

The Study of the Variant Origin and Course of the Vertebral Artery

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Abstract

The aim of study was to present and describe the variant anatomical origins of the vertebral artery and its entrance into the cervical vertebra. The study material consists of 50 embalmed cadavers 9 females and 41 males at the Dr. D. Y. Patil Medical College, Nerul, Navi Mumbai. Out of which in 3 (6%) cadavers were found where the left vertebral artery arises directly from the arch of aorta between the origins of the left common carotid and the left subclavian artery. In all cadavers right vertebral artery arises from the first part of right subclavian artery. These vertebral arteries coursed upward to the transverse foramen of cervical vertebra at different levels. Out of the 50 cadavers, the right vertebral arteries entered through transverse foramen of 6th and 5th cervical vertebrae 46 (92%) and 4 (8%) respectively. Left vertebral artery entered through transverse foramen of 6th cervical vertebra in 44 (88%), while those of 5th and 4th in 4 (8%) and 2 (4%). The vertebral artery is important to posterior cerebral circulation so it is of clinical importance to know the origin and course of the vertebral artery. The relation is important while performing transpedicular fixation or other spinal surgeries.

Keywords: Vertebral Artery; Arch of Aorta; Cervical Vertebrae.

Introduction

An understanding of variability of vertebral artery remains most important in angiography and surgical procedures where incomplete knowledge of anatomy can lead to serious complication. This has become an important era of carotid artery stents, vertebral artery stents and therapeutic options of intracranial interventions.

The vertebral arteries arise from the superoposterior aspect of the first part of subclavian artery, medial to

scalenus anterior muscle. The vessel takes a vertical posterior course to enter into the foramen transversarium of sixth cervical vertebra. The vertebral artery on both sides passes through the foramina transversarium of the first six cervical vertebrae, after passing through the transverse foramen of atlas passes posteromedially on its posterior arch, penetrates the posterior atlanto-occipital membrane and dura matter respectively and then enter the cranial cavity through the foramen magnum. They unite at the caudal border of the pons to form an unpaired basilar artery, which supplies the brain [1]. The vertebral artery (VA) is important to posterior cerebral circulation. The segment of the artery from its origin at subclavian artery to its respective transverse foramen of cervical vertebra is called the pretransverse or prevertebral segment [2].

A variation in the origin and distribution of the vertebral artery can cause alterations in cerebral hemodynamic that may predispose to aneurysmal formation with a greater risk of accidents [3, 4].

The present study showed anomalous origin of left vertebral artery and variation of vertebral artery

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entering the transverse foramen of cervical vertebra, have variable prevertebral course which is clinically important.

Material and Method

The present study consisted of dissection of head and neck region, was carried out on 50 adult cadavers 9 females and 41 males in dissection hall of Anatomy Department of Dr. D. Y. Patil Medical College Nerul, Navi Mumbai over the period of three years (2011-2014).

During the dissection, we observed the origin and course of vertebral artery from its origin to the entry in the foramen transversarium of cervical vertebra. Each vertebral artery was identified in the root of the neck arising from first part of subclavian artery lying behind common carotid artery and vertebral vein and passing through a scaleno-vertebral triangle between longus colli and scalenus anterior muscle. Each vertebral artery was dissected free of its loose connective tissue attachments from its origin up to the transverse foramen of the cervical vertebrae.

Result

In present study, 50 human cadavers 9 females and 41 males were dissected to study variations in the origin of vertebral artery and its entrance into the transverse foramen of the cervical vertebra. In all cadavers right vertebral artery arises from the first part of subclavian artery. Variant origin of left vertebral artery was found in 3 (6%) cadaver. In which the left vertebral artery took origin directly from the arch of aorta between the left common carotid artery (LCCA) and the left subclavian artery (LSA) (Figure 1). Then artery, ascended behind the left common carotid artery while stellate ganglion and ventral rami of cervical spinal nerves were related posterior and thoracic duct arched anterior to it before it entered the foramen transversarium of cervical vertebra.

As per Table 1, Out of the 50 cadavers, the right vertebral arteries entered through transverse foramen of 6th and 5th cervical vertebrae 46 (92%) and 4 (8%) respectively (Figure 2). left vertebral artery entered through transverse foramen of 6th cervical vertebra in 44 (88%) cases, while in 4(8%) cases it entered through the 5th cervical vertebra (Figure 1). and in only 2(4%) cases, we observed that it entered into the C4 (Figure 2).

Table 1: Present study showing variation of vertebral artery entering foramen transversarium of cervical vertebrae

	RT VA (50)	Lt VA (50)	Total VA (100)
C ₄	-	2(4%)	2%
C ₅	4(8%)	4(8%)	8%
C ₆	46(92%)	44(88%)	90%
C ₇	-	-	-

Table 2: Aortic Origins of vertebral artery described by other studies

Author (Year)	Incidence
Bean (1905) ^[8]	5.2%
Adachi (1928) ^[9]	5.4%
Stein et al. (1962) ^[10]	6%
Argenson et al. (1980) ^[11]	5.8%
Nizanowski et al. (1982) ^[12]	3.1%
Lippert Pab(1985) ^[7]	3%
Cavdar and Arisan (1989) ^[13]	8.3%
Takafuji and Safo (1991) ^[14]	6.9%
Vorster et al. (1998) ^[15]	5%
Panicker et al. (2002) ^[16]	5%
Komiyama et al. (2001) ^[17]	2.4%
Yamaki K et al.(2006) ^[6]	5.8%.
Patil ST et al. (2012) ^[18]	8%
C Bhattarai et al. (2010) ^[19]	7%

Table 3: Comparisons of Variation of vertebral artery entering foramen transversarium of cervical vertebrae

Entrance into the cervical vertebra	Adachi (1928)	Yamaki (2006)	Present study
C3	0	6.7%	0
C4	7.4%	16.7%	2%
C5	66.66%	43.3%	8%
C6	14.8%	33.3%	90%
C7	11.11%	0	0
Number of cases	27	30	100

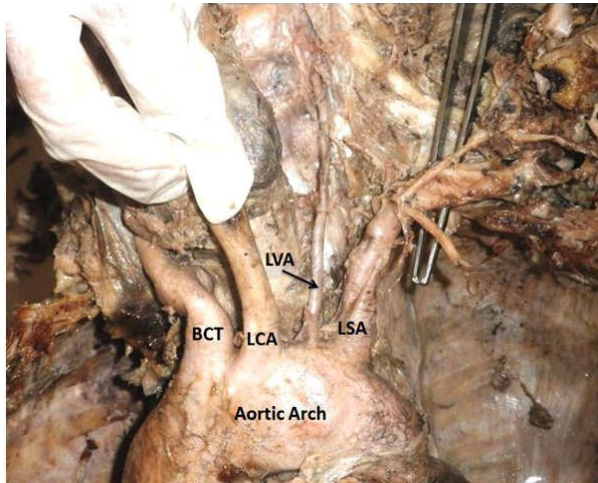


Fig. 1: Origin of left vertebral artery from the arch of aorta and enters into foramen transversarium of C5, LVA: Left Vertebral Artery, LCA: Left Common Carotid Artery, BCT: Brachio Cephalic Trunk, LSA: Left Subclavian Artery

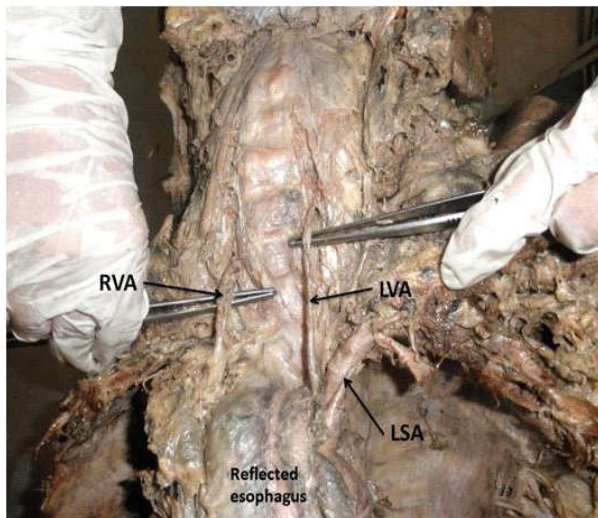


Fig. 2: LVA: Left vertebral artery enters foramen transversarium of C4, RVA: Right vertebral artery enters foramen transversarium of C5, LSA: Left Subclavian Artery

Discussion

Anatomic and morphological variations of the vertebral artery are of immense importance in Surgery, angiography and all non-invasive procedures. The right vertebral artery may arise from

the following: **A.** First part of subclavian artery, closer to the brachiocephalic artery (1%) or to the anterior scalene muscle; **B.** directly from the aortic arch (3%); **C.** The right common carotid artery when the right subclavian artery is branching from the aorta beyond the left subclavian artery; **D.** The brachiocephalic trunk, the right vertebral artery may pass behind the oesophagus [5]. The left vertebral artery may arise directly from the left common carotid artery, or the root of subclavian artery, close to the arch of aorta. It may arise from the arch of aorta [6]. In our study all 50 right vertebral arteries arise from the first part of subclavian artery.

Lippert Pab's classified the LVA according to the origin from the aortic arch as: between the LCCA and LSA (Type A, 3%), between a common trunk formed by BT and LCCA and LSA (Type B, <1%), after the LCCA (Type C, <1%), after the LSA as the third branch (Type D, <0.1%), after a common trunk as the second branch (Type E, <0.1%), different from Type A, RSA appears from descending aorta (Type F, <0.1%), one of two roots as a penultimate branch (Type G, <1%), both VA branch from the aortic arch (Type H, <0.1%) [7]. In present study 6% LVA originates from aortic arch between the LCCA and LSA.

The vertebral artery of aortic arch origin has been earlier described by different authors in the range of 1.6 - 8.3% (Table 2).

Nizanowski, in their study on 160 cadavers and 100 fetuses, found the Left Vertebral Artery originating from the aortic arch in seven adults and one fetus [12]. Panicker reported the Left Vertebral Artery originated directly from arch of aorta between the left common carotid artery and left subclavian artery [16].

Yamaki k et al. [6] described the correlation exist between vertebral artery entering the foramen at abnormal level and variation of its origin from subclavian artery.

Entrance point of the Left Vertebral Artery originating from the aortic arch was also reported variable. Most common entrance points were reported as C5 and C6, respectively [6, 9].

Different levels of entry of the VA to the transverse foramen may also contribute to differences in

hemodynamics [17]. According to Gray's Anatomy, the artery enters the transverse foramina of the 6th cervical vertebra in 90% cases, while those of 7th, 5th, 4th and 3rd in 2%, 5%, 2% and 1% cases respectively [1]. We also found the same findings, on right side 46(92%) and on left side 44(88%), total 90% vertebral arteries entered into the transverse foramen of sixth cervical vertebra while in C5 and C4, it is 8% and 2% respectively.

In a study by Bruneau M et al., out of 500 vertebral arteries studied, by means of MRI and CT angiographic images found variations in 7% (35) cases. In his study it was also found vertebral artery entering at C3, C4, C5 or C7 level respectively in 0.2%, 1.0%, 5.0% and 0.8% of all specimens. Bruneau et al also described bilateral anomaly 0.8% (2) and unilateral anomaly 12.4% (31 out of 250) which was more common on left side [20]. Kajimoto BHJ et al. in his study described variations of vertebral artery entering the transverse foramen of 7th cervical vertebra to be 7.5% [21].

Embryological Basis

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 anastomoses [22]. In the present study left sixth dorsal intersegmental artery might have persisted as first part of vertebral artery hence left vertebral artery is arising from arch of aorta. According to Vorster et al. (1998) the proximal parts of the segmental arteries are exposed to longitudinal tension and bending due to caudal shifting of the aorta resulting in retarded blood flow and abnormal connections between longitudinal channels (vertebral artery) and subclavian artery or aorta [15].

Conclusion

If we see the variant origin of the vertebral artery, it is found mostly on left side. We found 6% of left vertebral artery arising from arch of aorta. While all right vertebral artery arising from their normal site i.e. 1st part of the right subclavian artery. The knowledge of potential left vertebral artery origin variants is necessary and beneficial for planning aortic arch surgery or endovascular interventions [2]. It is of clinical importance to know the origin and course of prevertebral segment of the vertebral artery in detail and being aware of the possible variations,

like in this study we found that it is more variable on left side than right side, this relation is important while performing transpedicular fixation or other spinal surgeries. The vertebral artery is subject to mechanical stress, dynamic obstructions, thrombosis that propagates to brain infarction and traumatic dissecting aneurysms in addition to constriction, embolism, and occlusive disease. In order to prevent complications, it is critical to assess vascularization in this region prior to conducting medical procedures. The extracranial portion of Vertebral Artery is frequently affected from atherosclerosis. The most common site of the consequent stenosis is its origin.

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