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DISC HERNIATIONS AND CAUDA EQUINA COMPRESSION IN UNILATERAL AND BILATERAL ARTICULAR FUSION LUMBOSACRAL TRANSITIONAL ANATOMY TYPES

Matveeva Niki[1], Chabukovska Radulovska J[2], Papazova M[1], Zhivadinovik J[1], Zafirova B[1], Bojadzieva B[1], Trpkovska B[1]

[1]Institute of Anatomy, Medical Faculty, Universit Ss Cyril and Methodius, Skopje, R. Macedonia
[2]University Clinic of Surgery, St. Naum Ohridski, Skopje, R. Macedonia

Abstract

The relationship between different lumbosacral transitional vertebra (LSTV) types, disc herniations and neural structures compromise has been sporadically reported.

The objectives of this study was to evaluate the relationship between articular fusion LSTV types, disc herniations and neural structures compromise.

A total of 92 patients with lumbosacral radicular syndrome who underwent MRI examination of the lumbar spine were included in the study. All patients had at least one evaluated disc herniation at the last three mobile levels. These patients were separated in two groups. Study group comprised 58 patients who presented with LSTV (articular fusion type based on Castellvi classification). Additionaly this group was separated in two subgroups; 25 patients with unilateral and 33 of them with bilateral articular fusion LSTV type. Thirty four patients without LSTV were assigned to the control group.

There were significantly more disc herniations (92% vs 73.5%, p=.03) and more severe cauda equine compression (12% vs 5.9%) at the level of transition in the LSTV unilateral articular fusion subgroup compared to the control group. At the adjacent proximal level significantly more disc herniations (93.9% vs 73.5%, p=.03) and more severe cauda equina compression (51.5% vs 14.7, p=.012) was observed in the LSTV bilateral articular fusion subgroup compared to the control group.

In conclusion, altered morphology and biomechanics in articular fusion LSTV types provoke disc herniations and severe cauda equina compression to occur more frequently compared to the normal lumbosacral junction.

Key words: spine; lumbosacral transitional vertebra; MRI; disc herniation; cauda equine.

Introduction

The incidence of lumbosacral transitional vertebra (developmental spinal anomaly) is between 4 and 30% in general population [1]. Controversial opinions exist regarding the clinical significance of this entity. However, many authors have demonstrated that there is an increase in degenerative changes such as disc protrusions, facet degeneration, nerve root canal stenosis and degenerative spondylolisthesis just above transitional lumbosacral segments. It is also accepted that the presence of a transitional vertebra may increase the incidence of disc herniations [2-4]. Some investigators have reported that this developmental anomaly leads to earlier occurrence and more severe disc degenerative changes and disc herniations in younger individuals [5]. Other authors reported that a lumbosacral transitional vertebra is protective for disc degeneration at the transitional segment, but prone to greater disc degeneration at the level above [6,7]. Many authors noticed a significant difference in the distribution of bulging disc or disc herniation, as it occurred in patients with LSTV, compared to patients without LSTV [8]. Since disc herniations are the most frequent cause of neural structures compression, besides surrounding structures, osseus, articular or ligamentous, there is a small number of studies that document the relationship between different types of lumbosacral transitional vertebra, disc herniations and neural structures compromise in the central and nerve root canals.

The objective of this study was to evaluate the relationship between articular fusion LSTV types and disc herniations, in terms of their prevalence and distribution and the grade of central canal neural structures compromise. These findings can help in understanding the natural history of lumbar disc herniations in the presence of LSTV, which is important for clinicians to make a decision or for surgeons to select appropriate fusion or disc replacement level.

Material and Methods

Subjects

In our study we analyzed MRI examinations of the lumbar spine performed form February to Septmber 2016 on patients referred to the University Clinic for Surgical Diseases "St. Naum Ohridski" in Skopje, by their general practitioner with lumbosacral radicular syndrome. According to the national general practitioner guideline, patients with diagnosis of lumbosacral radicular syndrome confirmed by a neurologist, after unsuccessful conservative treatment for at least six weeks were subject to MR imaging examination of the lumbar spine. After institutional review board approval, 58 patients (24 males, 34 females, mean age 57.3±12 years) with evaluated at least one lumbar disc herniation at the last three mobile levels who presented with LSTV articular fusion type were included in the study. This group was additionaly divided into two subgroups based on the Castellvi classification; unilateral articular fusion subgroup (N=25) and bilateral articular fusion subgroup (N=33). These patients were referred to as the study group. Thirty four patients (19 males, 15 females, mean age 51 ±10 years) with evaluated at least one lumbar disc herniation at the last three mobile levels without LSTV were added randomly and referred to as the control group. Patients with kyphoscoliosis, spondylolisthesis, history of previous spine surgery, spinal fracture, other congenital spinal anomalies, tumor or infection were excluded from the study.

MR images

All patients underwent the same imaging protocol. MR imaging examination of the lumbosacral spine was preformed with 1,5 T MR unit (Signa HDI) with a spinal surface coil. The imaging protocol consisted of a sagittal T1-weighted fast spin-echo sequence (FSE) (repetition time msec/echo time msec, 800/14; section thickness,4mm; field of view, 360x360 mm; matrix, 448 x 224), sagittal T2-weighted turbo spin-echo sequence (3520/102; section thickness, 4 mm; intersection gap, 10 mm; echo train length of 24), coronal T2-weighted FSE and axial T2-weighted FSE sequences at one or multiple levels (4,660/120; section thickness, 4 mm; intersection gap, 0.6 mm; echo train length of 27; field of view, 200x200 mm; matrix 320 x 256) and oblique HI RES T2 FRFSE (fast relaxation fast spin echo), (TR/TE 3000/88; section thickness 2 mm, intersection gap 1 mm; field of view 22x22, matrix 320x320).

All images were reviewed by experienced diagnostic radiologist blinded to the original reports of the MRI studies and the final MRI diagnosis was determined.

The last three motion segments of the lumbar spine were assessed for the presence of disc herniations and the grade of cauda equina compression. Disc contour was assessed using the recommendations of the Combined Task Forces of NASS, ASSR, and ASNR [9]. Herniated discs were classified as protrusion or extrusion, based on the shape of the displaced material and sequestration (lost continuity with the parent disc). Bulging discs (disc tissue extending beyond the edges of the apophyses), symmetric and asymmetric were not considered a form of herniation, although they have potential to cause significant compression of the neural structures. Cauda equina compression was graded with a system based on the obliteration of the anterior cerebrospinal fluid space (CSF space) and separation degree of the cauda equina on T2 weighted axial images: 1, no compromise of the dural sac without obliteration of anterior CSF space; 2, mild stenosis with anterior CSF space mildly obliterated with clear separation of all cauda equina; 3, moderate stenosis with moderate obliteration of anterior CSF space and some cauda eqina aggregated; 4, severe stenosis with with complete obliteration of anterior CSF space, marked compression of the dural sac and none of the cauda equina could be vissualy separated [10].

Statistical analysis was performed using the SPSS (version20, Chicago, IL, USA). Descriptive statistics were used. The chi square test was used to evaluate the relationship between the presence of lumbar disc herniations, their distribution and the LSTV types. The chi square test was used to evaluate the differences in the grades of cauda equina compression between the non LSTV group and the uniarticular and biarticular fusion LSTV subgroup. To compare disc herniations prevalence and the grades of cauda equine compression between non LSTV and LSTV group an unpaired, two tailed Mann Whitney test was used. A p value less than 0.05 was considered statistically significant.

Results

Disc herniations

At the last three mobile segments (L3-4, L4-5 and L5-S) patents from the study LSTV group demonstrated higher prevalence of disc herniations (62%, 82.8%, 86.2% vs 47%, 73.5%, 73.5%, respectively), Table 1. At the L3-4 level the increased number of disc herniations was observed in bilateral articular fusion LSTV subgroup compared to the control and unilateral articular fusion subgroup, although the difference didnốt reach statistical significance (69.7% vs 47% and 52% respectively, Fig. 1). There were significantly more disc herniations in the bilateral articular fusion LSTV subgroup at the L4-5 level compared to the control group and to the unilateral articular fusion LSTV subgroup at the same level (93.9 % vs 73.5% and 68%, respectively, p=.03; Fig.1). At L5-S level the increased number of disc herniations was observed in unilateral articular fusion LSTV subgroup compared to the control group and to the bilateral articular fusion subgroup, (92% vs 73.5%; and 81.8%, respectively, Fig.1).

Table 1. Comparison of disc herniations prevalence and severe cauda equina compression between the control group (without LSTV) and the study group (with LSTV)

	Disc herniations Cauda Equina Compression	Control Group	LSTV Group	P value
L3-4	Disc Herniations	16 (47%)	36 (62%)	.163
	Severe cauda equina compression	3 (8.8%)	16 (27.6)	.004*
L4-5	Disc Herniations	25(73.5%)	8 (82.8%)	.294
	Severe cauda equina compression	5(14.7%)	27(46.5%)	.001*
L5-S	Disc Herniations	25(73.5%)	50 (86.2%)	.133
	Severe cauda equina compression	2(5.9%)	3 (5.2%)	.910

*,p≤.05

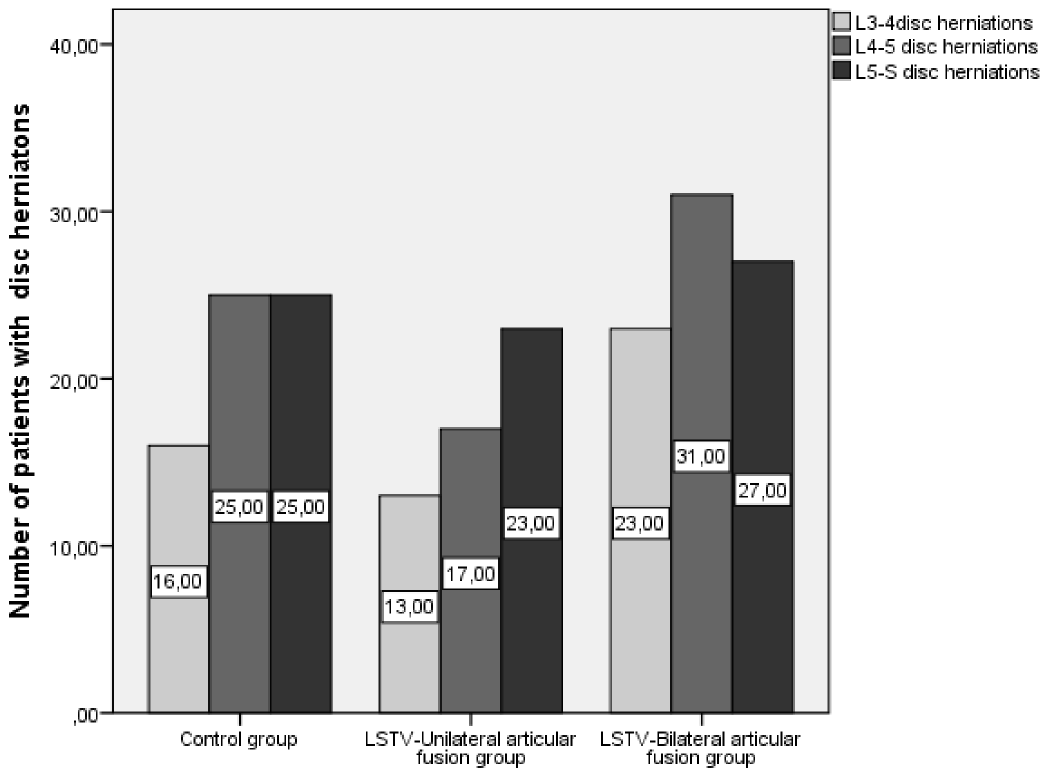

Figure 1. Prevalence and distribution of disc herniations in patients withot LSTV and in patients with LSTV, unilateral and bilateral articular fusion

Disc herniations equally affected the last two motion segments in patients with normal lumbosacral junction, in 73.5% of these patients disc herniations were evaluated at L4-5 or L5-S level. Disc herniations were most frequent finding at L5-S level in unilateral articular fusion LSTV subgroup, in 92% of these patients, and at L4-5 level in bilateral articular fusion LSTV subgroup, in 91% of patients belonging to this subgroup, Fig.1.

Cauda equina compression

At the levels L3-4 and L4-5 patents from the study LSTV group demonstrated significantly higher prevalence of cauda equine compression (27.6%, 46.5% vs 8.8%, 14.7%, respectively p=.004, p=.001,), Table 1.

At L3-4 level significantly more severe cauda euina compression was found in patients with unilateral articular fusion and bilateral articular fusion LSTV type compared to the patients belonging the control group (28% and 27.3%, respectively vs 8.8%; p=.002; Fig. 2). Also moderate cauda equine compression was evaluated in more patents with unilateral articular fusion and bilateral articular fusion compared to the patients belonging the control group (20% and 33.3%, respectively vs 8.8%, Fig.2).

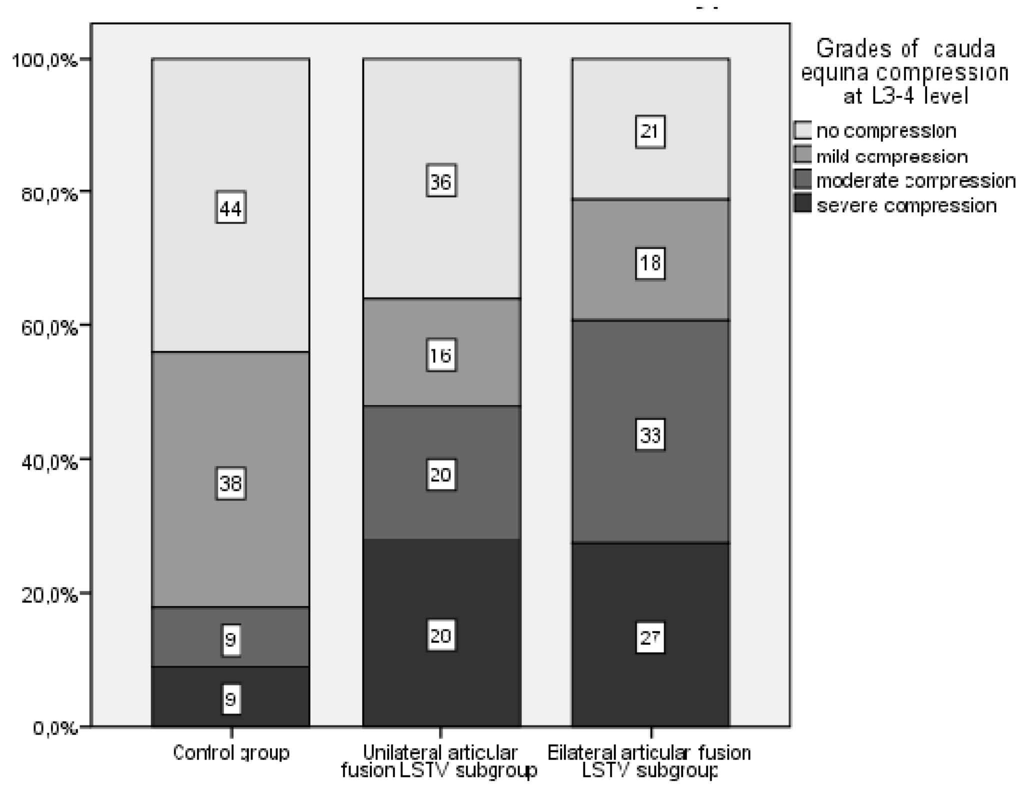

Figure 2. Grades of cauda equina compression at L3-4 Level in patients withot LSTV and in patients with LSTV, unilateral and bilateral articular fusion

At L4-5 level almost all patients with bilateral articular fusion LST type demonstrated cauda equine compression. Among the LSTV group, in unilateral and bilateral articular fusion subgroups significantly more severe cauda equine compression at L4-5 level was observed (40% and 51.5% respectively vs 14.7%; p=.012; Fig. 3). In bilateral articular fusion subgroup only 3% of the patients did not demonstrate cauda equina compromise, unlike the control group where more patients, even 32.4% of them did not demonstrate cauda equina compromise in the central canal, Fig.3.

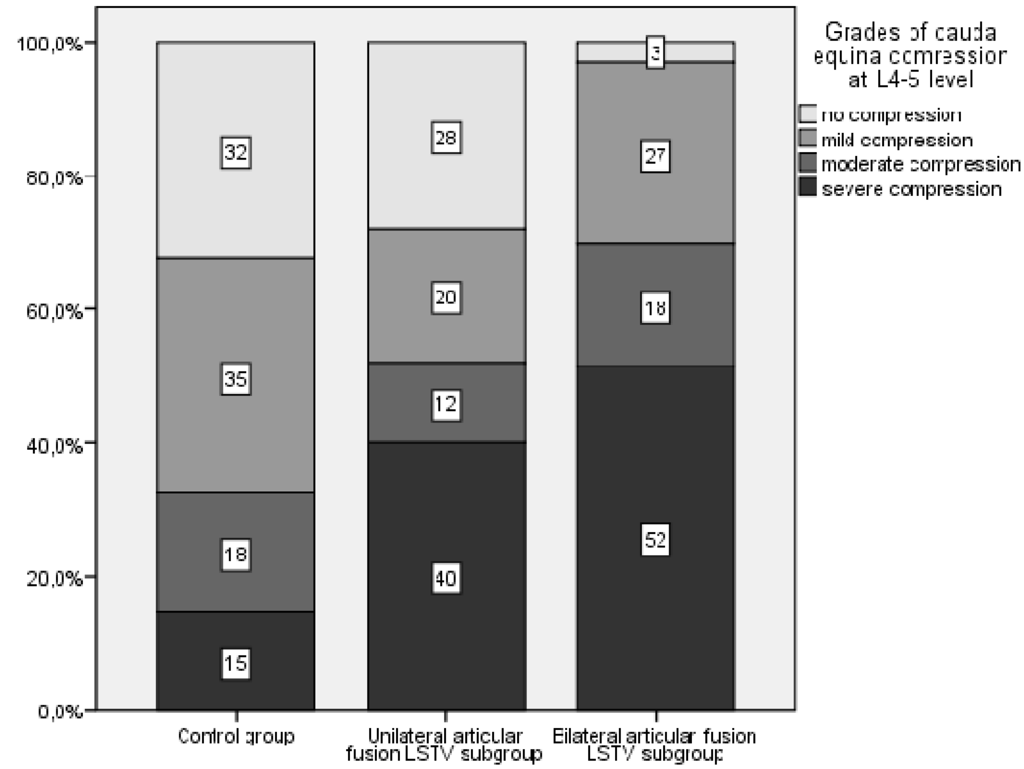

Figure 3. Grades of cauda equina compression at L4-5 level in patients withot LSTV and in patients with LSTV, unilateral and bilateral articular fusion

At L5-S level in the LSTV bilateral articular fusion subgroup no severe cauda equina compression was observed. In the LSTV unilateral articular fusion subgroup 56% of the patients demonstrated mostly mild cauda equina compression at the lumbosacral junction, Fig.4. Severe cauda equina compression at this level was observed only in 12% patients, Fig.4.

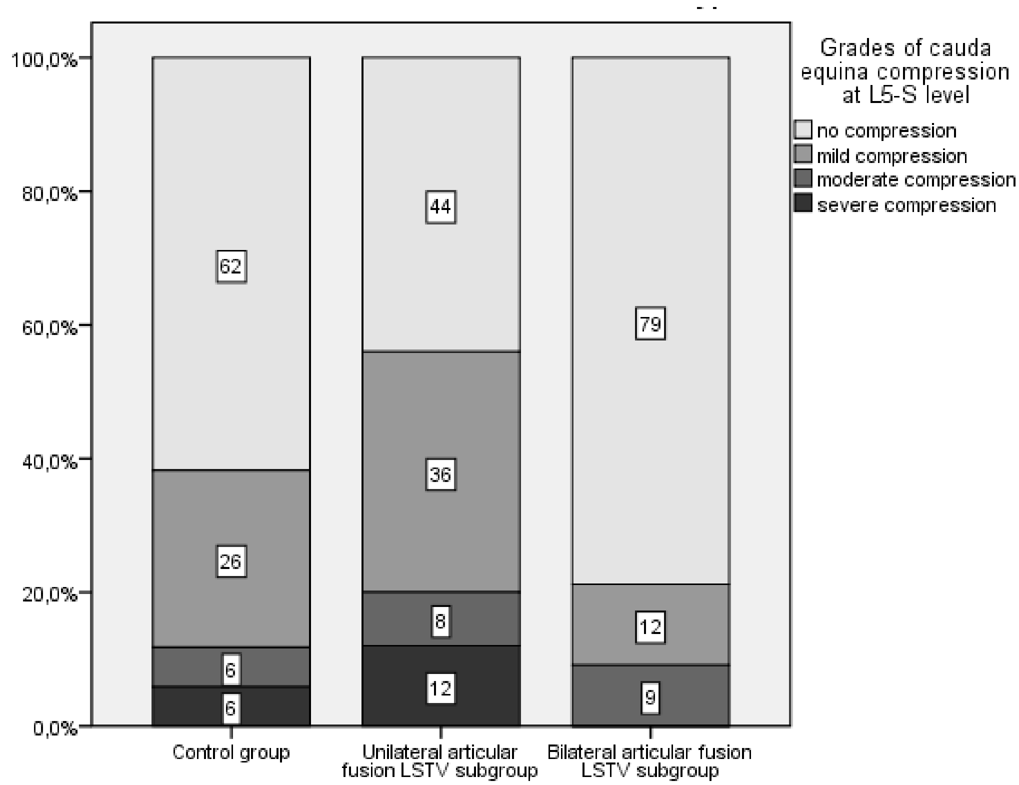

Figure 4. Grades of cauda equina compression at L5-S level in patients withot LSTV and in patients with LSTV, unilateral and bilateral articular fusion

Discussion

The potential association between LSTV and low back pain has been subject of interest since it was first described by Bertolotti. In the literature, the prevalence of LSTV in patients seeking care for low back pain ranges from 4.6% to 35.6%. Among 8280 patients with low back pain, 10.6% had LSTV [11,12]. Pain in the presence of LSTV may arise from disc herniations, disc degeneration, facet joint arthrosis, spinal canal or foraminal stenosis [13,14]. According to our data, among the adult population with lumbosacral radicular syndrome there was a higher prevalence of disc herniations in patients with LSTV, unilateral and bilateral articular fusion subgroup compared to the control group, at the lumbosacral junction (92% vs 73.5% and 81.8% vs 73.5%). At the adjacent proximal level, L4-5 disc herniations were most prevalent in bilateral articular fusion LSTV subgroup compared to the control group (93.9% vs 73.5%). Avimadje et al. found 52.7% of patients with a lumbar disc herniation who also had an LSTV, while only 18.3% of the control group had an LSTV [15]. According to Otani et al. patients with transitional vertebra experience disc herniation more frequently (17% vs 11%) and at a younger age (35 years old vs 59 years old) compared to patients without a transitional vertebra. Our results showed that higher prevalence of disc herniations at the lumbosacral junction was found predominantly in unilateral articular fusion subgroup compared to the control group. Lumbar disc herniations occurred on the same side as transitional vertebra in unilateral articular fusion subgroup in contrast to biarticular fusion where disc herniations were a more frequent finding at the level above the anomalous articulations. Unilateral articular fusion results in asymmetric morphology and biomechanic alterations. The side bearing the additional pseudoarticulation supports a larger proportion of load, resulting in increased one-sided muscle activity and asymmetrical movement, factors that influence on the onset of disc herniations.

Asymmetry can cause early degenerative changes within the normal contralateral facet joint, giving rise to facet pain [16-20]. Otani et al. reported 83% of patients with a disc herniation in the presence of an LSTV experienced symptoms arising from the last caudal mobile segment. The same author reported that patients with disc herniation and no transitional vertebrae most frequently (59%) had symptoms arising from the 2nd last mobile segment. These results are in concordance with our data, disc herniations with severe neural structures compromise were most prevalent at the adjacent proximal level in bilateral articular fusion subgroup. Bilateral articular fusion leads to balanced reduced mobility of the lumbosacral junction and transfers stress to the adjacent proximal mobile segment. This finding confirms the thesis of more excessive transfer of stress from the segments with restricted mobility to the spine fully mobile segments. The effect of transitional articular fused vertebra on the adjacent proximal disc may mimic the situation after a fusion operation when movement at one or more disc spaces (fusion levels) is restricted in relation to other disc levels (proximal to the fusion levels). In addition, severe neural structures compression found in our LSTV patients could be due to more massive, larger disc herniations. Many authors suggest that low back pain complaints might be worse in the presence of an LSTV. Worse pain may result from the concentration of external stress on adjacent vertebral levels. Among 881 young male patients, Taskaynatan et al. reported that the presence of an LSTV increased the severity of patientûs clinical picture and severity of pain [21]. According to Yavuz et al. subjects with low back pain and no malformation reported an average pain level on the Visual Analog Scale for Pain (VAS) of 2.2 versus 4.8 in patients with low back pain and a transitional vertebra [22]. Secer et al. [23] found an occurrence rate of 4.5% LSTV in young subjects with neurologic deficit and low back pain. Severe radiating pain in patients with an LSTV can be a consequence of increased prevalence of massive disc herniations associated with severe neural structures compression at the high stress levels. Surgeons should take into consideration altered morphology and biomechanics in transitional states especially when they decide on selection the adequate level for total disc replacement, levels of fusion or in application of adequate fusion technique. Limited number of studies has analyzed the subgroups of lumbosacral transitional vertebra [24]. Limitation of our study is the small sample of LSTV subgroups. The results were verified by the comparison between the LSTV group and the control group. The interreader reliability of the different parameters for grading neural structures compression was not subject of this study.

Conclusion

In conclusion, altered morphology and biomechanics in LSTV articular fusion types provoke disc herniations to occur more frequently at the last mobile lumbar segments. The last mobile levels are high stress zones in LSTV, so disc herniations were associated with more severe cauda equine compression at the level of transition and at the adjacent proximal level.

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