Variant Origin of Left Vertebral Artery: Cadaveric Case Report

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Abstract

A thorough understanding of anomalous vertebral arteries is paramount when performing both diagnostic and interventional angiography in the head and neck. An abnormal origin of the vertebral artery may favour cerebral disorders because of alterations in cerebral hemodynamics and predispose the patient to intracranial aneurysms. Persistence of the proximal part of 6th intersegmental artery to the left dorsal aorta or 4th left aortic arch presumably could yield the left vertebral artery from the aortic arch, proximal to the left subclavian origin. This is the most common anomalous origin. Knowledge of variations of vessels like left vertebral artery is of vital interest to the surgeons because a minor accidental injury of the vessels causes sudden massive hemorrhage. The present report should be of interest for the clinicians with regard to vascular variations in the neck and thoracic region, and may give insight into elucidating the developmental mechanism of angiogenesis.

Key Words: Left Vertebral Artery, Variation, Aortic Arch, Subclavian Artery, Embryology

Introduction

Variation in the origin of arteries need to be documented so that it can help to be considered in studying normal structure and function of the arterial system and during clinical procedures such as physical examination, diagnosis and surgical procedures. Arterial variations within the thorax are common, complex and can be found in diverse forms. [1] The usual branches of arch of aorta (AA) are brachiocephalic trunk, left common carotid artery and left subclavian artery. Variations in the branching pattern of the aortic arch range from differences in the distance between origins of different branches to the number of branches. Some of these variations in the pattern and course of arterial branching can include four or more branches from the aortic arch, retroesophgeal subclavian artery, left vertebral artery arising from aortic arch and arch of aorta giving two common trunks. [2] Variations, when there are more than three branches originating from the aortic arch may include the vertebral arteries or the extra branch may be the thyroidea ima artery which ascends in front of the trachea to the thyroid gland. Several researchers have reported anomalous origins of the LVA such as from the aortic arch, between the left common carotid artery (LCCA) and left subclavian artery (LSA), after LSA, from the thyrocervical trunk, from the brachiocephalic trunk (BCT), from the common carotid artery, from the external carotid artery, from a common carotid trunk formed by LSA and left vertebral artery (LVA). Left vertebral artery with 2 origins is also documented. [3]

The usual source of the vertebral arteries is directly from the superior surface of the first part of the subclavian arteries medial to the scalenus anterior muscle.

The vessel takes a vertical posterior course to enter into the transverse process of the sixth cervical vertebra. It continues through the transverse foramina of the first six cervical vertebrae and after passing through the transverse foramen of the atlas, turns posteromedially on its posterior arch, pierces the atlantooccipital membrane and the dura mater, respectively and then enters the foramen magnum. At the lower pontine border, it joins its fellow to form the basilar artery, thus supplying the brainstem and the posterior part of cerebrum, becoming important in posterior cerebral circulation by contributing for the arterial cerbraral circle (circle of Willis). [4]

After emerging in the thoracic cavity consideration of anatomical variations in the branching pattern of aortic arch, its main branches and the vertebral arteries (VA) can have significance for diagnostic and surgical procedures in the thorax, the head and the neck. Many or most variations are totally benign; some are errors of embryologic developmental timing or persistence of normally obliterated structure.

The present study describes the variation in the source of the left vertebral artery found in a 65 year old Ethiopian cadaver.

Case Report/presentation

The aortic arch usually gives three branches, namely, the BCT, LCCA, and LSA. In the present case report the aortic arch in a cadaver of a 65 years old man was observed to have four branches namely BCT, LCCA, LVA and LSA. During a routine gross anatomy dissection session of the thorax for preclinical I medical students of college of health sciences, Mekelle University, Ethiopia; it was found that the aortic arch gives an unusual additional branch located between the left common carotid artery and left subclavian artery. In the dissection of structures in the thorax particularly in the mediastinum , the lungs were removed, superior vena cava and brachiocephalic veins cleared, and pericardium opened to expose ascending aorta which continues as the arch of aorta. The aortic arch together with the proximal parts of the four branches arising from it were cut and removed and pictured for separate observation and detail (Figure 1). With further careful observation, this aberrant branch from the aortic arch was identified as the left vertebral artery (LVA). The LVA originated from the aortic arch between the origins of the LCCA and the LSA. The diameter of the left vertebral artery was narrower than both the diameters of adjacent arteries namely the left common carotid artery and the left subclavian artery.

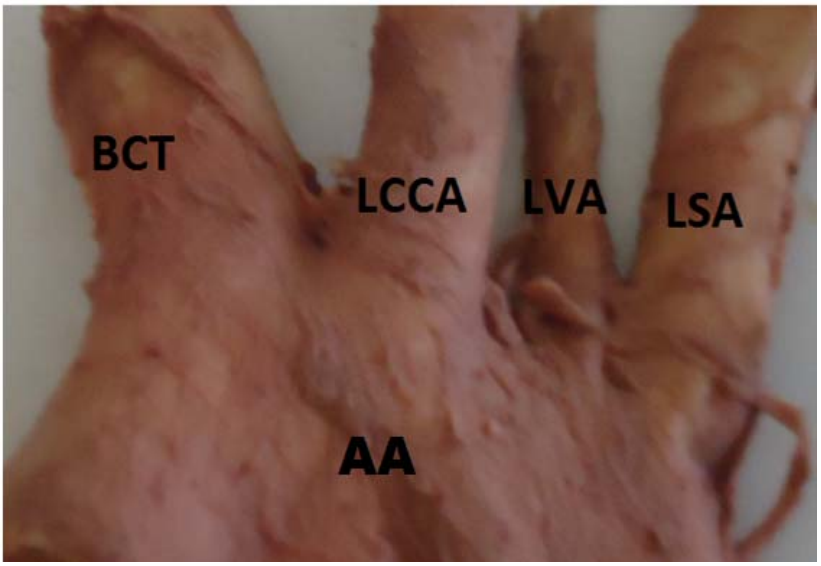

Figure 1: Picture showing left vertebral artery (LVA) arising from the aortic arch in a 65 years old male cadaver, College of Health Sciences, Mekelle University, Ethiopia, 2014.

Discussion

Without a thorough understanding of anomalous origins of the great vessels, angiography can be difficult or impossible. A thorough understanding of variant vertebral arteries is paramount when performing both diagnostic and interventional angiography in the head and neck. [5] The vertebral artery can be characterized by its small diameter in relation to great length, segmental branches, and fusion of paired arteries into one artery, the basilar artery (BA) that gives important branches to form the arterial cerebral circle (circle of Wills). An understanding of the variability of the vertebral artery also remains most important in angiography and surgical procedures where an incomplete knowledge of anatomy can lead to serious implications. An abnormal origin of the vertebral artery may favor cerebral disorders because of alterations in cerebral hemodynamics and predispose the patient to intracranial aneurysms. If the vertebral arteries are not identified in their normal position, this finding can be misinterpreted as the vessels being congenitally absent. Anomalous origins may lead to altered hemodynamics and predispose the patient to intracranial aneurysm formation. [3]

The vertebral artery and its branches are target of arteriographic investigations, ultrasound and Doppler visualization, MRI and CT imaging in many contemporary diagnostic procedures. [6]

Anomalous blood vessels are of common occurrence. They may be due (i) to the choice of unusual paths in the primitive vascular plexus, (ii) to the persistence of vessels normally obliterated, (iii) to the disappearance of vessels normally retained, and (iv) to incomplete development and to fusions and absorption of parts usually distinct.[1] A left vertebral artery of aortic origin may be because of the persistence of the dorsal division of the left 6^{th} intersegmental as the first part of the vertebral artery instead of that of the left 7th intersegmental artery, which seems to be the cause of variation in our case. [5]The origin of the left vertebral artery from the arch of aorta has been documented by different authors with a range of 3.0%–8.3%-table 1. [3].

Table 1. Incidence of left vertebral artery of aortic arch origin in different populations

Author (s)	**Year**	Population	**Incidence (%)**
Bean [7]	1905	Baltimore	5.2%
Stein et al. [8]	1962	New York	6%
Nizanowski et al. [9]	1982	Polish	3.1%
Vorster et al. [10]	1988	South African	5%
Matula et.al [11]	1997	Austrian	3.0
Nelson and Sparks[12]	2001	Japanese	4.1%
Panicker et al. [13]	2002	India	5%
Bhatia et al.[14]	2005	Australian	7.4%
Shin et al.[15]	2008	Korean	8.1%
Bhattarai and Poudel [16]	2010	Nepalese	7.0%

If the vertebral arteries are not identified in their normal position, this finding can be misinterpreted as the vessels being congenitally absent. Anomalous origins may lead to altered hemodynamics and predispose the patient to intercranial aneurysm formation. To understand anomalies of the great vessels and their branches, one must first understand embryologic development of the aortic arch.

Embryology

During embryonic development of the aortic arches(labeled 1-6 in figure) ,right and left dorsal aorta and cervical intersegmental arteries(labeled 1^{st} -7^{th} in figure), the vertebral arteries are formed by the longitudinal anastomosis of the intersegenmetal arteries (1^{st} -7^{th}) and arise as the first branches of the subclavian arteries which in turn are derived mainly from the 7^{th} pair of intersgemental arteries.

Usually the first part of vertebral artery develops from proximal part of dorsal branch of seventh cervical intersegmental artery proximal to postcostal anastomosis.

The second part is derived from longitudinal communications of the postcostal anastomosis with the consequent regression of the stems of the upper six intersegmental arteries. Third part develops from spinal branch of the first cervical intersegmental artery. Fourth part owes its development from the pre neural division of the spinal branch. In the present study, the left sixth dorsal intersegmental artery might have persisted as the first part of vertebral artery hence left vertebral artery was arising from arch of aorta.[13]

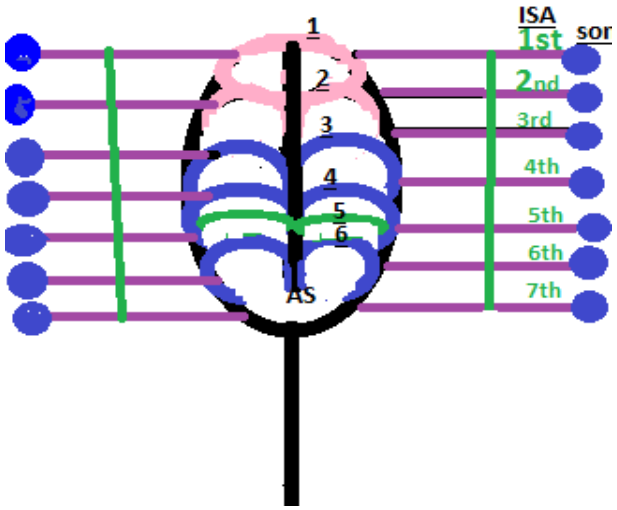

Figure 2. Schematic representation of aortic arches (1-6) connecting aortic sac(AS) to the right and left dorsal aortas from which cervical intersegmental arteries (1^{st} -7^{th}) arise to supply somites and their anastomosis will give rise the vertebral arteries during embryonic period.

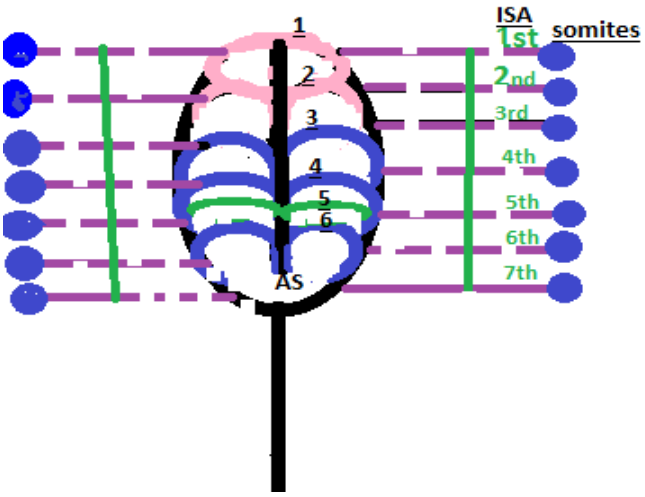

Figure 3A Diagram showing degeneration of the proximal and distal parts (to site of postcostal anastomosis) of intersegmental arteries(1-6) except the persistence of anastomosing segments to give vertebral arteries and the 7th pairs which give parts of the subclavan arteries.

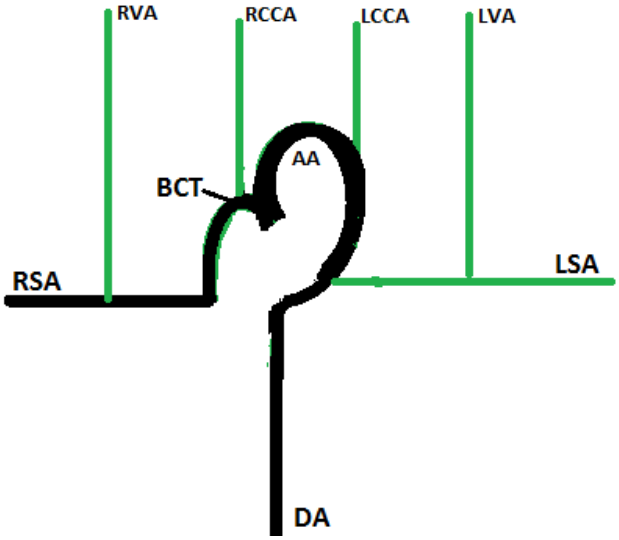

Figure3B: Schematic representation of the final usual braches of arch of aorta, subclavian arteries and normal origin of the vertebral arteries.

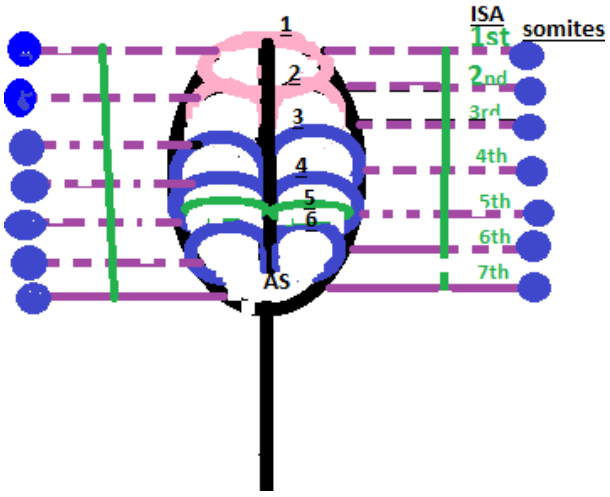

Figure 4A: Diagram showing persistence of proximal segment of 6th intersegmental artery to give prevertebral segment of left vertebral artery which maintains its connection with the arch of aorta.

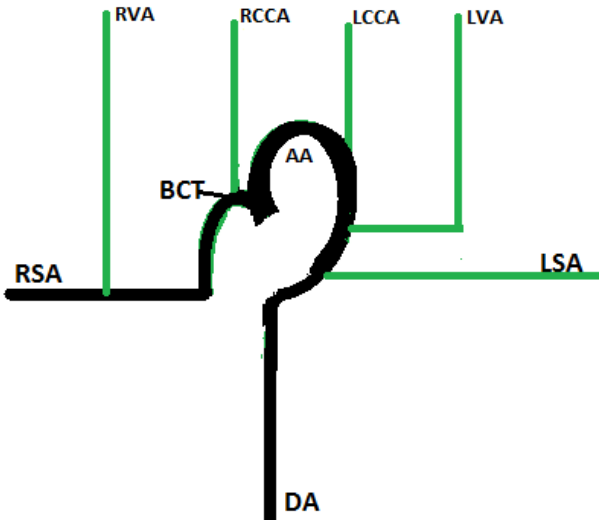

Figure 4B: Schematic representation that shows origin of left vertebral artery from arch of aorta due to persistence of proximal segment of left 6th intersegmental artery

Understanding the great vessels of the aortic arch and their variations is important for both the endovascular interventionist and the diagnostic radiologist. In cases, where vertebral artery arises from aortic arch, we feel, that the proximal part of 6th intersegmental artery fails to disappear, so blood flow through it persists forming a vertebral artery of aortic arch origin. As a preferential blood flows to this persistent channel the blood flow through anastamosing channel between 6th and 7th intersegmental arteries decreases which ultimately disappears. The prevertebral part of the VA is frequently affected from atherosclerosis and it is the common site of stenosis [4]. Knowledge of such variations of vessels is of vital interest to the surgeons because a minor accidental injury of the vessels causes sudden massive hemorrhage. Persistence of the proximal part of 6th intersegmental artery to the left dorsal aorta or 4th left aortic arch presumably could yield the left vertebral artery from the aortic arch, proximal to the left subclavian origin. This is the most common anomalous origin which seems to be the cause of variation in our case.

Conflict of interest

No conflict of interest

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