

Research Article

Absence of costal element of the foramen transversarium of atlas vertebrae

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ABSTRACT

Background: Since scanty literature is available on the absence of costal element forming foramen transversarium of atlas vertebra therefore this study was undertaken. Atlas vertebrae were examined to see the presence of foramen transversarium and their boundaries.

Methods: Hundred foramina transversaria of 50 atlas vertebrae were examined grossly.

Results: Foramen transversarium was seen to be present in all the transverse processes of the atlas vertebrae examined. Costal element was found to be missing in seven foramina transversaria out of 100 foramina seen. It was found to be absent on the right side in three vertebrae and in two it was absent bilaterally.

Conclusions: In case the costal element of the foramen transversarium is absent, the second part of vertebral artery passing through this foramen is liable to be damaged while operating at the level of atlanto-occipital joint the operating surgeon should be aware of such variations so as to avoid injury of second part of vertebral artery and subsequently preventing any kind of neurological involvement. Radiologists must also know about such variations so as to correctly interpret radiological image of the craniovertebral region.

Keywords: Atlas, Costal element, First cervical vertebra, Foramen transversarium

INTRODUCTION

First cervical vertebra, i.e. the atlas is ring shaped, with an anterior arch, a posterior arch and two lateral masses. Its transverse processes are large, projecting out laterally and downwards from the lateral masses, they are long, and their anterior and posterior tubercles are fused into one mass. Each transverse process bears a foramen known as foramen transversarium (Figure 1).

The second part of the vertebral artery traverses through this foramen before entering the occipital triangle and then the cranial cavity. Many bony variations have been described by different authors.¹⁻³ Scanty literature is available on the absence of costal element of the first

cervical vertebra and its impact on the clinical anatomy of this region. Therefore, a study was conducted on fifty atlas vertebrae to look for absence of costal element of foramen transversarium.

METHODS

Fifty dry atlas vertebrae of adult size of unknown sex but of a mixed North Indian population were obtained from the department of Anatomy, University College of Medical Sciences and GTB Hospital, for the present study. Broken or incomplete atlases were excluded from the study. Presence or absence of foramen transversarium was grossly looked for and the boundaries carefully noted in hundred transverse processes of 50 atlas vertebrae.

RESULTS

Out of one hundred transverse processes of atlas vertebrae examined, we found that all the specimens had foramina transversaria (Figure 1, 2, 3). Absence of costal element was noticed in five atlas vertebrae (10%) out of 50 atlas vertebrae examined. Anterior margin of the foramen transversarium was absent on the right side in three cases out of 100 foramina transversaria examined (3%) (Figure 2). This margin was absent bilaterally in two cases out of 100 foraminae seen (2%) (Figure 3).



Figure 1: Showing a normal atlas vertebra with an anterior arch, a posterior arch and two lateral masses. Arrow marked at transverse process bearing a complete foramen transversarium jutting out from each lateral mass.



Figure 2: Absence of costal element in the right foramen transversarium of atlas vertebra.



Figure 3: Absence of costal element of foramina transversaria of both transverse process of atlas vertebra.

DISCUSSION

Foramina transversaria of the cervical vertebrae consist of anterior and posterior parts. Anterior portion is homologue of the rib in thoracic region, and therefore named as costal process or element. It arises from the side of the vertebral body and is directed laterally in front of the foramen ending in anterior tubercle. Posterior part is the true transverse process which springs from the vertebral arch behind this foramen. It is directed forwards and laterally and ends in flattened tubercle, the posterior tubercle. These two parts are joined outside the foramen by a bar of bone, the costotransverse bar. Atlas, the first cervical vertebra, has clinically complex and important relationship with vertebral artery. Authors have written about the consequences of injury to the vertebral artery during craniovertebral surgery.⁴⁻⁹ Amongst cervical vertebrae, the atlas shows maximum incidence of variability. The variations of atlas that have been reported include split superior articular process, split anterior or posterior or arch or some bony arch embracing vertebral artery.² Partial or total fusion of atlas vertebra with the occipital bone has also been seen.^{1,10}

In the present study, foramina transversaria were seen in all of the atlases examined. However, unilateral absence of foramen transversarium, on the left side has been reported by Vasudeva and Kumar (1995).¹² Bilateral absence of foramen transversarium was observed by Nayak (2007).¹³ Taitz et al (1978),¹⁴ reported absence of the transverse foramen at C4 and C6 vertebrae.

The current study corresponded to Karau and Odela (2013),¹¹ who observed transverse foramen in all the atlas specimens seen by them. Their literature search did not reveal incidences of absent transverse foramina Presence of foramina transversaria in all the transverse processes of atlas vertebrae in the study of Karau and Odela (2013) and the present study could be due to epigenetic variations.

Although, many variations of atlas have been reported but scanty literature was available on the absence of costal element of the transverse process of atlas and its resultant effect. Therefore, foramina transversaria of the transverse processes of atlas were examined to look for the presence or absence of costal element of the foramen. Costal element was seen to be missing on the right side in three atlases and it was bilaterally absent in two. Karau and Odela (2013)¹¹ found that transverse foramina were incomplete in 8 cases, predominantly on the right side. Generally, there was an incomplete bony bridge forming a groove for the vertebral vessels. It is reported that tortuosity of the vertebral artery may cause bony erosion, or impede complete formation of the transverse foramen (Hadley, 1995; Hyypa, 1974).^{15,16} Developmental changes could account for the anomaly observed. Some authors have suggested that stress and posture in the erect human is one of the factors responsible for shaping bony architecture of the neck region (Taitz et al., 1986).¹⁷

Radiologists should be aware of the occurrence of incomplete transverse foramina of the atlas, as these can be confused with acquired anomaly.

It is suggested that neurosurgeons should be aware of such variations while operating at the level of first cervical vertebra so as to prevent accidental injury of the vertebral artery and thereby preventing any neurological deficit. Radiologists must also be aware of this fact in order to correctly interpret the radiograph or CT scan or MRI image of the craniovertebral region.

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