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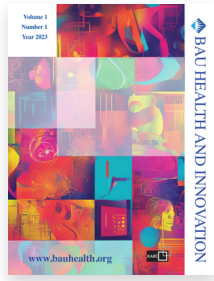

Original Article

Investigation of the Relationship Between Multifidus Muscle and Lumbar Disc Herniation Through Magnetic Resonance Imaging

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Abstract

Objectives: The aim of the research is to analyze the relationship between multifidus muscle (MM) atrophy and disc herniation in the lumbar region through magnetic resonance imaging.

Methods: A total of 254 patients aged between 18 and 62 were evaluated for MM atrophy and herniated discs. Research is conducted retrospectively. T2-weighted axial slices were used for bilateral evaluation of the cross-sectional area and fatty infiltration of the lumbar MM. Analyses were made on L4/L5 and L5/S1 level intervertebral discs and lumbar MMs at these levels. On the T2-weighted axial sequences, visual assessment was used for fatty infiltration and manual measurement techniques for muscle area.

Results: Research demonstrated that 157 of 254 patients involved have L4/L5 level disc herniation, and 89 of 157 patients (35.1%) also have MM atrophy. 28 patients do not have disc herniation but have muscle atrophy. I addition, at the L5/S1 level, 174 of 254 patients have disc herniation, while 114 of them also have muscle atrophy. On the other hand, 56 of 254 patients (11.1%) without disc herniation have MM atrophy.

Conclusion: In the light of the data mentioned above, the relationship between MM atrophy and disc herniation is determined.

Keywords: Atrophy, herniation, lumbar disc, lumbar multifidus muscle, magnetic resonance imaging.

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The multifidus muscle (MM) is located deep in the spine and is located between the vertebrae. Research has shown that by stabilizing each vertebra at the segmental level, multifidus provides stability for spinal ligaments, intervertebral discs, and joint capsules and reduces the risk of injury when these structures are exposed to stress. Furthermore, the MM is innervated segmentally, but other back muscles are innervated from more than one segment. Due to this feature, segmental innervation problems are observed in the MM as a result of situations that cause segmental nerve irritation.[1,2] The complex structure of the human lumbar spine is optimized for carrying loads without damage while providing sufficient stability. The nucleus pulposus provides a "preload" range that provides greater resistance to pressures and applied forces.[3] ROM values by the American Association of Orthopedic Surgeons Flexion is stated as 80°, extension: 35°, lateral flexion: 35°, rotation: 45°. Range of motion varies by segment in the lumbar

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region. 75% of the flexion movement of the lumbar region occurs in the L4-L5 segment, 20% in the L5-S1 segment, and the remaining 5% occurs in the L4 and above levels. In addition, since the lumbar region carries the entire load of the body, morphological changes, especially in the lumbar MM, are closely related to local pathological changes.[4]

According to the literature, bilateral lumbar multifidus muscle (LMM) was not symmetrical in acute low back pain (LBP),[5] chronic LBP and lumbar disc diseases.[6–8] Studies have shown that 80% of patients with lumbar disc herniation (LDH) show different degrees of LMM atrophy.[9] Some studies have shown that LDH time and duration are positively associated with atrophy.[10,11] The most common area for disc herniation is the lumbar region, and more than 90% of it occurs in segments between L4/L5 and L5/S1.[12] It is suggested that muscle atrophy also occurs during aging.[13,14] In addition, when the biomechanical etiologies of chronic LBP are examined, it is seen that the lumbar spine is the main stabilizer of the LMM. LBP is a global health problem that affects 80% of people in the world and causes the quality of life to decrease due to restrictions in activities.[15] Although 10 years of research is devoted to describing the etiology of LBP, the factors that trigger part of LBP remain uncertain and limit the possibility of designing effective preventive strategies.[16–18]

Two leading causes of back pain are the sedentary lifestyle and reduced physical activity associated with weakness and atrophy of the paraspinal muscles.[19] Long-term neurological inhibition of LMM following LBP is a very common cause. Due to these risk factors, they tend to be directly related to waist injuries and the incidence and severity of LMM atrophy.[16]

There are two main mechanisms of atrophy in the paraspinal muscles: reduced activity and denervation. Atrophy due to denervation in the paraspinal muscles is not common in disc herniation and compression that irritates the nerve root.[20] In LMM, it has been demonstrated in studies that it is strongly associated with LBP, and atrophy appears as fatty infiltration.[21]

Chronic diseases that cause prolonged neurological inhibition and muscle atrophy, especially after low back trauma, may cause the replacement of fibrils in the healthy LMM with adipose tissue.[16,17] Two main findings of muscle atrophy are evident in radiology: muscle volume decrease and increase in intramuscular fatty infiltration.[21] In magnetic resonance imaging (MRI), atrophy caused by lubrication in the MM is defined as areas of high signal intensity on axial T1-weighted images.[17,22,23]

The ideal imaging method for radiological evaluation of the lumbar MM is MRI. MRI separates soft tissues from each other more easily and makes it easier to examine their internal structures more clearly. On the other hand, MRI enables multi-plane images to be obtained without changing the patient's position.[24] The most preferred imaging techniques for evaluation of the lumbar MM are MRI, as well as computed tomography (CT) and ultrasound.[1,21,25]

The main purpose of our study is to determine whether there is a relationship between lumbar disc degeneration and the degree of fatty infiltration as well as the diameter of the LMM. The second aim was to investigate the degree of LMM fatty infiltration regarding the age and gender of patients.

Materials and Methods

In this retrospective study, MR images of 254 patients (127 males and 127 females) were randomly examined among patients who had undergone MRI examinations. The exclusion criteria were as follows: spinal fractures, spinal cord injuries, spinal infections, spinal tumors, previous spinal surgery, and vertebral deformities such as kyphosis or scoliosis, comorbidities such as cerebrovascular accidents or severe musculoskeletal disease, and rheumatoid conditions. Approval numbered 2020-02/03 was obtained from the Bahçeşehir University Scientific Research and Publication Ethics Committee on February 5, 2020, to conduct the study.

All lumbar MRI images were obtained according to the standard Lumbar MRI protocol (Axial T2-weighted fast spin echo; TR: 3800 ms, TE: 100 ms; Sagittal T2-weighted fast spin echo; TR: 2500 ms, TE: 100 ms; Sagittal T1-weighted spin echo; TR: 500 ms, TE: 10 ms) with the 1.5 Tesla Philips Achieva MRI device (Philips Healthcare, Best, The Netherlands). Images were evaluated on the workstation (INFINITT PACS, Infinitt Healthcare, South Korea).

T2-weighted axial slices were used for bilateral evaluation of the cross-sectional area (CSA) and fatty infiltration of the LMM. Analyses were made on L4/L5 and L5/S1 level intervertebral discs and LMM at these levels. On the T2-weighted axial sequences, visual assessment was used for the evaluation of fat infiltration and was graded as "normal (Grade 0)" for 0–10% fat within the muscle, "slight (Grade 1)" for 10–50% fat, and "severe (Grade 2)" for >50% fat.[17] Muscle CSAs were detected by marking the borders of the LMM with a free-hand region of interest.

Statistical Analysis

Descriptive statistics of the data were made using standard deviation, mean, frequency, and ratio values.

Table 1. Distribution of the herniation levels (L4/L5 and L5/S1) among gender groups

Gender	L4/L5 disc herniation		L5/S1 disc herniation	
	Without	With	Without	With
Female (n=127)	43	84	51	76
Percentage regarding gender (n=127), %	33.9	66.1	40.2	59.8
Percentage regarding herniation (n=254), %	16.9	33.1	20.1	29.9
Male	54	73	24	103
Percentage regarding gender (n=127), %	42.5	57.5	18.9	81.1
Percentage regarding herniation (n=254), %	21.2	28.7	9.5	40.5
Total	97	157	75	179

Whether the variables are in a nominal distribution was measured by the Kolmogorov–Smirnov test. The Chi-square test is used to analyze non-parametric group differences at a nominal level. The T-test and One Sample Anova tests were used in the analysis of quantitative independent data. IBM® SPSS®, SPSS 25 (SPSS Inc., Chicago, IL, USA) software was used in the analysis. In the evaluations of the study, $p<0.05$ was accepted as the statistical significance level.

Results

The total number of patients included in the study was 254, and the distribution in terms of gender was 127 (50%) female and 127 (50%) male. The average age of women in the study is 39.6±9.22, and men are 39.7±9.90.

The presence of the herniation and the distribution of the herniation levels among genders are shown in Table 1.

L4 Level Multifidus Atrophy plan according to age in 254 people who participated in the study: at the age of 40, 96 of 131 patients had loss of the MM, and Grade 1 and 2 atrophy was detected in the MM in 35 of them. When individuals aged 40 years and older are examined, loss of the MM was observed in 44 of 131 patients, whereas Grade 1 and 2 atrophy was detected in the MM in 79 patients (Table 2).

When L5 Level Multifidus Atrophy was examined according to age in 254 people who participated in the study, there was no loss of the MM in 67 of the 131 individuals under the age of 40 years, and Grade 1 and 2 atrophy was detected in the MM in 64 of them. When looking at individuals aged 40 and over, 24 of them did not have loss in the MM, whereas Grade 1 and 2 atrophy was detected in the MM in 99 of them (Table 3).

There was a predilection for the presence of herniation at the L4/L5 level for patients ≥40 years of age, but this relation was not significant for the L5/S1 level (Tables 2, 3).

Table 2. The relationship between L4/L5 disc herniation and age

	L4/L5 disc herniation		Total	p
	Without	With		
Age				
<40	60	71	131	<0.05
≥40	37	86	123	
Total	97	157	254	

Table 3. The relationship between L5/S1 disc herniation and age

	L5/S1 disc herniation		Total	p
	Without	With		
Age				
<40	37	94	131	>0.05
≥40	38	85	123	
Total	75	179	254	

In the 254 people who participated in the study, it was found that 89 (35.1%) of 157 patients with L4/L5 level herniation and 114 patients (35.1%) out of 174 with L5/S1 level herniation were found to have atrophy in the MM, whereas 28 (11.1%) patients out of 97 patients without herniation at L4/L5 level and 56 patients (11.1%) out of 80 patients without herniation at L5/S1 level also had atrophy in the MM. In line with these data, a significant relationship was found between herniation and atrophy in the MM, regardless of gender (Tables 4, 5).

The average muscle areas among gender groups were examined in four groups in terms of age (18–29, 30–39, 40–49, and 50+). Muscle areas of women were determined to be 791 mm^2, 839 mm^2, 802 mm^2 and 846 mm^2, respectively, in these groups, whereas they were 1057 mm^2, 1006 mm^2, 965 mm^2, and 907 mm^2 among men ($p<0.05$).

Table 4. The relationship between L4 / L5 Level herniation and atrophy of multifidus muscle

	Multifidus muscle atrophy		Total	p
	Grade 0	Grade 1,2		
L4 / L5 disc herniation				
(-)	69	28	97	<0.05
(+)	68	89	157	
Total	139	115	254	

Table 5. L5/S1 Level The relationship between herniation and atrophy in the multifidus muscle

	Multifidus muscle atrophy		Total	p
	Grade 0	Grade 1,2		
L5 / S1 disc herniation				
(-)	24	56	80	<0.05
(+)	60	114	174	
Total	84	170	254	

Discussion

The main purpose in the planning of this study is to examine the relationship between the atrophy in the MM s at L4/L5 and L5/S1 levels and disc herniation at the same levels. In addition, MM atrophy and disc herniation were investigated in accordance with age and gender factors. In our study, a significant relationship was found between MM atrophy and herniation. Although there was a significant difference in L4/L5 level herniation between individuals under the age of 40 years and the age of 40 years and over, but at L5 / S1 level no significant difference was found (p> 0.05). While there is no significant difference in L4 / L5 level, there was a significant difference between men and women at L5/S1 level. There is a significant difference between individuals under the age of 40 and individuals the age of 40 years and over in terms of atrophy in the MM for both segments. However, although there was a significant difference in the L4/L5 segment within gender, there was no significant difference in the L5-S1 segment.

In addition to muscle atrophy, which is an important factor in the development of herniation and other degenerative changes in the disc at the lumbar region, there are two other important mechanisms. These mechanisms are excessive rotational strains and unbalanced loading on the discs. Rotational stresses cause changes in both facet joints and intervertebral discs. Compressive stresses mostly affect the L5/S1 segment.[26] In other studies, disc herniation was most frequently detected in the L5/S1 segments.[27,28] In the study of Sayit; For L4/L5, L5/S1 levels, 79.5% of patients detected lumbar intervertebral disc herniation at any level with MRI, 20.5% did not detect intervertebral disc herniation. Our study showed that 98% of the patients had herniation in one of the segments (L4/L5, L5/S1 segments). In addition, disc herniation in accordance with the literature was found to be 9% higher in the L5/S1 segment compared to the L4/L5 segment.[28]

Mobility in the lumbar region usually occurs at the L5/S1 level, then at the L4/L5 level, which increases the stress at these levels, and accordingly, paraspinal muscles need to be more strong at these levels.[19] Therefore, in our study, we evaluated the LMM at the L4/L5 and L5/S1 levels. In studies by Ekin et al. (2016), and Sayit (2019):[23,28] Lumbar disc hernia was found more frequently in patients with LMM atrophy than patients without atrophy. The coexistence of LMM atrophy and disc hernia at the L5/S1 level revealed that it was not age-related. In contrast, Faur et al. (2019) [29] showed that the percentage of atrophy of the LMM is higher at lower levels in the lumbar region (L5/S1) and has a low correlation with the degree of disc degeneration. In our study, a significant relationship was found between the LMM atrophy at the L4/L5 and L5/S1 levels and herniation. When this relationship is analyzed in terms of age variable, there was a significant relationship at L4/L5 level but no significant relationship at L5/S1 level.

In a study conducted by Takatalo et al. (2009)[30] in the lumbar region, 54 % of patients had single-level disc disease, whereas 21 % of patients had multi-level disc disease. In the same study, it was revealed that the prevalence of disc herniation in the lumbar region was higher in males than females. Similarly, we revealed that 63.7% of patients had herniation in one segment, and 34.3% had in multiple segments. In general, although herniation was observed in men more than women, it was found that women had 4.4% higher rate of herniation at the L4/L5 level were than men, and men had 10.6% higher rate of herniation than women at the L5/S1 level.

In a study conducted by Ekin et al. (2016);[23] LMM atrophy in women and men found significantly higher in L5/S1 than in L4/L5. All patients with atrophy in L4/L5 also had atrophy in L5/S1. However, only 33.8% of patients with LMM atrophy in L5/S1 detected co-atrophy in L4/L5. Below 40 years LMM atrophy rate is 12.4% at the L4/L5 level aged, 48.2% the age of 40 years and above, 48.7% and 80.1%, respectively for the L5/S1 level. In our study, LMM atrophy was found to be significantly higher in L5-S1 level compared to L4-L5 level (18.5%) in accordance with the literature. In L5/S1, 37.8% of the people with LM muscle atrophy coincide with the

literature when atrophy appeared at the L4/L5 level, but in this study, 85% of the people with atrophy at the L4/L5 level also had the L5/S1 level. LMM atrophy was found 13.7% under the age of 40 for the L4/L5 level, 31.1% at the age of 40 years and over, 25.1% and 39% respectively for the L5/S1 levels.

In our study, a significant relationship was found between degenerative disc disease and LMM atrophy at both L4/L5 and L5/S1 levels. In addition, although there was a significant difference in the level of L4/L5 herniation between individuals under the age of 40 years and individuals the age of 40 and over, no significant difference was found in the level of L5/S1 herniation. In terms of gender, while there is no significant difference in L4/L5 level, there is a significant difference between men and women in the L5/S1 level. There is a significant difference between individuals under the age of 40 and individuals the age of 40 years and over in terms of atrophy in the MM for both segments. However, although there was a significant difference in the L4/L5 segment within the gender, no significant difference was found in the L5/S1 segment.

In the study conducted by Woodham et al. (2014),[21] they reported that spinal manipulative treatment with LM muscle stabilization exercises may reduce LM muscle atrophy. These results show that the rate of LM muscle atrophy in patients increases with age and causes stabilization losses in the lumbar region. Therefore, it is recommended to perform exercises for strengthening the LM muscle in young individuals, especially the elderly, and to take chiropractic or osteopathic treatment to protect the kinesiology of the lumbar region.

Conclusion

The strength of this study is that the selected hospital is based in Istanbul and is highly preferred by the local people. In this way, all patients were selected from the large sample pool. However, due to time constraints, the study could not be conducted on a large number of patients and in more than one center. It is recommended to repeat this research topic with more samples and multi-centers in order to ensure that the results represent a wider population.

Disclosures

Peer-review: Externally peer-reviewed.

Conflict of Interest: All authors declared no conflict of interest.

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Ethics Committee Approval: The study was approved by the Bahçeşehir University Clinical Research Ethics Committee (no: 2020-02/03, date: 05/02/2020).

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References

1. Danneels LA, Vanderstraeten GG, Cambier DC, Witvrouw EE, De Cuyper HJ. CT imaging of trunk muscles in chronic low back pain patients and healthy control subjects. Eur Spine J 2000;9(4):266–72.
2. Winslow JJ, Jackson M, Getzin A, Costello M. Rehabilitation of a young athlete with extension-based low back pain addressing motor-control impairments and central sensitization. J Athl Train 2018;53(2):168–73.
3. Hirsch C, Ingelmark BE, Miller M. The anatomical basis for low back pain. Studies on the presence of sensory nerve endings in ligamentous, capsular and intervertebral disc structures in the human lumbar spine. Acta orthop Scand 1963;33:1–17.
4. Moromizato K, Kimura R, Fukase H, Yamaguchi K, Ishida H. Whole-body patterns of the range of joint motion in young adults: Masculine type and feminine type. J Physiol Anthropol 2016;35(1):23.
5. Hides JA, Richardson CA, Jull GA. Multifidus muscle recovery is not automatic after resolution of acute, first-episode low back pain. Spine (Phila Pa 1976) 1996;21:2763–9.
6. Gibbons LE, Latikka P, Videman T, Manninen H, Battié MC. The association of trunk muscle cross-sectional area and magnetic resonance image parameters with isokinetic and psychophysical lifting strength and static back muscle endurance in men. J Spinal Disord 1997;10:398–403.
7. Parkkola R, Rytökoski U, Kormano M. Magnetic resonance imaging of the discs and trunk muscles in patients with chronic low back pain and healthy control subjects. Spine (Phila Pa 1976) 1993;18:830–6.
8. Yoshihara K, Shirai Y, Nakayama Y, Uesaka S. Histochemical changes in the multifidus muscle in patients with lumbar intervertebral disc herniation. Spine (Phila Pa 1976) 2001;26:622–6.
9. Kader DF, Wardlaw D, Smith FW. Correlation between the MRI changes in the lumbar multifidus muscles and leg pain. Clin Radiol 2000;55:145–9.
10. Beneck GJ, Kulig K. Multifidus atrophy is localized and bilateral in active persons with chronic unilateral low back pain. Arch Phys Med Rehabil 2012;93(2):300–6.
11. Zhong YB, Xu HS, Li JH. Cross-sectional area of LMmuscle in different stages of LDH. Clin Edu Gen Pra 2014;12:256–9.
12. Fritz U, Niethard JP. Duale Reihe Orthopädie und Unfallchirurgie. Stuttgart: Georg Thieme Verlag; 2005. p. 404–14.

13. Fortin M, Yuan Y, Battié MC. Factors associated with paraspinal muscle asymmetry in size and composition in a general population sample of men. Phys Ther 2013;93(11):1540–50.
14. Valentin S, Licka T, Elliott J. Age and side-related morphometric MRI evaluation of trunk muscles in people without back pain. Man Ther 2015;20:90–5.
15. Altinkaya N, Cekinmez M. Lumbar multifidus muscle changes in unilateral lumbar disc herniation using magnetic resonance imaging. Skeletal Radiol 2016;45(1):73–7.
16. Freeman MD, Woodham MA, Woodham AW. The role of the lumbar multifidus in chronic low back pain: A review. PM R 2010;2(2):142–6; quiz 1 p following 167.
17. Kjaer P, Bendix T, Sorensen JS, Korsholm L, Leboeuf-Yde C. Are MRI-defined fat infiltrations in the multifidus muscles associated with low back pain? BMC Med 2007;5(2):2.
18. Öncü J, İlişer R, Çelebi G, Kuran B, Durlanık G. Efficacy of lumbar epidural corticosteroid injections on clinical status of the patients with radiculopathy. Med Bull Sisli Etfal Hosp 2014;48(1):34–8.
19. Chen SM, Liu MF, Cook J, Bass S, Lo SK. Sedentary lifestyle as a risk factor for low back pain: A systematic review. Int Arch Occup Environ Health 2009;82(7):797–806.
20. Kulig K, Scheid AR, Beauregard R, Popovich JM Jr., Beneck GJ, Colletti PM. Multifidus morphology in persons scheduled for single-level lumbar microdiscectomy: Qualitative and quantitative assessment with anatomical correlates. Am J Phys Med Rehabil 2009;88(5):355–61.
21. Woodham M, Woodham A, Skeate JG, Freeman M. Long-term lumbar multifidus muscle atrophy changes documented with magnetic resonance imaging: A case series. J Radiol Case Rep 2014;8:27–34.
22. Sun D, Liu P, Cheng J, Ma Z, Liu J, Qin, T. Correlation between intervertebral disc degeneration, paraspinal muscle atrophy, and lumbar facet joints degeneration in patients with lumbar disc herniation. BMC Musculoskelet Disord 2017;18(1):167.
23. Ekin EE, Kurtul Yıldız H, Mutlu H. Age and sex-based distribution of lumbar multifidus muscle atrophy and coexistence of disc hernia: An MRI study of 2028 patients. Diagn Interv Radiol 2016;22(3):273–6.
24. Budak ÇE, Bozkurt MR. The magnetic resonance imaging (mri) analysis of deteriorations in the lumbar spine disks. AJIT 2013;4(12):125–44.
25. Fortin M, Rosenstein B, Levesque J, Nandlall N. Ultrasound Imaging Analysis of the Lumbar Multifidus Muscle Echo Intensity: Intra-Rater and Inter-Rater Reliability of a Novice and an Experienced Rater. Medicina (Kaunas). 2021;57(5):512.
26. Nerlich AG, Schleicher ED, Boos N. 1997 volvo award winner in basic science studies. Immunohistologic markers for age-related changes of human lumbar intervertebral discs. Spine (Phila Pa 1976) 1997;22(24):2781–95.
27. Cheung KM, Karppinen J, Chan D, Ho DW, Song YQ, Sham P, et al. Prevalence and pattern of lumbar magnetic resonance imaging changes in a population study of one thousand forty-three individuals. Spine (Phila Pa 1976) 2009;34(9):934–40.
28. Sayıt E. The relationship of lumbar multifidus muscle change to disc hernia and low back pain: An magnetic resonance imaging study. Istanb Med J= Istanbul Tip Dergisi 2019;20(2):111–4.
29. Faur C, Patrascu JM, Haragus H, Anglitoiu B. Correlation between multifidus fatty atrophy and lumbar disc degeneration in low back pain. BMC Musculoskelet Disord 2019;20(1):414.
30. Takatalo J, Karppinen J, Niinimäki J, Taimela S, Näyhä S, Järvelin MR, et al. Prevalence of degenerative imaging findings in lumbar magnetic resonance imaging among young adults. Spine (Phila Pa 1976) 2009;34(16):1716–21.