Association of Ultrasonography Findings with Pain, Range of Motion, Disability, and Pressure Pain Threshold in Subjects with Upper Trapezius Myofascial Pain Syndrome

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ABSTRACT

Purpose: The purpose of the present study was to evaluate the association of ultrasonography findings with pain, range of motion, disability, and pressure pain threshold in patients with upper trapezius myofascial pain syndrome.

Methods: A total of 60 subjects with upper trapezius myofascial pain syndrome (mean age: 25.90±4.47 y; mean weight: 63.53±7.76 kg; mean height: 166.55±5.65 cm; and pain duration: 9.75±6.04 month) were selected with nonprobability convenient sampling method and examined. After methodological study, all participants were evaluated regarding their pain, cervical range of motion, functional disability, pressure pain threshold (PPT), maximum muscle and fascia thickness as well as strain ratio by the following instruments, respectively: visual analogue scale, goniometry, neck disability index, algometer, sonography, and sonoelastography.

Results: The ICC values for intra- and inter-examiner reliability of variables were high to very high (0.72-0.96). The correlation coefficients between pain (r=0.22), range of motion (r=0.11), disability (r=0.13), PPT (r=0.32), and maximum thickness of muscle were moderate. The correlation coefficients between pain (r=0.13), range of motion (r=0.23), disability (r=0.17), PPT (r=0.23) and maximum thickness of fascia were low. The correlation coefficients between pain (r=-0.65), range of motion (r=-0.23), disability (r=-0.41), PPT (r=0.71) were high. Values of β for strain ratio and pain were -0.35 (P=0.01), range of motion, -0.14, (P=0.03); disability, -0.19, (P=0.03); and PPT, 0.41 (P<0.001).

Conclusion: Strain ratio of upper trapezius muscle in subjects with myofascial pain syndrome has strong correlation with pain, disability, and PPT. However, maximum muscle thickness and fascia of the upper trapezius are correlated with these variables poorly. PPT is the highly correlated factor with strain ratio.

Keywords:
Myofascial pain syndrome, Sonography, Disability, Strain ratio

1. Introduction

One of the major reasons for pain and dysfunction in musculoskeletal system is myofascial pain syndrome [1]. About 95% of patients with chronic pain are affected by myofascial pain syndrome [2]. Millions of people suffer from this syndrome, which incurs a great deal of cost to society [3]. Also, this syndrome is considered a clinical challenge for a long time [4]. Myofascial pain syndrome is a common, non-articular, and musculoskeletal disorder which its main characteristic is trigger points. The trigger points may be active or latent [5].

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Sonography is a non-invasive, reliable and simple method for assessing changes in muscles thickness, fibers angle, and length of muscle fascicle. In this method, probability for crosstalk is low and repeatability for assessing muscular thickness is acceptable [6]. In many studies, measuring muscle thickness with sonography is reported as an important factor in comparing healthy individuals with patients [7, 8].

However, difference in muscle thickness (in different angles of motion range) between healthy and patient groups has been mentioned as well [9]. Furthermore, in recent studies besides measuring the muscle thickness, measurement of fascia thickness (for assessing the treatment or its outcomes) has been taken into specific account [10, 11]. On the other hand, sonoelastography is a method based on ultrasound, which shows stiffness of soft tissue both qualitatively and quantitatively (strain ratio) [12]. The strain ratio is in fact the movement of target tissue in relation to other tissues (such as fat) following surface pressure, which is applied for calculating elasticity of living tissue. Furthermore, the more the strain ratio of a muscle, the less its stiffness [5, 12]. Sidkar et al. revealed that stiffness of upper trapezius muscle in individuals with myofascial pain syndrome is higher compared to healthy individuals [5].

Although, sonography and sonoelastography are used in order to assess thickness and strain ratio, their correlation with clinical findings, especially pain, motion range, disability and pressure pain threshold have not been studied yet [5]. Therefore, the present study aimed to investigate the correlation between sonography and sonoelastography findings with pain, range of motion, disability and pressure pain threshold in patients with upper trapezius myofascial pain syndrome. Besides, more correlated variables to sonographic findings would be determined.

2. Materials & Methods

A total of 60 participants aged 20 to 40 years with upper trapezius myofascial pain syndrome were recruited for this study through nonprobability sampling method. They were referred to medical and physiotherapy centers affiliated to University of Social Welfare and Rehabilitation sciences during 2013-14. This research was a descriptive cross-sectional and non-experimental study in which the correlation between several dependent and independent variables were investigated. Also, before data collection, a preliminary investigation as well as methodological research was carried out by two examiners to determine the repeatability of the measurements [7]. It should be noted that each examiner recorded the intended variables 3 times in each session and the interval between tests and retests was 1 week.

The inclusion criteria were as follows: chronic pain for more than 3 months and diagnosis of active trigger points in upper trapezius by two physical therapists based on Simons's criteria [5]. The criteria includes 1) taut band in muscles, 2) tender points in upper trapezius muscles, and 3) pain recognition, i.e. certain patterns of pain prevalence following pressure on trigger points (back and lateral parts of neck, temple, above eye and maxilla of involved part).

No participants in this study had history of fractures in spine and limbs, operation, tumor, infection, rheumatoid arthritis, anatomic abnormalities, dizziness, neurologic or metabolic diseases, and severe osteoarthritis. Also, the participants did not take analgesics, anti-inflammatory drugs as well as hypnotic drugs at least one week before test and on the day of the test. The participants had no addiction to alcohol and narcotics [5, 12]. Finally, after qualification of the participants and explaining the purpose and method of the experiment to them, they signed the consent form.

For data collection, a individual questionnaire was used in which the individual's characteristics, including age, weight, and height was recorded. Moreover, the information obtained from examiner's assessment was registered in it as well. In order to assess the pain intensity, the visual analogue scale was used by marking a 10-cm line segment which the patient marked after explaining the procedure [11]. A goniometer (UG, 360, Vekro, USA) was used to measure the range of motion of neck. Neck disability index was used to measure performance of individuals and finally pressure algometry was applied to record pressure pain threshold (Force gauge, FG-5005, RS232, Lutron Electronic, Arizona, USA) [13-15].

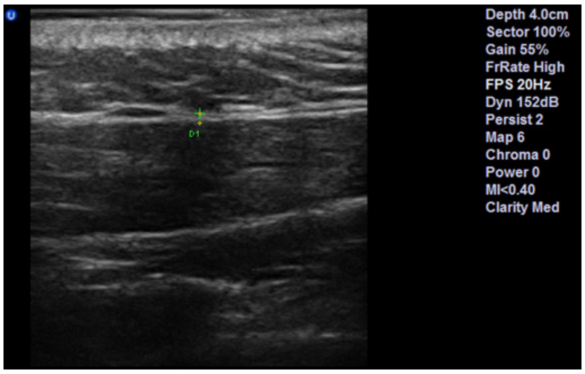
Clinical examinations

The central area between acromion and spinous process of the seventh cervical vertebra was initially palpated by the examiner (the most common part for trigger points in upper trapezius muscle). One of the important parts in assessing individuals was to find spinous process of the seventh cervical vertebra, which was done by bending and straightening the neck. In this way, the examiner touched 2 of the most prominent cervical inferior spinous processes by the index and middle finger while the neck was flexed. Then, the participant was asked to straighten the head. While the upper process moved forward and lower process remained immovable, the second one was the spinous process of the seventh vertebra, but when both remained immovable, the upper process belonged to the seventh vertebra. Then, this point was marked with marker and a line was drawn from there to acromion process. The middle point of this line was considered as a primary part of upper trapezius muscle trigger point. It should be mentioned that regardless of number of latent trigger points, the subjects had at least one active trigger point in primary point of the muscle (between acromion and spinous process of the seventh cervical vertebra).

B-mode sonography

All participants were assessed by supersonic ultrasonic (Ultrasound, Sonix MDP, British, Columbia, Canada) and linear transducer, 5-14 MHz at trigger points of upper trapezius muscle [5]. At first, the patient was placed on the prone position. The hands were placed beside the body, head and neck in middle line and the body on pillow normally with no deviation. Then, the patient was asked not to move the head and neck and not to talk during assessment [17]. Transducer was placed on the muscle at trigger point site so that the muscle fibers were seen as being parallel.

The middle point of transducer was settled on a place, which was previously marked on the muscle. Transducer was adjusted in such a way that the muscle fibers and fascia were parallel and two ends of the muscle were at their thickest state. Then, the longitudinal image of upper trapezius muscle was recorded and the maximum thickness of the muscle and fascia in the middle part of transducer was measured [10]. As a result, the highest distance between margins of the lower and upper hyperechogenic of the muscle was recorded as its maximum thickness and the distance between lower and upper part of fascia was recorded as its maximum thickness (of upper trapezius muscle) (Figure 1). All assessments were done without



PHYSICAL TREATMENTS

Figure 1. Measurement of thickness of upper trapezius myofascial.

placing pressure on skin and to make sure of this, 100 μm of gel was used between transducer and skin. The obtained image by sonography was measured 3 times at each trial by the examiner and their mean value was recorded as the real size. Furthermore, the differences between the measurements were not significant (P<0.70) [10-12].

Sonoelastography

Sonoelastography is combination of two images: one elastogram at the left side and the other two-dimensional sonography at the right side. The elastogram image is colored and varied from tough (red), to average (green), and soft (blue), which are qualitative criteria [12]. In this method, the examiner places the ultrasound probe vertically on the intended tissue. To obtain the best possible image, the system was equipped with feedback index in real-time, which revealed the proper value of pressure in the assessed area [18]. This system was scored from 1 to 6 and in case the pressure during assessment was favorable; the green color was displayed in the middle of the monitor (score 4).

But if the pressure was low or high, the green color would turn to blue or red [18]. The patient was placed in the prone position with hands beside the body. The studied area was the same as the area assessed in two-dimensional sonography. In order to determine the strain ratio, first a region of interest measuring 2×5 mm was specified inside the fat tissue and then a region of interest measuring 3×8 mm inside the muscle in middle part and the strain ratio was determined numerically and based on the formula Kx=F0 (where K=pressure, x=movement, F=force) in the image (Figure 2) [19].

Moreover, in this formula only the movement is calculated. Then, the elastography software calculated the relation of movement in two tissues of muscle and fat automatically and quantitatively and displayed them on monitor as strain ratio [19]. All measurements were done at the end of the expiration of the patient and examiner. Sonoelastography was performed 3 times at each trial and the mean value was recorded as the real score. Worthy of note that all tests were repeated with one weak interval in order to study the repeatability [12, 17, 18].

In the present study, the Kolmogorov–Smirnov test was used to study the normality of distribution of each variable. The Intra-Class Coefficient (ICC) test and Standard Errors of Measurements (SEM) were used to analyze the repeatability; also the Pearson correlation test was applied to assess the association of the maximum thickness of up-

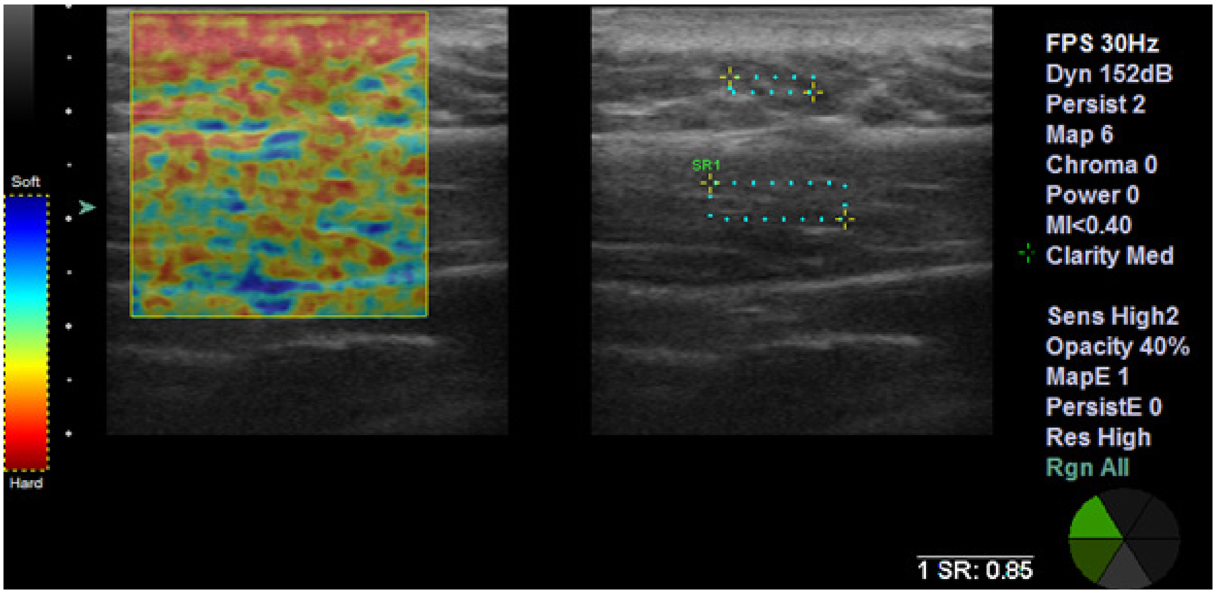


Figure 2. Measurement of strain ratio.

PHYSICAL TREATMENTS

per trapezius muscle, maximum thickness of fascia, and the strain ratio with independent variables of the study. In addition, multiple linear regression test was used to determine the correlation between independent variables (such as pain, range of motion, functional disability and pressure pain threshold) and dependent variables (such as thickness of muscle, fascia and strain ratio). Also, in this study, the synchronous method was used for the analysis of correlation between dependent and independent variables. Moreover, β coefficient (in multiple regression) was applied as a relative index for comparison of intensity of correlation among different independent variables and prioritizing their correlations with dependent variables. The level of significance (P value) indicates the significance of coefficient statistically.

3. Results

Table 1 shows the mean age, weight, and height of the study individuals with myofascial pain syndrome.

The results of ICC analyses revealed that test-retest and between examines reliability of quantitative variables, including neck flexion (0.86, 0.92), extension (0.89, 0.72), rotation to right (0.91, 0.79) and left (0.78, 0.90), as well as lateral bending to right (0.88, 0.79) to left (0.91, 0.89), pressure pain threshold (0.82, 0.71), maximum thickness of upper trapezius muscle (0.93, 0.89), maximum thickness of upper trapezius fascia (0.96, 0.88), and strain ratio (0.70, 0.81) were high to very high.

The correlations among variables of the present study were as follows: the correlation (r) between pain and maximum thickness of muscle, 0.22; maximum thickness of fascia, 0.13; and strain ratio, 0.65. The correlation between range of motion and maximum thickness of fascia was 0.09 and strain ratio as -0.23. Furthermore, the correlation of functional disability with maximum thickness of muscle was 0.13, with maximum thickness of fascia, 0.17; and with strain ratio, -0.41. Also, the correlations between pressure pain threshold and maximum thickness of muscle was -0.32, maximum thickness of fascia, -0.23; and strain ratio, 0.71 (Table 2). Also, β coefficient for pain variable was 0.35 (P=0.010); range of motion, -0.1 (P=0.030), functional disability, -0.19= (P=0.03), and pressure pain threshold, 0.41 (Table 3).

Table 1. Descriptive statistics of subjects with myofascial pain syndrome.

Variable	Mean±SD
Age (y)	25.90±4.47
Weight (kg)	63.53±7.76
Height (cm)	166.55±5.65
Time affected (mo)	9.75±6.04

PHYSICAL TREATMENTS

Table 2. The correlation between pain, range of motion, functional disability, pressure pain threshold and maximum thickness of muscle, fascia and strain ratio.

Dependent variable	Independent variable	r	P value
Maximum thickness of upper trapezius muscle	Pain	0.22	0.12
	Range of motion	0.11-0.19	0.33-0.68
	Disability (NDI*)	0.13	0.87
	Pressure pain threshold	-0.32	0.11
Maximum thickness of upper trapezius fascia	Pain	0.13	0.45
	Range of motion	0.09-0.11	0.99-0.56
	Disability (NDI)	0.17	0.61
	Pressure pain threshold	-0.23	0.42
Strain ratio	Pain	-0.65	0.02
	Range of motion	0.23-0.32	0.12-0.08
	Disability (NDI)	-0.41	0.04
	Pressure pain threshold	0.71	0.01

Neck Disability Index

PHYSICAL TREATMENTS

4. Discussion

The results of the present study revealed that strain ratio of upper trapezius muscle has a significant and reverse correlation with pain and functional disability and significant and direct correlation with pressure pain threshold. While there were no significant correlations between the maximum thickness of muscle and upper trapezius fascia and variables of pain, range of motion, functional disability and pressure pain threshold in individuals with myofascial pain syndrome. Finally, pressure pain threshold had the highest correlation to strain ratio while range of motion had the lowest correlation.

Correlation between muscle thickness and fascia with clinical symptoms

The ultrasound was used in many studies in order to assess musculoskeletal injuries and evaluate treatment consequences [5, 20]. However, little research has been carried out on correlation between clinical findings and sonography images [10]. Stecco et al. (2014) reported that there are significant differences between two groups of healthy and patient with regard to fascia thickness, sternocleidomastoid, and middle scalene muscles. However, no report was found regarding repeatability of fascia and muscle thickness with sonography. Also, in the mentioned study, a medium statistical correlation (r=0.38) was reported between fascia thickness and pain in individuals with neck pain [10].

But, in the present study, there was a low correlation between fascia thickness and pain (r=0.13). Fabianna et al. reported that during bending the neck with different muscular contractions, from low to high, the thickness of deep muscles of neck and sternocleidomastoid muscle was higher in healthy individuals [21]. Apparently, trigger points and pain in individuals with myofascial pain syndrome are among factors that should be taken into consideration while assessing the correlation between muscle and fascia thickness with clinical symptoms [20].

Table 3. β coefficient for pain, range of motion, functional disability and pressure pain threshold.

Factor	β	Standard error	Standard β	t	P value
Pain	-0.35	0.04	0.08	3.38	0.01
Range of motion	-0.14	0.05	0.02	1.32	0.53
Disability (NDI)	-0.19	0.01	0.03	2.76	0.004
Pressure pain threshold	0.41	0.09	0.03	4.91	<0.001

PHYSICAL TREATMENTS

Correlation between strain ratio and clinical symptoms

Elastography or elasticity imaging is a new and noninvasive method for assessing changes in mechanical strain in tissues [11]. Sidkar et al. presented in their research that muscle stiffness is harder in patients with myofascial pain syndrome than the healthy ones [5]. Also, Maher et al. showed that stiffness of upper trapezius muscle is different in sitting and prone positions. Moreover, these researchers indicated that following pain relieve resulting from dry needling, muscle stiffness will decrease. Although, in this study the correlation between pain and muscle stiffness was not directly investigated, the findings revealed that pain reduction can decrease muscle stiffness [22]. These findings were somewhat consistent with the findings of the present study. Paula et al. showed that muscle stiffness has a high correlation with pain, dysfunction, and knee extensor torque of men with arthritis. The reason proposed for increase in muscle stiffness in these patients is change in joint kinematic and cartilage destruction, while in the current study, increase in muscle stiffness is due to the taut band in muscle following damage [23].

As mentioned in the present study, strain ratio of muscle to fat tissue was measured as a quantitative criterion. The strain ratio has a reverse correlation with stiffness, i.e. the more the strain ratio of a muscle, the less its stiffness [12]. On the other hand, there is a direct correlation between pressure pain threshold and strain ration, i.e. the more the strain ratio, the less the stiffness and therefore less pressure is needed for stimulating trigger points [15]. Andersen et al. studied the correlation between pressure pain threshold and stiffness in normal and injured muscles. The results revealed no significant correlation between pressure pain threshold and stiffness in healthy muscles, while there is a significant correlation between pressure pain threshold and muscle stiffness in people with damaged muscle [24].

In many studies, muscular atrophy is regarded an important factor in causing pain and disability [25] and less attention is paid to fascia thickness [10]. Also, decrease in muscular thickness has been shown in patients with pain in neck compared to healthy individuals [25]. Although muscular thickness has been studied in both patients with pain in neck and in other musculoskeletal disorders mainly for stability muscles of face, considering the critical and physiological role of myofascia in causing chronic pain and changing joint biomechanics, it seems necessary to study thickness and its relationship with clinical findings [2, 5, 26].

In patients with myofascial pain syndrome, muscular thickness increases due to increase in fiber joints and sarcomeres in parallel and series, causing pain and disorder [5]. Therefore, considering the results of the present study, the medium correlation of clinical parameters with muscular thickness, and the strong correlation of muscular stiffness with the mentioned items, it seems that besides musculoskeletal disorders, muscular stiffness is an important factor in studying muscular changes [12].

Sonoelastography is a simple method which can be used in clinical setting, which shows the elastic properties of soft tissue. Since the physiotherapist only assesses the muscular stiffness only by touching, this instrument can provide the quantitative and qualitative map of the muscular stiffness as well [11].

The strain ratio of upper trapezius muscle in patients with myofascial pain syndrome has a strong correlation with pain, disability, and pressure pain threshold. While the maximum thickness of upper trapezius fascia and muscle has a weak correlation with the mentioned variables. The pressure pain threshold is the most relevant factor to the strain ratio in these individuals.

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