

# Aortic Arch Origin Of Left Vertebral Artery Possibly Associated To A Left Frontal Arteriovenous Malformation: Case Report

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Vascular anatomy is an unreplaceable knowledge for any surgical and interventional specialist, where its proficiency must include at least the most common anatomical variants described in the population. In this subject, aortic arch and its branches are not an exception. The most common anatomical variant of the aortic arch branches is a fourth vessel arising from it, corresponding to the origin of the left vertebral artery. In this case report

we describe a patient with an aortic arch branches' variant plus an intracranial arteriovenous malformation. Up to our knowledge, this is the first case report describing with a proper imaging protocol both a vertebral artery variation and an arteriovenous malformation. Although there is no evidence supporting an association among these two vascular conditions, hereby we present a coincidental vascular finding that requires further research as to propose possible association.

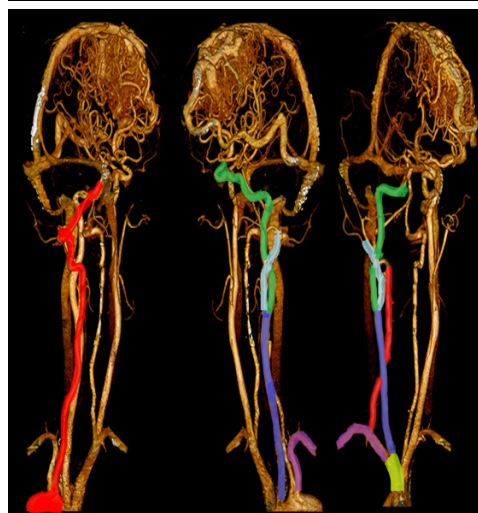
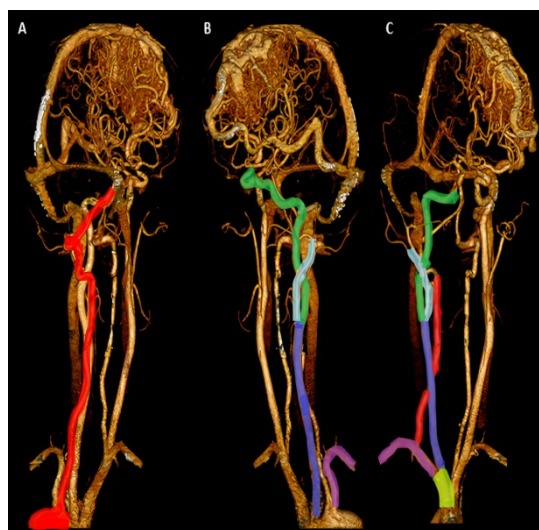
Key words: vertebral artery, arteriovenous malformation, aortic arch origin, vascular variant.

## INTRODUCTION

In normal conditions, the aortic arch gives rise to the brachiocephalic trunk, the right common carotid artery and the left subclavian artery (LSA). The left vertebral artery (LVA) arises as the first branch of the LSA, from its posterolateral aspect, 0.5-2 cm medial to the thyrocervical trunk. It is divided into four segments: V1 or ostial segment goes from its origin at the subclavian artery until reaching the transverse foramen of C6; V2 or foraminal segment which traverse through the transverse foramina of C6 to C1; V3 or suboccipital segment courses posterior and superiorly to the posterior arch of the atlas until piercing the atlanto-occipital membrane and duramater; and V4 or intradural segment which joins the contralateral vertebral artery to form the basilar artery. In 1928, Buntaro Adachi, best known for his studies of vascular anatomy and considered the master of vascular anatomical variations, described in his masterpiece "Das Arteriensystem der Japaner", a variation in which a fourth vessel, an anomalous LVA, arises from the aortic arch, classified as Adachi Type C.

## CASE REPORT

A 16-year-old man with no relevant medical records presented with a single episode of focal to bilateral tonic-clonic seizure. Medical treatment was initiated, with good seizure control, as no new episodes occurred, with levetiracetam 1g PO bid. A computed tomography (CT) brain scan was performed, in which a hyperdense lesion in the left frontal lobe, concordant with an arteriovenous malformation (AVM) was observed. A CT angiography confirmed the diagnosis. A 7x5x4 cm AVM located in the left frontal lobe, over eloquent areas (precentral and Broca's areas), and an aortic arch origin of the left vertebral artery was observed.



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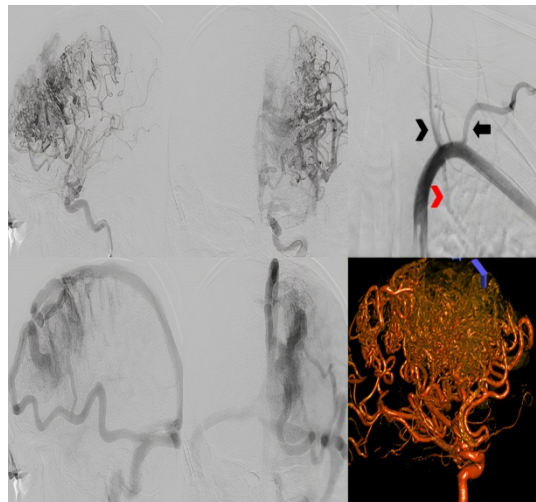
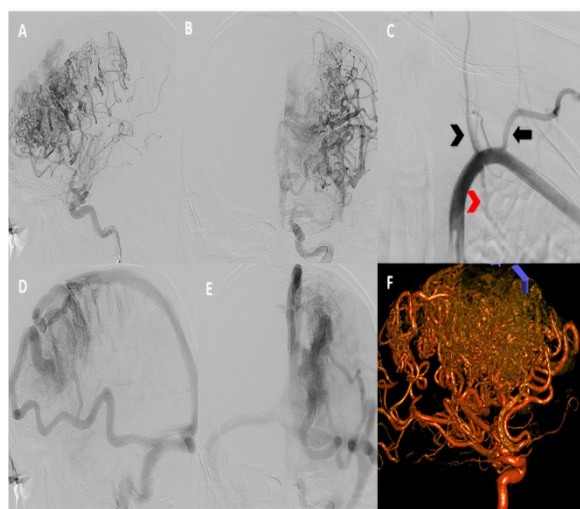
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**Figure 1: 3D reconstructions.** A, posterolateral: the LVA (red) arises directly from the aortic arch, distal and posterior to the left common carotid artery (LCCA). B, anterolateral: the LSA (purple) is distal to the LVA, and the LCCA (dark blue) can be followed towards its bifurcation. The ECA (light blue) can be distinguished from the ICA (dark green), as it arises in an anteromedial fashion and has extracranial branches. C, brachiocephalic trunk (light green): normal disposition of vascular anatomy. The RVA (red) arises as the first branch of the subclavian artery (purple) and runs posteriorly to the right CCA.

To further classify the AVM, a digital subtraction angiography (DSA) was performed. We found a left frontal lesion, with afferent feeders provided by the anterior circulation, mainly from cortical branches of the middle (precentral and central branches) and anterior (pericallosal and callosomarginal arteries) cerebral arteries, as well as from the posterior communicating arteries. There was a superficial venous drainage pattern with efferent branches to the superior sagittal sinus via the prefrontal and frontal veins, and to the left transverse sinus via the vein of Labbé (Figure 2A-F). Thus, a Speltzer-Martin grade of IV was granted due to size (3 points), eloquency (1 point), and superficial drainage (0 points). In consensus with the neurosurgical, neuroendovascular, and radiosurgery teams, conservative management with serial follow-up and observation was agreed due to the characteristics of the lesion. After 12 months of surveillance, the patient remains asymptomatic and seizure-free.



**Figure 2: DSA findings.** A, lateral and B, anteroposterior (AP) arterial phase views: afferent feeders from cortical branches of the middle cerebral artery (MCA) and anterior cerebral artery (ACA) supply the AVM. C, AP view of the LSA: the thyrocervical trunk (black arrowhead), the costocervical trunk (black arrow), and internal thoracic artery (red arrowhead) can be seen, however the LVA is not observed emerging from this vessel. D, lateral and E, AP venous phase views: superficial drainage

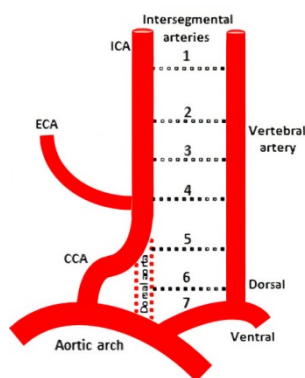
towards the superior sagittal sinus and vein of Labbé. F, 3D reconstruction in a lateral view showing the left frontal AVM.

**DISCUSSION**

Multiple variations of the origin of the vertebral arteries have been previously described including examples such as arteries arising from the aortic arch, common carotid, or internal carotid artery. The most frequent variant, with a reported prevalence ranging from 3-8% [8], is the LVA arising directly from the aortic arch between the LCCA and the LSA. However, an association between this anatomical variation and an AVM, such as the one presented in this paper, has not been described before. We recognize that an association between these two entities cannot be made with a single case, acknowledging this as a limitation of our manuscript. However, our main purpose is to set a precedent in order to enlighten a thorough search and identify a possible relationship in the near future.

The embryological basis for this anatomic variant derives from failure in the regression of the left sixth intersegmental artery, its dorsal branch, and the adjacent segment of the dorsal aorta. In normal conditions the LVA arises from the dorsal division of the seventh intersegmental artery.

Although the majority of patients that carry this anatomic variation remain asymptomatic, it is essential to understand the precise vascular anatomy of the supra-aortic arteries, especially when endovascular or surgical procedures are planned in the area. Although some have hypothesized that these variations could lead to cerebral blood flow disturbances, there is no evidence that backup an increased risk for cerebrovascular disorders. A failure in the identification of this anatomic variant could easily lead to a misdiagnosis or vertebral aplasia or hypoplasia.



**Figure 3: Embryologic development of the LVA.** The left vertebral artery originates from the dorsal division of the seventh intersegmental artery, which forms the proximal portion of the left subclavian artery. When there is failure in the regression of the sixth intersegmental artery and a portion of the dorsal aorta, the left vertebral artery arises directly from the aortic arch as an independent trunk from the subclavian artery.

**CONCLUSIONS**

A LVA originating directly from the aorta is the most prevalent anomaly found in the aortic arch anatomic variants. However, no previous cases reporting the association of this anomaly with a frontal AVM have been reported. A precise association between these two entities cannot be proposed with a single case, thus further cases must be studied. Vascular imaging examinations, such as, CT angiography must always be performed before planning any procedure in the region, as to properly identify the precise origin of all supra-aortic branches.

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