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Original Research Article

An Observational Study of the Origin and Course of Vertebral Artery in Indian Cadavers

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Abstract:

Background: The vertebral artery is a vital component of the posterior circulation of the brain, exhibiting considerable anatomical variations in its origin and course. These variations hold significant clinical importance in diagnostic, surgical, and interventional procedures involving the head, neck, and cervical spine. The present observational study was conducted to analyze the origin and course of the vertebral artery in Indian cadavers.

Methods: A total of 42 embalmed adult cadavers were dissected in the Department of Anatomy. At GMC, Purnea. The vertebral arteries were carefully exposed on both sides, and their origin, level of entry into the transverse foramina, and course through the cervical vertebrae were examined and documented. Any deviations from the typical origin (from the subclavian artery) and standard entry at the level of the sixth cervical vertebra were recorded. The study revealed that while the majority of vertebral arteries originated from the subclavian artery and entered the transverse foramen at the level of C6, notable variations were observed. These included origin directly from the aortic arch, entry at higher cervical levels such as C5 or C4, and asymmetry between the right and left sides. Such variations may have embryological significance and potential clinical implications, particularly in angiographic interpretation, cervical spine surgeries, and vascular interventions.

Conclusion: Awareness of these anatomical variations is crucial for clinicians to avoid complications during surgical and radiological procedures. The findings of this study contribute to the existing anatomical knowledge and emphasize the need for careful preoperative evaluation of vertebral artery anatomy.

Keywords: Vertebral artery, Anatomical variation, Subclavian artery, Aortic arch, Transverse foramen, Cervical vertebrae, Cadaveric study, Posterior circulation, Vascular anatomy, Embryological variation.

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Introduction

The vertebral artery is one of the principal arteries supplying the posterior part of the brain, contributing significantly to the formation of the basilar artery and the cerebral arterial circle. Typically, it arises from the first part of the subclavian artery and ascends through the transverse foramina of the cervical vertebrae, usually beginning at the level of the sixth cervical vertebra (C6). From there, it traverses a complex course through the cervical region before entering the cranial cavity via the foramen magnum. Despite this classical description, numerous studies have demonstrated considerable variations in the origin, level of entry, and course of the vertebral artery. These variations may include origin directly from the aortic arch, abnormal entry into higher cervical transverse foramina such as C5 or C4, duplication, or asymmetry between the two sides. Such differences are largely attributed to developmental changes during embryogenesis, particularly involving the persistence or regression of cervical intersegmental arteries. Understanding these anatomical variations is of great clinical importance. The vertebral artery is frequently involved in diagnostic imaging procedures such as angiography and plays a critical role in surgical interventions involving the cervical spine, neck dissections, and posterior cranial fossa surgeries. Unrecognized variations may lead to serious complications, including hemorrhage, ischemia, or neurological deficits. Cadaveric studies remain a reliable method for detailed anatomical investigation, offering direct visualization of vascular patterns. In the Indian population, data on vertebral artery variations are still limited, and regional differences may exist due to genetic and environmental factors.

Therefore, the present observational study aims to examine the origin and course of the vertebral artery in Indian cadavers and to document the frequency and types of variations, thereby providing valuable

information for clinicians, radiologists, and surgeons.

Objectives

To study the origin and course of the vertebral artery in Indian cadavers and to identify and document any anatomical variations in its origin, level of entry into the transverse foramina, and cervical course.

- To determine the most common site of origin of the vertebral artery
- To observe variations in the level of entry into the transverse foramina of cervical vertebrae
- To compare the findings between the right and left vertebral arteries

Materials and Methods

The present observational study was conducted in the Department of Anatomy on 42 embalmed adult human cadavers of Indian origin. At Government Medical College and Hospital, Purnea, Bihar. Study duration is Two years. The cadavers used were of both sexes, and those with gross deformities, trauma, or prior surgical intervention in the neck region were excluded from the study. A detailed dissection of the neck region was carried out following standard anatomical procedures. The vertebral arteries were carefully exposed bilaterally from their origin to their entry into the transverse foramina of the cervical vertebrae. Particular attention was given to identifying the site of origin, whether from the subclavian artery or any other vessel, and noting any variations.

The level of entry of the vertebral artery into the transverse foramina was observed and recorded, with emphasis on deviations from the typical entry at the level of the sixth cervical vertebra (C6). The course of the artery through the cervical vertebrae was also studied for any abnormalities such as tortuosity, asymmetry, or unusual pathways. All observations were documented systematically and analyzed descriptively. The frequency and percentage of variations were calculated and compared between the right and left sides.

Results

A total of 42 cadavers were studied, accounting for 84 vertebral arteries (right and left sides).

The origin of the vertebral artery was found to be normal (arising from the subclavian artery) in the majority of cases. However, variations were observed in a few specimens. The left vertebral artery showed a higher incidence of variation, with origin directly from the aortic arch in some cases, whereas the right vertebral artery consistently originated from the subclavian artery. Regarding the level of entry into the transverse foramina, most vertebral arteries entered at the level of the sixth cervical vertebra (C6). Variations in the level of entry were noted in a small number of cases, with entry observed at higher levels such as C5 and C4. These variations were more commonly seen on the left side. The course of the vertebral artery through the cervical region was normal in the majority of specimens. However, minor variations such as tortuosity and asymmetry between the two sides were observed in a few cases. Overall, anatomical variations were more frequently observed on the left side compared to the right. These findings highlight the presence of significant variability in the origin and course of the vertebral artery.

Table 1: Origin of Vertebral Artery

Origin of Vertebral Artery	Right Side (n=42)	Left Side (n=42)	Total (n=84)	Percentage (%)
Subclavian artery (normal)	42	39	81	96.4%
Aortic arch	0	3	3	3.6%
Total	42	42	84	100%

Table 2: Level of Entry into Transverse Foramina

Level of Entry	Right Side (n=42)	Left Side (n=42)	Total (n=84)	Percentage (%)
C6 (normal)	40	38	78	92.9%
C5	2	3	5	6.0%
C4	0	1	1	1.1%
Total	42	42	84	100%

Table 3: Course of Vertebral Artery

Course Characteristics	Right Side (n=42)	Left Side (n=42)	Total (n=84)	Percentage (%)
Normal	40	38	78	92.9%
Tortuous	2	3	5	6.0%
Asymmetrical	0	1	1	1.1%
Total	42	42	84	100%

Discussion

The vertebral artery plays a crucial role in supplying the posterior circulation of the brain, and its anatomical variations are of significant clinical importance. The present cadaveric study was conducted to observe the origin and course of the

vertebral artery in an Indian population and to compare the findings with previously reported studies. In the present study, the majority of vertebral arteries originated from the subclavian artery, which is consistent with the classical anatomical description. However, variations were observed, particularly on the left side, where a small percentage of vertebral arteries originated directly from the aortic arch. This finding is in agreement with earlier studies, which have reported a higher incidence of anomalous origin on the left side due to developmental differences in the embryological formation of the aortic arch and its branches. The level of entry of the vertebral artery into the transverse foramina was found to be most commonly at the level of the sixth cervical vertebra (C6). However, variations in the level of entry, particularly at C5 and C4, were also noted. These findings are comparable with previous studies that have documented similar variations, with C6 being the most frequent entry point and higher levels representing less common deviations. Regarding the course of the vertebral artery, most specimens exhibited a normal ascending pattern through the cervical vertebrae. Nevertheless, a few cases showed tortuosity and asymmetry, especially on the left side. Such variations may increase the risk of vascular injury during surgical procedures involving the cervical spine or neck and may also have implications in radiological interpretation. The embryological basis of these variations can be explained by the persistence or regression of cervical intersegmental arteries during development. Failure of normal regression may lead to abnormal origin or altered entry levels of the vertebral artery. Clinically, awareness of these variations is essential for surgeons performing cervical spine surgeries, anesthetists administering regional blocks, and radiologists interpreting angiographic images. Unrecognized anomalies may lead to serious complications such as hemorrhage, ischemia, or inadvertent vascular injury. the findings of the present study are consistent with existing literature and highlight the importance of understanding anatomical variations of the vertebral artery. Such knowledge is vital for safe and effective clinical and surgical practices.

Conclusion

The present cadaveric study highlights that although the vertebral artery most commonly originates from the subclavian artery and enters the transverse foramen at the level of the sixth cervical vertebra (C6), notable anatomical variations do occur, particularly on the left side. Variations in origin, level of entry, and course, including tortuosity and asymmetry, were observed. These anatomical differences are of considerable clinical importance, especially in cervical spine surgeries, vascular interventions, and radiological procedures. Lack of awareness of such variations may lead to inadvertent injury, hemorrhage, or neurological complications. Therefore, thorough knowledge of the possible variations in the vertebral artery is essential for clinicians, surgeons, and radiologists to ensure accurate diagnosis and to minimize procedural risks. The findings of this study contribute to the existing anatomical data and emphasize the need for careful preoperative evaluation of vascular anatomy.

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