

AN OSTEOLOGICAL STUDY OF FORAMEN TRASVERSARIUM: VARIATIONS AND CLINICAL ASPECTSYogesh Yadav¹, Preeti Goswami², Veena Bharihoke³**HOW TO CITE THIS ARTICLE:**

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ABSTRACT: Foramen transversarium are located on the transverse process of cervical vertebrae and are the cardinal features of cervical vertebrae. These foramina are known to exhibit variations in size, shape and may be absent or duplicated. Keeping this in mind, a study was done to record these variations. A hundred and twenty dry typical cervical vertebrae procured from department of anatomy were used for this study. Unilateral double foramen transversarium were seen in 2.5% cases while 4.16% cases showed bilateral double foramen transversarium. 0.83% cases showed symmetrical foramen transversarium and another 1.66% cases showed incomplete foramen transversarium. The normal factor responsible for such anomalies is developmental or related to variation in course of vertebral artery. The recognition of this variation provides safety and efficiency for the posterior approaches of the cervical spine.

KEYWORDS: Foramen Transversarium, cervical vertebrae, variations.

INTRODUCTION: The cervical vertebrae are the smallest of the movable vertebrae, and are characterized by a foramen in each transverse process. It displays anterior and posterior roots or bars that terminate laterally as anterior and posterior tubercles. The roots are connected lateral to the foramen by an intertubercular lamella of bone referred as the costotransverse bar.⁽¹⁾ This foramen transmits the vertebral artery, vertebral vein and sympathetic nerve fibers. The vertebral artery enters its vertebral course nearly always at the foramen transversarium of C6; it is not surprising therefore, that the foramen of C7, which transmits only the vein, is small or even sometimes absent.⁽²⁾ The transverse process is morphologically composite around the foramen transversarium. Its dorsal and ventral bars terminate laterally as corresponding tubercles. The tubercles are connected lateral to the foramen by the costal (intertubercular) lamellae; these three elements represent morphologically the capitellum, tubercle & neck of cervical costal element. The attachment of the dorsal bar to the pediculo-laminar junction represents the morphological transverse process and the attachment of the ventral bar to the ventral body represents the capitellar process.⁽¹⁾

MATERIALS AND METHODS: 120 dried typical human cervical vertebrae (C3-C6) of both sexes which were procured from bone collections of department of anatomy were included in this study. Number of foramen transversarium present on the transverse process of all these vertebrae were observed macroscopically and photographed. The data was tabulated (Table-1) and analyzed.

OBSERVATIONS AND RESULTS: Out of 120 cervical vertebrae, 12 were found to have anomalous foramen transversarium. 3 of them had double foramen transversarium unilaterally, 2 on the right

ORIGINAL ARTICLE

side and 1 on the left (Figure-1), whereas in 5 cases, bilateral double foramen transversarium were observed (Figure-2). In 2 cases, there was a bony spicule incompletely dividing the foramen (Figure-3). In one case there was asymmetry in the size of foramen transversarium (figure-4) while in another there in unusually small foramen transversarium bilaterally (Figure-5).



Fig. 1: Unilateral double FT



Fig. 2: Bilateral double FT



Fig. 3: Unilateral incomplete divided FT



Fig. 4: Asymmetrical FT



Fig. 5: Bilateral small FT

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Sl. No	Anomaly	Cases seen	Percentage %
1	Unilateral double FT	3	2.5
2	Bilateral double FT	5	4.16
3	Incomplete FT	2	1.66
4	Asymmetrical FT	1	0.83
5	Bilateral narrow FT	1	0.83

TABLE 1: OBSERVATIONS

DISCUSSION: Many studies have been carried out about the morphology of foramen transversarium. One of the studies by Jarostaw Wysocki et al⁽³⁾ on 100 vertebral columns revealed divided foramen transversarium, most frequently at the level of C6 (45.6%) and rarest at the level of C3 (2.8%). Satheesha Nayak B⁽⁴⁾ in 2008 reported abnormal foramina on the posterior arch of atlas. Similarly, C. Taitz et al⁽⁵⁾ conducted a study on 36 vertebrae & found 34 vertebrae with double foramen transversarium. Akram Abood Jaffar et al⁽⁶⁾ reported that accessory foramen transversarium is more common in lower cervical vertebra mostly C6 (70%). Another study by Das Srijit⁽⁷⁾ on 132 cervical vertebrae reported 2 cases of double foramen transversarium. Anatomically, the foramen transversarium is described to be divided by a fibrous or bony bridge, separating the artery and the vein,⁽⁸⁾ the smaller posterior part that encloses a branch of vertebral nerve and the vertebral vein is called "Accessory vertebral foramen".⁽⁹⁾

The vertebral nerve ascends from the stellate ganglion up to the level of C3; two branches from this nerve are formed running towards the 6th spinal nerve, and one of these branches passes through the accessory foramen.⁽⁹⁾ The foramen transversarium is a result of the special formation of the cervical transverse processes. It is formed by the vestigial costal element fused to the body and the true transverse process of the vertebra. The vertebral vessels and nervous plexus are caught between these two bony parts. The foramen transversarium is closed laterally by the costotransverse bar, a thin plate of bone connecting the rib element to the original transverse process.⁽⁵⁾ The vertebral arteries constitute one of the vascular components of the cervical region of the spinal column that ascend parallel to the spines through the transverse foramina of the upper six cervical vertebrae.

They supply the cervical part of spinal cord, spinal ganglions, meninges and duramater in the posterior cranial fossa. It was reported that this artery enters the foramen transversarium of vertebra at C6 in 88% of cases, and C7 and C5 in only 5% and 7% of cases.⁽¹⁰⁾ Since the vertebral vessels are the factors in the formation of the foramen transversarium, it can be assumed that variations in the presence and course of the vertebral vessels will manifest as variant foramen transversarium. In contrast, variations of the foramen transversarium can be useful in estimating the variations of the vessels. An absence of foramen transversarium could mean absent vertebral artery.⁽⁵⁾

A narrowing of the foramina indicates narrowness of the vessels and so on. The tortuosity of the vertebral artery may be a factor on the development of the variations of the FT. Embryological factors may also contribute to the development of these variations. The deformation and variations of this foramen may affect the anatomical course of vital vascular and neural structures, and consequently cause pathological conditions. Double FT or "FT bipartita" is a rare condition and

ORIGINAL ARTICLE

seldom reported in the literature.⁽¹¹⁾ It may be unilateral or bilateral depending on the course of vertebral artery. Vertebral artery is developed from the fusion of longitudinal anastomoses that link the cervical intersegmental arteries, which branch off from the primitive dorsal aorta. These intersegmental arteries eventually regress, except for the seventh artery, which forms the proximal portion of the subclavian artery, including the beginning of the vertebral artery.⁽¹²⁾ The duplication is thought to represent the failure of controlled regression of two intersegmental arteries and a segment of the primitive dorsal aorta. Bilateral occurrence of these failures is the etiology behind bilateral duplication of the vertebral artery.⁽¹²⁾ Triple foramina transversaria is a very unusual variation and such a vertebra shows two costal bars instead of one.⁽⁵⁾ The presence of the variation of FT may cause vertebrobasilar insufficiency as a result of neck movements. Variations in the number and size of the FT of cervical vertebrae may result in headache, migraine and fainting attacks due to compression of vertebral artery.⁽¹³⁾

CONCLUSION: The surgical anatomy of the foramen transversarium and vertebral artery are important to the neurosurgeons and radiologists. So in this study, it was found that unilateral double foramen transversarium are more common which is followed by bilateral double foramen transversarium. Also it was found that the anomalies are more common down the vertebral column which is in accordance with the previous workers. The anatomy and morphology of foramen transversarium is useful to the operating spine surgeons and radiologists in the interpretation of radiographic films and computed tomogram scans. Maintaining the vertebral artery intact constitutes an important concern during cervical procedures⁽¹⁴⁾ since minor lesions may result in severe hemorrhages or even death. Compression or spasm of the vertebral artery is manifested not only by neurological symptoms but also by hearing disturbances.⁽¹⁵⁾ Therefore any surgical intervention or during diagnostic approach, these anomalies should be borne in mind.

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ORIGINAL ARTICLE

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