

Original Research Article

Transverse sacralization of lumbar vertebrae: prevalence according to Castellvi classification

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ABSTRACT

Background: Sacralization of L5 is a congenital anomaly, in which the lumbar vertebra, mainly its transverse process, gets fused or semi-fused with the sacrum or the ilium or to both. This fusion can occur in one or both sides of the body. Sacralization leads to fusion of the L5 (fifth lumbar vertebra) and S1 (first sacral vertebra) and the intervertebral disc between them may be narrow. Sacralization of lumbar vertebra may be asymptomatic but is not always clinically insignificant. While sacralization may not affect at all, it can cause problems in some cases. Sacralization may be at times associated with problems in biomechanics and affect the ways of movement and posture control. Sacralization may also be an important consideration in disc surgeries. This study has been carried out to find out prevalence of sacralisation of transverse process of fifth lumbar vertebrae.

Methods: The present study of transverse sacralisation of fifth lumbar vertebra was carried out on 35 randomly selected patients. The sample consisted of patients undergoing CT scan for abdominal complains. Bone window of all patients were evaluated to look for lumbosacral transitional vertebra.

Results: The prevalence of transverse sacralization of lumbar vertebra turned out to be 25.7% out of which Castellvi type IIb was found to be most common, accounting for 33.3% cases. 5.7% comprised the group of normal variant (Castellvi's type I) and 68.6% were normal.

Conclusions: It is important to determine lumbosacral transitional vertebra as it can affect spinal movement and put excess stress on the lumbar vertebrae and in between disc. Moreover it can have a bearing on counting of vertebral levels specially during planning of spinal surgery.

Keywords: Lumbosacral transitional vertebra, Saralization of L5 vertebra, Castellvi classification

INTRODUCTION

In 21st century backache is common complaint. Low back pain (LBP) is quite a common ailment affecting about 80% of the population in their life time.¹ Lumbosacral transitional vertebrae (LSTV) occur as a result of congenital anomaly in the segmentation of the lumbosacral spine. LSTV includes either the involvement of L5 in sacrum or S1 into the lumbar vertebrae. Sacralization means addition of sacral elements by the incorporation of Fifth lumbar vertebra. The incorporation

of the fifth lumbar vertebra with the sacrum may be unilateral or bilateral producing partial or complete sacralisation. Complete sacralization consists of complete bony union between the abnormal transverse process and the sacrum. Incomplete sacralization shows a well-defined joint line between the process and the sacrum. Bertolotti 1st observed the LSTV and stated that these abnormal vertebrae may produce low back pain due to arthritic changes which occur at the site of false articulation.² LSTV are common with the prevalence ranging from 1-20%.^{3,4} Some previous workers have

suggested the role of LSTV in low back pain, whereas others have contradicted the role of LSTV.⁵⁻⁷

METHODS

Place and time of the study

Study period

15th October 2016 to 15th November 2016

Place of the study

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This study was designed as a retrospective analysis of radiological images (CT scan). 35 patients were randomly selected. This was a group of patients that came for abdominal complains for which CT scan was done. It was ensured that bone window of CT scan included adequate visualization of the following anatomical structures - the last thoracic vertebra with the attached rib, all the lumbar vertebrae including the transverse processes of the first and last lumbar vertebrae, sacrum and iliac crests. Patients of both sexes and all age groups were included. Patients with trauma causing anatomical distortion of vertebral column were excluded from the study.

The numbering of the lumbar vertebrae was done according to the method described by Bron et al.⁸ According to this method, a vertebra showing the presence of an attached rib, either fully formed or rudimentary, was considered to be the last thoracic vertebra, and the next caudal vertebra was named the first lumbar vertebra. The lumbar vertebra with the longest transverse process was considered as the third lumbar vertebra.

Based on these anatomical characteristics, we defined "transverse sacralization of L5" when the transverse process of the last lumbar vertebra formed either a pseudarthrosis or a bony bridge with the sacral ala. The morphological type of LSTV was identified based on Castellvi's classification. Type I is considered to be a normal variant. Demographic data (age and sex), the presence of LSTV in the radiographic images and its type was recorded.

RESULTS

In present study on 35 patients, 9 cases (25.7%) of transverse sacralization of L₅ vertebra, 2 cases (5.7%) of Castellvi type I normal variant and 24 (68.6%) absolutely normal cases were found. Castellvi type IIb was found to be most common type, accounting for 33.3% cases, followed by Castellvi type IIa and IIIb accounting for 18.2% each.

Table 1: Prevalence of transverse sacralization of L5 vertebra.

| Prevalence | % |
|---|------|
| Normal | 68.6 |
| Normal variant (Type I) | 5.7 |
| Transverse sacralization of L5 vertebra | 25.7 |

Table 2: Prevalence according to Castellvi classification.

| Type | % | |
|---------|------|------|
| Type I | Ia | 9.1 |
| | Ib | 9.1 |
| Type II | IIa | 18.2 |
| | IIb | 27.2 |
| Type II | IIIa | 9.1 |
| | IIIb | 18.2 |
| Type IV | - | 9.1 |

Table 3: Prevalence according sex.

| Sex | % |
|--------|------|
| Male | 57.1 |
| Female | 42.9 |



Figure 1a & 1b: In a 55 year old male shows normal lumbar and sacral vertebrae and MIP image shows normal transverse process of L5. No evidence of pseudoarthrosis / fusion with sacrum.

In present study on 35 patients, 24 patients (68.6%) were absolutely normal as given in Figure 1a and 1b. Castellvi type Ia as shown in Figure 2a and Ib in Figure 2b accounted for 9% cases each. Castellvi type IIa as shown in Figure 3a and 3b and IIb as in Figure 3c accounted for 18.2% and 27.2 % cases respectively. Type IIb was found to be most common. Castellvi type IIIa as in Figure 4a and 4b and IIIb as in Figure 4c accounted for 9.1% and 18.2 % cases respectively. Castellvi type IV as shown in Figure 5 accounted for 9.1% cases.



Figure 2a: MIP image in 30 year old female showing enlarged dysplastic right transverse process of L5 (Castellvi type Ia). However no evidence of pseudoarthrosis / fusion of transverse process of L5 with sacrum are noted.



Figure 3c: MIP image in 40 year old female showing enlarged bilateral transverse processes of L5 with pseudoarthrosis with sacrum (Castellvi type IIb).



Figure 2b: MIP image in 24 year old female showing enlarged dysplastic bilateral transverse processes of L5 (Castellvi type IIa).



Figure 4a and 4b: MIP image in 75 year old female showing fusion of left transverse processes of L5 with sacrum (Castellvi type IIIa).



Fig 3a and 3b: MIP image in 60 year old male showing enlarged left transverse process of L5 with pseudoarthrosis with sacrum (Castellvi type IIa). However no evidence of fusion of L5 vertebral body or transverse process with sacrum noted.



Figure 4c: MIP image in 50 year old female showing fusion of bilateral transverse processes of L5 with sacrum (Castellvi type IIIb).



Figure 5: MIP image in 80 year old male showing pseudo articulation of enlarged right transverse process of L5 with sacrum and fusion of left transverse processes of L5 with sacrum (Castellvi type IV).

DISCUSSION

In this retrospective study our aim is to determine the prevalence of transverse sacralization of L₅ vertebra and to classify them according to Castellvi classification for lumbosacral transition vertebra. Prevalance according to Castellvi classification is also determined. Numbering of lumbar vertebra was done using method described by Bron et al. Minimum Intensity Projection images were used to evaluate the relation of transverse process of L₅ vertebra with sacrum.

To understand the LSTV or sacralisation, we need to know the embryological origin of lumbar vertebrae. It commences at 3rd week of intrauterine life. All vertebrae originate from somites that form along the cranial-caudal axis, on either side of the notochord, from presomatic mesoderm. These somites differentiate further into dermomyotome (future inner dermis and muscle) and sclerotome. Each sclerotome consists of loosely packed cells cranially and densely packed cells caudally. Some densely packed cells move cranially opposite the center of myotome where they form intervertebral disc. The remaining densely packed cells fuse with the loosely arranged cells of immediately caudal sclerotome to form mesenchymal centrum, body of vertebra. The mesenchymal cells surrounding the neural tube form neural arch. Ossification of vertebra begins in 8th week & ends by 25th year. There are two primary centers & five secondary centers present in each vertebra.⁹ Secondary centers are one for the tip of spinous process, one for the tip each transverse process & two each for annular epiphyses. The primary cause of LSTV is cranial shifts that mean sacralization of the last lumbar vertebrae & partial shifts which mean unilateral fusion of the transverse processes. Literature is unclear about exact origin of LSTV; it is likely a product of both genetic

predisposition (Hox gene product concentration) and developmental influences. Various studies have been done to find out the causes, incidence and clinical features of sacralisation of lumbar vertebrae. Kharinar and Nachale found 6.6% of cases in their study.¹⁰ Which Correlate with the observations done by Chet Savage(7%, 2005).¹¹ Magora and Schwartz found 20.8% sacralization in his study; Sacralization was found in 11.1% cases by Kubavat dharati et al and Peter et al reported 6.2% sacralisation.¹²⁻¹⁴ Otani et al stated that a lumbosacral transitional vertebra was found more often in patients with disc herniation (17%) than in the control group(11%).¹⁵ The person is usually asymptomatic or may present with symptoms which include spinal or radicular pain, disc degeneration, L4/L5 disc prolapse, lumbar scoliosis and lumbar extradural defects¹⁶. In transitional lumbosacral segmentation, it was observed that the lumbosacral intervertebral disc is significantly narrowed.¹⁷⁻¹⁹

The incidence of disc herniation is found to be higher and can occur even at young ages.²⁰⁻²² There was also relationship established between transitional vertebrae and the degree of slippage in spondylolytic spondylolisthesis.²³ In addition, this anomaly has known implications in the field of disc surgery. There are reports of surgery being performed at the wrong lumbar level and the presence of a transitional vertebra may contribute to this error.²⁴ It has been demonstrated that the discs immediately above the transitional vertebra were significantly more degenerative (disc protrusion or extrusion) compared with the disc found between the transitional vertebra and the sacrum.^{25,26} Also, nerve root canal stenosis has been found at the level suprajacent to the transitional vertebra.²⁵ According to Castellvi et al the transitional vertebrae cause abnormal torque movements above these anomalous vertebrae, a fact that could result in disc degeneration.²⁷ Aihara et al in an anatomical study of 70 cadavers claimed that the iliolumbar ligament at the level immediately above the transitional vertebra is much thinner and weaker than in cadavers without a lumbosacral transitional vertebra.²⁶ LSTV therefore may be one of the causative factors for low back pain and the importance of its identification in patients with low back pain cannot be ignored. Complications of sacralization of 5th lumbar vertebra causes pain are actual pressure on nerves or nerve trunks, ligamentous strain around the sacralization, compression of soft tissues between bony joints, by an actual arthritis if a joint is present, by a bursitis if a bursa is present. Failure to recognize & to find LSTV during spinal surgery may have serious complications. LSTV is associated with disc herniation, sciatic pain in some individuals. During delivery of baby, pelvis fails to expand in sacralization. Pain erupts 1st time in young age & frequently history given is pain for few years. The improper formation and union of somites can cause vertebral abnormalities, including block vertebrae, cleft vertebra, and unilateral and bilateral Hemivertebrae.²⁸ Lumbar spine experiences more abuse from normal functions than any other part of human

skeleton.^{20,21} According to Eyo et al to be able to give support to and bear the weight of the body, the integrity of all the vertebrae in the spine, particularly in the lower back must be maintained.^{29,30}

CONCLUSION

The importance of determining lumbosacral transitional vertebra is that it can have a bearing on counting of vertebral levels specially during planning of spinal surgery. Failure to recognise and to number LSTV during spinal surgery may have serious consequences. It can affect spinal movement and put excess stress on the lumbar vertebrae and in-between disc, may be the cause of back pain. Hence it is important to determine the presence of sacralization of lumbar vertebra.

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