

# Aberrant Origin of the Left Vertebral Artery from the Arch of Aorta: A Cadaveric Case Report

S Danthanarayana, G H A D D Kumara, M H D I Dharmapriya, S C Samarasinghe, E A S  
T Edirisinghe, S Dissanayake, P H Dissanayake, S G Yasawardene

*Department of Anatomy, Faculty of Medical Sciences, University of Sri Jayewardenepura*

## Abstract

Anatomical variations in the origin of main branches of the aortic arch are not uncommon but can have significant clinical implications. We present a case of an unusual origin of the left vertebral artery from the aortic arch, a finding that was incidentally discovered during a routine cadaveric dissection session of an undergraduate teaching program. The cadaver was preserved using standard embalming techniques. During the routine thoracic dissection, 4 direct branches were identified to arise from aortic arch. One aberrant artery between left common carotid and left subclavian artery was identified as the left vertebral artery. After the initial lateral curvature, it ascended lying over the transverse process of 7th thoracic vertebra and then entering C6 transverse foramen. No other significant vascular anomalies were identified.

DOI: <https://doi.org/10.4038/slj.v10i1.305>

Sri Lanka Anatomy Journal 2026;10(I): 145-150

*Corresponding author*

S Dissanayake

email: [sdissanayake@sjp.ac.lk](mailto:sdissanayake@sjp.ac.lk)



<https://orcid.org/0009-0007-2530-9628>

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## Introduction

The aortic arch represents the direct continuation of the ascending aorta. It originates at the level of the right second costal cartilage, and arches backwards over the left bronchus to reach the body of T4 vertebra just to the left of the midline (1, 2). In general, three main branches originate from the upward convexity of the arch: the brachiocephalic trunk, the left common carotid artery and the left subclavian artery (2). Nevertheless, anatomical variations in the branching pattern of the aortic arch have been documented in numerous studies (3).

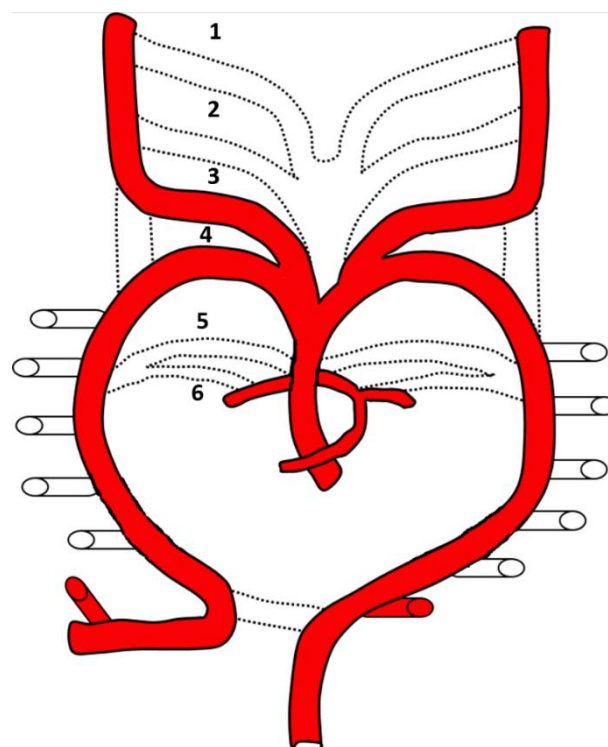
### *Embryonic development of vertebral artery*

In order to understand the variations of the vertebral artery, it is important to understand the embryology of the great vessels. The six pairs of aortic arches give rise to the aortic arch proper and its branches during the 4-6<sup>th</sup> weeks of embryonic life. Each aortic arch pair fuses with the dorsal aortic sac bilaterally. The first, second, and fifth aortic arches disappear. The third arch gives rise to common and internal carotid arteries on both sides. The right fourth arch gives rise to the brachiocephalic trunk. The left fourth arch gives rise to the aortic arch proper. Each sixth arch artery gives off an artery to the developing lung bud (Pulmonary artery) (Figure 01).

For each somite, there is a dorsal intersegmental artery. Each subclavian artery normally gives rise to the seventh intersegmental artery. These seventh intersegmental arteries give rise to the initial segments of the vertebral artery. The remaining part of vertebral artery is derived from anastomoses of the first to sixth intersegmental arteries in transverse manner.

The left vertebral artery might arise from arch of aorta due to the excess absorption of the segment of the left subclavian artery between

the origin of the aortic arch and the vertebral artery.



**Figure 1 - Schematic diagram of the development of the arch of Aorta and great vessels. 1: First aortic arches (regress), 2: Second aortic arch (regress), 3: Third aortic arch(becomes bilateral common and internal carotid arteries), 4: Fourth aortic arch, 5: Fifth aortic arch (regress), 6: Sixth aortic arch (becomes the pulmonary artery)**

Also, if the left 7<sup>th</sup> inter segmental artery arise from the arch of the aorta will give rise to abnormal vertebral artery origin. The direct origin of the left vertebral artery between the left common carotid and the left subclavian arteries is one of those branching patterns which has been classified as “Adachi Type C. It is reported to be the second commonest variation with a prevalence of approximately 0.79 – 8 % (4, 5), the most common being the type A which is the normal branching of the arch of the aorta. Owing to the complex embryological development of the aortic arch and its branches, deviation from normal anatomy of the branching patterns is common (5, 6).

The vertebral artery is normally formed by the longitudinal anastomosis of the seventh cervical intersegmental arteries. The intersegmental arteries obliterate except the seventh intersegmental artery, which gives rise to the subclavian artery and the origin of vertebral artery. Usually, the vertebral artery arises from the subclavian artery medial to the thyrocervical trunk. In few cases, the anastomosis between the sixth and seventh intersegmental arteries does not develop on the left side, resulting the sixth intersegmental artery to persist and become the left vertebral artery arising from the aortic arch between the left common carotid and subclavian arteries (7).

The vertebral arteries and their major branches (sometimes referred to as the ‘vertebrobasilar system’) essentially supply blood to the upper spinal cord, the brainstem and cerebellum, and a significant but variable part of the posterior cerebral hemisphere (1). In this case report we present an aberrant origin of the left vertebral artery that directly arises from the aortic arch.

Reportedly, this variant type is more prone to certain pathologic processes and surgical complications (5). Given its importance, having precise knowledge of this variant anatomy is essential in both Clinical practice and medical education.

### **Case presentation**

Formalin preserved male cadaver of an 80-yr-old, person donated to the Department of Anatomy, Faculty of Medical Sciences, University of Sri Jayewardenepura for medical education and research purposes was dissected for routine teaching learning activities. The anomalous origin of the left vertebral artery was an incidental finding during dissection of the thoracic region.

Thoracic cavity was opened, and the superior mediastinum was further dissected. It was

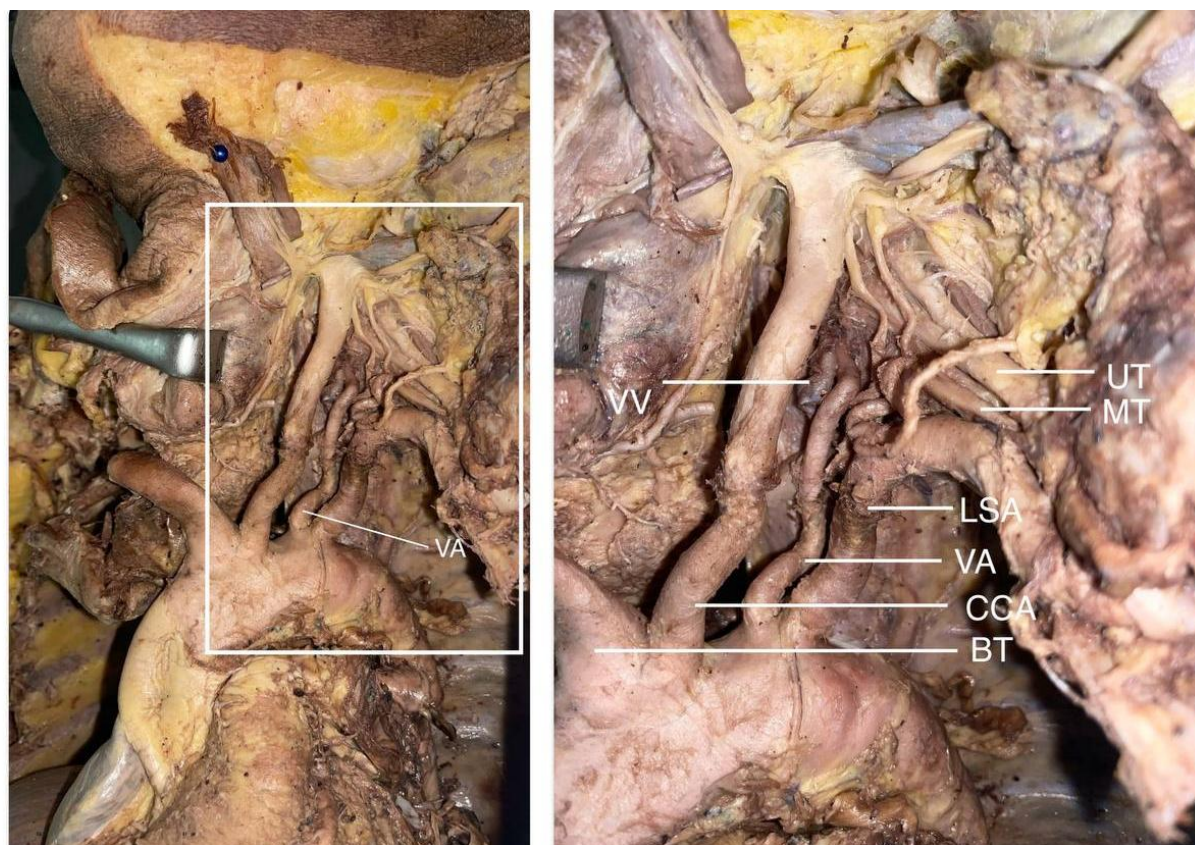
observed that the arch of aorta had four branches arising from its superior surface. The brachiocephalic trunk, left common carotid artery and left subclavian artery were observed in their normal anatomical positions. The aberrant artery was noted in between the origins of the left common carotid artery and the left subclavian artery (Figure 02 and 03).

Further dissections were done to explore the course of the aberrant artery by extending the dissections up to the root of the neck, Separate incision was placed in the neck to visualize the relationships of the aberrant vessel to the surrounding structures in the neck.

Sternocleidomastoid and infrahyoid muscles were divided to explore the underlying structures of the neck. The contents within the carotid sheath were identified. Both internal jugular vein and left vagus nerve were retracted from the field. Prevertebral muscles (longus colli and longus capitis muscle) and lateral vertebral muscles (anterior, middle and posterior scalene muscles) were noted. Brachial plexus nerve roots were identified, and the upper trunk was traced back to C5 and C6 root levels while middle trunk traced to corresponding C7 vertebral level.

The aberrant artery arising from the aortic arch initially had a tortuous course, then ascended vertically to enter the transverse foramen of the sixth cervical vertebra (C6). Thereafter, it followed the typical pathway of the vertebral artery. Therefore, we identified this artery as an aberrant left vertebral artery which branched off directly from the aortic arch.

Right sided vertebral artery was identified in the root of the neck arising from the first part of the right subclavian artery, lying behind common carotid artery and vertebral vein. The right vertebral artery had a normal origin and followed the usual anatomical course.



**Figure 2 – Aberrant Origin of the Left Vertebral Artery from the Aortic Arch. VV: Vertebral Vein; VA: Vertebral Vein; CCA: Common Carotid Artery; BA: Brachiocephalic Trunk; LSA: Left Subclavian Artery; UT: Upper Trunk of Brachial Plexus; MT: Middle Trunk of Brachial Plexus**

The distance between the origin of the aberrant left vertebral artery and the entrance to the C6 transverse foramen was 64.3 mm. The diameters of the aberrant left vertebral artery at its origin and at the transverse foramen were measured as 4.5 mm and 37.9 mm respectively. No other vascular anomalies were observed in the thoracic or cervical regions.

## Discussion

### *Normal Anatomy and Variant Anatomy*

Typically, the right and left vertebral arteries arise from the respective subclavian arteries. And then enters through transverse process of 6th cervical vertebra to continue its cervical segment. However, aberrant origins from the aortic arch, common carotid artery, or other vascular structures have been documented. Vertebral artery originating directly from the aortic arch has been found to be the most

common variant in the documented literature (7). The maldevelopment of the anastomosis between the sixth and seventh intersegmental arteries on the left side, resulting in the persistence of sixth intersegmental artery and becoming the left vertebral artery arising from the aortic arch between the left common carotid and subclavian artery is the embryological explanation. Other variable origins on the left included its origin from a common trunk with left subclavian artery and on the right the origins were from the brachiocephalic trunk with or without duplication of the right vertebral artery originating both from aortic arch and the brachiocephalic trunk (8, 9).

Additionally previous studies also reported variations in the level of entering the transverse foramen ranging from 7th to 3rd cervical vertebra (9).

The aberrant origin of the vertebral artery can be classified based on its position relative to the other major arteries branching from the aortic arch. Adachi classified this variation into three types: A, B, and C. Type A variation is most common, observed in 80% of individuals. There are three major branches from the aortic arch: brachiocephalic trunk, left common carotid, and LSA. Type B variation is observed in 11% of individuals in which brachiocephalic and left common carotid arteries originate from the common trunk, not separately. A third variation, Type C, includes the origin of the LVA directly from the aortic arch proximal to the origin of the LSA (10). In addition, a Japanese cadaveric study has reported a correlation existing between vertebral artery entering the foramen at abnormal level and variation of its origin from subclavian artery, which is not supported by our findings (11).

### ***Clinical Implications***

Aberrant vertebral artery origin is more frequently left-sided and unilateral (7). In general, this variant does not typically present symptoms in daily life (7). However, its presence carries significant clinical implications that warrant attention. Our case report underscores the importance of recognizing this vascular variant, as understanding such variations play a role in thoracic surgeries.

Direct origin of the vertebral artery from the arch of aorta can alter hemodynamics of the posterior circulation (12). This is due to the increased blood flow in the left vertebral artery as a result of both the increased diameter of the vessel and the direct flow of blood in a straight line from the aorta to the brain. This may lead to an imbalanced supply of blood to the circle of Willis and may create a risk factor for cerebrovascular diseases (4). Also, it was found that the left vertebral artery arising from the aortic arch is affected by hypoplasia resulting diminished blood flow in the vessel and thereby reduced posterior circulation

(6). Additionally, this may increase the chances of aneurysm formation in the vertebrobasilar system of the body (13). According to Gluncic et al., the vertebral artery's prevertebral segment is frequently affected by atherosclerosis (13). Tulshidas Patil et al. reported that death secondary to cerebrovascular disease is more common among cadavers with left vertebral artery with aberrant origin. (normal variation vs variation in LVA origin: 12% vs 23.5) (6).

In comparison to the normal anatomical origin of the left vertebral artery, the direct origin from the aortic arch is associated with a higher incidence of vertebral artery dissection due to its abnormally long course (7,13). There was a statistically significant association between the presence of a vertebral artery that originates directly from the aortic arch and Stanford B aortic dissection, where it was seen more frequently in patients with Stanford B aortic dissection (4).

Variants in the origin and course of major vessels arising from the aortic arch are clinically significant, as unawareness of these variations can lead to serious surgical complications during procedures in the superior mediastinum and root of the neck. This type of variation is exposed for a greater length due to its higher level of entry to the transverse foramina of the cervical spine, implicating for cervical, spinal and vascular surgery (6). Therefore, proper identification of the aberrant left vertebral artery before surgery is crucial to prevent or decrease possible complications during surgery. According to previous studies, a proper knowledge of the anatomy of the left vertebral artery, especially if it has an aberrant origin is crucial to prevent rebleeding during ventral approach to the cervical spine (4, 7). Vertebrobasilar artery insufficiency can have an 80-95% mortality rate in a patient. Therefore, the vertebrobasilar system should be handled carefully to prevent massive bleeding in the patient (13).

## Conclusion

Aberrant vertebral arteries originating from the aortic arch represent a notable anatomical variation with implications for clinical practice. Although often asymptomatic, the identification of such anomalies is crucial for the safe planning and execution of surgical and endovascular procedures. This case highlights the importance of detailed imaging studies in diagnosing vascular anomalies and underscores the need for awareness among clinicians regarding these variations.

**Acknowledgement:** We would like to express our gratitude to the donor and his family who donated this cadaver to the Faculty of Medical Sciences, University of Sri Jayewardenepura.

**Conflict of interest:** All authors wish to declare that there are no conflicts of interest.

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