

A Morphological Study on Cervical Vertebrae and It's Clinical Relevance

Padmalatha K¹, Kalpana S Udupa², Bindusar G Hosmani³

Abstract

Background: Cervical vertebrae are seven in number. C3-6 are typical whereas C1 (Atlas), C2 (Axis) and C7 (Vertebrae prominens) are atypical. The cervical vertebrae are identified by the presence of foramen transversarium in the transverse process. Skeletal abnormalities of cervical region or in craniocervical region are of interest to anatomists, orthopaedicians, neurologists, neurosurgeons and even orthodontists. These abnormalities may result in severe neck pain, decreased neck mobility, muscular weakness and sensory deficits of both upper limbs and sudden unexpected deaths. **Aims and Objectives:** The present study is carried out to know the incidence of variations with respect to it's morphology seen in both typical and atypical cervical vertebrae. **Materials and Methods:** The study is conducted on a total of 210 dry human adult cervical vertebrae of both sexes obtained from Department of Anatomy, ESIC Medical College & PGIMS, Rajajinagar, Bengaluru. The cervical vertebrae showing variations with respect to it's morphology were identified and the photographs were taken. **Results:** We came across the presence of fused cervical vertebrae (C2, 3 & 4) and (C6 & 7), arcuate foramen, elongated odontoid process, assymetrical foramen transversarium and double foramen transversarium. **Conclusion:** A thorough knowledge of these variations will be helpful for neurosurgeons, radiologists, head & neck and vascular surgeons.

Keywords: Cervical Vertebrae; Foramen Transversarium; Arcuate Foramen; Odontoid Process; Fused Vertebrae.

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Introduction

Cervical vertebrae are the smallest of the moveable vertebrae and are characterized by a foramen in each transverse process. They are classified as atypical or peculiar cervical vertebrae which includes first, second and seventh vertebrae, and typical cervical vertebrae which includes third, fourth, fifth and sixth vertebrae [1].

Foramen transversarium which is the

characteristic feature of cervical vertebrae is formed by the vestigial costal element fused to the body and the true transverse process of vertebra. The vertebral vessels and nervous plexus are caught between these two bony parts and closed laterally by costotransverse bar which is a thin plate of bone that connects the rib element to the original transverse process [2].

Materials and Methods

Two hundred and ten dried human cervical vertebrae were obtained from Department of Anatomy at ESIC Medical College & PGIMS, Rajajinagar Bengaluru to study the variations with respect to morphology of cervical vertebrae, it's incidence and clinical relevance. All the cervical vertebrae were examined, defective bones were excluded from the study. Cervical vertebrae showing variations with respect to morphology were compiled and photographed.

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Results

We came across the presence of fused cervical vertebrae in two, firstly where second, third and fourth vertebrae were fused and in second bone where sixth and seventh cervical vertebrae were fused [Figs. 1a,1b,2a,2b,3a & 3b] & [Table 1].

Fused Cervical Vertebrae [2,3,4]

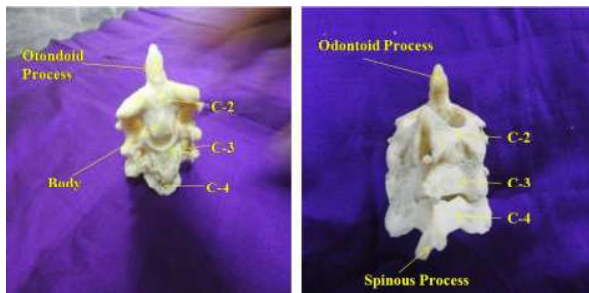


Fig. 1a: Anterior View **Fig. 1b:** Posterior View

Fused Cervical vertebrae [6 & 7]

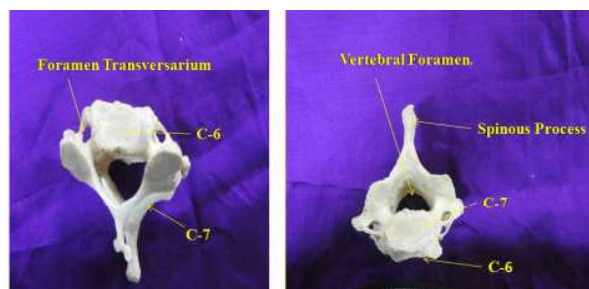


Fig. 2a: Superior View **Fig. 2b:** Inferior view

Fused Cervical Vertebrae [6 & 7]



Fig. 3a: Lateral View **Fig. 3b:** Posterior View

Table 1: Incidence of Fused Cervical Vertebrae

Type of Variation	No of cases	Incidence%
Fused Cervical Vertebrae (2,3 & 4) & (6 & 7)	02	0.95

Two bones showing the presence of arcuate foramen, both the bones showing presence of

arcuate foramen unilaterally on the left side. [Figure 4 & 5] & [Table 2].

Arcuate Foramen



Fig. 4: Superior View

Arcuate Foramen



Fig. 5: Inferior View

Table 2: Incidence of Arcuate Foramen

Type of Variation	No of cases	Incidence %
Arcuate Foramen (unilateral) on left side	02	0.95
Arcuate Foramen (unilateral) on right side	00	00
Arcuate Foramen (bilateral)	00	00

One axis bone presented with an elongated projection on odontoid process [Figure 6a & 6b] & [Table 3]

Elongated Bony Projection on Odontoid Process

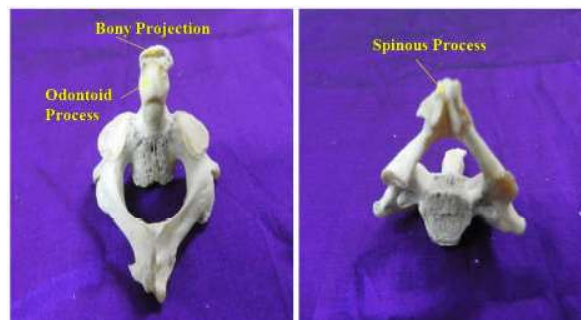


Fig. 6a: Postero-superior View

Fig.6b: Inferior View

Table 3: Incidence of Elongated bony projection on Odontoid process

Type of Variation	No of cases	Incidence%
Elongated bony projection on odontoid process	01	0.48

The occurrence of assymetrical foramen transversarium was seen in one typical cervical vertebra.[Figure 7a & 7b] & [Table 4]

Asymmetrical Formen Transversarium

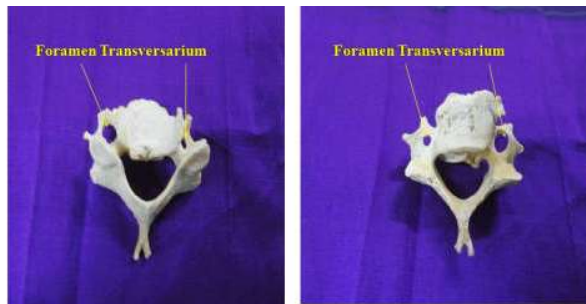


Fig. 7a: Superior View **Fig. 7b:** Inferior View

Double Foramen Transversarium



Fig. 8:

Bilateral Double Foramen Transversarium

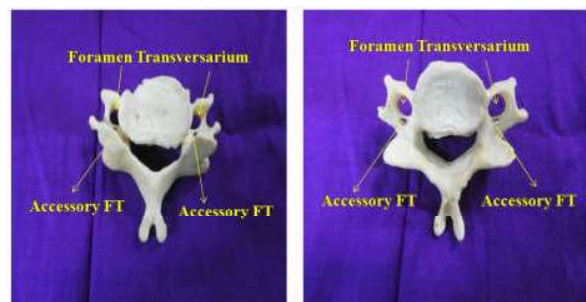


Fig. 9a: Superior View **Fig. 9b:** Inferior View

The occurrence of double foramen transversarium was seen in five bones bilaterally and in five bones unilaterally. The double foramen transversarium bilaterally present in four typical cervical vertebrae

and one atlas, whereas unilaterally present in four typical cervical vertebrae and one atlas, all were present unilaterally on the right side [Figure 8,9 &10] & [Table 5]

Unilateral Double Foramen Transversarium

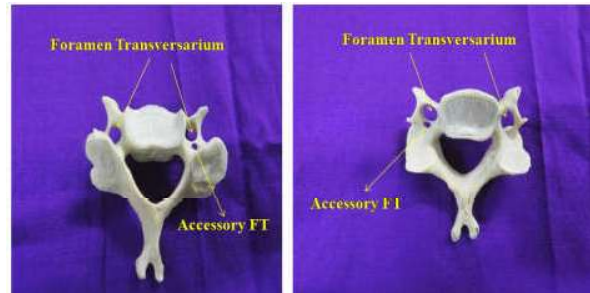


Fig. 10a: Superior View **Fig. 10b:** Inferior View

Table 5: Incidence of Double Foramen Transversarium

Type of Variation	No of cases	Incidence%
Double Foramen Transversarium (bilateral)	05	2.38
Double Foramen Transversarium (unilateral) on right side	05	2.38
Double Foramen Transversarium (unilateral) on left side	00	00

Discussion

Fused cervical vertebrae is also considered as Block vertebrae. The Orthodontist will usually be the first ones to identify cervical abnormalities as they are asymptomatic until adolescence or young adulthood. The congenital fusion of second cervical vertebra axis with the third cervical vertebrae will limit the movements taking place between these bones and therefore third cervical vertebra is known as "Vertebrae Critica" by Cave. This anomaly may be asymptomatic, however it may also present with manifestation of serious clinical features such as Myelopathy and also may be associated with syndromes such as Klippel-feil & Crouzon's syndrome. Fused cervical vertebrae results in limitation of neck movements, muscular weakness, atrophy and morphological sensory loss [3].

Location of Block Vertebrae in order of frequency are cervical spine (C2,3 and C5,6), lumbar spine (L4,5) and any sections of thoracic spine [4].

Vertebral fusion anomalies are likely to be associated with disturbance of pax-1 gene expression in the developing vertebral column [5].

Defects in the development of occipital and cervical somites and effect of environment, genetic factors during third week of conception may lead to

such fusion of vertebra [6].

Vertebral column starts developing during third week with segmentation of paraxial mesoderm forming somites. Failure of normal segmentation of embryological spines may lead to fused vertebra/block vertebra. If congenital, it can be one of the primary malformation of chorda dorsalis [7].

If acquired, it's usually associated with serious diseases such as juvenile rheumatoid arthritis, tuberculosis and trauma. Incidental radiographic findings helps in the early diagnosis of fused cervical vertebrae [8].

Arcuate foramen is a foramen or canal present when sulcus arteriae vertebralis which is situated on the cranial surface of posterior arch of atlas occasionally gets converted into foramen by a bony bridge [9].

First description of of arcuate foramen was done by Kimmerle in the year 1930. Arcuate foramen has many other names like kimmerle's anomaly/foramen atlantoideum/foramen retroarticulare superior/ponticulus posterior of atlas. It is usually associated with chronic tension type headaches and neurosensory type hearing loss [10].

Arcuate foramen is classified into three groups depending upon complete or incomplete ossification of the ligaments

- I Represents retroarticular impression on posterior arch of atlas
- II Defined retroarticular sulcus
- III Complete bony ring [11].

Arcuate foramen is associated with Barie-Lieou syndrome which presents with headache, retroorbital pain, vasomotor disturbance of face, disturbance of vision, swallowing and phonation [12].

Elongated Bony projection on odontoid process occurs as a result of calcification of the ligaments attached to dens. It usually develops as a result of inflammatory disease/ traumatic injury especially in elderly [13].

The various odontoid anomalies are Os Odontoideum, posteriorly inclined odontoid, Os terminale, odontoid hypoplasia, odontoid aplasia, odontoid duplication and anteverted odontoid [14].

Calcium deposition around odontoid process results in crowned dens syndrome where in patients presents with neck pain and increased body temperature. It can be misdiagnosed as polymyalgia rheumatica, giant cell arteritis, meningitis or spondylitis [15].

Assymetrical Foramen transversarium results due to tortuosity of vertebral artery, which may cause bone destruction and hence may be a factor determining the size of foramen transversarium and asymmetry in size of foramen transversarium [16]

Impingement of osteophytes from uncinat process and articular process of cervical vertebrae is also responsible for narrowing of foramen transversarium and compression of vertebral artery or irritation of surrounding sympathetic plexus [17]

Double foramen transversarium occurs due to variations in the vertebral vessels which will be manifested in the changes of foramen transversarium as vertebral vessels play a key role in the formation of foramen transversarium. In contrast, variations of foramen transversarium can be useful in estimating the variations of vessels [18].

If foramen transversarium is divided by fibrous/ bony bridge, separating the artery and vein, the smaller posterior part encloses a branch of nerve and vertebral vein which forms the accessory vertebral foramen [19].

Variations of foramen transversarium causes vertebrobasilar insufficiency as a result of neck movements, may also result in headache, migraine and fainting attacks [20].

Double foramen transversarium is also correlated with duplicate vertebral artery, bifid/duplicate origin and fenestration of vertebral artery [21].

Conclusion

In the present study the following variations of the cervical vertebrae were observed

Fused cervical vertebrae-0.95%

Arcuate foramen-0.95 %

Elongated bony projection -0.48%

Assymetrical foramen transversarium-0.48%

Double foramen transversarium-bilateral-2.38%

Double foramen transversarium-unilateral on right side-2.38%

Double foramen transversarium-unilateral on left side-0%

These variations are noteworthy to neurosurgeons, orthopaedicians, surgeons, spine surgeons and radiologists. Knowledge of such anomalies is important for anaesthesiologists also during endotracheal intubation.

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