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RESEARCH ARTICLE OPEN ACCESS

ANOMALOUS EMERGENCE OF THE LEFT VERTEBRAL ARTERY FROM THE AORTIC ARCH AND ITS MORPHOMETRIC CHARACTERIZATION

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ABSTRACT

The aortic arch typically gives rise to three main branches: the brachiocephalic trunk, which is the first and largest branch and divides into the right common carotid and right subclavian arteries; the left common carotid artery as the second branch; and the left subclavian artery as the third. However, anatomical variations in this branching pattern are relatively common and carry clinical significance. Among these, the direct origin of the left vertebral artery from the aortic arch—usually located between the left common carotid and left subclavian arteries—stands out as a noteworthy variation. The present case report describes such an anatomical variation, identified during the dissection of a specimen in the Human Anatomy Laboratory at the School of Health Sciences (ESA), State University of Amazonas (UEA).

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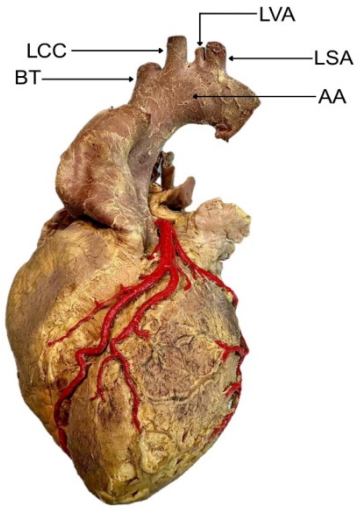
INTRODUCTION

The vertebral artery is an important blood vessel responsible for supplying the brain, particularly structures located in the posterior cranial fossa, such as the brainstem, cerebellum, and occipital lobes of the brain. Typically, it originates from the superior aspect of its respective subclavian artery and, after its emergence, ascends through the neck via the transverse foramina of the six cervical vertebrae, entering the cranial cavity through the foramen magnum of the occipital bone (BRIEFLANDS, 2022). Within the cranial cavity, the two vertebral arteries unite to form the basilar artery, constituting the so-called vertebrobasilar system. This system is responsible for vascularizing the posterior portion of the brain and gives rise to important branches, such as the cerebellar and pontine arteries, which supply the cerebellum and brainstem, as well as the posterior cerebral arteries, which irrigate the occipital lobes and part of the diencephalon (MACHADO, 2022). However, as documented in the literature, anatomical variations in the origin and course of the left vertebral artery are relatively frequent and have important clinical implications. The frequency of left vertebral artery variations is higher than that of the right, reaching up to about 6% of cases (MOORE, DALLEY & AGUR, 2019). Among these variations, its direct origin from the aortic arch—typically between the left common carotid and subclavian arteries—is the most frequently reported, with a prevalence ranging from approximately 1% to 6% of the population, depending on the geographical region (SONWANI et al., 2023). In this context, such variation is also observed in Brazil, occurring in about 4% of cases according to anatomical studies on cadavers (TARDIEU et al., 2017). Other anomalies include duplications, hypoplasias, entry at atypical levels of the transverse foramina, and common origin with the right subclavian artery (BERGMAN et al., 2021). To differentiate these variations, several classifications have been proposed, such as Adachi's classification, which describes origin patterns near the aortic arch and defines this variation as "Adachi Type C," and Williams' classification, which considers morphology and clinical implications. Although often asymptomatic, variations in the origin of the left vertebral artery should be recognized and studied due to their potential clinical and surgical implications. For instance, according to Popieluszko et al., patients with this variation, owing to the longer course of the vertebral artery, are at greater risk of developing arterial dissection—a condition in which a tear occurs in the inner layer of the arterial wall, allowing blood to enter between the layers of the vessel wall, forming a false

lumen. This may reduce or obstruct normal blood flow and lead to serious complications, such as ischemia or stroke. Moreover, during catheterization procedures and non-invasive imaging exams, the vessel's atypical positioning can contribute to misdiagnoses, such as vessel occlusion or arterial disease (DEMIR; ASLAN, 2025). Despite the growing interest in vertebral artery variations, there remains a scarcity of information on this topic in certain populations, particularly in regional groups with poorly studied genetic characteristics. This lack of data underscores the importance of new studies that accurately document these variations. Reporting cases in which the left vertebral artery presents an origin different from the expected pattern enriches anatomical literature and offers practical benefits. For anatomists, these data expand knowledge of circulation in the neck and cranial regions; for radiologists, they facilitate accurate interpretation of imaging exams; and for surgeons, they allow for more precise procedural planning, helping to avoid errors and complications.

CASE REPORT

During the anatomical dissection of a male cadaver at the Human Anatomy Laboratory of the State University of Amazonas, a fourth arterial branch was identified originating directly from the aortic arch (Figure 1), situated between the left subclavian artery and the left common carotid artery. Detailed examination determined that this branch corresponded to the origin of the left vertebral artery.Morphometric analysis was performed using a DTX digital caliper, with the following vessel diameters recorded: aortic arch (17.8 mm), left common carotid artery (5.5 mm), left vertebral artery (3.6 mm), and left subclavian artery (6.5 mm). These findings contribute to the precise characterization of the variation, demonstrating dimensions consistent with the literature and highlighting the importance of its documentation for surgical planning and interventional procedures in the cervical and thoracic regions.

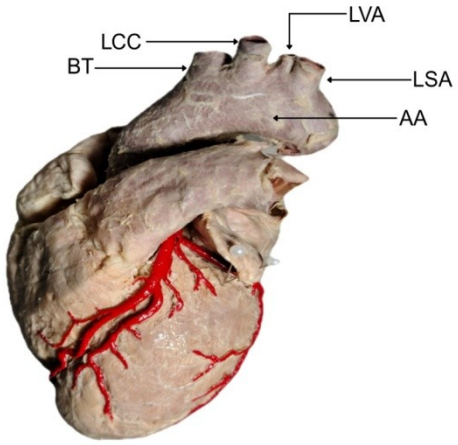


AA = aortic arch; BT = brachiocephalic trunk; LSA = left subclavian artery; LVA = left vertebral artery; LCC = left common carotid.

Figure 1.

DISCUSSION

The vertebral arteries typically develop between the 33rd and 55th day of intrauterine life, arising from the longitudinal anastomoses connecting the seven cervical intersegmental arteries. During normal development, the intersegmental arteries regress, with the exception of the seventh, which forms the subclavian artery and incorporates the origin of the vertebral artery. In some cases, failure of the anastomosis between the sixth and seventh intersegmental arteries on the left side results in persistence of the sixth intersegmental artery, leading to the left vertebral artery originating directly from the aortic arch between the left common carotid and subclavian arteries (WASSERMAN et al., 1997). Beyond developmental anomalies, deletion of chromosome 22q11 has also been associated with such aortic arch variations (MOMMA et al., 1999).



AA = aortic arch; BT = brachiocephalic trunk; LSA = left subclavian artery; LVA = left vertebral artery; LCC = left common carotid.

Figure 2.

The aortic arch—continuing from the ascending aorta—most commonly gives rise to three branches: the brachiocephalic trunk, the left common carotid artery, and the left subclavian artery, in approximately 85% of individuals (Kurt et al., 1997). Nevertheless, anatomical variants are relatively common. The most frequent involves the right subclavian artery arising directly from the aortic arch and following an aberrant course to the right upper limb (Zapata et al., 1993). Under typical conditions, the left vertebral artery originates from the left subclavian artery, medial to the thyrocervical trunk, and supplies the upper spinal cord, brainstem, and cerebellum. It ascends through the transverse foramina of all cervical vertebrae except the seventh and enters the posterior cranial fossa via the foramen magnum (BORLEY et al., 2008). Atypical branching patterns of the aortic arch have been documented and classified. One such pattern is the direct origin of the left vertebral artery between the left common carotid and subclavian arteries, categorized as an "Adachi Type C" variation (Figure 2). This is considered the second most common aortic arch branching variant, with reported prevalence ranging from 0.79% to 8% (CELIKYAY et al., 2013). Anomalies in the origin of the vertebral artery are usually asymptomatic and are most often identified during postmortem anatomical studies. However, variations of the aortic arch have important clinical implications, particularly in carotid artery stenting. Faggioli et al. reported that both neurological risk and technical failure rates in carotid stenting procedures are higher in patients with aortic arch anomalies (FAGGIOLI et al., 2007).

CONCLUSION

A direct origin of the vertebral artery from the aortic arch may significantly alter cerebral hemodynamics due to the increased blood flow through the left vertebral artery. Both an enlarged vessel diameter and the direct, linear blood flow from the aorta to the brain may contribute to an imbalanced perfusion of the circle of Willis, potentially increasing the risk for cerebrovascular disease. From a surgical standpoint, preoperative identification of an aberrant left vertebral artery is essential, as it can help prevent or mitigate potential complications during vascular or neurosurgical procedures.frequently reported anatomical variation of this vessel in humans.

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