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Research Article

VARIATIONS OF FORAMEN TRANSVERSARIUM IN SEVENTH CERVICAL VERTEBRA

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ABSTRACT
The cardinal feature of cervical vertebrae is the foramen transversarium which transmits the vertebral artery, its accompanying veins and a sympathetic plexus from the inferior cervical ganglion. The foramen transversarium of the seventh cervical vertebra, which is usually smaller than the foramen transversaria of other cervical vertebrae, transmits only the vertebral vein and a grey ramus filament from the inferior ganglion. The aim of the present study was to observe accessory and absent foramen transversaria in the seventh cervical vertebra. The study material consisted of 58 seventh cervical vertebrae of adult dried human bone taken from achieve of department of anatomy. The variations in the foramen transversarium were analyzed. The accessory foramen transversarium was present bilaterally in 9 and unilaterally in 10 vertebrae (7 right-sided and 3 left-sided). In 3 cases, the foramen transversarium was absent and in these cases, the vertebral vein along with plexus probably enters the sixth cervical vertebra along with the vertebral artery. The mean diameter of the accessory foramen transversarium was measured and was of nearly same size. The accessory foramen transversaria could be because of remnants of costal element and presence of this could be of surgical importance.

Keywords: *Accessory Foramen, Absent Foramen Transversarium, Seventh Cervical Vertebra, Dried Human Bone*

INTRODUCTION
The cervical vertebrae are identified by the presence of a foramen in their transverse processes called the foramen transversarium (F.T). The F.T is formed when the costal element, which is vestigial and has fused with the true transverse element to form a composite transverse process (Hamilton, 1976). The F.T of seventh cervical vertebra differs from the other cervical vertebrae in the smallness of its size (Moore and Dalley, 1999). It transmits only the vertebral vein and a filament (grey ramus) from the inferior ganglion but does not transmit the vertebral artery (Frazer, 1965). The foramen transversarium may be divided by a bony spicule (Williams *et al.*, 2000).
The aim of the present study was to study the morphology and variations in the foramina transversaria of the seventh cervical vertebrae. The anatomical knowledge of the variations in the F.T of cervical vertebrae can be of importance to the neurologists and those who advocate instrumentation in the cervical region. The variations of F.T are important for the clinicians and radiologists for proper interpretation of X-rays and CT scans.

MATERIALS AND METHODS
The present work was conducted to study the variations of the foramen transversarium in the seventh cervical vertebrae. For this study, 58 seventh cervical vertebrae were selected from 277 cervical vertebrae. These vertebrae were selected from the archives of the department of Anatomy, Gian Sagar Medical & Dental College, Banur, Punjab and Swami Devi Dayal Dental College, Barwala, Haryana.
Each seventh cervical vertebra was observed carefully for variations in foramen transversarium and presence of accessory foramen transversarium.
Where the accessory foramen transversarium was present unilaterally, its side and size were observed and noted .Where the accessory foramen transversarium was present bilaterally, it was observed that the size

of accessory foramen transversarium was symmetrical or asymmetrical. Absence of foramen transversarium was also noted
The size of the foramen transversarium was measured with the help of digital Vernier calipers.

RESULTS AND DISCUSSION

Results

58 seventh cervical vertebrae were studied for the presence and variations of accessory foramen transversarium. In 22 vertebrae, variations in the Foramen transversarium were observed (Table 1).

Table 1: Variations in Foramen Transversarium (22 vertebrae-37.9 %)

Accessory F.T- Bilateral (9)		**Accessory F.T- Unilateral (10)**		**Absent F.T- (3)**	
Asymmetrical	Symmetrical	Right side	Left side	Bilateral	Unilateral
3	6	7	3	1	1

The accessory foramen transversarium was present bilaterally (figure 1) in 9 seventh cervical vertebrae. In 6 vertebrae, the accessory foramen was asymmetrical and in 3 vertebrae, it was almost symmetrical on both- right and left side.

Figure 1: Bilateral accessory foramen transversarium (FT), body of C7 (B), Spine (S), Pedicle (P) and transverse process (TP)

In 10 seventh cervical vertebrae, the accessory foramen transversarium was present unilaterally (figure 2) in 7 it was present on the right side and in 3 on the left side. The mean diameter of the accessory foramen transversarium on the right side was 1.85 mm (1.11- 2.92) and that of left side was 2.04mm (1.23- 3.2).

Figure 2: Unilateral accessory foramen transversarium (FT), body of C7 (B), Spine (S), Pedicle (P) and transverse process (TP)

In 3 seventh cervical vertebrae, the foramen transversarium was absent. In 2 vertebrae, it was absent on both right and left sides (figure 3) and in 1 vertebra, it was absent only on the left side.

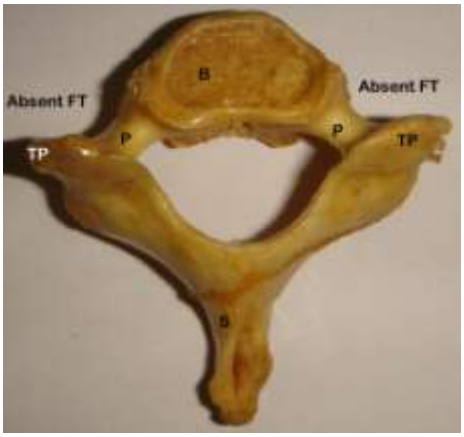

Figure 3: Absent foramen transversarium (FT) on both sides, body of C7 (B), Spine (S), Pedicle (P) and transverse process (TP)

Discussion

The vertebrae of the cervical and proximal thoracic part of the human vertebral column are the area undergoing the most intense transformation during phylogeny, leading to many anatomical variants (Anas *et al.*, 2009; Jovanovic *et al.*, 1990). Studies have been conducted earlier to study the variations of F.T in cervical vertebrae (Jovanovic, 1990; Shaaraway *et al.*, 2008). Accessory F.T has been observed in dry skeletons and in cadaver during dissection and reported in C5 & C6 vertebrae (Patasi *et al.*, 2009; Taitz *et al.*, 1978). The present study was undertaken to see the variations in the foramina transversaria of the seventh cervical vertebrae.

The F.T of the seventh cervical vertebra transmits vascular, nerve branches, fibrous & adipose tissue and is sometimes divided by a bony spicule (Vasudeva and Kumar, 1995; Williams *et al.*, 2000). It may be smaller than the F.T of other cervical vertebrae or may be completely absent (Murlimanju *et al.*, 2011).

In the present study, out of 58 seventh cervical vertebrae, an accessory F.T was observed in 19 vertebrae (32.7%). It is called an accessory foramen as the foramen was apparently divided by a bony spicule. In a study conducted by Taitz *et al.*, (1978), Veeramani and Shankar (2011), out of 31 seventh cervical vertebrae, accessory F.T were observed only in 4(12.9%) which is less than those observed in present study. It could be because of the sample difference.

A study conducted by Murlimanju *et al.*, (2011), Wysocki *et al.*, (2003) on 363 typical & atypical cervical vertebrae presented an accessory F.T in 1.6% vertebrae. The incidence of accessory F.T of the study by Murlimanju *et al.*, (2011), Wysocki *et al.*, (2003) cannot be compared to the present study that has been conducted only on seventh cervical vertebrae.

In the present investigation, the accessory F.T was present bilaterally in 9 and unilaterally in10 vertebrae (7-right sided and 3 left-sided). In the study conducted by Murlimanju *et al.*, (2011), Wysocki *et al.*, (2003) the incidence of accessory F.T has been reported to be more on the left side while it was more on the right side in the present study. A case of triplicate accessory F.T has been reported by Wysocki *et al.*, (2003), Nayak (2007) while no such vertebra was found in the present study.

The reasons for the presence of accessory F.T can be developmental or vascular. It might be due to double rib bone element on the same side fusing to the original transverse process resulting in unusual number of F.T (Veeramani and Shankar, 2011).

The accessory F.T may be due to variations in the vertebral vessels. The vertebral artery arises from the subclavian artery & usually traverses through the F.T of all cervical vertebrae except the seventh (Frazer,

1965). But unusual origin of vertebral artery was reported from arch of aorta and from the thyrocervical trunk (Sharma *et al.*, 2010; Kubikova *et al.*, 2008). Double vertebral artery has been reported by Rath and Prakash (1984) while unilateral & bilateral absence of vertebral artery has also been reported (Aravindhan and Singh, 2009; Lui *et al.*, 1987). Sometimes, the vertebral artery traverses through the F.T of the seventh cervical vertebrae (Bailey, 2003; Mace and Holliday, 1986). It was suggested by Traitz (1978) that the narrowness of F.T suggested a small vertebral artery and an absence of F.T suggested an absent vertebral artery. Also, a large-sized F.T may be due to the presence of big vertebral vein or connective tissue.

The F.T was found to be absent in two vertebrae- bilaterally in one and unilaterally (on left side) in one seventh cervical vertebra. A study conducted on Atlas vertebrae presented unilateral and bilateral absence of F.T (Caovilla *et al.*, 2011; Das *et al.*, 2005). In another study, F.T was absent in C4 & C6 vertebrae (Veeramani and Shankar, 2011). The variations in the number and size of F.T may be an important cause for complaints like headache, migraine and fainting attacks due to compression of the vertebral artery (Hollinshed, 1954). An accessory F.T may narrow the size of real transverse process and may result in pressure on vertebral vessels and sympathetic plexus embedding in it (Taitz *et al.*, 1978).

Conclusion

In the present study, variations were observed in the F.T of 22 vertebrae out of the 58 seventh cervical vertebrae that were studied. An accessory F.T was observed in 19 cases while absence of F.T was observed in 3 vertebrae. The reasons for these variations could be developmental or vascular. The anatomical knowledge of the variations in the F.T of cervical vertebrae can be of immense importance to the neurologists and those who advocate instrumentation in the cervical region. The variations of F.T are important for the clinicians and radiologists for proper interpretation of X-rays and CT scans.

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