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Original Research Article

Morphometric Assessment of the Foramen Transversarium of Cervical Vertebrae: An Observational Study

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Abstract

Aim: To study the morphometry of foramen transversarium of the cervical vertebrae on both sides.

Material & Methods: The present study was conducted in the department of Anatomy, Vardhman institute of medical sciences, Pawapuri, Nalanda, Bihar, India for three months. 400 dry human cervical vertebras of unknown age and sex were utilized for this study.

Results: After intercomparison, the p-value was found to be <0.001 ($p<0.05$) in all cases, which was statistically significant**.** A significant increase in the diameter of the foramen transversarium was observed on the left side of all vertebrae studied.

Conclusion: Successful surgical management in degenerative, traumatic, and neoplastic diseases of the cervical spine needs well-detailed knowledge of the anatomy of the cervical spinal column.

Keywords: morphometry, foramen transversarium, vertebrae

Introduction

Musculoskeletal disorders result from injury or damage to the neurovascular bundles, bones, and associated structures [1]. The vertebral column is one of the structures vulnerable to musculoskeletal injury, especially the cervical vertebrae (CV), among others. The CV forms an essential component of the vertebral column [2] and presents the vertebral body, vertebral arch, vertebral foramen, articular facet, spinous process, and foramen transversarium (FT) as essential anatomical adaptation features [3]. The FT is an important and noticeable feature of the cervical vertebrae that occupies the sympathetic fibers, vertebral vein (VV), and vertebral artery (VA) [4]. This foramen is also known as VA foramen concerning the VA that passes through it [5], which makes anatomical knowledge regarding the variations of FT essential in diagnosis, radiological assessment, and medical imaging interpretation [6].

There is correlation between the atlas morphology with head and neck posture [7]. Thus, the presence of other bony

variations, as well as the prevalence of neck syndromes and injuries necessitates the study of the atlas transverse foramina. The recognition of this variation provides safety and efficiency for the posterior approaches of cervical spine [8]. From the clinical point of view, occipital neuralgia is usually unilateral and has a characteristic shock like pain lasting for a short duration indicative of neural origin [8]. The pain is confined to the dermatome of the nerve root at the lower occipital region of scalp and upper neck. Compression of the nerve root by an abnormal course of vertebral artery has been reported in the literature. Bony abnormalities at the craniovertebral junction can cause occipital headache due to abnormal course of vertebral artery and joint instability [9-10].

Recently, there was a report on the direct measurement of sub axial cervical pedicles in Thai patients [11]. However, the morphometry of FT and FA in the northeast Thai population has not yet been investigated. Therefore, this study aimed to investigate the morphometry and incidence of FT. In addition, the variant formation of FA was also recorded. This morphometric study explored the size of the FT for consideration prior to upper cervical spine fixation in the Thai population, with the aim of avoiding injury to vertebral vessels and the sympathetic plexus.

Material & Methods:

The present study was conducted in the department of Anatomy, Vardhman institute of medical sciences, Pawapuri, Nalanda, Bihar, India for three months. 400 dry human cervical vertebras of unknown age and sex were utilized for this study. Complete intact vertebrae only were taken into consideration for the study. Vertebra which was damaged, incompletely formed, and with any signs of previous injuries were excluded from the study.

For each cervical vertebra, the foramen transversarium was studied and the following parameters were noted for the present study.

1. The highest diameter of foramen transversarium on the right and left side.
2. Incidence of accessory foramen
3. Absence of foramen. The diameters were measured by using Digital Vernier caliper. In the case of a vertebra with two foramina, we considered smaller foramen as accessory foramen transversarium and larger foramen as main FT.

Results:

Among 400 vertebrae studied, the accessory foramina were noted in 93 (23.25%) vertebrae. On 32 (8%) vertebrae the accessory foramen was observed on both sides of the vertebra and in the remaining 65 (16.25%), it was observed on one side.

Among the unilateral cases, 32 were present on the right side and 16 were on the left side. In both unilateral and bilateral cases, the increased incidence of accessory foramina was noted more in the C6 vertebra. Compared to the main foramen, the accessory foramen transversarium was smaller in all cases (Figure 1). No variations were observed in C1 and C2. The incidence of triple foramen was not noted.

The mean diameter and standard deviation of foramen transversarium from C1 to C7 were compared on both sides. After intercomparison, the p-value was found to be <0.001 ($p<0.05$) in all cases, which was statistically significant [Table 1]. Hence, a significant increase in the diameter of the foramen transversarium was observed on the left side of all vertebrae studied.

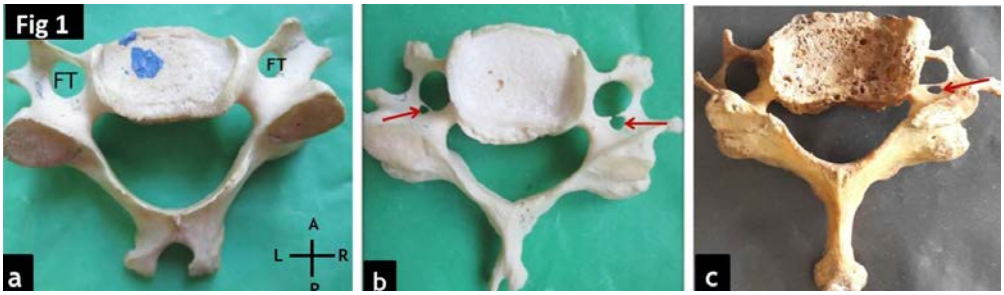

Figure 1: Superior view: a) Typical cervical vertebra with foramen transversarium on both sides b) Typical cervical vertebra showing bilateral FT c) Cervical vertebra showing unilateral FT on right side

Table 1: Diameter of foramen transversarium of cervical vertebrae (C1-C7) on both sides

Diameter of foramen transversarium (mm)	Right (n=400) Mean ±SD	Left(n=400) Mean ±SD	p-value
C1	6.58±0.67	6.82±0.5	<0.001*
C2	5.54±0.18	6.40±1.22	<0.001*
C3	4.90±0.23	5.20±0.16	<0.001*
C4	6.02±0.14	6.37±0.20	<0.001*
C5	6.30±0.15	6.68±0.15	<0.001*
C6	6.40±0.21	6.38±0.16	<0.001*
C7	6.25±1.02	6.69±0.17	<0.001*

Discussion:

The APD measurement was approximately 5.3 mm in male and 4.9 mm in female, APD was larger in male than the female, which agreed with a previous study that reported larger APD measurement of FT in males than in females [12].

The cases of oblique elliptical (left to right) shape of FTs were documented. There were 25 FT observed for this type. Only three (2.31%) FT exhibits type 5 (elliptical from left to right oblique) on the right side, and a total number of 22 (16.92%) was observed on the left side. The frequencies of oblique elliptical shapes, both right to left and left to right types, are similar considerably and differed from other shape types. A recent study by Kwiatkowska et al. [13] reported similar findings of approximately 10%. A total of 34 were observed for the irregular type of FT. Seventeen (13.07%) FT exhibited type 6 (irregular) in this study on the right side, and the same total of 17 (13.07%) was also observed on the left side. This result corroborates the previous finding by Aziz and Morgan [14] that documented a 10% frequency for the irregular type of FT. The absence of FT (type 7) 0.77% was observed on the left side of a male specimen. This incidence is lower in comparison to previous studies reported by Zibis et al. [15]

In South Africans, no difference in FT diameters of the upper spine vertebrae has been found [16]. In general, the transverse diameter of the left side is greater than that of the right side in some nationalities including the Thai population [17]. In the literature, the shape of the FT can be classified into 5, 12, and 13 types. [18]

Moreover, it has been suggested that the preponderance of osteophytes on lateral margins of FT could lead to narrowing of

Medio lateral diameter leading to compression of vertebral artery and its dissection [19]. Hence it can be assumed that oval shape FT oval 29.6% with anteroposterior diameter greater than Medio lateral diameter had minimal risk of vertebral artery compression syndrome. Also, it is well known that any narrowing of FT may result information of atheromatous plaques in vertebral artery which may result in thrombosis/emboli /reflex spasm predisposing to vertebrobasilar insufficiency [20].

Murlimanju et al [21] reported the presence of accessory foramen on one side is more common than both sides. In the present study, in 21 (6%) vertebrae the accessory foramen was observed on both sides of the vertebra, and in the remaining 45 (13%), it was observed on one side. Among the presence of foramen on one side, 30 were present on the right side and 15 were on the left side.

We noted an increased diameter of a foramen in the C1 vertebra, more on the left side in the present study. The maximum diameter of C1 could be due to the largest calibre of the vertebral artery at the level of the C1. Since the vertebral artery within the foramen transversarium did not have constant caliber during its course, as reported by Cavder et al.[22]Cavder reported that the artery was reduced in caliber from C6 to C3; it began to re-increase in its caliber above C3 and reached its largest caliber at the C1 level.

Cagnie et al [23] showed that at all levels, the greater diameter was noted on left side of vertebra than the right side. In the present study also, we observed a significant increase in the diameter of the foramen transversarium on the left side compared to the right side. [24]

Conclusion:

Successful surgical management in degenerative, traumatic, and neoplastic diseases of the cervical spine needs well-detailed knowledge of the anatomy of the cervical spinal column. The morphometric parameters of foramen transversarium studied on both sides in all vertebras will be added data and can serve as a helpful guide while performing various surgeries of the neck region and for proper interpretation of X-rays and CT scan.

References:

1. A.M. Briggs, A.D. Woolf, K. Dreinh¨ofer, N. Homb, D.G. Hoy, D. Kopansky-Giles, L. March, Reducing the global burden of musculoskeletal conditions, Bull. World Health Organ. 2018:96(5):366–368.
2. A.P. Singh, C. Anand, S. Singh, A study of anatomical variations in the transverse foramen of cervical vertebrae for morphological & clinical importance, Int. J. Contemporary Med. Res. 2019:6 (6):9–11.
3. K.L. Moore, A.F. Dalley, A.M.R. Agur, Clinically Oriented Anatomy, seventh ed., Lippincott Williams & Wilkins, 2013.
4. M.M. Guerra, P.R. Fuentes, I. Roa, G. Molinet, F. Robles, I. Roa, Anatomical variations of the foramen transversarium in cervical vertebrae, Int. J. Morphol. 2047;35 (2):719–722.
5. W.K. Hsu, Advanced techniques in cervical spine surgery, J. Bone Joint Surg. 2011:93(8): 780–788.
6. B.V. Murlimanju, L.V. Prabhu, K. Shilpa, R. Rai, K.V. Dhananjaya, P.J. Jiji, Accessory transverse foramina in the cervical spine: incidence, embryological basis, morphology, and surgical importance, Turk. Neurosurg. 2011:21 384–387,
7. Hunter CR, Mayfield FH. Role of the upper cervical roots in the production of pain in the head. American Journal of Surgery 1949:78: 743- 751.
8. Hyyppa SE, Laasonen EM, Halonen V. Erosion of cervical vertebrae caused by elongated and tortuous vertebral arteries. Neuroradiology 1974:7(1): 49-51.

9. Karau PB, Odula P. Some anatomical and morphometric observations in the foramina of the atlas among Kenyans. Anat J of Africa 2013:2(1): 61-66.
10. Moore KL, Dalley AF. Clinical oriented Anatomy. (5thedn), Williams and Wilkins Lippencott, Netherlands, 2006:1-485.
11. Pekala PA, Henry BM, Pekala JR, et al. Prevalence of foramen arcuale and its clinical significance: a meta-analysis of 55,985 subjects. J Neurosurg Spine 2017; 27:276-90.
12. S.W. Malik, B.D. Stemper, U. Metkar, N. Yoganandan, B.S. Shender, R.D. Rao, Location of the transverse foramen in the subaxial cervical spine in a young asymptomatic population, Spine. 2010:35 (12):514–519.
13. A.M. Vasuki, M. Jamuna, M. Nirmaladevi, D.J. Hepzibah, K. Radhika, K. Krishnan, An osteological study of foramen transversarium of cervical vertebrae and its clinical significance, Int. J. Anat. Res. 2018:6 (12):4906–4913.
14. B. Kwiatkowska, J. Szczurowski, D. Nowakowski, Variation in foramina transversaria of human cervical vertebrae in the medieval population from Sypniewo (Poland), Anthropol. Rev. 2014:77 (2):175–188.
15. J.N. Aziz, M. Morgan, Morphological study of the foramen transversarium of the Atlas vertebra among the Egyptian population, and its clinical significance, Anatomy Physiol, Biochem. Int. J. 2018:4(4):1–5
16. Abdul RS, Lazarus L, Rennie C, Satyapal KS. The foramen transversarium of typical and atypical cervical vertebrae: morphology and morphometry. Int J Morphol 2018; 36:1439-46.
17. Guerra MM, Fuentes PR, Roa I. Anatomical variations of the foramen transversarium in cervical vertebrae. Int J Morphol 2017; 35:719-22.
18. Taitz C, Nathan H, Arensburg B. Anatomical observations of the foramina transversaria. J Neurol Neurosurg Psychiatry 1978; 41:170-6.
19. Sandikcioglu M, Skov S, Solow B. Atlas morphology in relation to craniofacial morphology and head posture. Eur J Orthod 1994:16(2): 96-103.
20. Taitz C, Nathan H. Some observations on the posterior and lateral bridge of atlas Acta Anat (basel) 1986:127(3): 212-217.
21. Murlimanju BV, Prabhu LV, Shilpa K, Rai R, Dhananjaya KVN, Jiji PJ. Accessory transverse foramina in the cervical spine: incidence, embryological basis, morphology and surgical importance. Turk Neurosurg. 2011;21(3):384–7.
22. Good, A., Wells, A., Katz, B., Alexander, M., Klokol, D., Chen, M. K., Wong, M. B., Cox, D. C., & Lakey, J. R. MALDI-ToF Analysis of Mitochondrial Peptides. Clinical Medicine Insights, 2022:3(2), 297–303.
23. Cavder S, Dalcik H, Erean F. Morpho study on the V2 segment of the vertebral artery, Okajimas – Folia. AnatJpn. 1996; 73:133–7.
24. Cagnie B, Barbaix E, Vinck E, D'Herde K, Cambier D. Extrinsic risk factors for compromised blood flow in the vertebral artery: anatomical observations of the transverse foramina from C3 to C7. Surg Radiol Anat. 2005;27(4):312