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ORIGINAL ARTICLE

INCIDENCE OF BLOCK VERTEBRAE IN SOUTH INDIANS: AN OSTEOMETRIC STUDY

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ABSTRACT: BACKGROUND: Fusion of consecutive vertebral segments results in block vertebrae or vertebral synostosis or spinal fusion. The fusion may be complete or incomplete involving the bodies of the vertebrae alone or along with vertebral arch. It affects most commonly the cervical region, followed by thoracic and lumbar regions. **AIM:** The present study was aimed to assess the incidence of block vertebrae in south Indian population. **METHODS AND MATERIAL:** We examined a total of 2400 fully ossified dried vertebrae collected for a period of 4 years in Department of Anatomy, Dr. VRK Women's Medical College. **RESULTS AND CONCLUSIONS:** The study revealed 6 different specimens of block vertebrae, with 4 cervical, 1 cervico-thoracic and 1 thoracic vertebral synostosis. The features of these block vertebrae were analysed in detail and photographed from different aspects. The total incidence of block vertebrae was found to be 0.25%. The embryological significance and clinical implications of block vertebrae at various levels have been discussed in this paper.
KEYWORDS: Block vertebrae, vertebral synostosis, spinal fusion, incidence.

INTRODUCTION: Vertebral anomalies are of interest not only to anatomists but also to orthopaedicians, neurologists and neurosurgeons. Various vertebral anomalies of anatomic interest have been reported viz.; occipitalisation, sacralisation, lumbarisation, absence of posterior elements of vertebral arch and vertebral synostosis.[1] Fusion of vertebrae at single or multiple levels is referred to as block vertebrae or spinal fusion or vertebral synostosis. The aetiology of vertebral synostosis can be congenital or acquired. The congenital vertebral synostosis is due to partial or complete non-segmentation of vertebrae at the time of organogenesis, manifesting into Klippel-Feil syndrome (KFS) or other associated spinal deformities.[2] Though rare, the acquired fusion of vertebrae is usually secondary to diseases like Juvenile rheumatoid arthritis, tuberculosis, other infections or trauma.[3] On contrary, the surgical fusion of two vertebrae is done in cases of trauma, spondylolisthesis, spinal stenosis and is known as spondylodesis or spondylosyndesis.[2] Congenital fusion of vertebrae most commonly involves cervical region, followed by thoracic and lumbar regions.[4] The thoracic vertebral fusion is often seen associated with ossification of anterior longitudinal ligament in diffuse idiopathic skeletal hyperostosis (DISH), ankylosing spondylitis, osteochondritis, etc.[5]

The block vertebrae may cause restricted movements, premature degenerative changes and associated neurological deficits. The symptoms may vary as per the extent and level of vertebral fusion. In the present study, we observed a total of 2400 vertebrae and documented 6 specimens of block vertebrae involving cervical and thoracic regions.

MATERIALS AND METHODS: The study was conducted on 2400 fully ossified vertebrae, collected for a period of four years in the department of Anatomy, Dr. V.R.K. Women's Medical College (batches

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2010, 2011, 2012 and 2013). The block vertebrae were studied and compared with their normal counterparts for analysis of body, lamina, pedicles, costal facets, foramina transversarium (FT), intervertebral foramina (IVF) and vertebral foramen (VF).

The broken, neonatal or non-dried specimens were excluded from the study. The specimens were photographed from anterior, posterior, right lateral and left lateral aspects. Measurements of the block vertebrae were taken with the help of a standard ruler. The parameters measured were height of fused vertebral bodies [(Right+ Left)/2], diameters of foraminae transversarium and intervertebral foraminae.

RESULTS: Among a total of 2400 vertebrae examined, we identified 6 specimens of block vertebrae belonging to different levels which accounted for a total incidence of 0.25%. The fusion included facet fusion, vertebral arch fusion and vertebral body fusion. We observed 4 cases of cervical vertebral synostosis, 1 case of cervico-thoracic vertebral synostosis and 1 case of thoracic vertebral synostosis. The features and measurements of individual block vertebrae are given in Table 1. The incidence of cervical vertebral synostosis was 0.5%, cervico-thoracic vertebral synostosis was 0.05% and thoracic vertebral synostosis was found to be 0.08%.

Feature	Case I A: C2-C3 fusion	Case I B: C2-C3 fusion	Case II A: C6-C7 fusion	Case II B: C6-C7 fusion	Case III: C7-T1 fusion	Case IV: T6-T7 fusion
Vertebral bodies Height (Rt+Lt/2)	CF; (3.5+3.3) /2=3.4	CF; (3.2+3.0) /2=3.1	CF; (2.1+2.3) /2=2.2	PF; (3.0+3.2) /2=3.1	AF; (2.7+3.2) /2=3.0	PF; (3.3+3.2)/2 = 3.25
Pedicles	UF	PF	UF	UF	UF	UF
Laminae	PF on left side	CF	PF on right side	UF	UF	UF
Articular processes	CF	CF	CF	UF	CF on right, UF on left	UF
Spinous processes	UF	CF	UF	UF	UF	UF
Vertebral foramen	Regular	Regular	Irregular anterior boundary	Regular	Regular	Regular
Intervert-ebral foramen	Oblique, Rt -1.0 Lt - 0.8	Arcuate, Rt - 0.5 Lt - 0.3	Arcuate, Rt - 0.5 Lt - 0.6	Definitive, Rt - 0.4 Lt - 0.3	Larger on Lt side, Rt - 0.7 Lt – 1.0	Definitive Rt - 1.2 Lt - 1.0
Foramen transvers-arium	PV: Rt-0.6 Lt- 0.5 SV: Rt-0.6 Lt-0.7	PV: Rt-0.4 Lt-0.2 SV:Rt-0.6-Lt-0.3	PV: Rt-0.5 Lt-0.7	PV: Rt-0.7 Lt-0.8 SV:Rt-0.6 Lt-0.4	--	--

Table 1: Showing features and dimensions (in cm) of block vertebrae at different levels

Note: UF: Unfused, PF: Partial fusion, CF: Complete fusion, AF: Asymmetric fusion, Lt: left, Rt: right, PV: Preceding vertebra, SV: Succeeding vertebra.

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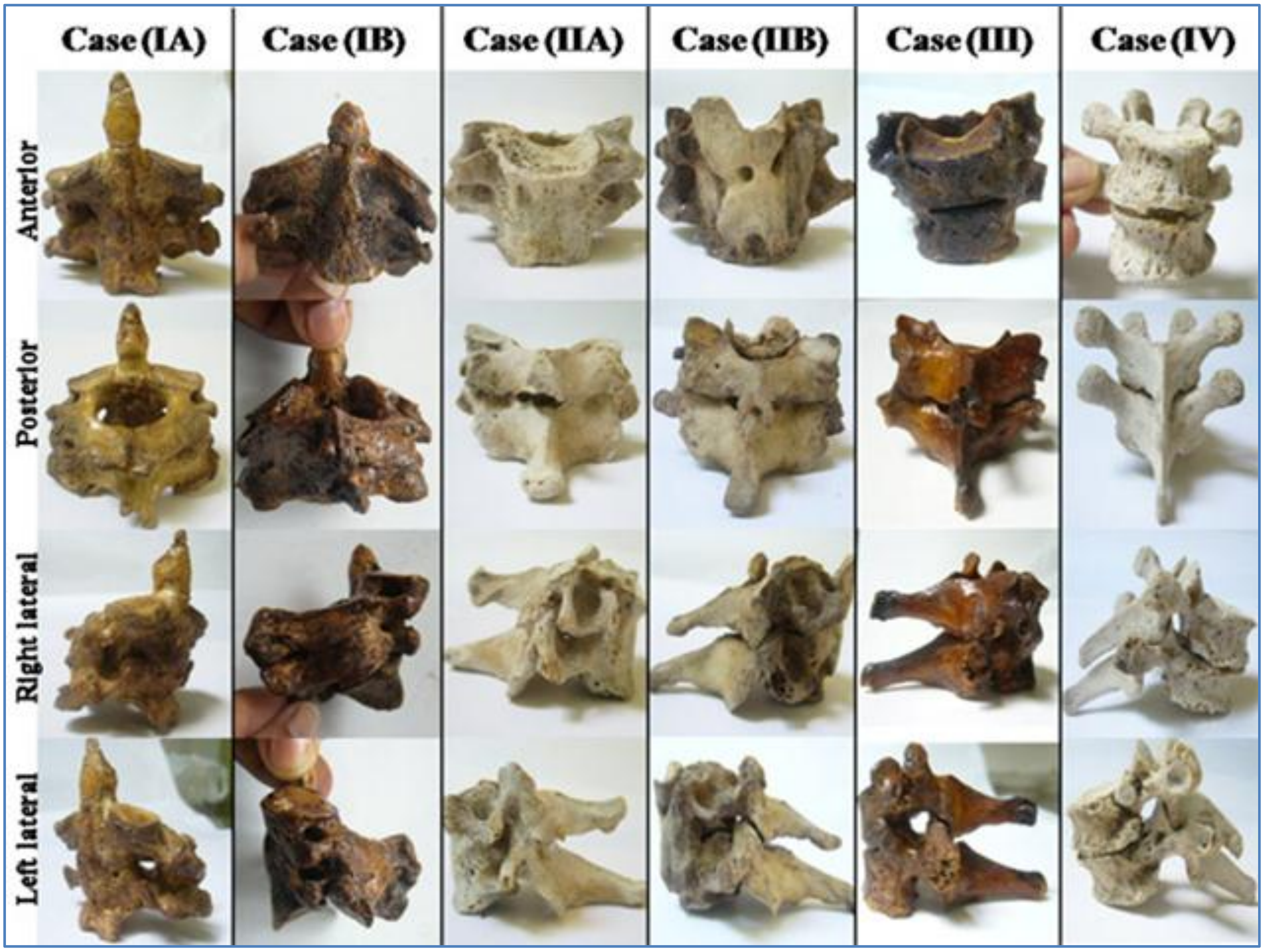

Figure 1: Shows photographs of block vertebrae taken from anterior, posterior, right lateral and left lateral aspects. Case IA: fusion of C2-C3 vertebral bodies, articular process and prominent IVF. Case IB: fusion of C2-C3 bodies, articular process, laminae and spine, with narrowed IVF. Case II A: complete fusion of C6-C7 bodies, articular process and partial fusion of laminae. Case II B: partial fusion of C6-C7 bodies with ossification of anterior longitudinal ligament. The articular process and laminae unfused. Case III: Asymmetric fusion of C7-T1 vertebral bodies, with larger left IVF. Case IV: Partial fusion of T6-T7, with well-defined IVF.

CERVICAL VERTEBRAL SYNOSTOSIS:
CASE-I: Cervical Vertebral synostosis at C2-C3: Two cases.

CASE I A: The body and articular processes were completely fused but the laminae showed partial fusion on left side. The pedicles and spinous processes remained unfused [Figure 1(IA)]. The IVF were well defined and the maximum diameter measured 1.0 cm on right and 0.8 cm on left side. The VF and FT appeared normal. The vertebral body height measured 3.5 cm on right and 3.3 cm on left side. The FT in C2 measured 0.6 cm on right and 0.5 cm on left side. Whereas, the FT in C3 measured 0.6 cm on right and 0.7 cm on left side. (Table 1)

CASE I B: The body, articular processes, laminae and spinous processes showed complete fusion but pedicles were partially fused [Figure 1(IB)]. The IVF were narrowed and measured 0.5 cm on right and 0.3 cm on left side. The VF and FT appeared normal. The height of the fused vertebral bodies was 3.2 cm on right side and 3.0 cm on left side. The FT in C2 measured 0.4 cm on right side and 0.2 cm on left side. Whereas, the FT in C3 measured 0.6 cm on right side and 0.3 cm on left side. (Table 1)

CASE-II: Cervical Vertebral synostosis at C6-C7: Two cases.

CASE II A: Their bodies and articular processes were completely fused. The lamina showed partial fusion on right side. The spinous processes were unfused. The IVF were evident between the two fused vertebrae. But the transverse bars of preceding vertebra (C6) were partially encroaching on to the IVF bilaterally giving it an arcuate appearance [Figure 1(IIA)]. The height of fused vertebral bodies was 2.1 cm on right side and 2.3 cm on left side. The maximum diameter of FT in C6 on right side measured 0.5 cm and left side measured 0.7 cm. The superior vertebral notches of C6 were narrowed due to the osteophytes. The VF was triangular showing irregular anterior boundary formed by fused vertebral bodies. (Table1).

CASE II B: The bodies were partially fused. The laminae, articular processes and spinous processes remained unfused. A definitive IVF were observed between the two fused vertebrae [Figure 1(IIB)]. The height of fused vertebral bodies measured 3.0 cm on right side and 3.2 cm on left side. Anteriorly the fused bodies showed abnormal ossification of the anterior longitudinal ligament. The VF was normal. The maximum diameter of the FT in C6 vertebra on right side measured 0.7 cm and left side measured 0.8 cm. The maximum diameter of FT in C7 vertebra on right side measured 0.6 cm and left side measured 0.4 cm. The superior vertebral notch of C6 was narrowed and measured around 0.3 cm on both the sides. (Table 1)

CERVICO-THORACIC VERTEBRAL SYNOSTOSIS:

CASE-III: Cervico-Thoracic vertebral synostosis at C7-T1: One case

There was asymmetric fusion of 7th cervical and 1st thoracic vertebrae with the bodies fused more on right side. The articular facets were completely fused on right side and remained unfused on left side [Figure 1(III)]. The IVF was larger on left side, measuring 1.0cm. The laminae and spinous processes were unfused. The costal facets were well defined and were present at the junction of fused vertebral bodies on right side. The height of fused vertebral bodies measured 2.7 cm on right side and 3.2 cm on left side. (Table 1)

THORACIC VERTEBRAL SYNOSTOSIS:

CASE-IV: Thoracic vertebral synostosis at T6-T7: One case

Their bodies were partially fused, but the articular processes, laminae and spinous processes were un fused. A definitive oval IVF was present between the two fused vertebrae [Figure 1(IV)]. The height of fused vertebral bodies was 3.3 cm on right side and 3.2 cm on left side. The IVF measured 1.2 cm on right and 1.0 cm on left side. (Table 1)

DISCUSSION: Block vertebrae mostly are attributed to developmental defects during differentiation of vertebral column, caused by non-segmentation of the primitive sclerotome. It has also been hypothesised that decreased local blood supply during 3rd to 8th week of development results in inappropriate segmentation.[6] Vertebral synostosis is the hallmark of Klippel Feil Syndrome (KFS), a triad of short neck, low posterior hairline and restricted neck mobility. The environmental or genetic factors like Mutation of Pax gene influence this anomaly.[7] Familial KFS is located on locus of chromosome 8q. Based on clinico-radiological features, KFS is classified into 3 types: Type I: Massive fusion of cervical and upper thoracic vertebrae into block, Type II: Isolated cervical fusion at C2-C3 or C5-C6 and Type III: Cervical fusion associated with lower thoracic or lumbar fusion. The C2-C3 or C5-C6 fusion is an autosomal dominant disorder and thoracic or lumbar fusion is an autosomal recessive disorder.[8]

Acquired fusion of vertebrae may be differentiated from congenital anomalies by a history of trauma or infection and by x-ray evidence of degeneration of the involved functional spinal unit.[9] Whereas, congenital fusions are characterized by absence of the intervertebral disc, or its replacement by a radio-opaque line; the "wasp-waist" appearance; smooth intervertebral foramina; a single spinous process for two vertebral bodies; and maintenance of vertebral body height on roentgenologic examination.[10] The clinical symptoms may vary from asymptomatic to myelopathy. Generally, restricted neck movement, muscular weakness, atrophy, neurological sensory loss with minor intermittent head and neck pain are associated with block vertebrae.[3]

The incidence of block vertebrae varied in literature, but is most commonly seen in cervical region. The prevalence of vertebral fusion in Lithuanian population was reported as 2.6% in cervical, 1.6% in thoracic and 0.5% in lumbar vertebrae.[11] In a recent study done on 48 adult dried vertebral columns, the incidence was found to be 6.25% in cervical, 4.16% in thoracic and 2.08% in lumbar regions.[12] In the present study, we observed four cases of cervical vertebral synostosis, one case of cervico-thoracic synostosis and one case of thoracic vertebral synostosis in 2400 vertebral specimens, which accounted for a total incidence of block vertebrae as 0.25%. The incidence of cervical vertebral synostosis was 0.5%, cervico-thoracic was 0.05% and thoracic was found to be 0.08%. The trends of fusion remain the same in all these studies including ours, with cervical spine involvement more frequent in fusion than thoracic or lumbar regions.

According to frequency, the commonest site of block vertebrae is C2-C3 with an incidence of 0.4% to 0.7% followed by C5-C6, lumbar (L4-L5) and thoracic region.[13] Up to 70% of occipitalizations have been seen associated with C2-C3 fusion with instability at the atlanto- axial articulation.[4] In our study, we observed two cases of C2-C3 fusion with no association of occipitalization. Previous reports have shown that upper fused cervical vertebrae cause laxity of ligaments between the occiput and the atlas, resulting in brainstem or cord compression and associated neurological symptoms.[14] The fused cervical vertebrae cause segmental dysfunction and can lead to Cervicogenic angina due to cervical nerve root irritation, mimicking true cardiogenic angina.[15] Anatomical explanation to this is, narrowing of IVF interposed between the fused vertebrae, causing compression of the structures passing through it, leading to neurological and vascular symptoms. In our study, the maximum diameters of IVF estimated in case IA, case IIA and case IIB was found to be much reduced (Table 1), when compared to normal standard IVF dimensions of cervical region.[16] Further, in case III of cervico-thoracic synostosis, due to asymmetric fusion of vertebrae, the left IVF was found to be much narrowed (Table 1) causing ipsilateral neurological symptoms due to left spinal nerve involvement.

Massive fusion of thoracic vertebrae can narrow the thorax leading to respiratory distress. Asphyxiating thoracic dystrophy is caused by narrow thorax and short ribs.[17] Butler (1971) described the anterior bony fusion of two vertebral bodies to be a rare manifestation of Scheuermann's vertebral osteochondritis, a condition of herniation of IVD tissues through the cartilage end plate of the vertebral bodies, which later on ossifies resulting in fusion of vertebral bodies.[18] In our study, the fusion between the thoracic vertebrae (case III) resembles that of osteochondritis with the vertebral bodies fused only anteriorly, hence appearing as acquired fusion (Figure 1).

Block vertebrae results in disturbance in postural biomechanics causing degenerative changes and disc prolapse at the adjoining segments in advanced age.[4] Hyperextension of neck while performing endo-tracheal intubation can precipitate disc prolapse in persons with the block vertebrae. If cisternal puncture or lumbar puncture is to be done, clinician should look for the possibility of block vertebra in cervical and lumbar regions respectively.[6] Hence early diagnosis and appropriate counseling on the management of known risk factors will be helpful, including change in lifestyle or therapeutic options.

CONCLUSION: The present study provides a comprehensive anatomy of block vertebrae involving different levels, with a total incidence of 0.25% and maximum frequency at cervical region. A greater knowledge of location, incidence and extent of fusion may assist the clinician in distinguishing congenital defects from acquired one and in analyzing the anatomical basis of compression symptoms. To the best of our knowledge, this is the first study estimating the incidence of block vertebrae in south Indian population.

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REFERENCES:

1. Thomas D, Kulkarni B G. A case of fusion of thoracic vertebra. Journal of Ayurveda and Holistic Medicine 2013; 1 (5): 23-26.
2. Kulkarni V, Ramesh BR. A spectrum of Vertebral Synostosis. International Journal of Basic and Applied Medical Sciences 2012; 2 (2): 71-77.
3. Erdil H, Yildiz N, Cimen M. Congenital fusion of cervical vertebrae and its clinical significance. Journal of Anatomical Society of India 2003; 52 (2): 125-127.
4. Soni P, Sharma V, Sengupta J. Cervical vertebral anomalies- incidental findings on lateral cephalograms. The Angle Orthodontist 2008; 78 (1): 176-180.
5. Elster AD. Bertolottis syndrome revisited transitional vertebrae of the lumbar spine. Spine 1989; 14 (12): 1373-7.
6. Wazir S, Mahajan A. Fusion of axis with third cervical vertebra-a case report. Indian J Fundamental Appl Sci 2011; 1 (4): 164-166.
7. Sherekar SK, Yadav YR, Basoor AS, Baghel A, Adam N. Clinical implications of alignment of upper and lower cervical spine. Neurological society of India 2006; 54: 264-267.
8. Gunderson CH, Greenspan RH, Glaser GH, Lubs HA. The Klippel Feil syndrome: genetic and clinical re-evaluation of cervical fusion. Medicine 1967; 46: 491-512.
9. Meschan I. Analysis of roentgen signs in general radiology. Vol no. 1. WB Saunders Company, Philadelphia. London. Pp 618-620. (1973).
10. Brown MW, Templeton AW, Hodges FJ III. The incidence of acquired and congenital fusions in the cervical spine. Am J Radiol 1964; 92: 1255-1259.
11. Masnicova S, Benus R. Developmental anomalies in skeletal remains from the Great Moravia and Middle Ages cemeteries at Devin. International journal of osteoarchaeology 2003; 13: 266-274.

12. Sharma M, Baidwan S, Jindal AK, Gorea RK. A study of vertebral synostosis and its clinical significance. J Punjab Acad Forensic Med Toxicol 2013; 13 (1): 20-23.
13. Samartzis D, Herman J, Lubicky JP. Classification of congenitally fused cervical patterns in Klippel Feil patients; Epidemiology and role in the development of cervical spine-related symptoms. Spine 2006; 31 (21) E 798-804.
14. Yadav Y, Goswami P, and Bharihoke V. Cervical Vertebra Synostosis (C2-C3) - A Case Report. American Journal of Medical Case Reports 2014; 2.6: 120-122.
15. Ito Y, Tanaka N, Fujimoto Y, Yasunaga Y, Ishida O, Ochi M. Cervical angina caused by atlantoaxial instability. J Spinal Disord Tech 2004; 17: 462-465.
16. Ruhli FJ, Henneberg M. Clinical perspectives on secular trends of intervertebral foramen diameters in an industrialized European society. Eur Spine J 2004; 13 (8): 733-739.
17. Bhargava S. Radiological Differential Diagnosis. 1st ed. New Delhi: Jaypee Brothers; 2005. p. 528.
18. Butler RW. Spontaneous anterior fusion of vertebral bodies. J Bone Joint Surg Br 1971; 53 (2): 230-235.

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