

Prevalence of Lumbosacral Transitional Vertebra in the 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-gender relationship.

Methods: Magnetic resonance images (MRI) of 1164 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%). Their correlation with age and gender variables was investigated. When age was examined by gender, the average age of the women was calculated as 42.2 ± 13.1 (13-64) years and the average age of men was calculated as 41.8 ± 13.0 (12-64) years. Age was statistically similar across the gender groups ($p=0.386$).

Conclusion: Lumbosacral transitional vertebra 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 made on 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 width, length and height of structures. The lumbosacral area is a critical area that is subjected to greater force and resistance compared to other parts of the body, and at this level there is a dramatical 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 as described is called lumbosacral transitional vertebra (LSTV) ^{1,2}. Lumbosacral transitional vertebra (LSTV) is a normal anatomical variation that has characteristics of both lumbar and sacral vertebrae and is a clinically important condition. Lumbosacral transitional vertebra, first described by Bertolotti in 1917 is a variation

that is usually detected randomly in patients presenting to the clinic with different and unrelated symptoms ³. 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 of the lowest lumbar segment or superior sacral segment vary from 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 squarer appearance in the sagittal plane, with an abnormal articulation formation rather than merging with the rest of the sacrum ⁴. 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 ⁵. The surrounding literature defining 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 findings to help understand LSTVs and their impact on patients ⁶. There is no standard method for diagnosing LSTV. Methods such as x-rays, CT and MRI are used in diagnosis. The oldest of these is direct radiographs made with x-rays. It is



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accepted that the diagnosis of LSTV can be best seen on anteroposterior radiographs.

CT is a method that allows imaging of bone and soft tissue elements of the spinal region and is quite successful in evaluating bones compared to other imaging methods. An important advantage of MRI is that the energy used is radio waves and images can be taken in any plane without changing the patient's position. At the same time, it is especially preferred because it is the method with the highest soft tissue contrast resolution power. In our study, we aimed to compare age, gender and lumbarization / sacralization values in patients from the Erzincan region who came to the clinic for various reasons and were diagnosed with LSTV.

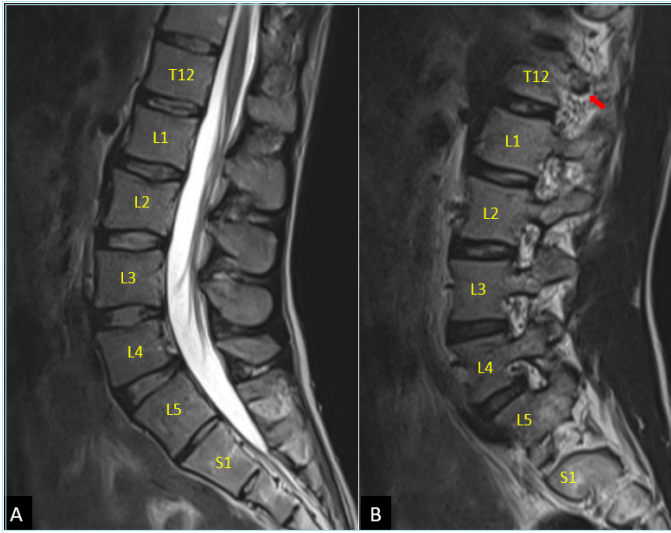


Figure 1 Sacralization of L5. Sagittal plane T2W lumbar magnetic resonance (MR) images (A-B) show the sacralized 5th lumbar vertebra. The 12th thoracic vertebra was confirmed by seeing the 12th rib (red arrow) on sagittal T2W MR images



Figure 2 Lumbarization of S1. In the sagittal plane, T2W lumbar magnetic resonance imaging (A) and lateral lumbar radiograph (B) show the lumbarized 1st sacral vertebra. The 12th thoracic vertebra was confirmed by seeing the 12th rib (red arrow) on the lateral lumbar radiograph.

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). Magnetic resonance images of the lumbosacral region of 1164 patients, taken in the Department of Radiodiagnostics between these dates, were scanned retrospectively. Over the age of 65, patients with scoliosis, spondylolisthesis, pelvic or spinal region trauma, and patients 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 with a 1.5T MRI machine and 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): 4120ms, TE (Time of Echo): 104ms, average: 2, field of view: 280 mm, slice thickness: 4mm, voxel size: 0.9*0.9*4 mm; sagittal plane T1 images TR: 646ms, TE: 9 ms, average: 2, field of view: 280mm, slice thickness: 4mm, voxel size: 0.9*0.9*4 mm, and axial plane T2-weighted images TR: 5070 ms, TE: 88ms, 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. MR images were transferred to an image archiving and transmission system workstation (Akgün PACS Viewer v7.5, Akgün Software, Ankara, Turkey) to analyze and make measurements in standard digital imaging and medical formats.

Evaluation of Images

The presence of the lumbosacral transitional vertebra, which constitutes the morphological data, was obtained from coronal and sagittal reformate images and recorded, and stated as lumbarization and sacralization.

Statistical Analysis

IBM SPSS 22 (IBM Corp., Armonk, N.Y., USA) package program was used in the statistical analysis of the study. The results were summarized as numbers (n) and percentages (%) for categorical variables, and as mean $\pm$ standard deviation and median, minimum – maximum values for continuous variables. Fisher 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 in 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 accepted as 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 the 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 created is shown in Figure 3.

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

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

Age distribution in groups with LSTV (lumbarization and sacralization) was examined and descriptive statistics of age are presented in Table 1. The median age value was found to be similar in the LSTV (S) and LSTV (L) groups ($p = 0.984$).

Discussion

Lumbosacral transitional vertebra is an anatomical anomaly seen between the 5th lumbar vertebra and the *os sacrum*⁷. Lumbosacral transitional vertebrae are seen as lumbarization and sacralization⁸. 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. Lumbarization is the development of the first sacral vertebra partially or completely in the lumbar type morphology. When it is complete, six lumbar vertebrae are seen⁹. The incidence of sacralization is higher than of lumbarization¹⁰.

The *ligamentum iliolumbale* is accepted as the reference point in determining the lumbosacral transitional vertebra. In a study

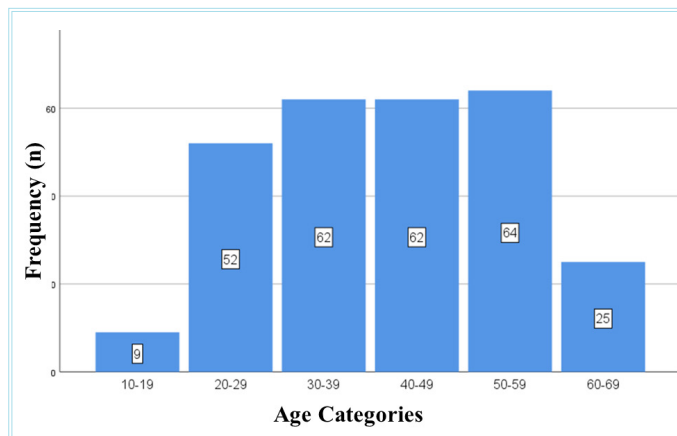


Figure 3. Age distribution of patients

conducted with magnetic resonance images, Carrino et al. found that the *ligamentum iliolumbale* originates from the 5th lumbar vertebra in 96.8 % of cases. Castellvi et al.¹¹ developed a radiological classification system that defines four types of lumbosacral transitional vertebrae. Type 1 also 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 the complete osseous fusion of the *processus transversus* to the *os sacrum*. It includes unilateral (3a) or bilateral (3b) lumbarization/sacralization. In Type 4, there is a Type 3 lumbosacral transitional vertebra on one side and a Type 2 lumbosacral transitional vertebra on the other side.

O'Driscoll et al.¹² developed four types of classification systems according to the presence or absence of the *discus intervertebralis* and antero-posterior length of S1-2 disc morphology using magnetic resonance images. According to this classification, between the *os sacrum* and the 1st sacral vertebra; Type 1 has no disc and is seen 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 commonest in those without LSTV. In type 3, there is a normal disc whose AP diameter is equal to the AP diameter of the *os sacrum*. Type 3 can be seen in the normal *columna vertebralis* and LSTV. Type 4 is similar to Type 3, the difference being that squareness is observed in the first sacral vertebra. There is a good correlation between the Type 4 disc and the lumbarized sacral vertebra.

In lumbosacral transitional vertebra abnormality, 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 region¹³. Since this condition increases the stabilization of this region, *discus intervertebralis* pathology is less common below the LSTV level, while disc degeneration is commoner here as the *discus vertebralis* at the upper level will carry the load¹⁴. The relationship between low back pain and lumbosacral transitional vertebrae was first described by Bertolotti in 1917 and was named Bertolotti syndrome¹⁵.

There are cases in the literature of surgical procedures performed at the wrong lumbar level if there is a lumbosacral transitional vertebra in both surgical interventions and injections, since it is not known which level the nerve root corresponds to. For this reason, lumbosacral transitional vertebra can have important clinical consequences¹³.

Although LSTV is a congenital anatomical variation frequently encountered in the lumbosacral region, neither its pathophysiology nor its biomechanical effects are yet fully understood¹⁶. In various studies, the incidence of LSTV varies between 4% and 37%¹⁷. This difference between rates is explained by assessment errors, differences

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

LSTV	Mean	SD	Median	Minimum	Maximum	p
Sacralization	41.80	15.519	41	23	64	0.984
Lumbarization	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	

SD: standard deviation. The Mann Whitney U test was applied.

in individual diagnosis and classification criteria, and factors that create confusion among the population samples investigated ¹⁸.

In the 28 studies conducted between 2000 and 2017 which we reviewed regarding LSTV, radiology images of 47,586 patients were examined and LSTV variation was detected in 6,353 patients (13.3%). In 15 of these, researchers stated LSGV to be 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 found to be 8.69%. In our study, the incidence of LSTV was higher than the average of these 28 studies. According to the averages of 15 studies indicating sacralization and lumbarization rates, sacralization and lumbarization 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% ¹⁹.

Study Limitations

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

Conclusion

In our study, we aimed to compare age, gender 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 lumbarization/sacralization rates observed according to regional patient profiles indicates the need for screening in a larger patient population.

Ethics

Ethics Committee Approval: Erzincan Binali Yıldırım University Clinical Research Ethics Committee (Ethics Committee decision date: March 30, 2023; decision number: 2023-07/4).

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

Author Contributions: Concept – K.B.; Design – K.B.; Supervision – K.B., M.K.A.; Resources – K.B., M.S.; Materials – K.B.; Data collection and/or Processing – K.B., M.K.A.; Analysis and/or Interpretation – K.B., M.K.A., M.S.; Literature Search – K.B., M.S.; Writing Manuscript – M.S., K.B.; Critical Review – K.B., M.K.A.; Other – M.S.

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

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