

ORIGINAL RESEARCH

ASSESSMENT OF MORPHOMETRY OF FORAMEN TRANSVERSARIUM OF SUB AXIAL VERTEBRAE AND ITS VARIATIONS

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ABSTRACT

Background: The cervical vertebrae are identified by the presence of foramen transversarium (FT) in the transverse processes. The present study was conducted to assess morphometry of foramen transversarium of sub axial vertebrae and its variations.

Materials & Methods: 62 dry human adult cervical vertebrae consisting of 108 foramen transversaria were studied and the anteroposterior and transverse diameters of all the foramen transversaria were measured to determine the size of the foramen transversaria. The size of right and left sides were compared. The distance between medial margin of uncinat process to medial margin of foramen transversarium was also measured.

Results: The mean transverse diameter of FT of typical cervical vertebrae of right side was 5.32 mm and left side was 5.50mm. Anteroposterior diameter of FT of right side was 4.86 mm and left side was 4.82 mm. Distance between medial margin of uncinat process to FT was 4.18 mm and left side was 4.41 mm. The difference was non- significant ($P > 0.05$). The mean transverse diameter of FT of seventh cervical vertebrae of right side was Transverse diameter of FT was 5.24 mm and left side was 5.10 mm. Anteroposterior diameter of FT of right side was 4.12 mm and left side was 3.92 mm. Distance between medial margin of uncinat process to FT of right side was 5.24 mm and left side was 5.62 mm. The difference was significant ($P < 0.05$).

Conclusion: The knowledge on the variations, dimensions and the distance between the medial borders of the uncinat process to foramen may be helpful for the neurosurgeons while performing decompression of artery through anterior approach to cervical spine.

Key words: foramen transversarium, uncinat process, vertebrae

Introduction

The human spinal column is composed of a series of vertebrae alternating with intervertebral discs that extend from the cranium to the coccyx. This resilient cylindrical column essentially protects the spinal cord and plays an important role in posture and locomotion.¹ Although their basic structure is similar, vertebrae vary in size and exhibit regional characteristics. The 7 cervical, 12 thoracic and 5 lumbar vertebrae are termed free while the 5 sacral and 4 coccygeal vertebrae are fixed.

The cervical vertebrae are identified by the presence of foramen transversarium (FT) in the transverse processes.² Foramen transversarium is formed by the vestigial costal element fused to the body and the true transverse process of the vertebra. The FT gives passage to the vertebral artery, vertebral veins, and sympathetic nerves from inferior cervical ganglion. The embryogenesis of the vertebral artery begins at approximately 32 days of intrauterine life and is completed by 40 days, between the 12.5- and 16-mm stages.³

Foramen transversarium (FT) is the special foramen located on the left and right transverse processes of the cervical vertebrae (C1 to C7) containing the vertebral vessels and sympathetic plexus.⁴ Each side of the vertebral artery originates from the subclavian artery before continuing onto the FT of the 6th or 7th cervical vertebrae through the atlas to form the basilar artery on the brain stem.⁵ Clinically, the variable morphology and pathology of the FT are important to consider when performing surgery for screw fixation of the upper or lower cervical spine. In addition, variations of FT could be associated with compression of vertebral vessels, resulting in blood flow disturbances, especially vertebrobasilar insufficiency.⁶ The present study was conducted to assess morphometry of foramen transversarium of sub axial vertebrae and its variations.

Materials & Methods

The present study comprised of 62 dry human adult cervical vertebrae consisting of 108 foramen transversaria. Among that 40 were typical and 10 were seventh cervical vertebrae. All the foramen transversaria were studied and the anteroposterior and transverse diameters of all the foramen transversaria were measured to determine the size of the foramen transversaria. The size of right and left sides were compared. The distance between medial margin of uncinat process to medial margin of foramen transversarium was also measured. Any observed variations were recorded. Data thus obtained were subjected to statistical analysis. P value < 0.05 was considered significant.

Results

Table I Assessment of size of FT of typical cervical vertebrae and distance from medial margin of uncinat process to FT

Parameter (mm)	Right side	Left side	P value
Transverse diameter of FT	5.32	5.50	0.92
Anteroposterior diameter of FT	4.86	4.82	0.95
Distance between medial margin of uncinat process to FT	4.18	4.41	0.81

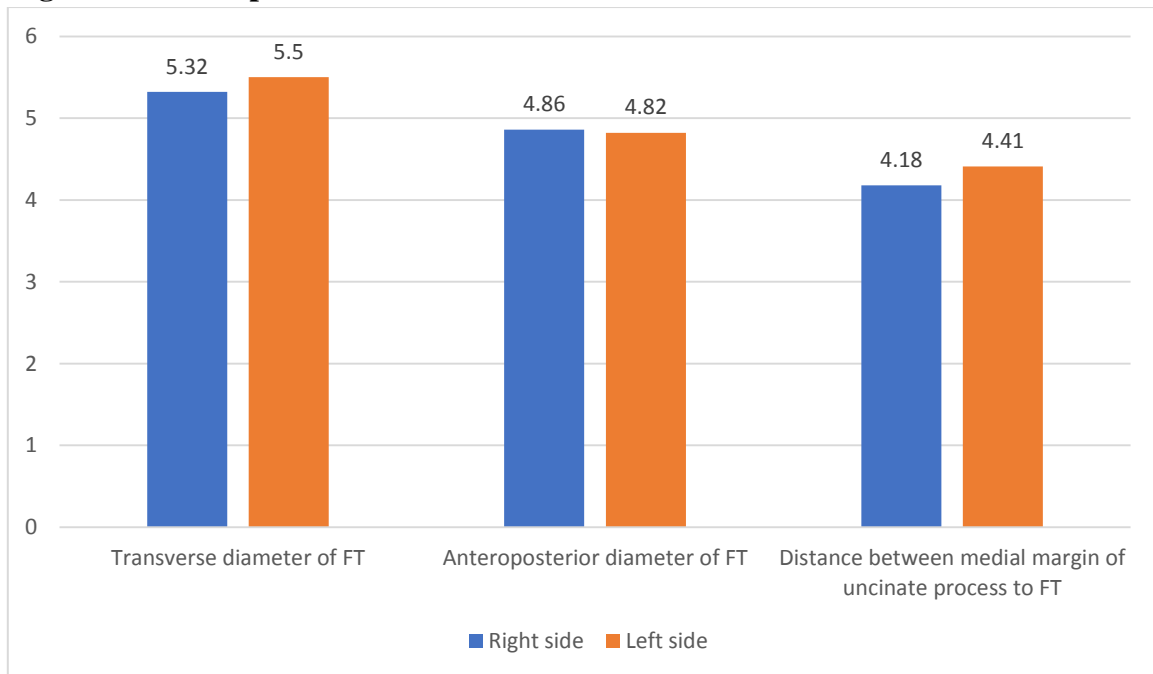
Table I shows that mean transverse diameter of FT of typical cervical vertebrae of right side was 5.32 mm and left side was 5.50mm. Anteroposterior diameter of FT of right side was 4.86 mm and left side was 4.82 mm. Distance between medial margin of uncinate process to FT was 4.18 mm and left side was 4.41 mm. The difference was non- significant ($P > 0.05$).

Table II Size of FT of seventh cervical vertebrae and distance from medial margin of uncinate process to FT

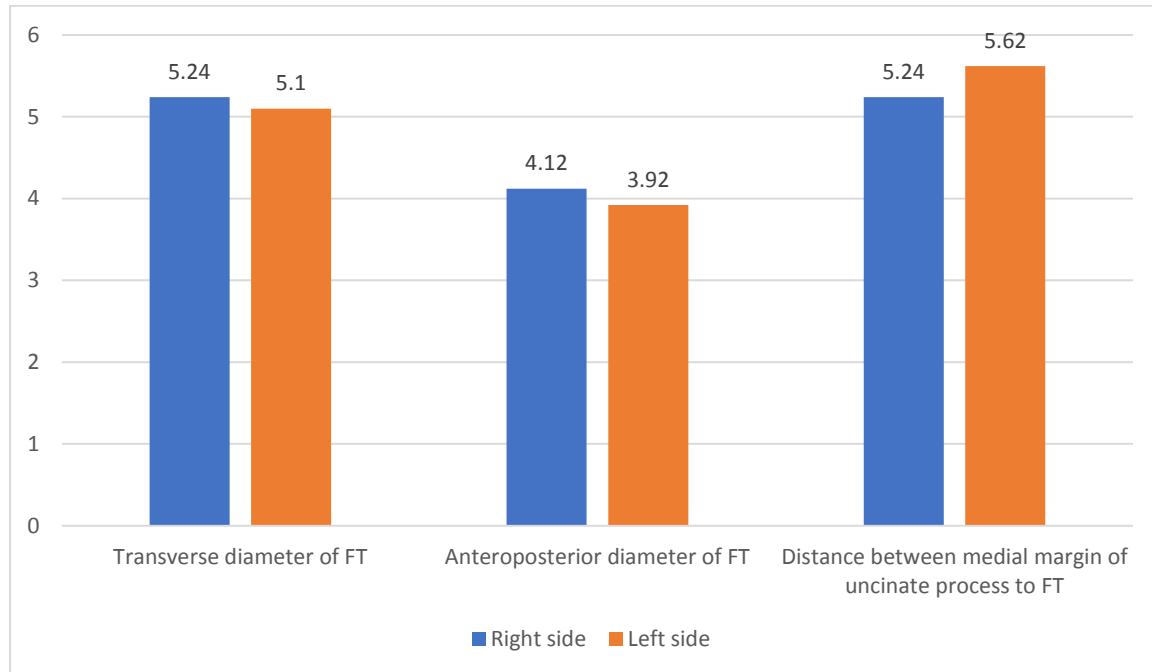
Parameter (mm)	Right side	Left side	P value
Transverse diameter of FT	5.24	5.10	0.05
Anteroposterior diameter of FT	4.12	3.92	0.02
Distance between medial margin of uncinate process to FT	5.24	5.62	0.01

Table II, graph II shows that mean transverse diameter of FT of seventh cervical vertebrae of right side was Transverse diameter of FT was 5.24 mm and left side was 5.10 mm. Anteroposterior diameter of FT of right side was 4.12 mm and left side was 3.92 mm. Distance between medial margin of uncinate process to FT of right side was 5.24 mm and left side was 5.62 mm. The difference was significant ($P < 0.05$).

Graph I Assessment of size of FT of typical cervical vertebrae and distance from medial margin of uncinate process to FT



Graph II Size of FT of seventh cervical vertebrae and distance from medial margin of uncinate process to FT



Discussion

Regardless of the fact that the cervical vertebrae are the smallest, they exhibit the greatest range and variety of movements that makes them prone to a diverse array of traumatic and degenerative conditions.^{7,8} For better management of diseases and mechanical processes, countless researchers have investigated the diverse aspects of human cervical spine, foremost being the anatomy, kinematics and mechanical properties of cervical vertebrae as well as intervertebral discs.⁹ As spinal ailments are frequently managed by arthrodesis which involves surgical fusion of adjacent degenerated vertebrae with plates and screws, accurate placement of screws is of paramount importance to circumvent damage to the vertebral artery, spinal medulla or nerve roots. The commonest form of arthrodesis is anterior cervical plate fixation.¹⁰ The present study was conducted to assess morphometry of foramen transversarium of sub axial vertebrae and its variations.

We found that mean transverse diameter of FT of typical cervical vertebrae of right side was 5.32 mm and left side was 5.50 mm. Anteroposterior diameter of FT of right side was 4.86 mm and left side was 4.82 mm. Distance between medial margin of uncinate process to FT was 4.18 mm and left side was 4.41 mm. Saluja et al¹¹ studied morphometric reference database for cervical vertebrae of 203 typical (C3-C6) cervical vertebrae. The morphometric analysis of the cervical vertebrae demonstrated that when compared with other races, the mean height (11.39 ± 1.08 mm) and transverse diameters (22.18 ± 2.52 mm) of the vertebral body were larger but antero-posterior diameter was less, making the vertebral bodies in Indians transversely longer. The dimensions of the pedicle, laminae, articular processes and spinous process were smaller when compared to other populations. There existed a highly significant difference ($p=0.002$) between the widths of the right and left superior & inferior articular processes. A great disparity of the pedicle transverse angle was noted in different populations but in Indians the angle was 44.47 ± 2.81 .

We observed that mean transverse diameter of FT of seventh cervical vertebrae of right side was Transverse diameter of FT was 5.24 mm and left side was 5.10 mm. Anteroposterior diameter of FT of right side was 4.12 mm and left side was 3.92 mm. Distance between medial margin of uncinat process to FT of right side was 5.24 mm and left side was 5.62 mm. Yesender et al¹² studied anatomical variations of foramen transversarium on 50 dry adult subaxial cervical vertebrae. Among that 40 were typical and 10 were seventh cervical vertebrae. All the foramen transversaria were observed for any anatomical variations and recorded. The anteroposterior and transverse diameters of all the foramen transversaria and the distance between the medial margins of uncinat process to the foramen transversarium were measured. The average transverse diameter of typical cervical vertebrae and seventh cervical vertebrae were $5.45 \pm 0.84\text{mm}$ and $5.13 \pm 1.22\text{mm}$ respectively. The average anteroposterior diameters of typical and seventh cervical vertebrae were $4.84 \pm 0.69\text{ mm}$ and $3.91 \pm 1.17\text{ mm}$ respectively. The distance from medial border of uncinat process to foramen transversaria was $4.28 \pm 0.77\text{ mm}$ in typical and $5.44 \pm 1.28\text{ mm}$ in seventh cervical vertebare. The incidence of double bubble foramen in typical cervical vertebrae was reported as 17.5%. The incidence of double foramen transversaria was 12.5% in seventh cervical vertebrae. Osteophytes were obstructing the foramen transversarium and narrowing it in 25% vertebrae.

Chaiyamon et al¹³ aimed to reveal the morphometry of FT and FA. The FT and FA of dried C1 and C2 vertebrae (identified bones; n=107, males=53 and females=54) were observed and measured. Anteroposterior (AP) and transverse diameters of the left and right FTs (n=214) were measured and compared between sexes. Variations and types of FT and FA found on the upper vertebrae were recorded and classified. The FT shape of the Thai C1 was AP elliptical, while of that of C2 was transverse elliptical. Compared to females, both diameters of the upper spine were significantly greater in males except for the AP diameter of C2 on the right side. All diameters were significantly different in both sexes and sides except for the AP diameter of C1 and C2. A common type of FT classified in C1 was type 2 (male [69.81%], female [79.63%]) whereas for C2 it was type 1 (male [63.21%], female [59.26%]). Moreover, an incomplete osseous bridge was a major FA subtype observed.

The shortcoming of the study is small samples of dry human adult cervical vertebrae were included in the study.

Conclusion

Authors found that the knowledge on the variations, dimensions and the distance between the medial borders of the uncinat process to foramen may be helpful for the neurosurgeons while performing decompression of artery through anterior approach to cervical spine.

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