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Research article

## A STUDY OF LUMBARISATION OF FIRST SACRAL VERTEBRA AMONG THE SOUTH INDIANS

\* Deepa TK<sup>1</sup>, Martin K John<sup>2</sup>

<sup>1,2</sup>Assistant Professor, Department of Anatomy, MES medical college, Perinthalmanna, Kerala

\*Corresponding author e-mail: amee2amee@yahoo.co.in

### ABSTRACT

**Background:** In the lumbosacral region, anatomical variations occur with changes in the number of sacral vertebra by deletion of first sacral vertebra or by the union of fifth lumbar or first coccyx with sacrum. The fifth lumbar vertebra may be fused with the sacrum in the case of sacralisation, or the first sacral vertebra may be fused with fifth lumbar vertebra in the case of lumbarisation. This may cause serious problems during spinal surgery if we may fail to recognise the lumbosacral transitional vertebra. **Materials and methods:** We studied 117 dry human sacra of South Indian population of known sex. Out of 117 sacra, 70 male and 47 female. The sacra with four vertebral segments were selected and studied its morphology. Its features were carefully examined and noted. **Result:** A typical sacrum consisting of five segments was observed in 103 (88.03%) specimen, while presence of lumbarisation was noted in 2 (1.70%) cases and sacralisation was noted in 12 (10.25%) cases. Sacrum with 3 pairs of sacral foramina is 1.70%. Among the 2 specimen, we got 1 male and 1 female respectively **Conclusion:** Present study shows that the lumbarisation of first sacral vertebra leads to the formation of three pairs of sacral foramina, which is 1.70% in South Indian population. This awareness of lumbosacral transitional vertebra (LSTV) will help to understand its importance during surgical procedures and also in reporting the radiographs such as X-rays, CT and MRI.

**Keywords:** Anatomic variations, congenital anomaly, lumbarisation, sacral foramina

### INTRODUCTION

The sacrum lies below the fifth lumbar vertebra and is formed by the fusion of five sacral vertebrae. It is wedged between the two hip bones and takes part in forming the pelvis. It is triangular in shape. Its upper end or base which articulates with the fifth lumbar vertebra: a lower end or apex which articulates with the coccyx. It has four pairs of sacral foramina that communicate with sacral canal.

At the cranial end of sacrum, when the fifth lumbar vertebra fuses with first sacral vertebra, known as the sacralisation of lumbar vertebra and when the first sacral vertebra fuses with the fifth lumbar vertebra, known as lumbarisation of first sacral vertebra<sup>1</sup>

Normally, the sacrum is formed by the fusion of five rudimentary vertebrae. But anatomical variations of

the sacrum have been reported like sacralisation of fifth lumbar vertebra and lumbarisation of first sacral vertebra. Sacralisation of fifth lumbar vertebra is the most common, whereas the lumbarisation of first sacral vertebra is less common<sup>2</sup>

In the present study, the sacrum had four sacral vertebrae instead of five sacral vertebrae as in normal sacrum. There were three sacral foramina along the dorsal and pelvic sacral surface. This is due to non fusion of 1<sup>st</sup> and 2<sup>nd</sup> segments of the sacrum ie, the lumbarisation of the first sacral vertebra. S5 vertebra was normal and S2 vertebra was well developed as like S1. S1 being completely separated from it, which may be due to developmental defect.

Bertolotti observed for the first time that, lumbarisation and sacralisation which comes under lumbosacral transitional vertebra are congenital anomalies of lumbosacral region.<sup>3</sup> Defect in the segmentation of the lumbosacral spine during development is the main cause for this condition.<sup>3,4</sup>

Genetic factors and ossification defects are also the potential cause of variation for the lumbosacral transitional vertebra. In both case the morphology is the same. So it is difficult to differentiate between the two defects.<sup>5,6</sup>

In this study, we focused on the prevalence of sacrum with 3 pairs of sacral foramina among the South Indian population, that in turns help to find out the variations in patients during radiological investigations complaining low back pain. Knowledge of this variation is important to diagnose lower back pain; disc prolapsed and is helpful in procedures like lumbar puncture and spinal anaesthesia.

**MATERIALS AND METHODS**

The present study includes 117 human sacra of known sex, were studied. All the sacra were of adult, but precise age was not known. Any change in the number of sacral vertebrae were selected and studied. The sacrum with four segments and three sacral foramina was noted.

The specimen with lumbarisation were examined and recorded. Two fold subdivision of lumbarisation was used. (1) Unilateral complete lumbarisation (11) bilateral complete lumbarisation of first sacral vertebra.

In this study, 2 sacrum with four sacral vertebrae and 3 pairs of sacral foramina showing bilateral complete lumbarisation of 1<sup>st</sup> sacral vertebra was selected. Incidence of sacrum with 3 pairs of sacral foramina is 1.70%. Among the 2 specimen, one is male and the other one is female respectively.

**RESULTS**

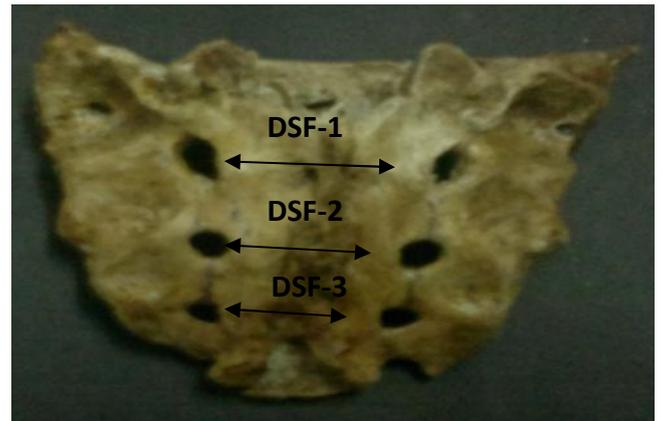
In the current study of 117 dry human sacra, 70 (60.5%) were male and 47 (39.5%) were female sacra. 14 cases (12.3%) of lumbosacral transitional vertebra and 103 (87.7%) normal vertebra are found.

Among the 14 cases of lumbosacral transitional vertebra, we got 2sacra with four sacral vertebrae and three pairs of sacral foramina showing bilateral complete lumbarisation of 1<sup>st</sup> sacral vertebra. One is

male and the other one is female. Incidence of sacrum with 3 pairs of sacral foramina is 1.70%.

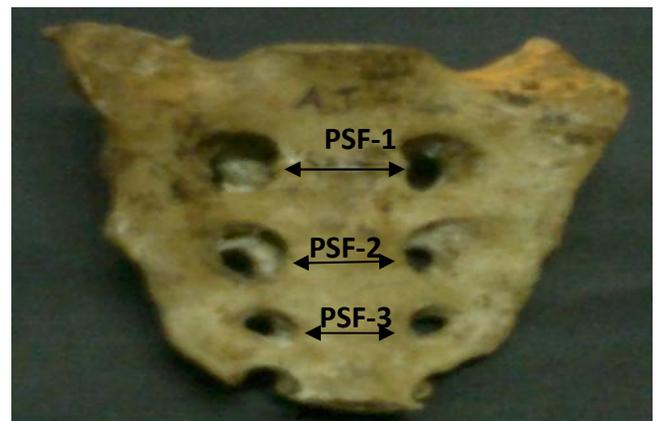
**Table 1: Frequency distribution of lumbarisation of 1<sup>st</sup> sacral vertebra & sacralisation of 5<sup>th</sup> lumbar vertebra**

	Male	Female	Total
Total number of sacra	70	47	117
Normal	61	42	103
Lumbarisation	1	1	2
Sacralisation	8	4	12



**Fig 1. Dorsal surface of sacrum**  
(DSF-1: First pair of dorsal sacral foramina, DSF-2: Second pair of dorsal sacral foramina, DSF-3:Third pair of dorsal sacral foramina)

We came across the sacrum with only bilateral complete lumbarisation and not any unilateral complete lumbarisation in any specimen. Parameters in sacrum with bilateral complete lumbarisation were smaller than normal dimension.



**Fig 2: Pelvic surface of sacrum.**  
(PSF1-first pair of pelvic sacral foramina, PSF2- second pair of pelvic sacral foramina, PSF3- third pair of pelvic sacral foramina)

## DISCUSSION

Variations in vertebrae are affected by gender, developmental factors and race. An increased number of vertebrae occur more often in males and a reduced number occurs more frequently in females.

Normally sacrum is formed by the fusion of five sacral vertebrae and it contains four pairs of sacral foramina. In the current study, we got sacrum with three pairs of sacral foramina showing bilateral complete lumbarisation of first sacral vertebra. In our study, the prevalence of sacrum with three pairs of sacral foramina is 1.70%.

In the lumbosacral region, anatomical variations occur frequently, making the sacrum the most variable portion of spine. The variation may be attributed to the dependency of the final sacral morphology to the load related fusion of the bone structure.<sup>7</sup> Failure to complete the ascending fusion may create a sixth lumbar vertebra, leaving a four piece or lumbarised sacrum.

The occurrence of lumbosacral transitional vertebrae is linked to its embryological development and osteological defects. Vertebrae are derived from the sclerotomes of the somites. Each sclerotome divides into three parts: cranial, middle and caudal. Embryologically, the vertebra receives contribution from caudal half of one sclerotome and from the cranial half of succeeding sclerotome. Thus lumbosacral transitional vertebrae are caused by the border shifts. Sacralisation of fifth lumbar vertebra is due to cranial shift and the lumbarisation of first sacral segment is due to caudal shift.<sup>8</sup>

The vast majority of people are affected by this spinal abnormality are born with it ie, it is congenital. Less common reasons could be traumatic injury, extreme arthritic changes and purposeful spinal fusion surgery. Mutations in the HOX 10 and HOX 11 paralogous genes results in the normal patterning of lumbar and sacral vertebra as well as the changes in the axial pattern, such as lumbosacral transition vertebrae.<sup>6,9,10</sup>

A sacrum with three pairs of sacral foramina has clinical and medicolegal implications. In order to avoid surgery at an incorrect level, it is important to identify the lumbarisation of first sacral vertebra and the sacralisation of fifth lumbar vertebra. The condition of lumbarisation of 1<sup>st</sup> sacral vertebra deserves attention of clinical anatomist, radiologists, morphologists and forensic experts. Hence we are

presenting such a variation which emphasize on its clinical relevance.<sup>11-13</sup>

Variation in segmental structure of vertebral column results in lumbarisation that demands more attention during anaesthetic and surgical intervention<sup>11</sup>. Knowledge of this variation is important to diagnose lower back pain, sciatica; disc prolapse and is helpful in procedures like spinal anesthesia and lumbar puncture.<sup>14</sup>

## CONCLUSION

The present study shows lumbarisation of first sacral vertebra with three pairs of sacral foramina instead of four pairs of sacral foramina.

Sacrum is clinically important for caudal epidural block. So incorrect numbering can theoretically lead to problems with the administration of intradural or epidural anaesthetics.<sup>14</sup> Surgical treatment of sacral lesions requires understanding of the underlying anatomy, a task made easier by understanding the developmental aspects and morphological changes that occur with growth.

The knowledge of this kind of anomaly is important while reporting the CT, MRI films and Xrays for correct clinical and radiological assessment. Thus clinically the lumbarisation of 1<sup>st</sup> sacral vertebra is of paramount importance to surgeons, clinical anatomists, forensic experts and morphologists.

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