Original Article

Indian Journal of Anatomy
Volume 6 Number 3, July - September 2017
DOI: http://dx.doi.org/10.21088/ija.2320.0022.6317.18

Anatomical Variants of Foramen Transversarium in Dried Cervical Vertebrae and Its Applied Importance

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Abstract

Background: The unique identity of cervical vertebrae is the presence of foramen transversarium in their transverse processes. Foramen transversarium (FT) differentiate cervical vertebrae from other vertebrae. It transmits vertebral artery, vertebral vein and sympathetic nerves from inferior cervical ganglion. Variations in number and size of FT of the cervical vertebrae may lead to headache, migraine and fainting attacks due to compression of vertebral artery. *Objective*: To study anatomical variants of foramen transversarium in dried cervical vertebrae and its applied importance. *Material &Methods*: The present study was conducted on 65dry human cervical vertebra of unknown age and sex in the Department of Anatomy, ACPM Medical College, Dhule. This was an observational study over a period of six months from August 2016 to Jan 2017.All the cervical vertebrae were observed macroscopically for the presence of double foramen transversarium on both sides and the results were analyzed and compared with other studies. *Results*: Double foramen transversarium was seen in 12 (18.5%) cervical vertebra out of total 65 vertebra studied. Out of 12 double FT, unilateral double FT was noted in 07 (58.3%) and bilateral double FT was seen in 05(41.7%) of cervical vertebra. Regular foramen was larger than accessory foramen. *Conclusion*: Anatomical variants of FT leads to various clinical symptoms and pathological conditions. Thorough knowledge of FT variants is helpful for neurosurgeons while operating and preventing injury to vertebral vessels in the spinal region and the radiologists for proper diagnosis.

Keywords: Variants; Foramen Transversarium; Cervical Vertebra; Vertebral Vessels.

Introduction

Foramen transversarium or transverse foramen is the unique identity of cervical vertebrae and differentiate it from other vertebra. In the developmental process, the costal element grows backwards to join the transverse element thereby enclosing a special foramen formation called foramen transversorium (FT) [1]. The FT transmit the vertebral artery, vertebral vein and sympathetic nerves from inferior cervical ganglion [2]. Accessory transverse foramen is small in size and generally found in 6th cervical vertebra and less frequently in the adjacent vertebra [3]. Anatomical variants of FT in shape, size and number as double FT are known to exhibit. Among these variants, double FT is a rare anatomical variant with applied importance as it may affect the course of vertebral artery or may give distorted appearance leading to vertebro basilar insufficiency.[4]

The objective of the present study is to find out incidence of anatomical variants -double FT in dry cervical vertebrae which has clinical importance to radiologists and surgeons for diagnosing and operating on cervical spine respectively.

Material & Methods

The present study was conducted in the department of Anatomy, ACPM Medical College, Dhule over a period of six months from August 2016 to January 2017. A total of 65 dry cervical vertebrae of unknown sex and age were collected from the boxes

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Received | 09.06.2017, **Accepted** | 28.06.2017

of osteology room and observed morphologically for the anatomical variants in vertebrae. All the well preserved cervical vertebrae with FT were included and defective, damaged or irregularly broken vertebrae were excluded. Among 65, 52 were typical cervical vertebrae (C3,C4,C5and C6) and 13were atypical (C7). Grossly the cervical vertebrae were observed for double FT on both sides, whether they were complete or incomplete or unilateral/bilateral or multiple/accessory etc. The results were analyzed and compared the findings with other researchers.

Results

We studied 65 cervical vertebrae morphologically for the presence of double FT either unilaterally or bilaterally. Out of 65 cervical vertebrae, the double FT was found in 12 vertebrae. The incidence of double FT in present study calculated as 18.5%.Among them, unilateral duplication found in 07(58.3%)% vertebrae and bilateral double FT was seen in 05(41.7%) vertebrae as shown in Table 1. Unilateral duplication was slightly more than bilateral one in our study. The accessory foramina were smaller than regular foramina.

Among bilateral double foramina transversorium (05), 04 were noted in typical and 01 was observed in atypical C7 vertebrae as shown in Figure 1(1a to1d) and Figure 3a respectively. In the unilateral FT(07),05 were found in typical and 02 were noted in atypical C7 vertebrae as shown in Figure 2 (2a to 2e) and figure 3b respectively. The incidence of double FT in the present study was 18.5% and this was compared with various previous studies.

Table 1: Incidence of double FT in present study

Types of vertebra	Number of vertebra (%)	Unilateral double FT (%)	Bilateral double FT (%)
Typical	52	05	04
Atypical	13	02	01
Total	65(100)	07(10.8)	05(7.7)

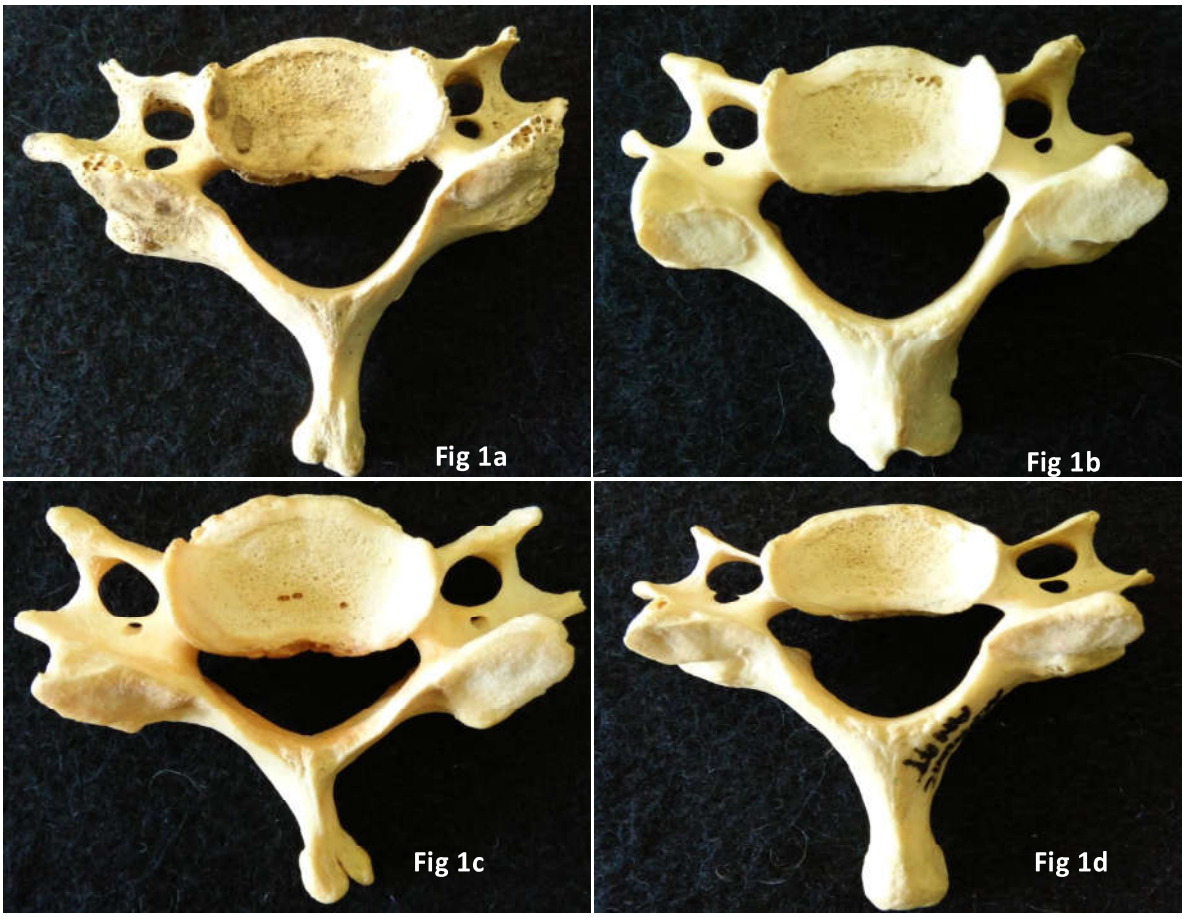

Fig. 1(a,b,c,d): Photograph showing bilateral double foramina transversorium in typical cervical vertebrae

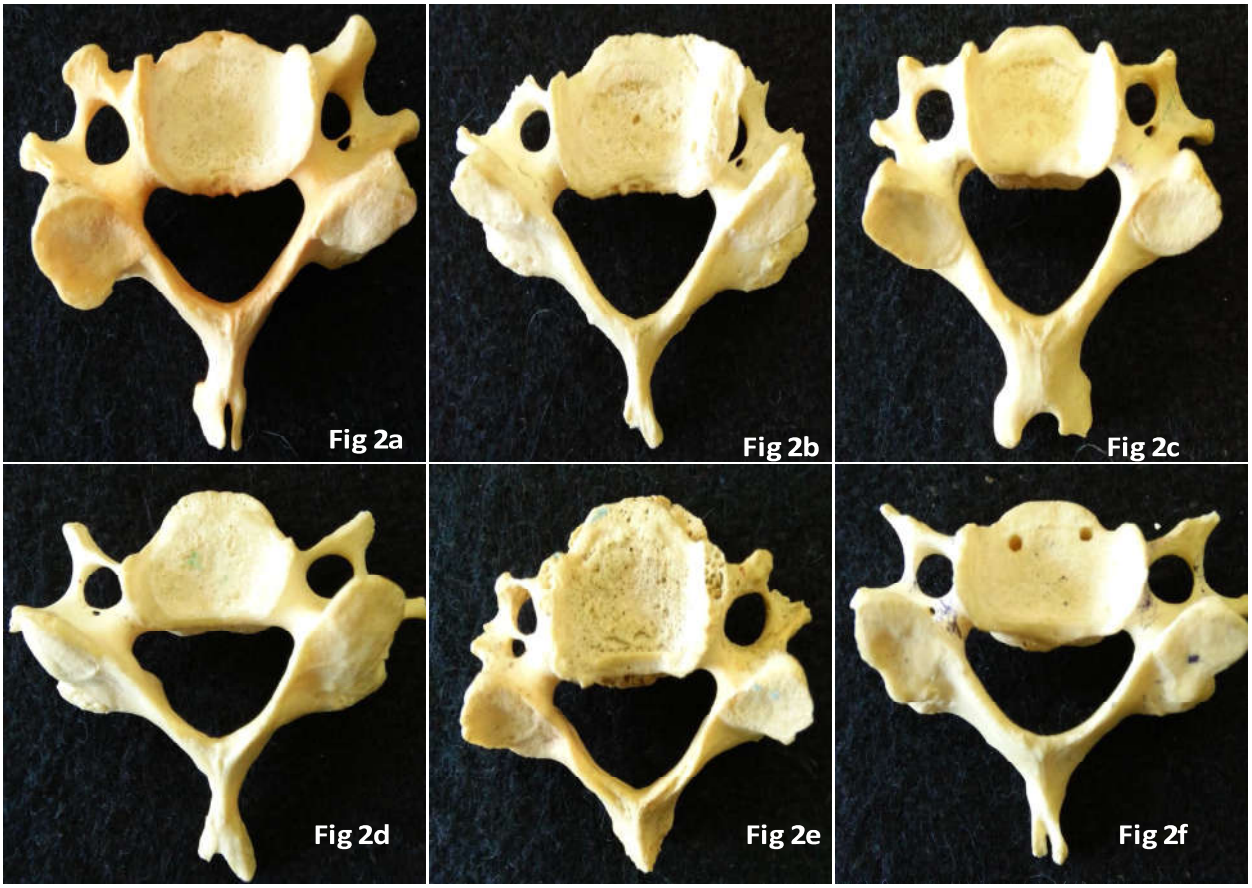

Fig. 2: Photograph showing right unilateral double foramen transversorium (a,b,c) and left unilateral duble foramen transversorium (d,e,f) in typical cervical vertebrae

Fig. 3: Photograph showing bilateral double foramen transversorium (3a) and unilateral (left) double foramen transversorium (3b) in atypical C-7 cervical vertebra

Table 2: Comparative study of incidence of double FT in different population

Authors	Year of study	Incidence of double FT	No of vertebrae	Population observed
Taitz C et al[7]	1978	7.0 %	480	India
Nagar Y et al[9]	1999	8.6 %	1388	Roman
Das S et al[10]	2005	1.5 %	132	India
Kaya S et al[11]	2011	22.5%	262	Jewish
Chaudhari ML et al[12]	2013	23.15%	133	India
Verma P et al[13]	2016	8.0%	200	North India
Patra A et al[14]	2017	10.67%	150	North India
Present study	2017	18.5%	65	Maharashtra, India

Discussion

Anatomical variants regarding size, shape and number of foramina transversorium of cervical vertebrae has been documented by many authors. The foramina transversorium is described by fibrous or bony bridge separating the vertebral artery and vein. It is formed by vestigial costal element fused to the body and the true transverse processes of the vertebrae. The vertebral vessels and nervous plexus are caught between these two bony parts. The FT closed laterally by the costochondral bar, a thin plate of bone connecting the rib elements to the original transverse process [5]. The vertebral nerve ascends from the stellate ganglion upto level of C3, two branch from this nerve are formed and one of these branch passed through accessory vertebral foramina (Smaller posterior part that encloses branch of vertebral vein and vertebral nerve) [6].

The vertebral artery passes through FT, therefore variations in vertebral artery might lead to variation in foramen. Hence it can be assessed that the variation in the process of course of the vertebral arteries will manifest as variation of the FT. In contrast variation of the FT can be useful in estimating variation of the vertebral artery [7]. Accessary FT may be bilateral/ unilateral depending upon the course of vertebral artery. Etiology of presence of accessory FT can be developmental or vascular [8].

The comparison of the incidence of double FT in different population is shown in Table 2. Previous studies by Taitz C et al (1978) [7] and Nagar Y et al (1999) [9] showed 7% and 8.6% of double FT in 480 and 1388 vertebrae respectively. Das S et al (2005) [10] studied 132 vertebra and found only 1.2% of double FT. In Jewish population (262), Kaya S el al (2011) [11] found 22.7% of double FT whereas in Indian population (2013), study by Chaudhari ML et al [12] showed 23.15% incidence of double FT on 133 cervical vertebrae. Recent reference like Verma P et al [13] from North India showed 8% of double FT in 200 cervical vertebra, whereas 10.67% by Patra A et al [14] in 2017 on North Indian population. In the present study, we studied 65 cervical vertebra and noted 12 (18.5%) vertebrae with double FT. In which, 12 double FT we observed unilateral double FT in 07 (58.3%) vertebrae and bilateral double FT in 05 (41.7%) vertebrae. We noted slightly higher incidence of unilateral double FT than bilateral FT as concordance with other studies by Kaya S et al [11] and Chaudhari ML et al [12].

In the literature, details are not available regarding the content of accessory FT. It is not clear whether one of the foramina is occupied by the artery and other by vein or each foramina is occupied by branch of vertebral vessels [15]. The knowledge of anatomical variants of FT is important for neurosurgeon and the radiologists due to vertebral artery. Their anatomy and morphology is useful to the operating spinal surgeons and radiologists in the interpretation of radiological films and CT /MRI scan. Maintaining of vertebral artery intact constitutes an important concern during cerebral procedures since minor lesions may result in severe hemorrhages or even death [16]. The vertebral and basilar arteries constitute to the blood supply of not only brain but also inner ear. Compression or spasm of vertebral artery are manifested not only by neurological (headache, migraine, fainting attacks) but also hearing disturbances [17].

Conclusion

In the present study, we observed 18.5% of double foramina transversarium in cervical vertebrae. Unilateral presence was more common than bilateral and double foramina were observed in lower cervical vertebra. Knowledge of anatomical variants is clinically important since course of vertebral artery may be distorted in such situations. Hence surgical anatomy of these variants foramina is important for the operating neurosurgeons on spine and radiologists while interpreting CT/MRI scans. Future prospective on the study of this subject includes correlation with dissected specimens and angiograms.

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