Original Research Article

Morphometry of foramen transversarium of sub axial vertebrae and its variations: An osteological assessment

Pallavi Sharma[1], Srikant Pandey[2*], Ramji Prasad Singh[3]

[1]Junior Resident, Department of Anatomy, Nalanda Medical College and Hospital, Patna Bihar, India
[2]Senior Resident, Department of Paediatrics,Nalanda Medical College and Hospital, Patna, Bihar, India
[3]Professor, Department of Anatomy, Nalanda Medical College and Hospital, Patna, Bihar, India

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Abstract

Background: The occurrence of vertebrobasilar insufficiency caused by rotation of the head has been reported due to thickened fibroligamentous structures, osteophyte formation, duplication of foramen transversarium, and congenital absence of the foramen transversarium. The size and variations of the foramen transversarium plays an important role in vertebrobasillar insufficiency. Aim: The present study was carried out on the anatomical variations of foramen transversarium of subaxialvertebrae. **Materials and Methods:** The present study was the conducted in Department of Anatomy, Nalanda Medical College and Hospital, Patna Bihar, India for 1 year. Total 120 dry sub axial cervical vertebrae (C3-C7) consisting of 240 foramen transversaria were collected for study. Among 120 vertebrae 75 belongs to typical type; 45 belongs to seventh cervical vertebrae.**Results:** Foramen transversarium of both sides of 120 sub axial vertebrae were studied. The anteroposterior length, transverse length and depth of foramen transversarium of both sides have been measured. The average antero-posterior length of foramen transversarium of typical cervical vertebrae and seventh cervical vertebrae were 5.52 mm ± 0.14 mm and 5.71 mm ± 0.91 mm respectively. The average transverse length of foramen transversarium of typical cervical vertebrae and seventh cervical vertebrae were 6.69mm±0.24 mm and 6.98mm±0.11mm respectively. The depth of foramen transversarium of typical cervical vertebrae and 7th cervical vertebrae were 3.41 mm ±0.12 mm and 2.90 mm ± 0.61 mm respectively. **Conclusion:** Anatomical knowledge on the dimensions of foramen transversarium of subaxial vertebrae and its variations will be useful for various spinal surgeries like spinal fixation procedures, decompression procedures.

Keywords: Double foramen transversarium, Bubble shaped foramen transversarium, sub axial cervical vertebrae

Introduction

The foramina transversari (FT) transmit the vertebral vascular bundle (vertebral artery, and veins) and the sympathetic plexus which accompanies the vessels. Derangements of these structures in their course because of narrowing or deformation of the foramina have been extensively investigated[1,2] The FT gives passage to the vertebral artery, vertebral veins, and sympathetic nerves from inferior cervical ganglion[3]. The embryogenesis of the vertebral artery begins at approximately 32 days of intrauterine life and is completed by 40 days, between the 12.5- and 16-mm stages[4,5]. Embryologically vertebral artery formation tales place by the fusion of the longitudinal anastomoses of cervical intersegmental arteries which were the branches of the primitive paired dorsal aorta. The intersegmental arteries gradually regress, except for the seventh intersegmental artery, which forms the proximal portion of the subclavian artery; including the point of origin of the vertebral artery[6]The posterior circulation of the brain is completely depended on the basilar artery formed from the fusion of two vertebral arteries. The tortuous course of vertebral artery and rarely medial position of transverse foramen in relation to the joint of Luschka may result in life-threatening iatrogenic injury following cervical decompression[7,8]Observations have been made on the variability of size and form, duplication, or.even absence of one or more of the foramina transversaria. It is suggested that, besides the embryological factors like the fusion of the costal process to vertebrae, other anatomical or functional conditions may also contribute to variations observed among FT. The deformation and variations of FT may affect the anatomical course of vital vascular and neural structures, and consequently cause pathological conditions[9]. Double foramen transversarium is a rare condition[10]and this type of variation may affect the course of the vertebral artery. The dimensions of foramen transversarium are very important for foraminotomy procedures, where IV disc or a bony spur is pressing on a nerve as it exits through the foramen, a foraminotomy may be done. This is making the opening of the foramen larger, so the nerve can exit the opening without being compressed. Our present study will give detailed knowledge about dimensions and variations of foramen transversarium. This will be useful for neurologists in various spinal fixation and decompression procedures. This will also be useful for clinicians and radiologists to interpret radiological images.

Materials and methods

The present study was the conducted in Department of Anatomy, Nalanda Medical College and Hospital, Patna Bihar, India for 1year.

Methodology

Total 120 dry sub axial cervical vertebrae (C3 - C7) consisting of 240 foramen transversaria were collected for study. Damaged, malformed and fractured vertebrae were excluded from the study. Among 120 vertebrae 75 belongs to typical type; 45 belongs to seventh cervical

**Correspondence*
Dr. Srikant Pandey
Senior Resident,Department of Paediatrics, Nalanda Medical College and Hospital, Patna, Bihar, India.
E-mail: pandeysrikant26@gmail.com

vertebrae. All the foramen transversarium were observed for any anatomical variations. The antero posterior length, transverse length and depth of the Foramen transversarium were measured using double tipped compass and digital vernier caliper and double tipped compass.

Statistical analysis

The recorded data was compiled entered in a spreadsheet computer program (Microsoft Excel 2010) and then exported to data editor page of SPSS version 20 (SPSS Inc., Chicago, Illinois, USA). Descriptive statistics included computation of percentages, means and standard deviations were calculated. Statistical test applied for the analysis were student t-test and chi-square test. Level of significance was set at $p \leq 0.05$.

Results

Foramen transversarium of both sides of 120 sub axial vertebrae were studied. The antero-posterior length, transverse length and depth of foramen transversarium of both sides have been measured. (figure 1) The average anteroposterior length of foramen transversarium of typical cervical vertebrae and seventh cervical vertebrae were 5.52 mm ± 0.14 mm and 5.71 mm ± 0.91 mm respectively (Table 1 and Table 2). The average transverse length of foramen transversarium of typical cervical vertebrae and seventh cervical vertebrae were 6.69 mm ± 0.24 mm and 6.98 mm ± 0.11 mm respectively (Table 1 and Table 2). The depth of foramen transversarium of typical cervical vertebrae and 7th cervical vertebrae were 3.41 mm ± 0.12 mm and 2.90 mm ± 0.61 mm respectively (Table. 1 and Table.2).

Table 1: Dimensions of foramen transversarium of typical cervical vertebrae

Parameter (in millimeter)	Right Side (mean ± SD)	Left Side (mean ± SD)
Transverse length	6.69 ± 0.24	6.66 ± 0.42
AP Length	5.52 ± 0.14	5.56 ± 0.48
Depth	3.41 ± 0.12	3.45 ± 0.75

Table 2: Dimensions of foramen transversarium of seventh cervical vertebrae

Parameter (in millimeter)	Right Side (mean ± sd)	Left Side (mean ± sd)
Transverse length	6.98 ± 0.11	6.78 ± 0.48
AP Length	5.71 ± 0.91	5.55 ± 0.72
Depth	2.90 ± 0.61	2.98 ± 0.45

There was no significant difference between right and left side. The incidence of double foramen transversarium on both sides of typical cervical vertebrae was noted in 5.84% of cases. The incidence of double foramen transversarium on both sides of seventh cervical vertebrae was noted in 1.67% of cases. (figure 2) Absent foramen transversarium on left side of seventh cervical vertebrae were noted in 4.17% of cases. Unilateral bubble shaped foramen transversarium of typical vertebrae were noted in 7.5% of cases. Unilateral bubble shaped foramen transversarium of seventh cervical vertebrae were noted in 4.17% of cases. Bilateral bubble shaped foramen transversarium of typical vertebrae were noted in 1.67% of cases. Bilateral bubble shaped foramen transversarium of seventh cervical vertebrae were noted in 2.5% of cases. (figure 3) Absence of foramen transversarium on one side of typical cervical vertebrae were noted in 2.5%of cases. Absence of foramen transversarium on one side of seventh cervical vertebrae was noted in 4.17% of cases.

Fig 1: Dimensions of foramen transversarium of a typical cervical vertebra

Fig 2: Double foramen transversarium of a typical cervical vertebra

Fig. 3: Bubble shaped foramen transversarium of a seventh cervical vertebra

Discussion

Morphometry of foramen transversarium of cervical vertebrae are important for spinal surgeons during decompression procedures like foraminectomy, foraminotomy. The posterior part of brain depends mainly on two vertebralarteries for their circulation. These vertebral arteries are tortuous in course. They are unequal in size in about 75% of cases[11]. Stenosis of vertebral artery with head rotation causes vertebro basilar insufficiency results in Bow-Hunter's stroke[12].

Many Authors have studied the dimensions of foramen transversarium using CT, dry specimens[13,14].Present study showed that the average APL of foramen transversarium in typical cervical vertebrae was 5.52mm ±0.14. The Average APL of foramen transversarium in seventh cervical vertebrae was 5.71mm±0.91mm. It was in variance with Yesender et al study. According to Yesender et al. the average TL of Foramen transversarium in typical vertebrae was 4.88mm±0.70mm[15]Present study showed that average TL of foramen Transversarium of typical cervical vertebrae and seventh cervical vertebrae were 6.69mm±0.24mm and 6.98mm±0.11mm respectively. These varied with previous in Gupta R et al. study[14] The average APL of foramen transversarium was minimum at C3, Maximum at C6. Transverse length of foramen transversarium was minimum at C3 and maximum at C5. But in the present study AP length of foramen transversarium was minimum at C3 and maximum at C4, transverse length of foramen transversarium was minimum at C6 and maximum at C7. There results varied from previous study. According to Riddishet al[16] study, double foramen transversarium on both sides of typical cervical vertebrae were found in 10.4% of cases. In the present study it was found in 11.67%.In muralimanjuet al[17]study, out of 363 typical & atypical cervical vertebrae presented, an double foramen transversarium found in 1.6% vertebrae. In present study double foramen transversarium on both sides of typical cervical vertebrae was found in 5.84% of cases. Double FT on both sides of seventh cervical vertebrae was found in 1.67% of cases. These results were varied with previous study. Presence of accessory FT observed in this present study represents further clinical importance of abnormal transverse foramen morphology. Duplications of extra cranial vertebral artery have been reported in previous studies[18-21]. Primitive dorsal aorta does not regress together with two intersegmental arteries that connect to the vertebral artery; this arrangement may give rise to duplication of vertebral artery[22] Failure of occlusion of inter segmental arteries may be responsible for duplication of vertebral artery carry more risk of thrombus formation & embolization[11]. In present study 4.17% of specimens of C7 did not have FT on one side,2.5% of specimens of typical cervical vertebrae did not have FT on one side. These results were in concurrence with previous studies. In present study bubble shaped FT (both unilateral and bilateral) of typical cervical vertebrae were observed in 5.84% of cases. Bubble shaped FT (both unilateral and bilateral) of seventh cervical vertebrae were observed in 6.67% of cases. The narrowing of FT may cause vertebrobasilar insufficiency and thrombus formation especially with head rotations. The narrowing may be due to cervical spondylosis[23]. Symptomatic vertebral artery stenosis may be caused by osteophytes that compresses the vertebral artery anteriorly from uncinate process or posteriorly from facet complex[24]. Translaminal screwing during spinal fixation surgeries may decreases the size of FT in lower cervical spine level.

Conclusion

Anatomical knowledge on the dimensions of foramen transversarium of subaxial vertebrae and its variations will be useful forvarious spinal surgeries like spinal fixation procedures, decompression procedures.

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