Investigation of cervical extensor muscle volume in females with fibromyalgia

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Abstract

Objective

Neck pain is one of the most common symptoms in individuals with fibromyalgia (FM). The aim of this cross-sectional study was to compare cervical extensor muscle volume measurements between FM patients with chronic neck pain and an asymptomatic control group, and to examine the relationship between cervical extensor muscle volume and pain, quality of life, and disability.

Methods

The study included 30 patients with FM and 30 asymptomatic control subjects. The volume of the cervical extensor muscles (obliquus capitis superior, obliquus capitis inferior and rectus capitis posterior major muscles) was assessed using 3T magnetic resonance imaging (MRI). The severity of FM was assessed using the Fibromyalgia Impact Questionnaire (FIQ), the Neck Disability Index (NDI) for neck disability, and the Visual Analogue Scale (VAS) for pain severity.

Results

The average volume values of all neck extensor muscles were significantly reduced in the FM group compared to the control group ($p<0.05$). There were significantly negative correlations between FIQ and NDI and the volumes of the obliquus capitis superior, obliquus capitis inferior, and rectus capitis posterior major muscles ($p<0.05$). However, there was no significant correlation between neck extensor muscle volume and age, VAS, and BMI scores ($p>0.05$).

Conclusion

This study has demonstrated a decrease in deep cervical extensor muscle volume in FM patients with chronic neck pain. When planning treatment for FM patients with neck pain, clinicians should consider cervical extensor muscle morphology.

Key words

fibromyalgia, magnetic resonance imaging, neck extensor muscle volume, chronic neck pain

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Introduction

Fibromyalgia (FM) is a chronic syndrome characterised by widespread pain and tenderness in specific anatomical areas of the body, along with fatigue, sleep disturbances, and cognitive and somatic symptoms (1, 2). It is reported that FM is more common in females than in males, and its prevalence in the general population ranges from 0.2% to 6.6% (3, 4). It is thought that certain genetic and environmental factors, along with abnormalities in autonomic and neuroendocrine system functions, may play a role in the pathophysiology of this syndrome (5). However, the literature does not provide clear information regarding the pathophysiology of FM (6).

Neck pain is one of the most common symptoms in individuals with FM (2, 7, 8). This condition is said to be related to the presence of multiple tender anatomical points in the neck region in the diagnostic criteria for FM (9). It has been suggested that abnormalities in pain inhibition mechanisms and sensory inputs in individuals with FM may cause differences in processing processes in the central nervous system. However, there is no definitive consensus on the pathophysiology of pain in individuals with FM (5).

It has been suggested that cognitive factors may influence activity levels and that this may lead to certain changes in muscle size, shape, and function (10). The idea that exercise and daily living activities in FM syndrome can often cause fatigue and trigger pain in tender points may lead individuals to avoid exercise (11). A systematic review in the literature addressing morphological muscle changes in patients with chronic neck pain reported that there may be decreases in the cross-sectional areas (CSA) of the neck extensor muscles (12).

Although neck pain is a common symptom in FM, we could not find any studies examining the relationship between deep neck muscles and pain and functional limitations in individuals with FM. Therefore, our study aimed to determine the volumes of the neck extensor muscles and compare them with the control group. Additionally, the relationship between muscle volume and neck pain, daily living activities, and FM severity was examined.

Methods

This study is a single-centre, prospective, and cross-sectional cohort study conducted at the Physical Therapy and Rehabilitation Department of Kayseri Training and Research Hospital in accordance with the principles of the Declaration of Helsinki. Our study was approved by the Non-Interventional Clinical Research Ethics Committee of Niğde Ömer Halisdemir University under protocol number 2024/105. Participants were informed about the study and written consent was obtained.

Sample size and determination of study groups

To determine the sample size for this study, it was calculated that at least 26 individuals would be included in the FM and control groups, assuming a power of 90% and a Type I error of 5%, with an effect size of 0.80. This calculation was performed using the G*power 3.1.9.6 program. Within this scope, a total of 60 individuals were included in our study, comprising 30 individuals with fibromyalgia and 30 control group individuals, whose magnetic resonance (MR) images were taken between November 2023 and December 2023.

The inclusion and exclusion criteria for individuals participating in the study were as follows:

Inclusion criteria:

- Having a diagnosis of fibromyalgia according to the American College of Rheumatology (ACR) 2016 Diagnostic Criteria;
- Being between the ages of 18-85;
- Being of the female gender;
- Not having any type of headache.

Exclusion criteria:

- Having chronic systemic diseases;
- Having inflammatory rheumatoid diseases (rheumatoid arthritis, ankylosing spondylitis, systemic lupus erythematosus, etc.);
- Having a history of malignancy;
- Having psychiatric disorders such as depression or schizophrenia;
- Having a history of autoimmune disorder;

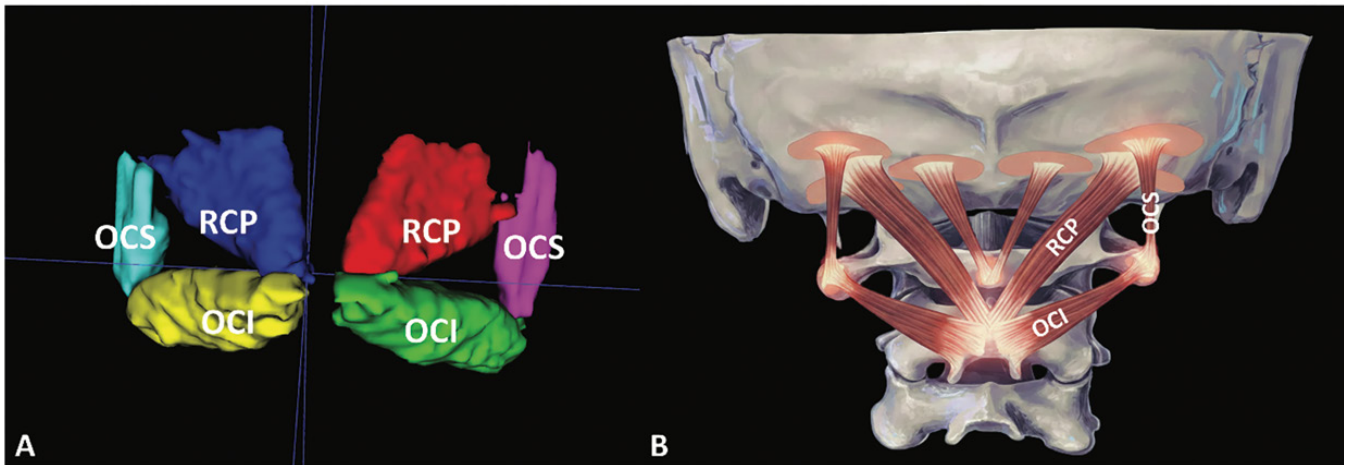

Fig. 1. A. Calculation of muscle volume using the ITK-SNAP program and 3D reconstruction; **B.** Schematic representation of muscles measured for volume. OCS: obliquus capitis superior muscle; OCI: obliquus capitis inferior muscle; RCP: rectus capitis posterior major muscle.

- Regular or excessive alcohol consumption;
- Having any type of headache.

The prevalence of fibromyalgia is significantly higher in female patients. To ensure optimal homogeneity and prevent possible hormonal effects, only female cases were included in both the patient and control groups. In addition, to ensure that the duration of the disease did not influence the findings in the fibromyalgia patients participating in the study, participants with similar disease durations were included in the study. The average age of participants was 45.29 (age range: 18–85). The female participating in the study consisted of sedentary housewives with similar body mass indexes (BMI).

Clinical scale assessment

Participants' age, body mass index (BMI), neck pain, FM severity and the severity of the impact of daily living activities on neck pain were recorded.

FM severity was assessed using the Fibromyalgia Impact Questionnaire (FIQ) used to assess the symptoms of the disease, functional limitations and effects on quality of life in individuals diagnosed with FM. The scoring results in a total score between 0 and 100, with a high score indicating increased symptom severity and impaired quality of life (13).

The severity of neck pain was assessed using the Visual Analogue Scale (VAS). One end of a 10-centimeter line was marked as '0' for no pain; the other end was marked as '10' for severe pain. Participants were asked to mark where their pain level fell on the scale. The distance from the '0' point (no pain) to the marked point was considered the person's pain intensity (14).

The level of impact of daily living activities on neck pain was assessed using the Neck Disability Index (NDI) (14). This scale consists of 10 items with a maximum score of 50 points. A high score indicates that neck pain has a more negative impact on daily activities (15).

Radiological evaluation

Volume analysis. Radiological images obtained using a Siemens Magnetom Skyra, Germany 3T (Tesla) Magnetic Resonance Imaging (MRI) device were used to calculate the volumes of the obliquus capitis superior muscle (OCS), obliquus capitis inferior muscle (OCI), and rectus capitis posterior major muscle (RCP). A T1-weighted magnetisation-prepared gradient echo with fast acquisition (MPRAGE) sequence was used to visualise the muscles.

The Insight Segmentation and Registration Tool Kit (ITK-SNAP) software program was used to measure muscle volumes in this study. In our study, muscle volumes were calculated using a semi-automatic segmentation algorithm in ITK-SNAP. The segmentation process was performed by loading the MRI data obtained in Digital Imaging and Communications in Medicine (DICOM) format into the ITK-SNAP toolkit. This algorithm classifies the pixels corresponding to the volume of the muscles to be measured in all MRI data slices in 3D and calculates the volume in cm^3 (Fig. 1) (6). The participants' MRI images were evaluated for pathological findings by a radiologist. The MRI data of individuals without pathological findings were measured by a specialist anatomist.

Statistical analysis

Whether the numerical variables were suitable for normal distribution was evaluated by Shapiro Wilk test. For numerical variables showing a normal distribution, the mean ± standard deviation was summarised. For comparisons between two groups, the independent samples t-test, one of the parametric tests, was used. The relationship between two normally distributed continuous variables was analysed by Pearson correlation coefficient. Two observers' measurements analysed with intraclass correlation coefficient for interobserver, and high agreement was found between the observers by using 95% estimated confidence intervals. Statistical analyses of this study were performed with IBM SPSS v. 22.0 (SPSS, Inc., Chicago, IL, USA). $p<0.05$ was accepted as statistical significance level.

Results

The demographic and clinical data of the participants are summarised in Table I. The age and BMI of the groups were similar ($p>0.05$) (Table I).

Table I. Demographic and clinical data of the participants.

Parameters	Participants with FM (n=30) mean ± SD	Control group (n=30) mean ± SD	*p*
Age (years)	46.80 ± 8.01	44.30 ±9.67	0.280
BMI (kg/m^2)	28.23 ± 3.99	26.47 ±4.13	0.100
VAS	7.26 ± 2.25	N/A	
FIQ	70.65 ± 16.35	N/A	
NDI	21.75 ± 7.12	N/A	

FM: fibromiyalgia; n: sample size, SD: standard deviation; BMI: body mass index; VAS: visual analogue scale; FIQ: fibromyalgia impact questionnaire; NDI: neck disability index; N/A: not applicable.

Table II. Comparison of muscle volume measurements between groups.

Parameters	Participants with FM (n=30) mean ± SD	Control group (n=30) mean ± SD	*p*
Right OCS (cm^3)	1.76 ± 0.39	1.92 ± 0.46	**0.028**
Left OCS (cm^3)	1.36 ± 0.43	1.85 ± 0.36	**0.014**
Right OCI (cm^3)	4.82 ± 0.87	4.98 ± 0.54	**<0.001**
Left OCI (cm^3)	4.35 ± 0.54	4.78 ± 0.62	**0.031**
Right RCP major (cm^3)	2.54 ± 0.82	2.61 ± 0.46	**0.044**
Left RCP major (cm^3)	2.45 ± 0.68	2.74 ± 0.64	**0.026**

FM: fibromyalgia; n: sample size; SD: standard deviation; OCS: obliquus capitis superior muscle; OCI: obliquus capitis inferior muscle; RCP: rectus capitis posterior major muscle.

Table III. Correlation between scales based on muscle volume measurement in individuals with FM.

Parameters		OCS	OCI	RCP
FIQ	r	-0.926	-0.846	-0.816
	p	**<0.001**	**<0.001**	**<0.001**
NDI	r	-0.533	-0.446	-0.516
	p	**0.018**	**0.033**	**<0.001**

FIQ: fibromyalgia impact questionnaire; NDI: neck disability index; OCS: obliquus capitis superior muscle; OCI: obliquus capitis inferior muscle; RCP: rectus capitis posterior major muscle; r: Pearson correlation coefficient.

The comparison of the volume values of the measured muscles between the groups is summarised in Table II. In the FM group, the volume values of both the right and left OCS, OCI, and RCP muscles were found to be lower than those in the control group (p<0.05) (Table II).

The data from the correlation analysis between scale values containing clinical data and the OCS, OCI, and RCP muscles are summarised in Table III. There was a very high level of linear relationship in the negative direction between the FIQ score and the OCS (r=-0.926, p<0.001), OCI (r= -0.846, p<0.001), and RCP (r= -0.816, p<0.001) muscles. A moderate negative linear relationship was found between the NDI score and the OCS (r=-0.533, p=0.018), OCI (r= -0.446, p=0.033), and RCP (r= -0.516, p<0.001) muscles (Table III). However, no significant correlation was found between muscle volume values and age, VAS, or BMI scores (p>0.05).

Discussion

Our findings revealed that individuals with chronic neck pain and FM had lower deep cervical extensor muscle volume compared to the asymptomatic control group. We also determined that there was a negative correlation between deep cervical extensor muscle volume and FM severity and the level of daily living activities performed.

Although some studies in the literature report that neck pain is a common symptom in FM, studies focusing on volumetric assessment of cervical extensor muscles in FM are limited (2). However, the literature reports that 3D images are more reliable than 2D images and provide more detailed anatomical information (16). Therefore, in our study, we determined the dimensions of the neck extensor muscles using 3D reconstruction. However, studies analysing the cross-sectional areas of the neck extensor muscles in FM are available in the literature. Fernández-de-las-Peñas *et al*. compared multifidus muscle thickness between individuals with chronic bilateral mechanical neck pain and a control group and reported that muscle thickness was lower in the

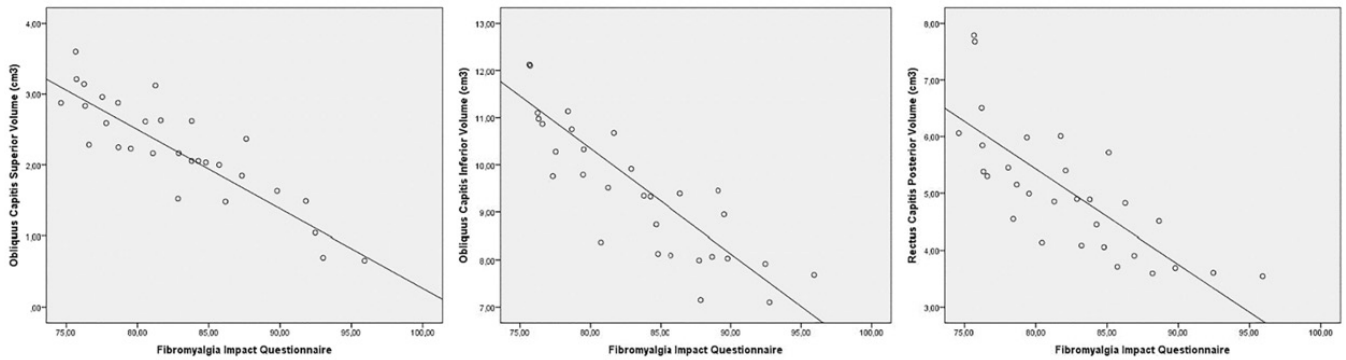

Fig. 2. Scatter plot of muscle volume values and FIQ.

FM group than in the control group (17). Similarly, Kuzu and Aras reported that the cross-sectional thicknesses of the multifidus, semispinalis capitis, semispinalis cervicis, splenius capitis, and trapezius muscles were lower in the FM group (2). In the present study, the volumes of the OCS, OCI, and RCP muscles, which are part of the deep cervical extensor muscle group, were determined using 3D reconstruction in participants with neck pain in the FM group and in the asymptomatic control group. Our data showed that individuals with FM had lower muscle volume ($p<0.05$). Based on these data, it can be concluded that there is a decrease in muscle volume in the deep cervical extensor muscles in FM. Etemadi *et al*. reported in their study evaluating the cross-sectional thickness and strength of the OCS and RCP muscles in women with chronic tension-type headache that both muscle cross-sectional thickness and muscle strength were lower compared to the control group. They also found a negative correlation between muscle strength and pain intensity (18). Our study found that individuals with FM had lower muscle volume compared to the healthy control group ($p<0.05$). A very strong negative correlation was found between the level of impact of daily living activities on neck pain (NDI score) and muscle volume ($p<0.05$). These data suggest that the decrease in muscle volume may be due to FM patients avoiding physical activity and exercise because of pain or the likelihood of triggering pain at tender points. It is a well-known fact that FM affects the daily activities and quality of life of individuals negatively (19). De Pauw *et al*. reported that muscle atrophy occurred in individuals with chronic idiopathic neck pain due to the disuse of pain-related muscles (12). In our study, we analysed the relationship between deep cervical extensor muscle volume and the severity of FM and the impact of daily living activities on neck pain. Our findings showed a negative correlation between OCS, OCI, and RCP muscle volumes and FIQ and NDI scores. According to these data, a reduction in muscle volume in the deep cervical extensor muscles negatively affects the quality of life of FM patients and increases neck dysfunction.

Limitations

The current study has certain limitations. First, the potential effects of demographic variables associated with FM in the literature, such as socioeconomic status and educational level of the sample, were not included in the analysis (20). Second, because FMS is epidemiologically more common in women, the study group consisted only of female participants; this limits the generalisability of the clinical findings to male patients. Third, the small sample size of the study limits the findings. Finally, the lack of questioning about participants' comorbidities and routine medication use requires caution in interpreting the findings.

Conclusion

In conclusion, this study has demonstrated the presence of morphological changes in the suboccipital neck muscles of patients with fibromyalgia. Furthermore, it was observed that an increase in FM severity leads to a decrease in muscle volume and may negatively affect the impact of daily living activities on neck pain. Based on the data obtained, it is believed that taking structural changes in the neck muscles into account when determining treatment strategies for FM patients with neck pain could enhance treatment efficacy and significantly contribute positively to the daily living activities of FM patients.

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