Research Article (Araştırma Makalesi)

The Evaluation of The Relationship Between Psoas Muscle Atrophy and Intervertebral Disc and Facet Joint Degeneration in Patients With Lumbar Pain Using Lumbar Spine MRI

Bel Ağrısı Şikâyeti Olan Hastalarda Psoas Kas Dejenerasyonunun Disk ve Faset Eklem Dejenerasyonu ile İlişkisinin Lomber MRG ile Ortaya Konması

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Özet

Amaç: Bel ağrısı şikâyeti olan hastalarda lomber Manyetik Rezonans (MR) görüntüleme ile psoas kasının lipoatrofisi ile faset ve disk dejenerasyonu arasındaki ilişkinin belirlenmesidir.

Gereç ve Yöntemler: Bu kesitsel çalışmada bel ağrısı bulunan 304 hasta retrospektif olarak incelendi. Bu hastaların lomber MR görüntüleri psoas kasının atrofi bulguları bakımından değerlendirildi. Her bir kas için yağ içeriği, yarı-kantitatif (evre 0-4) olarak derecelendirildi. Her bir hastanın disk ve faset eklem dejenerasyonları derecelendirildi. Psoas kas kalınlıkları vertebraya paralel olacak şekilde medio-lateral aksiyel planda ölçüldü.

Bulgular: Hastaların sağ psoas kası kalınlığının ortalama 35.9±7.2 mm, sol psoas kası kalınlığının ortalama 35.8±7.1mm olduğu tespit edilmiştir. Ek olarak sağ psoas kası dejenerasyonunun %41.8'inin grade 1, %41.1'inin grade 2 seviyesinde, sol psoas kası dejenerasyonunun %33.6'sının grade 1, %45.1'inin grade 2 seviyesinde, sağ faset dejenerasyonunun %64.1'inin grade 1, %23.4'ünün grade 2 seviyesinde, sol faset dejenerasyonunun %53.9'unun grade 1, %30.3'ünün grade 2 seviyesinde olduğu görülmüştür.

Sonuç: Lomber vertebranın MR görüntülerinin değerlendirilmesinde psoas kasların atrofi bakımından incelenmesi gerekmektedir. Bel ağrısı bulunan hastalarda psoas kasının lipoatrofinin bilinmesi, daha iyi rehabilitasyon planlaması yapılmasında faydalı olabilir.

Anahtar kelimeler: Disk, Faset eklem, Bel ağrısı, Manyetik rezonans görüntüleme, Psoas kası

Abstract

Objective: The purpose of the present study was to determine the relationship between psoas muscle lipoatrophy and facet and disc degeneration in patients with low back pain with lumbar spinal Magnetic Resonance Imaging (MRI).

Material and Methods: A total of 304 patients who had low back pain were included in this retrospective cross-sectional study. The lumbar MRIs of all patients were evaluated for signs of psoas muscle atrophy. Fat content for each muscle was graded semi-quantitatively (Grade 0-4). The disc and facet joint degenerations of each patient were also graded. Psoas muscle thickness was measured in the mediolateral axial plane parallel to the vertebra.

Results: It was found that the mean right psoas muscle thickness score of the patients was 35.9±7.2 mm on average, and the mean left psoas muscle thickness score was 35.8±7.1 mm. It was also found that 41.8% of the right psoas muscle degeneration was grade 1, 41.1% was grade 2, 33.6% of the left psoas muscle degeneration was grade 1, 45.1% was grade 2, 64.1% of the right facet degeneration was grade 1, 23.4% was grade 2, and 53.9% of the left facet degeneration was grade 1, and 30.3% was grade 2.

Conclusion: When lumbar spine MRI examinations are evaluated, psoas muscles must also be evaluated in terms of atrophy. Indicating psoas muscle lipoatrophy in patients with low back pain may be useful for better rehabilitation planning.

Keywords: Disc, Facet joint, Low back pain, Magnetic Resonance Imaging, Psoas muscle

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INTRODUCTION

The psoas muscle originates from the transverse protrusions and intervertebral discs of the 12th thoracic and all lumbar vertebrae descend from both sides of the spine, and pass under the inguinal ligament joining with the fibers of the iliac muscle, and ends at the femur by adhering to the trochanter minora. The tonus and quality of the psoas muscle affect the pelvis and all the organs in its interior and play an important role in stabilizing the pelvis. It has the feature of being a postural muscle supporting the lumbar lordosis (1). Previous studies reported that atrophy of the paraspinal muscles affects the lumbar lordosis and is also a risk factor for degenerative disc disease (2). Paravertebral muscles and ligaments play important roles in stabilizing the lumbar spine (3). Also, the psoas is an important hip flexor. The decreased cross-sectional diameter of these muscles may cause losses in appropriate biomechanical dynamics and back pain(4). Atrophy of the muscles at the lumbar level causes losses of strength and a decrease in muscle endurance in these muscle groups in patients who have chronic low back pain(5).

To the best of our knowledge, there are no studies in the literature showing the relationship between psoas muscle atrophy or lipoatrophy degeneration and disc degeneration or facet joint degeneration. In the present study, the purpose was to uncover the relationship between the degeneration of the Psoas muscles supporting the lumbar vertebrae and the degeneration of the facet joint and intervertebral disc.

MATERIALS AND METHODS

The lumbar Magnetic Resonance Imaging (MRI) images of 304 patients who had low back pain were evaluated retrospectively. Since the distinction between the paraspinal muscles can be best made at the L4-L5 level, the assessment was made at this level. By using axial sections, the thickness of the psoas muscle was measured at the level of the 4th lumbar vertebra mediolaterally, parallel to the vertebral body (**Image 1**).

At this level, the fatty atrophy degeneration of the muscle was grouped according to the Goutallier classification (Grade 0: normal muscle-**Image 2a**, Grade 1: some fatty streaks-*Image 2b*, Grade 2: less than 50% fatty muscle atrophy-**Image 2c**, Grade 3: 50% fatty muscle atrophy-**Image 2d**, Grade 4: greater than 50% fatty muscle atrophy-**Image 2e**) (6). The lumbar disc at the same level was grouped according to the Pfirrmann Classification (Grade 1: The structure of the disc is homogeneous, with a bright hyperintense white signal intensity and a normal disc height-**Image 3a**, Grade 2: The structure of the disc is inhomogeneous, with a hyperintense white signal. The distinction between nucleus and annulus is clear, and the disc height is normal, with or without horizontal gray bands-**Image 3b**, Grade 3: The structure of the disc is inhomogeneous, with intermediate gray signal intensity. The distinction between nucleus and annulus is unclear, and the disc height is normal or slightly decreased-**Image 3c**. Grade 4: The structure of the disc is inhomogeneous, with a hypointense dark gray signal intensity. The distinction between nucleus and annulus is lost, and the disc height is normal or moderately decreased-**Image 3d**. Grade 5: The structure of the disc is inhomogeneous, with hypointense black signal intensity. The distinction between nucleus and annulus is lost, and the disc space is collapsed-**Image3e**)(7). The facet joints at this level were grouped according to the classification made by Fujwara A. et al. (Grade 1: normal-**Image 4a**, Grade 2: Joint space narrowing or mild osteophyte-**Image 4b**, Grade 3: Sclerosis or moderate osteophyte-**Image 4c**, Grade 4: Marked osteophyte-**Image 4d**) (8).

Ethics: The present study was approved by the Clinical Research Ethics Committee of Malatya Turgut Ozal University (Ethical Decision date and number No: 2022/81).

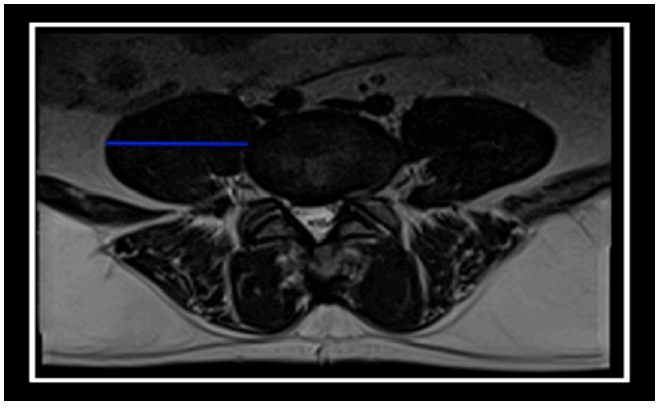

Image 1. The thickness of the psoas muscle was measured at the level of the 4th lumbar vertebra mediolaterally, parallel to the vertebral body.

Image 2 (a,b,c,d,e). The fatty atrophy degeneration of the psoas muscle was grouped according to the Goutallier classification.

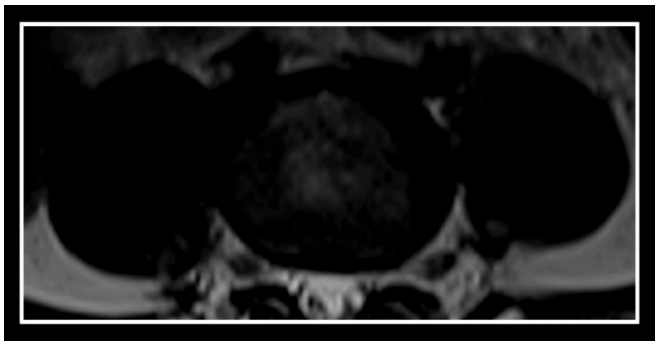

Image 2a. Grade 0 : Normal muscle

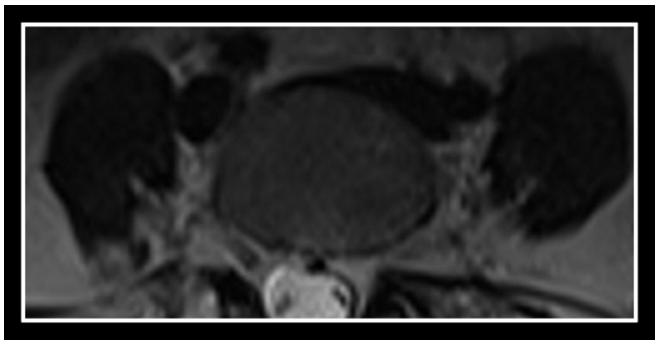

Image 2c. Grade 2 less than 50% fatty muscle atrophy

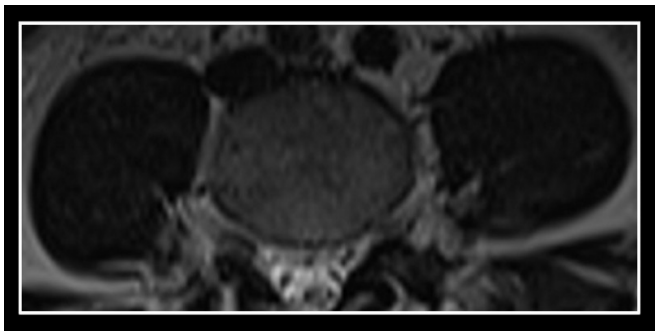

Image 2b. Grade 1 some fatty streaks

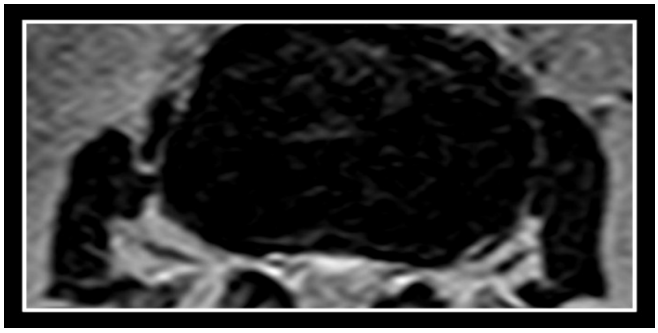

Image 2d. Grade 3 50% fatty muscle atrophy

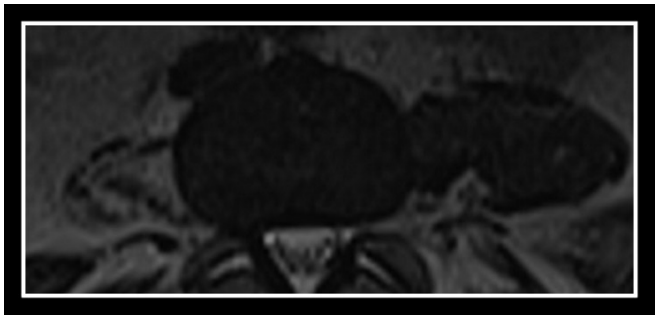

Image 2e. Grade 4 greater than 50% fatty muscle atrophy

Image 3 (a,b,c,d). The lumbar disc at the same level was grouped according to the Pfirrmann Classification

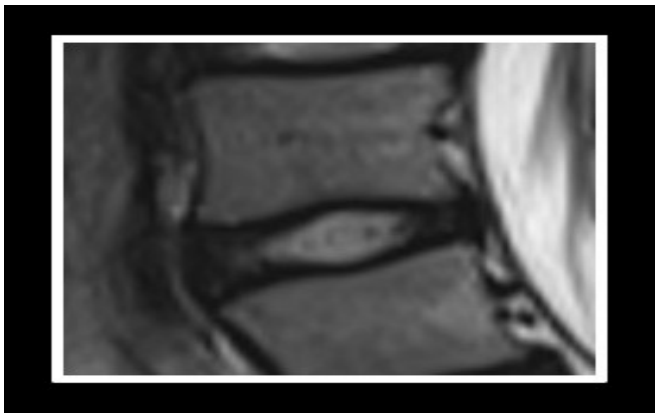

Image 3a. Grade 1: The structure of the disc is homogeneous, with a bright hyperintense white signal intensity and a normal disc height.

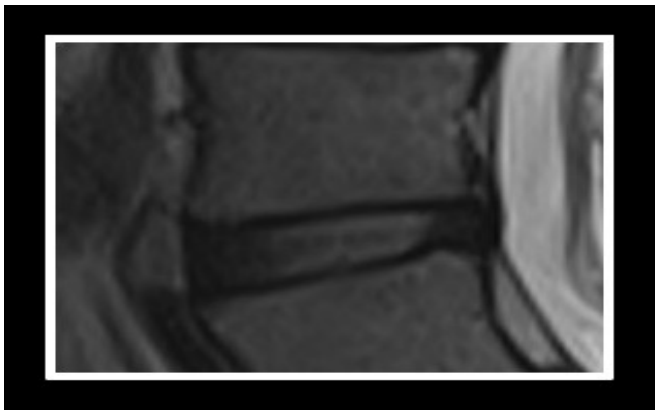

Image 3b. Grade 2: The structure of the disc is inhomogeneous, with a hyperintense white signal. The distinction between nucleus and annulus is clear, and the disc height is normal, with or without horizontal gray bands

Image 3c. Grade 3: The structure of the disc is inhomogeneous, with intermediate gray signal intensity. The distinction between nucleus and annulus is unclear, and the disc height is normal or slightly decreased.

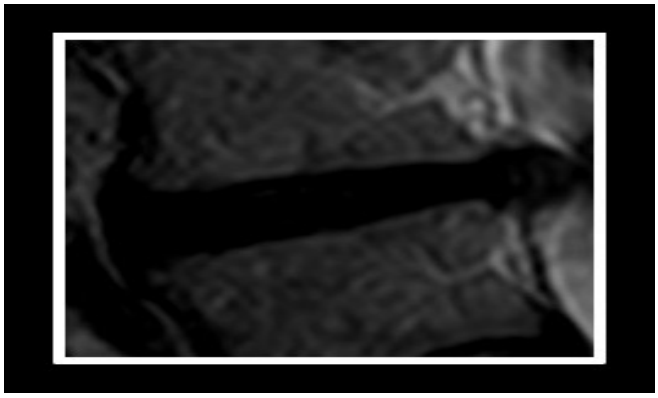

Image 3d. Grade 4: The structure of the disc is inhomogeneous, with a hypointense dark gray signal intensity. The distinction between nucleus and annulus is lost, and the disc height is normal or moderately decreased.

Image 4 (a,b,c,d). The facet joints at this level were grouped according to the classification made by Fujwara A. et al.

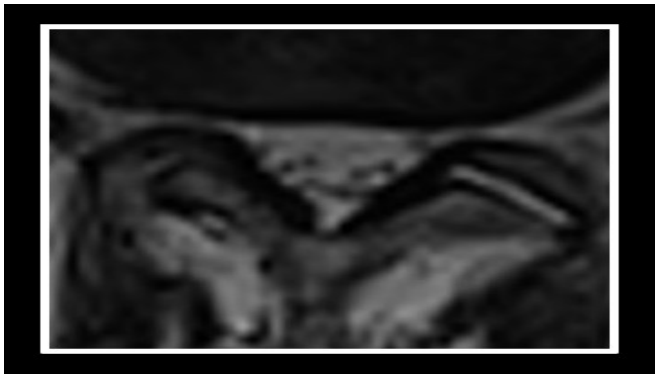

Image 4a. Grade 1: normal

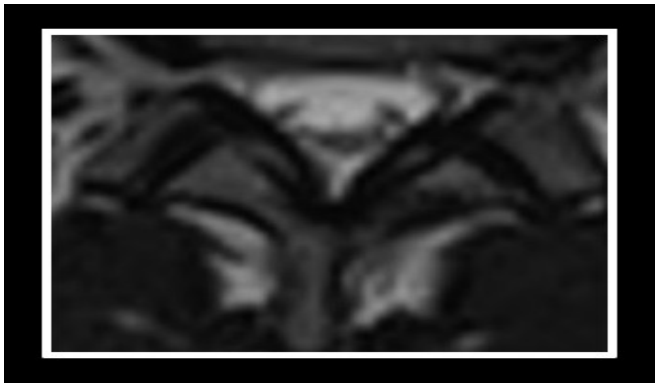

Image 4b. Grade 2: Joint space narrowing or mild osteophyte

Image 4c. Grade 3: Sclerosis or moderate osteophyte

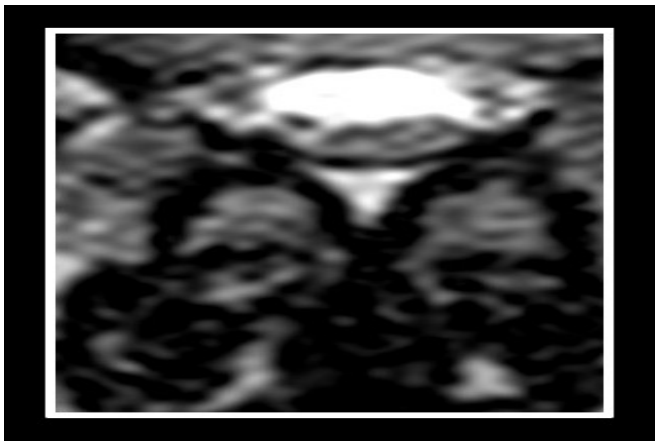

Image 4d. Grade 4: Marked osteophyte

Measurement Reliability

All measurements of cross-sectional muscle thickness in MRI were taken by two radiologists blinded to each other and the side of symptoms. Measurements were performed twice and the average was used in the primary analysis.

Statistical Analysis

The study data were evaluated by using the SPSS 21.0 statistical program. The conformity of the continuous variables to the normal distribution was investigated by using visual (histogram and probability graphs) and analytical methods (Kolmogorov-Smirnov/Shapiro-Wilk tests). The mean and standard deviation were used in the data that complied with the normal distribution and the median and minimum-maximum values were given in the data that did not comply with the normal distribution in the descriptive statistics of the study. The Chi-Square Test was used to show whether there was a difference between the categorical variables in the study. The Student t-Test or One-Way Anova Analysis of Variance was used to compare the continuous variables with parametric characteristics in independent groups, and the Mann-Whitney U-test or Kruskal Wallis Analysis of Variance was used to compare the continuous variables that did not have parametric characteristics in independent groups. A p value less than 0.05 was accepted for statistical significance.

RESULTS

The demographic characteristics of the patients are summarized in **Table 1**. It was found that the mean age of the patients was 46.8±14.8. When the gender distribution was examined, it was found that 59.5% of the patients were female and 40.5% were male (**Table 1**).

Table 1. Demographic Characteristics

		n	Mean±SD
Age		304	46.8±14.8
		n	**%**
Gender	**Female**	181	59.5
	Male	123	40.5

SD: Standart Deviation

The characteristics of people whose psoas muscle thickness was measured are summarized in **Table 2**. It was found that the mean right psoas muscle thickness of the patients was 35.9±7.2 mm, and the mean left psoas muscle thickness was 35.8±7.1mm. Also, 41.8% of the right psoas muscle degeneration was Grade 1, 41.1% was Grade 2, 33.6% of the left psoas muscle degeneration was Grade 1, 45.1% was Grade 2, 64.1% of the right facet joint degeneration was Grade 1, 23.4% was Grade 2, and 53.9% of the left facet joint degeneration was Grade 1, 30.3% was Grade 2. The details are given in **Table 2**.

Table 2. Characteristics of the participants whose psoas muscle lengths were measured

		n	Mean±SD
Number of the participants whose right psoas muscle lengths were measured		304	35.9±7.2mm
Number of the participants whose left psoas muscle lengths were measured		304	35.8±7.1mm
		n	**%**
Right Psoas Muscle Degeneration	Grade 0	127	41.8
	Grade 1	125	41.1
	Grade 2	50	16.4
	Grade 3	0	0.0
	Grade 4	2	0.7
Right Facet Joint Degeneration	Grade 1	195	64.1
	Grade 2	71	23.4
	Grade 3	28	9.2
	Grade 4	10	3.3
Left Psoas Muscle Degeneration	Grade 0	102	33.6
	Grade 1	137	45.1
	Grade 2	63	20.7
	Grade 3	1	0.3
	Grade 4	1	0.3

Table 2. Characteristics of the participants whose psoas muscle lengths were measured *(Continued)*			
		n	**Mean±SD**
Number of the participants whose right psoas Muscle Lengths were measured		304	35.9±7.2mm
Number of the participants whose left psoas Muscle Lengths were measured		304	35.8±7.1mm
		n	**%**
Left Facet Joint Degeneration	Grade 1	164	53.9
	Grade 2	92	30.3
	Grade 3	33	10.9
	Grade 4	15	4.9
L4-L5 Disk Degeneration	Grade 1	37	12.2
	Grade 2	52	17.1
	Grade 3	70	23.0
	Grade 4	91	29.9
	Grade 5	54	17.8

The relationship between right psoas muscle degeneration and right facet joint degeneration is given in **Table 3**. Although 1.6% of the patients with right psoas muscle degeneration Grade 0 had right facet joint degeneration as Grade 3-4, 20.3% of patients with right psoas muscle degeneration Grade 1-4 had right facet joint degeneration as Grade 3-4. When the two groups were compared in terms of Grade 3-4 right facet joint degeneration, it was found that patients who had right psoas muscle degeneration Grade 1-4 were higher at statistically significant levels than those with Grade 0. The details are given in **Table 3**.

The relationship between left psoas muscle degeneration and left facet joint degeneration is given in **Table 4**. Although 1.0% of the patients who had left psoas muscle degeneration Grade 0 had left facet joint degeneration as Grade 3-4, 23.3% of the patients who had left psoas muscle degeneration Grade 1-4 had left facet joint degeneration as Grade 3-4. When the two groups were compared in terms of Grade 3-4 left facet joint degeneration, it was found that patients who had left psoas muscle degeneration Grade 1-4 were higher at statistically significant levels than those with Grade 0. The details are given in **Table 4**.

Table 3. Comparison of the relationship between right psoas muscle degeneration and right facet joint degeneration						
		Right Psoas Muscle Degeneration				**p**
		Grade 0		**Grade 1-4**		
		n	**%**	**n**	**%**	
Right Facet Joint Degeneration	Grade 1-2	125	98.4	141	79.7	<0.001
	Grade 3-4	2	1.6	36	20.3	

Table 4. Comparison of the relationship between left psoas muscle degeneration and left facet joint degeneration						
		Left Psoas Muscle Degeneration				**p**
		Grade 0		**Grade 1-4**		
		n	**%**	**n**	**%**	
Left Facet Joint Degeneration	Grade 1-2	101	99.0	155	76.7	<0.001
	Grade 3-4	1	1.0	47	23.3	

The right and left facet joint degeneration levels and psoas muscle thicknesses are compared in **Table 5**. When the table is examined, it is seen that the psoas muscle thicknesses were lower at statistically significant levels in patients with right and left facet joint Grade 3-4 degeneration than in patients with Grade 1-2 degeneration. The details are given in **Table 5**.

The L4-L5 disc degeneration level and psoas muscle thickness are evaluated in **Table 6**. When the table is examined, it is seen that the right psoas muscle thickness was found to be higher at statistically significant levels in those with disc degeneration levels Grade 1-2-3 when compared to those with Grade 4 and Grade 5 disc degeneration levels. The details are given in **Table 6**.

The relationship between right and left psoas muscle degeneration and L4-L5 disc degeneration is given in **Table 7**. When the table is examined, it is seen that the rate of high-grade (Grade 4 and Grade 5) disc degeneration was higher at statistically significant levels in patients with Grade 1-4 muscle degeneration in the right and left psoas muscles than in patients with grade 0 muscle degeneration. The details are given in **Table 7**.

Table 5. Comparison of right and left facet joint degeneration levels and psoas muscle thicknesses

	Left Facet Joint Degeneration		p
	Grade 1-2	**Grade 3-4**	
Left Psoas Muscle Thickness	36.4(21.0-55.0)mm	33.0(19.0-51.0)mm	0.002
	Right Facet Joint Degeneration		**p**
	Grade 1-2	**Grade 3-4**	
Right Psoas Muscle Thickness	36.4±7.1mm	32.5±7.3mm	0.002

Table 6. Relation between L4-L5 disk degeneration and psoas muscle thicknesses

	Disk Degeneration			p
	Grade 1-2-3	**Grade 4**	**Grade 5**	
Left Psoas Muscle Thickness	36.7(22.0-53.6) mm	34.0(19.0-55.0) mm	36.0(21.0-53.2) mm	0.141
Right Psoas Muscle Thickness[1, 2]	36.7(23.0-52.0) mm	34.0(19.0-58.6) mm	34.8(21.0-55.0) mm	0.007

[1] There is a statistically significant difference between Grade 1-2-3 and Grade 4 Groups
[2] There is a statistically significant difference between Grade 1-2-3 and Grade 5 Groups

Table 7. Relation between right and left psoas muscle degeneration and L4-L5 disk degeneration

		Left Psoas Muscle Degeneration				p
		Grade 0		**Grade 1-4**		
		n	**%**	**n**	**%**	
Disk [1, 2, 3]	Grade 1-2-3	78	76.5	81	40.1	<0.001
	Grade 4	20	19.6	71	35.1	
	Grade 5	4	3.9	50	24.8	
		Right Psoas Muscle Degeneration				**p**
		Grade 0		**Grade 1-4**		
		n	**%**	**n**	**%**	
Disk [1, 2, 3]	Grade 1-2-3	93	73.2	66	37.3	<0.001
	Grade 4	27	21.3	64	36.2	
	Grade 5	7	5.5	47	26.6	

[1] There is a statistically significant difference between Grade 1-2-3 and Grade 4 Groups
[2] There is a statistically significant difference between Grade 1-2-3 and Grade 5 Groups
[3] There is a statistically significant difference between Grade 4 and Grade 5 Groups

The psoas muscle thicknesses are evaluated according to muscle degeneration levels in **Table 8**. When the table is examined, it is seen that the muscle thicknesses were found to be higher at statistically significant levels in patients with right and left muscle degeneration Grade 0 than in patients with Grade 1-4. The details are given in **Table 8**.

The age ranges are evaluated according to muscle degeneration levels in **Table 9** and **Table 10**. When the table is examined, it is seen that the patients with right muscle degeneration Grade 0 were in the 20-39 age range, the patients with Grade 1-4 were in the 40-59 age range, the patients with the left muscle degeneration Grade 0 were in the 20-39 age range, and the patients with Grade 1-4 were in the 40-59 age range. The details are given in **Table 9** and **Table 10**.

DISCUSSION

Muscle support is provided for the lower back by the multifidus, erector spinae, psoas, and quadratus lumborum. Impaired muscle support may be a factor in the persistence of low back pain (9). In adults who have chronic low back pain, a decrease is detected in muscle areas, especially at the lower vertebrae levels (10). Studies show that there is a decreased area of the muscles and an increase in the intramuscular fatty tissue in patients who have chronic low back pain, and it was suggested that this occurs because of the decreased muscle use (11). Strengthening the psoas muscle because of its direct attachment to the lumbar spine has an important role in providing lumbar lordosis (12). Changes such as decreased cross-sectional area of the muscles and increased amount of adipose tissue were also demonstrated

Table 8. Comparison of muscle degeneration levels and psoas muscle thicknesses

	Psoas Right Muscle is Degenerated		p
	Grade 0 (n=127)	Grade 1-4 (n=177)	
Right Psoas Muscle Thickness	41.00(27.00-58.60)	33.00(19.00-53.00)	<0.001
	Psoas Left Muscle is Degenerated		
	Grade 0 (n=102)	Grade 1-4 (n=202)	
Left Psoas Muscle Thickness	40.00(27.20-55.00)	33.00(19.00-53.00)	<0.001

Table 9. Relation between right psoas muscle degeneration and age ranges

		Right Psoas Muscle Degeneration				p
		Grade 0		Grade 1-4		
		n	%	n	%	
Age	<20	1	.8	0	0.0	<0.001
	20-29	30	23.6	10	5.6	
	30-39	41	32.3	21	11.9	
	40-49	26	20.5	49	27.7	
	50-59	24	18.9	39	22.0	
	60-69	4	3.1	38	21.5	
	>=70	1	.8	20	11.3	

Table 10. Relation between left psoas muscle degeneration and age ranges

		Left Psoas Muscle Degeneration				p
		Grade 0		Grade 1-4		
		n	%	n	%	
Age	<20	1	1.0	0	0.0	<0.001
	20-29	27	26.5	13	6.4	
	30-39	38	37.3	24	11.9	
	40-49	17	16.7	58	28.7	

in different parts of the body, such as the rotator cuff (13-14). Studies were conducted to identify changes in the paravertebral muscles in patients who have chronic low back pain. In these studies, an increase was detected in fat tissue and a decrease in muscle volume in the cross-sectional area in muscles because of the degeneration in paravertebral muscles (15-17). In the present study, psoas muscle degeneration, facet joint, and L4-L5 intervertebral disc degenerations were evaluated according to psoas muscle thickness. When the muscle groups with and without degeneration were compared in the present study, it was determined that the thickness of the muscles with degeneration decreased.

Lumbar Facet Syndrome (LFS) is a mechanical instability syndrome occurring because of degenerative and traumatic causes in the facet joints in the lumbar area (18). Low back pain is one of the most common musculoskeletal problems in adults. It is already known that facet syndrome in the lumbar spine is responsible for 15-40% of chronic low back pain (19). The facet joints have a narrow joint space and can perform limited gliding motion. Facet joints consist of 1-2 ml of fluid in the joint space, synovial membrane, 2-4 mm-thick hyaline cartilage, and approximately 1 mm-thick fibrous capsule (20,21). Depending on the position of the spine, the amount of load may differ on the discs and facets. It was reported that 70% of standing body weight is shared by the intervertebral discs and 30% by the facet joints. Lower lumbar facets are more involved in load-bearing than upper ones. Mostly, the rotational strains affect the L4 and L5 facet joints (22). Microtraumas, macrotraumas, postural reasons caused by flexion, and rotational stresses play roles in facet joint degeneration. The mechanical load on the intervertebral disc may be unevenly distributed and degeneration may occur more easily in facet asymmetry (23,24). It was observed in the present study that the severity of degeneration increased in the facet joints with the degeneration of the psoas muscles. Also, patients who had thicker psoas muscles had a lower degree of degeneration of the facet joints.

Degenerative changes in the facet joints cause local inflammation and pain (25). The incidence of degeneration and osteoarthritis in the facet joints increases at significant levels with advancing age (26). For these reasons, we think that the psoas muscles must have sufficient thickness to protect the facet joints.

Intervertebral discs are located between the vertebrae constituting 1/3 of the spine height with the main task of carrying loads, distributing the load, and allowing muscle movement. It is 7-8 mm thick and 4 cm (anteroposterior) in diameter in the lumbar area. The intervertebral disc has a solid structure and is connected by end-plates between both adjacent vertebrae and can absorb stress. The gelatinous nucleus pulpous part of the intervertebral disc, which is surrounded by the annulus fibrosus, is responsible for the controlled movement of the disc (27). It is already known that the most important cause of chronic low back pain is intervertebral disc degeneration. Degenerative disc disease causes instability in the spine (28). Degenerative changes in the ipsilateral multifidus and psoas major muscles and the decreased muscle areas were shown in patients who have disc herniation (29). The atrophy of the muscle groups at the lumbar level and a decrease in strength of the muscles occur in patients with chronic low back pain (30). In a study that compared the relationships of the psoas major, quadratus lumborum, and erector spinae muscles with disc herniation, it was shown that the psoas muscle area was significantly smaller in patients with disc herniation (31). In the present study, it was shown that patients who have high-degree degeneration of the disc also had a high-degree degeneration in the psoas muscle. Also, in the present study, it was found that patients who had high psoas muscle thickness had a lower degree of disc degeneration.

CONCLUSION

In patients with preserved psoas muscle thickness, lower-grade degeneration type is seen in the psoas muscle, and low-grade degeneration in the facet joint and disc can be seen in patients with preserved psoas muscle thickness.It is generally accepted that low back pain occurs because of a multifactorial etiology. For this reason, the degeneration of the facet joints and disc can be reduced as well as protecting the muscle by performing exercises for the Psoas muscle, which plays an important role in the stabilization of the lumbar region in patients with low back pain. We think that evaluating and reporting the degeneration of the Psoas muscle, facet joints, and disc in lumbar MRI images may be important for accurately guiding the treatment.

Limitations

There are a few limitations that need to be considered when reviewing our findings. First, there is an inherent concern for selection and reporting bias in conducting a review of the literature. Furthermore, most studies we identified were retrospective cohort or case-control studies with moderate inherent bias. There are not enou-

gh data on the contribution of psoas muscle atrophy to low back pain. There is no standard measure for psoas muscle atrophy. The scales used to measure psoas muscle degeneration are heterogeneous and subjective. The retrospective nature of the study was another limitation.

Human subjects: Informed consent was obtained from all the participants of this study.

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