brachiocephalic trunk, left common carotid, left vertebral, and left subclavian arteries. Type 4, bovine and left vertebral: common trunk of the brachiocephalic trunk and the left common carotid, followed by the left vertebral and the left subclavian. Type 5, common carotid variant - right to left the branches are the right subclavian artery, followed by a common trunk for the right common carotid and left common carotid and the left subclavian. Type 6, aberrant right subclavian: right to left, branches are right common carotid and left common carotid, a left subclavian, and an aberrant right subclavian. Type 7, right sided aortic arch- the arch of aorta passes from left to right, giving a "mirrored" branching pattern.[4] Based on this classification, our case report corresponds to type 4 pattern- "the bovine and left vertebral variant of arch of aorta".

A review of the literature on studies conducted in the Indian population reveals that the present variation has been rarely reported. Patil et al. observed a prevalence of 14.66% for the bovine arch and 8% for the left vertebral artery originating directly from aortic arch; however, a combination of both variations was not reported.[5] A similar branching

pattern -common origin of brachiocephalic trunk and left common carotid with left vertebral artery arising from arch was reported in a 41-year-old Tanzanian male cadaver.[6] According to a study by Natsis et al. in the Greek population, the prevalence of this variation is approximately 2% .[7]

By the fourth week of embryonic development, the pharyngeal arches begin to form, each supplied by an arch artery. These arteries connect ventrally to the right and left horn of aortic sac and dorsally to the dorsal aorta. The normal adult arterial pattern emerges through the persistence, regression and migration of various embryonic segments. The arch of aorta typically develops from aortic sac, left horn of aortic sac and left fourth arch artery whereas brachiocephalic trunk from right horn of aortic sac, common carotid artery from proximal part of third arch artery and left subclavian from left seventh cervical intersegmental artery.[8] However, abnormal migration or persistence of different segments of aortic arch during embryological development can lead to variations in its branching pattern.

Elumalai et al. explained the bovine variant as follows: instead of arising independently from the arch, the origin of left common carotid artery was shifted to the right and it merged with the origin of brachiocephalic trunk. This suggests that the left third arch artery arised from right horn. Alternatively, this variation may result from the failure of the aortic sac to divide into the right and left horns, leading to a direct connection of the left common carotid artery to the aortic sac.[9] The vertebral artery develops from the cervical intersegmental arteries. The first part arises from the dorsal division of the seventh cervical intersegmental artery; the second part develops from postcostal longitudinal anastomosis between the C6 to C1 and third part from spinal branch of the first cervical intersegmental artery.[10] The variant origin can be due to persistence of dorsal division of left sixth cervical intersegmental artery and partial regression of the left seventh cervical intersegmental artery. This can also be explained by the arch of aorta taking origin from left seventh cervical intersegmental artery, incorporating a portion of the embryonic tissue destined for the of left subclavian artery, thereby causing the left vertebral artery to arise directly from the arch.[9]

A recent systematic review and meta-analysis concluded that variations of the arch are associated with an increased risk for congenital heart disease in approximately 30% of cases, extracardiac defects in 14.1% of cases and chromosomal aberration like 22q11del - Di George syndrome (1% to 6%). This points to the importance of identifying such variations during antenatal anomaly scans and thereby preventing unnecessary complications during postnatal surgery for associated cardiac anomalies.[11]

Although in most cases the bovine variant is an incidental finding, its wide diameter at the origin may alter the hemodynamics of aortic blood flow, potentially increasing the risk of thoracic aortic aneurysm and aortic dissection.[12] Bovine variant makes transfemoral stenting of the left common carotid artery more difficult due to the two tight turns from arch of aorta to the brachiocephalic trunk and then into the left common carotid artery. Wang et al. found that, in patients with direct origin of left vertebral artery have hypoplasia of the artery thereby reducing blood flow in the posterior circulation increasing the incidence of cerebrovascular disease. Variant origin can make the left vertebral artery more exposed thus making it more vulnerable during anterior and lateral spinal decompression surgeries.[13] The bovine arch is often described as the true silent killer because of its known association with Stanford type A Aortic dissection and direct origin of vertebral artery is associated with Stanford type B aortic dissection.[9]

CONCLUSIONS

Variant branching patterns of arch of aorta are associated with a wide spectrum of clinical conditions. The bovine arch is often described as the true silent killer because of its known association with aortic dissection. These variations can complicate surgical or interventional procedures involving the thoracic aorta and cervical spine, thereby increasing patient morbidity and mortality. Therefore, clear understanding of the branching pattern of aortic arch is important.

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