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Pathological Findings of Spinal MRI in Patients with Lumbosacral Transitional Vertebra

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Abstract: Low back pain is one of the most common causes of disability for individuals of working age in developed countries. Along with vast traumatic, infectious, tumors and infiltrative causes, degenerative disk transformations have been accepted as major etiologic factors. Lumbosacral Transitional Vertebra (LSTV) is one of the congenital factors that might cause disk degeneration. The purpose of this research is to assess the type and frequency of pathological findings in adjacent vertebra in a group of Iranian patients with LSTV. Patients and methods: In a cross sectional study between April 2006 and September 2007, we evaluated all patients who indicated to do lumbosacral MRI because of low back pain. All patients had Lumbar X-ray. Among them, considering plain AP lumbar spine x-ray for all patients, 91 patients were determined to have LSTV (Castelvi grade 2-4) that were enrolled in the study. Among 91 patients with LSTV, 58 (63.7%) were females ($p = 0.01$). The LSTV type IIIb (28.6%) was the most common type. The frequency of anterior osteophyt reached to its peak in level L4-L5 (51.6%) ($p<0.0001$). Such a trend was seen in posterior osteophyt. The frequency of the facet hypertrophy in the level L4-L5 was 46.2% and in the level L5-S1 was 31.9% ($p = 0.04$). Moreover, the frequency of the flavum ligament hypertrophy in these levels were 38.5 and19.8%, respectively ($p<0.0001$). The mean severities of disk degeneration in levels L4-L5 and L5-S1 were 2.8±1.3 and 2.5±1.3, respectively ($p = 0.022$). The frequency of disk herniation in the level L4-L5 was 67% and in the level L5-S1 was 34.1% ($p<0.0001$). In addition, the mean severities of disk herniation in these levels are 1.3±1.0 and 0.6±1.0, respectively ($p<0.0001$). Finally, the mean value of the disk height in the level L4-L5 was 9.6±2.0 mm and in the level L5-S1 was 7.4±2.6 mm ($p<0.0001$). It seems that pathologies have been increased in the level above the LSTV in compare to the level below it.

Key words: Lumbosacral transitional vertebra, MRI, spine, pathological, congenital factors, hypertrophy

INTRODUCTION

Low back pain is one of the most common causes of disability for individuals of working age in developed countries (Benneker *et al*., 2005). More over, up to 80% of general population experience some kind of low back pain in their lifetime (Bejia *et al*., 2005). Along with vast traumatic, infectious, tumors and infiltrative causes, degenerative disk transformations have been accepted as major etiologic factors, which are influenced by congenital anomalies and acquired pathologies in tissue conformation and spinal column biodynamic (Vergauwven *et al*., 1997). Factors like acute and chronic traumas; senile tissue transformations and mechanical stress are known risk factors contributing to degenerative disk and joint disease. One might consider why congenital anomalies, which theoretically can alter biodynamic of spinal column, shouldn't be a cause for accelerated DJD.

One of these congenital anomalies is Lumbosacral Transitional Vertebra (LSTV). According to Castellvi *et al*. (1984), study in a lumbosacral transitional vertebra is referred as an elongated transverse process of the last lumbar vertebra which may has articulation with iIlium; prevalence of such a phenomenon is estimated between 4-20% in different studies (Hughes *et al*., 2004). However, its role in causing low back pain remains controversial.

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Recent studies have been implying that LSTV may alter degenerative process in adjacent vertebra (Hughes *et al*., 2004; Luoma *et al*., 2004). It is presumed if LSTV could affect this process, then it may play a role in causing low back pain (Dai *et al*., 1999). Considering the recent progresses in MR imaging of interverebral disk and joints, early identification of changes can be accurately identified (Hughes *et al*., 2004).

As a prevention rule, the more knowledge is gathered about etiology of the disease, the better preventive strategies such as lifestyle and job modifications, new specific exercises and even preventive orthose could emerge in hope of being able to postpone the disabling phase of DJD in spinal column.

According to the above mentioned points, we are going to assess the type and frequency of pathological findings in adjacent vertebra in a group of Iranian patients with LSTV.

MATERIALS AND METHODS

In a cross sectional study done between April 2006 and September 2007 in Imam Khomeini's medical imaging center, we evaluated all patients who indicated to do lumbosacral MRI because of low back pain (without any prior history of surgical, traumatic spine events or known cancer). Thus, totally 380 patients were initially evaluated. Considering plain AP lumbar spine X-ray for all patients, 91 patients were determined to have LSTV (Castelvi grade 2-4) (Castellvi *et al*., 1984) (Table 1) that were enrolled in the study.

Routine lumbar MRI protocols including sagittal T_1, T_2 and axial T_1 weighted images were performed by General Electric Signa, 1.5 tesla. In lumbosacral MRI and plain X-ray, we evaluated disk degeneration grades (Pfirreman *et al*., 2001) (Table 2), disk herniation classification (Czervionke and Haughton, 2002) (Table 3), anterior and posterior osteophytes, disk height, ligamentum flavum hypertrophy (>4 mm in T_1) and facet joint hypertrophy (assessed in Axial T_1 section) (Luoma *et al*., 2004; Czervionke and Haughton, 2002; Pfirreman *et al*., 2001).

Then we assessed the frequency of the pathological findings in different lumbar spinal levels (L1-L2 to L5-S1). Also, we compared the frequency of all these pathologies between L4-L5 with L5-S1 levels.

We use the chi-square, Mann-Whitney and Wilcoxon Signed Rank tests for statistical analysis by SPSS version 11.5, $p<0.05$ consider as statistically significant.

Table 1: Classification of LSTV after (Castellvi *et al*., 1984)

Grade	Definition	
0	Normal	
Ia	Unilateral	Dysplastic transverse process. with height 19 mm
Ib	Bilateral	
IIa	Unilateral	Incomplete lumbarisation/sacralisation
IIb	Bilateral	Enlarged transverse process with pseudarthrosis with the adjacent sacral ala
IIIa	Unilateral	Complete lumbarisation/sacralisation
IIIb	Bilateral	Enlarged transverse process, which has a complete fusion with the adjacent sacral ala
IV	Mixed	

Table 2: Disk degeneration grades

Grade	Structure	Distinction of nucleus and annulus	Signal intensity	Height of intervertebral disc
I	Homogeneous, bright white	Clear	Hyperintense, isointense to cerebrospinal fluid	Normal
II	Inhomogeneous with or without horizontal bands	Clear	Hyperintense, isointense to cerebrospinal fluid	Normal
III	Inhomogeneous, gray	Unclear	Intermediate	Normal to slightly decreased
IV	Inhomogeneous, gray to black	Lost	Intermediate to hypointense	Normal to moderately decreased
V	Inhomogeneous, black	Lost	Hypointense	Collapsed disc space

Table 3: Disk herniation classification

Grade	Definition
0	Normal
1	Bulging: A disk that extends diffusely beyond the adjacent vertebral body margins in all directions
2	Protruding disk: Focal or asymmetric extension of disk beyond the vertebral disk margin
3	Extruded disk: Disk that has extended through all layers of the annulus and appears as focal epidural mass obscuring the epidural fat
4	Free disk fragment (sequestered disk): One that is no longer in continuity with the parent disk material

RESULTS

Among 91 patients with LSTV, 33 (36.3%) were males and 58 (63.7%) were females (p = 0.01) with mean age of 41±15.7 (18-77). The LSTV type IIIb (28.6%) was the commonest type (Table 4).

The frequency of the anterior osteophyte reached to its peak in the L4-L5 level 51.6%; however, it dropped dramatically in the L5-S1 Level 28.6% (p<0.0001). In addition, a similar trend was seen in the posterior osteophyte (Table 5).

The mean value of the disk height in the level L4-L5 was 9.6±2.0 mm and in the level L5-S1 was 7.4±2.6 mm (p<0.0001).

Frequencies of the facet hypertrophy and the flavum ligament hypertrophy are illustrated in Table 6. The frequency of the facet hypertrophy in the level L4-L5 was 46.2% and in the level L5-S1 was 31.9% (p = 0.04). Moreover, the frequency of the flavum ligament hypertrophy in levels L4-L5 and L5-S1 were 38.5 and 19.8%, respectively (p<0.0001).

In different lumbar spinal levels (L1-L2 to L5-S1), the frequency of the disk degeneration grade has been shown in Table 7. If grade (I) is considered as normal and other grades (II, III, IV, V) are considered as with disc degeneration; thus, the frequency of disk degeneration in the level L4-L5 is 81.3% and in the level L5-S1 is 72.5% (p = 0.11). However, the mean severities of disk degeneration in these 2 levels were 2.8±1.3 and 2.5±1.3, respectively that was statistically significant (p = 0.022).

Additionally, the frequencies of disk herniation classification in levels (L1-L2 to L5-S1) were (Table 8). Like disk degeneration, If grade(I) is considered as normal and other grades (II, III, IV) are considered as with disc herniation; then, the frequency of disk herniation in the level L4-L5 is 67% and in the level L5-S1 is 34.1% (p<0.0001). In addition, the mean severities of disk herniation in these levels are 1.3±1.0 and 0.6±1.0, respectively (p<0.0001).

Table 4: The frequency of different types of LSTV

	Frequency	(%)
LSTV type		
IIa	22	24.2
IIb	22	24.2
IIIa	5	5.5
IIIb	26	28.6
IV	16	17.6
Total	91	100.0

Table 5: The frequencies of anterior and posterior osteophyte

	Yes		No	
	Count	Row (%)	Count	Row (%)
Anterior osteophyte L1-L2	20	22.0	71	78.0
Anterior osteophyte L2-L3	29	31.9	62	68.1
Anterior osteophyte L3-L4	43	47.3	48	52.7
Anterior osteophyte L4-L5	47	51.6	44	48.4
Anterior osteophyte L5-S1	26	28.6	65	71.4
Posterior osteophyte L1-L2	6	6.6	85	93.4
Posterior osteophyte L2-L3	8	8.8	83	91.2
Posterior osteophyte L3-L4	15	16.5	76	83.5
Posterior osteophyte L4-L5	23	25.3	68	74.7
Posterior osteophyte L5-S1	16	17.6	75	82.4

Table 6: The frequencies of facet hypertrophy and flavum ligament hypertrophy

	Count	Column (%)
Facet hypertrophy L1-L2	2	2.2
Facet hypertrophy L2-L3	5	5.5
Facet hypertrophy L3-L4	23	25.3
Facet hypertrophy L4-L5	42	46.2
Facet hypertrophy L5-S1	29	31.9
Flavum ligament hypertrophy L1-L2	0	0.0
Flavum ligament hypertrophy L2-L3	2	2.2
Flavum ligament hypertrophy L3-L4	15	16.5
Flavum ligament hypertrophy L4-L5	35	38.5
Flavum ligament hypertrophy L5-S1	18	19.8

Table 7: The frequencies of disk degeneration grades

Disk degeneration	I	II	III	IV	V
L1-L2					
Count	49	22	11	8	1
(%)	53.8	24.2	12.1	8.8	1.1
L2-L3					
Count	40	27	12	10	2
(%)	44.0	29.7	13.2	11.0	2.2
L3-L4					
Count	33	18	21	16	3
(%)	36.3	19.8	23.1	17.6	3.3
L4-L5					
Count	17	25	15	24	10
(%)	18.7	27.5	16.5	26.4	11.0
L5-S1					
Count	25	31	12	14	9
(%)	27.5	34.1	13.2	15.4	9.9

DISCUSSION

First of all, the female's dominancy in numbers was interesting and this finding hasn't been mentioned by other researchers. There wasn't any selection priority and maybe it is because of female's perseverance to visit doctors sooner although they have little pain or there is a genetically tendency.

In addition, LSTV type 2 (IIa and IIb) was the commonest type among patients with low back pain than in controls, which was noticed by Dai *et al.* (1999), moreover, in Pekendil *et al.* (2004) research there were 26 patients with LSTV type 2. However, LSTV type 3 was the commonest type in Delport *et al.* (2006). In our study, the frequency of bilateral LSTV (Type Iib + IIIb = 52.8%) was higher than unilateral LSTV (type IIa + IIIa = 29.7%). This was mentioned by Delport *et al.* (2006).

As mentioned previously, 67% of patients had disk herniation in the level L4-L5while only 34.1% of them had disk herniation in the level L5-S1. Moreover, in surveys which were done by Vergauwen *et al.* (1997) and Elester *et al.* (1989) only thing was mentioned was about

Table 8: The frequencies of disk herniation classification

Disc herniation	0	I	II	III	IV
L1-L2					
Count	77	12	1	1	0
(%)	84.6	13.2	1.1	1.1	0.0
L2-L3					
Count	74	12	4	1	0
(%)	81.3	13.2	4.4	1.1	0.0
L3-L4					
Count	59	19	12	1	0
(%)	64.8	20.9	13.2	1.1	0.0
L4-L5					
Count	30	18	34	8	1
(%)	33.0	19.8	37.4	8.8	1.1
L5-S1					
Count	60	13	12	4	2
(%)	65.9	14.3	13.2	4.4	2.2

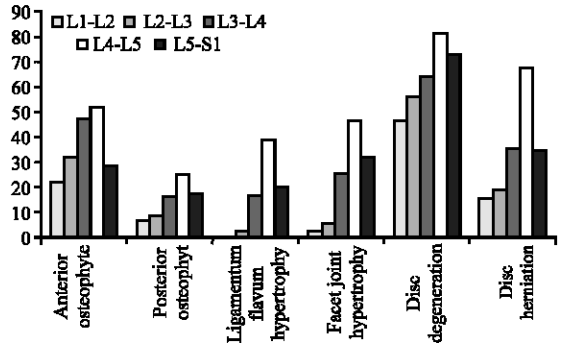

Fig. 1: The frequencies in all values (%)

the increase in prevalence of disk herniation in level L4-L5 in patients with LSTV in compare with patients without LSTV at the same level. In Li *et al.* (2006) research, which patients were divided to two groups of with and without disk herniation the frequency of LSTV was higher in patients with herniation. In addition, in the research that was done by Otani *et al.* (2001) in Japan, the similar results obtained; moreover, he noticed that the point where the herniated disk causes pressure on nerve root was located above the LSTV level.

More important, the frequency and mean severity of disk degeneration, like disk herniation, reach to their peaks in the level L4-L5 and drop in the level L5-S1 that consents the role of LSTV in preserving the L5-S1 disk and destructing the L4-L5 disk. This finding is remarked by Luoma *et al.* (2004) which LSTV causes an increase in the disk degeneration in the level L4-L5 in young male patients and it preserve the lower disk from degeneration in middle aged male patients. In addition, Aihara *et al.* (2005) and Vergauwen *et al.* (1997) noticed this importance in their researches.

By evaluating anterior and posterior osteophytes, ligamentum flavum hypertrophy and facet joint hypertrophy, a similar trend that these values increase steadily until the level L4-L5 and then they decrease sharply in the level L5-S1 is revealed. Such a trend hasn't been mentioned yet (Fig. 1).

Finally, the mean value of the disk height in the level L4-L5 was 9.6±2.0 mm and it was higher than the level L5-S1 was 7.4±2.6 mm because LSTV is an obstacle in front of disk formation in the level below it. This important notice was mentioned by Hsieh *et al.* (2000).

CONCLUSION

It seems that pathologies have been increased in the level above the LSTV in compare to the level below it. However, this fact that LSTV causes more degenerative changes in upper disk and preserve the lower disk needs researches in which both patients with LSTV and normal people are enrolled.

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