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Original Article

Prevalence of lumbosacral transitional vertebra in patients with chronic low back pain: a descriptive cross-sectional study

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Abstract: Background: Numerous causes of low back pain have been identified like spondylosis, spondylolysis, spondylolisthesis, facet lesions, discal abnormalities, vertebral instability, degenerative osteoarthritis, etc., These causes of low back pain are seen commonly in >50 years of age. Lumbosacral transitional vertebra (LSTV) is a common congenital anomaly with multitude of intermediate morphologic manifestations between the typical sacral and lumbar vertebra reported by some authors as a cause of low back pain. There are racial differences reported in the literature on the prevalence of LSTV. There is no common consensus in literature about the association between LSTV and low back pain. There is a paucity of literature on the subject in the Indian population, hence the current study was conducted. Material and methods: 60 cases of low back pain and 60 controls were included in the study. Patients between 18-50 years of age with low back pain of >12 weeks duration who were fulfilling the inclusion criteria were included in the study. The plain radiographs were screened by two observers (one Orthopaedician and one Radiologist) for the presence or absence of lumbosacral transitional vertebra (LSTV) and classification was determined by consensus. The incidence of LSTV was calculated in both the groups (cases and controls) and evaluated for statistical significance. Results: Prevalence of lumbosacral transitional vertebra (LSTV) was found to be 38.33% in cases group as compared to control group (21.66%) and was statistically significant (*p* value <0.05). Prevalence of lumbarisation was higher in case group (10%) in comparison to control group (5.0%) but not found to be statistically significant. Prevalence of sacralisation was also found to be higher in case group (28.33%) as compared to control group (16.67%). This was not found to be statistically significant. Conclusion: The present study showed a higher prevalence of lumbosacral transitional vertebra (LSTV) in case group (38.33%) as compared to control group (21.66%) which was found to be statistically significant. Prevalence of lumbarisation and sacralisation were both found to be higher in the case group in comparison to control group, but the difference was not statistically significant. However, further studies with larger sample would be needed to conclusively determine any association between low back pain and subtypes of LSTV.

Keywords: Back pain, sacralisation, lumbarisation, plain radiographs, transitional vertebra, prevalence

Introduction

Low back pain is a very common problem that most people experience in their lifetime [1-4]. Numerous causes of back pain have been identified in >50 yrs. of age, like spondylosis, spondylolysis, spondylolisthesis, facet lesions, discal abnormalities, vertebral instability, degenerative osteoarthritis, etc., but in young patients the exact cause of low back pain is often unclear [5, 6].

Lumbosacral transitional vertebra [LSTV] is a common congenital anomaly. In this either the fifth lumbar vertebra may show assimilation with the sacrum (sacralization), or the first sacral vertebra may show transition to a lumbar configuration (lumbarisation) [7].

Castellvi *et al*. [8] classified LSTV into 4 type (**Figure 1**) based on their morphologic and clinical characteristics concerning herniated nucleus pulposus.

TYPE 1 - Dysplastic transverse process; unilateral [a] or bilateral [b]. Large triangular transverse process, measuring at least 19 mm in width, in this type location of herniated nucleus

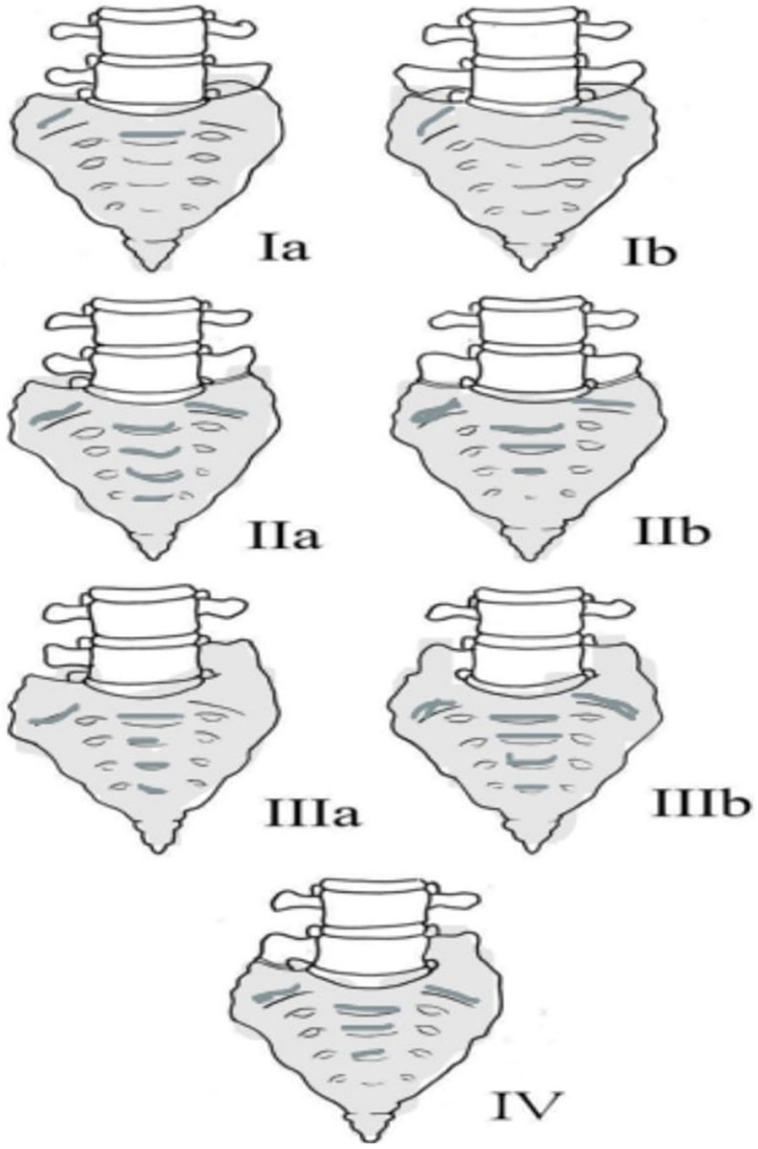

Figure 1. Diagrammatic representation of LSTV classification according to Castellvi et al. [8].

pulposus was not different from that seen in the normal population.

TYPE 2 - Incomplete lumbarisation/sacralisation; unilateral [a] or bilateral [b]. In this type, enlarged transverse process, which appears to follow the contour of the sacral ala. They are considered incomplete because there appears to be a di-arthrodial joint between the transverse process and the sacrum. In this type incidence of herniation just above transition was 83.4%.

TYPE 3 - Complete lumbarisation/sacralisation; with unilateral [a] or bilateral [b], this is similar to type 2 except that instead of the di-arthrodial joint between the transverse process and the sacrum, there is true bony union.

TYPE 4 - Mixed; type 2 on one side and type 3 on the other side. In type 3 and type 4, there are similar distributions of herniation as shown in the normal population. And also, there is no herniation at the level of transition.

It has been reported that people with LSTV are more prone to develop back pain [9-11]. The various etiologies of low back pain in LSTV can be; degeneration of anomalous articulation between an LSTV and the sacrum [12], disc, spinal canal, and posterior element pathology at the level above a transition [13], extraforaminal stenosis secondary to the presence of broadened transverse process of the transitional vertebra [14], decrease paraspinal muscle volume and increased lumbar lordosis [15], facet joint arthrosis contralateral to a unilateral fused or articulating LSTV [12].

There are racial differences reported in the literature on the prevalence of LSTV. The prevalence in the Western population is reported between 12% to 30% [7, 9, 10, 16-20], in Chinese population it is reported to be 4% [21] and 4-19% in few Indian studies [22-25]. In general population the prevalence of lumbarisation reported is 3.4-7.2% whereas sacralization is 1.7-14% [26]. The incidence of LSTV is found to be more in males than females [18].

There is no common consensus in literature about the association between LSTV and low back pain. There is a paucity of literature on the subject in the Indian population, hence the current study was conducted to find out prevalence of lumbosacral transitional vertebra in

Table 1. Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
● Cases; Patients between 18-50 years with a complaint of chronic lower back pain of >12 weeks duration. ● Controls: Patients between 18 yrs. - 50 yrs. of age, who underwent X-ray KUB (Kidney and Urinary Bladder) for complaints other than low back pain.	Patients with objective causes of low back pain. ● Congenital anomaly. ● Infective conditions of the spine. ● Traumatic spine. ● Primary or metastatic neoplasm of the spine. Degenerative spine diseases. ● Inflammatory disorders. ● Prior spine surgery.

patients with chronic low back pain in the Indian population.

Material and methods

Patient enrollment criteria

After approval by the Institutional Ethics Committee (IECHR/2020/PG/47/38-R1), written informed consent was taken from patients for participation. 60 cases and 60 controls were included in the study (**Table 1**). During the study duration adult patients between 18 yrs. to 50 yrs. with complaints of lower back pain of more than 12 weeks duration, attending orthopedics OPD, and fulfilling the inclusion and exclusion criteria were recruited in the study. Detailed history along with a thorough physical examination was performed.

Taking Gupta R *et al*. [24] as a reference, the percentage of LSTV was 26% in their low back patient's group and 4% in their control group, to estimate this difference as alpha =5% and power =80%, a sample of 40 cases and 40 controls was determined, but we were able to recruit 60 cases and 60 controls.

Diagnostic modalities

All patients were screened by relevant laboratory and radiological investigation, to rule out objective causes of low back pain (traumatic, infective, inflammatory, neoplastic, etc.). Patients with any objective cause of low back pain were excluded. Recruited patients underwent X-ray lumbosacral spine (A-P and lateral view), including the last rib.

The plain radiographs were screened by two observers (one Orthopaedician and one Radiologist) for the presence or absence of LSTV and classification was determined by consensus. The observers were made aware of the classification and printed format of the same was given to them. The data was recorded in a proforma. The incidence of LSTV was calculated in both the groups (cases and controls) and evaluated for statistical significance.

The numbering of the lumbar vertebra was done according to the method described by Bron *et al.* [27]. 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.

As described by Chakraverty *et al*. [28], the intercristal line on the Xray LS spine AP view was considered to be correspondent to the L4-L5 disc space. An upward and laterally directed transverse process was considered to belong to a thoracic vertebra, whereas a horizontally directed transverse process was considered to belong to a lumbar vertebra. The lumbar vertebra with the longest transverse process was considered the third lumbar vertebra.

Statistical analysis

Statistical analysis was done by using SPSS v20.0. The data was represented as mean and standard deviation. Continuous variables were compared using student's t test and nominal data was compared using chi-square test. p value <0.05 was taken as significant.

Results

Radiological assessment analysis

60 cases and 60 controls fulfilling the inclusion criteria were included in the study. We found

Table 2. Comparison of lumbosacral transitional vertebra (LSTV) prevalence between two groups

Groups	LSTV		Chi-square value	*p*-value
	No N (%)	Yes N (%)		
Cases	37 (61.67)	23 (38.33)	3.968	0.046*
Lumbarisation	54 (90)	06 (10)		
Sacralisation	43 (71.7)	17 (28.3)		
Controls	47 (78.3)	13 (21.7)		
Lumbarisation	57 (95)	03 (05)		
Sacralisation	50 (83.4)	10 (16.6)		

**P* value is <0.05 and found to be significant.

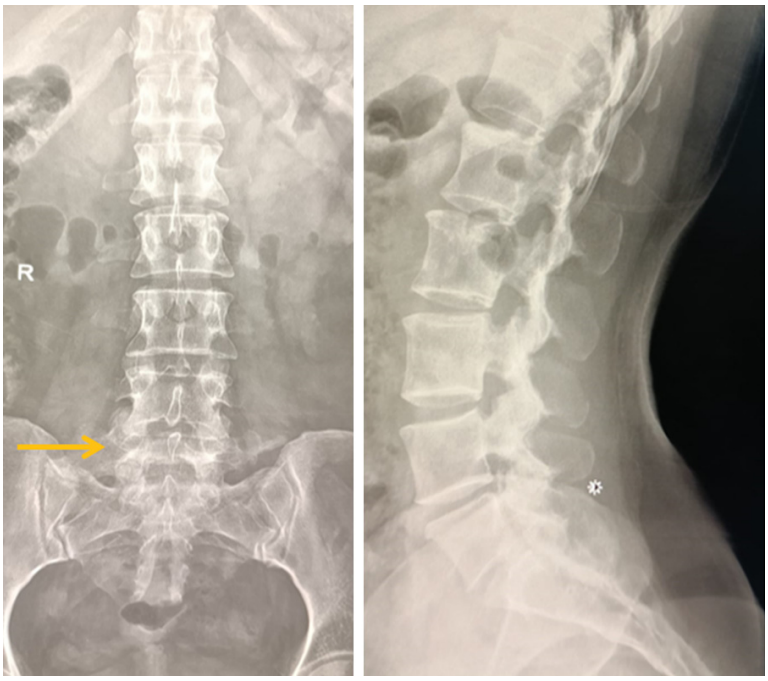

Figure 2. X-ray LS spine AP and lateral view shows pseudoarthrosis on right side (arrow) and diagnosed as incomplete lumbarisation and classified as Castellvi type 2A.

LSTV in 38.33% cases while it was seen in 21.66% controls. Chi square analysis suggested that there was greater prevalence of LSTV in cases as compared to control group. The *p*-value was <0.05 which was found to be significant.

There was lumbarisation in 10% cases and 6.67% controls (6.67%). Fisher's exact test analysis suggests that there was no significant difference of lumbarisation prevalence between cases and control group. The *p*-value was >0.05 (**Table 2**).

Sacralisation was seen in 28.33% cases and 16.67% controls. Chi square analysis suggests that there is no significant difference of sacralization prevalence between cases and control group of subjects. The *p*-value was >0.05 (**Table 2**).

The commonest types of LSTV were Castellvi 2A (7 cases) and 2B Castellvi (6 cases) in the case group. In control group commonest type was again Castellvi type 2 (2A and 2B 3 cases each) (**Figures 2-4**).

Statistical analysis for individual types was not done due to the small sample sizes in individual subgroup (**Table 3**).

Clinical assessment analysis

56.7% cases had back pain with radiculopathy. Out of 34 cases of radiculopathy 41.18% were found to have LSTV, whereas out of 26 cases without radiculopathy 34.66% were found to have LSTV.

Chi square analysis suggested that there was no significant association between radiculopathy and LSTV (**Table 4**).

Discussion

In the current study, prevalence of LSTV was 38.33% (23 out of 60) amongst the cases with complaints of backache. The control group (without backache) in contrast was found to have a prevalence of only 21.66% (13 out of 60) which we have assumed to be representative of the general population. This difference was found to be statistically significant.

In previous studies prevalence of LSTV in Western population was reported to be 12-30% [7, 9, 10, 16-20], and in Indian population the reported prevalence was around 4-19% [22-25, 29]. In current study it was found to be 21.6%. Such wide variation in prevalence of LSTV in general population can be explained by genetic etiopathogenesis of LSTV, kind of study population chosen, criteria & classification

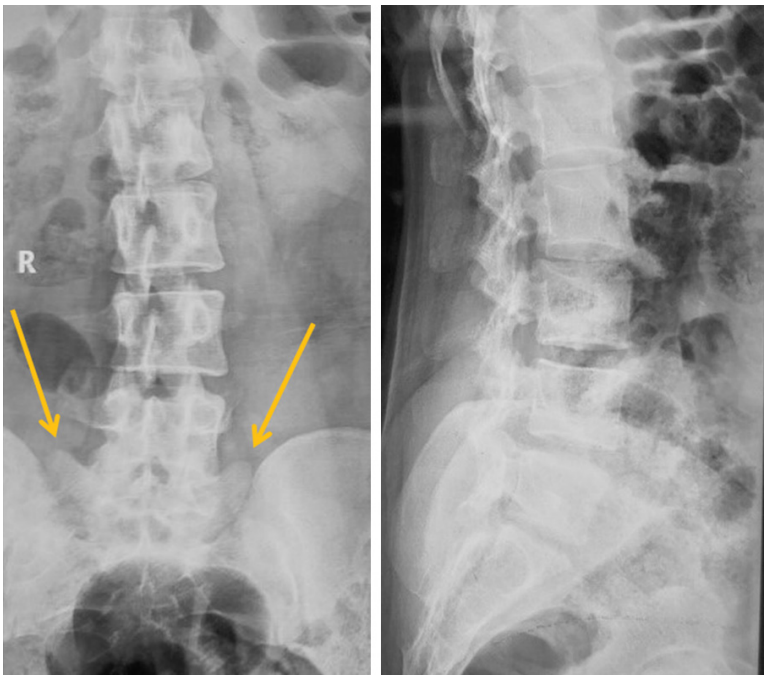

Figure 3. X-ray LS spine AP and lateral view with pseudoarthrosis on both sides (arrow) and diagnosed as incomplete lumbarisation and classified as Castellvi type 2B.

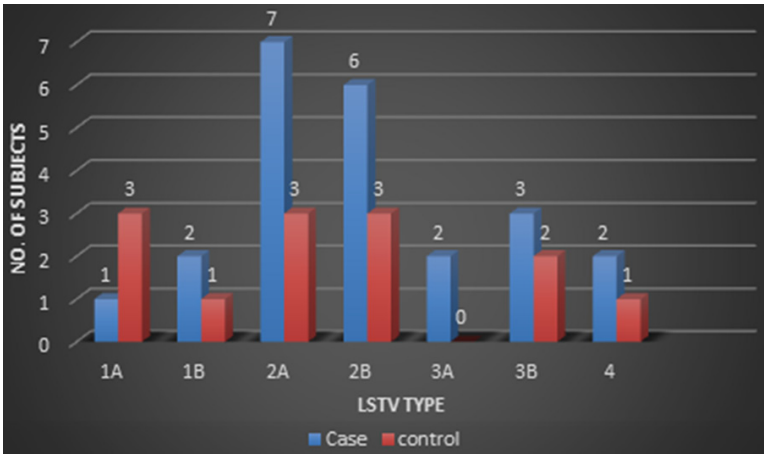

Figure 4. Bar diagram showing prevalence of different type of LSTV in case and control group.

systems used and imaging modalities used in the studies (**Table 5**).

In the present study, the relatively high prevalence of LSTV even in the control group (21.66%) could be explained by the fact that the controls were recruited from patients presenting to the hospital for some ailment (even if not backache) and thus cannot be taken as wholly representative of the general population at large. There might be some other hidden confounding factors at play, not accounted for in the present study.

Considering studies which looked for prevalence of LSTV specifically in patients with low backache, it was found to be 22-37% [6, 9, 22, 24, 30-32] (**Table 6**). This prevalence (in backache patients) in our study is also higher at 38.33%. The current study was conducted during Covid pandemic and there is a possibility that this could have altered the patient profile of average backache towards more severe one. In other words, there might be a differential distribution of LSTV prevalence with differing severity of backache and our study may inadvertently have picked up only the more severe backache cases.

The prevalence of lumbarisation and sacralisation was found to be higher in cases than controls (10% vs 5.0% for lumbarisation and 28.33% vs 16.67% for sacralisation), however the difference was not statistically significant. The prevalence of sacralisation was found to be higher, which is consistent with the available literature [7, 10, 17, 22].

The commonest types of LSTV according to Castellvi classification was found in the case group 2A (7 cases) and 2B (6 cases). In control group commonest type was type 2 (2A and 2B 3 cases each). Even though this was in accordance with previous studies [18, 30, 33], which indicated a higher association of type 2 LSTV with backache (possibly due to the pseudoarthrosis leading to early arthritic changes), but our results could not be analyzed for statistical significance due to the small number of each subtype found.

Table 3. Subtypes of LSTV according to Castellvi et al.

		CASE/CONTROL		Total	%
		Case	Control		
LSTV TYPE	1A	1	3	4	11.11
	1B	2	1	3	8.33
	2A	7	3	10	27.78
	2B	6	3	9	25
	3A	2	0	2	5.55
	3B	3	2	5	13.89
	4	2	1	3	8.33
	Total	23	13	36	
NO LSTV		37	47	84	
Total		60	60	120	

Table 4. Association of Radiculopathy in cases with LSTV

		LSTV			%	Chi-square	*p*-value
		N	Y	Total			
Radiculopathy	N	17	9	26	34.66	0.268	0.064
	Y	20	14	34	41.18		
Total		37	23	60			

Table 5. Studies showing prevalence of LSTV in general population

S No.	Year	Author	Sample Size	Prevalence
1	2022	Current study	60	21.6%
2	2022	Jaakko et al. [16]	1468	21.1%
3	2018	Gopalan B et al. [22]	224	19.6%
4	2018	Patra et al. [23]	50	12%
5	2014	Gupta et al. [24]	50	4%
6	2014	Sekharappa et al. [25]	1000	8.1%
7	2013	Ucar et al. [17]	3607	18.9%
8	2012	Nardo et al. [18]	841	18.1%
9	2006	Hughes et al. [7]	500	13.4%
10	2005	Peterson et al.[19]	353	12.2%
11	2003	Steinberg et al. [10]	464	18.3%
12	2002	Erken et al. [20]	1053	29.8%
13	1999	Dai et al. [9]	184	15.8%

A common complaint among the cases was that of radiculopathy which was seen in 56.7% (34/60) of the cases, which can be a manifestation of a symptomatic LSTV on account of the increased rotational stress on the discs above a partially fused LSTV segment promoting accelerated disc degeneration and thus radiculopathy [34]. Our study showed a higher prevalence of LSTV in cases with radiculopathy (14/34, 41.18%) as compared to those cases without radiculopathy (9/26, 34.66%) which was consistent with previous studies [8, 35, 36]. This difference was however statistically non-significant (*p*-value 0.064).

The limitation of this study was that the controls in this study were recruited from patients presenting to the hospital for some ailment (even if not backache) and thus may not be representative of the general population at large. Limited sample size precludes us from categorizing the data by various subtypes of LSTV and thus meaningful observations cannot be derived for the same. The data may have particular skewness towards only the more severe cases due to increase in the threshold to seek medical attention in the patients due to the ongoing COVID pandemic. The observation documented in our study was based on X-ray findings. CT is a better radiographic modality for identification and classification of LSTV, but due to the additional radiation exposure CT was not done.

Conclusion

The present study showed a higher prevalence of LSTV in case group (38.33%) as compared to control group (21.66%) which was found to be statistically significant. Prevalence of lumbarisation and sacralisation were both found to be higher in the case group in comparison to control group, but the difference was not statistically significant, however further studies with larger sample size would be needed to conclusively determine any such association. Thus, we recommend that for better identification and categorization of all transitional vertebra, further studies should include, larger number of cases from general population and more detailed imaging like Computer tomography scant.

Disclosure of conflict of interest

None.

Table 6. Studies showing prevalence of LSTV in patients with complaints of backache

S. No.	Year	Author	Sample Size	Prevalence
1.	2022	Present Study	60	38.3%
2	2021	V. Sivakumar et al. [32]	450	28%
3	2020	Daniel et al. [30]	100	22%
4	2019	Ravikant et al. [31]	500	26.8%
5	2018	Gopalan B et al. [22]	372	27.2%
6	2014	Gupta et al. [24]	50	26%
7	2001	Eyo et al. [6]	300	37%
9	1999	Dai et al. [9]	276	35.1%

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