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Original Research Article

Sacralization of lumbar vertebrae-prevalence and association with low back ache and radiculopathy

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ABSTRACT

Background: Low back pain (LBP) is a prevalent condition, often associated with various anatomical anomalies, including lumbar sacralization, that is, the fusion of the fifth lumbar vertebra (L5) with the sacrum. This study aims to evaluate the prevalence of sacralization among LBP patients and its relationship with radiculopathy.
Methods: A retrospective study was conducted at the department of orthopaedics, Justice KS Hegde charitable hospital, from January 1, 2023, to July 31, 2024. Patients aged 18-75 years presenting with LBP who underwent lumbosacral radiographs were included. Demographic and clinical data were collected, and sacralization types were classified using the Castellvi system. Statistical analyses were performed using the chi-square test.
Results: Among 771 radiographs analysed, the prevalence of sacralization was 10.1%. Most subjects were over 41 years old (81.6%), with a majority being female (54.5%). Type I A was the most common form of sacralization (30.77%). A significant association between sacralization and radiculopathy was observed, with 70 of the 78 subjects with sacralization experiencing radiculopathy ($p<0.0005$).
Conclusions: This study indicates a noteworthy association between sacralization and radiculopathy in patients with LBP. Given the low prevalence of sacralization, the findings emphasize the importance of recognizing anatomical variations in clinical evaluations of patients with low back ache, particularly in older populations. Further research is warranted to explore the implications of these anatomical anomalies on treatment strategies and patient outcomes.

Keywords: LBP, Lumbar sacralization, Radiculopathy, Castellvi system, Lumbo-sacral transitional vertebrae

INTRODUCTION

Low back pain (LBP) is one of the most prevalent musculoskeletal disorders, with numerous potential causes, including congenital spinal anomalies. One such anomaly is sacralization, a condition where the L5 fuses with the first sacral segment (S1), forming a lumbosacral transitional vertebra (LSTV). This anatomical variation complicates the accurate identification of vertebral segments, and its clinical significance has been the subject of debate in the literature. Several studies have identified sacralization in populations with LBP, although opinions vary on whether this condition is clinically relevant or merely an incidental finding.[1-3]

While some studies suggest sacralization lacks clinical importance and does not significantly contribute to LBP, other reports indicate that LSTV may predispose individuals to specific spinal conditions, including disc degeneration and nerve root irritation.[4-6] The association between Bertolotti's syndrome-a condition linking LSTV with LBP-has been recognized since its description by Mario Bertolotti in 1917, yet the nature of this relationship remains unclear.[7]

Few studies like Tini et al and Moore et al have investigated the relationship between lumbar sacralization and low back ache and have found a positive association between LSTV and chronic LBP, the precise mechanisms by which sacralization contributes to pain and radiculopathy remain poorly understood.[8,9]

Given the conflicting findings, varied school of thoughts and lacunaes in the existing literature, the present study aims to investigate the prevalence of sacralization among patients with LBP and to explore its potential relationship with radiculopathy. This study also intends to classify sacralization according to the Castellvi system and evaluate the association sacralization and radiculopathy.

METHODS

Type of study

It was retrospective study type.

Study setting

Study conducted at department of orthopaedics, Justice KS Hegde charitable hospital, Deralakatte, Mangalore

Study period

Study carried out from 1st January 2023 to 31st July 2024.

Inclusion criteria

Patients between age group of 18-75 years who had radiograph of lumbo-sacral spine in view of low back ache were included.

Exclusion criteria

Patients who had history of trauma to the back, history of prior spinal surgery, history of spinal infection, history of malignant disease/metastasis were excluded.

Methods and data collection

Patients with radiographs of lumbosacral spine with complaints of low back ache were identified from the medical records department (MRD) and picture archiving and communication system (PACS) of the hospital, by using the appropriate international classification of diseases (ICD)-code. All the demographic and clinical data were obtained from the patient files and using open electronic medical records (OPEMR).

Sample size

The sample size was calculated using the Cochran's formula for cross-sectional studies, assuming a 10% prevalence of sacralization among LBP patients, with a 95% confidence level and a 5% margin of error. This calculation provided an adequate sample size of 771 radiographs for the study.

Ethical consideration

Approval was obtained from institutional ethical committee (IEC) for the study.

The demographic and clinical data collected include: Age of patient (corresponding to the time of radiograph), sex of patient, body mass index (BMI; at the time of initial registration) and presence of radiculopathy.

Further different types of sacralization were identified based on Castellvi classification system as given below.

Table 1: Castellvi radiographic classification system of sacralization.

Types	Description
Type IA	A unilateral TP height greater than or equal to 19 mm
Type IB	Both processes height greater than or equal to 19 mm
Type IIA	Presence of unilateral articulation between the TP and the sacrum
Type IIB	Presence of bilateral articulation between the TP and the sacrum
Type IIIA	Unilateral fusion of the TP and the sacrum
Type IIIB	Bilateral fusion of the TP and the sacrum
Type IV	Unilateral type II transition (articulation) with a type III (fusion) on the contralateral side

Statistical analysis

Descriptive statistics were used to summarize the data. The chi-square test was performed using SPSS version 19 to examine association between sacralization and radiculopathy. A $p<0.05$ was considered statistically significant.

RESULTS

In this study, majority of participants were aged over 41 years, accounting for a total of 631 individuals (81.6%) as shown in Table 2 while slight majority of the subjects were female (54.5%) as shown in Table 3.

Approximately 81.7% of subjects were either overweight or obese as shown in Table 4. Out of the 771 radiographs assessed, the prevalence of sacralization was relatively low at 10.1% as shown in Table 5.

Among the 78 subjects with sacralization, presence of different types of sacralization was assessed for using Castellvi radiographic classification system. Type I A

(30.77%) was the most prevalent form of sacralization, with type I B (21.79%) being the second most prevalent form as shown in Table 6.

Further, in this study the relationship between radiculopathy and sacralization was analysed, revealing that, out of 78 participants having sacralization, 70 of them had radiculopathy and out of the 693 participants not having lumbar sacralization, 94 of them had radiculopathy. The analysis indicated a statistically significant association between radiculopathy and sacralization, with a p<0.0005 as shown in Table 7.

Table 2: Age distribution of the study participants (n=771).

Age group (in years)	N	Percentage (%)
<30	51	6.6
31-40	129	16.7
41-50	293	38
>50	298	38.6

Table 3: Gender distribution of study participants (n=771).

Gender	N	Percentage (%)
Male	351	45.5
Female	420	54.5

Table 4: Distribution of BMI among the study participants (n=771).

BMI (kg/m^2)	N	Percentage (%)
Normal	353	45.7
Overweight	278	36
Obese	141	18.3

Table 5: Prevalence of sacralization amongst the study participants (n=771).

Sacralization	N	Percentage (%)
Present	78	10.1
Absent	693	89.9

Table 6: Prevalence of different types of sacralization in accordance with Castellvi radiographic classification system amongst study participants having sacralisation (n=78).

Type of sacralization	N	Percentage (%)
Type I A	24	30.77
Type I B	17	21.79
Type II A	10	12.82
Type II B	7	8.97
Type III A	5	6.41
Type III B	9	11.54
Type IV	6	7.7

Table 7: Strong positive statistical association demonstrated between presence of sacralization and presence of radiculopathy with p<0.0005.

Radiculopathy	Sacralization		P value
	Present	Absent	
Present	70	94	<0.0005
Absent	8	599	

DISCUSSION

The association between LSTV and back pain has been a topic of discussion since its identification in 1917. A study by Tini et al involving 4,000 patients found no significant differences in LBP between those with and without LSTV with regards to the clinical factors assessed.[10] Conversely, other research, such as that by Quinlan et al supports the idea that LSTV may be a significant contributing factor to LBP.[11,12]

In a prospective study by Dai et al a link between LSTV and LBP was established using radiographic methods similar to those used in our research. They categorized LSTV according to Castellvi's classification but focused on a population with chronic back pain, limiting their ability to attribute the cause of pain directly to LSTV due to potential other contributing factors which could not be eliminated.[5] In contrast, our study excluded patients with trauma, those who presented with history or signs of infection, history of undergoing spinal surgeries and those with history or signs of malignant disease or metastasis. This approach taken brought out the true inherent prevalence and association of lumbar sacralization with low back ache and radiculopathy.

Similarly, Taskaynatan et al conducted a prospective study on young male patients with persistent pain and used radiographs to explore the relationship between LSTV and LBP.[6] However, their findings could not be generalized to older individuals or females due to the sample's demographic limitations. In contrast, our study included patients aged 18 to 75 years, irrespective of gender. Hence our study was not limited to a particular section and explored a much-diversified population of patients with low back ache.

Aihara et al highlighted that the presence of a LSTV could lead to above-disc lumbar disc degeneration and significant weakening of iliolumbar ligament, potentially contributing to LBP.[2] Otani et al concluded that while LSTV does not affect incidence of nerve-root symptoms, it might increase the risk of developing LBP in individuals with conditions like disc herniation or lumbar canal stenosis.[7] Radiculopathy, in contrast, our findings in this study showed a positive co relation of lumbar sacralization with radiculopathy, as most of the patients with lumbar sacralization and low back ache reported radiculopathy.

Additionally, research by Nardo et al revealed that 53.9% of participants reported LBP despite lacking LSTV, while

18.1% of those with LSTV had a history of back pain. Notably, their findings showed that groups classified as II and IV under Castellvi's system had a higher prevalence and severity of LBP (73% and 66%, respectively).[4] This is in contrast to our results which showed that type 1 under Castellvi's system had highest prevalence in patients with low back ache.

Taskaynatan et al analysed 881 young males and found a correlation between LSTV and pain severity, although studies linking LSTV to pain intensity and physical activity are limited.[6] This connection is critical as individuals with more severe pain are more likely to seek medical care, whereas those with manageable discomfort may remain undiagnosed.

Our study further tried to explore the exact association between the presence of lumbar sacralization and radiculopathy which is seldom reported in the literature. It concluded that there is a statistically significant positive corelation between radiculopathy and finding of sacralization. However, the relationship of sacralization with disc degeneration disease (DDD) could not be objectively looked into as it required screening of other investigations like MRI. However, radiculopathy is the most common symptom of DDD and nerve root compression. Hence, very fact that lumbar sacralization exhibits a strong positive association with radiculopathy in itself is a proof that lumbar sacralization bears a significant influence and effect on incidence and progression of lower lumbar intervertebral disc prolapse and DDD.

A significant limitation of our research is its retrospective design, which restricts evaluation of various clinical parameters. Future studies should adopt detailed classification of LSTV to explore its specific effects on LBP.

CONCLUSION

This study aimed to investigate the prevalence of sacralization among patients with LBP and its potential relationship with radiculopathy. Our findings suggest that sacralization, while relatively infrequent (10.1% prevalence), has a statistically significant association with radiculopathy among LBP patients.

The demographic data revealed a predominant representation of older individuals, particularly those over 41 years, and a notable prevalence of overweight and obesity among participants. This aligns with existing literature that links obesity to increased risk of musculoskeletal disorders, including LBP. The female predominance in our study is consistent with previous reports highlighting gender differences in the presentation and perception of back pain, which may be attributed to various psychosocial and anatomical factors.

Our classification of sacralization, based on the Castellvi system, identified type I A as the most prevalent form among participants, with significant findings regarding the relationship between radiculopathy and sacralization. The majority of subjects with sacralization reported radiculopathy, suggesting that anatomical anomalies in the lumbosacral region may contribute to nerve root irritation or compression. $P<0.0005$ indicates a robust statistical association, warranting further investigation into mechanistic links between sacralization and radiculopathy.

Existing literature presents mixed findings on clinical significance of LSTV and its role in back pain. Some studies, like those by Tini et al and Quinlan et al highlight conflicting views on whether LSTV significantly contributes to LBP. Our findings echo the need for nuanced understanding in clinical settings, where the presence of sacralization could be a relevant factor influencing treatment decisions.

Furthermore, relationship between sacralization and disc degeneration, while hypothesized based on existing research, remains an area for future exploration. Retrospective design of our study limits our ability to establish causation or explore the interplay of sacralization with other degenerative changes in the lumbosacral spine. Future research should aim for a prospective design, allowing for longitudinal follow-up and the assessment of additional variables such as imaging findings related to disc degeneration.

In summary, this study provides strong evidence of an association between sacralization of the lumbar vertebrae and radiculopathy in patients with LBP. Although sacralization is a relatively uncommon condition, it appears to be a significant contributor to radiculopathy, particularly among older individuals and those with pre-existing spinal abnormalities. The findings underscore the importance of considering anatomical variations like LSTV clinical evaluations of LBP. This study contributes to a growing body of evidence suggesting that sacralization may be more clinically relevant than previously thought, and it calls for further research to better understand the underlying mechanisms, particularly in relation to disc degeneration and spinal instability.

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