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Original Research Article

ANATOMICAL VARIATIONS IN FORAMEN TRANSVERSARIUM OF TYPICAL CERVICAL VERTEBRAE AND ITS CLINICAL SIGNIFICANCE

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ABSTRACT

Background: Cervical vertebrae have a typical feature that is presence of foramen bilaterally in their transverse process which is named as foramen transversarium through it passes vertebral artery, vertebral vein and sympathetic plexus of nerves. Among these cervical vertebrae typical cervical vertebrae have a typical bifid spine along with foramen transversarium. Deformation and variations of this foramen may affect the anatomical course of vascular and neural structures, and consequently may cause pathological conditions.

Objectives: To observe the anatomical variations in the foramen transversarium of typical cervical vertebrae.

Materials and Methods: Present work was carried on 163 dry typical (C3-C6) cervical vertebrae of unknown sex and age. Each vertebra was observed for shape, symmetry and number of foramen transversarium present in both transverse processes of cervical vertebra. Also we observed presence of any bony spicules in foramen transversarium.

Results: We found accessary foramen transversarium in 24 (14.72%) vertebrae. Among these 16 (9.81%) vertebrae were having bilateral and 8 (4.90%) vertebrae had unilateral accessary foramen transversarium. We classified foramen transversarium according to the shape and direction of the main diameter of foramen into seven types.

Conclusions: Anatomical knowledge of these variations is helpful for spine surgeons in preoperative planning and for preventing injury of vertebral vessel along with sympathetic nerves during cervical surgical approaches.

KEY WORDS: Foramen Transversarium, Typical Cervical Vertebrae, Accessory Foramen, Vertebral Artery, Vertebral Vein.

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INTRODUCTION

Cervical vertebrae are characterized by the presence of Foramen Transversarium (FT) in transverse process. Its formation is a result of the special formation of the cervical transverse processes which is formed by the vestigial costal element fused to the body and the true transverse process of the vertebra. It is closed laterally by the costo-transverse bar which is a thin plate of bone connecting the rib element to the original transverse process [1]. Vertebral vessels and sympathetic nerves from inferior cervical ganglion pass through FT of all cervical vertebrae except the seventh. FT is known to exhibit variations with respect to the shape, size and number. Etiology of variations of FT may be developmental and related to variations of the anatomical course of vertebral vessels which

may be responsible for pathological conditions such as vertebra-basilar insufficiency [2, 3]. Vertebro-basilar insufficiency occurs as a result of compression of vertebral artery during neck movements and characterized by headache, migraine and fainting attack. Also, inner ear derives its blood supply from vertebral and basilar arteries. Spasm of these arteries may cause labyrinthine or hearing disturbances along with neurological symptoms [1, 3]. Therefore, the knowledge about these variations is very helpful for radiologist and clinician in interpretation of X-rays, computed tomograms and MRI scans. It is also important for the neurosurgeons.

MATERIALS AND METHODS

We studied 163 dry typical (C3-C6) cervical vertebrae of unknown sex and age which were available in our department. Cervical vertebrae with deformities and damaged FT were excluded from the study. Each vertebra was observed for shape, symmetry and number of foramen transversarium present in both transverse processes of cervical vertebra. In vertebrae having accessory FT the larger foramen was taken as the main foramen and smaller one as accessory foramen. Also we noted presence of spicules in it.

RESULTS

We found accessory foramen transversarium in 24 (14.72%) vertebrae (Fig. 1, 2). Among these 16 (9.81%) vertebrae were having bilateral (Fig. 1) and 8 (4.90%) vertebrae had unilateral accessory FT (Fig.2).

We classified FT according to the shape and direction of the main diameter of FT into seven types (Table 1). Our observations were done according to studies made by Taitz et al [1]. Each vertebra was studied as seen from above in an antero-posterior direction with the body of the vertebra facing the examiner. In addition we observed 'D' and irregular shaped FT. We observed symmetrical FT in 91 (55.82%) vertebrae out of 163 vertebrae.

The diameters of the FT were measured with a Digital Vernier caliper. Average diameter on right side was 5.46 mm and on left 5.80 mm. We observed presence of spicules in 12 (7.36%) out of 163 vertebrae.

Fig. 1: Showing bilateral accessory foramen transversarium (AFT).

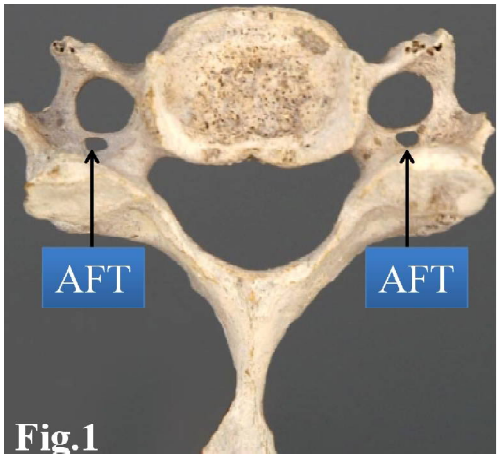


Fig. 2: Showing unilateral accessory foramen transversarium (AFT).

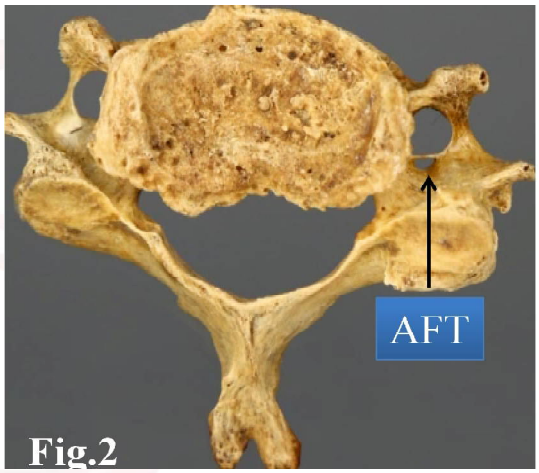
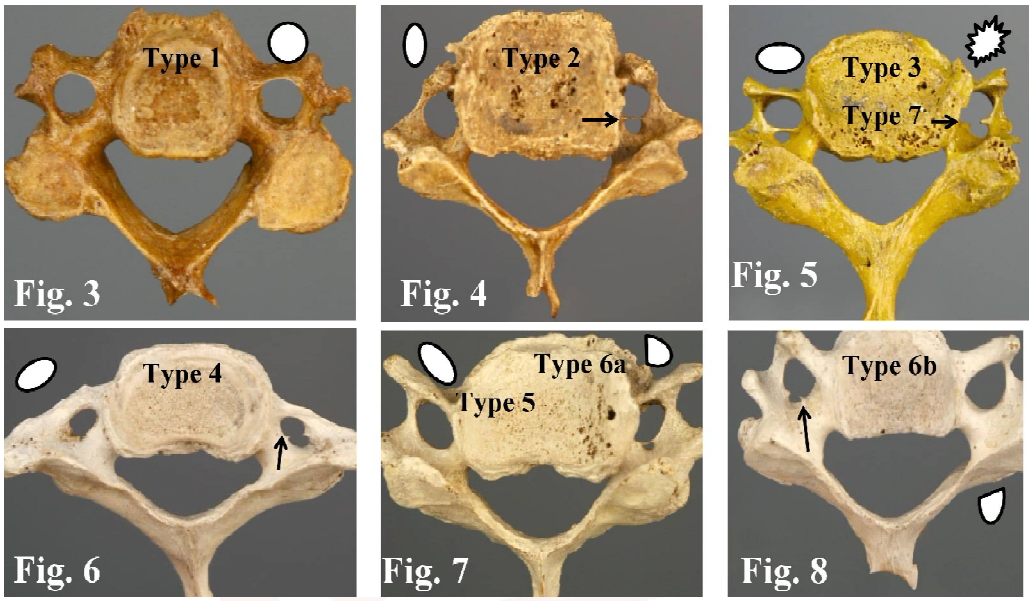


Table 1: Different types of shapes of foramen transversarium.

Type of foramen	shapes	Percentage (n=163) Rt	Lt	Total Percentage
Type 1		20.24 (n=33)	22.69 (n=37)	42.93
Type 2		8.5 (n=14)	9.2 (n=15)	17.7
Type 3		6.13 (n=10)	5.52 (n=9)	11.65
Type 4		21.47 (n=35)	23.31 (n=38)	44.78
Type 5		19.63 (n=32)	19.01 (n=31)	38.64
Type 6 -a		11.04 (n=18)	9.20 (n=15)	20.24
Type 6- b		8.58 (n=14)	6.13 (n=10)	14.71
Type 7		4.29 (n=7)	4.90 (n=8)	9.19

Fig. 3, 4, 5, 6, 7, 8: Showing different types of shapes of foramen transversarium and arrow (Black) shows bony spicules in foramen transversarium.



DISCUSSION

Anatomical variations in foramen transversarium of cervical vertebrae have been reported by many authors. Cervical intersegmental arteries arise from the dorsolateral aspect of the dorsal aorta and from it the vertebral artery is developed. These arteries link up with each another and form the longitudinal anastomotic channels, except the seventh cervical intersegmental artery. Remaining arteries regress and modified to form the vertebral artery [4]. When there is failure in controlled regression of intersegmental arteries it leads to duplication of the vertebral artery. The vertebral artery passes through FT; therefore variations in vertebral artery might lead to variations in foramen. So, it can be assumed that the variations in the presence and course of the vertebral arteries will manifest as variations of the foramen transversarium. In contrast variations in foramen transversarium can be useful in estimating variations of the vertebral artery [1].

Accessory FT may be unilateral or bilat-eral depending on the course of vertebral artery. Etiology for the presence of accessory FT can be developmental or vascular. It may occur due to double rib bone element on the same side fusing to the original transverse process resulting in unusual number of FT [5]. The association of accessory FT and duplication of vertebral artery may be possible. Radiological studies confirmed that, when there is absence of FT in such cases the vertebral artery bypasses the vertebra [6].

Table 2 shows the incidence of accessory FT reported by various authors which is variable from 1.5 % to 27.33%. Taitz et al [1] studied FT from various populations and reported accessory FT in 7% of vertebrae and three transverse foramina unilaterally in single vertebra. In contrast Das et al [2] has reported duplicated foramen transversarium in two cases out of 132 cases he examined. According to Shaaray et al [16] ac-cessory foramen transversarium were most common in lower cervical vertebrae (C5, C6 and C7).

Table 2: Comparison of studies about incidence of accessory FT (foramen transversarium).

Authors	No of specimen	Incidence of accessory FT	Unilateral accessory FT	Bilateral accessory FT
Taitz et al[1]	480	7%	-	-
Das et al.[7]	132	1.50%		
Sharma et al.[8]	200	8%	3.50%	4.50%
Murlimanju et al [9]	363	1.60%	1.30%	0.50%
Chaudhari et al[10]	133	23.15%	14. 73%	8.42%
Shital et al. [11]	210	16.19%	9.52%	6.67%
Patra et al.[12]	150	22%	10.67%	11.33%
Akhtar et al. [13]	174	14.36%	11.49%	2.87%
Gujar et al. [14]	150	27.33%	18%	9.33%
Mishra et al. [15]	220	14.09%	4.54%	9.54%
Present study	163	14.72%	4.90%	9.81%

Murlimanju et al [9] reported accessory foramen in 1.6% cases (only in 6 verte-brae out of 363) out of which 5 vertebrae had bilateral acces-

sory FT. Present study observed accessory FT in 14.72% cases which goes well with Akhtar et al. [13] and Mishra et al.[15] as given in table 2. Mishra et al. [15] studied the FT in 220 dried typical cervical vertebrae and observed accessory FT 14.09% vertebrae. Among them 9.54% vertebrae had bilateral and 14.54% vertebrae had unilateral accessory FT. In our study we analyzed different types of shapes of FT. We found Type 4 shape of FT was present 44.78% which is the common shape (Table 1).

FT is known to exhibit variations in its shape, size and numbers. Under such conditions the course of vertebral artery may be distorted. The variations of FT may be one of the causes for complaints like headaches, migraine and fainting attacks, usually due to compression of the vertebral artery [17]. Therefore, surgical anatomy and morphology of FT is useful for the operating spine surgeons and radiologist while doing computed tomography and magnetic resonant imaging scans [18].

CONCLUSION

The present study observed accessory FT in 14.72% cases. Also, FT exhibit variation in shape and symmetry. The etiological factors were explained on an embryological basis. A thorough knowledge of these variations will be helpful to radiologists, neurosurgeons and recognition of this variation is important for spine surgeons while operating in this region.

Conflicts of Interests: None

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