

Sacralization: the structural complications and body biomechanics

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ABSTRACT

The lumbosacral region of the body not only protects the spinal cord and related structures but also transmits the body weight to the lower extremity and maintains or balances the body posture. The present study was carried out on 20 dry adult sacra (10 males +10 females) to find out the incidence and type of sacralization using the score system developed by Khairnar and Rajale (2013) and classification proposed by Castellvi et al. (1984) for the degree of transition based on form and orientation of the transverse processes of LSTV. Results show the Type III LSTV in 20% of male sacra and 10% of female sacra and indicate more male predominance and suggested that sacralization bring remarkable changes in the structural organization of vertebral levels and highlighted its clinical impact on the body like low back pain, compression of nerves, pseudoarthrosis, etc.

Key Words: LSTV, Anatomical variations, Sacralization, Low backpain, Clinical implications, Sacrum

INTRODUCTION:

Sacrum, the primary part of skeleton of pelvis and is formed from the fusion of five rudimentary vertebrae, gives forward concavity and looks like a single wedge-shaped bone, usually wider in proportion to its length in the females than in the males.

Sacralization is the congenital anomaly in which the transverse process of the last lumbar vertebra L5 fuses to the sacrum on one side or both or to ilium or both and represents the transitional state at lumbosacral junctions and are susceptible to degenerative changes resulting from the altered load-bearing patterns at these regions (Mahato, 2013). These anomalies are congenital and are observed at about 3.5 % of people and it is usually bilateral. Although sacralization may be a cause of low back pain, it is asymptomatic in many cases especially bilateral type. Low back pain in these cases most likely occurs due to chronic faulty biomechanics, the L5-S1 intervertebral disc may be thin and narrow. Anatomical organization of the lumbar vertebra is irregular with large body, stout pedicle, thick lamina, slender transverse processes, short, thick square spinous process. Because of this robust structure lumbar vertebra are known for their characteristic biomechanics and support and transfer the upper body weight and provide mobility in the lower region of back. So if any type of structural disorientation occurs either accidentally or congenitally, becomes the cause of severe low back pain and related clinical complications (Bertolotti, 1917; Wikipedia, 2012; Dullerud, 1999).

The present study is an effort to analyse the structural complications of sacralization and its related impact on the body biomechanics.

MATERIAL AND METHODS:

The present study included an examination of 20 adult sacra (10 males +10 females) available in the department of anatomy, Desh Bhagat Dental College & Hospital for the cases of sacralization. Out of which three dry sacra (two males + one female) completely fused L5 vertebra with first sacral segment and rest of the sacra are excluded from the study. Score system formulated by Khairnar and Rajale (2013) is used for morphological analysis of sacralization. Six structures assessed in the score system are left & right inferior articular facets, left & right transverse processes and the left and right sides of the vertebral body.

A score given in such a way that 1 point is awarded for:

- a. Unilateral fusion of vertebral body (right or left half)
- b. Unilateral fusion of transverse process (right or left half)
- c. Unilateral fusion of inferior articular process (right or left half)

Classification proposed by Castellvi et al. 1984 (Table 1) for the degree of transition based on form and orientation of the transverse processes of LSTV was used in the study.

Table: 1 Castellvi et al.1984 classification for sacralization.

Type I	Dysplastic transverse process	Unilateral (a) or bilateral (b) large triangular transverse process, at least 19mm wide.
Type II	Incomplete lumbarisation/sacralisation	Enlarged transverse process with unilateral (a) or bilateral (b) pseudarthrosis with the adjacent sacral ala
Type III	Complete lumbarisation /scaralisation	Enlarged transverse process with unilateral (a) or bilateral (b) complete fusion with the adjacent sacral ala
Type IV	Mixed	Type IIa on one side and Type IIIa on the other.

OBSERVATION AND RESULTS:

In present study of 20 dry human sacra, 10 were males and 10 were females out of which 2 males (20%) and 01 female (10%) showed the cases of sacralization.

After complete morphological and score system analysis, it has been observed that in all the three specimens of sacra bilateral sacralization has been found (Table 2).

Table 2: Scoring system of present study.

Specimen No.	Vertebral Body		Transverse Process		Inferior articular facets		Total Score
	Right	Left	Right	Left	Right	Left	
1.(Male)	1	1	1	1	1	1	06
2.(Male)	0	0	1	1	1	1	04
3.(female)	1	1	1	1	1	1	06

According to classification of LSTV (Castellvi et al.1984) present specimen of all sacra shows TYPE III LSTV which shows enlarged transverse process, with bilateral (b) complete fusion with adjacent sacral ala (Table 2 and Fig.1).

Figure 1: Bilateral Sacralization of 5th Lumbar Vertebra in the specimen-1, 2 and 3
SPECIMEN – 1 (Male)



POSTERIOR VIEW



ANTERIOR VIEW

SPECIMEN – 2 (Male)



POSTERIOR VIEW



ANTERIOR VIEW

SPECIMEN – 3 (Female)



POSTERIOR VIEW



ANTERIOR VIEW

DISCUSSION:

The present study shows that the frequency of developing sacralisation is more in males (20%) in comparison to females (10%). Sacralization is varied by race and incidence as is reported by various previous studies such that in Arabs and Indians (Bustami, 1989) and Americans (Moore & Illinois, 1925). The present cases of sacralization shows Type III LSTV in which the enlarged transverse process with complete bilateral fusion with adjacent sacral ala.

The embryological development & osteological defects is linked to the occurrence of lumbosacral transitions. Embryologically, the vertebra receives contribution from caudal half of one sclerotome and from the cranial half succeeding sclerotome. (Kubavat et al. 2012). Genetically it has been observed that the Hox 11 group is essential for the genesis of sacral and caudal vertebra and thus their over expression is expected to produce signs of sacralization or caudalization at their levels of axial skeleton (Wellik and Capecchi, 2003) and these genes are among the major players in the specification of morphological identity of the vertebrae (Krumlauf, 1994). Further the mutations of Hox II and Pax 1/Pax 9 genes to varying degrees in human embryos is always accompanied by anomalies i.e. misshapen knee joint, fore and hind limbs, modified parathyroid, thymus, involvement of ultimobranchial body, the absence of teeth, a cleft secondary palate, supernumerary digits either in part or fully depending on mutation (Rajani, 2012)

In females the lumbo-sacralisation of 5th lumbar vertebra may cause greater difficulty during labor because of less mobile pelvis (lumbo-sacral joint) and may cause low back pain and it is one of the important factors in the emergence of lumbar disc herniations which usually occurs at the level above the lumbosacral transitional vertebra rather than at the level of transitional vertebra in patient with low back pain. (Kubavat et al. 2012).

Majority of the explained cases of low back pain, especially in young adults, may be diagnosed & treated keeping sacralisation as one of the etiological factor and relationship between low back pain and sacralization of lumbar vertebra is very well explained by Bertollity, 1917 and following complications have been summarized as follows:-

1. Actual pressure on nerves or nerve trunks.
2. Ligamentous strain.
3. Compression of soft tissue between bony joints.
4. By an actual arthritis if a joint is present.

5. By a bursitis if a bursa is present.

Repetitive flexion and extension stress the transitional lumbosacral osseous complex and the stress is observed greatest at the superior disc space and the articulation between the transitional transverse process and sacrum (Leonard et al. 2003) and may sometimes give origin to the spondylolisthesis which is the complication documented arising as a result of sacralization. (Moore & Llinosis, 1925).

According to Park et al. (1976) biochemical changes such that increased intradiscal pressure, increased facet loading etc. plays a primary role in causing adjacent segment disease in which the progressive spinal degeneration with age is also thought to be a major contributor.

CONCLUSION:

Sacralization in living human beings brings very remarkable structural changes in the anatomy of skeleton of pelvis which can be the reason of various serious complications of low back pain, complicated delivery or labor, vertebral deterioration or disc compressions which all together shows its great impact on the body mechanics. The findings of the present study are important from the viewpoint of sacralization and the associated disorders.

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