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Original Article

Lumbosacral alignment in lumbar disc herniation

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Abstract

Aim: Lumbosacral alignment has a potential role in providing proper spinal function, balanced and appropriate posture. The aim of our study was to compare lumbosacral angles between lumbar disc herniation and lumbar disc herniation-free patients. It was aimed to identify specific changes in lumbar disc herniation.

Material and Methods: A total of 118 (69 female, 49 male) patients with the complaint of chronic low back pain were enrolled. Lumbar magnetic resonance images and standing lateral lumbar radiographs were obtained from the electronic hospital database. The presence or absence of disc herniation was diagnosed with lumbar magnetic resonance images. Measurement of lumbosacral angles were performed on the standing lateral lumbar radiographs.

Results: Lumber lordosis angle and lumbosacral disc angle were significantly smaller in the lumbar disc herniation group ($p = 0.033$ and $p = 0.038$). No significant difference was detected in sacral tilt and lumbosacral angle ($p = 0.705$ and $p = 0.413$).

Conclusion: The variations in lumbosacral angles cause changes in the spinal kinematics that may affect the occurrence of disc herniation. Loss of lumbar lordosis increases the compressive forces on the spine and may associate with the presence of disc herniation. Lumbosacral alignment must be taken into account when evaluate the pathophysiology of lumbar disc herniation.

Keywords: Lumbosacral alignment; lumbar disc herniation; lumbar lordosis angle.

INTRODUCTION

Low back pain is an important health issue that increases health care costs and causes absenteeism (1, 2). Lumbosacral alignment plays a major role for proper spinal function and it provides a balanced and an appropriate posture (3). Researches related with lumbosacral alignment have mainly focused on patients with low back pain (4, 5, 6) and have been found to be associated with flattened spine and vertical sacrum (6, 7). Harrison et al. (8) demonstrated that acute low back pain patients have hyperlordotic spine but patients with chronic low back pain have hypolordotic spine. Deterioration in lumbosacral alignment alters pressure on the posterior ligaments and facet joints. This condition causes low back pain (9). Along with that, chronic low back pain patients modify spinal posture to decrease pain that contributes deterioration in lumbosacral alignment.

One of the major causes of chronic low back pain is lumbar disc herniation (LDH). The lumbosacral alignment and LDH link has been poorly examined. Harrison et al. (8) reported that patients with chronic low back pain might have aberrant disc loads related to loss of lordosis. There is evidence that even in asymptomatic patients lower lumbar lordosis angle (LLA) increases lumbar shear loads (10). The alteration of loading with loss of the lumbar lordosis may be the reason of disc degeneration.

Chronic low back pain is associated with less lumbar lordosis and more vertical sacrum. Chronic low back pain group consists of patients either with or without LDH. Thus, alterations of lumbosacral morphology cannot be attributed purely to LDH. Therefore, it is more acceptable to compare chronic low back patients with LDH to patients without LDH, rather than to compare with healthy volunteers. In this way, the variations in lumbosacral morphology may be attributed to LDH. The aim of our study was to compare lumbosacral alignment between LDH and LDH-free patients suffering chronic low back pain and to identify specific changes in LDH.

MATERIAL and METHODS

This descriptive study was carried out in Kahramanmaraş Sutcu Imam University Department of Physical Medicine

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and Rehabilitation. According to the results of the hospital registry system, 941 patients with the complaint of chronic low back pain (symptom duration > 12 weeks) aged 18 years and above were identified between January 2016 and September 2017. Among these, 118 patients who had lumbar magnetic resonance images (MRIs) along with standing lateral radiographs were included in this study. Radiological images were obtained from the electronic hospital database. Ethical approval was obtained from the Medical Ethics Committee of Kahramanmaraş Sütçü Imam University (approval date: 06.12.2017; approval number: 14).

Patients who had any record or indicator of surgery of spina, spinal infections, spondylodiscitis, excessive vertebral fracture, ankylosing spondylitis, spinal malignancies, and scoliosis were excluded from the study. Patients whose radiological images were not convenient were excluded. Patients in which the interval of lumbar standing lateral radiography and lumbar MRI was more than one month were excluded from this study.

Remaining 118 patients were divided into 2 groups (LDH group and LDH-free group). The presence or absence of LDH was diagnosed with lumbar MRIs. LDH-free group consisted of chronic low back pain patients without disc herniation on lumbar MRIs.

Patients with normal disc or disc bulging without nerve root and/or cord irritation on lumbar MRIs were classified as LDH-free group. Patients with bulging causing nerve root and/or cord irritation, as well as disc protrusion or disc extrusion on lumbar MRIs were classified as LDH group (11).

We evaluated the lumbosacral alignment using digitalized standing lateral lumbar radiographs by hospital software (Enlil PACS System software). Lumbosacral angles can be calculated on radiographs with this software.

Calculation methods are described as follows:

Lumber lordosis angle (LLA): This angle is calculated from intersecting the line which is tangent to the upper edge of the L1 vertebra and the line which is tangent to the lower edge of the L5 vertebra.

Sacral tilt (ST): This angle is calculated from the intersection of the line that is tangent to the posterior section of S1vertebra and the vertical line.

Lumbosacral angle (LSA): This angle is calculated from the intersection of the line, which is tangent to the upper end plate of the vertebra S1, and the horizontal line.

Lumbosacral disc angle (LSDA): This angle is calculated from the intersection of line that is tangent to the inferior end plate of L5 vertebra and line that is tangent the superior end plate of S1 vertebra (12, 13).

Statistical analysis

Statistical analyses were performed with SPSS version 20.0 for Windows (SPSS Inc., Chicago, IL, USA). Mean ± standard deviation, number and percentage were used for the data expression. Distribution of normality was evaluated with Shapiro-Wilk test. Independent samples t test was performed to determine the differences in continuous variables and Chi-Square test in categorical variables. Spearman correlation test was used to detect the correlations between lumbosacral angles. The statistical significance value was considered as 0.05.

RESULTS

A total of 118 patients (58.4%, n = 69 female; 41.6%, n = 49 male) were in included in this study. Sevent-one patients (57.7%, n = 41 female; 42.3%, n = 30 male) were in LDH group; 47 patients were (59.6%, n = 28 female; 40.4%, n = 19 male) were in LDH-free group. The mean age of the LDH group was 53.94 ±16.54 years and the LDH-free group was 52.31 ± 17.61 years. No significant difference was detected in terms of sex and age between two groups (p = 0.844 and p = 0.612).

LLA and LSDA were significantly smaller in the LDH group (p = 0.033 and p = 0.038). No significant difference was detected between two groups in ST and LSA (p = 0.705 and p = 0.413) (Table 1).

Table 1. Lumbosacral Angles in LDH-Free and LDH Group

	LDH-Free Group (n = 47)	LDH Group (n = 71)	p
LLA (⁰)	39.85 ±8.86	36.90±5.92	0.033
ST (⁰)	38.96 ±6.95	38.47 ±6.68	0.705
LSA (⁰)	38.00±10.48	36.61 ±7.81	0.413
LSDA (⁰)	8.68 ±2.43	7.77 ±2.24	0.038

LDH, lumbar disc herniation; LLA, lumbar lordosis angle; ST, sacral tilt; LSA, lumbosacral angle; LSDA, lumbosacral disc angle.

When the LDH group and the LDH-free group were evaluated together (n = 118) and analyzed according to gender; all angles were higher in female patients, but statistical significance level was reached only for ST (p = 0.035) (Table 2).

In the LDH group, LLA, ST, LSA and LSDA were higher in females. However, difference in ST was significant (p = 0.024) (Table 2).

When patients were evaluated as a whole (n = 118) and correlation analyses of lumbosacral angles with each other were performed; LLA was significantly and positively correlated with ST (r = 0.243; p = 0.008). Additionally, LSA showed significant and positive correlations with LLA, ST and LSDA (r = 0.512; p < 0.001, r = 0.439; p < 0.001 and r = 0.213; p = 0.020).

In the LDH group, LSA was significantly and positively correlated with LLA and ST (r = 0.449; p < 0.001 and r = 0.431; p < 0.001).

Table 2 . Comparison of Lumbosacral Angles between Male and Female Patients

	Low Back Pain Group	p	LDH Group	p
LLA (⁰)				
Male	37.03 ± 7.75	0.192	35.35 ± 6.61	0.058
Female	38.82 ± 7.00		38.04 ± 5.15	
ST(⁰)				
Male	37.11 ± 5.61	0.035	36.39 ± 5.66	0.024
Female	39.77 ± 7.32		40.00 ± 7.02	
LSA (⁰)				
Male	36.04 ± 8.01	0.255	35.69 ± 7.92	0.400
Female	37.96 ± 9.54		37.28 ± 7.75	
LSDA (⁰)				
Male	7.73 ± 2.38	0.120	7.53 ± 2.04	0.446
Female	8.42 ± 2.31		7.94 ± 2.39	

LDH, lumbar disc herniation; LLA, lumbar lordosis angle; ST, sacral tilt; LSA, lumbosacral angle; LSDA, lumbosacral disc angle. Low back pain group consists of LDH-Free patients and LDH patients

DISCUSSION

Significant differences were detected in LLA and LSDA between two groups. LSA was significantly and positively correlated with LLA and ST in the LDH group. We aimed to investigate the specific biomechanical changes in LDH rather than chronic low back pain in this study. Lumbosacral morphology is one of the crucial factors for an appropriate and a balanced spine. Lumbosacral alignment, which includes geometric parameters, has been known to affect mechanical properties during compressive loading (14,15).

Previous studies mainly evaluated lumbosacral alignment in healthy volunteers or in patients with chronic low back pain or spondylolisthesis (3-16,17). However, the number of studies, which assessed the lumbosacral morphology in LDH, is relatively scarce (18,19). In previous researches evaluating lumbosacral morphology in LDH; patients with LDH were compared to healthy controls (18,19). Endo et al. (18) included 61 LDH patients and 60 healthy controls in their study that demonstrated that patients with LDH have hypolordotic spine and more vertical sacrum. Rajnics et al. (19) compared 50 LDH patients to 30 healthy controls. They reported a lower lumber lordosis and more vertical sacrum in their research. Chronic low back pain also leads to loss of lumbar lordosis and a vertical sacrum (4,5). Thus, changes in lumbosacral alignment cannot be attributed purely to LDH. Benlidayı et al. (11) compared LDH patients to LDH-free patients who also had complaints of chronic low back pain and no significant differences in lumbosacral angles were found between two groups. In their study, lumbar MRIs obtained in the supine position were used for lumbosacral angle measurements that may affect the results of this study. In our study, we demonstrated that patients with LDH have significantly smaller LLA and LSDA than LDH-free patients. The physiologic structure of lumbosacral alignment plays a crucial role in the distribution of forces applied on the intervertebral discs, corpus vertebrae and facet joints of the spine (20). The variations in lumbosacral alignment may cause changes in the spinal kinematics, which can affect the occurrence of disc herniation. Loss of lumbar lordosis may increase the compressive forces on the spine and may associate with the presence of disc herniation. Beside this, LDH can also influence the lumbosacral curvatures. Postural changes to cope with pain and decrement in disc height can change lumbosacral alignment (7). Sciatic nerve irritation, tonic contraction of the lumbopelvic muscles in LDH patients may also influence the lumbosacral alignment. Decrease in LLA may be a result of an effort to reduce sciatic nerve irritation in LDH (18). LSDA was significantly smaller in LDH group. One of the reasons for this change may be that the greater part of disc herniation occur at the level of L5-S1. Greater shear force at the lower part of the lumbar region in chronic low back pain patients may lead to this difference (11).

The relationships of lumbosacral angles with each other play a crucial role in maintaining physiological and appropriate function of the spino-pelvic unit. Biomechanically, the loss of lordosis causes anterior displacement of the C7 plumb line and a vertical sacrum. The purpose of this process is compensating the anterior translation of gravitational axis (21). Low pelvic incidence values were reported to lead a decrement in LSA that causes flattening the LLA (22). In our study, when the whole patients were evaluated, LLA was significantly and positively correlated with ST. Additionally, LSA showed a significant positive correlation with LLA, ST and LSDA. In the LDH group, LSA was significantly and positively correlated with LLA and ST. Correlation analyses of our study was consistent with the literature.

When the LDH group and the LDH-free group were evaluated together (n=118) and analyzed according to gender; all angles were higher in female patients, but statistical significance level was reached only for ST. In the LDH group, LLA, ST, LSA and LSDA were higher in females. Difference was also significant in ST. Benlidayi et al. (23) found a hyperlordotic posture in female gender. Jannsen et al. (24) reported differences in female spine compared to male spine, but found no difference in lumbar lordosis between male and female patients. Anterior obstetric load on the females' spine may lead to differences in lumbosacral alignment (25).

In most of the studies regarding lumbosacral alignment in patients with LDH lumbosacral angles were calculated on lumbar MRIs. Lumbar MRIs were obtained in supine position. Activity of lumbosacral muscles and shear forces on the spine change in supine position. Reference points for measuring lumbosacral angles were identified for standing radiographs. For these reasons, lumbar MRIs are not suitable for the measurement of lumbosacral angles (26). Therefore, we determined the presence or absence of LDH using lumbar MRIs but lumbosacral angles were calculated on standing lateral lumbar radiographs.

Small sample size is one of the limitations of our study. We evaluated patients who had lumbar MRIs along with standing lateral radiographs. This condition led to a small sample size. It has a retrospective design that limits the evaluation of body mass index, pain level, pain duration, physical activity and exercise status. We could not evaluate healthy controls as a result of retrospective design.

CONCLUSION

Several factors influence the occurrence of LDH. A certain risk factor cannot be purely responsible for the presence of discopathy. Variations in lumbosacral morphology may affect the biomechanics of spine and lead to LDH. Additionally, lumbosacral alignment may be influenced by irritation of sciatic nerve and tonic contraction of the lumbosacral muscles. Lumbosacral alignment must be taken into account when evaluate the pathophysiology of LDH. Assessment of lumbosacral alignment gives beneficial information about the pathogenesis of LDH. In further researches regarding lumbosacral alignment in LDH, body mass index, pain intensity, pain duration, working status and physical activity should be evaluated to acquire more reliable and accurate results.

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