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Interesting Facts about the Foramen Transversarium of Cervical Vertebra

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Abstract:
Background and Aim: *Study of foramen transversarium was made with respect to its shape, diameter, presence of accessory foramen and osteophytic encroachment. The data provided by the present study on morphology will be helpful to solve puzzles about foramen transversarium.*
Material and Methods: *100 foramen transversarium were studied in fifty dry cervical vertebrae which were randomly selected irrespective of age and sex for the study from the Department of Anatomy, Madurai medical college, Madurai. Digital Vernier caliper was used to measure the diameter.*
Results: *The study about the foramen transversarium of the cervical vertebrae presented the following interesting findings;*

1. *Most common shape of foramen transversarium was found to be round and the least common shape was found to be ellipitical with main diameter antero-posteriorly.*
2. *The average diameter of foramen transversarium on left side was greater than that on the right side.*
3. *Unilateral accessory foramen was common than the bilateral accessory foramen.*
4. *Osteophytic encroachmen impinging upon the foramen transversarium was noted.*

Conclusion: *The implications of this study will be of great use to the radiologists, neurologists and surgeons who advocate interventions in the foramina transversarium.*
Key Words: *Foramen transversarium,, osteophytic encroachment*

I. Introduction

All mammals have seven cervical vertebrae. Anatomists divide them into two regions[1],
Upper cervical region – C1 and C2
Lower cervical region – C3 to C7

Foramen transversarium is situated on the transverse process of the C1- C7 cervical vertebrae. It transmits the vertebral artery, veins and sympathetic nerves. Foramen transversarium is known to exhibit various variations with regard to its size and shape, it may be duplicated or even absent. Shapes of the foramen transversarium were analysed and categorised into five types. Diameters of the foramen transversarium were measured separately on right and left side of the cervical vertebra. Presence of accessory foramen was observed. Osteophytes or bony overgrowth partially covering the foramen transversarium from the superior articular process of the cervical vertebra are known as osteophytic encroachment. These osteophytes project laterally encroaching upon the contents of the foramen transversarium. These variations in the foramen may lead to derangements of the structures within the foramen transversarium.

Compression of the vertebral arteries which is transmitted through the foramen could manifest not only as neurological symptoms, but also as labyrinthine or hearing disturbances,as vertebral artery corresponds to the blood supply not only of the brain but also of the inner ear Romanov et al [2] 1973.

II. Materials And Methods :

Hundred foramen transversarium were studied in fifty dry cervical vertebrae. The vertebra were randomly selected irrespective of age and sex for the study from the Department of Anatomy, Madurai medical college, Madurai. The diameters were measured by the using Digital Vernier caliper. For each cervical vertebra the foramen transversarium were examined and studied and the following parameters were noted;

1. shape and type of the foramen transversarium
2. diameter of foramen transversarium on right and left side.
3. presence of accessory foramen or absent foramen
4. presence of osteophytic encroachment

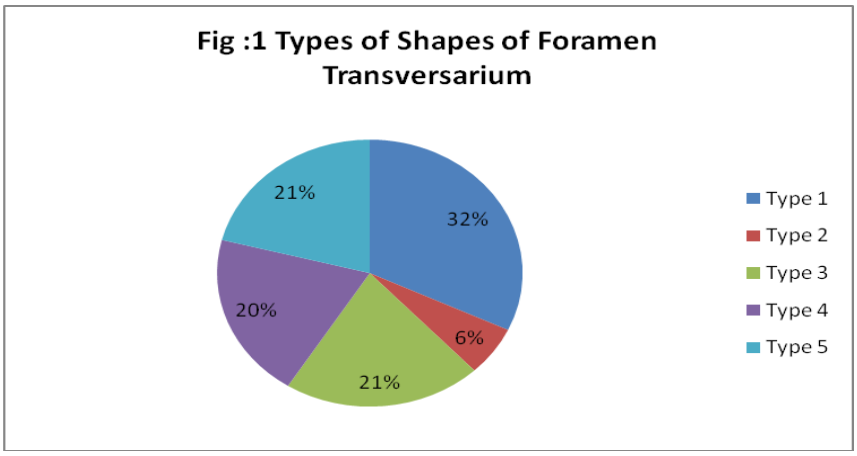
III. Results:

According to the shape and direction of the main diameter, foramen transversarium were classified into five types. This observation is done according to studies made by C.Taitz, H.Nathan and B.Arensberg[3] , Department of Anatomy, Israel. The vertebrae were studied as seen from above in an antero-posterior direction with the body of the vertebrae facing the examiner.

Type 1 – round
Type 2 – elliptical with main diameter [length] anterior-posterior
Type 3 – elliptical with main diameter transverse [breadth]
Type 4- elliptical with main diameter oblique from right to left
Type 5- elliptical with main diameter oblique from left to right

Table 1: Types of shapes of foramen transversarium

TYPE OF FORAMEN	SHAPES
Type1	
Type 2	
Type 3	
Type 4	
Type 5	



The diameters of the foramen transversarium were measured with a Digital Vernier caliper utilizing the largest available foramen on the transverse process of the cervical vertebra. The foramen transversarium was examined on right and left side separately and average of their diameters for C1 to C7 cervical vertebra were calculated.

Table 2:Average measurement of the diameters of Foramen transversarium

CERVICAL VERTEBRA	RIGHT SIDE	LEFT SIDE
C1	6.2 mm	6.34mm
C2	5.62mm	6.4mm
C3	4.83mm	5.27mm
C4	6.0mm	6.3mm
C5	6.6mm	6.8mm
C6	6.04mm	6.70mm
C7	6.65mm	6.73mm

It must be noted that the foramen of the axis C2 is different from the foramina of other vertebrae in that it is not a simple foramen, but of an angulated canal with two openings, inferior and lateral as shown in Fig (2,3)

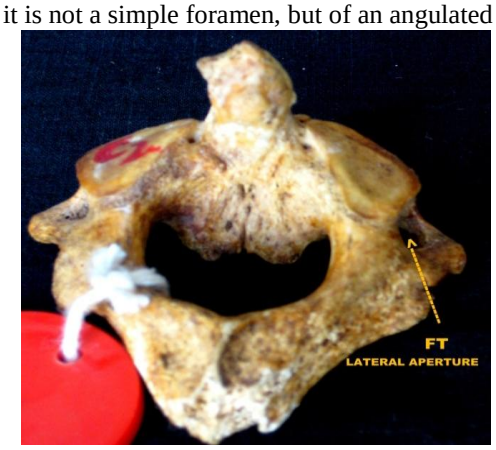


fig:2 lateral aperture of foramen transversarium of **c 2**

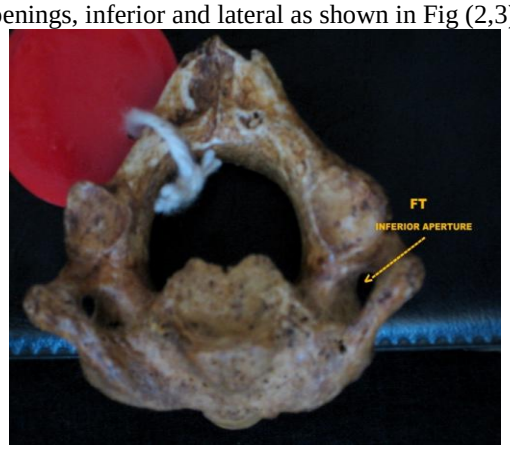


fig: 3 inferior aperture of foramen transversarium of **c 2**

Accessory foramen were seen in the transverse process of the cervical vertebra, both unilateral and bilateral accessory foramens were encountered in the study and recorded. In this study totally eight accessory foramen was found, five of which were unilaterally present (Fig 4) and three accessory foramen were present bilaterally (Fig 5) in the transverse process of the cervical vertebra. Osteophytic encroachment originating from the uncinate and articular processes impinging upon the foramen transversarium were found and noted in C1,C2and C5 cervical vertebra.

fig : 4 unilateral accessory foramen

fig : 5 bilateral accessory foramen

IV. Discussion :

According to studies done by C.Taitz, H.Nathan and B.Arensburg[3] , Department of Anatomy, Israel, the shape and type of foramen transversarium were analysed. It was seen that the Type 1 (round) shape of foramen transversarium was found in 32% contributing to common shape in the present study. Type 3(elliptical with main diameter transverse) and Type 5(elliptical with main diameter oblique from left to right) was found in 21%, Type 4

(elliptical with main diameter oblique from right to left) in 20% and the least common shape was found to be

Type 2(elliptical with main diameter antero-posterior) which contributed to only 6% of the total cervical vertebrae and represented by Fig:1 Pie diagram in the study.

Measurement of diameter of foramen transversarium showed that the highest maximum of the diameter was noted in the transverse process of C1 (atlas) vertebra which was about 8.25mm in the study. Cavder et al [4] showed that the vertebral artery did not have constant caliber during its course within the foramen transversarium. It is reduced in caliber from C6 to C3; above C3 it began to re-increase in its caliber and at C1 level reached its largest caliber. The distortion of vertebral artery and its largest caliber at the level of the C1 atlas could be considered as a mechanical factor responsible for the maximum diameter of C1.

The lowest minimum was 1.91mm observed in C7 cervical vertebra in the present study. Study on Anatomical Observation of foramen transversarium from C3 to C7 by Cagnie B [5] (2005) showed that that the C7 had smallest diameter.

Average values were calculated and tabulated as shown in table 2. It is calculated from this study that average right side diameter was 5.99 mm and that on left side was 6.36 mm, which implies larger diameter on the left side.

Cagnie B [5] (2005) showed that that at all levels, the left foramen had greater diameter than those on right side. Epstein [6] (1969) found the vertebral arteries of the left side was bigger than those on the right. A study made by Rawal Jitendra D [7], revealed an asymmetry of the vertebral artery with a larger diameter on left side than on the right. Henceforth, larger diameter of vertebral artery on left side could be accounted for the larger diameter of foramen transversarium on the left side.

Unilateral accessory foramen (5%) was more common than the bilateral accessory foramen (3%) in the present study. Pretty Rathnakar et al (2013)[8]showed 5.7% of vertebra having accessory foramen transversarium, unilateral (3.6%) being more common than bilateral(1.4%).

In a study by Y.I.Anas, UG Esomonu [9] (2009) showed that the variations recorded included the presence of accessory foramen in atlas, C5 and C6 vertebra. In the present study, accessory foramen were found bilaterally in C5 and C6 cervical vertebrae.

Caovilla et al [10] (2000) showed variations in the number and size of the foramen transversarium may be one of the causes of headache, migraine and fainting attacks due to compression of the vertebral artery. Small foramen were found in C5, C6 and C7 cervical vertebra (Fig 6). Thus frequent small foramen were found in the lower group of cervical vertebrae.

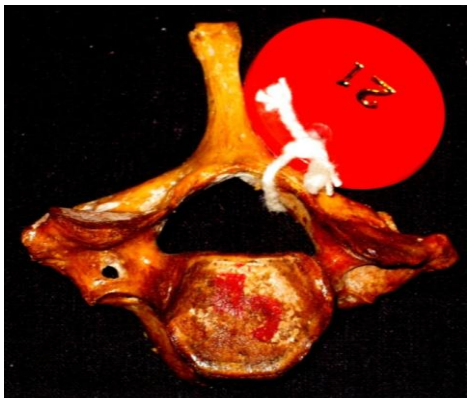


fig: 6 right - small foramen, left – absent foramen

fig : 7 osteophytic encroachment - left side

Osteophytic encroachment was observed in 3% of the specimens in the present study present in C1 , C2 (Fig 7) and C5 cervical vertebra. . Osteophytosis, swellings or adhesions in this foramina causes compression of the surrounding sympathetic plexus. Such encroachment may be due to occupational or bony overgrowth but most often it is due to trauma

Cagnie B [5](2005) studied in 111 transverse foramina that about half of the osteophytes of the superior articular process partially covered foramen causes obstruction. In the present study osteophytes were found partially covering the foramen transversarium from the superior articular process of the cervical vertebra. Kovacs, Tatlow and Bammer et al [11] have shown from their studies that impingement of osteophytes can cause compression of the vertebral artery.

Citlow JS [12] (1999) showed that compression of vertebral artery at C5 by osteophyte caused vertigo triggered by neck extension. It should be rememebered that both the vertebral and basilar arteries correspond to the blood supply not only of the brain but also of the inner ear. Therefore compression of the vertebral arteries or spasms of the same arteries could be manifested not only by neurological symptoms, but also by labyrinthine or hearing disturbances, Romanov et al [2] (1973) .

V. Summary And Conclusion:

The study about foramen transversarium of the cervical vertebrae presented the following interesting findings;

1. Type 1 shape of foramen transversarium was found to be of 32% in the study contributing to common shape followed by type 3 and 5 in 21%, type4 in 20% and the least common shape was found to be type 2 which contributed to only 6% of the total cervical vertebrae.
2. The average diameter on right side was 5.99 mm and that on left side was 6.36 mm, which implies larger

foramen on the left side.
3. Unilateral accessory foramen were seen in 5% of the specimens and 3% showed bilateral accessory foramen. Bilateral accessory foramen and Small foramen were noticed in the lower group of cervical vertebrae, in C5 and C6 cervical vertebrae
4. Osteophytic encroachment was noted in 3% of the cervical vertebra particularly in the upper group

The data provided by the present study on the morphology of foramen transversarium can be helpful in the interpretation of radiographic pictures and in computerized tomography for the diagnostic purposes. They may also be of assistance in determining a more accurate surgical approach to the removal of osteophytes or spurs compressing the vertebral arteries, or for other interventions in that area.

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