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**Original Research Article**

# Thoracic vertebral synostosis & its clinical importance

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## Abstract

**Background:** Thoracic vertebral synostosis is of interest not only to the anatomist but also to surgeons, neurologist, orthopedician, radiologist, anaesthetics and for forensic medicine also. Various vertebral anomalies have been reported by different authors such as Sacralisation, Lumbarisation, Occipitalisation, absence of posterior elements of vertebral arch and vertebral synostosis.

**Methods:** The present study was conducted on 408 dry adult human vertebrae of unknown age & sex obtained from the Department of Anatomy, All India Institute of Medical Sciences, Phulwari-Sharif, Patna.

**Result:** According to our study, we found presence of one set of fused 4th and 5$^{th}$ thoracic vertebrae (2.94%), one set of 5$^{th}$ to 8$^{th}$ thoracic vertebrae (2.94%). Out of 34 sets of vertebral columns we got 2 sets of fused thoracic vertebrae 5.88%. 2 sets of fused thoracic vertebrae present ossification of the anterior longitudinal ligament.

**Conclusions:** Knowledge about any deviation from the normal anatomy of vertebral column can lead to major or minor complications affecting the different system of the body. This study is also clinically important as they might be associated with genitourinary, neurological and musculoskeletal abnormalities.

**Keywords:** Vertebral synostosis, Spinal fusion, vertebral anomaly, Thoracic vertebrae.

## 1. Introduction

Congenital anomalies of the vertebral column are of interest not only to the anatomist but also to surgeons, neurologist, orthopedician, radiologist, anaesthetics and for forensic medicine also. Various vertebral anomalies have been reported by different authors such as Sacralisation, Lumbarisation, Occipitalisation, absence of posterior elements of vertebral arch and vertebral synostosis [1]. These anomalies may be associated with pain, muscular weakness of limbs and sensory deficits. The vertebral column usually consists of 33 vertebral segments and derived from the sclerotomes of somites [2].

The fusion of two or more vertebra is called as vertebral synostosis or block vertebrae which may occur in the cervical, thoracic & lumbar [3]. Trauma, Tuberculosis or other infections and juvenile rheumatoid arthritis are responsible for acquired fusion of vertebrae [4].Smith and co-worker reported that in the intrauterine period of 7-8$^{th}$ week of fetus, PAX gene family member HuP48 expression is essential for the segmentation during the development of vertebral column [5]. Congenital fusion of vertebrae is most common in the cervical region, followed by thoracic and lumbar regions. Masnicova and Benus reported that the prevalence of vertebral synostosis in Lithuanian population was 2.6% in cervical, 1.65% in thoracic and 0.5% in the lumbar region [6].

## 2. Materials and methods

The present study was conducted on 408 dry adult human thoracic vertebrae of unknown age & sex obtained from the Department of Anatomy, All India Institute of Medical Sciences, Phulwari-Sharif, Patna. The study was completed over a period of 6 months (September to January 2018). The vertebrae were macroscopically observed to find if there exists any abnormal fusion between adjacent vertebral bodies, pedicles, laminae, spines or transverse processes. Appropriate measurements were taken and specimen was photographed. The features were measured

by Digital Caliper (DVCA 150) 150mm having accuracy of +/- 0.03 mm.

**2.1 Inclusion criteria**

All intact adult dry vertebrae were included in the present study.

**2.2 Exclusion criteria**

Broken, damaged and neonatal bones were excluded from the study.

## 3. Result

The features and measurements of the fused vertebra are given in Table 1 & 2 and shown in Figure 1-3. Among 34 vertebral columns, i.e. 408 thoracic vertebrae, we observed two sets of fused thoracic vertebrae, one set of two (Figure 1) and one set of four fused thoracic Vertebrae (Figure 2). There was a one case of thoracic typical vertebra where a typical rib was fused with it (Figure 3).

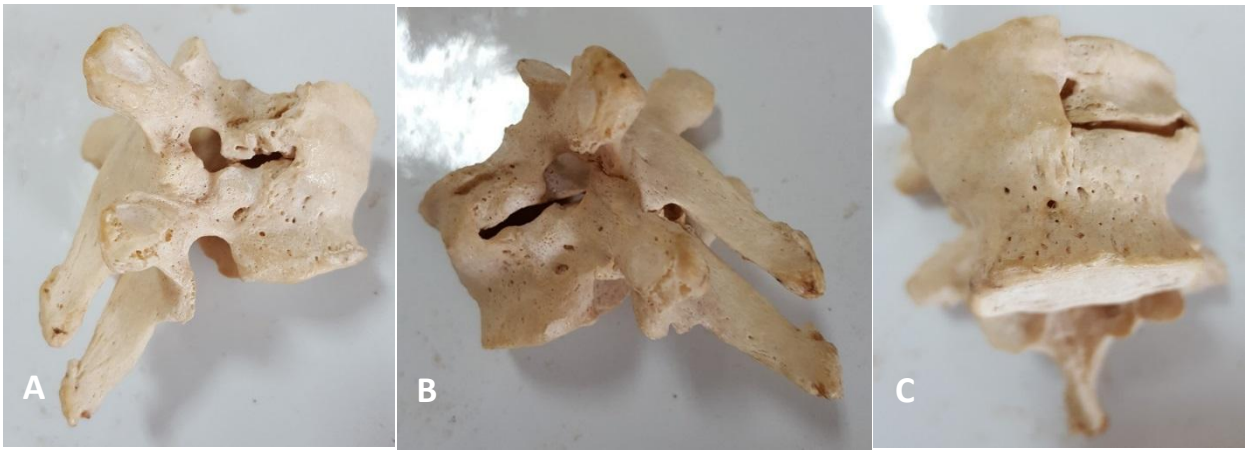


**Figure 1: Fusion of two thoracic vertebrae (A): Right lateral aspect (B): left lateral aspect (C): Anterior aspect**

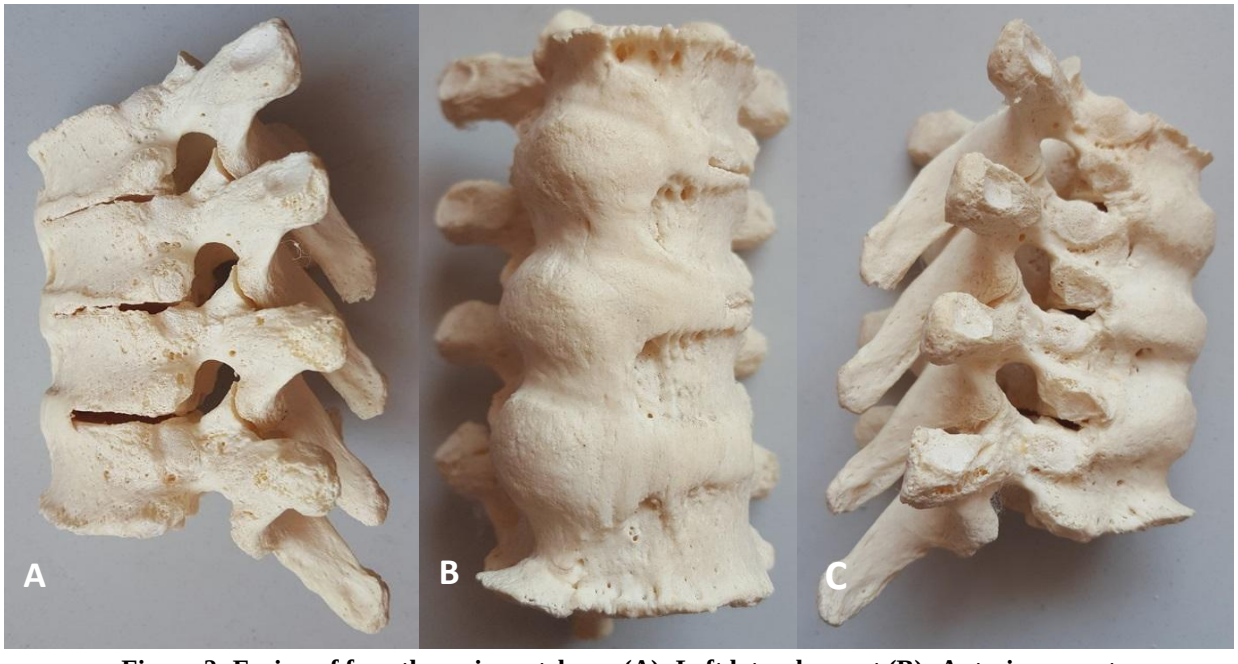


**Figure 2: Fusion of four thoracic vertebrae. (A): Left lateral aspect (B): Anterior aspect (C): Right lateral aspect**


**Figure 3: Fusion of thoracic typical vertebra and a typical rib. (A): anterior aspect (B): left lateral aspect**

The Length difference between right and left side intervertebral foramen ranged 3.05-3.16 mm and width difference ranged 0.53-1.5mm.

According to our study, we found presence of one set of fused 4th and 5th thoracic vertebrae (2.94%), one set of 5th to 8th thoracic vertebrae (2.94%). Out of 34 sets of vertebral columns we got 2 sets of fused thoracic vertebrae 5.88%. 2 sets of fused thoracic vertebrae present ossification of the anterior longitudinal ligament.

**Table 1: Showing dimensions of fused typical thoracic vertebrae (in millimetre)**

| Sl. No. | Parts of vertebra | No. of fused typical thoracic vertebrae | View | Upper vertebra (mm) | Lower vertebra (mm) |
|---|---|---|---|---|---|
| 1 | Body | 2 | Antero-posterior | 27.04 | 29.78 |
| | | | Transverse | 25.01 | 26.50 |
| | | 4 | Antero-posterior | 27.48 | 30.81 |
| | | | Transverse | 25.18 | 31.80 |
| 2 | Spinal canal | 2 | Antero-posterior | 15.42 | 14.62 |
| | | | Transverse | 14.73 | 15.50 |
| | | 4 | Antero-posterior | 13.52 | 13.74 |
| | | | Transverse | 14.63 | 16.60 |

**Table 2: Measurements of intervertebral foramen of all fused thoracic vertebrae**

| Sl. No. | No. of fused typical thoracic vertebrae | Figure No. | Intervertebral foramen (mm) | | |
|---|---|---|---|---|---|
| | | | Dimensions | Right | Left |
| 1 | 2 | Fig 1 (A, B and C) | Length | 10.43 | 9.89 |
| | | | width | 7.23 | 7.10 |
| 2 | 4 | Fig 2 (A, B and C) | Length | 12.90 | 12.94 |
| | | | width | 7.90 | 7.23 |
| | | | Length | 13.59 | 12.26 |
| | | | Width | 7.12 | 7.19 |
| | | | Length | 10.94 | 12.57 |
| | | | width | 6.40 | 6.7 |

## 4. Discussion

Several studies have been reported to record the incidence of vertebral synostosis and it is rare to find such variations in dry bones and also in clinical cases.

The frequency of fusion of vertebrae is more common in cervical (70-75%) followed by thoracic (15-20%) and lumber (10%) [7]. In the present study fusion of thoracic vertebrae is present in 5.88%.

Scoliosis is found in patients with Klippel-Feil anomaly. In these patients vertebrae are abnormal in shape [8].The causes of this fusion can be congenital or acquired. Congenital Vertebral anomaly is caused by genetic and environmental factors. Presence of congenital Vertebral Malformation in human and animal models has been associated with various maternal exposures during pregnancy, anticonvulsant medications, hyperthermia, maternal insulin-dependent diabetes mellitus, and Gestational diabetes [9, 10]. Different vertebral anomalies such ashemi-vertebrae, block vertebrae butterfly vertebrae, transitional vertebrae, and in extreme cases spina bifida can cause compression of the spinal cord and alterations of the shape and number of vertebrae [11, 12].

Surgeons are able to detect congenital vertebral synostosis *in vivo*, but it is very difficult to determine whether the defect is congenital, acquired, or both. These type of anomalies are also associated with kidney problems. Although the occurrence of congenital vertebral synostosis is 1 in 1000 live births [13]. More recent studies indicate that the incidence of Congenital vertebral Malformation in the general population is unknown as many people who are asymptomatic do not present for medical care [14,15]. Congenital vertebral malformation (CVM) in humans may be associated with kyphosis, scoliosis, neck and back pain, disability, cosmetic disfigurement, pulmonary compromise, and functional distress. They can also associate with muscle problem and neurological sensory loss [16].

In our study, we got two sets of the thoracic vertebra having ossification of the anterior longitudinal ligament indicating 5.88%. We found one set of fused thoracic vertebrae T5, T6, T7 and T8. Nagaraj Mallashetty *et al* reported that the bodies of upper ten thoracic vertebrae were fused together due to ossification of the anterior longitudinal ligament [17]. Down syndrome, cervico-oculo-acoustic syndrome and VACTERL syndrome are associated with congenital spinal deformities [10]. Vadgaonkar *et al* reported fusion of the typical thoracic vertebrae and lumbar vertebrae [18]. Erdil and co-worker observed five clinical cases of congenital fusion of cervical vertebrae [19].

The measurement of intervertebral foramina may be significant in different clinical aspect. These measurements are also important in the medicolegal investigation. Due to the paucity of references of the morphometric study of the intervertebral foramen of thoracic vertebra, this needs to be further studies.

## 5. Conclusion

In the present study we found 5.88% fused thoracic vertebrae, out of34 vertebral column. Identification of thoracic vertebral synostosis at an early age can prevent many disabilities and complications or it can be helpful for other hidden pathologies also. Although thoracic vertebral synostosis is a rare finding but it can highlight many clinical aspects. Vertebra synostosis can be congenital or acquired. Knowledge about any deviation from the normal anatomy of vertebral column can lead to major or minor complications affecting the different system of the body. This study is also clinically important as they might be associated with genitourinary, neurological and musculoskeletal abnormalities.

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