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ORIGINAL ARTICLE PM&R

Ultrasonographic evaluation of muscle thickness in female patients with fibromyalgia and its relationship with clinical parameters

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ABSTRACT

OBJECTIVE: The aim of this study was to compare the ultrasonographic thickness of selected major muscles of patients with fibromyalgia syndrome (FMS) and asymptomatic control subjects and to evaluate the relationship between muscle thickness and muscle strength, physical performance, kinesiophobia, and clinical variables.

METHODS: Twenty-two FMS patients and 18 asymptomatic control cases who applied to the physical medicine and rehabilitation outpatient clinic were included. The thickness of the gastrocnemius medialis/lateralis, trapezius, and upper arm muscle was evaluated with ultrasonography. Muscle strength was evaluated with hand grip strength, muscle performance with chair stand test (CST), walking performance with 10 m walking test, disease severity with Fibromyalgia Impact Questionnaire-Revised, pain severity with VAS, and kinesiophobia with TAMPA kinesiophobia scale.

RESULTS: The mean thickness values of all the muscles measured were significantly decreased in the FMS group compared with the control ($p<0.05$). There were positive correlations between gastrocnemius medialis/lateralis and upper arm muscle thickness with hand grip strength ($p<0.01$, $r=0.602$, $r=0.663$, $r=0.567$, respectively) and positive correlations between gastrocnemius medialis/lateralis muscle thickness with CST ($p<0.05$, $r=0.507$, $r=0.512$, respectively). TAMPA was significantly negatively correlated with gastrocnemius medialis/lateralis and upper arm muscle thickness.

CONCLUSION: Muscle thickness, strength, and performance decrease in FMS patients. This reduction in muscle strength, performance, and size is associated with kinesiophobia. Strengthening exercises should be included in the management of FMS patients. However, caution should be exercised when prescribing exercises that require extreme muscle performance, considering that it may cause kinesiophobia.

Keywords: Fibromyalgia, kinesiophobia; muscle strength; performance; ultrasound.

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Fibromyalgia syndrome (FMS) is a condition of unknown etiology, characterized by chronic widespread pain, often accompanied by fatigue, insomnia, concentration disorders, and psychological disturbances [1, 2]. Although many hypotheses have been proposed, none of them has been widely accepted and its etiopathogenesis is still unclear [3, 4].

Clinically, some symptoms of FMS (fatigue, pain, muscle aches, and trigger points) suggest skeletal muscle involvement. In the literature, muscle biopsy studies conducted in fibromyalgia patients emphasize the morphological and metabolic changes in the muscles, and the role of peripheral mechanisms in chronic pain [5, 6]. Therefore, changes in peripheral muscles need to be better understood.

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It has been reported in ultrasound studies in the literature that muscle function, mass, and structure are affected in several populations [7, 8]. Increasing fear of pain prevents the patient from moving and activities of daily living are reduced, which causes more injury avoidance and fear of movement in patients. In FMS, the fear of pain plays a very important role in daily physical activity habits. It was reported that 40% of the patients showed high levels of fear of movement and avoidance behaviors toward physical activity [9]. This vicious cycle can also make an additional contribution to changes in muscle mass, size, and function.

The number of imaging studies examining changes in muscle morphology in FMS patients is insufficient in the literature [10–12]. Among these studies, only two study using ultrasonography, in which neck muscles were measured, was identified [10, 11].

In many studies, the physical performance and strength of individuals with FMS were found to be lower than healthy women and the general population [13–15]. Jones et al. [16] reported that 25% of individuals with FMS had difficulty in personal care, 60% had difficulty in light housework, climbing stairs, walking a kilometer, and lifting weights, and more than 90% of them had difficulty in doing heavy housework.

However, to the best of our knowledge, no study evaluating the relationship of muscle thickness, physical performance, muscle strength, and kinesiophobia together in patients with FMS has been found in the literature.

The aim of this study was to compare the ultrasonographic thickness of selected major muscles of FMS patients and asymptomatic control subjects and to evaluate the relationship between muscle thickness and muscle strength, physical performance, kinesiophobia, and clinical variables.

MATERIALS AND METHODS

A cross-sectional study was conducted to compare ultrasonographic measurements of gastrocnemius medialis (GC-med), gastrocnemius lateralis (GC-lat) trapezius, and upper arm muscle thicknesses of FMS patients with asymptomatic control subjects and to investigate the relationship between functional status, pain status, muscle strength, and kinesiophobia with muscle thicknesses in FMS patients. Twenty-two FMS patients and 18 asymptomatic control cases who applied to the physical medicine and rehabilitation outpatient clinic between April and October 2017 were included in the study.

Highlight key points

- Fibromyalgia causes decrease in muscle thickness.
- Reduction in muscle thickness is associated with loss of muscle strength and physical performance.
- Kinesiophobia is associated with decrease in muscle thickness.
- In the planning of exercise programs in patients with fibromyalgia, the intensity of exercise should be adjusted carefully in order not to cause kinesiophobia.

The FMS group consisted of patients aged between 18 and 65 years who were diagnosed according to the 2010 criteria of the American College of Rheumatology (ACR), diagnosed at least 6 months ago [2]. Patients were included in the study regardless of their physical activity level. Patients diagnosed with malignancy, inflammatory, neurological diseases, cognitive disorders, orthopedic problems, diabetes mellitus, endocrinological problems, and those who did not give consent to participate were excluded. The study protocol was approved by the Ethics Committee of Istanbul Medeniyet University Goztepe Training and Research Hospital (2017/0002, March 23, 2017) by the Declaration of Helsinki. Written consent was obtained from the participants before the study. The study was conducted according to the STROBE checklist for reporting observational studies.

Clinical Measurements

Age, gender, body mass index (BMI), and disease duration were recorded as demographic parameters.

Visual Analog Scale (VAS)

VAS was recorded to determine the pain level of the participant. On the 0–10 cm chart, the patient was described as having no pain as 0 and 10 as the most severe pain he had ever felt in his life, and he was required to tick the severity of the pain. Then the point was measured with a millimeter ruler [17].

Chair Stand Test (CST)

It reflects the lower extremity muscle strength and physical performance of individuals. The patient is required to sit in the middle of a 43.18 cm high chair straight, feet on the ground with crossed arms in front of his chest. The test starts with the command and the count of full standing up for 30 s constitutes the individual's score. The reliability and feasibility of the test have been evaluated in FMS [18].

10 m Walk Test (10MWT)

For 10MWT, a distance of 14 m with the first and last 2 m marked was determined, and the time that patients walked between 2 and 12 m was measured. To minimize the effects of habituation and fatigue, the states were performed in duplicate, in random order, and the average time was recorded in seconds [19].

Hand Grip Strength

Grip strength was measured at the dominant hand using a hydraulic hand dynamometer (Irvington, NY 10533, USA) following published procedures [20]. The test position is seated in a chair with a backrest on a flat surface, arms close to the body and relaxed, elbow bent 90°, wrist open 0–30°, and ulnar deviation 0–15°. For grip strength measurement, the dynamometer is held in an upright position. Patients were required to squeeze as hard as they could. Both hands were tested for three trials. The highest force (in kg) was taken for the dependent variable.

TAMPA Scale for Kinesiophobia

It is a Likert-type questionnaire consisting of 17 questions scored between 1 and 4 (1: I strongly disagree, 2: I do not agree, 3: I agree, 4: I completely agree) [21]. The maximum value on the scale is 68. The cutoff value is 37, and values below this value are low-grade kinesiophobia. Over 37 are considered high-grade kinesiophobia. Turkish validity and reliability were done by Tunca Yılmaz et al. [22].

Revised Fibromyalgia Impact Questionnaire (FIQR)

FIQR is a questionnaire that evaluates the limitations and functional disability of individuals with FMS with a total of 21 questions in three sections: Physical function, general effect, and symptoms. All questions are evaluated on a numerical scale between 0 and 10. The higher the score obtained from the questionnaire, the higher the disability due to fibromyalgia. The Turkish version of the questionnaire, whose validity and reliability studies were conducted, was used in the study [23].

Ultrasound Measurements

Ultrasonographic evaluations of the muscles were performed with a 5–10-MHz linear array transducer (DC-T6 [Mindray, China]) by the same experienced physiatrist. In the study, upper arm muscle thickness measurement due to its important effect on upper extremity functions, gastrocnemius muscle thickness measurement due to its role in lower extremity activities and walking, trapezius muscle thickness measurement to evaluate the effect of the disease on non-extremity muscles were performed. Upper trapezius muscle thickness measurements were made by placing the probe horizontally on the muscle at the level of the C6 spinous process (Fig. 1). Upper arm muscle thickness measurement was made from 60% distal of the distance between the lateral epicondyle of the humerus and the acromial process of the shoulder on the dominant side (Fig. 2). GC-med and GC-lat muscle thickness measurements were made by placing the transduc-

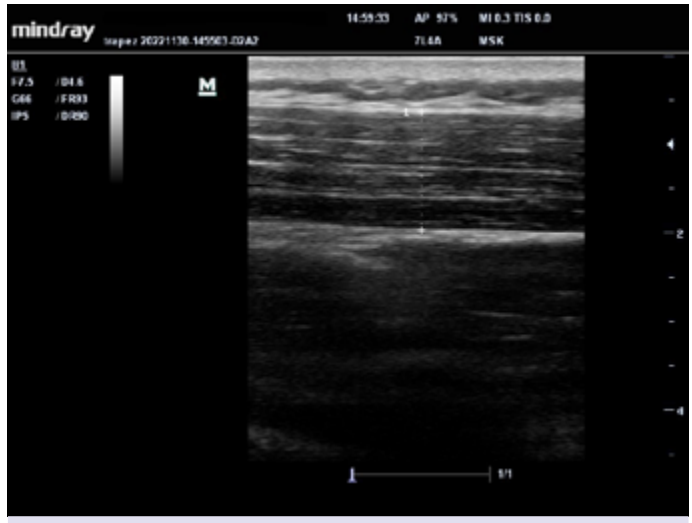

Figure 1. Measurement of trapezius muscle thickness by ultrasonography.

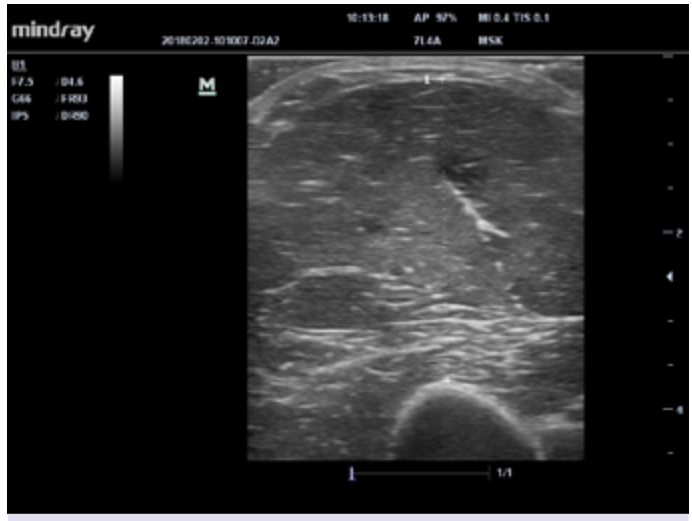

Figure 2. Measurement of upper arm muscle thickness by ultrasonography.

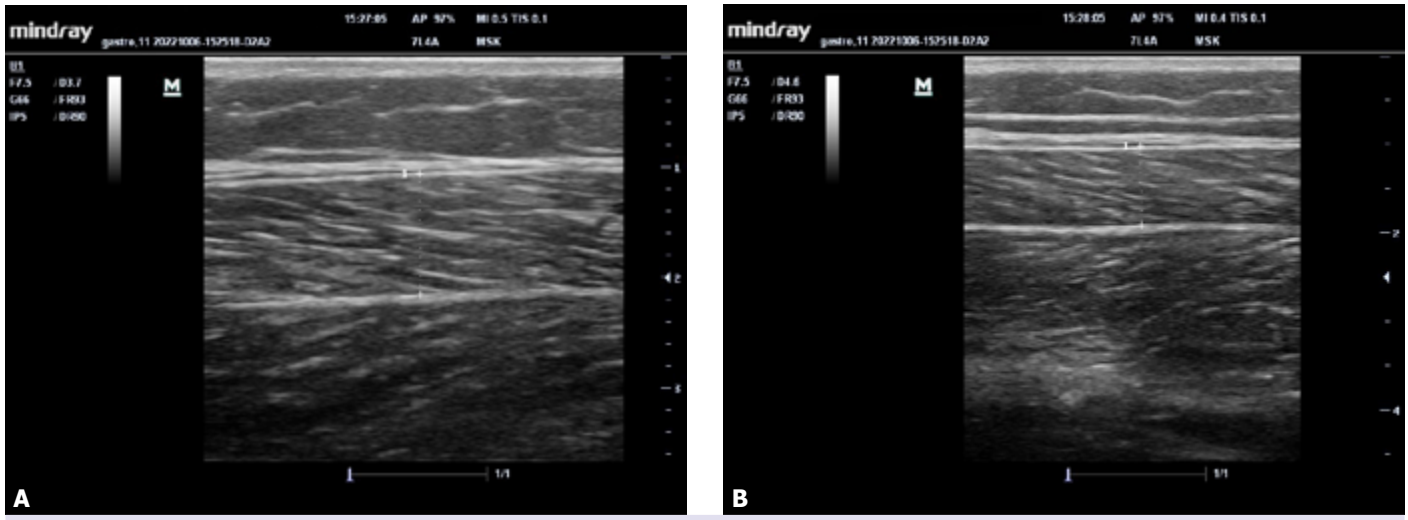

FIGURE 3. **(A)** Measurement of gastrocnemius medialis muscle thickness by ultrasonography. **(B)** Measurement of gastrocnemius lateralis muscle thickness by ultrasonography

er longitudinally in the proximal 30% of the distance between the lateral condyle of the tibia and the lateral malleolus (Fig. 3A, B). The transducer was placed on the line, and special care was taken to avoid applying excessive pressure. This scanning was repeated 3 times, and the mean of three measurements was taken.

Statistical Analysis

Before the study, power analysis was performed using G-power to determine the number of samples. Using the mean and standard deviation data of trapezius muscle thickness of patients and control groups with fibromyalgia in the literature, the effect power was calculated as 1.13 [10]. When alpha was 0.05 and 1-beta was 0.90, the number of samples to be taken in each group was determined as 18.

Statistical analysis was conducted using the Statistical Package for the Social Sciences version 22.0 (IBM Corp., Chicago, IL, USA). Demographic and clinical data were compared and descriptive statistics were summarized as mean±standard deviation or median (IQR) values for continuous variables. Statistically significant differences between groups were determined using the independent samples t-test for continuous variables. In determining the normal distribution, the Shapiro–Wilk test was used. The level of correlation between variables was determined using Pearson correlation coefficients where the data were normally distributed and Spearman Rho correlation coefficients where the data were not normally distributed. Cohen's classification was used for the effect size of the relationship is the correlation coefficient: Between 0.10 and 0.29 is defined as small; between 0.30 and 0.49 as a medium; and 0.50 to 1.0 as a large correlation [24]. The results were evaluated bilaterally at 95% confidence interval, significance level at $p<0.05$ and $p<0.01$.

RESULTS

The study was conducted on a total of 40 participants (22 patients with fibromyalgia for at least 6 months diagnosed by the ACR criteria and 18 asymptomatic control subjects). Demographic characteristics are given in Table 1. Statistically, the study groups had no statistical difference in terms of mean age and BMI ($p>0.05$). Patients with fibromyalgia had significantly lower CST and HGS values and higher 10MWT and TAMPA values compared to control subjects ($p<0.05$) (Table 1).

Intraclass correlation coefficients (ICC) were calculated to evaluate the intra-rater reliability of muscle thickness measurements by ultrasound. In the patient group, the ICC values for the GC-med/GC-lat and trapezius muscle and upper arm muscle were 0.973 (95% CI 0.935–0.988), 0.959 (95% CI 0.904–0.983), 0.985 (95% CI 0.965–0.994), and 0.971 (95% CI 0.932–0.988), respectively. The ICC values for the same muscles in the control group were 0.985 (95% CI 0.960–0.994), 0.969 (95% CI 0.919–0.988), 0.983 (95% CI 0.956–0.9944), 0.985 (95% CI 0.961–0.994), respectively.

Table 1. Demographics for groups

	Fibromyalgia group (n=22)	Asymptomatic control group (n=18)	p
Age (years)	39.36±10.61	37.38±9.82	0.549
BMI	25.48±5.25	23.60±2.95	0.185
Disease duration (month)	72.00 (90.00)*		
VAS	8.00 (2.00)*		
Chair Stand Test	9.45±1.81	12.77±1.62	0.001
10MWT (sc)	8.64±.86	6.84±.36	0.001
Hand grip strength (kg)	25.13±6.39	30.88±5.44	0.004
TAMPA	43.50±7.62	28.66±5.19	0.001
FIQR	54.00 (24.25)*		

BMI: Body mass index; VAS: Visual analog scale; 10MWT: 10 m Walk Test; TAMPA: TAMPA Scale for Kinesiophobia; FIQR: Fibromyalgia impact questionnaire-revised; *: Median (IQR).

Table 2. Muscle thickness measurements for groups

	Fibromyalgia group (n=22)	Asymptomatic control group (n=18)	p
Gastrocnemius med thickness (mm)	16.32±1.48	19.77±2.09	**0.001**
Gastrocnemius lat thickness (mm)	13.40±1.28	16.61±1.97	**0.001**
Trapezius thickness (mm)	11.18±1.99	12.62±1.70	**0.020**
Upper arm muscle thickness (mm)	24.78±3.91	28.37±4.88	**0.014**

Independent sample t-test.

All measured muscle thicknesses of the FMS group were found to be statistically significantly lower than the control group ($p<0.05$) (Table 2). Table 3 shows the correlation analysis between demographic data and disease-related parameters. While no statistically significant correlation was found between age, BMI, VAS, CST, 10MWT, HGS, FIQR, and TAMPA ($p<0.05$), a statistically significant negative large correlation was found between disease duration and HGS ($p<0.05$). A positive medium correlation was found between HGS and CST ($p<0.05$), and a negative large statistically significant correlation was found between TAMPA and HGS and between TAMPA and CST ($p<0.001$).

Table 4 shows the correlation analysis between muscle thicknesses and disease-related parameters. A statistically significant positive large correlation was found between GC-med and GC-lat muscle thicknesses and CST and HGS ($p<05$ and $p<0.01$, respectively, for both GC-med and GC-lat). In addition, a statistically significant negative large correlation was found between GC-med, GC-lat, and TAMPA ($p<0.001$). There was a statistically significant positive large correlation between upper arm muscle thickness and HGS, a statistically significant negative medium correlation between upper arm muscle thickness and CST, and a statistically significant negative medium correlation between upper arm muscle thickness and TAMPA ($p<0.01$, $p<0.05$, $p<0.05$, respectively).

DISCUSSION

In this study, ultrasonographically measured GC-med/GC-lat, trapezius, and upper arm muscle thicknesses in fibromyalgia patients were compared with asymptomatic control subjects, and the relationship between muscle thickness and disease-related parameters was evaluated.

TABLE 3. Correlation analysis between demographics and disease-related parameters

	Age	BMI	DD	VAS	CST	10MWT	HGS	FIQR	TAMPA
Age									
rho	1	0.150	0.331†	0.261†	-0.089	0.203	-0.230	0.269†	-0.050
p		0.504	0.132	0.240	0.695	0.366	0.303	0.226	0.824
BMI									
rho		1	0.139†	0.162†	-0.123	0.114	-0.033	0.066†	0.031
p			0.537	0.472	0.585	0.613	0.884	0.770	0.891
DD									
rho			1	0.288†	-0.102†	0.317†	-0.505*†	0.144†	0.317†
p				0.193	0.652	0.151	0.016	0.523	0.151
VAS									
rho				1	-0.054†	0.170†	-0.367†	0.192†	0.079†
p					0.813	0.450	0.093	0.391	0.727
CST									
rho					1	-0.186	0.499*	-0.143†	-0.761**
p						0.408	0.018	0.526	0.000
10MWT									
rho						1	-0.208	0.315†	0.229
p							0.353	0.153	0.306
Hand grip strength									
rho							1	-0.290†	-0.798**
p								0.190	0.000
FIQR									
rho								1	0.259†
p									0.245
TAMPA									
rho									1
p									

*: P<0.05; **: P<0.01; †: Spearman correlation test; BMI: Body mass index; DD: Disease duration; VAS: Visual analog scale; CST: Chair stand test; 10MWT: 10 m Walk Test; HGS: Hand grip strength; FIQR: Fibromyalgia impact questionnaire-revised; TAMPA: TAMPA Scale for Kinesiophobia.

All muscle thicknesses were lower in the fibromyalgia group. This result is consistent with our study hypothesis and the literature on chronic painful conditions. Kuzu and Aras [10] evaluated neck extensor muscle thicknesses in 41 patients with fibromyalgia and found that all muscle thicknesses investigated were lower in the fibromyalgia group. Fernández-De-Las-Peñas et al. [25] reported lower cervical multifidus muscle thickness evaluated by ultrasound in patients with chronic mechanical neck pain compared to healthy controls and interpreted that fear of pain may contribute to muscle atrophy. Ozcakar et al. [26] also stated that fear of movement due to chronic pain may cause a decrease in muscle volume in the following years. In this study, compatible with Ozcakar, the relationship between muscle strength and disease duration and also the relationship between muscle strength and kinesiophobia was shown. Therefore, it seems that one of the priority targets in chronic pain should be kinesiophobia.

The thickness of the GC-med, GC-lat, and upper arm muscles was associated with muscle strength and muscle performance, and the thickness of the GC and upper arm muscle was associated with kinesiophobia. Bonaterra et al. [27] examined the morphology of the GC and soleus muscles in fibromyalgia mice models and found a 21.6% reduction in fiber cross-sectional area in the GC muscle. These results reveal the relationship between muscle morphological changes and loss of muscle strength in FMS patients.

Table 4. Correlation analysis between disease-related parameters and muscle thickness measurements

	GC-med	GC-lat	Trapezius	Upper arm
VAS				
rho	-0.087†	-0.145†	0.204†	0.104†
p	0.700	0.519	0.363	0.646
CST				
rho	0.507*	0.512*	-0.048	0.151
p	0.016	0.015	0.831	0.501
10MWT				
rho	0.078	-0.040	0.064	-0.051
p	0.729	0.861	0.777	0.820
Hand grip strength				
rho	0.602**	0.663**	0.125	0.567**
p	0.003	0.001	0.578	0.006
FIQR				
rho	-0.169†	0.069†	0.341†	-0.202†
p	0.451	0.759	0.121	0.368
TAMPA				
rho	-0.713**	-0.725**	-0.197	-0.482*
p	0.000	0.000	0.378	0.023

*: P<0.05; **: P<0.01; †: Spearman correlation test; GC: Gastrocnemius; VAS: Visual analog scale; CST: Chair stand test; 10MWT: 10 Meter Walk Test; FIQR: Fibromyalgia impact questionnaire-revised; TAMPA: TAMPA Scale for Kinesiophobia.

In this study, HGS was found to be associated with upper arm, GC-med and GC-lat muscle thicknesses, and CST was associated with GC-med and GC-lat muscle thicknesses. However, 10MWT was not associated with muscle thickness. While HGS and CST can be considered activities that require intense muscle performance, 10MWT is a walking activity that does not require advanced muscle performance. While the thickness of the upper and lower extremity muscles is associated with kinesiophobia because they are affected by intense muscle performance, the thickness of the trapezius muscle is not associated with kinesiophobia since it is not exposed to intense and direct stress. Russek et al. [28] investigated movement-related fear and quality of life in fibromyalgia patients and found kinesiophobia in 72.9% of the participants.

Fibromyalgia patients avoid strenuous activities in their daily lives, which leads to muscle atrophy. In this study, while thicknesses of upper and lower extremity muscles, which require intense activity, decreased to kinesiophobia, 10MWT, which reflects walking performance, was not found to be associated with kinesiophobia. For this reason, activities such as "walking" that do not cause kinesiophobia as they require a certain level of muscle activity should be given priority in the exercise programs of patients with fibromyalgia and it is necessary to be more careful when choosing exercises that require excessive muscle activity, as they can cause kinesiophobia.

In the literature, 20–35% lower muscle strength has been reported in FMS patients [15, 29, 30]. Köklü et al. [31] reported lower HGS in fibromyalgia patients compared to asymptomatic controls, but HGS was not associated with disease severity. In this study, muscle thicknesses were lower than the control, and muscle thickness was found to be correlated with HGS. Similarly, no significant relationship could be demonstrated between pain and quality of life and HGS.

No correlation was observed between muscle thicknesses and VAS, 10MWT, and FIQR in this study. Similarly, Kuzu and Aras [10] did not report the relationship between neck extensor muscle thickness and pain. Differently, Kuzu and Aras found a relationship between cervical multifidus, splenius capitis, trapezius muscle thicknesses, neck disability index, and FIQ. Valera-Calero et al. [11] also found no relationship between the cervical multifidus muscle cross-sectional area and the severity of pain in patients with fibromyalgia.

This study has some limitations. Evaluation of muscle metabolism together with muscle thickness and evaluation of lower extremity muscle performance with more objective methods such as isokinetic devices can provide more accurate results. In this study, large muscles were selected from the upper extremity and lower extremity and neck muscle groups. Future studies should be performed with a larger sample and in more diverse muscle groups.

Conclusion

These results show that muscle size and strength, performance decrease in FMS patients. This reduction in muscle strength, performance, and size is associated with kinesiophobia. The GC and upper arm muscles were found to be most associated with muscle strength and performance, while the GC-med, GC-lat, and upper arm muscles were found to be the most associated with kinesiophobia. Strengthening exercises should be included in the management of FMS patients. However, caution should be exercised when prescribing exercises that require extreme muscle performance, considering that it may cause kinesiophobia. Breaking the vicious circle of kinesiophobia is of great importance to increase the continuity of exercise.

Ethics Committee Approval: The Istanbul Medeniyet University Goztepe Training and Research Hospital Clinical Research Ethics Committee granted approval for this study (date: 23.03.2017, number: 2017/0002).

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