



## LEFT VERTEBRAL ARTERY OF AORTIC ARCH ORIGIN - ONTOGENY AND CLINICAL SIGNIFICANCE

### Anatomy

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### ABSTRACT

Accurate knowledge of the normal and variant anatomy of the vertebral artery is important for diagnostic angiography and surgical procedures in head and neck region and will provide an anatomical basis to assist surgeons in performing safe vascular surgery involving the major branches of this region. Here we are presenting a case report in which left vertebral artery(LVA) was taking origin from aortic arch between Left common carotid artery(LCCA) and Left subclavian artery(LSA) instead of arising directly from subclavian artery while on right side, vertebral artery was found to be of normal origin. We will discuss incidence, ontogeny and clinical implications in detail related to this anomaly.

### KEYWORDS

Variant, Vertebral artery, Aortic arch, Subclavian artery

### INTRODUCTION-

Normally, Vertebral artery arises from posterolateral aspect of subclavian artery. After taking origin it ascends vertically upwards in scaleno-vertebral triangle to enter into the foramen transversarium of 6<sup>th</sup> cervical vertebra and it is known as pre-transverse segment of vertebral artery. Abnormalities in the origin of vertebral artery are of diagnostic importance either prior to vascular surgery in the neck region or in case of intra-vascular disease such as arteriovenous malformations or cerebral aneurysms.<sup>1</sup> Chances of vertebral injury are also increased if its origin is anomalous as in cervical spinal surgery.<sup>2</sup>

According to Nathan and Seidel<sup>3</sup>, the derangements in origin and course of main vessels occurring either individually or in combination with other cardiovascular defects are mostly explainable on the ontogenic basis. They reported a case of LVA of aortic arch origin associated with retro-esophageal right subclavian artery and thoracic duct terminating on the right side, though the origin of the right vertebral artery was normal. Thus Kerr et al<sup>4</sup> rightly blamed the complex ontogenic development of vascular system for a myriad of clinically relevant anomalies.

### CASE REPORT-

During routine dissection for undergraduate students in Adesh medical college and Hospital, Mohri, we came across a rare variant of LVA of aortic arch origin. Left vertebral artery arises from aortic arch between the origins of LCCA and LSA. After its origin it ascends vertically upwards to enter into foramen transversarium of 6<sup>th</sup> cervical vertebra. (Fig. 1) Length of this pre-vertebral segment of vertebral artery was 8.5 cm. However, the right vertebral artery arose normally from postero-superior aspect of 1<sup>st</sup> part of right subclavian artery.

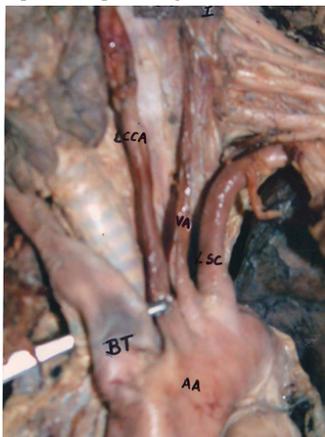


Fig. 1 Showing VA taking origin from AA in between LCCA and LSA

[VA: Left vertebral artery; LCCA: Left common carotid artery; LSA: Left subclavian artery; AA: Aortic arch; BT: Brachiocephalic Trunk]

### DISCUSSION

Most of the earlier workers encountered it in 2.4 – 8.3% of their dissections (Table I). However, its incidence is increased manifold (40%) in Down syndrome.<sup>5</sup>

TABLE I SHOWING INCIDENCE OF LEFT VERTEBRAL ARTERY OF AORTIC ARCH ORIGIN

Sr. No.	Author (year)	%age incidence
1.	Bean (1905) <sup>6</sup>	5.2%
2.	DeGaris (1924) <sup>7</sup>	3.3%
3.	Daseler and Anson (1959) <sup>8</sup>	4.25%
4.	Stein et al (1962) <sup>9</sup>	6%
5.	Argenson et al (1980) <sup>10</sup>	5.8%
6.	Nizanowski et al (1982) <sup>11</sup>	3.1%
7.	Cavdar and Arisan (1989) <sup>12</sup>	8.3%
8.	Vorster et al (1998) <sup>13</sup>	5%
9.	Komiyana et al(2001) <sup>14</sup>	2.4%
10.	Panicker et al (2002) <sup>5</sup>	5%
11.	Yamaki et al(2006) <sup>16</sup>	5.8%
12.	Imre et al(2010) <sup>17</sup>	2.5%

Schwarzacher and Krammer<sup>18</sup> came across a bilateral origin of vertebral arteries from aortic arch, the right one arising from the dorsomedial aspect of aortic arch opposite the ligamentum arteriosum at the level of third thoracic vertebra and the left emanating between left subclavian and left common carotid arteries.

### Ontogeny

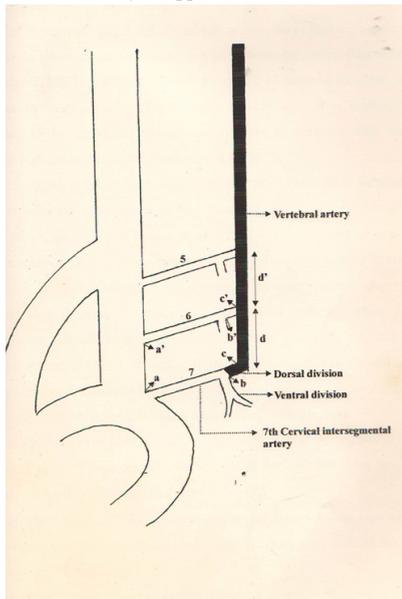
According to Matula et al<sup>19</sup>, the vertebral artery is formed between 32<sup>nd</sup> and 40<sup>th</sup> gestational day (7-18mm embryo) from fusion of secondary persistent segments of cervical arteries and the primitive dorsal aortic arch. They are of the firm belief that whereas an abnormal arrangements of this fusion process is definitely responsible for any abnormal origins, the possibility of these abnormalities in fusion contributing to some tortuosities of the vessel also can not be ruled out.

Vorster et al<sup>13</sup> believe that there are 2 factors which influence the development of the branches of the subclavian artery. First, ability of the blood to follow the longitudinal channels offering least resistance and second the tension on the vessels resulting from the caudal shifting of the heart and aorta. Further citing the work of Congdon<sup>20</sup> they opined that the vertebral artery develops from longitudinal arterial channels of inter segmental anastomosis. Due to caudal shifting of the aorta the proximal parts of these segmental arteries are exposed to longitudinal tension and bending with the resulting retarded blood flow. It might

have resulted in abnormal connections between the longitudinal channels (vertebral artery) and aortic arch.

However Panicker et al<sup>15</sup> acknowledging the views of Vorster et al<sup>13</sup> opined that a left vertebral arteries of aortic origin may be because of persistence of dorsal division of left 6<sup>th</sup> intersegmental artery as 1<sup>st</sup> part of vertebral artery instead of that of left 7<sup>th</sup> dorsal intersegmental artery.

If we have a look at **fig. 2**, normally 1<sup>st</sup> part of vertebral artery develops from dorsal division (segment bc) of 7<sup>th</sup> intersegmental artery (Segment ab) which itself forms proximal part of left subclavian artery. The 6<sup>th</sup> intersegmental artery (segment a'b') and its dorsal division (b'c') usually disappear as does the segment aa' of dorsal aorta. In the cases where vertebral artery arises from aortic arch, we feel, that dorsal branch of 6<sup>th</sup> intersegmental artery (segment b'c'), 6<sup>th</sup> intersegmental artery itself (segment a'b') and segment a-a' of dorsal aorta fail to disappear so blood flow through these persists forming a vertebral artery of aortic arch origin. As a preferential blood flow to this persistent channel (a-a'-b'- c') the flow through channel (b-c-d) decreases which ultimately disappears.



**Fig 2. Showing Ontogeny of Left Vertebral artery of Aortic arch origin**

### Clinical significance

Most of the workers agree without reserve that the anatomical and morphological variations of vertebral artery are significant for diagnostic and surgical procedures in head and neck region, where an incompatible knowledge can lead to complications.<sup>21-24</sup>

An abnormal origin of vertebral artery may favour cerebral disorders because of alterations in cerebral haemodynamic.<sup>25</sup> Although overall incidence of anomalous origin of pre-vertebral segment of vertebral artery is very low, it is extremely important to be aware of these complications in patients with this anomaly.<sup>15,26</sup>

The most frequent pathology affecting the extracranial vertebral artery is atherosclerosis<sup>27</sup>, the commonest site of which according to Fisher et al<sup>28</sup> is at the origin of vessel from subclavian artery. They further underlined its importance during evaluation of vertebrobasilar insufficiency thought to be due to atherosclerotic disease, and during cannulation of vertebral artery for endovascular procedures in such patients. Vitte et al<sup>29</sup> stressed to keep the abnormal origin of vertebral artery in mind during its manual compression used routinely for positional haemodynamic vertebrobasilar insufficiency and cautioned to take a special care in these cases.

Komiyana et al<sup>14</sup> found a left vertebral artery of aortic origin associated with a significantly higher incidence of vertebral artery dissection than that of a normal origin.

Satti et al<sup>30</sup> The anomalous origin of vertebral arteries may be misinterpreted as being congenitally absent or be wrongly assumed to be occluded, either by eluding catheterization during angiography or

by lying outside the region of interest during non-invasive studies such as CT angiography, MR angiography or Doppler sonography

### CONCLUSION:

Thorough knowledge of the variations in origin and distribution of vertebral artery is an essential pre-requisite for diagnostic procedures and performing endovascular surgeries in the head and neck region. If anomalous vertebral artery is diagnosed then other anomalies associated with this like AV malformations, cerebral aneurysms etc. must be ruled out.

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