

A Study of Anatomical Variations in Transverse Foramen of Cervical Vertebrae for Morphological and Clinical Importance

A.P. Singh¹, Chhitij Anand², Saumya Singh³

ABSTRACT

Introduction: Cervical vertebrae constitute the skeletal framework of vertebral column in the region. The most important feature to identify the cervical vertebra is the presence of foramen transversarium. Vertebral artery, vertebral vein and sympathetic chain run through this foramen as a single unit. Compartmentalization or absence of the foramen may alter the course of these structures.

Material and methods: The study was performed on 240 dry human cervical vertebrae of both sexes, which were collected from Anatomy department of MSYMCH, Meerut and HIMS, Varanasi. The variations in number and shape were observed, recorded and analyzed. The intact cervical vertebrae without any degenerative or traumatic disorders were included in this study.

Result: Out of 240 cervical vertebrae, 63 vertebrae were found to have variations in the transverse foramina. Complete double transverse foramina were observed in 48 vertebrae (20%), out of which unilateral double foramina were found in 29 vertebrae (12%) and bilateral double foramina were found in 19 vertebrae (8%). Similarly, incomplete double transverse foramina were observed in 15 vertebrae (6%), of which the foramina were unilateral in 8 vertebrae (4%) and bilateral in 5 vertebrae (2%).

Conclusion: In our study, we observed the double foramen transversarium in 26.25% of the cases. These variations may alter the course of vertebral artery. Presence of compartmentalization suggests the chances of compression of neurovascular bundle. Spicules of incomplete septation between the two foramina may pierce the vascular or neural structures resulting into vascular insufficiency or persisting pain. These findings may suggest a cue to the spinal surgeons in planning preoperative procedures for surgeries related to this region.

Keywords: Typical Cervical Vertebrae, Foramen transversarium, Variations, Accessory Foramen, Vertebral Vessels

INTRODUCTION

Cervical vertebrae constitute the skeletal framework of vertebral column in the neck region. It starts just below the skull and extends at the top of the thoracic spine. Approximately 8% of overall body length is accounted by the cervical spine whereas for the cervical (neck) length, 80% is contributed by the cervical vertebral bodies and about 20% is provided by the intervertebral discs. The most important feature to identify the cervical vertebra is its small vertebral body with beveled edges and bifid spine with presence of foramen transversarium. The foramen transversarium

is formed by the costal and transverse elements that are connected to each other around of the transverse process. The costal element is formed by the anterior root, anterior tubercle, costotransverse bar and posterior tubercle whereas, transverse element by the posterior root. Anterior and posterior tubercles are connected lateral to the foramen by the costotransverse bar.¹ Vertebrae develop from sclerotome portion of somites derived from paraxial mesoderm which is regulated by HOX genes. Foramen transversarium develops by vestigial costal element anteriorly and true transverse process posteriorly.² This foramen transmits vertebral artery, vertebral vein and sympathetic fibres from the inferior cervical ganglion in all the cervical vertebrae except C7 vertebra. C7 only transmits vertebral vein through foramen transversarium.³ In some cases, this foramen may be small or absent. Compartmentalization or absence of the foramen may alter the course of these structures, causing pathological conditions like vertebrobasilar insufficiency. Compression of vertebral artery is characterized by headache, migraine and fainting attack.

Study aimed at identification of the possible variations of foramen transversarium of cervical vertebrae with the objectives to identify cervical vertebrae foramen transversarium variations for morphological and clinical importance and to correlate our findings with other studies done previously.

MATERIAL AND METHODS

The present observational study was performed on 240 dry human cervical vertebrae of unknown sex and age, available in the Departments of Anatomy, Heritage Institute of Medical Sciences, Varanasi, U.P. and Mulayam Singh Yadav Medical College and Hospital, Meerut, U.P. The consents and permission for the study was taken from the respective Head of the department and Institute Head.

¹Assistant Professor, Department of Anatomy, Heritage institute of Medical Sciences, Varanasi, U.P., ²Associate Professor, Department of Anatomy, Mulayam Singh Yadav Medical College and Hospital, Meerut, U.P., ³Assistant Professor, Department of Microbiology, Heritage institute of medical sciences, Varanasi, U.P., India

Corresponding author: Dr. Chhitij Anand, Associate Professor, Department of Anatomy, Mulayam Singh Yadav Medical College and Hospitals, Meerut, U.P, India-245206.

How to cite this article: A.P. Singh, Chhitij Anand, Saumya Singh. A study of anatomical variations in transverse foramen of cervical vertebrae for morphological and clinical importance. International Journal of Contemporary Medical Research 2019;6(6):F9-F11.

DOI: <http://dx.doi.org/10.21276/ijcmr.2019.6.6.19>

Variations in transverse foramina	U/L	Percentage (%)	B/L	Percentage (%)	Total Percentage (%)
Vertebrae with complete double transverse foramina	29	12	19	8	20
Vertebrae with incomplete double transverse foramina	9	4	6	2	6

Table-1: Showing the incidence of accessory FT in the cervical vertebrae

Authors	Katikie reddi et al	Chaudhari et al	Chandra vadiya et al	Sharma et al	Taitz et al	Patra et al	Omar et al	Mishra et al	Present study
Number of vertebrae	100	133	140	200	480	150	315	220	240
Incidence of accessory transverse foramen (%)	3	23.75	4.76	8	7	22	9.8	14.09	26.25
Unilateral accessory transverse foramen (%)	2	14.7	3.8	3.5	4.24	10.6	7.3	9.4	15.75
Bilateral accessory transverse foramen (%)	1	8.42	0.95	4.5	3.75	11.3	2.5	4.5	9.5

Table-2: Comparison of Accessory transverse foramen with other studies

Authors	Year	Prevalence of accessory Transverse foramen %	Study sample	Population
Jaen et al	1974	11.91	2111	North American (Mexican)
Taitz et al	1978	7	480	Indian
Nagar et al	1999	8.6	1388	Roman –Byzantine jews
Aydinlioglou et al	2001	13.65	222	Turkish
Kaya et al	2011	22.7	22	Jewish
Karau PB, Oduia P	2012	3.9	102	Kenyan
Guerra M. et al	2017	17.35	121	Chile
Present study	2018	26.25	240	Indian

Table-3: Prevalence of accessory transverse foramen in different study populations



Figure-1: Complete unilateral double transverse foramina

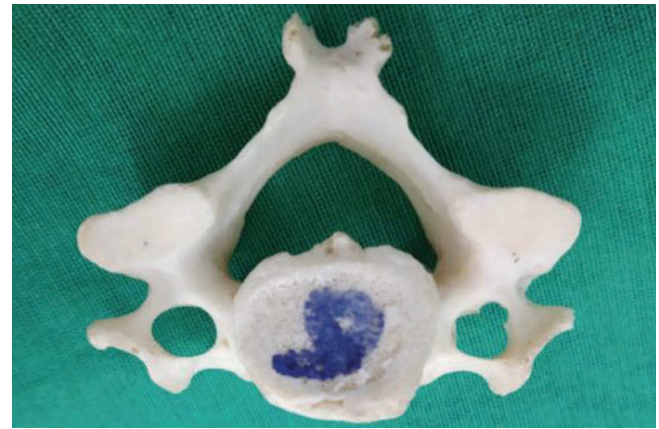


Figure-3: Incomplete unilateral double transverse foramina



Figure-2: Complete bilateral double transverse foramina



Figure-4: Incomplete bilateral double transverse foramina

Inclusion Criteria: Intact cervical vertebrae without any degenerative or traumatic disorders were included in this study.

Exclusion Criteria: Deformed /Damaged Vertebrae
Vertebrae having variations in transverse foramina were photographed. Variations in number and shape were observed, recorded with data compilation and analysis done using Microsoft Excel software.

RESULT

Out of 240 cervical vertebrae studied, 63 vertebrae were found to have variations in the transverse foramina. Complete double transverse foramina were observed in 48 vertebrae (20%), out of which unilateral double foramina (Fig.1) were found in 29 vertebrae (12%) and bilateral double foramina (Fig.2) were found in 19 vertebrae (8%). Incomplete double transverse foramina were observed in 15 vertebrae (6%), of which the foramina were unilateral (Fig.3) in 9 vertebrae (4%) and bilateral (Fig.4) in 6 vertebrae (2%). The incidence of accessory transverse foramina in the cervical vertebrae has been shown in table 1.

DISCUSSION

As we know, the main structure passes through foramen transversarium is vertebral artery. During the formation of vertebral artery some portion of the primitive dorsal aorta may not degenerate along with the two intersegmental arteries which connect the vertebral artery and this arrangement may lead to double origin and duplication of the vertebral artery. The vertebral arteries supply the cervical part of spinal cord, spinal ganglions and meninges in the posterior cranial fossa.⁵ As the vertebral vessels are the important in the formation of the foramen transversarium, it can be apparent that variations in the presence and course of the vertebral vessels will result in variation in foramen transversarium. A narrowing of the foramina indicates narrowness of the vessels and so on.⁷ The accessory foramina transversaria were most common at the lower cervical vertebrae (C5, C6 and C7), mostly in C6. Several authors of India and abroad have studied the variations in foramen transversarium. Anatomical variations in foramen transversarium of cervical vertebrae have been reported by Katikie reddy et al⁹, Chaudhari et al⁶, Chandra vadiya et al¹⁰, Sharma et al¹¹, Taitz et al⁵, Patra et al, Omar et al, Mishra et al.⁷ Result of our study is closely related to the study done by Chaudhari et al which is shown in table 2. We also compared our observation with past studies done by the authors of other country like Jaen et al, Taitz et al, Nagar et al¹³, Aydinlioglou et al¹⁵, Kaya et al⁴, Karau PB and Oduia P et al¹², and Guerra M. et al.¹⁴ Our study is closely related to Kaya et al, whose study was done on Jewish population in the year 2011 (Table 3).

CONCLUSION

In our study we observed the double foramen transversarium in 26.25% of the cases. This study provides further information on incidence and morphological basis of transverse foramina with variation awareness. Its incidence

is clinically important for spine surgeons to prevent intra-operative complications by damaging vertebral vessels. It is also useful for radiologist during CT and MRI scan helping them in radiological imaging, neurological diagnosis and in complex surgical procedures in the cervical area.

REFERENCES

1. Newell RLM. The back. In: Standring S, editor. Gray's Anatomy, The anatomical basis of clinical practice. 40th ed. Churchill Livingstone Elsevier; 2008.p713,763 – 73.
2. Burns SH, Mior SA, O'Connor SMO. Cervical spondylotic myelopathy: Part – I: anatomical and pathomechanical consideration. J. Canadian Chiropractic Association (JCCA) 1991;35:23-29.
3. A.K.Datta, Essentials of Human Anatomy, Head & Neck, Chapter 7, Deep structures of Neck, 4th edi, pp 200–203.
4. Kaya S, Yilmaz ND, Pusat S, Kural C, Kirik A, Izci Y. Double foramen transversarium variation in ancient byzantine cervical vertebrae: preliminary report of an anthropological study, *turk neurosurg* 2011;21:534-38.
5. Taitz C, Anatomical observations of Foramen transversarium, *J. Neurol. Neurosurg Psychiatry* 1978;41:170-76.
6. Chaudhari ML, Maheria PB, Bachuwar SP. Double Foramen Transversarium in Cervical Vertebra: Morphology and Clinical importance. 2013;2:1084-1088.
7. Mishra GP, Bhatnagar S, Singh B. Anatomical Variations in Foramen Transversarium of Typical Cervical Vertebrae and Clinical Significance. *IJBR* 2014;5:06.
8. Das S, Suri R, Kapur V. Double foramen transversaria: an osteological study with clinical implications. *Int Med J.* 2005;12:311-3.
9. Katikireddy RS, Setty SNRS. A study of double foramen transversarium in dried cervical vertebra. *Int J Health Sci Res.* 2014;4:59-61.
10. Laxmi Chandravadiya, Shailesh Patel, Jatin Goda, Vipul Chavda, Srushti Ruparelia, Shamin Patel: Double foramen transversarium in cervical vertebra: morphology and clinical importance. *Int J Res Med.* 2013; 2;103-105.
11. Sharma Archana, Singh Kuldeep, Gupta Vishnu, Srivastava Shubha. Double foramen transversarium in cervical vertebra an osteological study. *J. Anat. Soc. India.* 2010; 59:229-231.
12. Karau PB, Oduia P. Some anatomical and morphometric observations in the foramina of the atlas among Kenyans. *Anat J of Africa* 2013; 2: 61-66.
13. Nagar Y, Taitz C, Reich R. What can we make of these fragments? Excavation at "Mamilla" Cave, Byzantine period, Jerusalem. *Int J Osteoarchaeol* 1999; 9:29-38.
14. Molinet, G. M.; Robles, F. P.; Roa, I. Anatomical variations of the foramen transversarium in cervical vertebrae. *Int. J. Morphol* 2017;35:719-722.
15. Aydinoglu A, Kavakli A, Yesilyurt H, Erdem S, Eroglu C: Foramen transversarium bipartita. *Van Tip Dirgisi.* 2001; 8:110-112.

Source of Support: Nil; **Conflict of Interest:** None

Submitted: 07-04-2019; **Accepted:** 30-04-2019; **Published:** 18-06-2019