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ARAŞTIRMA YAZISI / RESEARCH ARTICLE

LOMBER DİSK HERNİASYONU İLE PARASPİNAL KASLARIN VOLÜMÜ VE YAĞLANMA DERECESİ ARASINDAKİ İLİŞKİNİN DEĞERLENDİRİLMESİ

ASSESSMENT OF THE CORRELATION BETWEEN LUMBAR DISC HERNIATION WITH THE VOLUME OF THE PARASPINAL MUSCLES AND THE DEGREE OF ADIPOSITY

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ABSTRACT

Introduction: We analyzed the correlation between disc herniation and the degree of adiposity and atrophy in paraspinal muscles (multifidus, psoas major, and erector spinae) of patients with chronic low back pain.

Materials and methods: We retrospectively evaluated patients with a chronic low back pain diagnosis who were examined by lumbar magnetic resonance imaging at our clinic between September 2008 and February 2009. The patient group included 120 subjects of both genders with disc herniation ranging in age from 20 to 70 years; 120 subjects of both genders without disc herniation aged 20–70 years were designated as the control group. The patient and control groups were divided into subgroups as aged 20–30, 31–40, 41–50, and ≥51 years. Adiposity and muscle atrophy of paraspinal muscles (multifidus, psoas major, and erector spinae) were examined in all groups. Patients were also evaluated in terms of the number of disc herniations, end-plate and facet degeneration, and transitional anomalies.

Results: The average value was significantly lower in the patient group for the multifidus mean muscle area compared to the control group in those aged ≥51 years (p=0.005). No significant differences between the patient and the control groups were observed for psoas major and erector spinae muscle areas in all age groups ($p > 0.05$). A significant difference was established in terms of mean multifidus and psoas muscle areas among the age groups ($p = 0.005$); however, no significant difference was found for mean erector spinae muscle area. A significant correlation was observed for disc herniation and facet joint degeneration in the 31–40-year-old group. Also, there was significant correlation with end-plate degene-ration and disc herniation in the 20–30-year-old group. No difference was detected for the mean muscle areas according to the number of disc herniations. A significant difference in the degree of adiposity was found between the patient and control groups ($p < 0.05$).

Conclusion: We identified a significant correlation between disc herniation and adiposity in paravertebral muscles of patients with chronic low back pain, and a significant correlation between disc herniation and severe atrophy only in the multifidus muscle in late middle-aged patients (≥51 years). However, muscle atrophy was not observed in the erector spinae muscle due to aging in the patient and control groups, whereas muscle atrophy developed in both the multifidus and psoas major muscles due to aging. No correlation was found between the number of disc herniations and muscle atrophy.

Key Words: lumbar disc herniation, paraspinal muscle, atrophy, adiposity, magnetic resonance imaging (MRI)

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INTRODUCTION

Lumbar disc herniation constitutes 2–3% of all low back pain (1). Poor posture, weakness in paravertebral muscles, lifting a heavy object in a bent or rotated position, driving vehicles for long periods of time, smoking, trauma, and biochemical changes occurring in the nucleus pulposus due to aging, are risk factors leading to degeneration and herniation of discs (2, 3).

A decrease in strength and endurance of paraspinal muscles, which have a significant function in maintaining the posture and movement of the spine, can cause abnormal posture, low back pain, and an increase in the prevalence of lumbar region injuries (1–4). Synergistic contraction of abdominal muscles and the multifidus at the lumbar level, psoas major, deep erector spinae, and multifidus muscles on the sagittal plane, and quadratus lumborum, hip abductor, and adductor muscles on the frontal plane and at the swing phase of walking provide stability (5–8). Atrophy and a decrease in strength and endurance of muscles occur in muscle groups at the lumbar level in patients with chronic low back pain (9, 10). Also, characteristic changes in the same-side multifidus and psoas major muscle, as well as decreased muscle area, have been reported to occur with lumbar disc herniation (11–13). However, other studies report no correlation between muscle atrophy and radiculopathy symptoms, nerve root compression, herniated nucleus pulposus, and a degenerated disc count (11).

In this study, the areas of the psoas major, multifidus, and erector spinae muscles, as well as the degree of adiposity in patients with disc herniation and suffering from chronic low back pain, were evaluated by magnetic resonance imaging (MRI) and compared with those in patients without disc herniation but with low back pain. The correlation between disc herniation and cross-sectional areas and the degree of adiposity of the paraspinal muscles was evaluated.

MATERIALS AND METHODS

Patients who underwent a lumbar MRI scan with a chronic (more than 3 months) low back pain diagnosis in our clinic between 01.09.2008 and 01.03.2009 were evaluated retrospectively. Inclusion criteria were the absence of a spinal primary or metastatic neoplasm, infectious pathology, inflammatory rheumatic disease with spinal involvement, neuromuscular disease, acute or chronic vertebral fracture, history of spinal surgery, history of steroid use, structural scoliosis, absence of a disease history that causes long-term immobilization, and presence of low back pain for more than 1 year. Patients who actively or professionally exercised or who had jobs requiring significant muscle strength were not included.

Patients fullfilling these criteria were retrospectively evaluated for disc herniation by two radiologists. The patient group included 120 subjects of both sexes with disc herniation ranging in age from 20 to 70 years, and 120 subjects of both sexes without disc herniation ranging in age from 20 to 70 years were designated as the control group. Patient and control groups were divided into subgroups consisting of 30 subjects each aged 20–30, 31–40, 41–50, and ≥51 years.

The average ages of the female and male patients were equal, but the mean heights and weights of the male patients were greater than those of the women.

MRI scans were conducted with a 1.5-Tesla MR device using a spine coil (Philips Intera, Best, The Netherlands) with patients in the neutral supine position. A routine evaluation was carried out with T2-weighted turbo spin-echo (TSE) sagittal, T1-weighted TSE sagittal, and T2-weighted TSE axial images. T2-weighted TSE (TR/TE 3650/120 ms) axial sections were used for muscle area measurements and to determine the degree of adiposity.

Cross-sectional area (CSA) measurements of the paraspinal muscles (multifidus, psoas major, erector spinae) were carried out from the L3–4 disc level with the area measurement program installed in the imaging device (cm2). The reason for selecting this level was because the highest paraspinal muscle area in some previous studies was reported to be at this level (14). Borders of each muscle to be measured were drawn with a cursor to exclude the fatty areas in the periphery and were digitally analyzed.

The degree of adiposity (fat content) of the paraspinal muscles (multifidus, psoas major, and erector spinae) was assessed according to the classification system utilized for the supraspinatus muscle: stage 0, no intramuscular fat; stage 1, linear fatty infiltration in muscle; stage 2, a significant amount of fat exists in muscle, but the amount is less than that of muscle tissue; stage 3, adipose tissue has an amount equal to muscle; stage 4, adipose content is more than the muscle tissue.

Statistics: An independent sample t-test, one-way analysis of variance, and the chi-square test were utilized for the statistical analyses. All analyses were carried out with SPSS for Windows (SPSS, Inc., Chicago, IL, USA), and 95% confidence intervals were calculated.

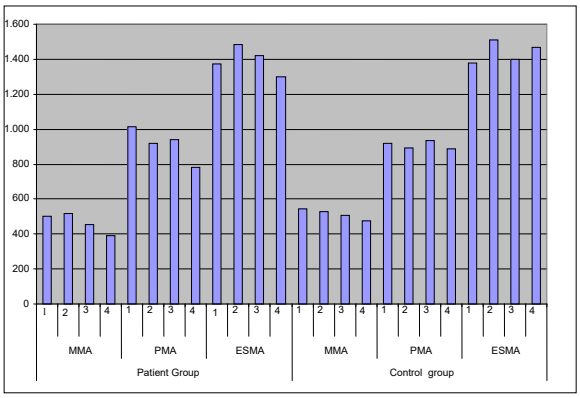
RESULTS

Patients ≥51 years old showed a significantly reduced mean multifidus muscle area (MMA) compared to the control group (p = 0.005). No differences were observed in any of the groups for the mean psoas and erector spinae muscle areas (**Table 1 and Graphic 1**).

	Age Grup	N	Med.	±	St.Deviation	p
MMA	Patient 20-30	30	502,16	±	121,70	0,270
	Control 20-30	30	541,38	±	149,41	
	Patient 31-40	30	518,11	±	173,53	0,817
	Control31-40	30	526,95	±	116,04	
	Patient 41-50	30	454,13	±	164,88	0,164
	Control 41-50	30	507,38	±	124,88	
	Patient 51+	30	392,67	±	110,11	0,005
	Control 51+	30	475,00	±	105,65	
PMA	Patient 20-30	30	1.014,96	±	341,77	0,281
	Control 20-30	30	919,99	±	334,44	
	Patient 31-40	30	916,39	±	280,09	0,765
	Control 31-40	30	893,87	±	299,57	
	Patient 41-50	30	937,79	±	349,67	0,970
	Control 41-50	30	933,97	±	427,86	
	Patient 51+	30	779,74	±	315,07	0,332
	Control 51+	30	889,16	±	525,41	
ESMA	Patient 20-30	30	1.374,02	±	353,27	0,971
	Control 20-30	30	1.377,34	±	361,75	
	Patient 31-40	30	1.484,10	±	436,57	0,796
	Control 31-40	30	1.511,16	±	368,27	
	Patient 41-50	30	1.421,06	±	323,19	0,824
	Control 41-50	30	1.401,38	±	356,77	
	Patient 51+	30	1.301,56	±	336,05	0,062
	Control 51+	30	1.466,56	±	335,66	

MMA: Multifidus muscle area, PMA; Psoas major muscle area, ESMA; Erector spinae muscle area

TABLE 1: Distribution in the mean muscle areas of patients and controls based on the age groups.



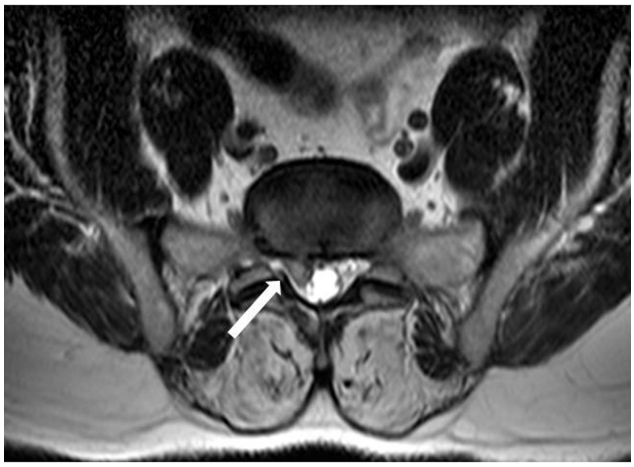
MMA: Multifidus muscle area, PMA; Psoas major muscle area, ESMA; Erector spinae muscle area

1: 20-30 age group, 2: 31-40 age group, 3: 41-50 age group, 4: 51 and older age group

Graphic 1: Distribution in the mean muscle areas of patients and controls based on the age groups.

A significant difference was found among the age groups in terms of mean MMA (p = 0.005). The Bonferroni method revealed that the mean MMA of patients age ≥51 years old was significantly lower compared to that of the other age groups. In cases with disc herniation, MMA was significantly lower in patients ≥51 years old compared to that in the other groups. Right paracentral disc herniation at the L5–S1 level and significant bilateral lipoatrophy were observed in the multifidus muscle in a 55-year-old woman (**Fig. 1**). A left foraminal protrusion at L3–4,

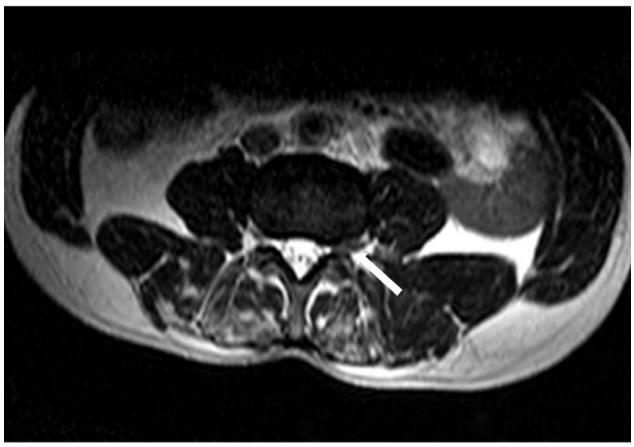
Figure 1: A 55-year-old woman with chronic low back pain. A right paracentral disc herniation was detected at the L5–S1 level on a T2-weighted axial image (white arrow), and bilateral significant lipoatrophy was observed in the multifidus muscle.



symmetrical volume loss in the bilateral multifidus muscle and right erector spinae, and fatty changes were present in a 45-year-old man (**Fig. 2**).

Mean psoas muscle area was significant lower in patients aged ≥51 years compared to that in

Figure 2: A 45-year-old man with a left foraminal protrusion at the L3–4 level on a T2-weighted axial image (white arrow) and symmetrical volume loss in bilateral multifidus and right erector spinae muscles with fatty changes.



the other groups (p = 0.045). No significant difference was observed among the age groups for mean erector spinae muscle area (**Table 2**). Cases were also assessed in terms of the facet joint, end-plate degeneration, and transitional

	Age Groups	N	Med.	±	St.Deviation	p
MMA	20–30	30	502,16	±	121,70	0,005
	31–40	30	518,11	±	173,53	
	41–50	30	454,13	±	164,88	
	51+	30	392,67	±	110,11	
PMA	20–30	30	1.014,96	±	341,77	0,045
	31–40	30	916,39	±	280,09	
	41–50	30	937,79	±	349,67	
	51+	30	779,74	±	315,07	
ESMA	20–30	30	1.374,02	±	353,27	0,266
	31–40	30	1.484,10	±	436,57	
	41–50	30	1.421,06	±	323,19	
	51+	30	1.301,56	±	336,05	

MMA: Multifidus muscle area, PMA; Psoas major muscle area, ESMA; Erector spinae muscle area

TABLE 2: Distribution in the mean muscle areas of patients based on the age groups.

anomalies. A significant difference was found between the patient and control groups for the facet degeneration rates in patients older than 31–40 years (p = 0.035). No difference was observed in the other patients or in the control group. A significant difference between the end-plate degeneration rates of patient and control groups was observed only in the 20–30-year-old group (p = 0.011). No differences were observed for the presence of transitional anomalies in any group.

No difference was found for the disc herniation count among the groups. Therefore, no correlation was observed between the muscle areas and number of disc herniations.

The degree of adiposity in the patient group was significantly higher than that in the control group (**Table 3**). Therefore, significant adiposity developed in the paraspinal muscles in cases with disc herniation compared to that in normal cases. Adiposity was observed most significantly in the multifidus and erector spinae and less significantly in the psoas major muscle (**Table 4**).

	Group	N	Med.	±	St.Dev.	p
Multifidus Adiposity Degree	Patient	120	1,33	±	0,88	0,000
	Control	120	0,60	±	0,61	
Psoas Adiposity Degree	Patient	120	0,69	±	0,62	0,000
	Control	120	0,20	±	0,42	
Erector Spinae Adiposity Degree	Patient	120	1,26	±	0,85	0,000
	Control	120	0,58	±	0,56	

TABLE 3: Average distribution of patient and control group cases based on the degree of adiposity.

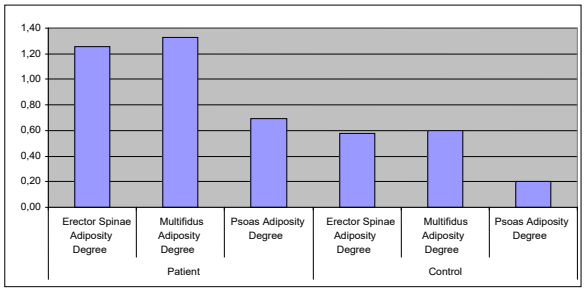


TABLE 4: Average distribution of patient and control group cases based on adiposity locations in the multifidus, psoas major, and erector spinae muscles.

Consequently, a significant volume loss was observed in the multifidus and psoas major muscles in patients aged ≥51 years. Disc herniation was correlated with a decrease in multifidus muscle only in the ≥51-year-old group. A significant increase in adiposity was established in the paraspinal muscle in the group with disc herniations compared to the control group. Based on these results, disc herniation was correlated with paraspinal muscle adiposity in all age groups and a decrease in multifidus muscle volume was observed in patients ≥51 years old with chronic low back pain.

DISCUSSION

Weakness in the paravertebral muscles is accepted as one of the reasons for a disc herniation. Numerous studies have reported significant correlations between muscle atrophy and radiculopathy symptoms, nerve root compression, herniated nucleus pulposus,

and degenerated and herniated discs (4–6, 8–18).

Low back pain decreases endurance and thus can cause paraspinal muscle weakness. However, specifying precisely whether the pathology in muscles started the pain or whether the muscle pathology formed as a result of avoidance or nonuse due to pain is generally not possible. Some researchers have reported that exhausted and weak muscles establish a predisposition to low back pain, and that the spinal movement segment is more prone to trauma and disc herniation due to insufficient muscle support. Other authors have reported that changes occur due to nonuse and avoidance due to low back pain (4–6, 8–11, 15–18).

The multifidus is the most important muscle for lumbar segmental stability and is the most medial and largest of the paraspinal muscles (7). This muscle provides segmental stability and controls movements in the neutral zone (7, 12, 18–22). Wilke et al. (18) compared the multifidus muscle with the erector spinae and psoas muscles and reported that the multifidus muscle provides two-thirds of the erection movement formed by the contraction of muscles in this region. A direct influence of the multifidus muscle on the stability of the lumbar-moving segment has also been demonstrated in animal experiments (19).

Kader et al. (11) established muscle atrophy in 80% of cases at various levels among 78 patients with low back pain in which they studied multifidus muscle atrophy, disc degeneration, and muscle compression. They demonstrated that muscle atrophy is more prevalent in subjects with leg pain in addition to low back pain; however, they found no difference in terms of atrophy between the subjects with or without symptoms of disc herniation or nerve compression. Changes in other paraspinal muscles besides the multifidus have also been studied, and the psoas muscle area is reduced at the side and level where a disc hernia is located in subjects with unilateral neurological compression due to disc herniation (23). Hyun et al. showed that unilateral lumbosacral radiculopathy is correlated with asymmetrical multifidus muscle atrophy (20). Numerous studies have reported morphological and histochemical changes in the multifidus muscle on the same side in patients with radiculopathy findings due to disc herniation (21-23).

Schilling et al. (24) studied the fat/water ratio in paraspinal muscles with proton MR spectroscopy in 10 patients with a lumbar disc herniation and compared their findings with a healthy control group. They established a significantly high fat/water ratio in the group with disc herniation when compared with the control group. Muscle biopsies were conducted in two patients, and the histological findings supported the spectroscopic results.

MRI can provide high soft tissue resolution, so detailed fatty and atrophic changes can be assessed. Numerous studies with MRI have shown morphological changes of the multifidus muscle in patients with low back pain and disc herniation (25-32). Woodham et al (25) have described fatty replacement and atrophy in lumbar multifidus muscle in patients with chronic low back pain and disc herniation. Min JH et al (25) showed that severe and extensive multifidus atrophy was observed in the patients with radiculopathy compared to patients without radiculopathy.

Kim WH et al (29) had reported that atrophy of the multifidus muscle was observed in the patients who had radiculopathy for 3 months or more. At this study, atrophic changes were related with the duration of the symptoms. Also, our patient group had symptoms more than 3 months. Kim WH et al described that there were no atrophic or fatty changes in patients who had symtpoms for 1 month or less.

According to Hides et al. (15), segmental dysfunction develops in the multifidus during the first acute and subacute low back pain attack. Fast multifidus muscle atrophy that could be detected by ultrasonography was found on the pain side. In that study, patients were told to exercise and the conclusion was made that atrophy of the multifidus muscle did not resolve even though symptoms improved

at the end of the treatment and that this condition could cause recurrence in the future. The earliest atrophy in lumbar paraspinal muscles did develop in the multifidus muscle.

Gursoy et al. (13) studied the psoas major, quadrates lumborum, and erector spinae muscles and compared their relationship to disc herniation. Sixty-one patients and 36 healthy individuals were examined. Patients were divided into three age groups. They have concluded that, the psoas muscle area was significantly smaller in patients with disc herniation (13). In our study, 240 cases were studied and divided into four individual age groups. We found that the mean MMA values were significantly lower in the patient group aged ≥51 years compared to those in the control group. While a difference was not observed between other age groups, multifidus muscle atrophy was correlated with disc herniation in the older age groups. The average values of the psoas muscle area were significantly lower in the patient group aged ≥51 years compared to the average values in the 20–30-year-old ($p = 0.034$) group. Mean erector spinae muscle area was not different among the age groups.

We also investigated the correlation among disc herniations, facet joint and end-plate degeneration, and transitional anomalies. As a result, facet joint degeneration was correlated with disc herniation only in the 31–40-year-old group and end-plate degeneration was correlated only in the 20–30-year-old group. Based on these results, disc herniation was not correlated with a transitional anomaly.

We found that disc herniation was correlated with significant adiposity in paravertebral muscles in patients with chronic low back pain. We only found a correlation between disc herniation and paravertebral muscle atrophy in the multifidus muscle in elderly group (≥51 years). Also, muscle atrophy was not observed with aging in the erector spinae muscle, whereas muscle atrophy developed with aging in both the multifidus and psoas major muscles. No relationship was established between the number of herniated discs and muscle atrophy.

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