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LUMBOPELVIC STABILITY, LUMBOPELVIC MOBILITY AND SPINOPELVIC PARAMETERS IN PATIENTS WITH LUMBAR DISC HERNIATION

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ABSTRACT

Objective: This study aimed to evaluate lumbopelvic stability, lumbopelvic mobility, and spinopelvic parameters in patients with lumbar disc hernia (LDH).

Materials and Methods: The study included 20 patients with LDH who met the study inclusion criteria and 20 age and gender-matched healthy volunteers. All the subjects were evaluated using a visual analog scale for pain intensity assessment, trunk flexor, and right/left lateral trunk flexor muscle endurance tests and Sorensen tests for lumbopelvic stability, Schober and sit-and-reach tests for lumbopelvic mobility, lateral radiography for spinopelvic parameters and the Oswestry Disability Index for physical functionality.

Results: There was a significant difference between the groups with respect to lumbopelvic stability, lumbopelvic mobility, lumbosacral angle, pain, and physical functionality ($p<0.05$). A highly significant moderate to good negative correlation was obtained between endurance tests and pain and functionality scores. A highly statistically significant moderate to good negative correlation was found between pain scores, Oswestry functionality questionnaire results and Schober test values.

Conclusion: The results of this study showed that lumbopelvic stability, lumbopelvic mobility and lumbosacral angle values were decreased in patients with LDH compared with healthy individuals. Therefore, lumbopelvic stability and mobility exercises, and postural control exercises to correct the protective mechanisms that will improve spinopelvic parameters as well as optimal posture, should be included in rehabilitation programs for patients with LDH.

Keywords: Low back pain, lumbar disc herniation, lumbopelvic stability, lumbopelvic mobility, spinopelvic parameters

INTRODUCTION

Lumbar disc herniation (LDH) is a condition characterized by low back and leg pain caused by compression of the lumbar spinal root by the degenerated disc[1]. The highest prevalence is detected between the age of 30-50 years with a male/female ratio of 2:1. In patients aged 25-55 years, approximately 95% of LDH occurs in the lower lumbar spine (L_4-L_5 and L_5-S_1 level), and disc herniation above this level is more common in those aged >55 years[2,3]. The development of disc herniation may be promoted by a negative relationship between load and flexibility in the lumbar region. High intervertebral disc pressures mainly occur in stressful flexion of the lumbar spine with rotational movements and might cause earlier and more frequent ruptures of the annulus fibrosus in the physiological aging process[4].

To achieve and maintain optimal body segment alignment with the spine, pelvis, and lower extremities, lumbopelvic stability must be provided both in a static position and during dynamic activity[5]. Any problem in the spinal column, spinal muscles and one of the neural control units or atrophy in the lumbar region muscles with intervertebral disc damage, which is of great importance in lumbar stabilization, may affect lumbopelvic stabilization[6]. Although some studies in literature have reported that lumbopelvic stabilization is significantly decreased in individuals with LDH compared to healthy individuals[7-10], others have suggested that there is no change[11].

Lumbopelvic mobility is characterized by the coordination of the lumbar spine and hip to the pelvis during flexion and extension in the sagittal plane[12-15]. The changes in the range of motion and timing of lumbopelvic mobility may change the bending stresses of the lumbar segments[16]. However, the changing movement patterns of the lumbopelvic region may be a result of low back pain because of LDH[17]. Although there are studies speculating that lumbopelvic mobility is reduced in individuals with LDH compared to healthy individuals[13,18], there are also studies that argue the opposite[19,20].

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The symptoms that develop in patients with LDH may cause certain changes in the sagittal and coronal shape of the vertebral column[21]. Again there are studies speculating that spinopelvic parameters differ in individuals with LDH compared to healthy individuals[22-24], and there are also studies showing no difference[25,26].

The target of rehabilitation of patients with LDH is to stabilize the spine in a balanced and neutral stance and to provide appropriate muscle activation of the lumbar spine and pelvis. To the best of our knowledge, there is no study in the literature that has evaluated lumbopelvic stability, lumbopelvic mobility and spinopelvic parameters in patients with LDH. Therefore, the aim of this study was to evaluate the lumbopelvic stability, lumbopelvic mobility, and spinopelvic parameters in patients with LDH and in healthy individuals. It is hoped that this will contribute to the planning of future rehabilitation programs.

MATERIALS AND METHODS

This study was planned as a Master's Thesis. Forty-two patients with LDH applied to the department, and 40 of them participated in this study. Two patients could not perform the assessment tests and were excluded. The evaluations made in the scope of the study were applied to all the individuals.

The study included patients who presented at Private Otağtepe Medical Center between May 2021 and November 2021 with complaints of low back pain and were diagnosed with LDH by a specialist physician, and a control group of age and gender-matched healthy individuals. The patients included were aged 18-65 years, had pain complaints ongoing for at least 3 months and at most 12 months, met the study inclusion criteria, and voluntarily agreed to participate in the study. Exclusion criteria were defined as the presence of any orthopedic, neurological, cardiopulmonary, or rheumatological disease, a history of surgery on the column vertebralis, the presence of congenital problems (such as limb length discrepancy), scoliosis, tumor, spondylolysis-spondylolisthesis, structural problems of the vertebral column such as vertebral fracture, a history of musculoskeletal injury in the last 6 months, a history of trauma, or pregnancy.

The study was approved by Üsküdar University Clinical Research Ethics Committee (date: 30/04/2021, approval no: 2021-103), and was conducted in line with the Declaration of Helsinki. The purpose and content of the study were explained to all subjects in writing and orally at the beginning of the study. The information and voluntary consent form prepared in line with the standards of the Ethics Committee was signed by all subjects. The demographic data of the participants were recorded on the "Socio-demographic Data Form" prepared by the researchers. To evaluate lumbopelvic stability, the body flexor muscle endurance test developed by McGill, the Sorensen test, and right and left lateral trunk flexor muscle endurance tests were used. The test positions were explained and demonstrated to the study subjects. They were then asked to maintain the trunk flexion, extension, right and left lateral flexion positions for as long as possible during the test, and the measurements were recorded in seconds with a stopwatch. The tests were ended when the test position was disturbed or when the subject said they could not continue the test. Each measurement was repeated twice and the best measurement result was recorded[27].

For the body flexor muscle endurance test, the subjects were positioned standing on a flat surface with knees flexed, hands crossed on their shoulders, and the body in 60° flexion[28,29]. The participants were positioned in the prone position in such a way that their anterior superior spina iliaca came to the edge of the bed and their upper body was extended forward in a flat position from the edge of the bed in the Sorensen test. It was fixed on the thigh with the help of a physiotherapist[27]. In the body right/left lateral flexor muscle endurance test, participants were placed in a side-lying position to carry their body weight on their forearms and toes. This test was applied separately for the right and left sides[30].

Lumbopelvic mobility was evaluated with Schober's test and the sit-and-reach test. In the Schober test, the L5 spinous process and 10 cm above it was marked when the participants were standing upright. The patient was asked to perform maximum flexion without bending the knees, and the distance between the two points was measured with a 7 mm-wide tape measure, and the amount of increase was recorded. A minimum increase of 5 cm was expected in the distance between two points; if this difference is <5 cm, it is evaluated as decreased lumbar mobility[31]. In the sit-and-reach test, the subjects sit on the floor with the legs and knees extended. Plantar flexion of the foot was prevented by placing a 30 cm high wooden block on the sole of the foot, and the subject is instructed to reach forward without bending the knees. After three stretches, the position is held for 2 seconds and the distance between the distal phalanx of the third finger of the hand and the toes is measured. Reaching as far as the toes was recorded as "0", reaching beyond the toes as "positive (+)" and not reaching the toes as "negative (-)"[32].

Lumbar lordosis, sacral angle and lumbosacral angle measurements of the spinopelvic parameters were evaluated on standing lateral radiographs method during which the subjects were positioned standing upright with hands on the neck, knees in full extension and feet shoulder-width apart. All the measurements were made directly on the radiographs using the Cobb Method and a goniometer. Lumbar lordosis was measured as the angle between the upper surface of the sacrum and the upper surface of the first lumbar vertebra (L_1-S_1)[33]. The sacral angle was measured as the angle between the S_1 vertebra superior endplate and the horizontal line. The lumbosacral angle was measured as the angle between the lines along the upper edge of the S_1 and the lower edge of the L_5 vertebra[34,35]. Each measurement was repeated three times and the average was recorded[36,37].

A visual analog scale (VAS) was used for pain assessment. The patient was asked to mark the intensity of his pain at rest, at night, and during activity on a 10 cm line marked from 0 to10, where 0 indicates no pain, and 10 indicates unbearable pain[38]. The Turkish version of the oswestry disability index (ODI) was used to evaluate the level of functionality and it was applied in face-to-face interviews with the study subjects. The validity study of the questionnaire was conducted by Yakut et al.[39]. The ODI measures the severity of pain as well as functional disability during activities of daily living such as personal care, walking, lifting, standing, sleeping, sitting, sexual life, social life, and travel. The ODI has 10 questions, each of which has 6 sections scored from 0-5 points. As the total score increases, the level of functionality decreases[40].

Statistical Analysis

The analysis of the study results was made using the Statistical Package for Social Sciences, version 16.0 software (SPSS Inc.; Chicago, IL, USA). The statistical significance value of $p \leq 0.05$ (two-sided) was taken in all analyses. The conformity of the data to normal distribution was tested with the Shapiro-Wilks test. Gender distributions in the groups were analyzed with the chi-square test. In the comparisons between the groups of the VAS scores, the ODI, McGill muscle endurance tests, Schober test from lumbopelvic mobility tests and the sit-reach test, the Mann-Whitney U test was used. In the spinopelvic parameter evaluations between groups, lumbar lordosis, sacral angle and lumbosacral angle measurement results were analyzed with the Independent Samples t-test. The correlations were analyzed with Spearman analysis.

RESULTS

The study was completed with 20 LDH patients and 20 healthy control subjects. Gender, age, height and body mass index were similar in both groups (Table 1). The distribution of herniation levels in patients with LDH is shown in Table 2.

The functionality levels of the LDH patients were statistically significantly lower than those of the healthy control group ($p<0.05$). The mean values of all endurance tests of the control group were higher than those of the LDH patients ($p<0.001$). The lumbopelvic mobility of the control group was higher than that of the LDH patient group. No statistically significant differences were detected between the two groups in respect of lumbar lordosis and sacral angle values (p=0.733, p=0.374). The lumbosacral angle values of LDH patients were statistically significantly decreased compared to the healthy control group (p=0.012, Table 3).

High-level significant negative correlations were found between endurance tests, pain scores, and functionality scores. There were also high-level significant positive correlations between pain and functionality scores. High-level statistically significant negative correlations were found between pain scores, ODI results, and Schober test values. There was a weak-moderate positive correlation between the endurance tests and the Schober test values (Table 4).

DISCUSSION

The results of the present study demonstrated that lumbopelvic stability, lumbopelvic mobility, and lumbosacral angle values were significantly decreased in patients with lumbar disc hernia compared to healthy individuals.

Atrophy, which may occur in the muscles because of LDH, may cause low back pain and affect the lumbopelvic stabilization as an important factor in low back pain[41]. Waldhelm and Li[29]. investigated the reliability of clinical measurements evaluating components related to core stabilization with a test-retest design on healthy young individuals, and reported that the reliability of trunk flexor muscle endurance test, Sorensen test, right/left lateral flexor muscle endurance tests were at the highest levels. In the present study, the lumbopelvic stability values of the cases were evaluated with these tests.

According to the results of a study by Abdelraouf and Abdel-aziem[8] athletes with low back pain yielded significantly lower results in the tested muscle endurance tests compared to a healthy group. In another study, trunk muscle endurance was compared between dancers with low back pain and healthy dancers, and it was found that dancers with low back pain had decreased right and left lateral trunk muscle endurance compared to the healthy dancers[10]. In contrast, Hosseinifar et al.[11] conducted a cross-sectional analytical study, and compared patients with chronic low back pain (n=30) and healthy individuals (n=30) in terms of lumbopelvic stability,

Table 1. The comparison of the demographic characteristics of the groups

	LDH group (n=20) Frequency (%)	Healthy group (n=20) Frequency (%)	p-value
Gender	14 Female (70%) 6 Male (30%)	13 Female (65%) 7 Male (35%)	0.736
	LDH group (n=20) Mean ± SD	**Healthy group (n=20) Mean ± SD**	**p-value**
Age (years)	45.25±7.59	42.10±11.39	0.151
Height (m)	1.63±0.09	1.67±0.08	0.262
Body mass index (kg/m²)	25.96±3.53	25.70±3.93	0.667

*<0,005, chi-square test, **Independent Samples t-test
n: Number of people, SD: Standard deviation, %: Percentage ratio, m: Meter, kg: Kilogram, LDH: Lumbar disc herniation

which is one of the factors suggested to prevent low back pain, and found that the groups were similar.

In the present study, similar to the results of the previous studies in the literature, it was found that all the endurance test values of the LDH patient group were decreased compared to the healthy control group. It can be considered that the *m. multfidius* and *m. transversus abdominis* muscles, which are among the main stabilizers, may develop atrophy because of LDH, and affect lumbopelvic stabilization. However, the structure of these muscles was not evaluated in this study. It can be recommended that future studies evaluate the muscle structures separately with methods such as measuring the cross-sectional area of the muscles on muscle ultrasound or lumbar MRI.

It has been speculated that repetitive lumbopelvic movement is a factor in the development and course of low back pain[42]. Kim et al.[13] evaluated the lumbopelvic rhythms during trunk flexion and extension in patients with low back pain and age-matched healthy individuals, and found statistically significant differences in lumbopelvic rhythms between the two groups. In a study that included 44 male adolescent football players with low back pain and 65 healthy male adolescent football players, it was found that the lumbopelvic movement was smaller in the group with low back pain compared to the healthy group[18].

Table 2. The distribution of herniation levels in patients with LDH

LDH Group (n=20)	L_1-L_2	L_2-L_3	L_3-L_4	L_4-L_5	L_5-S_1
Bulging	2	5	10	13	6
Protrusion		2	1	3	4
Extrusion				2	1
Sequestration					

n: Number of people, L: Lumbar vertebra, LDH: Lumbar disc herniation

In another study that included 39 healthy women and 27 women with low back pain, all aged 19-63 years, the effects of flexibility on low back pain were examined. The mean sit-reach test values was measured as 6.56 cm in the healthy women and as 4.11 cm in the female patients with low back pain[20]. In the present study, the Schober's test measurement was mean 14 cm in LDH patients and 15.85 cm in the healthy control group. The mean value of the sit-and-reach test measurements was 0.25 cm in the LDH patients and 2.05 cm in the control group.

The symptoms that develop in patients with LDH may cause certain changes in the sagittal and coronal shape of the vertebral column[21]. Several studies have focused on radiological parameters to assess the status of spinal sagittal imbalance[43]. In the present study, the lumbar lordosis angle, sacral angle, and lumbosacral angle values were measured on standing lateral radiographs to evaluate spinopelvic parameters. According to literature data, the lumbar lordosis angle is between 30°-80°, the sacral angle is between 30°-41°, and the lumbosacral angle is between 10° and 15° in a person standing at rest[33,35,44,45]. In a study investigating spinopelvic parameters between patients with LDH and healthy control subjects in the elderly population, the lumbar lordosis angle and sacral angle were found to be significantly lower in the lumbar disc herniated group compared to the control group[22]. In another retrospective and cross-sectional study, Endo et al.[23] evaluated spinopelvic parameters in LDH patients (n=61) and healthy individuals (n=60), and reported that the lumbar lordosis angle was smaller in the LDH patients (36.7°) than in the healthy individuals (49°). In addition to those studies, it has been suggested in another study that the lumbar lordosis angle is normal in patients with low back pain compared to healthy control subjects[25]. The sacral angle and lumbosacral angle values of 120 LDH patients and 120 healthy individuals were examined in a study by Ghasemi et al.[26] No statistically significant differences were detected between the sacral angle values of the LDH group (40.52°) compared with the control

Table 3. The comparisons of the clinical evaluation results of the groups

	LDH group (n=20) Mean ± SD	**Healthy group (n=20) Mean ± SD**	**p-value**
Body flexor muscle endurance test (sec)	12.76±1.20	34.41±1.56	**p<0.001***
Sorensen test (sec)	17.92±1.62	48.66±3.34	
Body right lateral flexor muscle endurance test (sec)	17.24±1.22	36.31±1.75	
Body left lateral flexor muscle endurance test (sec)	16.47±1.32	36.21±1.91	
Schober test (cm)	14±1.47	15.85±0.9	**0.000***
Sit-and-reach test (cm)	0.25±2.38	2.05±2.42	**0.021***
Lumber lordosis angle (degree)	54.39±7.24	56.76±9.26	0.733
Sacral angle (degree)	38.15±5.56	38.86±7.37	0.374
Lumbosacral angle (degree)	7.08±3.95	10.28±3.69	**0.012****
VAS	7.50±1.84	-	**-**
Oswestry disability index	23.50±8.28	1.15±2.73	**0.000***

*<0.005, Mann-Whitney U test, **Independent Sample t-test
VAS: Visual analog scale, n: Number of subjects, cm: Centimeter, sec: Second, SD: Standard deviation, LDH: Lumbar disc herniation

Table 4. Correlations between the endurance, mobility, pain, and functionality assessments

		Sorensen test	Body FMET	Right LFMET	Left LFMET	Schober test	Sit-and-reach test	Oswestry disability index
Sorensen test (sec)	p	-	**0.001**	**0.000**	**0.000**	**0.030**	0.185	**0.000**
	r	-	0.505	0.595	0.678	0.344	0.214	-0.717
Body FMET (sec)	p	**0.001**	-	**0.000**	**0.000**	**0.001**	0.144	**0.000**
	r	0.505	-	0.660	0.663	0.506	0.235	-0.625
Right LFMET (sec)	p	**0.000**	**0.000**	-	**0.000**	**0.003**	0.056	**0.000**
	r	0.595	0.660	-	0.909	0.455	0.304	-0.629
Left LFMET (sec)	p	**0.000**	**0.000**	0.000	-	**0.018**	0.053	**0.000**
	r	0.678	0.663	0.909	-	0.374	0.309	-0.608
Schober test (cm)	p	**0.030**	**0.001**	**0.003**	**0.018**	-	**0.001**	**0.000**
	r	0.344	0.506	0.455	0.374	-	0.514	-0.672
Sit-reach test (cm)	p	0.185	0.144	0.056	0.053	**0.001**	-	0.071
	r	0.214	0.235	0.304	0.309	0.514	-	-0.288
VAS	p	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.060**	**0.000**
	r	-0.585	-0.695	-0.596	-0.598	-0.602	-0.300	0.800
Oswestry disability index	p	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	0.071	-
	r	-0.717	-0.625	-0.629	-0.608	-0.672	-0.288	-

VAS: Visual analog scale, FMET: Flexor muscle endurance test, LFMET: Lateral flexor muscle endurance test, cm: Centimeter, sec: Second

group (39.30°). Sagittal spino-pelvic alignment was evaluated in a study of 198 patients with chronic low back pain and 709 healthy subjects. The sacral angle and lumbosacral angles were found to be significantly smaller in the patient group with chronic low back pain compared to the healthy control group. The lumbar lordosis angle (41°) in the patient group with chronic low back pain and the lumbar lordosis angle (42°) in the healthy group were small, but it was concluded that the difference was not statistically significant[35].

The lumbar lordosis angle, sacral angle, and lumbosacral angle values that were measured in the present study were similar to those reported in the literature. The lumbar lordosis angle was measured as 54.39° in LDH patients and 56.76° in healthy individuals. The sacral angle was 38.15° in LDH patients and 38.86° in healthy individuals. The lumbosacral angle was measured as 7.08° in LDH patients and 10.28° in healthy individuals. According to the results of the present study, the mean lumbar lordosis and sacral angle values of the patients with LDH and the healthy control group subjects were similar within the range of physiological values. It was also observed that the lumbosacral angle was decreased in the LDH group compared to the healthy control group and according to the physiological limits reported in the literature.

CONCLUSION

The results of this study demonstrated that lumbopelvic stability, lumbopelvic mobility, and lumbosacral angle values of the patients with LDH were statistically significantly lower than those of the healthy control group. When a rehabilitation program is created for LDH patients, lumbopelvic stability and mobility must be considered to be able to increase functionality after pain control is achieved. In addition to specific and isolated exercise training, exercises which aim to provide optimal postural control would be beneficial in rehabilitation programs.

Ethics

Ethics Committee Approval: The study was approved by the Üsküdar University Clinical Research Ethics Committee (date: 30/04/2021, approval no: 2021-103).

Informed Consent: The information and voluntary consent form prepared in line with the standards of the Ethics Committee was signed by all subjects.

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Authorship Contributions

Surgical and Medical Practices: B.Ö., T.K.Ç., Concept: B.Ö., T.K.Ç., Design: B.Ö., T.K.Ç., Data Collection or Processing: B.Ö., Analysis or Interpretation: B.Ö., T.K.Ç., Literature Search: B.Ö., T.K.Ç., Writing: B.Ö., T.K.Ç.

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