

## A Morphometric Study to Assess the Lumbosacral Transitional Vertebrae and its Clinical Implications

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### Abstract

**Aim:** The aim of the present study was to assess the lumbosacral transitional vertebrae and its clinical implications.

**Methods:** The present study included an examination of 100 adult sacra (75 male and 25 female) available in the Department of Anatomy, Darbhanga Medical College and Hospital, Laheriasarai, Darbhanga, Bihar, India for the presence of LSTV. Duration of study from June 2020 to May 2021

**Results:** In the present study of 100 sacra, 75 (75%) were male and 25 (25%) were female. Only 20 showed Lumbosacral Transitional Vertebrae and 80 were normal sacra. Out of 75 male sacra, 12 and out of 25 female sacra, 8 were found to be Lumbosacral Transitional Vertebrae. Out of 20 LSTV, 15 sacrum showed complete sacralization of 5th lumbar vertebrae, 2 sacrum showed simultaneous sacralization of 1st coccygeal vertebrae and incomplete lumbarization of 1st sacral vertebrae and 3 sacrum showed complete lumbarization of 1st sacral vertebrae. Out of total 20 Lumbosacral Transitional Vertebrae, 15 fall in Type III of Castellvi classification, all of which were bilateral (IIIb). 5 fall in Type IV (mixed) category of Castellvi classification in which we found unilateral pseudarthrosis with the adjacent sacral ala on the left side and complete fusion with the adjacent sacral ala on the right side.

**Conclusion:** LSTV is a benign anatomical variation of the lumbosacral spine that is most frequently encountered by the spinal surgeon. The list of differential diagnosis should always include Bertolotti's syndrome, when investigating back pain in young patients. Knowledge of the biomechanical alterations within the spine caused by LSTVs will aid the radiologist in understanding and recognizing the imaging findings seen in patients with low back pain and a transitional segment.

**Keywords:** Lumbosacral; Transitional; Vertebra; Low back pain

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### Introduction

Lumbosacral transitional vertebra (LSTV) is a congenital anomaly of the spine that arises because of mutations in the Hox genes, giving rise to sacralization (fifth lumbar vertebra shows assimilation to the sacrum) and lumbarization (first sacral vertebra shows lumbar configuration). Spinal disorders (concurrent or secondary) that are commonly associated with LSTV [1] are spinal degeneration and spinal instability. A nine times higher risk for disc degeneration suprajacent to LSTV [2] and altered function of lumbar nerve roots [3] were associated with LSTV, whereas spinal canal stenosis [4] and spondylolisthesis [5] were not associated with LSTV. Evidence vary with regard to the association of pars lysis with LSTV; Otani et al

[6] have shown a positive correlation, whereas Elster<sup>2</sup> have shown no correlation between the two entities.

Perhaps the most controversial aspect is the association of LSTV with low back pain (LBP). Studies showing positive correlation implicate disc herniation or degeneration proximal to LSTV [7], disc herniation compressing the nerve roots [8], arthritic pseudo articulation between LSTV and the sacral ala [8], facet joint contralateral to the fused/articulating LSTV [9], or extraforaminal stenosis secondary to a broadened transverse process. [10] In contrast, some studies have also demonstrated no association of LSTV with LBP. [11,12] Luoma et al [12] studied 138 middle-aged

men (40–45 years) and 25 young asymptomatic men (18–20 years) and reported no association of transitional vertebra with any type of LBP among the middle-aged men. They also reported that the disc below the transitional vertebra was protected from degeneration among the middle-aged men, whereas the disc above the transitional vertebra showed signs of degeneration among the young asymptomatic men. Tini et al [11] studied 4,000 lumbar radiographs in patients with LBP and 1,873 patients without LBP. They reported the incidences of LSTV as 6.7% and 5%, respectively, and concluded that LSTV was not related to LBP.

The aim of the present study was to assess the lumbosacral transitional vertebrae and its clinical implications.

### Materials and Methods

The present study included an examination of 100 adult sacra (75 male and 25 female) available in the Department of Anatomy, Darbhanga Medical College and Hospital, Laheriasarai, Darbhanga, Bihar, India for the presence of LSTV. Duration of study June 2020 to May 2021

We classified them using Castellvi classification. Dry human sacra and human skeleton were studied for lumbosacral transition and numerical variations. Skeletal variations like Sacralization of L-5, lumbarization of S-1, number of sacral vertebra, shape of sacral hiatus and coccygeal fusion were also recorded.

### Results

**Table 1: Incidence of Lumbosacral Transitional Vertebrae**

Types		Male	Female
Lumbosacral transitional vertebrae	20	12	8
Normal vertebrae	80	63	17
<b>Total</b>	<b>100</b>	<b>75</b>	<b>25</b>

In the present study of 100 sacra, 75 (75%) were male and 25 (25%) were female. Only 20 showed Lumbosacral Transitional Vertebrae and 80 were normal sacra. Out of 75 male sacra, 12 and out of 25 female sacra, 8 were found to be Lumbosacral Transitional Vertebrae.

**Table 2: Incidence of sacralization, lumbarization and fusion of coccyx in cases of LSTV**

Types	Male	Female	Total
Sacralization	11	4	15
Lumbarization	2	1	3
Coccyx fusion	1	1	2

Out of 20 LSTV, 15 sacrum showed complete sacralization of 5th lumbar vertebrae, 2 sacrum showed simultaneous sacralization of 1st coccygeal vertebrae and incomplete lumbarization of 1st sacral vertebrae and 3 sacrum showed complete lumbarization of 1st sacral vertebrae.

**Table 3: Incidence of types of LSTV**

Types of LSTV	Male	Female	Total
Type I	-	-	-
Type II	-	-	-
Type III b	11	4	15
Type IV	3	2	5

Out of total 20 Lumbosacral Transitional Vertebrae, 15 fall in Type III of Castellvi classification, all of which were bilateral (IIIb). 5 fall in Type IV (mixed) category of Castellvi classification in which we found unilateral pseudarthrosis with the adjacent sacral ala on the left side and complete fusion with the adjacent sacral ala on the right side.

### Discussion

Lumbosacral transitional vertebrae (LSTV) are congenital anomalies of the lumbosacral spine, involving lumbarization of 1st sacral vertebrae and sacralization, either of last lumbar or 1st coccygeal

vertebrae. Its prevalence is 4- 30% in general population.

In the present study of 100 sacra, 75 (75%) were male and 25 (25%) were female. Only 20 showed Lumbosacral Transitional Vertebrae and 80 were normal sacra. Out of 75 male sacra, 12 and out of 25 female sacra, 8 were found to be Lumbosacral Transitional Vertebrae. The occurrence of LSTV is linked to its embryological development and ossification defects. Vertebral column develops from the sclerotome of somite. Each sclerotome consists of loosely placed cells cranially and densely arranged cells caudally. Some densely packed cells migrate cranially opposite the center of myotome

where they form intervertebral disc. The remaining densely packed cells fuse with loosely arranged cells of the immediately caudal sclerotome to form the mesenchymal centrum, which develops into the vertebral body. Medial derivatives of sclerotome are vertebral body and intervertebral disc, while neural arches derive from the lateral regions of sclerotome. [14] Developmental defects occurring at the lumbosacral junction can result in transitional vertebrae that have characteristics of both lumbar and sacral vertebrae. That is, the morphology of the affected vertebra is intermediary or transitional with a combination of lumbar and sacral anatomical structures. The resulting characteristics produce a variety of morphological configurations collectively referred to as lumbosacral transitional vertebrae (LSTV). The developmental defects that result in LSTV are thought to be caused by delay in the timing threshold events occurring at the lumbosacral junction. This causes developmental fields to overlap or expand beyond normal, resulting in boundary shifts at the transitional areas of the vertebral column. Boundary shifts at the lumbosacral junction can occur caudally (lumbarization) or cranially (sacralization). [15]

Out of 20 LSTV, 15 sacrum showed complete sacralization of 5th lumbar vertebrae, 2 sacrum showed simultaneous sacralization of 1st coccygeal vertebrae and incomplete lumbarization of 1st sacral vertebrae and 3 sacrum showed complete lumbarization of 1st sacral vertebrae. Out of total 20 Lumbosacral Transitional Vertebrae, 15 fall in Type III of Castellvi classification, all of which were bilateral (IIIb). 5 fall in Type IV (mixed) category of Castellvi classification in which we found unilateral pseudarthrosis with the adjacent sacral ala on the left side and complete fusion with the adjacent sacral ala on the right side. There are many reasons to believe that the presence of a transitional vertebra can lead to low back pain. Probable causes of low back pain include disc degeneration, disc prolapse, spinal stenosis, spondylolisthesis, muscle strain or sprain, sacroiliac joint pain, chemical irritation, and nerve impingement; and the presence of a LSTV could potentially cause any of these. However, numerous studies have found no significant correlation between transitional vertebrae and low back pain [16,17], many other studies [13,18] have found a significant correlation. Patients of LSTV have increased risk of disc bulge /prolapse/ herniation, slippage in lytic spondylolisthesis, low back pain from ipsilateral/ contralateral facet joint. It has been hypothesized that the lumbosacral transitional vertebra decreases the annulus fibrosus degeneration of the disc below, without having the same effect on endplates and nuclear complex. [17]

Sacralization of fifth lumbar vertebra may cause greater difficulty during labor because of less mobile pelvis and it may result in low back pain problem.

Malanga and Cook reported wrong level emergency decompression surgery, in a patient with cauda equina syndrome due to false assessment of complete lumbarization of S1. [19] It supports the notion of a variant position of lumbosacral dermatomes. [20] In forensic medicine, this anomaly can be very useful for identification of skeletal remains. [21] During medicolegal investigations, some congenital abnormalities are of vital importance in identification, especially when antemortem records are available. A person with lumbosacral transitional vertebra is likely to seek medical advice if the condition is symptomatic and thus there is a high chance that antemortem medical records exist.

### Conclusion

LSTV is a benign anatomical variation of the lumbosacral spine that is most frequently encountered by the spinal surgeon. The list of differential diagnosis should always include Bertolotti's syndrome, when investigating back pain in young patients. Knowledge of the biomechanical alterations within the spine caused by LSTVs will aid the radiologist in understanding and recognizing the imaging findings seen in patients with low back pain and a transitional segment.

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