RESEARCHERID
THOMSON REUTERS
Open Access Journal
International Journal of Medical Research and Pharmaceutical Sciences
Volume 4 (Issue 8): August 2017 ISSN: 2394-9414
DOI- 10.5281/zenodo.846753 Impact Factor- 3.109

COMPARISON OF MORPHOMETRIC PARAMETERS BETWEEN SYNOSTOSIS VERTEBRAE AND NORMAL VERTEBRAE WITH ITS CLINICAL SIGNIFICANCE

Dr. Naina Wakode*[1] Dr. Santosh Wakode[2]
*[1] Department of Anatomy AIIMS, Bhubaneshwar, India
[2]Department of Physiology, AIIMS, Bhopal, India

Keywords: *Vertebral synostosis, Klippel Feil syndrome, Intervertebral foramen, fused type of osteophyte.*

Abstract

Objective: Vertebral synostosis results in disturbance in postural biomechanics causing early degenerative changes like osteophytes formation, neurological deficits and disc prolapse in the advance age. The present study was aimed to assess the incidence of vertebral synostosis in eastern region of India and to see the comparisons of morphometric parameters between synostosis vertebrae and normal vertebrae.
Material & Method: In present study, we observed a total of 1506 fully ossified vertebrae
Results: Case 1: Incomplete fusion of 6th and 7th cervical vertebra. The intervertebral foramen dimensions of fused cervical vertebra decrease as compare to normal intervertebral foramen of cervical vertebra. Case 2: partial fusion of 12th thoracic vertebra with 1st lumbar vertebra. Case 3: complete fusion between the 4th lumbar vertebra with 5th lumbar vertebra. The features of the vertebral synostosis were analyzed in detail. The total incidence of vertebral synostosis found to be 0.199%.
Conclusion: Vertebral synostosis may be due congenital condition or may be due to acquired condition. Diagnosis of such anomalies can be of great importance for the patients so that necessary management or lifestyle changes can be done to prevent the severity of degeneration.
.

Introduction

Alternation in the expression of 20p11 gene have been associated with some vertebral anomalies. Mutation in Hox gene family have been found detected in cervical vertebral anomalies (1, 2). Vertebral synostosis results in disturbance in postural biomechanics causing early degenerative changes like osteophytes formation, neurological deficits and disc prolapse at the adjoining segments in the advance age. The etiology of vertebral synostosis may be congenital or acquired. Synostosis in vertebra can be in the form of complete or incomplete fusion that is, only the body is fused, or fusion of neural arches only. Incidence of congenital vertebral synostosis varied in literature, but is most commonly seen in cervical region, followed by thoracic and lumber region. Sharma M (3) studied 48 adult dry vertebral columns and incidence was found to be 6.25% in cervical region, 4.16% in thoracic and 2.08% in lumbar region.

In present study, we observed a total of 1056 fully ossified vertebrae and documented one cervical fusion, one thoracolumbar fusion, one case of lumbar vertebra fusion. The present study was aimed to assess the incidence of vertebral synostosis in eastern region of India and to see the comparisons of morphometric parameters between synostosis vertebrae and normal vertebrae with its clinical significance.

Materials and methods

A study was conducted on 1056 fully ossified vertebrae in department of anatomy, AIIMS, Bhubaneswar. On examinations of all vertebrae, we found fusion of 6th and 7th cervical vertebra, fusion of the 12th thoracic vertebra with 1st lumbar vertebra and fusion between 4th and 5th lumbar vertebra. Reading of all parameter was taken with the help of sliding caliper (Figure 1) and reading is in millimeters.

RESEARCHERID
THOMSON REUTERS
Open Access Journal
International Journal of Medical Research and Pharmaceutical Sciences
Volume 4 (Issue 8): August 2017 ISSN: 2394-9414
DOI- 10.5281/zenodo.846753 Impact Factor- 3.109

Results and Discussion

Case 1: Incomplete fusion of 6th and 7th cervical vertebra. Only the body of 6th and 7th cervical vertebra fused anteroposteriorly, and transversely. No fusion of other elements like pedicle, lamina, transvers process and spinous process. (Figure 1). Morphometric readings of various parameters of fused vertebra and normal vertebra given in Table No. 1. The intervertebral foramen dimensions of fused cervical vertebra decrease as compared to the normal intervertebral foramen of the cervical vertebra.

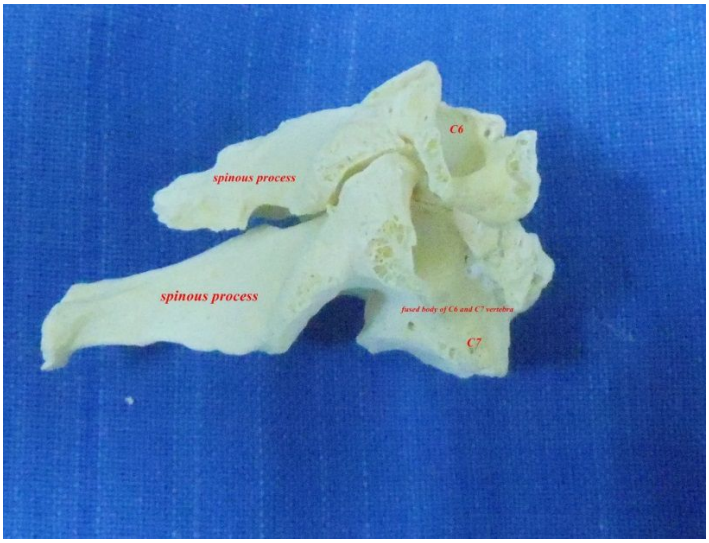

Figure 1: Fusion of the body of C6 and C7 vertebra

Table 1. Morphometric readings of various parameters of fused vertebra and normal vertebra

Sr. no.	Parts of vertebra	Parameters	Fused cervical vertebra		Normal cervical vertebra	
1	Body	Height	24.88		13.09	
		Anteroposterior diameter	15.38		17.18	
		Transverse diameter	15.03		17.38	
2	Pedicle		Right side	Left side	Right side	Left side
		Height	19.88	20.32	9.39	7.6
3	Lamina thickness	At upper level	2.44	3.41	1.79	1.85
		At middle level	5.25	5.62	3.9	4.02
		At lower level	3.21	3.88	3.91	3.77
4	Intervertebral foramen	Superoinferior height	9.01	9.68	10.25	10.22
		Transverse diameter	6.24	5.36	7.50	6.91

Case 2: Partial fusion of 12th thoracic vertebra with 1st lumbar vertebra. A fusion of the anterior region of the body occur only. Costal facet were completely fused on right side. On left side costal facet visible. Posterior part of the body, articular process, laminae, and spinous processes were unfused. Fusion was incomplete. (Figure 2) As compared to normal vertebra anteroposterior and transverse diameter of the body of fused thoracolumbar vertebra definitely increased. (Table no. 2)

RESEARCHERID
THOMSON REUTERS
Open Access Journal
International Journal of Medical Research and Pharmaceutical Sciences
Volume 4 (Issue 8): August 2017 ISSN: 2394-9414
DOI- 10.5281/zenodo.846753 Impact Factor- 3.109

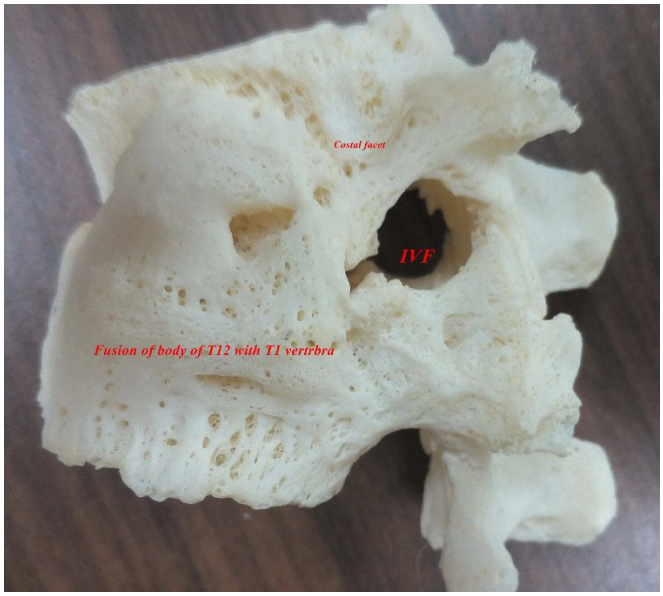

Figure 2: Fusion of body of T12 with L1 vertebra

Table 2. Morphometric readings of various parameters of fused vertebra and normal vertebra

Sr. no.	Parts of vertebra	Parameters	Fused thoracic with lumbar vertebra		Normal thoracic vertebra	
1	Body	Height	45.85		13.09	
		Anteroposterior diameter	22.38		17.18	
		Transverse diameter	28.03		17.38	
2	Pedicle	Height	Right side	Left side	Right side	Left side
			19.98	20.55	9.39	7.6
3	Lamina thickness	At upper level	2.44	3.41	1.79	1.85
		At middle level	5.25	5.62	3.9	4.02
		At lower level	3.21	3.88	3.91	3.77
4	Intervertebral foramen	Superoinferior height	9.40	8.89	10.94	9.87
		Transverse diameter	3.22	3.56	4.26	4.08

Case 3: Complete fusion between the 4th lumbar vertebra with 5th lumbar vertebra. A pear shape intervertebral foramen visible on the right side while on left side, kidney shaped intervertebral foramen were present. Massive "fused type of osteophyte" found on the anterior surface of body of the lumbar vertebra. (Figure 3). As compared to the normal vertebra anteroposterior and transverse diameter of the body of fused the lumbar vertebra definitely increased. The diameters of the intervertebral foramen (IVF) found to be decreased in the fused lumbar vertebra. (Table no.3)

RESEARCHERID
THOMSON REUTERS
Open Access Journal
International Journal of Medical Research and Pharmaceutical Sciences
Volume 4 (Issue 8): August 2017 ISSN: 2394-9414
DOI- 10.5281/zenodo.846753 Impact Factor- 3.109

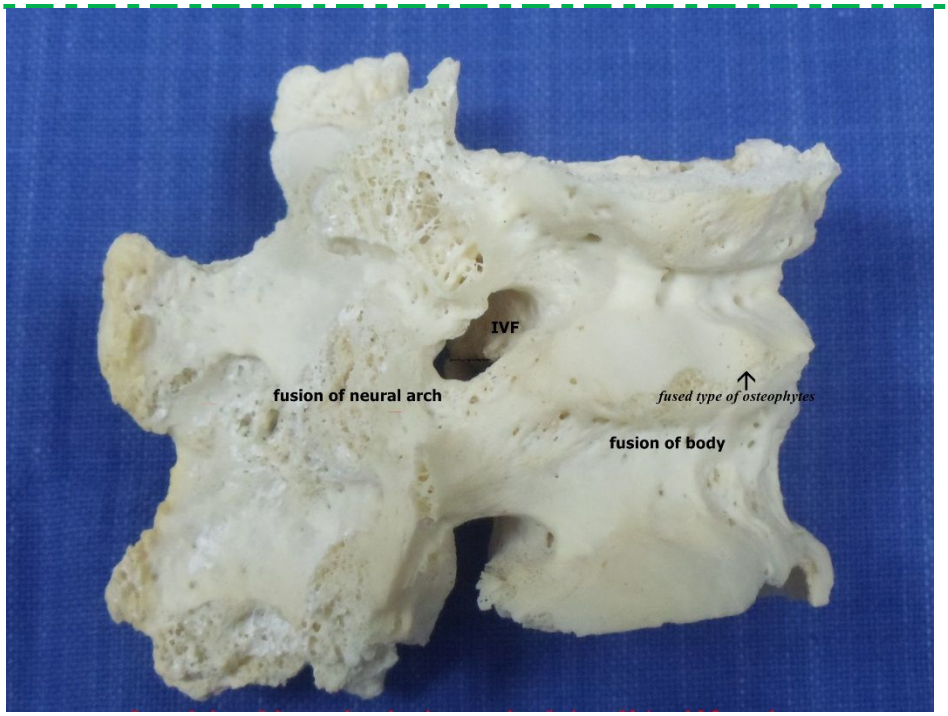

Figure 3: Complete Fusion of L3 and L4 vertebra

Table 3. Morphometric readings of various parameters of fused lumbar vertebra and normal vertebra

Sr. no.	Parts of vertebra	Parameters	Fused lumbar vertebra		Normal vertebra	
1	Body	Height	49.44		23.44	
		Anteroposterior diameter	30.20		34.68	
		Transverse diameter	51.78		40.78	
2	Pedicle	Height	Right side	Left side	Right side	Left side
			38.74	44.21	13.12	13.53
3	Lamina thickness	At upper level	3.94	4.51	4.53	3.39
		At middle level	12.82	11.78	6.80	8.08
		At lower level	6.97	5.47	5.86	6.85
4	Intervertebral foramen	Superoinferior height	13.59	11.48	15.57	13.25
		Transverse diameter	4.09	6.53	6.45	7.82

We observed the three cases of vertebral synostosis and the total incidence of vertebral synostosis found to be 0.199%.

RESEARCHERID
THOMSON REUTERS
Open Access Journal
International Journal of Medical Research and Pharmaceutical Sciences
Volume 4 (Issue 8): August 2017 ISSN: 2394-9414
DOI- 10.5281/zenodo.846753 Impact Factor- 3.109

Discussion

It is important to identify the cause of vertebral synostosis whether it is congenital or acquired. Vertebral synostosis has been reported by many authors and is most commonly found at C2-C3, C5-C6, T12- L1, L4-L5, in order of incidence (4, 5). Somites are formed from paraxial mesoderm that lies on each side of neural tube. The somites are subdivided into three parts, ventromedial sclerotome, intermediate myotome, and lateral dermatome. During the fourth week, sclerotome cells migrate around the spinal cord and notochord to merge with cells from opposing somite on the other side of neural tube. As development continues, the sclerotome portion of each somite also undergoes a process called resegmentation. Resegmentation occur when the caudal half of each sclerotome grows into and fuse with the cephalic half of each subjacent sclerotome. Thus, each vertebra is formed from the combination of the caudal half of one somite and the cranial half of its neighbor (6). Congenital synostosis of vertebra is because of embryological failure of normal spinal segmentation. The probable reason behind this is the decrease in blood supply to fetus during 4-8th week of gestation (7). Congenital vertebral synostosis may be due to Klippel Feil syndrome, Larsen syndrome, spondylocarpotarsal syndrome and Goldenhar syndrome. Diagnosis of such anomalies can be of great importance for patients so that necessary management or lifestyle changes can be done to prevent or delay the severity of degeneration.

A study by Yogesh et al. (8) has noted that cervical congenital vertebral synostosis between C2 and C3, can lead to severe neck pain, muscular weakness and sensory involvement of bilateral upper limbs and even sudden unexpected death. Klippel Feil syndrome generally present with the triad short neck, low hair line, restricted neck movement. Murice Klippel and Andre Feil categorized cervical synostosis into 3 types.

Type I- Fusion of many cervical and upper thoracic vertebra.
Type II- Fusion of 2nd cervical vertebra with 3rd cervical vertebra or hemivertebra.
Type III- cervical fusion with lower thoracic or lumbar vertebral fusion.

Radiologically Klippel Feil syndrome shows anteroposterior narrowing of vertebral bodies (Wasp's waist sign). In present study, anteroposterior diameter of cervical vertebra in middle position were definitely decreased. As there were no degenerative changes in present case of cervical vertebral synostosis, so more likely it goes toward congenital defect. In such cases, there were maximum chances of complications like canal stenosis, herniation and myelopathies. (9, 10, 11). Same was also noted by Erdil H (12). Congenital cervical vertebral synostosis may be found in some other syndromes and their comparisons were given in Table no. 4

Table no. 4: Comparisons of Congenital cervical vertebral synostosis

	Syndrome	Congenital cervical vertebral synostosis with other features
1	Klippel Feil syndrome	Hemivertebrae, spina bifida, scoliosis, Sprengel deformity, Chiari I malformation, associate cord abnormalities
2	Spondylocarpotarsal synostosis	Scoliosis, lordosis, carpal and tarsal synostosis, club feet, mild facial dimorphisms, midline cleft palate
3	Larsen syndrome	Scoliosis, retinal anomalies, sensorineural deafness, pesplanus, dental enamel hypoplasia. laryngotracheomalacia
4	Goldenhar syndrome	Craniofacial microsomia, microtia, anaotia, ocular dermoid cysts, cleft lip and palate

If the patient diagnosed with Larsen syndrome, there therapeutic management was differed. Extra care should be required during general anesthesia. As there has been increased chances of airway complications related to laryngotracheomalacia. Thus, it has been suggested that such anesthetic agent should be given to the patient which give rise to rapid induction and recovery (13). Proper genetic counselling has been needed for the family, if patient diagnosed with such congenital cervical vertebral synostosis.

RESEARCHERID
THOMSON REUTERS
Open Access Journal
International Journal of Medical Research and Pharmaceutical Sciences
Volume 4 (Issue 8): August 2017 ISSN: 2394-9414
DOI- 10.5281/zenodo.846753 Impact Factor- 3.109

Morphometric parameters which were taken in the present study may useful during surgeries done for Klippel-Feil Syndrome patient like posterior instrumented fusion, hypermobile nonfused segment (14). Fusion between the typical thoracic vertebra and lumbar vertebra were reported by Vadgaonkar et al (15) which can cause low back ache. Same was found in our study. Anterolateral fusion of the bodies of 12th thoracic vertebra fuse with 1st lumbar vertebra was observed in our study. Reason of such type of fusion between thoracic and lumbar vertebra could be acquired. Sharma, et al suggested that acquired fusion of vertebra may be due to tuberculosis, juvenile rheumatoid arthritis and trauma (3). In present study, massive fusion between 3rd and 4th lumbar vertebra was observed along with degenerative changes like osteophyte formation. Such changes may lead to internal disruption of the intervertebral disc, abnormal motion of the vertebra, compression of the cauda equina and nerves, lumber radiculopathy. Two major structures lie in close proximity to the spine are the inferior vena cava and abdominal aorta, both of which have been affected by osteophytes. So, there was likely chances of osteophyte to exert pressure on the aortic wall. This may sometimes lead do perforation (16, 17).

Osteophytes can also protrude into the spinal canal and foramina causing nerve root compression. In our present study, fusion type of osteophytes was found on anterior surface of bodies of lumbar vertebra. This may cause pressure on the abdominal aorta and inferior vena cava with serious health implications. (18) Because of decreased in diameter of intervertebral foramina of fuse vertebra, there were likely chances of spinal root compression. Early diagnosis of vertebral synostosis, will be helpful in documenting the change due to an injury and degenerative process. This also helpful to change the lifestyle to lead a normal healthy lifestyle. Surgical intervention for cervical vertebral synostosis, carries a higher risk of mortality during intubation and this can precipitate the disc prolapse during hyperextension of neck. If lumbar puncture is to be done, then surgeons should look for the possibility of vertebral synostosis.

Conclusion

Present study concluded that, synostosis of vertebrae can be congenital or acquired. Likely causes for cervical synostosis may be due to congenital that is Klippel Feil syndrome, Spondylocarpotarsal synostosis, Larsen syndrome, Goldenhar syndrome. Acquired causes for synostosis of vertebrae, are tuberculosis, juvenile rheumatoid arthritis and trauma, this mainly affect thoracic, lumbar vertebrae. Likely complication of vertebral synostosis is radiculopathy, spinal nerve compression, and pressure over abdominal aorta, inferior vena cava. While dealing with vertebral synostosis, such complication should be kept in mind. However, the present study was done in a small sample size. More research is required to address the clinical significance of synostosis vertebra. The present study provides dimensions, comparisons of various parameter of synostosis vertebra. These details can be clinically important as they might be associated with, neurological and musculoskeletal abnormalities. The total incidence of vertebral synostosis is 0.199% in eastern region of India.

References

1. *McGaughran J, Oates A, Donnai D, Read AP, Tassabehji M. Mutations in PAX1 may be associated with Klippel–Feil syndrome. Eur J Hum Genet 2003; 11:468-74.*
2. *Giampietro P, Raggio C, Reynolds C, Shukla SK, McPherson E, Ghebranious N, et al. An analysis of PAX1 in the development of vertebral malformations. Clin Genet 2005; 68:448-453.*
3. *Sharma M, Baidwan S, Jindal AK, Gorea RK. A study of vertebral synostosis and its clinical significance Journal of Punjab Academy of Forensic Medicine & Toxicology 2013; 13:20-24.*
4. *Block vertebra. Available from http://www.eradiography.net/radpath/b/blockvertebra.htm.*

International Journal of Medical Research and Pharmaceutical Sciences
Volume 4 (Issue 8): August 2017 ISSN: 2394-9414
DOI- 10.5281/zenodo.846753 Impact Factor- 3.109

5. *Soni P, Sharma V, Sengupta J. Cervical vertebral anomalies: Incidental findings on lateral Cephalogram. Angle Orthodontist 2008; 78:178–80.*
6. *T. W. Sadler. The Axial Skeleton. Langman's Medical Embryology, 13th edn. New Delhi; Wolters Kluwer; 2017. P 152-153.*
7. *Moon MS , Yoon MG, Kwon K, Kim S, Lin J, Lee B. Radiological assessment of the effect of congenital C3-4 synostosis on adjacent segments. Asian spine J 2015; 9:895-900.*
8. *Yadav Y, Goswami P, Bharihoke V. Cervical Vertebra Synostosis (C2-C3) - A Case Report. American Journal of Medical Case Reports 2014; 2:120-2.*
9. *Ted L Tewfik, MD. Manifestations of Craniofacial Syndromes. Available from http://emedicine.medscape.com/article/844209-overview.*
10. *Goldenhar Syndrome. FACES: The National Craniofacial Association. February 2016; Available from, http://www.faces-cranio.org/pdf/GOLDENHAR.pdf.*
11. *Jakobiec FA, Stagner AM, Katowitz WR, Eagle RC Jr. Abnormalities of the eyes, such as droopy eyelids, anophthalmia/microphthalmia, epibulbar tumors (noncancerous growths in the eyes), retinal abnormalities, and vision loss. Surv Ophthalmol. February 2016.*
12. *Erdil H, Yidiz N, Cimen M. Congenital fusion of cervical vertebrae and its clinical significance. Journal of Anatomical society of India 2003; 52:125-27.*
13. *Morishima T, Sobue K, Tanaka S, So M, Arima H, Ando H, et al. Sevoflurane for general anaesthetic management in a patient with Larsen syndrome. Paediatr Anaesth 2004; 14:194-195.*
14. *Samartzis D, Lubicky JP, Herman J, Kalluri P, Shen FH. Symptomatic cervical disc herniation in a pediatric Klippel-Feil patient: the risk of neural injury associated with extensive congenitally fused vertebrae and a hypermobile segment. Spine (Phila Pa 1976). 2006; 31:E335-8.*
15. *Vadgaonkar R , Murlimanju BV, Pai MM, Prabhu LV, Madhyastha S. Synostosis of dorsolumbar spine: an anatomical investigation with emphasis on clinical and embryological details. Clin Ter 2013; 64:513-7.*
16. *Klaassen Z, Tubbs RS, Apaydin N, Hage R, Jordan R, Loukas M. Vertebral spinal osteophytes. Anat Sci Int 2011; 86:1-9.*
17. *Dregelid E, Jenssen G, Jonung T, Braaten A. Pseudoaneurysm of the abdominal aorta due to a needle-like osteophyte on the first lumbar vertebra. J Vasc Surg. 2007; 45:1059–61.*
18. *Chanapa P, Yoshiyuki T, Mahakkanukrauh P. Distribution and length of osteophytes in the lumbar vertebrae and risk of rupture of abdominal aortic aneurysms: a study of dry bones from Chiang Mai, Thailand. Anat Cell Biol 2014; 47: 157–61.*

Open Access Journal
International Journal of Medical Research and Pharmaceutical Sciences
Volume 4 (Issue 8): August 2017 ISSN: 2394-9414
DOI- 10.5281/zenodo.846753 Impact Factor- 3.109

Author Bibliography

	**Dr. Naina Wakode** **Working as associate professor in department of Anatomy, AIIMS, Bhubaneshwar**
	**Dr. Santosh Wakode** **Working as associate professor in department of Physiology, AIIMS, Bhopal.**