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RETROSPECTIVE REVIEW OF SPINOPELVIC PARAMETERS IN PATIENTS WHO HAD SURGERY FOR LUMBAR DISC HERNIA: CROSS-SECTIONAL CASE STUDY

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ABSTRACT

Objective: This study examined the effect of spinopelvic parameters on the formation of lumbar disc herniation (LDH) in patients who underwent surgery due to LDH was examined. For this purpose, a retrospective cross-sectional analysis was performed on two groups; healthy individuals and those who underwent surgery.

Materials and Methods: Correlation between clinical examination, plain radiography, and magnetic resonance imaging was performed for patients with LDH. Patients who underwent surgery for L4-5 and L5-S1 levels were included in the study. Healthy controls were included in Group 1, and patients who underwent LDH surgery were included in Group 2. Spinopelvic parameters (LL, L1-L4, L4-S1, SS, PI, PT angles) were measured using Surgimap. The obtained data were statistically compared using SPSS.

Results: There was no difference between the two groups in L1-L4, SS, PI, and PT measurements. LL (p=0.004) and L4-S1 lordosis angles (p=0.001) were found to be lower in Group 2 than in Group 1. In Group 2, no difference was found in any parameter regarding the formation of disc degeneration at a single or multiple levels. In group 2, PI values of the L4-5 disc level were higher than those of the L5-S1 disc level (p=0.032).

Conclusion: There were no statistically significant differences between groups 1 and 2, except for LL. Decreased LL is a risk factor for surgery for disc herniation.

Keywords: Spine surgery, lumbar disc herniation, spinopelvic parameter

INTRODUCTION

In modern societies, one of common causes of lumbago and radiculopathy become lumbar disc herniation (LDH). In some cases, functional loss in lumbar movements can significantly restrict daily activities, leading to a decrease in productivity and working time, which in turn affects the cost of living and work. The literature suggests that the clinical symptoms of LDH are associated with sagittal imbalance of the spine[1]. Sagittal balance refers to the state in which a person can maintain a stable posture with minimum muscle expenditure.

Achieving sagittal balance requires the coordinated function of the spinal and pelvic bone structures, the integrity of the disc material, the mechanical behavior of the ligaments, muscle strength, muscle endurance, and the interaction among these components[2]. Spinal sagittal imbalance has been primarily assessed through radiological parameters in various studies[3,4]. One of the key spinopelvic parameters, pelvic incidence (PI), has been debated regarding its involvement in the pathogenesis of LDH. While some studies have found a difference in PI between LDH patients and the general population [5,6], others have reported no such difference[7,8]. On the other hand, lumbar lordosis (LL) appears to be associated with PI and is thought to influence the disc degeneration process[9]. As a parameter, PI fixes reflect the shape and size of the pelvis. PI and LL are in a dynamic relationship and they explain the importance of lumbar postural curvature for maintaining spinal balance[10]. There are very few studies that have comprehensively examined the relationship between the degree of lordotic curve and low back pain[9,11]. LL is closely related to other spinopelvic measurements such as sacral tilt (SS) and pelvic tilt (PT). These values have important roles in regulating the sagittal balance. To compensate for this sagittal imbalance, the pelvis tilts backward by increasing PT and decreasing SS, thus adjusting posture[6]. Less degeneration

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is observed in LDH patients at an early age, suggesting that the regulatory mechanisms maintaining sagittal balance are more effective during this period. This may help explain the sagittal morphology observed in LDH patients.

In this study, the effect of spinopelvic parameters on LDH formation in patients operated for LDH was examined. For this purpose, radiographic data of a patient group (range of age: 20-50) underwent surgical process for LDH. A control group of healthy individuals who did not undergo lumbar surgery were retrospectively examined and compared.

MATERIALS AND METHODS

The approval for this study by the Clinical Research Ethics Committee of the Bursa Uludağ University Faculty of Medicine (approval number: 2011-KAEK-26, date: 18.10.2023). In this study, patients whose diagnosis was confirmed by magnetic resonance imaging (MRI) after clinical examination in the orthopedics and traumatology clinic between June 2019 and September 2023, who did not respond to conservative treatment and who were operated on due to LDH, and cases of appropriate age and gender as a control group were directly examined. The radiographs were evaluated retrospectively. The control group consisting of healthy individuals was called Group 1, and patients between the ages of 20 and 50 who had undergone surgery due to LDH were called Group 2. All surgical procedures were performed by a single surgeon. Exclusion criteria were as follows: patients with recurrent disc disease who previously underwent surgery for LDH, patients with additional spinal deformity or degenerative changes, patients who underwent surgery at more than one level, and patients over 50 years of age. Patients in whom reference anatomical regions could not be selected for measurement or whose preoperative lumbar MRIs could not be obtained along with films taken at inappropriate doses were also excluded from the study. Group 2 included patients who operated for L4-5 and L5-S1 levels, while a patient who operated for L3-4 level was excluded from the study. Retrospective evaluation was performed with preoperative standing lumbar two-way radiographs and radiographs covering the entire lumbar region from the thoracolumbar level to the hip joints. In both groups all parameters (LL, SS, PI, PT, L1-L4 and L4-S1) angles were measured on standing lateral radiographs using the Surgimap (NY 10016, USA) program by a single person who performed the surgical procedure (Figure 1). Measurements of both groups were made by a single person who performed the surgical procedure with the Surgimap program. By looking at the preoperative MRIs of Group 2 cases, the disc levels where the operation was performed and the presence of an additional degenerative disc level were determined. Two groups were compared statistically by measuring spinopelvic parameters (LL, L1-L4, L4-S1, SS, PI, PT angles).

Statistical Analysis

Use the Shapiro-Wilks test to test whether the data are normally distributed. If the data were normally distributed, comparisons between groups were made using the Student t-test and the results were interpreted as mean ± standard deviation. If the data were not normally distributed, comparisons between groups were made using the Mann-Whitney U test and descriptive data were given as mean (minimum-maximum) values. Comparisons of categorical data between groups were made using the Pearson chi square test and descriptive statistics were given as n (%). The significance test was α=0.05. Analysises were performed using the SPSS (v25).

RESULTS

The files of 186 operated patients who had diagnosis of LDH were retrospectively examined. Age and gender comparisons were also made between Group 1 and Group 2. There were 18 men and 18 women in both groups. In this study, no statistically significant difference was found according to gender. While the mean and standard deviation according to age was 40.36±6.26 in Group 1, it was 40.69±6.21 for Group 2 (p=0.821).

At the evaluation for MRIs in Group 2, all cases were shown in axial T2 MRI images according to the Michigan State University (MSU) classification. In the MSU classification the size and location of disc herniation are measured at the level of maximal extrusion in reference to a single intra-facet line drawn transversely across the lumbar canal, to and from the medial edges of the right and left facet joint articulations. To portray the size of disc herniation, the lesion is described as 1, 2, or 3 (Figure 2). To further qualify location of the disc herniation, the lesion is described as A, B, or C. The right and left central quadrants represent zone-A. The right and left lateral

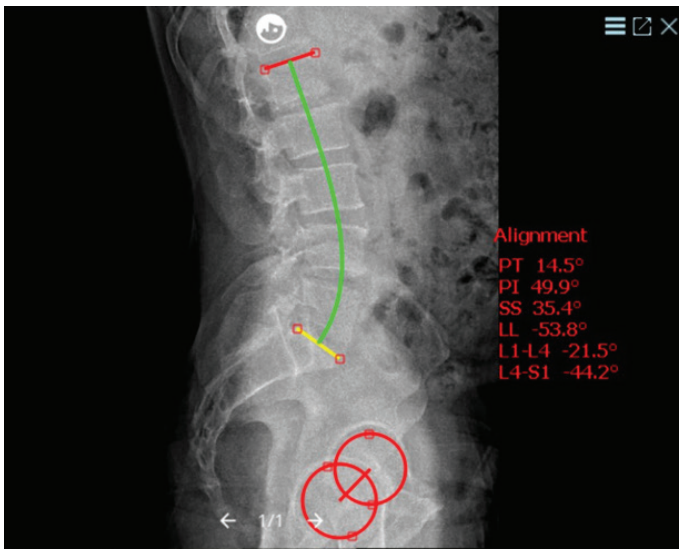

Figure 1. Measurements made using the Surgimap program
PT: Pelvic Tilt, PI: Pelvic Incidence, LL: Lumbar lordosis, SS: Sacral Tilt

quadrants represent zone-B. A third zone-C is represented at the level of the foramen by the area that extends beyond the medial margin of either facet joint, past the borderline of the lateral quadrants (Figure 3). In accordance with the clinical findings; 36 cases with moderate and severe disc herniations, consisting of patients in groups 2 and 3 according to disc herniation size and A, AB and B according to localization, were included in the study, (Figure 2, 3)[12]. Group 1 consists of 367 cases from the hospital database who complained of low back pain or had lumbar bidirectional radiography taken for the differential diagnosis of lumbar pathology; It was created with 36 cases of statistically similar age and gender and no spine pathology was detected in the bidirectional radiographic images.

The significant difference was not detected between the Group 1 and the Group 2 according to PT, PI, SS and LL (Table 1). In terms of LL, there was a significant difference between the Group 1 and the Group 2. The LL values are higher in the Group 1 compared to the Group 2 (p=0.004) (Table 1). Although there were no difference between the two groups for PT, PI and SS, but LL was significantly lower in the Group 2 (Table 1).

In terms of L4-S1 lordosis angle, a significant difference was not observed between Group 1 and the Group 2. The L4-S1 values was higher in Group 1 (p=0.001) (Table 1).

In Group 2, the number of men with one disc degeneration was 9 (45.0%), the number of women is 11 (55.0%); with more than one disc degeneration, the number of men is 9 (56.3%), the number of women is 7 (43.8%). To gender, there was no difference in the Group 2 with one disc degeneration and more than one disc degeneration (p=0.737). There were no significant differences in the Group 2 with one disc degeneration and with more than one disc degeneration in terms of age, SS, LL, PT, PI, L1-L4 and L4-S1 (Table 2).

In comparison according to the LDH level, the number of men in the L4-5 group was 8 (53.3%), the number of women was 7 (46.7%), the number of men in the L5-S1 group was 10 (47.6%), and the number of women was 11 (52.4%). The significant difference was not detected according to LDH level to gender as statistically. The significant difference was not detected according to LDH level in terms of age, SS, LL, PT, L1-L4 and L4-S1 (Table 3). The significant difference was not detected in terms of PI for LDH level. The PI values of the L4-5 disc level was higher than L5-S1 disc level (p=0.032) (Table 3).

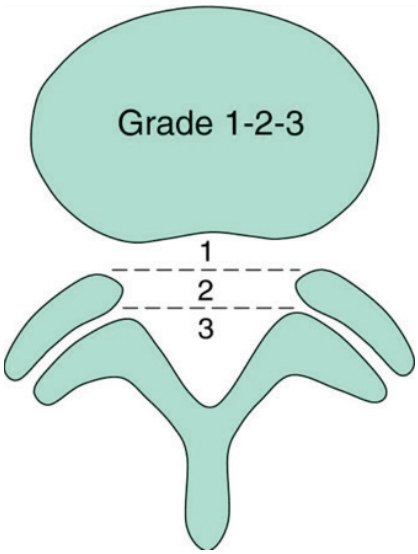

Figure 2. Grading the disc herniation for size. Grade 1 lession have little impact and grade 3 have the most impact on nevre compression

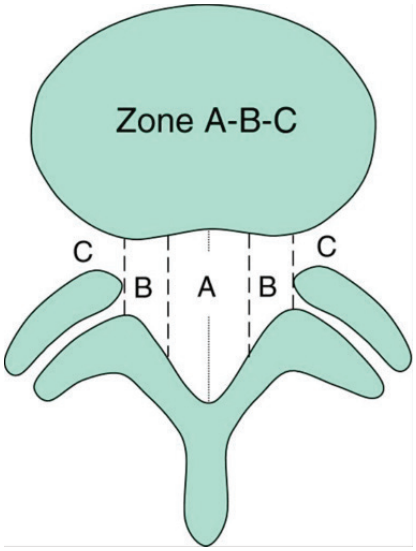

Figure 3. Zoning the disc for location. Lesions have more impact in tighter zone B and C

Table 1. Comparisons according to control and operation group

	Grup 1 (n=36)	Grup 2 (n=36)	
	Mean ± SD/Median (min.-max.)	Mean ± SD/Median (min.-max.)	p-value
PT	15.70 (1.9-27.3)	13.65 (5.7-32.3)	0.551##
PI	48.80±10.64	46.76±9.20	0.388#
SS	33.58±8.99	31.67±7.25	0.323#
LL	57.20±12.49	49.12±10.44	0.004#
L1-L4	23.15±8.16	20.98±6.74	0.223#
L4-S1	46.29±8.39	39.04±8.67	0.001#

#Student's t-test, ##Mann-Whitney U test. PT: Pelvic tilt, PI: Pelvic incidence, LL: Lumbar lordosis, SS: Sacral tilt, SD: Standard deviation, min.-max.: Minimum-maximum

Table 2. Comparison according to disc degeneration in Group 2

	Disc degeneration		
	One level (n=20)	More than one (n=16)	
	Mean ± SD/Median (min.-max.)	Mean ± SD/Median (min.-max.)	p-value
Age	41.25±5.57	40.00±7.04	0.556#
PT	13.30 (5.70-25.8)	13.65 (7.00-32.30)	0.888##
PI	46.90 (33.50-57.90)	47.15 (32.20-69.90)	0.498##
SS	30.76±7.58	32.80±6.88	0.409#
LL	50.09±11.98	47.91±8.35	0.542#
L1-L4	21.60 (10.7-31.8)	22.15 (1.9-28.9)	0.718##
L4-S1	39.40±10.63	38.60±5.64	0.789#

#Student's t-test, ##Mann-Whitney U test. PT: Pelvic tilt, PI: Pelvic incidence, LL: Lumbar lordosis, SS: Sacral tilt, SD: Standard deviation, min.-max.: Minimum-maximum

Table 3. Comparison according to LDH level in Group 2

	LDH level		
	L4-5 (n=15)	L5-S1 (n=21)	
	Mean ± SD/Median (min.-max.)	Mean ± SD/Median (min.-max.)	p-value
Age	41.20±4.74	40.33±7.17	0.686#
PT	14.6 (9.1-31.5)	11.7 (5.7-32.3)	0.109##
PI	50.61±9.50	44.01±8.13	0.032#
SS	33.57±8.37	30.31±6.19	0.188#
LL	51.09±11.95	47.71±9.26	0.346#
L1-L4	21.66±6.36	20.50±7.11	0.616#
L4-S1	40.27±10.27	38.16±7.47	0.479#

#Student's t-test, ##Mann-Whitney U test. PT: Pelvic tilt, PI: Pelvic incidence, LL: Lumbar lordosis, SS: Sacral tilt, SD: Standard deviation, min.-max.: Minimum-maximum

DISCUSSION

The lumbar region provides the connection between the trunk and lower limbs in maintaining the sagittal posture. If the spine is imagined as a pillar of a crane, the total contact pressure into the lumbar intervertebral disc can be measured by the sum of body weight pressure and posterior paraspinal muscle force pressure. As the LL is greater, the effect of the contact force acting on the posterior elements will be greater. The contact force shifts forward towards the intervertebral discs with the low PI and LL. As a result, the vertebral endplates are close to the horizontal plane. The pressure of vertical contact force increases and the resulting intradiscal pressure increases significantly[11]. Pourabbas Tahvildari et al.[11] found low-angle values of PI and LL in patients with LDH.

Yokoyama et al.[13] also stated that compared to healthy individuals, a significant decrease in LL and SS and an increase in PT and sagittal vertical axis were observed in patients with LDH. Comparing of Group 1 and Group 2; L1-L4 lordosis, SS, PI and PT angular values were similar. LL was found to be lower in Group 2 (p=0.004). The decrease total LL was found to be due to L5-S1, which was found to be statistically low (p=0.001). Since two-way lumbar radiographs that could not be taken standing or lying down due to severe LDH symptoms were not included in the study and standard patient positioning was performed in lumbar radiographs, it can be claimed that there was a loss of LL in the surgery group and this could cause lumbar disc pathology.

Poonia et al.[14] stated that in patients with high PI and SS, increased shear stress in the lumbosacral junction will increase disc degeneration and prolapse by causing more tension in the anterior and posterior facet joints of the intervertebral disc in the L5-S1 distance. In the same study, it was stated that the increase in LL, SS, PT and PI caused in increased risks of pathology in discs of L4-L5, while the increased angles of PT and LL caused an increase in disc pathology in L5-S1. To Poonia et al.[14] patients with higher PI and SS and therefore higher LL values were found. In this study, while SS, PI and PT values in Group 2 did not vary compared to the control group, LL was found to be lower.

In the study of Barrey et al.[15], It has been shown that certain sagittal changes in the spine may increase the risk of LDH[15]. A straight spine profile with low LL was associated with an high risk of disc degeneration at L4-L5 and L5-S1 levels. These individuals have developing early-onset disc degeneration[16,17].

In this study group, in all spinopelvic parameters, although the significant difference was not observed in LL of L1-L4 in Group 2 (p=0.223), a decrease in the total LL angle was detected (p=0.001) due to the difference in the L4-S1 lordosis angle (p=0.004).

Liu et al.[18] emphasized that PI, which has a significant effect on lumbar disc degeneration, being too large or too small may predispose to the emergence of lumbar disc degeneration. They also reported that L5-S1 disc degeneration had a significant effect on pelvic postural parameters (PT, SS). It has been stated that L5-S1 degeneration was the main causal factor of pelvic posterior rotation and compensatory process. In this study, no significant difference was found between the groups in the PI value, which is a pelvic constant parameter. In group 2, no statistical difference was found in spinopelvic parameters when compared with 20 patients with single level disc degeneration and 16 patients with multiple level disc degeneration. However, when the levels of disc herniation were considered, PI value was lower in the L5-S1 group (21 cases) than L4-L5 group (15 cases) (p=0.032).

Study Limitations

The limitations can be listed as follows: Classification can be made according to demographic characteristics and pathophysiology of LDH. Due to the limited number of cases, the professions and body mass index of the cases could not be evaluated in the study. Due to the lack of control group MRIs, possible disc pathology that did not show clinical findings could not be ruled out. The study can be multi-center and have more descriptive features with a larger number of patients.

CONCLUSION

In this study, the effect of spinopelvic parameters within the individual's anatomical and physical structure was examined, apart from external factors that initiate degeneration in LDH formation and cause deterioration of the compensatory mechanism in the process leading up to surgery. No difference was found between healthy and operated groups as statistically, except for LL. In particular, the effect of PI, which is an individual-specific fixed parameter, on LDH formation was not detected. Decreased LL may be a risk factor for disc herniation requiring surgical treatment. The relationship between spinopelvic parameters and LDH needs to be examined in new studies that are multi-center, more comprehensive and include a larger number of patients.

Footnote

Ethics Committee Approval: The approval for this study by the Clinical Research Ethics Committee of the Bursa Uludağ University Faculty of Medicine (approval number: 2011-KAEK-26, date: 18.10.2023).

Informed Consent: Retrospective study.

Authorship Contributions

Surgical and Medical Practices: B.A., Concept: B.A., H.Ü., K.Y., Ü.Ö.G., Design: B.A., H.Ü., K.Y., Ü.Ö.G., Data Collection or Processing: B.A., H.Ü., K.Y., Ü.Ö.G., Analysis or Interpretation: B.A., Literature Search: B.A., Writing: B.A., H.Ü., K.Y., Ü.Ö.G.

Conflict of Interest: The authors have no conflicts of interest to declare.

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