

# Study of Thoracic Vertebral Synostosis in North India

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Received July 15, 2014; Revised August 18, 2014; Accepted September 02, 2014

**Abstract** The fusion of vertebral column is a rare anomaly usually congenital in origin. Fusion of the vertebra can be congenital or acquired. Embryologically, failure of resegmentation of the vertebra is the cause. The differentiation and resegmentation of vertebrae occur at the time of organogenesis. Thus resegmentation is the hallmark of vertebral development. Inappropriate vertebral fusion results in block vertebrae or spinal fusion or vertebral synostosis. Fusion of vertebrae can be acquired in case of trauma, tuberculosis and juvenile arthritis. It can occur at various levels viz., cervical, lumbar and thoracic vertebral levels in order of frequency. Among the 350 dry specimens of all vertebrae collected in the Department of Anatomy, two anomalous sets of fused thoracic vertebrae were found. Knowledge about any deviation from the normal anatomy of our vertebral column is very essential especially for orthopedician, forensic pathologist, neurologist and clinical anatomist for diagnosing the patients with such vertebral anomalies. Any congenital or acquired abnormality in the vertebrae may be asymptomatic or a cause of discomfort and inability to carry out various day to day activities because of the important structure related to them.

**Keywords:** fused vertebrae, thoracic synostosis

**Cite This Article:** Preeti Goswami, and Yogesh Yadav, "Study of Thoracic Vertebral Synostosis in North India." *American Journal of Medical Case Reports*, vol. 2, no. 9 (2014): 170-172. doi: 10.12691/ajmcr-2-9-2.

## 1. Introduction

The fusion of two or more vertebrae is a congenital anomaly of vertebral column. Such fusions may occur in the cervical, thoracic or lumbar region [1]. The fusion of thoracic vertebrae can present clinical signs like congenital scoliosis early in life and shortening of the trunk with scoliosis and/or lordosis in older children [2].

The vertebral column is derived from the sclerotomes of somites [3]. It is composed of vertebrae and intervertebral discs between them [4]. It is one among the chief manifestations of body segmentation or metamerism. The fusion of two or more vertebrae may occur in the cervical region (Klippel-Feil syndrome), atlas to occipital bone (occipitalization of atlas), fifth lumbar vertebra to the sacrum (sacralization of fifth lumbar vertebra) or in the thoracic region [5]. The fusion of thoracic vertebrae is the rarest among the three types- cervical, lumbar and thoracic. The fusion of two vertebrae can be congenital or acquired. The surgical fusion of two vertebrae is known as spondylodesis or spondylosyndesis. Acquired fusion can be due to diseases like tuberculosis, juvenile rheumatoid arthritis and trauma [6]. The prevalence of vertebral synostosis in Lithuanian population is 2.6% of cervical vertebra fusion, 1.6% of thoracic vertebral fusion and 0.5% of lumbar vertebral fusion [7].

## 2. Methods

A study on 350 dry specimens of vertebrae was done on the different features of specimens. They were also

checked for variations from normal anatomy. The embryological and clinical significance due to variations are discussed.

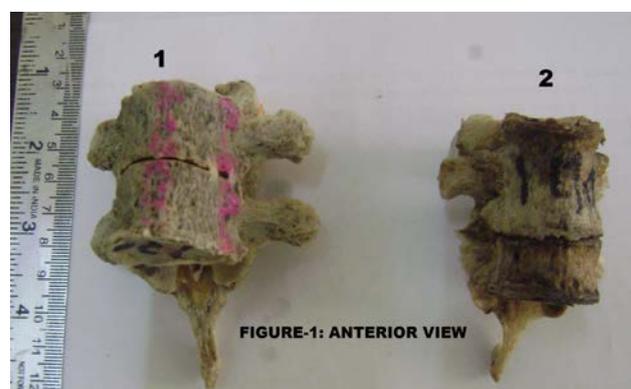


Figure 1.



Figure 2.

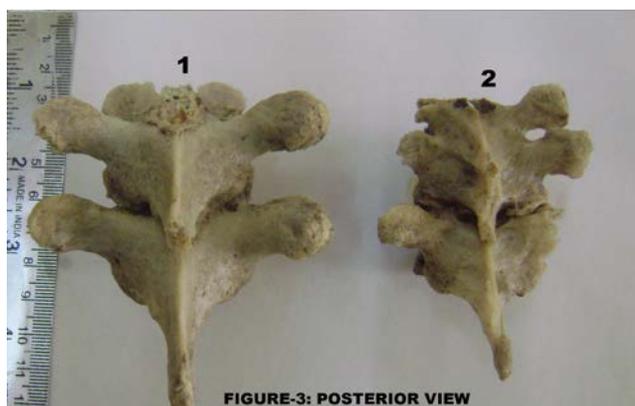


Figure 3.

### 3. Observations

In the present study, we found two sets of fused thoracic vertebrae among 350 dry specimens of all assorted vertebrae of unknown sex (Figure 1). In first set two thoracic vertebrae and in second set three thoracic vertebrae were fused. Features of the first and second specimen were discussed in Table 1 and Table 2 respectively. In first specimen the junction of fusion of both laminae and spinous process (Figure 2), there is a groove with linear crest on both sides, which demarcates the fusion. The costal facets are seen on either side of the body near its junction. In second specimen at the junction of fusion of both laminae and spinous process, there is a groove with linear crest on both sides, which demarcates the fusion is present between 2<sup>nd</sup> & 3<sup>rd</sup> vertebrae. The costal facets are seen on either side of the body near its junction. There is no clear demarcation between the body, lamina & spinous process of 1<sup>st</sup> & 2<sup>nd</sup> vertebrae (Figure 3). Costal facets on either side of body and vertebral foraminae are seen.

Table 1. Various dimensions of 1 set of fused vertebrae

Parts of Vertebra	View	Upper Vertebra	Lower Vertebra
Body	AP	2.0 cm.	2.3 cm.
	Transverse	2.7 cm.	2.9 cm.
Spinal Canal	AP	1.3 cm.	1.6 cm.
	Transverse	1.7 cm.	1.8 cm.
Vertebral Foramen	Right	1.0 cm.	
	Left	0.8 cm.	
Fused Lamina	4.2 cm.		

Table 2. Various dimensions of 2 set of fused vertebrae

Parts of Vertebra	View	Upper Vertebra	Lower Vertebra
Body	AP	1.4 cm.	2.3 cm.
	Transverse	2.1 cm.	2.9 cm.
Spinal Canal	AP	1.2 cm.	1.6 cm.
	Transverse	1.4 cm.	1.8 cm.
Vertebral Foramen	Right	0.7 cm.	0.8 cm.
	Left	0.7 cm.	0.9 cm.
Fused Lamina	5.0 cm.		

### 4. Discussion

The vertebral column develops from paired somites, each composed of a dermatome, myotome and sclerotome. They arise initially in the cervical region (4th week), increasing in number cranio-caudally. In the 5th week, the sclerotomic cells of the somites lose their adherence and migrate to the vertebral centrum, neural processes and costal processes. Each thoracic neural process gives rise to a cartilaginous pedicle, transverse process, and lamina. The ossification centres arise, one for the centrum and one each for the neural processes. Their timing is idiosyncratic, starting in the 4th month at T10 and L1 (centra) and C2 and T1 (neural processes) and spreading up and down the column [8]. The segmentation of the vertebra occurs at the time of organogenesis. The non-segmentation of the primitive sclerotome is the cause for fused vertebra or block vertebra. The embryological time period for the occurrence of synostosis can be analyzed from the anatomical features. In this case, the pedicles and transverse process are not fused indicates that the initial development was normal [9]. Radiologically, three types of vertebral fusion have been described: Single fused cervical segment seen in 25% of patients, multiple, contiguous fused segments seen in 25% patients and multiple, non-contiguous fused seen in 50% patients [10].

Anatomically, the intervertebral discs form a fifth of the post axial vertebral column [11]. The absence of intervertebral disc therefore leads to shortening of the column and thereby shortening of the trunk. The thoracic vertebrae and the intervening disc along with the ribs help to maintain the shape and length of the thorax. Fusion of the vertebrae and the absence of the disc will narrow the thorax and can lead to respiratory distress. Asphyxiating thoracic dystrophy is caused by narrow thorax and short ribs [12]. Apart from the developmental anomalies the vertebral fusion can be associated with radiculopathy and myelopathy. The other associated complications mentioned are [13]:

1. Musculoskeletal-club feet, Sprengel’s deformity, Klippel-Feil syndrome, dysplasia of hip, scoliosis
  2. Renal-unilateral horse-shoe kidney, duplicated kidney or ureters, hypospadias
  3. Congenital heart disease
  4. Neural axis-diastematomyelia, tethered cord, Arnold-Chiari malformation
  5. Jaw and external deformities, cleft palate, cervical rib.
- Such fusion may also lead to wrong calculation of vertebrae clinically as well as radiologically.

### 5. Conclusion

Fusion of the vertebra can be congenital or acquired. Embryologically, failure of resegmentation of the vertebra is the cause. This can lead to wide complications affecting different systems of body. Knowledge about any deviation from the normal anatomy of our vertebral column is very essential especially for orthopedician, forensic pathologist, neurologist and clinical anatomist for diagnosing the patients with such vertebral anomalies as well as misinterpretation of number of vertebrae radiologically and clinically.

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Thoracic insufficiency is one of the negative consequences that vertebral column curvature might have when coupled with multiple vertebral malformations; it might also be caused by unilateral rib synostosis, especially in the thoracic segment. This condition disables normal pulmonary ventilation and development as the child grows; clinically, it manifests itself in the form of respiratory failure and impaired motility of the thoracic walls [3]. Mehta et al. have proven the vertebral column growth to be in direct correlation with the thorax development. Their data suggest that any pathology in any of those compartments will inevitably result in scoliotic spinal deformity, as well as in a severe thoracic deformity [4]. Karol et al., Emans et al. have confirmed the negative impact of early arthrodesis. Khaleel Ahmed, Taqdees Fatima, Priyanka M. "A Study on Thoracic Vertebral Synostosis & its Clinical Importance". *Journal of Evolution of Medical and Dental Sciences* 2015; Vol. 4, Issue 02, January 05; Page: 156-159, DOI: 10.14260/jemds/2015/26. ABSTRACT: Vertebral anomalies are of interest not only to anatomist, but also to orthopedician, neurologist & neurosurgeons. Various vertebral anomalies of anatomic interest have been reported namely; occipitalisation, sacralisation, lumbarisation, absence of posterior elements of vertebral arch & vertebral synostosis. The fusion of vertebral column is ... Vertebral synostosis or block vertebrae is a condition where incomplete segmentation of somites results in fusion of adjacent vertebrae. Out of 392 intact cervical vertebrae 4 cases of cervical synostosis at different level were noticed (fig 1 to 8 ). One case of thoracic vertebral synostosis, two thoracolumbar, one lumbar, two lumbosacral and two sacrococcygeal synostosis were observed (fig 9 to16). The details of their level of fusion, nature of fusion etc are described in a tabulated form in table 1 & table 2. We observed more or less complete fusion of vertebrae in case of all cervical and lumbar synostosis where as thoracic, thoracolumbar and lumbosacral synostosis were incomplete.