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Gender Differences in Balance, Lumbar Multifidus Muscle, Pain, and Kinesiophobia in Patients with Lumbar Spinal Stenosis

Lomber Spinal Stenozlu Hastalarda Denge, Lomber Multifidus Kası, Ağrı ve Kinezyofobide Cinsiyet Farklılıkları

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ABSTRACT

Aim: The aim of this study was to examine balance, lumbar multifidus muscle thickness and cross-sectional area (CSA), pain, disability and kinesiophobia levels, and to compare these parameters in terms of gender in patients with lumbar spinal stenosis (LSS).
Material and Methods: This cross-sectional study included 59 patients, 33 (55.9%) female and 26 (44.1%) male, diagnosed with LSS by magnetic resonance imaging (MRI). Low back and leg pains, dynamic and static balances, disability and kinesiophobia levels of patients with LSS were evaluated. Lumbar multifidus muscle thickness and total CSA were obtained from MRI images. Obtained data were compared according to gender.
Results: Females had significantly more low back pain than males (p=0.043), in patients with LSS. Additionally, females with LSS had worse dynamic and static balances (p=0.005, and p=0.001, respectively) and higher levels of disability (p=0.001), and kinesiophobia (p=0.001). Females with LSS had less lumbar multifidus muscle thickness and CSA than males on both the right and left sides. Also, right multifidus muscle thickness correlated with both dynamic (r=-0.289; p=0.027) and static (r=0.349; p=0.007) balances. Significant correlations were detected between low back and leg pain with dynamic and static balances, disability, and kinesiophobia in patients with LSS.
Conclusion: Females with LSS have higher levels of pain, disability, and kinesiophobia than males. Also, LSS affects females' balance functions more and causes further degeneration of the multifidus muscle. Therefore, gender differences should be examined during the clinical follow-up process in LSS.
Keywords: Lumbar spinal stenosis; gender differences; multifidus; balance; pain; kinesiophobia.

ÖZ

Amaç: Bu çalışmanın amacı lomber spinal stenozu (LSS) olan hastalarda denge, lomber multifidus kas kalınlığı ve kesit alanı (cross-sectional area, CSA), ağrı, sakatlık ve kinezyofobi düzeylerini incelemek ve bu parametreleri cinsiyet açısından karşılaştırmaktır.
Gereç ve Yöntemler: Bu kesitsel çalışmaya manyetik rezonans görüntüleme (MRG) ile LSS tanısı konulan 33 (%55,9) kadın ve 26 (%44,1) erkek olmak üzere 59 hasta dahil edildi. LSS'li hastaların bel ve bacak ağrıları, dinamik ve statik dengeleri, özürlülük ve kinezyofobi düzeyleri değerlendirildi. MRG görüntülerinden lomber multifidus kas kalınlığı ve toplam CSA elde edildi. Elde edilen veriler cinsiyete göre karşılaştırıldı.
Bulgular: LSS'li hastalarda, kadınlar erkeklere göre anlamlı olarak daha fazla bel ağrısına sahipti (p=0,043). Ayrıca, LSS'li kadınlarda daha kötü dinamik ve statik denge (sırasıyla p=0,005 ve p=0,001), daha yüksek düzeyde özürlülük (p=0,001) ve kinezyofobi (p=0,001) vardı. LSS'li kadınlarda hem sağ hem de sol tarafta lomber multifidus kas kalınlığı ve CSA erkeklere göre daha azdı. Ayrıca sağ multifidus kas kalınlığı hem dinamik (r=-0,289; p=0,027) hem de statik (r=0,349; p=0.007) denge ile koreleydi. LSS'li hastalarda bel ve bacak ağrısı ile dinamik ve statik dengeler, özürlülük ve kinezyofobi arasında anlamlı korelasyonlar saptandı.
Sonuç: LSS'li kadınlarda erkeklere göre daha yüksek düzeyde ağrı, özürlülük ve kinezyofobi vardır. Ayrıca LSS, kadınların denge fonksiyonlarını daha fazla etkiler ve multifidus kasının daha fazla dejenerasyonuna neden olur. Bu nedenle LSS'de klinik takip sürecinde cinsiyet farklılıkları incelenmelidir.
Anahtar kelimeler: Lomber spinal stenoz; cinsiyet farklılıkları; multifidus; denge; ağrı, kinezyofobi.

INTRODUCTION

Lumbar spinal stenosis (LSS) is a syndrome that occurs when the narrowing in the nerve root canal or intervertebral foramen due to various reasons compresses the neural elements. Pain and neurological symptoms may occur with nerve compression (1). Although seen in both genders, LSS is more common in females and manifests clinically with neurogenic claudication or radicular symptoms (2,3). Patients with LSS exhibit a forward-leaning posture because lumbar extension and walking trigger lower back and leg pain. This posture disorder causes balance problems by causing the person's center of gravity to shift (4,5). In LSS, both static and dynamic balance functions are restricted (6-8).

The multifidus muscle is an important stabilizer of the lumbar spine due to its morphological features such as high cross-sectional area (CSA), dense short muscle fibers, and tonic function of deep fibers. Nerve root compression with spinal stenosis may cause morphological changes in the multifidus muscle (9). Atrophic changes in multifidus muscle morphology are associated with chronic low back pain and increased functional disability in patients with LSS (10,11). In addition, degeneration occurring in the multifidus muscle also causes a decrease in the thickness and CSA of the muscle (12). This condition is associated with loss of balance in various populations (12,13). The results of LSS related to degeneration in paraspinal muscles are contradictory according to gender. Hiyama et al. (14) showed that the multifidus muscle CSA at the lumbar region levels in LSS was less in females. However, Chua et al. (10) determined that the total multifidus CSA did not make a difference between genders. Examining paraspinal muscles, such as multifidus, is important as they play an essential role in maintaining balance and stability.

It is reported that there is a decrease in balance parameters and an increase in pain and disability in patients with LSS (15). Studies in the literature emphasize that the level of disability in females is higher than in males (4,16). This may result from biopsychosocial problems such as decreased tolerance levels in females. However, the evidence on this issue is insufficient (16). Negative beliefs about pain or disease lead to negative reactions in the minds. This leads to kinesiophobia, which is fear-avoidance behavior due to pain experience. Avoidance behavior results in disuse, disability, and depression in individuals and causes individuals to feel more pain. Kinesiophobia is an important factor that may limit function in LSS (17). Although it is stated in the literature that females are more affected by pain, anxiety, and fear (18), there are contradictory results, such as the level of kinesiophobia may be higher in males (19). This situation is not explained in the LSS.

It is observed in the literature that individuals with LSS experience balance problems, an increase in pain and disability levels, and a decrease in paravertebral muscle mass. This situation varies between genders. Additionally, there is insufficient evidence regarding kinesiophobia levels according to gender in LSS. Considering these factors, there are conflicting results in the literature, and it is not clear (10). Examining the differences between genders in patients with LSS is important for choosing the appropriate treatment. Therefore, this study aimed to compare balance, multifidus muscle thickness and CSA, pain, disability, and kinesiophobia levels between genders in patients with LSS and examine their relationship.

MATERIAL AND METHODS

Study Design and Patients

This cross-sectional, descriptive study was conducted in October 2023 and included patients diagnosed with LSS referred to the Neurosurgery outpatient clinic of Karabük University Research and Training Hospital. The patient's LSS was confirmed by a spine specialist using magnetic resonance imaging (MRI). Patients who were diagnosed with LSS at the L4/5 level by MRI were over 18 years old, could stand independently, and volunteered to participate in the study were included in the study. Those who had a history of severe neurological disease (such as Parkinson's, hemiplegia, multiple sclerosis), had a surgical operation on the lumbar region in the last year, had severe joint disease in the lower extremity, malignancy in the spine, had an operation on the lower extremity, and had visual impairment and/or those with vestibular system problems were excluded.

The number of patients to participate in the study was determined based on the multifidus muscle CSA results obtained from a previous study (20). For 80% power, effect size (d) of 0.826, and margin of error (α) of 0.05, at least 24 individuals in both groups were determined as at least 48 with the G*Power v.3.1.9 package.

A total of 59 patients, 33 females, and 26 males, were included in the study. Demographic and clinical characteristics of the patients were recorded. The patients' pain intensity, multifidus muscle thickness and CSA, balance, disability, and kinesiophobia were evaluated and compared according to gender.

The study was approved by the Clinical Research Ethics Committee of Kastamonu University (2023/KAEK-111, 04.10.2023) and was conducted by the Declaration of Helsinki. Written informed consent was obtained from all patients to participate in the study.

Outcome Measures

Pain Intensity: Pain intensity was recorded using the numerical rating scale (NRS) for the waist and leg. NRS ranges from 0 to 10, with a score of 10 indicating the worst pain imaginable (6).

Multifidus Muscle Measurement: Multifidus muscle thickness and muscle CSA, a paraspinal muscle at the L4/5 level, were evaluated using an MRI device (Vision; Siemens Medical Solutions, Erlangen, Germany). The thickness and CSA of the muscle were measured separately on each side. During MRI, patients were placed in a neutral position (supine position, knees extended, and hands on the abdomen). A radiologist evaluated MRI data of lumbar multifidus muscle thickness and CSA. Multifidus muscle thickness from T1 and T2 sagittal and T2 axial images; CSA was evaluated from T2 axial sections with a digital workstation program (Magic View 1000; Siemens, Erlangen, Germany). To determine the CSA of the muscle, it was measured in cm^2, considering the attachment positions to the fascia. The maximum distance between the attachment point of the anterior muscle fascia to the vertebral lamina and the posterior muscle fascia was calculated as the anterior-posterior muscle thickness in

millimeters (21). The reliability of MRI in measuring CSA of the multifidus muscle is acceptable; moderate reliability: 0.858, internal reliability: 0.823 (22).

Balance: The static balance of the individuals was evaluated with the single-leg stance test (SLST). The eyes were open during the test, and the test was performed for 30 seconds (23). Three trials were conducted on the affected side, and the best result obtained was used. Duration was recorded in seconds. The time up and go (TUG) test evaluated individuals' dynamic balance and mobility (24). TUG test measures the patient's backward walking performance in getting up from a standard chair, walking 3 m, turning around, and sitting down again at the starting point (23). The time elapsed during the test was recorded in seconds with a stopwatch.

Disability: The Turkish form of the Oswestry disability index (ODI) was used to evaluate disability. The revised form of ODI, developed to assess functional disability in low back pain, consists of 10 items (pain intensity, personal care, lifting, walking, sitting, standing, sleep, travel, social life, and degree of pain change). Pain-related disability ranges from 0 to 100 points, and higher scores indicate increased disability (25).

Kinesiophobia: The Tampa scale for kinesiophobia (TSK) was used to measure individuals' fear of movement and re-injury. This scale consists of 17 questions, and all items are rated on a 4-point Likert scale (1: strongly disagree to 4: strongly agree). The total score varies from 17 to 68, and as the score increases, the fear of movement increases (17).

Statistical Analysis

IBM SPSS v.22 package was used for statistical data analysis. The normal distribution of the data was evaluated with the Shapiro-Wilk test and histogram graphs. Descriptive statistics were given as mean and standard deviation for normally distributed data and median, interquartile range, minimum, and maximum values for non-normally distributed variables. Categorical data were presented as numbers and percentages. Student's t-test and Mann-Whitney U test were used to compare the two groups, and the chi-square test was used to compare qualitative data. Correlation analysis was used to examine the relationship between quantitative data. Correlation coefficients were considered as >0.89 very strong correlation, 0.70-0.89 strong correlation, 0.40-0.69 medium correlation, and 0.20-0.39 weak correlation (26). Statistical significance was evaluated at $p<0.05$ level.

RESULTS

In total, 35 female and 26 male patients with LSS were screened, and two female patients with LSS were excluded from the study (they did not want to participate in the evaluation due to pain). 33 (55.9%) female LSS patients with a mean age of 58.73±7.93 years and 26 (44.1%) male patients with a mean age of 57.54±8.56 years participated in the study. A comparison of the demographic characteristics of the LSS patients participating in the study according to gender is shown in Table 1.

When the pain results of the groups were compared, low back pain in females with LSS was found to be statistically higher (p=0.043), but leg pain was similar between genders (p=0.089). Multifidus muscle thickness and CSA for both the right and left sides were also less in females with LSS. A comparison of study parameters according to gender is shown in Table 2.

Table 1. Demographic characteristics of the patients

	Female (n=33)	Male (n=26)	p	Total (n=59)
Age (years)	58.73±7.93	57.54±8.56	0.587	58.20±8.16
Height (cm)	162.24±4.84	172.69±4.64	**<0.001**	166.85±7.04
Weight (kg)	70.21±5.80	77.85±6,63	**<0.001**	73.58±7.22
Body mass index (kg/m^2)	26.67±1.96	26.07±1.64	0.218	26.41±1.84
Duration of symptoms (month)	84 (24-120) [15-180]	42 (12-87) [3-240]	0.087	72 (24-120) [3-240]
Affected side, n (%)				
Right	8 (24.2%)	7 (26.9%)		15 (25.4%)
Left	13 (39.4%)	7 (26.9%)	0.591	20 (33.9%)
Bilateral	12 (36.4%)	12 (46.2%)		24 (40.7%)

descriptive statistics were presented in the form of mean±standard deviation, or median (interquartile range, 25th-75th percentile) [minimum-maximum], as appropriate

Table 2. Comparison of pain, muscle parameters, balance, disability, and kinesiophobia according to gender

	Female (n=33)	Male (n=26)	p	Total (n=59)
NRS for low back pain	6.18±1.77	5.15±2.03	**0.043**	5.73±1.94
NRS for leg pain	6.48±1.69	5.69±1.80	0.089	6.14±1.77
Right MF thickness (mm)	38.87±5.29	42.98±6.73	**0.011**	40.68±6.26
Right MF CSA (cm^2)	8.7 (7.0-8.7) [4.5-14.9]	9.3 (8.2-11.6) [6.1-17.4]	**0.001**	8.8 (7.5-10.7) [4.5-17.4]
Left MF thickness (mm)	38.45±5.08	44.10±6.36	**<0.001**	40.94±6.30
Left MF CSA (cm^2)	8.5 (6.9-9.1) [4.9-14.9]	10.1 (8.5-10.5) [6.8-15.9]	**<0.001**	9.0 (7.3-10.1) [4.9-15.9]
TUG test (sec)	13.07±2.72	11.20±2.05	**0.005**	12.25±2.60
SLST (sec)	8.9 (11.2-14.4) [3.3-26.3]	14.8 (9.9-12.6) [3.3-27.2]	**0.001**	10.4 (10.2-14.2) [3.3-27.2]
ODI	66.30±9.76	51.15±12.95	**0.001**	59.63±13.50
TSK	49.70±3.51	45.58±4.02	**0.001**	47.88±4.24

NRS: numeric rating scale, MF: multifidus, CSA: cross-sectional area, TUG: time up and go, SLST: single-leg stance test, ODI: Oswestry disability index, TSK: Tampa scale for kinesiophobia, descriptive statistics were presented in the form of mean±standard deviation, or median (interquartile range, 25th-75th percentile) [minimum-maximum], as appropriate

Table 3. Correlation between pain, muscle parameters, balance, disability and kinesiophobia

		NRS for low back pain	NRS for leg pain	Right MF thickness	Right MF CSA	Left MF thickness	Left MF CSA	TUG test	SLST	ODI
NRS for low back pain	**r**									
	p									
NRS for leg pain	**r**	0.914								
	p	**<0.001**								
Right MF thickness	**r**	-0.260	-0.207							
	p	**0.047**	0.116							
Right MF CSA	**r**	-0.265	-0.207	0.781						
	p	**0.042**	0.115	**<0.001**						
Left MF thickness	**r**	-0.221	-0.177	0.879	0.729					
	p	0.093	0.181	**<0.001**	**<0.001**					
Left MF CSA	**r**	-0.136	-0.101	0.762	0.743	0.815				
	p	0.303	0.448	**<0.001**	**<0.001**	**<0.001**				
TUG test	**r**	0.435	0.380	-0.289	-0.126	-0.212	-0.078			
	p	**0.001**	**0.003**	**0.027**	0.340	0.107	0.558			
SLST	**r**	-0.649	-0.644	0.349	0.207	0.368	0.206	-0.738		
	p	**0.001**	**0.001**	**0.007**	0.116	**0.004**	0.117	**<0.001**		
ODI	**r**	0.590	0.525	-0.309	-0.312	-0.290	-0.227	0.607	-0.713	
	p	**0.001**	**0.001**	**0.017**	**0.016**	**0.026**	0.084	**<0.001**	**<0.001**	
TSK	**r**	0.313	0.274	-0.201	-0.205	-0.186	-0.182	0.627	-0.591	0.781
	p	**0.016**	**0.036**	0.127	0.120	0.157	0.167	**<0.001**	**<0.001**	**<0.001**

NRS: numeric rating scale, MF: multifidus, CSA: cross-sectional area, TUG: time up and go, SLST: single-leg stance test, ODI: Oswestry disability index, TSK: Tampa scale for kinesiophobia

In patients with LSS, weak to moderate correlations were detected between low back and leg pain with TUG, SLST, disability, and kinesiophobia. While right MF muscle thickness correlated with both TUG (r=-0.289; p=0.027) and SLST (r=0.349; p=0.007), the correlation of left MF muscle thickness with SLST was determined (r=0.368; p=0.004). The correlation coefficients between study parameters are shown in Table 3.

DISCUSSION

This study presented that females with LSS had higher levels of low back pain, disability, and kinesiophobia than males. In addition, it was determined that females' balance functions were worse, and their multifidus muscle thickness and CSA were less in patients with LSS. It was determined that increased pain level in patients with LSS was associated with multifidus muscle degeneration, impaired static and dynamic balance, and increased disability and kinesiophobia.

In LSS, chronic low back pain occurs due to degenerative changes in the spine. Pressure on the nerve roots causes pain in the leg that increases with walking (3). Studies have shown that individuals with LSS experience severe pain in the low back and legs (4,11). However, the effect of gender on clinical decision-making in lumbar degenerative diseases has not been adequately examined (10). Although it has been shown in the literature that females have higher pain intensity and more painful symptoms in the general population (27), there are conflicting results between genders in LSS. Kim et al. (4), who investigated symptom severity and pain sensitivity in patients with LSS, showed that, according to VAS, females' low back and leg pains were significantly higher than males. Similarly, it has been reported that low back pain before surgery is more severe in females (28). However, Chua et al. (10) showed that males and females had similar lower back and leg pain levels before surgery in the LSS. In this study, like many studies, it was determined that females experienced more low back pain than males, but leg pain was similar. Due to the different perception levels of pain, females' pain levels may be higher (4). This situation may also be explained by the fact that females are more sensitive to mechanical pain stimuli (28). Therefore, it is important to consider gender differences in the clinical decision-making process.

This study showed that the multifidus muscle CSA at the L4/5 level was reduced more in females with LSS. These findings are like several studies investigating the difference between genders (13,14). Hiyama et al. (14) showed that the multifidus muscle CSA at three different levels in the lumbar region in patients with LSS was less in females. In another study, Chua et al. (10) found that while the total multifidus CSA of males and females was similar in LSS, the functional multifidus CSA was less in females. This difference may be explained by fat infiltration, which affects the muscle's functionality and causes degeneration, is higher in females. In addition, the fact that the patients in Chua et al.'s (10) study were older than this study may affect the results with increased fat infiltration. Also, degenerative changes in the muscle affect functionality by causing a decrease in muscle thickness (12). It is stated that the lumbar multifidus muscle thickness is less in patients with low back pain (21,29). However, the difference that this situation creates between genders is not explained in the LSS. This study determined that females with LSS had less multifidus muscle thickness at the L4/5 level. The change in muscle thickness also leads to a decrease in the muscle's ability to contract (29). This is important in maintaining balance and stability for the multifidus, a deep muscle of the lumbar region (13). In addition, muscle thickness measurement is essential because it provides easy and objective information (21). For this reason, it is necessary to evaluate the morphological features of the muscle for gender during the clinical follow-up process in LSS.

Gender affects balance and physical activity levels. It has been shown that as age increases, females have worse

results than males in both physical and balance performance (30,31). Sung and Ham (31) found that females had worse stability than males during postural changes in patients with LSS. Thornes et al. (6) obtained worse balance results in females with LSS in their study evaluating dynamic balance with the mini-best test. Similarly, in this study, it was determined that both static and dynamic balance were worse in females with LSS. This condition may be associated with pain and muscle degeneration in females. Because it is stated that pain results in claudication, disability, and postural disorders in individuals (7). Also, in LSS, pain intensity, and balance function are negatively related (15). The stability and balance of the lumbar spine depend on the paraspinal muscles surrounding it. Also, muscle atrophies in this region deteriorate the body's stability (32). Similarly, this study found a relationship between balance parameters and muscle thickness, low back, and leg pain. In addition, since the pain intensity and multifidus muscle measurement results of females with LSS differed from males in this study, it may have impacted balance. In this context, it is necessary to evaluate the balance considering these factors regarding gender.

Perceived pain varies according to gender (4). Other factors that cause pain and pathology also cause disability in LSS. Studies emphasize that the level of disability in females with LSS is higher than in males (4,10). Similar to the literature, in this study, females were found to have more disabilities than males according to their ODI scores. Pain perception and tolerance levels appear to be more sensitive in females (4). This may explain the increase in disability among females. Additionally, this study found a relationship between disability with pain and balance. Since pain affects daily activities and causes limitations, previous studies have also presented a relationship between disability and pain in LSS (15,23). In addition, this limitation affects stability, leading to a positive relationship between disability and balance (7,17). This may also explain the difference in balance between the genders. However, the relationship between disability and multifidus muscle CSA has not been adequately examined. Studies conducted in this context have found a relationship between the multifidus and pre-operative disability (10,20). This study found a relationship between multifidus thickness and multifidus CSA and disability. This may be due to the impact of daily activities due to impaired balance and proprioceptive feedback (8) due to multifidus muscle degeneration.

In this study, females' kinesiophobia levels were higher than males. Females are more affected by pain, anxiety, and fear than males (18). However, some studies indicate that the level of kinesiophobia is higher in males (19,33). Rovner et al. (33) found that male kinesiophobia values were higher when the TSK results were examined in a study involving individuals with chronic musculoskeletal pain. However, this situation is unclear in LSS. The greater prevalence of kinesiophobia in males has been associated with higher expectations and fear of losing work capacity and productivity due to re-injury (17,33). Additionally, this study found a relationship between kinesiophobia with pain and disability in LSS. This relationship has been demonstrated in a study at LSS (15). Therefore, the higher prevalence of kinesiophobia in females in this study may be due to decreased expectations due to advanced age and increased pain and disability in females.

CONCLUSION

This study showed that females had higher levels of pain, disability, and kinesiophobia than males. Also, LSS affects females' balance functions more and causes further degeneration of the multifidus muscle. In patients with LSS, increased pain levels are associated with multifidus muscle degeneration, impaired static and dynamic balance, and increased disability and kinesiophobia. Therefore, it is essential to examine these factors specifically for gender in LSS.

Ethics Committee Approval: The study was approved by the Clinical Research Ethics Committee of Kastamonu University (04.10.2023, 2023-KAEK-111).

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