

Surgico-Clinical Significance of Accessory Foramina Transversaria in Cervical Vertebrae

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Abstract

Introduction: The cervical vertebrae, located in the neck region of the spinal column, is recognized by the presence of the Foramen Transversarium (FT) on their horizontal processes. This anatomical feature allows for the passage of vertebral artery. Variations in the size, shape, and number of FT may lead to clinical symptoms, emphasizing the need to understand these anomalies for safe and effective medical interventions. The study's primary objective was to investigate the significance of foramina transversaria in the cervical spine.

Methodology: In this study, 150 cervical vertebrae were macroscopically examined to identify the presence of accessory FT. The investigation was conducted over a 16-month period and excluded vertebrae with congenital defects or pathological issues. The data collected was analyzed and presented in a tabular format.

Results: Out of the 150 cervical vertebrae investigated, 50 exhibited accessory foramen transversarium, resulting in an incidence of 33%. Among these, 15 featured Unilateral Accessory Foramen Transversarium, primarily on the left side. Bilateral Accessory Foramen Transversarium was more common, with the foramina often found in the lower spinal vertebrae (C5 and C7).

Conclusion: Observations of this research shed light on the occurrence and characteristics of accessory foramina transversaria in cervical vertebrae. This knowledge is valuable for spine surgeons and radiologists, especially when performing computed tomography and magnetic resonance imaging scans. Additionally, it underscores the importance of precise anatomical understanding in surgical procedures involving the cervical spine, as even minor lesions to the vertebral artery can result in life-threatening hemorrhage. The research serves as a foundation for future investigations aimed at enhancing surgical methodologies and improving patient safety in cervical spine surgeries.

Keywords: Cervical Vertebrae, Accessory Foramina Transversaria, Cervical Spine, Magnetic Resonance Imaging, Unilateral Accessory Foramen Transversarium.

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Introduction

The “cervical vertebrae”, located in the neck region of the spinal column, constitute a critical part of the human skeletal structure. Their distinctiveness is marked by the appearance of the “Foramen Transversarium” (FT), a defining feature that characterizes this set of vertebrae. These lateral processes, housing the FT, are the result of fused costal elements with their true transverse processes, offering a unique anatomical signature [1].

“Foramen transversarium” which is situated on the transverse processes of “cervical vertebrae”, serves a vital function in facilitating the track of the “vertebral artery”, “vertebral vein”, and

“sympathetic nerves” [1]. Typically, the “foramen transversarium” accommodates the second segment of the “vertebral artery” (VA), “vertebral veins” (VV), and sympathetic fibers that originate from the “cervicothoracic ganglion” (vertebral nerve). “Double foramina transversarium”, although uncommon, represents an unusual anatomical variation that can potentially influence the trajectory of the “vertebral artery” [2]. These foramina can vary in terms of their size, shape, and number, and in some cases, they may be absent, incomplete, or duplicated. These variations are influenced by developmental factors that affect the path of the vertebral artery. It is essential to understand and

identify these variations, especially when performing posterior surgical procedures on the cervical spine, as they directly impact patient safety and surgical accuracy [2].

The opening of the FT serves as a pathway for the “vertebral artery”, vertebral vein, and “sympathetic fibers” that originate from the inferior cervical ganglion. In certain cervical vertebrae, like C7, the foramen transversarium only transmits the vertebral vein [2]. The progress of the “foramen transversarium” is closely connected to the specialized growth of the cervical transverse process, where remnants fuse with the vertebrae and true transverse process [3].

Variations in the quantity and dimensions of the “foramen transversarium” may lead to clinical consequences, potentially resulting in symptoms such as headaches, migraines, and episodes of fainting due to “vertebral artery compression” [4]. These variations can lead to vascular insufficiency, highlighting the importance of precise knowledge of surgical anatomy and morphology.

For orthopedic surgeons and radiologists conducting digital tomography and magnetic MRI scans, a profound comprehension of these anatomical variances holds immense value [5]. In medical procedures concerning the “cervical spine”, the preservation of the vertebral artery's integrity stands as a paramount consideration, given that even minor lesions can potentially lead to significant hemorrhage or fatal consequences. As a result, anatomical investigations have been undertaken with the objective of reducing the likelihood of inadvertent intraoperative harm to the arterial vessels [5, 6].

The main aim of this research was to examine the frequency of “accessory foramina transversaria” in the cervical spine, contributing to a deeper comprehension of this complex anatomical characteristic and its potential clinical significance.

Material and Methods

Table 1: Accessory Foramina in cervical vertebrae

S.No	Vertebrae Type	Sample No.	Right	Left	Double
1.	C1-C2	25	0	0	3
2.	C3-C4	26	0	2	4
3.	C5	75	2	3	20
4.	C7	24	3	5	8
Total		150	5	10	35

Out of the 150 cervical vertebrae investigated, 50 of them had accessory foramen transversaria, resulting in an incidence of 33% and for the 15 samples with unilateral accessory foramen transversaria. Most of these accessory foramina were observed on the left side. During the research, “bilateral accessory foramen transversarium” was more common. This suggests that these accessory foramina were present

The investigation involved the examination of 150 cervical vertebrae. This study was conducted at Andhra Medical College, located in Vishakhapatnam, Andhra Pradesh, India. The duration of the study spanned 16 months, commencing in June 2022 and concluding in August 2023. To ensure the accuracy and relevance of the findings, certain criteria were established for the selection of vertebrae to be included in the study. Specifically, vertebrae with innate defects or pathological issues were not included in the investigation. This exclusion criteria aimed to focus the study on the normal anatomy of cervical vertebrae, thus eliminating any potential confounding factors.

The primary method employed in this study was the macroscopic examination of cervical vertebrae. This entailed a thorough visual inspection of each vertebra to identify the presence of “accessory foramina transversaria” (AFT). Macroscopic examination allows for the direct observation of anatomical features without the need for specialized equipment or invasive procedures. In cases where “accessory foramina transversaria” were identified during the macroscopic examination, photographic documentation was utilized. Photographing these anatomical features provides a visual record that can be referred to for further analysis, documentation, and reference in the research findings. The collected data was subjected to detailed analysis.

Results

Out of 150 cervical vertebrae that were taken into investigation, 50 had accessory foramen transversaria. Its incidence was calculated to be 33%. Of these 50 samples, 15 of them had “Unilateral Accessory Foramen Transversarium”, which is 10% of the samples, most of which were on the left side. “Bilateral Accessory Foramen Transversarium” was more common during our research. The “accessory foramina” were commonly present in the “lower cervical vertebrae” in C5 and C7 as presented in table 1 below.

on both sides of the vertebrae, contributing to the overall complexity of the cervical vertebral anatomy.

The data presented in Table 1 indicates that “accessory foramina” transversaria were commonly found in the “lower cervical vertebrae”, with C5 and C7 having the highest occurrences. The study also

observed instances of double foramina transversaria in the C5 vertebra, with most accessory foramina located posteriorly to the main foramen transversarium. One notable finding was a unilateral accessory foramen transversarium with three openings on the right side, further emphasizing the variation in cervical vertebral anatomy. Notably, neither the atlas vertebra (C1) nor the axis vertebra (C2) exhibited any additional accessory foramina. Additionally, there were no vertebrae found that lacked any accessory features, indicating that variations in “cervical vertebral” anatomy are common.

Discussion

The provided research explores the existence and alterations of the "Foramen Transversarium" (FT) in “cervical vertebrae” and its potential medical and surgical implications. The findings revealed an incidence rate of 33% among the examined “cervical vertebrae”. This percentage indicates that a significant proportion of cervical vertebrae possess foramina transversaria, thereby confirming the prominence of this anatomical feature in the cervical spine. “Unilateral accessory foramen transversaria” were found in 15% “cervical vertebrae”. “Bilateral accessory foramen transversaria” was present in 12% of cervical vertebrae. The study also provided insights into the distribution of accessory foramina across different cervical vertebrae. The data indicates that “accessory foramina” were most found in the lower end cervical vertebrae, particularly in C5 and C7. This regional prevalence may have implications for surgical procedures targeting these specific cervical regions.

The “vertebral vessels” play a role in the occurrence of the “foramen transversarium”. It is likely that changes in the path of the vertebral arteries will result in variations in the “foramen transversarium”. Similarly, variations in the “foramen transversarium” could be used to estimate alterations in the vessels. If the foramina become narrower, it may indicate narrower vessels. If there are two foramina transversaria, it could mean that there is a duplication of the vertebral artery [6]. Researchers also discovered that “accessory foramen transversaria” was more commonly found in the lower vertebral section, particularly in C5 [7, 8]. This aligns with our research and observations.

Das Serjit observed two instances of double foramen transversarium during his research, whereas we observed in 18 of the samples [8]. Research where 100 vertebral columns were investigated found that segmented foramen was most common at the level of vertebra C6 and least common at the level of vertebra C2 [9]. “Accessory foramen transversarium” were mostly found in lower cervical vertebrae, particularly in C7 while we found them in C7. From an anatomical perspective, it is noted that

the “foramen transversarium” is typically partitioned by a fibrous or bony structure that separates the vertebral artery from the vertebral vein. In many instances, an accessory foramen is observed, characterized by a larger anterior compartment and a smaller posterior compartment. This anatomical characteristic functions to contain a segment of the “inferior cervical ganglion” and the vertebral vein. [9].

The existence of a “double foramen transversarium” can be connected to the occurrence of a duplicated vertebral artery, signifying that the artery originates from two points and follows a certain distance [10]. The formation of the “vertebral artery” occurs through the merging of a longitudinal anastomosis, connecting the cervical intersegmental arteries that branch from the dorsal division of the “somatic intersegmental artery” in the dorsal tracheal region. When there is bilateral duplication of vertebral arteries, it is due to the bilateral presence of these anomalies [11]. Since the presence and trajectory of vertebral arteries are integral to the formation of the FT, any deviations in the vertebral arteries can be inferred to correspond with variations in the “foramen transversarium”. Conversely, alterations observed in the “foramen transversarium” can potentially indicate variations in the vessels [11].

Conclusion

In our study, we noticed the occurrence of “accessory foramen transversarium” in 50 out of 150 cervical vertebrae. Unilateral occurrence of this anatomical feature was found to be more prevalent, followed by bilateral occurrence, which aligns with previous research findings. The anatomy and morphology of the foramen transversarium hold significance for spine surgeons and radiologists when interpreting radiographic films. It is important to note that compression of the artery can lead to both neurological manifestations and auditory impairments.

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