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ANATOMICAL VARIATIONS OF VERTEBRAL ARTERY - A CADAVERIC STUDY WITH CLINICAL RELEVANCE

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Abstract:
Introduction: Vertebral arteries originate from the root of the neck as the first branches from the superior-posterior aspect of the subclavian arteries. The VA typically gives off spinal, muscular, meningeal branches, the anterior spinal artery, ramus choroideus ventriculi quarti, medial and lateral medullary branches and the terminal branch, the posterior inferior cerebellar artery (PICA).
Material and methods: An observational cadaveric study was conducted on 30 formalin-fixed human cadavers from 2022 to 2025 in the Department of Anatomy, Chalmeda Anandarao institute of medical sciences, Karimnagar, Telangana, India.
Results: Variations were found in the origin and course of vertebral artery in our study. Variations in the origin of vertebral artery were found in four cases (6.6%) out of 30 cadavers, 60 vertebral arteries are examined. The Left Vertebral artery was arising directly from the arch of aorta instead of arising from Subclavian artery in four cases (6.6%). Variation in the course of vertebral artery was found in one case (1.6%). Left vertebral artery was entering into the foramen transversarium of C3 vertebra instead of C6.
Discussion: The left vertebral artery arising directly from arch of aorta between left common carotid and left subclavian arteries which accounts to about 2.4-5.8 percent of cases. In most occasions the LVA emerged between the left common carotid artery (LCCA) and the left subclavian artery (LSCA). The LVA varies in origin more than the right.
Conclusion: Vertebral artery and its variations is of great importance for the planning of aortic arch surgery or endovascular intervention and prevention of vascular complications during minimally invasive diagnosis and treatment of cerebral vascular diseases.

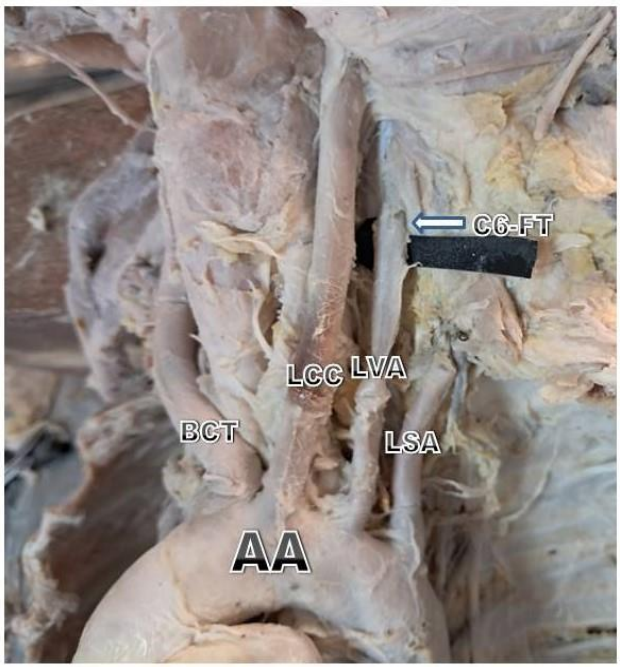
Introduction: Vertebral arteries originate from the root of the neck as the first branches from the superior-posterior aspect of the subclavian arteries [1]. Then, vertebral arteries ascend the neck to enter the cranial cavity and supply blood to the brain. The two vertebral arteries are usually unequal in size; the left one is usually larger than the right one [2]. Normally the vertebral artery (VA) is divided into four segments. In the first segment, the artery course dorsally after originating from the

subclavian artery until it enters the foramen of the C6. The second segment lies within the transverse foramina of C6 to C2. The third portion is the distal extracranial segment that is short and tortuous. The artery passes through the transverse foramen (TF) of the atlas and then curves backwards and medially behind the lateral mass of the atlas. It then makes a sharp turn to pierce the dura mater, thereby entering the cranium through the foramen magnum. The fourth segment is entirely intracranial and terminates when the vertebral arteries join at the lower pontine border to form the basilar artery. The VA typically gives off spinal, muscular, meningeal branches, the anterior spinal artery, ramus choroideus ventriculi quarti, medial and lateral medullary branches and the terminal branch, the posterior inferior cerebellar artery (PICA). Numerous variants are found in the origin and course of the vertebral artery. Generally it enters into go into the foramen transversarium of C6 and passes up but sometimes it may go into foramen transversarium of any other cervical vertebrae [3, 4]. Also, occasionally the vertebral artery takes its origin directly from the arch of aorta as an alternative of subclavian artery. These variations, if present, are important from the diagnostic as well as surgical point of view [5, 6]. The surgical indications in the cervical region include spondylosis, a herniated disc, tumor and trauma. This information is important for endovascular or cardiothoracic operations in the head and neck region. This has become more important in the era of carotid artery stents, vertebral artery stents, and new therapeutic options for intracranial interventions [7].

Material and methods: An observational cadaveric study was conducted on 30 formalin-fixed human cadavers from 2022 to 2025 in the Department of Anatomy, Chalmeda Anandarao institute of medical sciences, Karimnagar, Telangana, India. Dissection was carried out in the scaleno-vertebral region on both the sides, so a total of 60 vertebral arteries were dissected. The prevertebral segment of the vertebral artery as well as the entrance and course of vertebral artery into foramina transversaria was assessed. The number of cadavers showing variations of vertebral artery was determined. The origin and course of both the right and left vertebral artery were noted. Photographs were taken and analyzed.

Inclusion criteria: All the cadavers used for dissection of undergraduate teaching in the year of 2022 to 2025 obtained from the Department of Anatomy, irrespective of age and sex were included in the study.
Exclusion criteria: Damaged vertebral arteries due to improper dissection by the students were excluded from the study.
Results: Variations were found in the origin and course of vertebral artery in our study. These variations were noted down as follows. To start with Variations in the origin of vertebral artery were found in four cases (6.6%) out of 30 cadavers, 60 vertebral arteries are examined. The Left Vertebral artery was arising directly from the arch of aorta instead of arising from Subclavian artery in four cases (6.6%).

Variation in the course of vertebral artery was found in one case (1.6%). Left vertebral artery was entering into the foramen transversarium of C3 vertebra instead of C6**.**



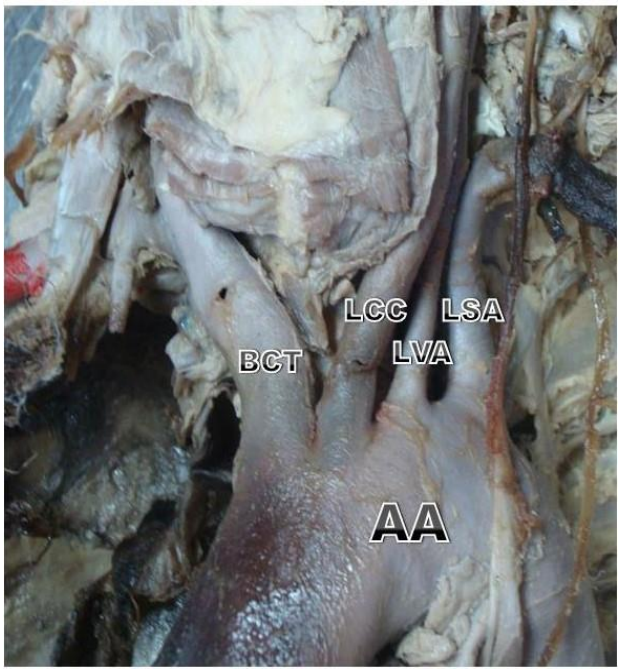
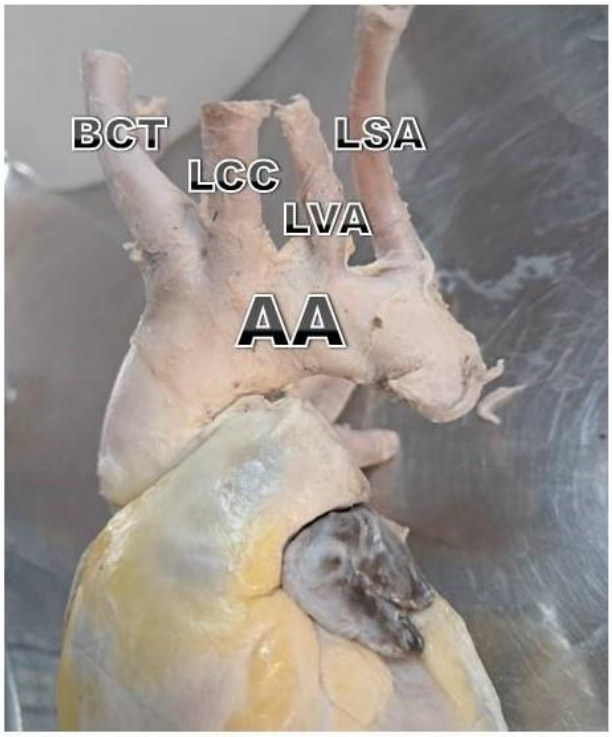


FIG 1 and 2: Left Vertebral Artery (LVA) arising from Aortic Arch (AA), BCT- Brachio-Cephalic Trunk, LCC- Left Common Carotid, LSA- Left Subclavian Artery and FT- Foramen Transversarium of 6th Cervical vertebra.



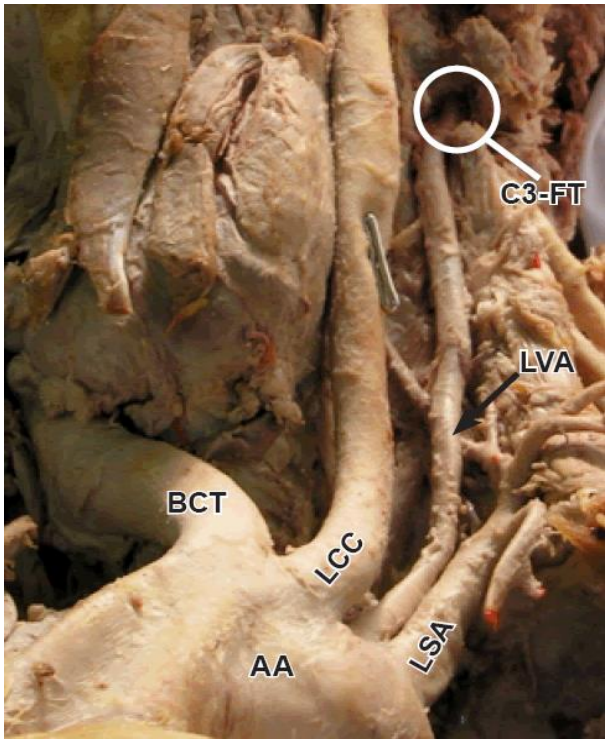


FIG 3 and 4: Left Vertebral Artery (LVA) arising from Aortic Arch (AA), BCT- Brachio-Cephalic Trunk, LCC- Left Common Carotid, LSA- Left Subclavian Artery and FT- Foramen Transversarium of 3rd Cervical vertebra.

Discussion: The vertebral artery is generally arising from first branch of the subclavian artery. Multiple variations in the origin of the vertebral artery have been reported by various authors, such as it can arise from the aortic arch, the common carotid or the internal carotid arteries. Gorey AR et al stated that the most frequent variant is the left vertebral artery arising directly from arch of aorta between left common carotid and left subclavian arteries which accounts to about 2.4-5.8 percent of cases [8]. Magklara et al., the direct origin of the LVA from the AA was observed in 6.7% of the

cases. In most occasions the LVA emerged between the left common carotid artery (LCCA) and the left subclavian artery (LSCA). A unique case of a LVA origin between the BCT and the LSCA was reported [9]. The LVA varies in origin more than the right. A case of bilateral anomalous origin of the vertebral artery from the aortic arch is also reported [10].

Vertebral artery arises from aortic arch, we feel that dorsal branch of 6th intersegmental artery may be making role in the development of first part of the vertebral artery instead of left 7th intersegmental artery hence, blood flows through these persists forming a vertebral artery of aortic arch origin [11]. In the present study out off 30 cadavers, 60 vertebral arteries are examined and found four left side vertebral arteries (6.6%) arising directly from aortic arch in between left common carotid and left subclavian arteries.

The left vertebral artery can enter the foramina transversaria in the second to seventh cervical vertebra. The left vertebral artery usually enters the sixth cervical foramina transversaria (88%), only in 57% cases the left vertebral artery will enter seventh or fifth cervical vertebra [12]. Rawal Jitendra D et al., dissected 50 vertebral arteries, and found 46 vertebral arteries entering the transverse foramen of the sixth cervical vertebra (92%) and 4 of them entering transverse process of seventh cervical vbra (8%) [13].

Fayza A. Abd EI Gawad et al. most of vertebral arteries entered through the foramen transversarium of C6 (91% on the left and 93% on the right). Out of 200 VA, the most common atypical entry of VA was passes through C5 (9 arteries, 4.5%) followed by C7 (3 arteries, 1.5%) then C4 (2 arteries, 1%) [14]. Susan Standring et al. have also mentioned that 10% of vertebral artery enters transverse foramina of cervical vertebrae other than C6 vertebrae [15]. Magklara et al. vertebral artery entered typically at C6 in 80% of the cases and the abnormal entrance occurred in 20% (C7, C5, and C4 with incidences 10.4%, 7.6%, and 2.3%, respectively) [9]. In the present study only one left vertebral artery (1.6%) was entering into the foramen transversarium of C3 vertebra instead of C6.

The agenesis of some branches of the vertebral artery is also identified as an important factor for the occurrence of strokes in the posterior region of the brain. Akgun et al., (2013) showed that a total of 63% of patients suffering from stroke in the posterior region of the brain had at least one anatomical variation in the vertebrobasilar circulation. Of a total of 135 patients, the most common variation was isolated agenesis of one of the posterior inferior cerebellar arteries, with 24.4% of the cases on the right side and 19.3% on the left side. In these cases, it was verified that the blood supply came from the well-developed ipsilateral anterior inferior cerebellar artery or by an anastomosis of the contralateral anterior inferior cerebellar artery [16].

Conclusions: Variations of the vertebral arteries are clinically important anatomical findings because they are directly involved in the occurrence of low to high complexity diseases. Its presence leads to changes in blood flow that can result in headaches, vertigo, and multitude of iatrogenic diseases.

Vertebral artery and its variations is of great importance for the planning of aortic arch surgery or endovascular intervention and prevention of vascular complications during minimally invasive diagnosis and treatment of cerebral vascular diseases.

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