

Variation in the number of sacral pieces

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Abstract: Sacrum consists of 4 to 7 pieces. Variation in the number of sacral pieces may be produced by sacralization or lumbarization. A sacralized L5 vertebra will give rise to a sacrum with 6 pieces whereas a completely lumbarized S1 will reduce the number of sacral pieces to 4. The first coccygeal piece may also be incorporated into the sacrum to produce a sacrum with 6 pieces. Lumbarization and sacralization are arise because of abnormal development of the vertebrae in this region and are usually associated with low back pain. The aim of the study was to study variation in the number of sacral pieces. Thirty dry human sacra were taken up for the study. The number of sacral pieces varied from 4 to 6. The incidences of sacra with 4, 5 and 6 pieces were 6.7%, 66.7% and 20% respectively. Four (13.3%) of the sacra with 6 segments resulted from incorporation of the first coccyx. Two (6.7%) of the sacra with 6 segments had sacralization of L5 vertebra. Two sacra (6.7%) had complete lumbarization of the S1 vertebra. Morphological or numerical variations of sacrum is common. Knowledge of these variations may help in the better management of low back pain.

Key words: Numerical variation, lumbarization, sacralization, lumbosacral transitional vertebra, low back pain

I. Introduction

Sacrum is a triangular bone formed by the fusion of five sacral vertebrae. It forms the posterosuperior wall of the pelvis. It is normally formed by the fusion of 5 sacral vertebrae. The function of the sacrum is to transmit the weight of the body to the hip bones. The numerical variations of the sacrum include partial or complete separation of the S1 segment from the sacrum (lumbarization), partial or complete fusion of the fifth lumbar vertebra with the first sacral vertebra (sacralization), the last two conditions may respectively increase or reduce the number of sacral pieces. The number of fused sacral pieces varies from 4 to 7 pieces.^[1] The variations consist of sacralization of L5 vertebra or lumbarization of the S1 vertebra or incorporation of first piece of coccyx to sacrum. A lumbosacral transition vertebra (LSTV) is an abnormal vertebra with a feature intermediate between lumbar and sacral vertebrae. Its transverse process may articulate or fuse with the sacrum or ilium of hip bone. LSTVs include lumbarization and sacralization. The LSTVs are associated with altered biomechanics of the spine and low back pain.^[2]

II. Materials & methods

The study was done on 30 human adult dry sacra at the Department of Anatomy, Regional Institute of Medical Sciences, Imphal. The number of segments or evidence of sacralisation or lumbarisation was noted.

III. Results

The number of sacral segments varied from 4 to 6. Eight sacra (26.6%) showed abnormal number of pieces [Table 1].

Table 1. Incidence of Sacra with Abnormal Number of Pieces

Sacrum with 4 pieces	Sacrum with 6 pieces					
	Sacralisation			Incorporation of coccyx to sacrum		
Lumbarisation	Complete & Unilateral	Complete & Bilateral	Total	Unilateral	Bilateral	Total
Complete & Bilateral 2 (6.7%)	Complete & Unilateral 1 (3.3%)	Complete & Bilateral 1 (3.3%)	Total 2 (6.7%)	Unilateral 1 (3.3%)	Bilateral 3 (10.0%)	Total 4 (13.3%)

Six (20.0%) sacra had 6 pieces. Most (66.7%) of them had had 5 pieces. Six (20.0%) sacra had 6 pieces. Two (6.7%) of the sacra with 6 segments had sacralization of L5 vertebra. One (3.3%) of these two had complete unilateral sacralization of L5 vertebra on the left side [Fig. 1]. Another one (3.3%) had bilateral complete sacralization of L5 vertebra [Fig. 2]. Four (13.3%) of these sacra with 6 segments resulted from incorporation of the first piece of coccyx [Fig. 3]. Out of these 4, one (3.3%) was unilateral (right-sided) and the other 3 (10%) were bilateral. Two (6.7%) sacra were found to have complete bilateral lumbarization and had only 4 pieces [Fig. 4].



Figure 1. Unilateral sacralisation (left side)



Figure 2. Complete sacralisation of L5 vertebra



Figure 3. Incorporation of 1st Coccygeal piece



Figure 4. Complete lumbarisation (four pieces)

IV. Discussion

The human sacrum consists of 4 to 6, rarely 7 pieces.^[1] According to Kumar et al^[3] and Shewale et al^[4] the incidences of sacra having 4, 5 and 6 were 1.9%, 88.7%, 9.4% and 3.0%, 85.0%, 12.0% respectively. Compared to these the incidences of sacra with 4 (6.7%) or 6 (20.0%) pieces in the present study were higher whereas the incidence of sacra with 5 pieces was lower (Table 2).

Table 2. Number of Sacral Pieces as Reported by Various Authors

Number of sacral segments	Kumar et al ^[3]	Shewale et al ^[4]	Present study
4	3 (1.9%)	5 (3.0%)	2 (6.7%)
5	141 (88.7%)	142 (85.0%)	22 (73.3%)
6	15 (9.4%)	20 (12.0%)	6 (20.0%)
Total	159 (100%)	167 (100%)	30 (100%)

Sacralized L5 vertebra or lumbarized S1 vertebra can bring about numerical variation in the sacral segments. Incorporation of L5 vertebra (sacralization) or the first coccygeal piece will form a sacrum that has 6 segments.^[1,5] The incorporation of the first coccygeal piece to sacrum can result from fusion of the coccygeal transverse process with the inferolateral margin of sacrum or ossification of the lateral sacrococcygeal ligament.^[5,6] In the present study, 6 (20.0%) sacra were found to have 6 pieces. Out of these, one (3.3%) had complete unilateral sacralization of L5 vertebra on the left side. Another sacrum (3.3%) had complete bilateral lumbarization and had sloping alae. These two cases of sacralization fall under type III(a) and III(b) of the Castellvi's classification^[7] of the LSTVs respectively. The milder forms of the LSTVs were missed as the present study was done on the isolated sacral specimens. Sharma et al^[8], Shewale et al^[4] and Deepa and John⁹ observed partial or complete sacralization in 14.1%, 9.8% and 10.3% of the cases respectively. The incidence of sacralisation in the present study was 6.7% which was lower than those of Sharma et al^[8], Shewale et al^[4] and Deepa and John^[9]. Complete bilateral lumbarization of S1 leads to reduction in the number of sacral segments to 4. Kubavat et al^[10] estimated the incidence of sacra with 3 pairs of sacral foramina or 4 segments to be 1.58% which apparently excluded unilateral or incomplete lumbarization. In the present study, the incidence of sacrum with 3 pairs of sacral foramina or 4 segments was higher (6.7%) than that of Kubavat et al^[10]. Sacralization is a more common variation than lumbarization.^[11] But the present study found equal incidence between lumbarization and sacralization (6.7% each). A sacrum with 7 pieces may arise when there is both sacralization of the L5 vertebra and incorporation of the first coccygeal vertebra to sacrum.¹ In the present study, there was no sacrum with 7 segments. It is stated that LSTVs are associated with altered biomechanics of the spine.^[2] The

disc above the transition vertebra may undergo degenerative changes due to hypermobility of the concerned joint and the disc below the transition vertebra is given certain degree of protection because of the resulting reduced mobility.^[12] The LSTVs are congenital conditions which result from defective development of the vertebrae in this region. Hox 10/11 paralogous genes are known to regulate axis patterning of the vertebral column and mutations in these genes can cause abnormal development of sacrum.^[13] During development of these vertebrae, there are border shifts which may be either cranial shift in the case of lumbarization or caudal shift in the case of sacralization.^[8] Patients with these abnormalities often present with low back pain. Accurate placement of iliosacral screws is difficult in patients with sacral dysmorphism.^[14]

V. Conclusion

The lumbosacral region of the vertebral column has attracted the anatomists, radiologists and orthopedic surgeons alike. The sacrum presents morphological or numerical variations. These variations are associated with low back pain. Knowledge of these variations may help in the better management of low back pain.

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