RESEARCH ARTICLE

DOI: 10.4274/AdvRadiolImaging.galenos.2024.09719
Adv Radiol Imaging 2024;1(3):51-4

Prevalence of Lumbosacral Transitional Vertebra in Turkish Population: A Retrospective Study

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Abstract

Objectives: To determine the prevalence of lumbosacral transitional vertebra (LSTV) in patients admitted to the hospital with various complaints in Erzincan and its surroundings and to determine the age-to-gender relationship.

Methods: Magnetic resonance images of 1,164 patients were retrospectively examined. Patients with disc degeneration, over the age of 65, patients with scoliosis, spondylolisthesis, pelvic and spinal region trauma, and patients who had previously undergone lumbar region surgery were excluded from the study. Our study is a retrospective cohort study.

Results: The prevalence of LSTV was 274 patients (23.53%), lumbarization was 264 patients (22.68%), and sacralization was 10 patients (0.85%). Correlations with age and gender variables were also investigated. When age was examined by sex, the average age of the women was calculated as 42.2±13.1 (13-64) years and that of the men was calculated as 41.8±13.0 (12-64) years. Age was statistically similar across the gender groups (p=0.386).

Conclusion: The LSTV is a frequently encountered anatomical variation. It is important to know this in advance and evaluate it, as it will reduce the risk of complications in the nerves and tissues originating from this area in both surgical and invasive interventions to the area.

Keywords: Lumbarization, sacralization, lumbosacral transitional vertebra, spinal surgery, magnetic resonance imaging

Introduction

Morphometric measurements of the human body and the contextual relationships between them constitute the basis of anatomical studies. Morphometry is the statistical presentation of some quantitative variables such as the width, length, and height of structures. The lumbosacral area is a critical area that is subjected to greater force and resistance than other parts of the body, and at this level, there is a dramatic change in the direction of transmission of forces.[1] The sacrum may contain six vertebrae in cases where an additional sacral vertebra is developed or when the fifth lumbar vertebra or the first coccygeal vertebrae are included in the area. The phenomenon of the inclusion of the fifth lumbar vertebra in the sacral region is called "sacralization", and the phenomenon of reduction of the sacral components due to the separation of the first sacral vertebra is called "lumbarization" Figures 1, 2. Lumbarization and sacralization of the lumbosacral region are referred to as the lumbosacral transitional vertebra (LSTV).[1,2] LSTV is a normal anatomical variation with characteristics of both the lumbar and sacral vertebrae and is considered a clinically important condition. LSTV, first described by Bertolotti[3] in 1917, is a variation that is usually detected randomly in patients presenting to the clinic with different and unrelated symptoms.[4] LSTVs are congenital spinal anomalies of the spine and are highly prevalent in the general population, with a reported value of 4-30%. The degrees of morphological variation in the lowest or superior sacral segment vary from the L5 vertebrae with enlarged longitudinal processes to complete fusion with the sacrum. On the contrary, the S1 vertebral segment may show varying degrees of lumbarization, such as well-formed lumbar-type facet joints, a square appearance in the sagittal plane, and abnormal articulation formation rather than merging with the rest of the sacrum.[5] In the literature; It is stated that since the existing biometric structure of the spine is disrupted in the presence of LSTV, clinical conditions such as spondylolysis, peripheral and central stenosis, intervertebral disc pathologies, and facet arthritis are encountered.[6] The literature defining the LSTV is relatively limited. There are many studies that discuss the prevalence, diagnosis, and management of LSTVs, but many of these studies show the need to reveal more population and variation

Cite this article as: Bingöl K, Arslan MK, Sunar M, Memiş KB. Prevalence of Lumbosacral Transitional Vertebra in Turkish Population: A Retrospective Study. Adv Radiol Imaging. 2024;1(3):51-4

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Received: 22.05.2024 Accepted: 17.07.2024 Epub: 18.07.2024 Published: 18.12.2024

findings to help understand LSTVs and their impact on patients.[7] There is no standard method for diagnosing LSTV. Methods such as X-rays, computed tomography (CT), and magnetic resonance imaging (MRI) are used for diagnosis. The oldest of these is direct radiographs made with X-rays. It is accepted that the diagnosis of LSTV can be best assessed using anteroposterior radiography.

CT is a method that allows imaging of bone and soft tissue elements in the spinal region and is quite successful in evaluating bones compared with other imaging methods. An important advantage of MRI is that radio waves are used, and images can be captured in any plane without changing the patient's position. At the same time, it is especially preferred because it has the highest soft tissue contrast resolution.

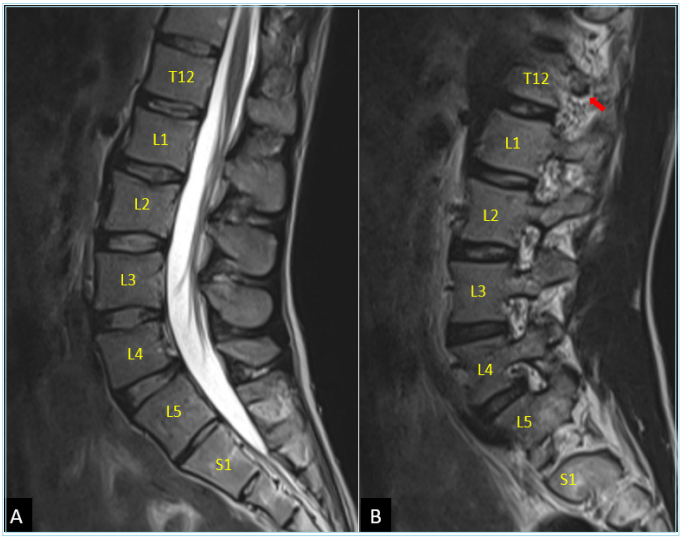

Figure 1. Sacralization of L5. Sagittal plane T2W lumbar magnetic resonance images (MRI) (A, B) showing the sacralized 5th lumbar vertebra. The 12th thoracic vertebra was confirmed by observing the 12th rib (red arrow) on sagittal T2W MRIs

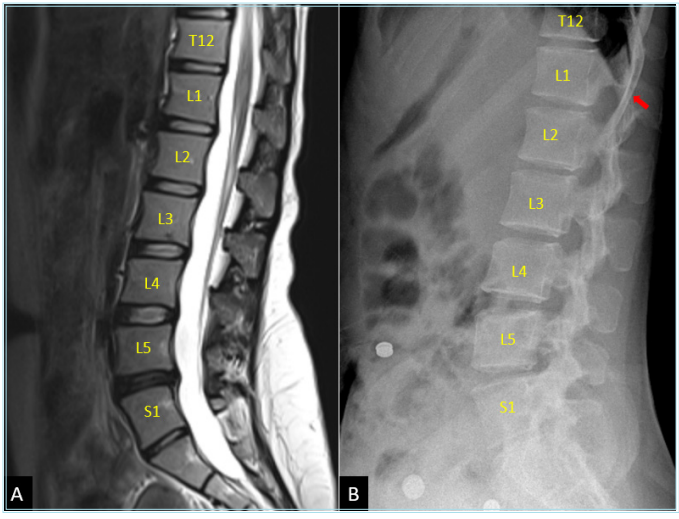

Figure 2. Lumbarization of S1. In the sagittal plane, T2-weighted lumbar magnetic resonance imaging (A) and lateral lumbar radiograph (B) show the summarized 1st sacral vertebra. The 12th thoracic vertebra was confirmed by observing the 12th rib (red arrow) on the lateral lumbar radiograph

In our study, we aimed to compare age, sex, and lumbalization/sacrosanctation values in patients from the Erzincan region who visited the clinic for various reasons and were diagnosed with LSTV.

Methods

Patient Population and Demographic Data

In this study, images taken at Erzincan Binali Yıldırım University Mengücek Gazi Training and Research Hospital Radiodiagnostic Department between 01.01.2020 and 21.07.2022 were used. Approval for the study was obtained from Erzincan Binali Yıldırım University Clinical Research Ethics Committee (ethics committee decision date: March 30, 2023; decision number: 2023-07/4). MRI of the lumbosacral region of 1,164 patients, which were obtained from the department of radiodiagnostics between these dates, were retrospectively analyzed. Patients aged >65 years, those with scoliosis, spondylolisthesis, pelvic or spinal region trauma, and those who had previously undergone lumbar region surgery were excluded from the study on the grounds that their normal anatomy may be disrupted. Finally, 274 patients (119 men, 155 women) who were eligible for the study were identified, and their gender and age were recorded.

Acquisition and Processing of Images

All MRI images were obtained using a 1.5T MRI machine with a 32-channel lumbar coil (Magnetom Aera, Siemens, Erlangen, Germany). Images were taken with the patient in the supine position: sagittal plane T2-weighted images TR (time of repetition): 4120 ms, TE (time of echo): 104 ms, average: 2, field of view: 280 mm, slice thickness: 4 mm, voxel size: 0.9*0.9*4 mm; sagittal plane T1 images TR: 646 ms, TE: 9 ms, average: 2, field of view: 280 mm, slice thickness: 4 mm, voxel size: 0.9*0.9*4 mm; and axial plane T2-weighted images TR: 5070 ms, TE: 88 ms, average: 1, field of view: 190 mm, slice thickness: 4 mm, voxel size: 0.7*0.7*4 mm.

All MRI images were re-evaluated by a radiologist with 10 years of experience. The MRIs were transferred to an image archiving and transmission system workstation (Akgün PACS Viewer v7.5, Akgün Software, Ankara, Turkey) for analysis and measurement in standard digital imaging and medical formats.

Evaluation of Images

The presence of the LSTV, which constitutes the morphological data, was obtained from the coronal and sagittal reformate images and recorded. This was considered as lumbarization and sacralization.

Statistical Analysis

IBM Statistical Package for the Social Sciences 22 (IBM Corp., Armonk, N.Y., USA) software was used for statistical analysis. The results are summarized as numbers (n) and percentages (%) for categorical variables and as mean±standard deviation and median and minimum-maximum values for continuous variables. The Fisher's exact test was used to analyze categorical variables. The assumption of normality for continuous variables was confirmed by the Kolmogorov-Smirnov test. When comparing continuous variables between two groups, Student's t-test was used when statistical assumptions were met, and Mann-Whitney U test was used when statistical assumptions were not met. The statistical significance level was set at 0.05 for all tests.

Results

As a result of retrospective screening, it was found that 121 (44.2%) of the 274 patients included in the study were male and 153 (55.8%) were female. The gender distribution of patients is presented in Figure 3 as percentages and numbers. The overall average age of the patients was found to be 41.6±13.0 (12-64) years, and the frequency distribution according to the age ranges is shown in Figure 3.

When age was examined by sex, the average age of the women was calculated as 42.2±13.1 (13-64) years and that of the men was calculated as 41.8±13.0 (12-64) years. The results are presented in Table 1. Age was statistically similar across the gender groups (p=0.386).

When LSTV positivity was examined, LSTV was observed in the form of lumbarization in 264 (96.4%) of the 274 patients included in the study.

Age distribution in groups with LSTV (lumbalization and sacralization) was examined, and descriptive statistics of age are presented in Table 1. The median age was similar between the LSTV (S) and LSTV (L) groups (p=0.984).

Discussion

LSTV is an anatomical anomaly observed between the 5th lumbar vertebra and the *os sacrum*.[8] LSTV are characterized by lumbarization and sacralization.[3] Sacralization is related to the extension of the *processus transversus* of the 5th lumbar vertebra and its fusion with the first sacral vertebra to varying degrees. Lumbalization is the development of the first sacral vertebra partially or completely in the lumbar-type morphology. When complete, six lumbar vertebrae are observed.[9] The incidence of sacralization is higher than that of lumbarization.[10]

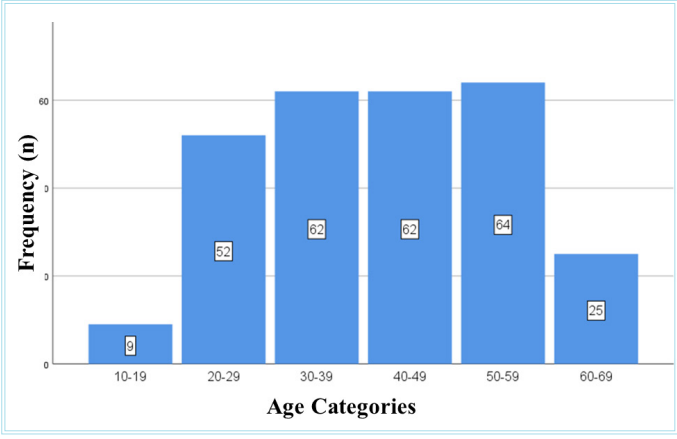

Figure 3. Age distribution of patients

The *ligamentum iliolumbale* is accepted as the reference point for determining the LSTV. In a study using MRI, Carrino et al.[11] found that the *ligamentum iliolumbale* originates from the 5th lumbar vertebra in 96.8 % of cases. Castellvi et al.[12] developed a radiological classification system that defines four types of LSTV. Type 1 includes unilateral (1a) or bilateral (1b) dysplastic *processus transversus*. In type 2, incomplete unilateral (2a) or bilateral (2b) lumbarization/sacralization is observed; there is a diarthrodial joint between the enlarged *processus transversus* and the *os sacrum*. Type 3 is defined by complete osseous fusion of the *processus transversus* to the *os sacrum*. It includes unilateral (3a) or bilateral (3b) lumbalization/sacralization. Type 4 has a type 3 LSTV on one side and a type 2 LSTV on the other side.

O'Driscoll et al.[13] developed four types of classification systems according to the presence or absence of the *discus intervertebralis* and anteroposterior length of S1-2 disc morphology using MRI. According to this classification, between the *os sacrum* and the 1st sacral vertebra; type 1 has no disc and is observed in those without LSTV. In type 2, there is a residual disc. The AP diameter is lower than the AP diameter of the *os sacrum*, and this type is most common in patients without LSTV. In type 3, a normal disc has an AP diameter equal to the AP diameter of the *os sacrum*. Type 3 is observed in the normal *columna vertebralis* and LSTV. Type 4 is similar to type 3, with the difference being that squareness is observed in the first sacral vertebra. There was a good correlation between the type 4 disc and the summarized sacral vertebra.

In patients with LSTV abnormalities, the joint limitation of this region increases as a result of the bilateral fusion of the *processus transversus* of the lowest lumbar vertebra and the *os sacrum*, and this affects the biomechanics of the lumbar region.[14] Because this condition increases the stabilization of this region, *discus intervertebralis* pathology is less common below the LSTV level, whereas disc degeneration is more common because the *discus vertebralis* at the upper level will carry the load.[15] The relationship between low back pain and LSTV was first described by Bertolotti[3] in 1917 and was named Bertolotti syndrome.[16]

There are cases in the literature of surgical procedures performed at the wrong lumbar level if there is a LSTV in both surgical interventions and injections, as it is not known which level the nerve root corresponds to. Therefore, the LSTV can have important clinical consequences.[14]

Although LSTV is a congenital anatomical variation frequently encountered in the lumbosacral region, its pathophysiology and biomechanical effects are not fully understood.[17] In various studies, the incidence of LSTV varies between 4% and 37%.[17] This difference between rates can be explained by assessment errors, differences in individual diagnosis and classification criteria, and factors that create confusion among the population samples investigated.[18,19]

Table 1. Age distribution of LSTV (lumbalization and sacralization) patients and by gender

LSTV	Mean	SD	Median	Minimum	Maximum	p
Sacralization	41.80	15.519	41	23	64	0.984
Lumbalization	41.55	12.965	42	12	64	
Women	42.2	13.1	43	13	64	0.386
Men	40.8	13.0	42	12	64	
Total	41.6	13.0	42	12	64	

The Mann-Whitney U test was applied.
SD: Standard deviation, LSTV: Lumbosacral transitional vertebra

In the 28 studies conducted between 2000 and 2017 that we reviewed regarding LSTV, radiological images of 47,586 patients were examined, and LSTV variations were detected in 6,353 patients (13.3%). In 15 of these studies, researchers stated that LSGV was associated with lumbarization and sacralization. These studies were conducted with a total of 30,053 patients, and the average LSTV rate was 12.45%. Of these, the lumbarization rate was 3.76%, and the sacralization rate was 8.69%. In our study, the incidence of LSTV was higher than the average of 28 studies. According to the averages of 15 studies on sacralization and lumbarization rates, these rates were quite different. In our study, the incidence of LSTV was 23.53%, of which lumbarization was 22.68% and sacralization was 0.85%.[20]

Study Limitations

Although our study was a comprehensive retrospective study, a majority suitable for typing could not be achieved because of the large number of patients who were excluded from the study. In the future, the scope of this study can be expanded to include various morphometric measurements to correlate LSTV with pain in patients with LSTV. Our lumbar MRIs cover T12. The detection was performed on the t12 vertebra.

Conclusion

In our study, we aimed to compare age, sex, and lumbarization/sacralization values in patients from the Erzincan region who came to the clinic for various reasons and were diagnosed with LSTV. Currently, MRI is a method used by radiologists in radiodiagnostic departments in medicine, both for accurate diagnosis and for diagnosis and morphometric measurements of congenital variations, such as LSTV. In addition, the variability in lumbalization/sacralization rates observed according to regional patient profiles indicates the need for screening in larger patient populations.

Ethics

Ethics Committee Approval: Erzincan Binali Yıldırım University Clinical Research Ethics Committee (decision date: 30.03.2023, decision number: 2023-07/4).

Informed Consent: Because this was a retrospective study, informed consent was not required by the ethics committee.

Footnotes

Author Contributions

Concept: K.B., Design: K.B., Data Collection or Processing: K.B., M.K.A., K.B.M., Analysis or Interpretation: K.B., M.K.A., M.S., Literature Search: K.B., M.K.A., K.B.M., Writing: K.B., M.S.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

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