

Study of Thoracic Vertebral Synostosis in North India

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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

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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.

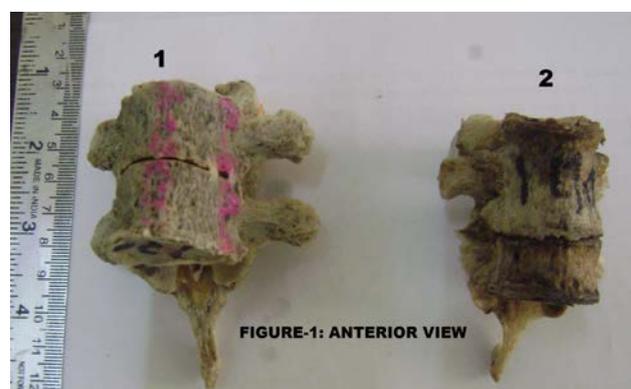


Figure 1.



Figure 2.

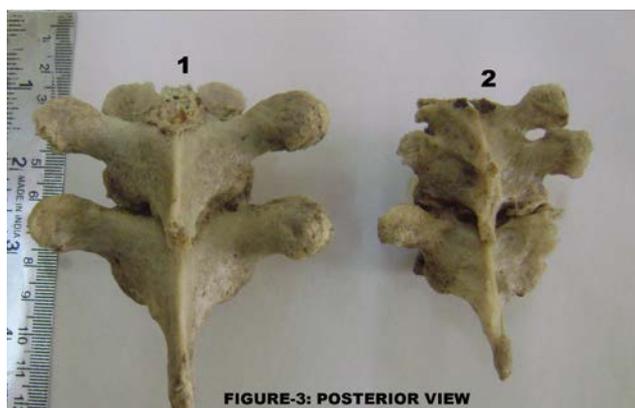


Figure 3.

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 2nd & 3rd 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 1st & 2nd 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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The present study had been carried out on the thoracic vertebrae of blackbuck. There were thirteen tho-racic vertebrae, which were characterized by long spinous process, cylindrical but shorter body and presence of cranial and caudal costal facets on their bodies. The supra spi-nous processes of the thoracic vertebrae increased in length and breadth up to the fourth vertebra (T 4) then gradually decreased. The maximum height of T 4 was 9.84 ± 0.028 cm. The backward inclination in the spinous process of thoracic vertebrae increased up to the ninth and then decreased. The greatest length of tho-racic Chapter 6: Thoracic cavity 1. Respiratory muscles and thoracic cavity with lungs (Ch. MÅ¼lling and K.-D. Budras) . . . 62 2. Heart, blood vessels, and nerves of the thoracic cavity (R. Habel and K.-D. Budras) . . . 64. Chapter 7: Abdominal wall and abdominal cavity 1 The abdominal wall (R. Habel, A. WÅ¼nsche and K.-D. Budras) . . . Å Volume I, Atlas of the Anatomy of the Dog, in addition to specific canine anatomy, provides the fundamental concepts of general anatomy required for the study of all mammals. The dog is small and inexpensive enough that a specimen can be allotted to each dissection team, with advantages in ease of dissection, review, and preser-vation. The vertebral column is comprised of the cervical, thoracic and lumbar vertebrae as well as the sacrum and coccyx. The palaeopathology will be discussed using Wells' classification (1964): A. congenital disease.Å Early synostosis between the vertebral body and the neural arch can occur and it may be so severe that there is a marked reduction in vertebral canal size (Mercer and Duthie, 1964). Several examples of dwarfs were described in Ancient Egypt and Nubia and attributed to achondroplasia.Å the original drawings and study of them suggested that the upper region of the verte-bral column may show non-union of the neural arches. Further examination of this mummy including radiological study is required before it may be accepted with conviction. Studies concerning a small numbers of cases treated conservatively were included too. We analyzed mid-term (5 to 7 years) and long-term results (7 years or more), both as regards the maintenance of the correction of scoliosis and the safety of instrumentation, the early and late complications of surgery and their effect on quality of life.Å No progression in a patient with 26° thoracic and 21° lumbar and failure of formation from the age of 10 (premenarchial) to the age of 14 (2 years postmenarchial).Å Ten patients showed contralateral rib synostosis. The average period of follow-up was 6 years with a range of approximately 10 months to 16 years. None of the two groups presented any neurological disorders. 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 and sex obtained from the Department of Anatomy, All India Institute of Medical Sciences, Phulwari-Sharif, Patna. Result: