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Case Report

Atypical vertebral artery: embryological explanation and implications in neck surgery*

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Abstract

Atypical branches of the aortic arch (AA) occur frequently but are poorly explained. In an 82-year-old Caucasian male cadaver who died of coronary artery disease with severe aortic stenosis, the left vertebral artery (LVA) originated from the AA between the common carotid and subclavian arteries. The prevertebral part of LVA was narrower and entered the C5 transverse foramen. The right vertebral artery (RVA) from the right subclavian was wider than LVA suggesting compensation to the cerebral circulation. An unusual LVA may be asymptomatic; however, it is important in neck and supraaortic arch surgery and in non-invasive neck procedures. Vertebral arteries (VAs) are formed by development of longitudinal anastomoses linking the cervical intersegmental arteries, which regress except the seventh that becomes the proximal subclavian artery, the point of origin of the adult VA. Persistence of the 6th dorsal intersegmental artery might account for LVA arising from AA proximal to the subclavian artery.

Key words [variant vertebral artery] [neck surgery] [cerebral circulation] [embryological error]

Introduction

Variation in origins of vessels from the aortic arch (AA) that supply head and neck structures has been reported earlier; however, mechanism of this developmental error is uncertain. The vertebral arteries (VAs) develop as longitudinal channels connecting the cranial intersegmental arteries; therefore, they are branches of subclavian arteries (SA). Left vertebral artery (LVA) arising from AA is described with a frequency of 2.5 to 5.8% in cadaveric specimens [1, 2], and results from radiological case studies corroborate these observations [3, 4]. The VA normally arises from the SA and enters the foramen transversaria at C6; however, the vertebral course can vary from C1-C6. Similarly, VA origins also vary from SA, AA, carotid arteries, thyrocervical trunk, and brachiocephalic trunk. Recognizing such variations during head and neck surgery, supraaortic arch surgery and non-invasive vascular procedures is important [3]. VAs are formed by the development of longitudinal anastomoses that link the cervical intersegmental arteries, which eventually regress except for the seventh, that becomes the proximal SA including the point of origin of the adult VA [5].

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Case Report

During routine cadaveric dissection of the thorax, we observed the left vertebral artery (LVA) originated from the aortic arch (AA) between the common carotid and subclavian arteries (Figure 1). The donor was an 82-year-old Caucasian male with coronary artery disease and severe aortic stenosis. The prevertebral part of LVA was tortuous, sclerotic, and narrower, entered the C5 transverse foramen. The right vertebral artery (RVA) was wider before entering the C6 transverse foramen, suggesting compensation to the cerebral circulation. Inner and outer diameters of LVA were 2.5 and 3.6 mm and of RVA were 5.6 and 6.0 mm, respectively. Dissection of the VA intracranial segments also showed LVA was narrower than RVA and together they formed the basilar artery. The comparison of histological sections stained with hematoxylin and eosin indicated normal thickness of the tunica intima and internal elastic lamina in both LVA and RVA; however, the tunica media of LVA exhibited marked thickening compared to the RVA. The tunica adventitia of both vessels had normal thickness; however, the vasa vasorum were increased.

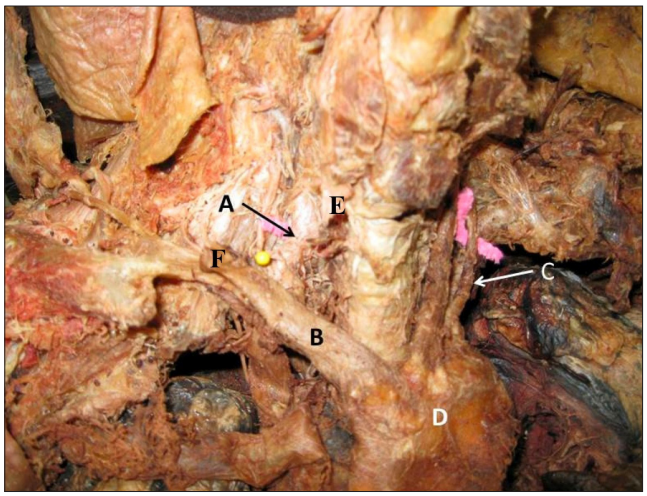

Figure 1. Actual cadaver specimen showing the aortic origin of the left vertebral artery. *(**A**: right vertebral artery; **B**: brachiocephalic trunk; **C**: left vertebral artery; **D**: aortic arch; **E**: right common carotid artery, damaged during embalming process; **F**: right subclavian artery)*

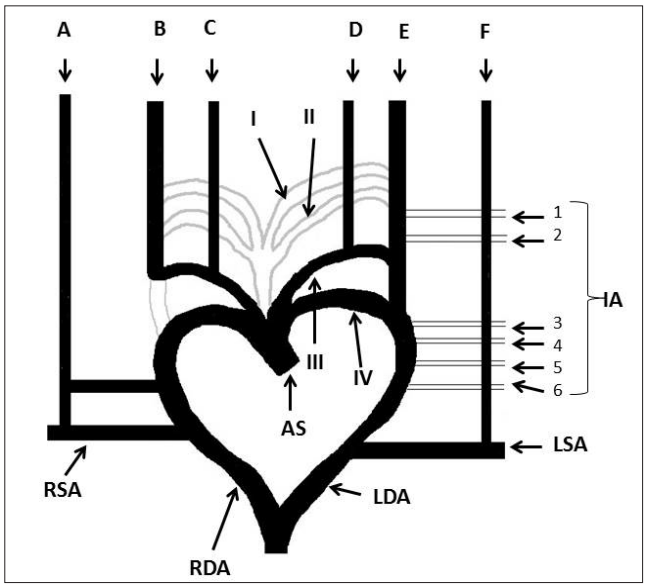

Figure 2. Schematic illustration of the normal embryonic development of vertebral artery. The *aortic sac (**AS**)* is connected with the left and right *dorsal aortas (**DA**)* through the aortic arches. The Roman numerals ***I-IV*** shows *aortic arches*. The *internal carotid (**ICA**)* and *external carotid (**ECA**)* arteries are marked. Longitudinal anastomoses that link the cervical *intersegmental arteries (**IA 1-6**)* form the *vertebral artery (**LVA, RVA**)*. The 7th IA becomes the *subclavian artery (**LSA, RSA**)*. *(**A**: right vertebral artery; **B**: brachiocephalic trunk; **C**: left vertebral artery; **D**: aortic arch; **E**: right common carotid artery; **F**: right subclavian artery)*

Discussion

Uncharacteristic origins of VA from the brachiocephalic trunk and common carotid artery [1, 4], AA [1-3], [6-9] and bilateral

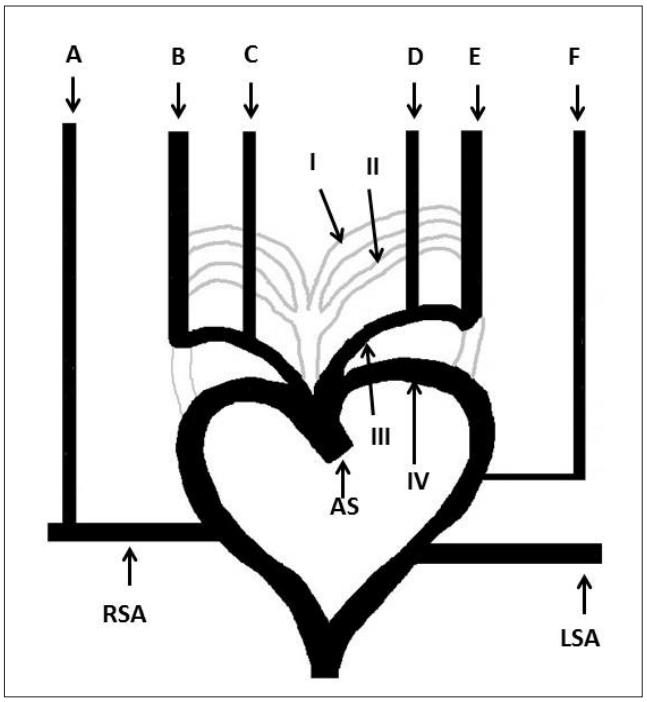

Figure 3. Schematic illustration of the aortic origin of *left vertebral artery (**LVA**)*. In this variant because the 6th intersegmental artery persists instead of the 7th, the LVA has originated from the aortic arch, between the left common and subclavian arteries. *(**I-IV**: aortic arches; **AS**: aortic sac; **LSA & RSA:** right and left subclavian arteries; **A**: right vertebral artery; **B**: brachiocephalic trunk; **C**: left vertebral artery; **D**: aortic arch; **E**: right common carotid artery; **F**: right subclavian artery)*

origin of VA from AA [10] have been reported. In our specimen, LVA originated from AA and its prevertebral part had a smaller diameter (2.5 mm) compared to 5.51 mm reported recently [6]. However, RVA originated from the right SA with a 5.6 mm diameter slightly larger than that reported recently [6] and considerably larger than LVA. Similarly, Panicker et al. reported diameters of 3.1 mm and 6.5 mm for LVA and RVA respectively [9]. Thus, RVA enlargements might provide compensatory elevation of cerebral circulation to prevent ischemia or the enlarged RVA could result from increased perfusion pressure.

Embryology

VAs form through a series of anastomoses connecting the first six cervical intersegmental arteries (IA) (Figure 2). Ultimately, the proximal (dorsal division) connections of the intersegmental arteries to the dorsal aorta degenerate, and the persisting seventh becomes the proximal part of adult SA including the VA origin. The longitudinal link between the first intersegmental artery and the proatlantal artery (first cervical radicular artery) creates continuity between the SA and basilar artery. In the present variant (Figure 3), LVA arises from AA, and previous studies suggest LVA of aortic origin results from persistence of the proximal (dorsal) part

of the 6th intersegmental artery as the prevertebral part of VA [6, 9, 10]. Others suggested it was the persistence of 7th intersegmental artery [11, 12]. The origin of LVA and RVA from AA has also been reported [10].

Unusual aortic origins of LVA are often incidental finding because they are clinically asymptomatic. Nonetheless, knowledge of atypical origins of supraaortic arteries is diagnostically important either before aortic or four-vessel angiography, neck and supraaortic arch surgery, or in non-invasive neck procedures. Whether a variant VA signals predisposition for cerebrovascular pathology is uncertain. However, atypical origins and distributions of the large aortic vessels can cause changes in cerebral hemodynamics that may lead to cerebral abnormalities [13]. Interestingly, aortic arch anomalies are also associated with chromosomal 22q deletion [14]. The extracranial portion, especially the prevertebral part of the VA is frequently affected from atherosclerosis and it is the common site of stenosis [6]. In the present case, we found LVA was sclerotic and narrow and RVA was dilated possibly protecting the brain from ischemia. The observed tortuous course of the prevertebral LVA seems common as a 39.1% incidence was reported previously [3]. The observed LVA atherosclerosis may have contributed to the tortuosity as suggested earlier [3]. While tortuosity may not create hemodynamical consequences' it might cause radicular symptoms by nerve compression, or have consequences during the cannulation for endovascular procedures.

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