International Journal of Life Sciences, Biotechnology and Pharma Research Vol. 13, No. 7, July 2024 Online ISSN: 2250-3137
Print ISSN: 2977-0122

DOI: 10.69605/ijlbpr_13.7.2024.143

ORIGINAL RESEARCH

Morphometric Evaluation of Foramen Transversarium of Sub Axial Vertebrae: An Institutional Based Study

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Received: 13 June 2024 Accepted: 25 July 2024

ABSTRACT

Background: The cervical vertebrae are distinguished by the presence of a unique anatomical feature: the transverse foramen (TF) within the transverse processes. The TF is formed by the union of the transverse process vertebral element posteriorly and the remains of the cervical rib vertebral element anteriorly. Present study was conducted for morphometric evaluation of foramen transversarium of sub axial vertebrae.

Materials and Methods: A total of 100 dry subaxial cervical vertebrae (C3-C7) were collected, comprising 200 foramen transversaria. The anteroposterior length, transverse length, and depth of the foramen transversarium were measured using a combination of instruments, including a double-tipped compass and a digital vernier caliper. Statistical analysis was performed using Student's t-test.

Results: The dimensions of the foramen transversarium in subaxial vertebrae were measured and recorded. The transverse length, anteroposterior length, and depth of the foramen transversarium were found to be 6.67 ± 0.15 mm, 5.54 ± 0.22 mm, and 3.44 ± 0.09 mm, respectively, on the right side of typical cervical vertebrae. The seventh cervical vertebrae exhibited slightly different dimensions. The prevalence of unilateral double foramen transversarium was found to be 5.2%, while the prevalence of bilateral double foramen transversarium was significantly higher, at 7.8%.

Conclusion: This study provides a comprehensive assessment of the morphometry of the foramen transversarium in subaxial cervical vertebrae. The results highlight significant variations in the dimensions of the foramen transversarium between typical cervical vertebrae and the seventh cervical vertebrae. The study also reveals a notable prevalence of double foramen transversarium. These findings have important implications for neurosurgeons, radiologists, and anatomists.

Keywords: Foramen Transversarium, Subaxial Cervical Vertebrae, Morphometry, Anatomical Variation.

INTRODUCTION

The cervical vertebrae are distinguished from other vertebrae in the vertebral column by the presence of a unique anatomical feature: the transverse foramen (TF) within the transverse processes.[1]

These transverse processes are bony projections that extend laterally from the vertebra, providing attachment sites for various muscles, ligaments, and other structures. The TF is formed by the union of the transverse process vertebral element posteriorly and the remains of the cervical rib vertebral element anteriorly. Notably, the cervical rib, a rudimentary anomalous rib, is typically absent in the first six cervical vertebrae but may be present in the seventh vertebra.[2]

The surgical anatomy of the foramen transversarium and vertebral artery are important to the neurosurgeons and radiologists. The variation of foramina transversarium is also important for surgeon during posterior cervical surgery.[3]

Present study was conducted for morphometric evaluation of foramen transversarium of sub axial vertebrae.

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MATERIALS AND METHODS

A total of 100 dry subaxial cervical vertebrae (C3-C7) were collected, comprising 200 foramen transversaria. Vertebrae with damage, malformations, or fractures were excluded from the study. The sample consisted of 70 typical cervical vertebrae and 30 seventh cervical vertebrae.

Anatomical Observations and Measurements

All foramen transversaria were examined for anatomical variations. The anteroposterior length, transverse length, and depth of the foramen transversarium were measured using a combination of instruments, including a double-tipped compass and a digital vernier caliper.

Statistical Analysis

The mean and standard deviations of the linear and angular parameters were calculated.The comparison of morphometric dimensions of the right and left sides was performed using Student's t-test.The p-value was calculated to determine the significance of the differences between the right and left sides.

RESULTS

The dimensions of the foramen transversarium in subaxial vertebrae were measured and recorded in table 1. In typical cervical vertebrae, the transverse length of the foramen transversarium was found to be 6.67 ± 0.15 mm on the right side and 6.63 ± 0.35 mm on the left side. The anteroposterior length was measured at 5.54 ± 0.22 mm on the right side and 5.58 ± 0.19 mm on the left side. The depth of the foramen transversarium was recorded at 3.44 ± 0.09 mm on the right side and 3.42 ± 0.36 mm on the left side. The seventh cervical vertebrae exhibited slightly different dimensions. The transverse length of the foramen transversarium was measured at 6.85 ± 0.12 mm on the right side and 6.75 ± 0.41 mm on the left side. The anteroposterior length was recorded at 5.62 ± 0.08 mm on the right side and 5.59 ± 0.53 mm on the left side. The depth of the foramen transversarium was found to be 3.05 ± 0.21 mm on the right side and 3.16 ± 0.11 mm on the left side.

The assessment of double foramen transversarium (table 2) in subaxial vertebrae revealed the prevalence of unilateral double foramen transversarium was found to be 5.2%, indicating that approximately one in twenty vertebrae exhibited this anatomical variation on one side. In contrast, the prevalence of bilateral double foramen transversarium was significantly higher, at 7.8%.

Table 1:Dimensions of foramen transversarium of sub axial vertebrae

Parameters (in mm)		Transverse length	Anteroposterior Length	Depth
Typical cervical vertebrae	Right side	6.67 ± 0.15	5.54± 0.22	3.44 ± 0.09
	Left side	6.63± 0.35	5.58± 0.19	3.42± 0.36
Seventh cervical vertebrae	Right side	6.85 ± 0.12	5.62± 0.08	3.05 ± 0.21
	Left side	6.75± 0.41	5.59± 0.53	3.16± 0.11

Table 2: Assessment of double foramen transversarium of sub axial vertebrae

Foramen transversarium	Percentage
Unilateral double	5.2%
Bilateral double	7.8%

DISCUSSION

The morphometric analysis of the foramen transversarium in cervical vertebrae is crucial for spinal surgeons, particularly during decompression procedures such as foraminectomy and foraminotomy. This is because the posterior part of the brain relies heavily on the vertebral arteries for blood supply. Notably, these arteries are tortuous in nature and often unequal in size, with studies showing asymmetry in approximately 75% of cases. Furthermore, stenosis of the vertebral artery, exacerbated by head rotation, can lead to vertebrobasilar insufficiency, increasing the risk of Bow-Hunter's stroke.[4,5]Vertebral Artery vascular insufficiency occur due to any alter any path of artery or duplication of foramen transversarium.[6]

The present study found that the dimensions of the foramen transversarium in subaxial vertebrae were measured, revealing distinct variations between typical cervical vertebrae and the seventh cervical vertebrae. In typical cervical vertebrae, the transverse length was 6.67 ± 0.15 mm on the right side and 6.63 ± 0.35 mm on the left side, while the anteroposterior length was 5.54 ± 0.22 mm on the right side and 5.58 ± 0.19 mm on the left side. The depth of the foramen transversarium was recorded at 3.44 ± 0.09 mm on the right side and 3.42 ± 0.36 mm on the left side. In contrast, the seventh cervical vertebrae exhibited slightly different dimensions, with a transverse length of 6.85 ± 0.12 mm on the right side and 6.75 ± 0.41 mm on the left side, an anteroposterior length of 5.62 ± 0.08 mm on the right side and 5.59 ± 0.53 mm on the left side, and a depth of 3.05 ± 0.21 mm on the right side and 3.16 ± 0.11 mm on the left side.A similar study by Sharma P et al[7] found the average anteroposterior length

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was 5.52 mm ± 0.14 mm for typical cervical vertebrae and 5.71 mm ± 0.91 mm for seventh cervical vertebrae. The average transverse length was 6.69 mm ± 0.24 mm and 6.98 mm ± 0.11 mm, respectively. Additionally, the depth of the foramen transversarium was measured at 3.41 mm ± 0.12 mm for typical cervical vertebrae and 2.90 mm ± 0.61 mm for seventh cervical vertebrae. Ananthi V et al[4] found the average antero posterior length of foramen transversarium of typical cervical vertebrae and seventh cervical vertebrae were 5.45 mm ± 0.12 mm and 5.66 mm ± 0.88 mm respectively. The average transverse length of foramen transversarium of typical and seventh cervical vertebrae was 6.72 mm ± 0.22 mm and 6.76 mm ± 0.08 mm respectively.

The present study assessed double foramen transversarium in subaxial vertebrae revealed interesting results. The prevalence of unilateral double foramen transversarium was found to be 5.2%, indicating that approximately one in twenty vertebrae exhibited this anatomical variation on one side. In contrast, the prevalence of bilateral double foramen transversarium was significantly higher, at 7.8%. This suggests that nearly one in thirteen vertebrae exhibited this variation on both sides. These findings highlight the importance of understanding anatomical variations in the cervical spine, particularly in the context of surgical procedures or diagnostic imaging.In agreement with Sharma A et al,[8] Patra A et al[9] andLaxmi et al[10]and our results showed that the incidence of bilateral double foramen transversariumwas common than the incidence of unilateral double foramen transversarium.In another study by Taha M et al,[11] out of the 240 cervical vertebrae, the incidence of bilateral and unilateral double foramen transversarium in typical cervical vertebrae was 38 vertebrae (15.8%) and the incidence of bilateral and unilateral double foraminatransversaria in atypical cervical vertebrae was 35 vertebrae (14.6%) which is more as found in our study.Adarwal D et al[3] reported unilateral double foramen transversarium in 2.5% cases while 1.25% cases showed bilateral double foramen transversarium. 0.625% cases showed asymmetrical foramen transversarium and another 0.625% cases showed incomplete foramen transversarium.

CONCLUSION

In conclusion, this study provides a comprehensive assessment of the morphometry of the foramen transversarium in subaxial cervical vertebrae. The results show significant variations in the dimensions of the foramen transversarium between typical cervical vertebrae and the seventh cervical vertebrae. Additionally, the study reveals a notable prevalence of double foramen transversarium, with 5.2% of vertebrae exhibiting unilateral duplication and 7.8% exhibiting bilateral duplication. These findings have important implications for neurosurgeons, radiologists, and anatomists, highlighting the need for a thorough understanding of the anatomical variations in the cervical spine. The results of this study can inform surgical procedures, diagnostic imaging, and anatomical education, ultimately contributing to improved patient outcomes and a deeper understanding of human anatomy.

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