MRI Assessment of Degeneration of Multifidus and Erector Spinae Muscles in Patients with Chronic Low Back Pain

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Research Article

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Abstract

Background

The aim of this study was to examine degeneration in the lumbar musculus multifidus (L.MF) and lumbar musculus erector spina (L.ES) muscles in patients with mechanical chronic low back pain, non-radiculopathy chronic low back pain with discopathy, and healthy individuals. The relationships with low back pain were examined by comparing the results according to gender, pain, and lumbar segments.

Material and Method:

Evaluation was made of 36 healthy control subjects (Group 1), 37 patients with mechanical low back pain (Group 2) and 41 non-radiculopathy, lumbar discopathy patients (Group 3). On axial magnetic resonance images at the L3-S1 level, asymmetry between the left and right sides was examined in respect of L.MF and L.ES surface cross-sectional areas (CSA), total surface cross-sectional area (TCSA = L.MF + L.ES), and fat infiltration.

Results

The mean CSA values showed a significant difference only in the right L.MF in the healthy control group ($p = 0.011$). No statistically significant difference was seen between the groups in the comparisons of TCSA, and a statistically significant difference was determined in respect of fat infiltration in the right and left L.MF and the left L.ES ($p = 0.011$, $p = 0.001$, $p = 0.027$, respectively). When the CSA and TCSA were examined according to gender within the groups, the values were found to be statistically significantly higher in males ($p < 0.001$). The CSA and TCSA values of the L.MF and L.ES showed a significant difference between segments (L3-L4, L4-L5, L5-S1) ($p < 0.001$). No asymmetry was observed between the left /right CSA and TCSA values of the groups. Fat infiltration showed a significant difference according to gender and segments ($p < 0.001$).

Conclusion

Fat infiltration in the L.MF muscle is related to mechanical low back pain and lumbar discopathy. That there was no difference between the groups in the CSA and TCSA values demonstrates the need for measurement of muscle atrophy associated with fat infiltration or functional cross-section area rather than CSA and TCSA.

Background

Low back pain (LBP) is a problem widely seen in the community which has social, psychological and economic burdens [1]. After upper respiratory tract infections, it is the most common reason for seeking medical help [2]. In individuals aged < 45 years, it is the most common cause of activity restriction [3]. Adults experience at least one episode of low back pain in a year at the rate of 15%-20%, and in their lifetime at the rate of 50%-80% [1]. This condition becomes a high-cost, socioeconomic health problem as a result of long-term morbidity causing workforce loss [4]. Although LBP is seen so frequently, the pathophysiology is still not fully understood and there is not sufficient correlation between research findings and symptoms [2]. The causes of LBP include lifestyle, working conditions, traumatic events, demographic characteristics, congenital malformations, and infectious, inflammatory, metabolic, neurogenic, neoplastic, and several other factors [1].

The paraspinal muscles, which play a role in the structural and functional stabilisation of the lumbar spine, are formed of muscle layers that primarily control intersegment movement with a superficial layer responsible for the spine and extremity movements [5]. The primary function of the paraspinal muscles is to provide extension of the spine. In addition, when the lumbar erector spina (L.ES) muscles move unilaterally, they assist lateral flexion. Biomechanical and morphological studies have shown that the lumbar musculus multifidus (L.MF) has good capacity for segmental support and control, but is insufficient to form turning moment. In contrast, the L.ES muscle forms a good turning moment but is not as effective as the L.MF in spinal orientation control [6, 7]. In comparison with all the other lumbar muscles, the L.MF is shorter, thicker, and has a large surface cross-sectional area (CSA). These characteristics allow the production of very great forces when the L.MF is short and are ideal for L.MF stability. In contrast to the multi-segmental innervation of the paraspinal muscle system, the L.MF has unilateral innervation originating from the medial branch of the posterior root of the segmental nerve [8]. This makes this muscle the most frequently and quickly affected muscle.

Muscle degeneration is morphologically characterised by a reduction in muscle size and increased fat tissue accumulation [9, 10]. Experimental studies have shown that muscle degeneration developed on the 3rd day after disc injury [11]. Degenerative changes in chronic LBP can be expected in at least 3 months on a general basis of between 6 months and 1 year, and long-term studies have stated that degeneration is expected in less than 1 year with no change occurring after 1 year [5, 12–14]. The size of paraspinal muscles is related to gender [15–18], body mass index (BMI) [12, 17, 19, 20], physical activity level, and family history [19]. The combined effects of family genes and shared early environment have been reported to be the strongest determinant of paraspinal muscle parameters [12]. In previous studies, fat infiltration of 9% has been observed in the paraspinal muscles of middle-aged, healthy volunteers [10].

To evaluate the structure and components of paraspinal muscle tissue, the non-invasive method of magnetic resonance imaging (MRI) has recently become more widely used to characterise the changes associated with mechanical stress or response to injury [21, 22]. MRI provides information about muscle CSA and fat infiltration with high resolution, contrast, and a clearer image of soft tissue, without exposure to radiation. It has also been stated that the reliability of MRI results is slightly better than that of computed tomography (CT) [23].

To the best of our knowledge, there is no study in literature that has compared patients with mechanical LBP and lumbar discopathy with a healthy control group in the same study. The aim of this study was to determine whether there is a need for different approaches to LBP patient groups by examining the morphology of the L.MF and L.ES muscles in patients with mechanical LBP, patients with lumbar discopathy, and a healthy control group. A secondary aim of the study was to evaluate the relationship of paraspinal muscle size and fat infiltration with age, gender, BMI, level of segmental involvement (L3-L4,L4-L5,L5-S1), and pain severity and duration.

Material And Method

Participants

The study included a total of 114 participants between November 2020 and February 2021. Group 1 comprised 36 healthy individuals, invited from social media and announcements, randomly selected from volunteers with no low back problem within the last year, and with no low back problem determined on radiology and physical examination. Group 2 comprised 37 patients, who presented at the Orthopaedics and Traumatology Department with complaints of low back pain, were not determined with any additional lumbar problem in physical examination or radiology and laboratory tests, and were diagnosed as idiopathic mechanical low back pain. Group 3 comprised 41 patients

determined with lumbar discopathy on MRI with no findings of radicular pain caused by root compression. For patients with suspected root compression, EMG was requested. The patients in all 3 groups were aged 20-65 years. The patients included in Group 2 and Group 3 were selected at random from patients with LBP ongoing for the last 3 months. LBP was defined as low back pain between the inferior edge of the costa and the gluteal fold. Patients were excluded from the study if they had inflammatory (ankylosing spondylitis), infectious, metabolic, neoplastic, hip, or pelvic disorders, leg shortness, neurogenic disease, vertebra fracture, structural deformity (scoliosis, kyphosis) malformations, or a history of lumbar surgery. Demographic, clinical and disease-related data were obtained from all the patients in all the groups in face-to-face interviews. Hemogram, erythrocyte sedimentation rate, full urine analysis, ASO, CRP, RF, salmonella, and brucella tests were requested when necessary for the differential diagnosis of patients. Pain severity was evaluated with a Visual Analog Scale (VAS). The examination of 90 patients was performed by the same physician experienced in spine surgery, and the lumbar spine MR images were analyzed by the a single experienced radiology specialist who was blinded to the clinical history. All the MR images were taken by the same radiology technician.

Approval for the study was granted by the Local Ethics Committee (YDU/2020/83-1160). Signed informed consent was obtained from all the study participants.

Measurements

Magnetic Resonance Imaging

Images were obtained using a 1.5 Tesla MRI unit (Sigma Explorer SV25.3 with up-to-date software and 16 channels; General Electric, Milwaukee, WI, USA). Following adjustment of the localisation with the patient in a supine position, a routine protocol was applied to the lumbar spine to pass through the centre of the disc at the measurement level between L3-S1. Turbo-spin echo T1 and T2-weighted sagittal slices and T2 axial slices parallel to the disc spaces were obtained at a thickness of 4mm. Evaluations were made of the right and left cross-sectional areas (CSA), the total cross-sectional area (TCSA =L.MF+L.ES), fat content, and asymmetry of the L.ES and the L.MF at the L3-S1 level. Kalichman et al reported moderate interobserver reliability on MRI, and excellent intra-observer reliability [24].

There is no consensus about the use of T1-weighted and T2-weighted MRI sequences. In most previous studies, degeneration has been graded using axial images. It has been stated that with T2-weighted slices in the evaluation, the muscle, fat, and fascial structures are more easily anatomically determined and differentiated (Figure 1) [25].

In this study, the CSA was quantitatively measured by determining the fascial borders of the muscles using Packs Report imaging and manual drawing. Fatty infiltration of the muscles was evaluated semi-quantitatively. In the evaluation, fat infiltration was graded as Grade 1: normal (fat infiltration of up to 10% of the muscle CSA), Grade 2: moderate (10%-50%) and Grade 3: severe (>50%) (Figure 2) [2, 8, 24, 26].

For internal reliability, 13 randomly selected patients were evaluated again by the same radiologist after an interval of 1 month. Intra-observer agreement was examined with Kappa and the Kappa value obtained was 0.941.

Statistical Analysis

Data obtained in the study were analyzed statistically using IBM SPSS vn. 23 (Chicago, IL, USA). Based on the mean CSA values, the minimum sample size was determined as 78 subjects to provide effect size of f=0.461, 95% confidence (1-α) and 95% test power (1-β). With the consideration of potential patient losses, the study was

completed with a total of 90 subjects. According to the post-hoc power analysis, the test power was determined to be 97.7% [27].

Conformity of the data to normal distribution was assessed with the Kolmogorov-Smirnov test. In the comparisons of data not showing normal distribution, the Kruskal Wallis and Mann Whitney U-tests were used. The main effects of group, gender and segment on CSA and TCSA were examined with the MANOVA test, taking age and BMI as covariate variables. In multiple comparisons, the Bonnferroni test was used. The Chi-square test was applied to examinations of categorical variables. A value of $p<0.05$ was accepted as statistically significant.

Results

The demographic characteristics of the study groups are shown in Table 1. Age and BMI values were placed in this model as covariate variables. It was aimed to control the effects of age and BMI on dependent variables.

Table 1: Comparisons of the age, gender, body mass index (BMI), duration of pain and pain severity (VAS score) of the patients according to the groups

	Healthy control group		Mechanical low back pain		Lumbar discopathy		Total		P
	$\bar{x} \pm \sigma$	median (min-max)	$\bar{x} \pm \sigma$	median (min-max)	$\bar{x} \pm \sigma$	median (min-max)	$\bar{x} \pm \sigma$	median (min-max)	
Age (years)	32.4 ± 8.19	33 (21 - 48)[a]	32.67 ± 9.09	28.5 (23 - 56)[a]	42,5 ± 6,27	44,5 (27 - 51)[b]	35,86 ± 9,16	36 (21 - 56)	**<0.001[1]**
BMI ($kg/m^{2)}$	25.01 ± 3.58	24.41 (19.25 - 32.79)[a]	24.76 ± 5.32	23.2 (18.08 - 36.63)[a]	28,07 ± 4,63	27,51 (20,24 - 36,2)[b]	25,95 ± 4,76	25,16 (18,08 - 36,63)	**0.010[1]**
Drt of LBP(m)	—	—	19.8 ± 29.8	6 (3 - 120)	48,1 ± 55,02	36 (3 - 240)	33,95 ± 46,13	10 (3 - 240)	**0.022[2]**
VAS – resting	—	—	1.77 ± 0.82	2 (1 - 4)	2,47 ± 1,38	2 (1 - 6)	2,12 ± 1,18	2 (1 - 6)	0.052[2]
VAS – active	—	—	3.23 ± 0.97	3 (2 - 6)	4,43 ± 1,81	4 (2 - 8)	3,83 ± 1,56	3 (2 - 8)	**0.009[2]**
Gender	n (%)		n (%)		n (%)				
Male	13 (43.3)		7 (23.3)		8 (26.7)		28 (31.1)		**0,200[3]**
Female	17 (56.7)		23 (76.7)		22 (73.3)		62 (68.9)		

[1]Kruskal Wallis, [2]Mann Whitney U, [3]Pearson Chi-Square, VAS (Visual Analog Scale), Drt of LBP (m): duration of Low Back Pain, [a-a] :the same letter indicates no difference between groups, [a-b-ab] : Different letters indicate a significant difference between groups.

Examinations of the CSA and TCSA of the groups

The mean CSA value showed a difference only in the right L.MF in the healthy control group (p=0.011). The mean CSA values in Group 1 were lower than those of Group 2 and Group 3. No difference was seen between the groups in respect of TCSA in the other muscle groups. There was no difference between Group 2 and Group 3.

Table 2: Descriptive statistics (mm^2) of the measurements

	Parameters	Healthy control group	Mechanical low back pain	Lumbar discopathy
CSA	Right L.MF(mm^2)	934.36 ± 264.05[a]	968.87 ± 301.57[b]	1036.74 ± 291.75[b]
	Left L.MF (mm^2)	947.18 ± 265.14	947.13 ± 295.38	1018.41 ± 287.11
	Right L.ES(mm^2)	1669.24 ± 456.47	1588.69 ± 581.23	1799.63 ± 492.89
	Left L.ES(mm^2)	1709.66 ± 466.18	1598.44 ± 563.83	1809.17 ± 521.59
TCSA	Right L.MF-L.ES(mm^2)	2603.6 ± 458.23	2557.56 ± 663.64	2836.38 ± 564.46
	Left L.MF-L.ES(mm^2)	2656.83 ± 477.35	2545.58 ± 636.81	2827.58 ± 574.53

[b-b] : the same letter indicates no difference between groups, [a-b] : Different letters indicate a significant difference between groups, CSA: Cross-sectional area, TCSA: Total cross-sectional area, L.MF: lumbar musculus multifidus, L.ES: lumbar erector spina

The mean CSA and TCSA values of all the muscle groups in the males of all three groups were determined to be statistically significantly higher than those of females (p<0.001) (Table 3).

In the healthy control group, no significant correlation was determined between age and CSA and TCSA values. A moderate positive correlation was determined in the group with mechanical LBP (p<0.05) and a weak positive correlation in the discopathy LBP group (p<0.05).

The CSA values in all the groups showed a statistically significant difference according to segments (L3-L4, L4-L5, L5-S1) (Table 3). In all the groups, the L.MF CSA was largest in the L5-S1 segment and smallest in the L3-L4 segment, and the L.ES CSA was largest at L3-4 and smallest at L5-S1. In the evaluation of asymmetry, no difference was determined between the groups in respect of CSA values of the right and left sides (Table 2).

A weak positive correlation was determined between CSA and TCSA according to BMI in Group 1 (p<0.05). A weak-moderate positive correlation was determined in Group 2 (p<0.05)and a moderate positive correlation in Group 3 (p<0.05).

In Groups 2 and 3, no correlation was determined between the duration of LBP and the CSA and TCSA of the muscles. In Group 2, a weak negative correlation was determined between resting pain severity and CSA and TCSA (p<0.05). No correlation was determined between activity pain severity and CSA of the muscles, and a weak negative correlation was determined with TCSA (p<0.05). In Group 3, no significant correlation was determined between resting and activity pain severity and the CSA and TCSA values.

Table 3. The CSA and TCSA values of the groups according to age, gender, segment, and BMI

		Group		Gender		Segment		Age		BMI	
		p	η^2	P	η^2	p	η^2	p	η^2	p	η^2
CSA	Right L.MF	**0.011**	0.034	**<0.001**	0.124	**<0.001**	0.587	0.186	0.007	**0.006**	0.029
	Left L.MF	0.073	0.020	**<0.001**	0.172	**<0.001**	0.593	0.833	0.000	**<0.05**	0.051
	Right L.ES	0.652	0.003	**<0.001**	0.106	**<0.001**	0.179	0.722	0.000	**<0.05**	0.180
	Left L.ES	0.460	0.006	**<0.001**	0.067	**<0.001**	0.159	0.194	0.006	**<0.05**	0.185
TCSA	Right L.MF - L.ES	0.218	0.012	**<0.001**	0.173	**0.046**	0.023	0.837	0.000	**<0.05**	0.192
	Left L.MF - L.ES	0.271	0.010	**<0.001**	0.151	0.062	0.021	0.259	0.005	**<0.05**	0.220

η^2: partial eta squared BMI (body mass index), CSA: Cross-sectional area, TCSA: Total cross-sectional area, L.MF: lumbar musculus multifidus, L.ES: lumbar erector spina, BMI: body mass index

Examination of Fat Infiltration of the Groups

When fat infiltration was examined, a significant difference was determined between the groups in respect of the right L.MF, left L.MF and left L.ES (p=0.011, p=0.001, p=0.027, respectively) (Table 4). No difference was determined bettween the groups in respect of right L.ES (p=0.0192). The rate of fat infiltrationn <10% was greater in Group 1 than in Groups 2 and 3. The rates of fat infiltration of 10%-50% and >50% were higher in Group 2 and Group 3 than in Group 1.

Table 4. Examination of the fat infiltration within the groups (simplified 3 grade system)

	Healthy control group	Mechanical LBP group	Discopathy LBP group	Total	P*
Fat infiltration R.L.MF					
<10%	38 (42.2)[a]	17 (18.9)[b]	27 (30)[ab]	82 (30.4)	0.011
10%-50%	52 (57.8)[a]	71 (78.9)[b]	62 (68.9)[ab]	185 (68.5)	
>50%	0 (0)	2 (2.2)	1 (1.1)	3 (1.1)	
Fat infiltration Left L.MF					
<10%	39 (43.3)[a]	15 (16.7)[b]	31 (34.4)[a]	85 (31.5)	0.001
10%-50%	51 (56.7)[a]	72 (80)[b]	58 (64.4)[ab]	181 (67)	
>50%	0 (0)	3 (3.3)	1 (1.1)	4 (1.5)	
Fat infiltration Right L.ES					
<10%	33 (36.7)	21 (23.3)	30 (33.3)	84 (31.1)	0.192
10%-50%	56 (62.2)	64 (71.1)	57 (63.3)	177 (65.6)	
>50%	1 (1.1)	5 (5.6)	3 (3.3)	9 (3.3)	
Fat infiltration Left L.ES					
<10%	34 (37.8)[a]	22 (24.4)[b]	31 (34.4)[ab]	87 (32.2)	0.027
10%-50%	55 (61.1)	61 (67.8)	58 (64.4)	174 (64.4)	
>50%	1 (1.1)	7 (7.8)	1 (1.1)	9 (3.3)	

*Chi-square test, L.MF: lumbar musculus multifidus, L.ES: lumbar erector spina,[a-a] : the same letter indicates no difference between groups, [a-b -ab:] Different letters indicate a significant difference between groups.

Fat infiltration in all the muscles showed a significant difference between the groups according to gender (p=0.001, p=0.001, p=0.009, p=0.002, respectively). In all the groups, a higher rate of fat infiltration was observed in females than in males.

In the correlation analysis of age and fat infiltration, a weak negative correlation was determined only in the left L.MF (r=0.123, p=0.043). No significant correlation was found between age and fat infiltration in the other muscles. No correlation was determined between BMI and fat infiltration.

Fat infiltration rates showed a significant difference according to segments (p<0.001). In the right L.MF, the lowest rate of fat infiltration was determined in L3-L4, and the highest in L5-S1. In the left L.MF, the lowest rate was in L3-L4, and the highest in L4-L5/L5-S1. In the right L.ES, the lowest rate was in L3-L4, and the highest in L4-L5/L5-S1, and in the left L.ES, the lowest rate was in L3-L4, and the highest in L5-S1.

In respect of pain duration and severity, a weak positive correlation was only determined between the duration of pain and left L.ES fat infiltration in Group 3 (p<0.05).

Discussion

Measurement of the morphology of lumbar paraspinal muscles has become a focus of interest in recent research related to the etiology of LBP [2, 5, 9, 10, 15, 28]. It has been suggested that dysfunction of these muscles is an important factor in the etiology and chronicity of LBP [10, 28]. Studies have also shown an association between paraspinal muscle atrophy and LBP [2, 9, 10, 12, 15, 16, 27, 29] and fat infiltration [10, 25, 26, 30–33]. However, several studies have reported no significant differences in paraspinal muscle size [19, 32–37] or fat content [9, 15, 28] when compared with healthy individuals.

In the current study, no significant correlation was determined between LBP and the CSA and TCSA values of the L.MF and L.ES. Dystrophic muscles may reduce the muscle measurement. This phenomenon is known as pseudohypertrophy, when fat deposits are located within the muscle fibres [10]. The neuromuscular dysfunction in LBP can cause histological changes in the muscle and this causes atrophy [26]. In addition, the muscle CSA can be reduced because of fat infiltration forming in the muscle bundles [24]. Muscle fatigue is a sign of muscle degeneration, and represents the number of muscle fibres, and the integrity of the individual muscle fibre area and contraction material [38]. Thus, the CSA basically represents the total number of muscle fibres and to a lesser extent, the size of the fibres [12] and the amount of fat in the muscle [16].

In Groups 2 and 3 of the current study, although not statistically significant, the amount of muscle visible on axial slices was less than in the control group, whereas there was both visibly and statistically more fat infiltration. The absence of difference in CSA between the groups in this study was attributed to the CSA not having changed due to increasing fat infiltration despite the reduced functional CSA of the muscles. Therefore, to determine whether or not there has really been a loss of muscle mass, examination of functional CSA is important in respect of providing clearer results, rather than CSA and TCSA values.

Previous studies have reported that males have greater CSA and higher paraspinal muscle density than females, that younger individuals have greater muscle density than older adults, and that individuals of lower weight have higher paraspinal muscle density than those who are overweight [34]. In the current study, the CSA and TCSA values of all the muscles were found to be higher in males than females, and fat infiltration was determined at a higher rate in females than males. These results were consistent with the literature [2, 8, 15–18, 20, 23, 24, 26, 39].

It has been stated that BMI and body weight are associated with a greater muscle CSA [19]. In some studies, a significant correlation has been determined between BMI and the L.MF and L.ES muscle values, and BMI has been stated to be asociated with paraspinal muscle changes [12]. However, there are also studies with results showing no relationship between BMI and CSA [10, 26, 27]. Kalichman et al determined a low but statistically significant negative correlation between BMI and paraspinal muscle density, and this was found to be non-significant in males but significant in females [24]. In the current study, a weak and moderate correlation was determined between BMI and CSA and TCSA.

Consistent with previous studies in literature, when the CSA and TCSA were examined according to segments (L3-L4, L4-L5, L5-S1), the CSA and TCSA values in all the current study groups were determined to be lowest at L3-L4 and highest at L5-S1 level [8, 10, 27, 36, 40–42].

Previous studies in literature can be seen to be weighted towards comparison of asymmetry between symptomatic and asymptomatic sides in groups with and without acute, chronic, and root compression pain [8, 15, 41–43]. Studies of healthy subjects have shown symmetry between the sides of the L.MF. In a study by Hides et al in 1992-94, the difference between the wide edge and the other side was shown to be 3 ± 4% in asymptomatic subjects [40].

Stokes et al recently showed this rate to be 7.2%-9.6% at the L4-5 level compared to the smallest edge [18]. Based on these results, it was stated that asymmetry of > 10% could be seen as potentially abnormal [24]. In the current study, no significant difference was found between the groups in respect of CSA asymmetry. This result was thought to be associated with the balanced distribution of fat infiltration formed in the muscles because there were no patients with acute, unilateral or root compression pain in either the mechanical LBP group or the discopathy LBP group.

In a study conducted to reveal the potential relationship between CSA and LBP with follow-up periods of 1 week, 1 month, 6 months, 1 year, and 15 years, there was seen to be a relationship between CSA and LBP up to 1 year, and no relationship was found in a period longer than 12 months [14]. A limited number of studies have shown a correlation between pain severity and CSA [5], whereas similar to the current study, the majority have shown no relationship between pain severity and CSA [2, 27, 39, 44]. Fat infiltration seems to be a late stage of muscle degeneration. L.MF fat infiltration is common in adults and is strongly correlated independently of body composition [26].

In obese individuals, body fat accumulates naturally in the muscles along the muscle system of the back, and although spine problems are frequently seen, it does not settle at the level of the last two lumbar vertebrae. That fat infiltration is mainly found in these two problem areas tends to show that it is lower back pain that initiates muscle changes [24]. There is no clarity in literature of the relationship between fat infiltration and chronic LBP [13, 14, 33]. Some studies have reported fat infiltration only in the L.MF in chronic LBP [26, 30, 31], while others have reported a relationship with fat infiltration in both the L.MF and L.ES [2, 26, 30, 32–34]. There are also studies reporting no relationship of fat infiltration in the L.MF and/or L.ES [9, 15].

The results of the current study showed increased fat infiltration in the L.MF of the LBP patients compared to the healthy control group, and no significant increase was observed in the L.ES. That degeneration is seen in the L.MF muscle of individuals with chronic LBP is thought to be due to the anatomy, function and innervation properties of this muscle.

The amount of intramuscular fat in the L.MF and L.ES has been shown to be significantly increased in upper lumbar segments compared to lower lumbar vertebral segments [24]. The observation of more paraspinal muscle atrophy (fat infiltration) in L5-S1 than in L3-L4 may be related to spinal pathology occurring at this level and a higher rate of degeneration. The size of the angle between L5-S1 level, that it carries the most weight and is the most mobile level of the spine, significantly increase stress in the vertebral unit. These factors are the probable reason for the paraspinal muscle changes observed at the involved level [12]. Consistent with previous findings in literature, the results of the current study showed that according to the segments of the L.MF and L.ES, the least fat infiltration was at L3-L4 and the most was at L5-S1 [2, 9, 24, 41].

No significant correlation was determined between pain duration and severity and fat infiltration in Group 2. In Group 3, a weak positive correlation was determined only between pain duration and fat infiltration in the left L.ES, and there was no correlation between the severity of pain and fat infiltration. In previous studies of the relationship between L.MF fat infiltration and LBP, there has been limited evidence of no significant relationship of fat infiltration with periods of less or more than one year [14]. The results of the current study were consistent with the literature.

The main limitations of this study was the small sample size [3, 9, 11] due to the difficulty of finding the same number of participants for three separate groups. Other limitations could be said to be that in the measurement of muscle mass, the functional cross-sectional area was not measured rather than CSA and TCSA, and there were no histological data which could be compared with the imaging findings.

Conclusion

Fat infiltration in the L.MF is related to mechanical LBP and discopathy. The evaluation of muscle mass should be made with measurement of muscle atrophy associated with fat infiltration or of functional cross-sectional area rather than CSA and TCSA. This could explain the lack of correlation found between chronic LBP and CSA and TCSA. The results of the patients with mechanical LBP and discopathy LBP were similar and the presence of high fat infiltration in the L.MF shows the need for appropriate lumbar stabilisation exercises in both of these groups for the preservation of the functions of this muscle. Mechanical LBP and discopathy without root compression were not related to paraspinal muscle asymmetry. There was seen to be a higher rate of fat infiltration in females than in males. Fat infiltration was determined to usually be at lower lumbar vertebral levels (L4-5, L5-S1) and usually in the muscle area adjoining the vertebral body. A correlation of CSA and TCSA with BMI was determined but there was no correlation with pain severity or duration.

Abbreviations

L.MF
Lumbar Musculus Multifidus, L.ES:Lumbar Musculus Erector Spinae, MRI:Magnetic Resonance Imaging, CSA:Cross-sectional Area, TCSA:Total cross-sectional area, VAS:Visual Analog Scale, LBP:Low back pain, BMI:Body mass index.

Declarations

Ethical Approval and Consent

The study was conducted in compliance with the principles of the Helsinki Declaration. Approval for the study was granted by the Ethics Committee of near East University (NEU/2020/83-1160). All the participants provided informed consent.

Permission to publish

Not applicable.

Data and materials availability

The data obtained and analyzed in this study is not available to the public because of ethical regulations and local management procedures, but can be obtained on request.

Conflict of Interests

The authors have no conflict of interests to declare.

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Author Contributions

A.Y. and T.Y. designed the study, interpreted the data, and made major contributions to the writing of the article. A.O. managed the study. A.Y. evaluated the suitability of the patients and referred potential participants to the polyclinics. All the authors examined the final draft of the manuscript, made changes, and approved it.

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Figures

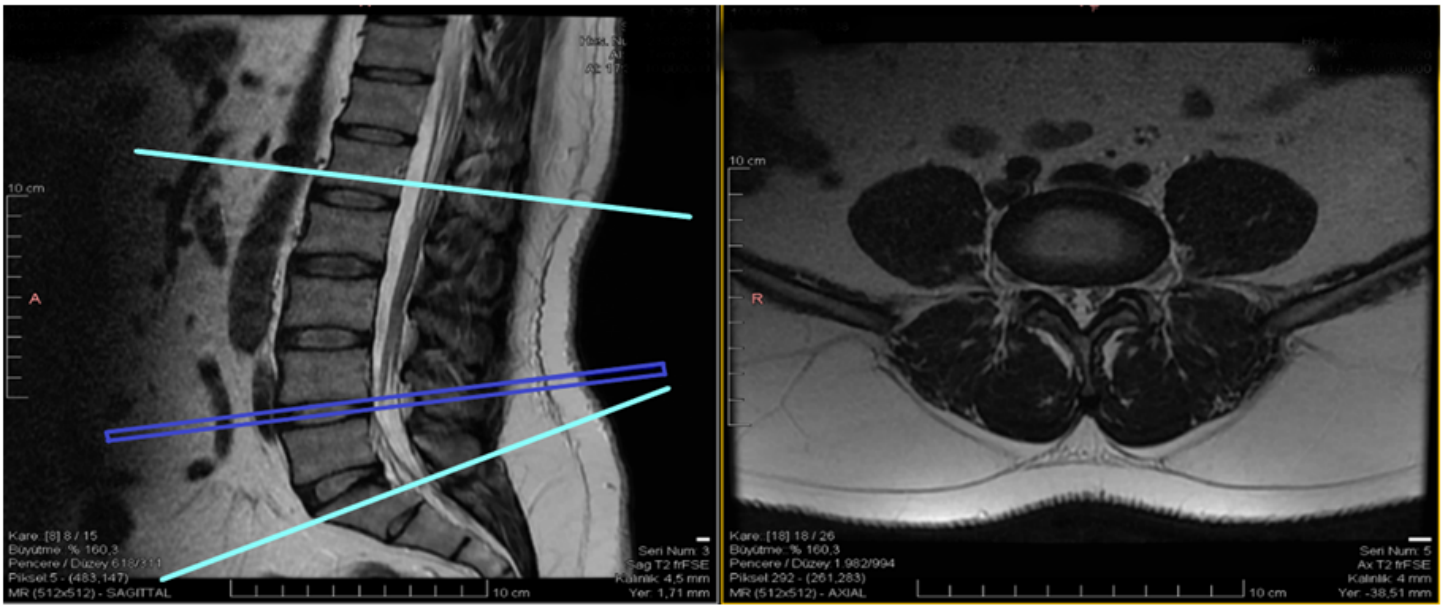

Figure 1

A subject in the healthy control group: L4-L5, T2 sagittal and axial MRI slices

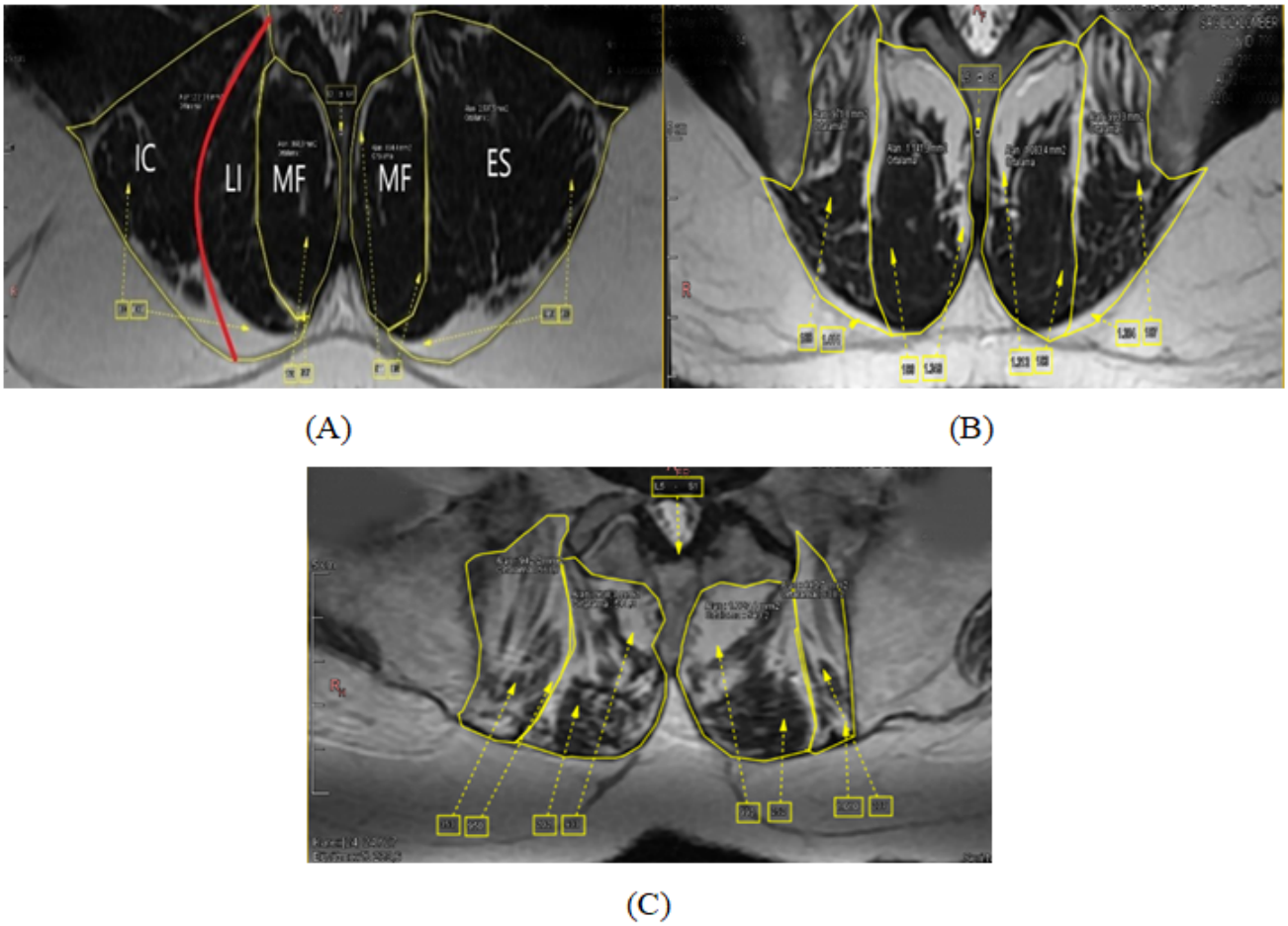

Figure 2

Muscle localisations and fat infiltration grades on T2 axial MRI slice (A) L.MF, L.ES, Musculus longissimus (LI), Musculus iliocostalis (IC) and Grade 1: <10% fat infiltration (B) Grade 2: 10%- 50% fat infiltration (C) Grade 3: >50% fat infiltration