Original Research Paper

A STUDY OF VERTEBRAL SYNOSTOSIS AND ITS CLINICAL SIGNIFICANCE

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Article history
Received June 05, 2013
Recd. in revised form June 12, 2013
Accepted on June 24, 2013
Available online June 25, 2013

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Abstract

Knowledge about any deviation from the normal anatomy of our vertebral column is very essential especially for an 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 either asymptomatic or a cause of discomfort and inability to carry out various day to day activities because of the important structures related to them. Fusion between the adjoining vertebrae may limit our movements especially in lumbar and cervical regions. This deviation is also helpful in identification of the individuals and is important for forensic medicine experts to know in certain situations. The present study was conducted on 48 adult dried vertebral columns to know the incidence of vertebral fusion in different regions; any associated structural abnormality, which might be a cause of neural or vascular symptoms. The incidence of fusion was seen maximum in lumbosacral region (10.46%), then in cervical, thoracic and lumbar regions in decreasing order. The causes could be congenital (failure of re-segmentation of somitomeres) or acquired thereby determining the extent of fusion between different parts of vertebrae involved in fusion.

Keywords: Identification; vertebral synostosis; vertebral anomalies

Introduction

The spinal column is the central structure in the vertebrate body which provides stability, posture and initiates all the movements. Formation of spine during embryonic life is a highly complex and regulated process. If disrupted, can lead to a variety of congenital anomalies including block vertebra, hemivertebra etc [1]. Abnormal fusion of vertebrae in different regions of vertebral column can lead to a variety of symptoms or may be asymptomatic depending upon the degree of compression exerted by such fused vertebrae on adjoining structures like nerves, blood vessels or spinal cord. Previous authors [2] named the fusion of vertebrae as Klippel Feil syndrome in cervical region, synspondylism in thoracic region or block vertebra in lumbar region

The fusion may be congenital due to failure of segmentation of sclerotomes at certain levels or may be acquired due to a number of other causes like tuberculosis, juvenile rheumatoid arthritis or trauma etc**.** Congenital anomalies like Klippel feil syndrome, fetal alcohol syndrome are associated with vertebral fusion. 75% of

vertebral fusions occur in cervical region [3]. Congenital anterior fusion of vertebrae is usually asymptomatic. Awareness of this anomaly is important for correct diagnosis [4].

Cervical vertebral fusion if accompanied by spinal canal stenosis, needs appropriate treatment and care, to avoid any complications. Thoracic vertebrae may be fused, although less frequently as compared to cervical, due to ossification of anterior longitudinal ligaments as seen in diffuse idiopathic skeletal hyperostosis(DISH), ankylosing spondylitis, osteochondritis etc. Transitional vertebra i.e Sacralisation of last lumbar vertebra (partial or complete) may be a cause of disc bulge or herniation nine times more common at the interspace immediately above it than at any other level [5].

Material and methods

The present study was conducted on 48 dried adult vertebral columns obtained from the Anatomy department of Gian Sagar Medical College & Hospital, Ramnagar, Patiala in Punjab. The vertebrae of all the regions were studied to see if there is any abnormal fusion between contiguous vertebral bodies, pedicles, laminae, spines or transverse processes. The measurements were done with the help of digital Vernier callipers having resolution of 0.02mm

Inclusion criteria- all intact adult vertebrae were included.

Exclusion criteria- neonatal and broken vertebrae were excluded from the study.

Observations

Upper Cervical vertebrae were found fused in 6.25% (cases1-3). Two Thoracic vertebrae in two thoracic spines were fused (4.16%) (Cases- 4, 5). Two lumbar vertebrae of one lumbar spine were fused (2.08%) (case - 6). Sacralisation of L5 (partial or complete) was observed in 10.41% (cases-7-11). Coccyx was fused to sacrum in 3 cases (6.25%) (cases- 12-14)

Case-1(figure-4, 5) in which C1, C2 and C3 vertebrae were fused seen as a single functional unit, with forward displacement of atlas, dens lying almost in the center of vertebral foramen, which measured 7.11mm antero-posteriorly. Lateral masses of atlas were fused with the superior articular facets of axis on both sides, bodies of 2nd and 3rd cervical vertebrae completely fused, and fusion of the left laminae of these two vertebrae. The spines and transverse processes of all the three vertebrae were separate. The facet for dens on the posterior aspect of anterior arch of atlas was also not well defined.

Case-2 was that of a block vertebra in which there was fusion between C2 &C3 with fused spines and laminae, bodies fused partially on the anterolateral aspect and completely posteriorly. Left superior articular facet of C2 showed wider and pitted surface, which overlapped the foramen transversarium of C2. Right intervertebral foramen was 7.12mm in height, but could not be measured on left side being overlapped by enlarged and uneven surfaced superior articular facet of C2(figure-1,2,3).

Case-3 bodies of C2 and C3 were partially fused on either side, articular processes completely fused with no fusion between spines and laminae. The intervertebral foramen was 9.48mm on right side and 11.07mm on left side (figure-4, 5).

Case-4, 5 in thoracic region, out of 48 vertebral columns, 2 cases showed fusion, only of two adjoining typical vertebral bodies partially. Case-4(figure 6) was the fusion between T2 and T3 vertebrae, whereas in case 5 the fusion was between T3 and T4 vertebrae both the cases showed fusion of their bodies only in the anterior median line, with no other part fused, maintained intervertebral disc space in both the cases.

Case-6 (figure-7, 8) in lumbar region, only two lumbar vertebrae L1 and L2 of one vertebral column were noted to have fused bodies with no fusion of vertebral arches. The bodies were completely fused with slight bulging at the level of fusion.

In lumbosacral region cases7-11(figure-9-13), complete or partial fusion between 5th lumbar vertebra and first sacral segment of the sacrum was observed. According to classification given by Castellvi et al, 2007 [6], two out of five cases

belonged to type III-B i.e fusion of both the transverse processes with the ala of sacrum, two were type III-B, but with bodies also fused with first sacral segment. One was of type-IV i.e. mixed type with left transverse process completely fused with ala, while the right transverse process enlarged.

In cases 12-14, the coccyx was fused with the last piece of sacrum forming five pairs of sacral foramina rather than four. The sacral cornua were ending higher up at the last sacral segment.

Discussion

During development of vertebrae the re-segmentation is very important. Inappropriate vertebral fusion results in anomalous vertebral synostosis or spinal fusion [2]**.** The etiology of fusion may be congenital, acquired or surgical. There may be associated anomalous fusion of cervical spine in conditions like Willet- Sprengel shoulder, Brevicollis, Kyphosis, congenital deafness, renal agenesis or cardiovascular abnormalities etc [7]. Prevalence of vertebral fusion in Lithuanian population was 2.6% in cervical, 1.65% in thoracic and 0.5%in lumbar vertebrae observed by previous workers[2]**.** In the present study, the incidence was 6.25% in cervical, 4.16% in thoracic and 2.08% in lumbar regions indicating the trend of fusion remaining the same in both the studies with cervical spine involved more frequently in fusion than thoracic and lumbar.

Congenital Cervical vertebral fusion leads to decrease in length of spine, prominent trapezei, webbed neck, lowered hair line, signs of peripheral nerve compression. Previous workers [8] found the incidence of C2-C3 fusion to be 0.4-0.7%. Abnormal segmentation of sclerotomes leading to formation of block vertebra during development may be because of decreased blood supply during 3rd- 8th weeks of intrauterine life [9]**.** Vertebral fusion anomalies are likely to be associated with disturbance of Pax-1 gene expression in developing vertebral column [10]**.**

In case-1 of present study**,** the antero-posterior diameter of vertebral foramen of atlas with fused axis and displaced dens was 7.11mm as compared to the values of AP diameter of atlas given by Gosavi and Vatsalaswamy, 2012 [11] who in their study observed it to be on an average between 25.66-27.89mm with a standard deviation of 2.59mm. With the dens almost in the center of vertebral foramen (fixed because of fusion between lateral masses of atlas and axis), narrowing it to a great extent might be a cause of neurological symptoms due to compression of spinal cord.

In case 2 of present study the intervertebral foramen height between fused C2 and C3 vertebrae was 7.12mm on right side in contrast with the observations of Lentell et al, 2002 [12] who found it to be on an average 12.2±1.3mm. Narrowing of the foramen might compress the structures passing through it leading to neurological and vascular symptoms.

According to Romanes, 1981 [13] congenital anomalies at cranio-vertebral or cervical region are common. Fusion between C2 and C3 vertebrae leads to limited movement between them and therefore C3 vertebra is given the name vertebra critica [14]**.**

Butler 1971 [15] 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. In the present study the fusion between the thoracic vertebrae resembles that of osteochondritis with the vertebral bodies fused only anteriorly.

In the present study the incidence of sacralisation was 10.42%, the previous authors observed it to be 9.2% [16], 11.6% [17] 14% [18][8].Sacralisation can have a bearing on the counting of vertebral levels especially during planning of spinal surgery [19]**.** Previous workers [20, 21] in their studies concluded that any change from the normal pattern of lumbar and sacral vertebrae such as lumbosacral transitional vertebra result from the mutation of Hox-10 and Hox-11 genes.

Sacralization of coccyx as observed in 6.25% cases in the present study may be a cause of failure of caudal block failure because of inability to feel the sacral cornua

an important landmark during the procedure of caudal anesthesia. It may also be a reason for prolonged second stage of labour and increased frequency of perineal tears because of immobility of coccyx and no increase in anteroposterior diameter of pelvic outlet during labour [22].
In case of unknown bodies with vertebral synostosis, if the ante mortem radiographs of such cases of vertebral synostosis are available then these radiographs may be helpful in identification of the dead bodies.

Conclusion

From the present study, we can conclude that after the lumbosacral region, cervical vertebrae are most commonly involved in congenital fusion especially those of upper cervical spine, whereas thoracic and lumbar vertebrae are usually fused due to acquired causes which may be infective, traumatic or surgical and vertebral synostosis can be helpful feature for identification.

Conflict of Interest

None Declared

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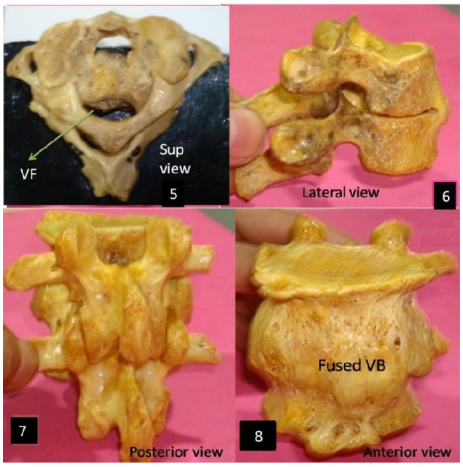
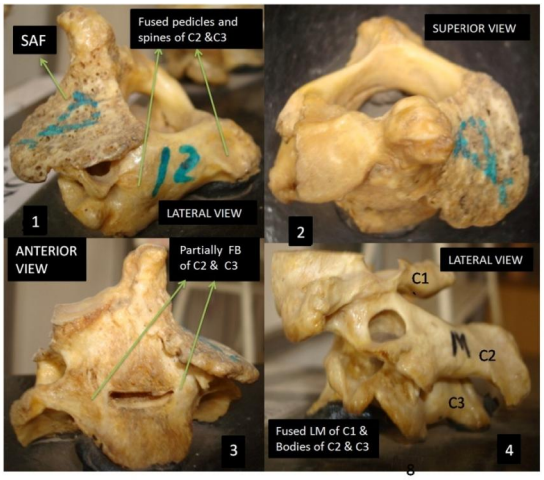
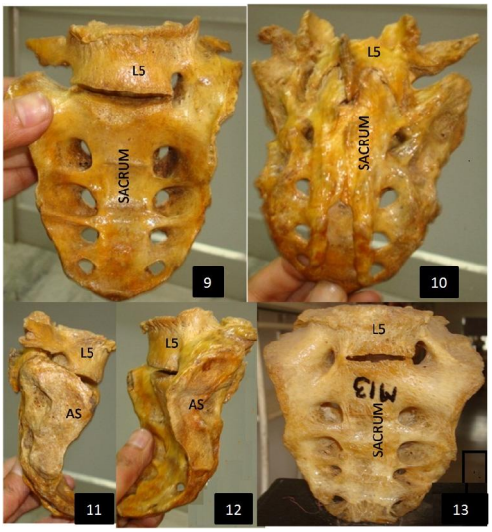


Legend 2: Figure-5 superior view of fused first three cervical vertebrae with atlas displaced forwards narrowing the vertebral foramen(VF). Gap between anterior arch of atlas and dens of axis can be seen. Figure-6 showing the partial fusion of thoracic(T2 &T3) vertebral bodies in the lateral view. Figure-7,8 showing posterior and anterior view of lumbar vertebrae(L2 & L3) with no fusion of vertebral arches and completely fused vertebral bodies(VB) with slight bulging at this level.



Legend 1: Figure-1 left lateral view of fused 2nd and 3rd cervical vertebrae showing fused spines and pedicles along with pitted and widened left superior articular facet of axis. Figure-2 is the superior view of the same vertebrae showing the left superior articular facet of axis overlapping the foramen transversarium. Figure-3 is depicting partially fused bodies (FB) of these vertebrae. Figure-4 showing first three cervical vertebrae fused in left lateral view with lateral masses of atlas fused with axis and 2nd and 3rd cervical bodies fused.



Legend 3: figure-9-12 showing anterior, posterior, lateral views of unilateral fusion of L5 vertebral transverse process (left) with ala of sacrum with enlarged right transverse process, (AS-auricular surface) Figure-13 showing bilateral fusion of L5 with ala of sacrum with partially fused bodies of L5 and S1 with 5 pairs of sacral foramina.

This article can be cited as:
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):20-4.