ORIGINAL ARTICLE

ASSESSMENT of X RAY GRAPHIES TOGETHER in THE DIAGNOSIS of THE TRANSITIONAL VERTEBRAE

Transizyonel Vertebra Tanısında Röntgen Grafilerinin Birlikte Değerlendirilmesi

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ABSTRACT

Objective: Full vertebral scanning and counting from C2 inferiorly is the gold standard for the lumbosacral transitional vertebrae (LSTV) diagnosis. We aimed to investigate the use of a postero-anterior chest (PA) radiograph and kidney, ureter, and bladder (KUB) X-ray combination, which would provide lower dose radiation exposure in LSTV diagnosis.
Material and Methods: This study was planned as a retrospective study and approval was obtained from the hospital education committee. PA and KUB X-rays of 327 patients were examined by 2 radiologists. Both of the x-ray graphs have been interpreted by the radiologist to detect existing LSTV. Scoliosis graphs were conducted of all 327 patients to detect LSTV. The sensitivity and specificity of KUB X-ray and PA radiograph in the diagnosis of LSTV were evaluated, considering the scoliosis radiograph findings as the descriptive finding.
Results: The performance accuracy of KUB X-ray for the diagnosis of LSTV, we have observed that it provided true positive results in 117 of the 120 subjects and false-negative in 3 subjects. It could detect 163 of the 207 subjects as true negative and the remaining 44 individuals as false positive. When we have evaluated the diagnostic performance of KUB X-ray and PA radiograph together we have observed that it provided true positive results in 119 of the 120 subjects and false-negative in 1 subject. It could detect 167 of the 207 subjects as true negative and the remaining 40 individuals as false positive.
Conclusion: The accurate diagnosis of LSTV is incredibly important as any misleading information can lead to inappropriate surgery or invasive procedure. The sensitivity of interpretation of PA radiograph and KUB X-ray together has been found as 97.6% and the specificity as 80.6%.

Keywords: *Lumbosacral Transitional Vertebrae; Kidney; Ureter; And Bladder X-Ray; Postero-Anterior Chest Radiography; Scoliosis Graph.*

ÖZET

Amaç: Lumbosakral transizyonel vertebra tanısında tüm vertebranın taranması ve C2 düzeyinden başlayarak inferiora doğru sayım altın standarttır. Bu çalışmadaki amacımız daha düşük doz radyasyon maruziyeti ile posterior anterior akciğer grafi (PA AC) ve direkt üriner sistem grafiler (DÜSG) birlikte değerlendirmesinin lumbosakral transizyonel vertebra (LSTV) tanısında kullanımını değerlendirmektir.
Gereç ve Yöntemler: İki radyolog tarafından 327 hastanın PA AC ve DÜSG'ü birlikte değerlendirildi. Her iki grafi birlikte LSTV açısından değerlendirildi. Daha sonra 327 hastanın skolyoz grafileri LSTV açısından değerlendirildi. Skolyoz grafi bulguları tanımlayıcı bulgu olarak kabul edilerek PA AC ve DÜSG'lerinin LSTV tanısındaki duyarlılık ve özgüllüğü değerlendirilmiştir.
Bulgular: DÜSG'ün LSTV teşhisinde tanısal doğruluğunu 120 olgunun 117'sinde gerçek pozitif, 3 olguda yanlış negatif sonuç tespit edildi. 207 olgudan163'ünü gerçek negatif ve kalan 44 olgu yanlış pozitif olarak tespit edildi. DÜSG ve PA AC grafileri birlikte değerlendirildiğinde 120 olgunun 119'unda doğru pozitif ve 1 olguda yanlış negatif sonuç elde edilmişti.167 olgu doğru negatif ve 40 vaka yanlış pozitif olarak değerlendirildi.
Sonuç: Herhangi bir yanıltıcı bilgi uygunsuz cerrahi veya invazif prosedür yol açabileceğinden, LSTV'nin doğru teşhisi son derece önemlidir. PA AC ve DÜSG'ün birlikte yorumlanmasının duyarlılığı %97,6 ve özgüllüğü %80,6 olarak bulunmuştur.

Anahtar Kelimeler: *Lumbosakral Transizyonel Vertebra; Direkt Üriner Sistem Grafisi; Posterior Anterior Akciğer Grafisi; Skolyoz Grafisi.*

INTRODUCTION

Lumbosacral transitional vertebrae is a common name for many L5 – S1 disorders. As one can assume from the anatomic localization the problem is a combination of both lumbarization of the superior sacral segment (S1) and sacralization of the lowest lumbar segment (L5). Sacralization of L5 is, unfortunately, the fusion process with the sacrum while lumbarization is the formation of squared vertebrae. A hard, strict-shaped articulated S1 is a typical appearance. The anomaly is unilateral and asymmetrical in most cases (1).

The strange anatomical variation comes into mind that when the L5 vertebrae fuse completely to the sacrum, 4 lumbar vertebrae exist, conversely when S1 detaches entirely from the sacrum, 6 lumbar vertebrae exist, and the sagittal contour of the spine becomes more lordotic. In other words, lumbosacral transitional vertebrae is false joint with related pathologies such as disc protrusion, nerve root canal stenosis, spondylosis, and sclerosis (2).

The first description of this pathology has been conducted by Bertolotti et al in 1917 as a congenital deficit. Castellvi has classified transitional vertebrae into 4 categories (3) .There is a dysplastic transverse process that articulates with the sacrum or forms a diarthrodial joint with the sacrum in Type I and Type II. Type I is considered a large transverse process measuring at least 19 mm in width, Type II is an actual diarthrodial joint between the last transverse process and the sacrum. Type I includes unilateral (Ia) or bilateral (Ib) dysplastic transverse processes, measuring at least 19 mm in width (craniocaudal dimension). Type II can be incomplete unilateral (IIa) or bilateral (IIb) lumbarization/sacralization with an enlarged transverse process that has a diarthrodial joint between itself and the sacrum. Type I and II is defined as incomplete process and can be both unilateral and bilateral. Type III is a bone fusion between the last transverse arm and the sacrum. Type III describes unilateral (3a) or bilateral (3b) lumbarization/ sacralization with the complete osseous fusion of the transverse arm to the sacrum. Type IV involves a unilateral Type II transition with a Type III pathology on the contralateral side. One should bear in mind that both Type III and IV are complete in structure and can be both unilateral and bilateral (3,4).

The clinical importance of transitional vertebrae is controversial also the prevalence varies in different articles according to their sample size. Due to the lack of a standardized /validated diagnostic tool the prevalence is has a wide range of 4%-35.9% (2). Some articles declare that transitional vertebrae is an incidental finding, and it is only diagnosed during imaging. Type I pathology has no clinical symptoms, and no treatment is necessary. Nardo et al. published that Type I and II consisted of 40%, Type III accounted for 11.5%, and Type IV for %5.25 of the patient population. The left side involvement is significantly higher. In terms of localization, the rate and gender vary as follows: lumbosacral transverse vertebrae are higher in men than women (28.1% vs. 11.1%) and sacralization is more common in males, while accessory L5-S1 articulations and lumbarization of S1 are more common in women (2,4,5).

There have been many debates on the clinical features of LSTV since it has been identified by Bertolotti. Some studies reported no pain and Castellvi et al. found that in patients with back pain and sciatica, the transitional vertebra was a prevalence of 30% (3). The pain might be a result of degeneration and/or abnormal articulation in the disk, spinal canal, and posterior vertebrae. Stenosis, facet arthrosis, and fusion are also other probable causes. Type I Castellvi patients do not present any clinical symptoms and individuals with Type IIa or Type IIIa may have contralateral facetogenic pain due to unilateral anomalous articulations or osseous fusion. The radiologist should provide clear-cut outcomes for the clinician and the surgeon to achieve positive results (2,6).

Full vertebral scanning and counting from C2 inferiorly is the gold standard for the LSTV diagnosis (7,8). A scoliosis graph of the whole vertebrae should be taken for the diagnosis of lumbosacral transitional vertebrae. However, the interpretation of postero-anterior chest (PA) radiograph - kidney, ureter, and bladder (KUB) X-ray together may be sufficient, and one does not require further scoliosis graphs. This leads to lower exposure to radiation. The milestone of this study lies beneath the fact that alternative radiologic tools rather than scoliosis graphs may be beneficial in daily clinical practice.

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MATERIAL AND METHODS

This study was planned as a retrospective study and approval was obtained from the hospital education committee (28.11.2018/32). All the graphics were taken before the study. This single-center study was conducted with 3500 patients who had applied to our hospital for getting committee reports for several reasons between July 1, 2018, and Dec 31, 2018. For the definitive diagnosis of LSTV/scoliosis, double-sided scoliosis radiographs were taken in 327 (9.34%) patients. The re-evaluation of PA and KUB X-rays of 3500 patients was scanned. The median age of the patients was 22.3 years (range between 20 – 24). An experienced radiologist re-evaluated the previous KUB X-ray images of these patients and recorded lumbarization and sacralization presence, transitional vertebrae classification based on the Castellvi Classification. After two weeks the same radiologist evaluated PA radiograph and KUB X-ray images together for the same data. Scoliosis radiographs were examined, and the presence of lumbarization and sacralization were evaluated and classified based on the Castellvi Classification. Scoliosis graph findings were regarded as the definitive diagnostic findings and were re-evaluated with the previous KUB X-ray and PA-KUB X-ray findings.

Statistical Analysis

All data were analyzed by IBM SPSS Statistics for Mac, version 25.0 (IBM Corp. Released 2017. IBM SPSS Statistics for Macintosh, Version 25.0. Armonk, NY: IBM Corp.). The normality of the data distribution was determined by the Shapiro-Wilk test, histogram, and Q-Q plots. The categorical values of the patients were expressed as a number and a percentage and were analyzed with a chi-square test. Continued values were presented as a mean standard deviation (SD) or median values and an interquartile range (IQR) of 25%–75. A four-eye table was created to evaluate the diagnostic performance of KUB X-ray and PA-KUB X-rays and calculated sensitivity, specificity, accuracy, positive likelihood ratio (PLR), and negative likelihood ratio (NLR) values. The 95% confidence intervals (95% CIs) were calculated whenever appropriate, and a two-tailed p-value <0.05 was considered statistically significant.

RESULTS

A total of 327 patients were evaluated with all three radiographs (PA radiograph, KUB X-ray, and scoliosis graphs) in terms of LSTV diagnosis during the study period. The median age of all patients was 22.3 and 303 of all patients were male (92.6%). LSTV grades of 120 patients were as follows; 39 patients (32.5%) were Type I, 54 patients were (45%) Type II, 23 patients (19.2%) were Type III, and only 4 patients (3.3%) were Type IV. When we have considered the performance accuracy of the KUB X-ray for the diagnosis of LSTV, we have observed that it provided true positive results in 117 of the 120 patients and false-negative in 3 patients. It could detect 163 of the 207 patients as true negative and the remaining 44 individuals as false positive. When we have evaluated the diagnostic performance of PA radiograph and KUB X-ray together, we have observed that it provided true positive results in 119 of the 120 patients and false-negative in 1patients. It could detect 167 of the 207 patients as true negative and the remaining 40 patients as false positive. Sensitivity, specificity, accuracy, PLR, and NLR of PA radiograph and KUB X-ray with 95% confidence interval were elaborated in Table-1.

Table 1. Sensitivity, specificity, accuracy, PLR, and NLR values of LG and LTG for diagnosis of LSTV

		KUB X-ray	PA-KUB X-ray
Sensitivity (n,%)	*For all subjects*	97.5 (92.8 to 99.4)	99.1 (95.44 to 99.8)
Specificity (n,%)	*For all subjects*	78.7 (72.5 to 84.1)	80.6 (74.6 to 85.8)
PLR (n)	*For all subjects*	4.59 (3.53 to 5.98)	5.13 (3.88 to 6.78)
NLR (n)	*For all subjects*	0.03 (0.01 to 0.09)	0.01 (0 to 0.07)
Accuracy (n,%)	*For all subjects*	85.6 (81.3 to 89.2)	87.4 (83.3 to 90.8)

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DISCUSSION

Mario Bertolotti first described the morphologic characteristics of LTSV and its association with low back pain in 1917, and this association has therefore been termed Bertolotti syndrome (9). Bertolotti identified the transverse vertebral disease in 1917 and also claimed that it can be both unilateral and bilateral. The bony structures could articulate fuse with sacrum and ilium. Bertolotti related those structural changes with low back pain. Up to date scientists could not achieved a consensus about the association between transitional vertebra and back pain. Many studies reported no low back pain for transverse vertebra problems however sacralization of the 5th lumbar vertebra causes additional pressure on nerve cells due to extra articulation including block vertebrae, cleft vertebra, and unilateral and bilateral hemivertebrae.

In some cases, inflammatory problems such as arthritis or bursitis may arise painful situations. Individuals with LSTV are prone to disk herniation also. Adult and young patients with LSTV could also present painful spondylolisthesis due to narrowed intervertebral disk space (10). One can easily derive that articulation, fusion, new formations, nerve pressure, and disk herniation are all causes of back pain. Spondylosis is also another discomfort reason for the patient (11). However, Tini et al published a series of 4.000 patients with no relevance of back pain and LSTV (12).

At this stage, the critical role of radiologist appear. The precise interpretation of the graphs and/or MRI data will guide the surgeon to achieve full recovery as the patients have different anatomical variances. The usual mistake is the evaluation of MRI data only without seeking any correlation (12,13) . Local corticosteroid and anesthetic injection, radiofrequency, ablation, and invasive surgery all require accurate radiologic support and a multidisciplinary approach to the patient (13).

In a study by Otani et al, they have reported that the diagnostic error for evaluation of vertebral segmentation on lumbar MRI alone was 14.1% and the spinal morphologic features and locations of the spinal and paraspinal structures on lumbar MRI are not completely reliable for the diagnosis of LSTVs and identification on the vertebral levels (14). However due to ease of access and perception of the practical way many clinicians tend to make their decision based on MRI only. On the other hand, the MRI enables the radiologists to determine the level of the lumbar vertebrae. Unfortunately, inaccurate results may occur frequently when the location is only determined from a lumbar radiograph or when MRI is used alone but the bigger mistake comes when the surgical operation is conducted regarding this fact (15).

Lian et al advocated that patients with low back pain generally do not have cervicothoracic imaging, but due to possible anatomic variations or anomalies in total vertebrae number of LSTV a whole spine scout imaging or lumbosacral X-ray preceding a lumbosacral MRI could be beneficial (8,16).

The accurate diagnosis of LSTV is incredibly important as any misleading information can lead to inappropriate surgery or invasive procedure. In our study the sensitivity of PA radiograph and KUB X-ray has been found as 97.6% and the specificity as 80.6%.

A scoliosis graph of the whole vertebrae should be taken for the diagnosis of lumbosacral transitional vertebrae. However, the interpretation of PA radiograph and KUB X-ray may be sufficient, and one does not require further scoliosis graphs. This leads to lower exposure to radiation.

The milestone of this study lies beneath the fact that alternative radiologic tools rather than scoliosis graphs may be beneficial in daily clinical practice. Regarding these outcomes, one could claim that PA radiograph and KUB X-ray together could be utilized as a primary diagnostic tool for LSTV. Including a scoliosis graph to the diagnosis for patients with bilateral 11 ribs or rudimentary 12 ribs would also derive accurate results. The main limitation of our study can be elaborated as the sample size. A larger sample size could provide more beneficial outcomes. On the other hand, only 7.4% of the patients were female so we could not evaluate gender-specific differences.

CONCLUSION

There is no established guideline for the diagnosis of LSTV, but the radiologist should consider accurate localization of the pathology and exposing the patient to the minimum level of radiation. The interpretation of PA radiograph and KUB X-ray together may be sufficient, and one does not require further scoliosis graphs. Further studies are necessary to provide more data on the LSTV.

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The authors declare that there is no conflict of interest between the authors.

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