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# Ultrasonography in Diagnosis of Myofascial Pain Syndrome and Reliability of Novel Ultrasonic Indexes of Upper Trapezius Muscle

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## SUMMARY

**Background.** Myofascial pain syndrome (MPS) is a common non-articular musculoskeletal disorder. It is characterized by local and referred pain due to the presence of myofascial trigger points (MTrPs). MTrPs most commonly involve the upper trapezius muscle and can be visualized using ultrasound imaging. This study was designed to determine the inter-rater reliability of some new ultrasonographic indices of the upper trapezius muscle and the sensitivity and specificity of 2D ultrasound imaging in the diagnosis of MPS.

**Materials and methods.** This semi-experimental study enrolled 15 participants of both genders (mean age: 40.60 ± 5.74 years) with suspected symptoms of MPS. In the first step of the study, the sensitivity and specificity of ultrasonography for diagnosis of MPS was determined in a double blind manner. In the second step, some ultrasonographic measurements, such as muscle thickness, area of MTrPs in longitudinal view, echogenicity of MTrPs in longitudinal view, echogenicity of muscle with MTrPs in longitudinal and transverse views, and the pennation angle of the upper trapezius muscle were measured twice and their reliability was determined using the value of the mean of the two measurements.

**Results.** The sensitivity and specificity of ultrasonographic diagnosis were 91% and 75%, respectively. The inter-rater reliability of upper trapezius muscle thickness, pennation angle, area of MTrPs, echogenicity of active MTrPs in longitudinal view, echogenicity of muscle with MTrPs in transverse view and echogenicity of muscle with MTrPs in longitudinal view were 0.91, 0.96, 0.93, 0.83, 0.93, and 0.91, respectively.

**Conclusions.** 1. Our findings indicated that ultrasonography is a useful method for the diagnosis of MPS owing to its high sensitivity. 2. Appropriate reliability of the quantitative ultrasonographic indices of interest, especially the area of MTrPs and their echogenicity, could be useful for long-term monitoring and designing interventional studies for better management of the syndrome.

**Key words:** Myofascial pain syndrome, Trigger point, Ultrasonography

## BACKGROUND

Myofascial pain syndrome (MPS) is a common non-articular musculoskeletal disorder which is reported in 95% of patients with many chronic musculoskeletal disorders[1]. The syndrome is characterized by local and referred pain due to the presence of myofascial trigger points (MTrPs) [2]. MTrPs are hard, palpable, discrete, and localized nodules located within taut bands of skeletal muscle which produce symptomatic referred pain on compression, restricted range of motion and substantial motor dysfunction [3,4]. MTrPs can present in active or latent states. Active MTrPs are associated with spontaneous pain that is present without palpation. Latent MTrPs are painful on firm palpation and are mainly associated with motor dysfunction and muscle tenderness [5].

In spite of a high prevalence of MPS, the pathophysiology of the syndrome and the role of MTrPs in this regard are not clearly understood. However, some evidence suggest that motor endplate dysfunction could lead to MTrPs [6,7].

Currently, the diagnostic approach to MPS is based on a clinical diagnosis of MTrPs and the associated symptom cluster [8].The reliability of clinical diagnosis of MPS based on MTrPs is limited due to factors such as inadequate training for clinical diagnosis of MPS in physicians and lack of definite evidence for the correlation between the physical findings of MTrPs and taut bands [9,10]. In spite of the limitations in clinical diagnosis of MPS, physical manoeuvres such as palpation remain a gold standard for detecting MTrPs and diagnosing MPS [11].

Recently, the use of radiological methods, mainly ultrasonography, has become a popular method for detecting MTrPs and determining their morphology. Some characteristics of ultrasonography such as its low risk, low cost, convenience and accessibility, make it a useful method for this purpose [12]. Several studies have indicated that 2- and 3-dimensional ultrasound imaging techniques could be used to detect MTrPs and their specific characteristics [13-15]. In addition, improvement of ultrasonographic devices in terms of imaging quality has made the opportunity for real-time scanning of the MTrPs structure [16].

Evaluation of MTrPs and the surrounding soft tissues with regard to new sonographic parameters such as echogenicity, which no studies have used before, and some muscle morphology indices, such as pennation angle, which was measured for the upper trapezius muscle for the first time in this study, can provide new data regarding the underlying pathophysiology and their relevance in MPS.

It is suggested that improvement of quantitative assessments of MTrPs and their soft-tissue mechanical properties could potentially be helpful in the diagnosis, management, and follow-up of patients with MPS. Considering the high prevalence of the syndrome and its related disability and the cost of its proper management, the results of this preliminary study could furnish baseline information for more interventional studies on the management of this syndrome. This study determined the inter-rater reliability of some new ultrasonographic indices of the upper trapezius muscle and the sensitivity and specificity of 2D ultrasound imaging in the diagnosis of MPS.

## MATERIAL AND METHODS

This semi-experimental study enrolled 15 participants (4 males and 11 females) with suspected symptoms of MPS between the ages of 30 and 50 years according to specific inclusion and exclusion criteria. The study protocol was approved by the physiotherapy review board and ethics committee at Shahid Beheshi University of Medical Sciences, Tehran, Iran. The code number of ethics committee approval was 6386 and the date was 2014/6/10. Before the test, written informed consent was obtained from each participant after explanation of the methods and goals of the study.

The inclusion criteria were as follows: age between 30 and 50 years, body mass index (BMI) between 22 and 25 $kg/m^2$ and symptoms suggestive of MPS in the central region of the upper trapezius muscle in patients who had experienced the characteristics pain over the past 3 months and had active MTrPs based on the Travell and Simons criteria [3]. Participants with any systemic disorder, malignancy, inflammatory disease, head-and-neck region infection, fibromyalgia, myopathy, cervical radiculopathy or myelopathy, atypical facial neuralgia or congenital spinal malformation were excluded. In addition, those with a history of neck-and-shoulder fracture, severe trauma in the neck-and-shoulder region during the past 6 months, vertebral and shoulder surgery, acupuncture or needling to the trigger points of the trapezius muscle and those who could not co-operate appropriately were also excluded.

After approval from Shahid Beheshi University of Medical Sciences, the study was performed at the radiology department of Isfahan University of Medical Sciences, Isfahan, Iran, from March to September 2014. The participants were selected by non-randomized sampling.

This study was performed in two steps:

First Step: In the first step of the study, participants with symptoms suggestive of MPS were examined by an expert physiotherapist with 20 years of

clinical experience to confirm the diagnosis of MPS. The examination was performed by palpation in the central region of the upper trapezius muscle approximately midway between the cervical vertebrae and the acromion. An active site was defined as at least one nodule detected by palpation which was both spontaneously painful and produced the characteristic pain.

In accordance with clinical examination, they were also referred to a radiologist (23 years of clinical practice) for ultrasonographic evaluation of the syndrome. Ultrasonographic evaluation was performed blindly and the radiologist was not aware about the results of clinical examination of the patients in this group. The ultrasonographic diagnosis of MPS was based on detection of MTrPs, which presented as focal hypoechoic (darker) areas with a heterogeneous echotexture [15]. Some healthy participants were also referred for both the clinical and ultrasonographic measurements.

The results of the first step of the study were investigated with regard to the sensitivity and specificity of ultrasonography compared to the results of clinical diagnosis, which was considered a gold standard for the diagnosis of MPS [11].

Second Step: In the second step of this study, some ultrasonographic measurements, such as muscle thickness, area of MTrPs in longitudinal view, echogenicity of MTrPs in longitudinal view, echogenicity of muscle with MTrPs in longitudinal and transverse views, and pennation angle of the upper trapezius muscle, were measured (Fig. 1).

In order to determine the index of inter-rater reliability of the above-mentioned ultrasonographic parameters, the participants were evaluated once more by the same radiologist and the parameters were measured for the second time within an hour interval. The reliability of the ultrasonographic indices was determined using the value of the mean of the two measurements.

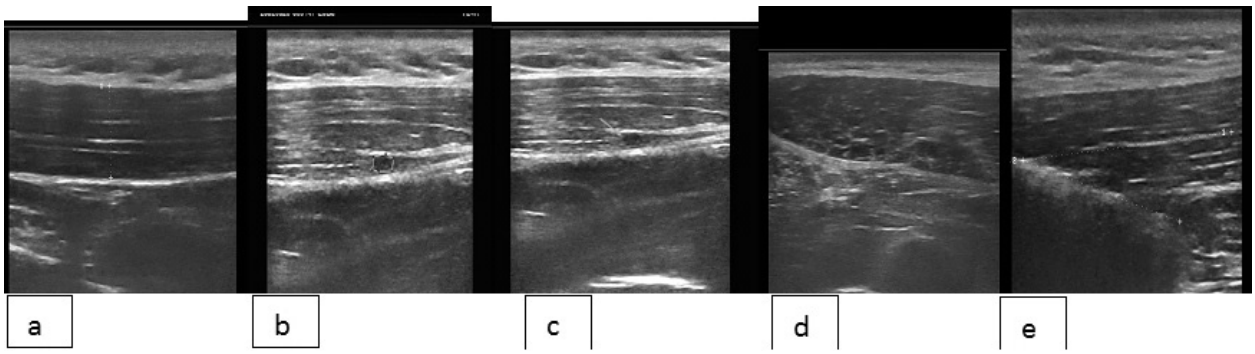
Ultrasonographic Measurements: Selected participants underwent an ultrasonographic examination using a Mindary DC-7 ultrasonographic device (Shenzhen-China) with an 8-10 linear array transducer. The procedure was performed while the participants were in a comfortable upright sitting position. In this position, the upper trapezius was visualized in the longitudinal and transverse views.

At first, thicknesses of the upper trapezius muscle and the pennation angle were measured and then the presence of MTrPs was determined using 2D gray-scale imaging. Muscle thickness was defined as the largest distance between the upper and lower borders of the upper trapezius muscle in millimeters. The pennation angle was defined as the angle (in degrees) between the deep aponeurosis and the muscle fibers at the insertion of the seventh cervical spinous process.

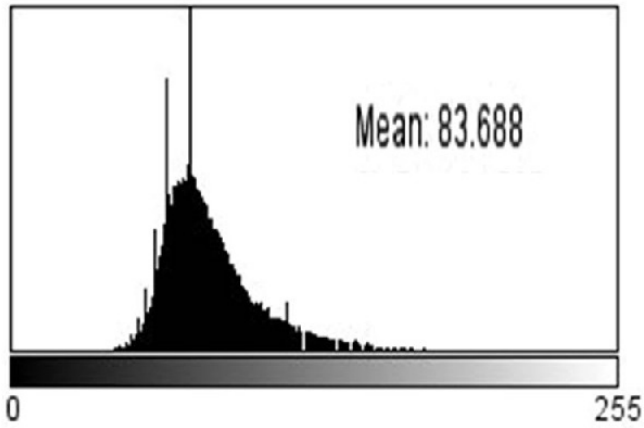
MTrPs in the upper trapezius appeared as focal hypoechoic (darker) areas with a heterogeneous echotexture. After detection of MTrPs, appropriate longitudinal and cross-sectional images of the muscles which held the MTrPs were obtained and recorded. The images were checked after their acquisition, using ImageJ software (Version 1.6.0) to determine the hypoechoic location and area ($cm^2$). The validity and reliability of the software had been confirmed in previous studies [17].

The echogenicity of the MTrPs as well as the echogenicity of the muscle in longitudinal and cross-sectional views were determined and recorded using the gray value histogram of the software. The software calculates the intensity of gray values on a scale of 0 to 255 and displays its histogram. The X-axis and Y-axis of the histogram represent the possible gray values and the number of pixels found for each gray value, respectively. The histogram displays the mean gray value as an L-mean (Fig. 2).

Data were analyzed using SPSS version 21 (SPSS Inc., Chicago, IL) software. The normal distribution




Fig, 1.Ultrasonographic measurement of upper trapezius muscle thickness (a), area of MTrPs in longitudinal view (b), muscle with MTrPs in longitudinal (c) and transverse (d) views and pennation angle (e)




Fig, 2. A histogram of MTrPs in upper trapezius muscle and the level of the L-mean

of data was assessed by Kolmogorov-Smirnov test. Inter-rater reliability of the variables was assessed through intra-class correlation coefficient ($ICC_{3,1}$), where P values less than 0.05 were considered statistically significant. As bootstrapping allows assigning measures of accuracy to sample estimates, in this study we used the bootstrap technique and results were almost the same.

## RESULTS

This study enrolled 15 participants (4 men, 11 women) with a mean age of 40.60 ± 5.74 years and symptoms suggestive of MPS were enrolled. Clinical diagnosis of MPS was established in 11 of the 15 patients and 4 of them were considered healthy. Ultrasonographic diagnosis was established in 12 of 15 patients. The sensitivity and specificity of ultrasonographic diagnosis were 91% and 75%, respectively. Table 1 presents the means (SE) and $ICC_{3,1}$ of the ultrasonographic parameters of interest.

## DISCUSSION

In this study, we first investigated the sensitivity and specificity of ultrasonography for the diagnosis of MPS and then determined the inter-rater reliability of some ultrasonographic parameters. Some of the parameters, such as area and echogenicity of MTrPs, can be considered useful for proper management of MPS.

As stated earlier, in order to improve the diagnosis and management of MPS, the use of ultrasonographic measurements has increased recently and its effectiveness and utility have been reported in some studies [13-15].

Turo et al. evaluated the ultrasonic characterization of the upper trapezius muscle in patients with chronic neck pain using ultrasonography and elastography. The authors compared the ultrasonography measurements with clinical findings derived from a standardized physical examination. They reported 69% sensitivity and 81% specificity for discriminating active MTrPs from normal muscle by the combination of entropy analysis and vibration elastography. According to their suggestion, in comparison with normal muscle, MTrPs have more heterogeneous stiffness and homogeneous texture. They emphasized the importance of evaluation of muscle tissue surrounding palpable MTrPs for better understanding of the pathophysiology of MPS [18].

With its high sensitivity and specificity as indicated in our study, ultrasonography can be a useful tool for diagnosing MPS.

Tab. 1. Mean (SE) and inter-rater reliability (ICC) of the ultrasonographic parameters of interest in two measurements in the study group (n=15)

| Ultrasonographic parameters | First measurement | Second measurement | ICC |
|---|---|---|---|
| Muscle thickness (mm) | 11.31(0.42) | 11.60(0.35) | 0.91 |
| Pennation angle (degree) | 14.49(0.75) | 14.62(0.62) | 0.96 |
| Area of MTrPs ($cm^2$) | 0.49(0.07) | 0.48(0.08) | 0.93 |
| Echogenicity of active MTrPs (longitudinal view) | 43.71(2.87) | 39.54(2.80) | 0.83 |
| Echogenicity of muscle with MTrPs (transverse view) | 56.15(3.74) | 53.26(3.43) | 0.93 |
| Echogenicity of muscle with MTrPs (longitudinal view) | 57.51(3.41) | 53.25(3.59) | 0.91 |

We further examined the inter-rater reliability of some quantitative ultrasonographic measurements such as muscle thickness, area of MTrPs, echogenicityof MTrPs in longitudinal view, echogenicity of muscle showing MTrPs in longitudinal and transverse views, and pennation angle. To the best of our knowledge, the pennation angle of the upper trapezius muscle was evaluated for the first time in this regard. Although the other indices had been evaluated before, the design of the current study was different from the previous ones.

Bentman and colleagues evaluated the reliability of measurement of middle trapezius muscle thickness using rehabilitative ultrasound imaging (RUSI). They reported that the measure had good inter-rater reliability (ICC=0.81) [19].

In our study, the reliability of muscle ultrasonography for the measurement of upper trapezius muscle thickness determined by our method also stood high, at $ICC_{3,1}$=0.91.

The indices of inter-rater reliability for other measurements were also high (0.83<ICC<0.96). The reliability of ultrasonography for the pennation angle of the upper trapezius muscle had not been studied earlier. Thus, considering the favorable reliability of these indices, they could be used to design interventional studies in the field of MPS management.

In this study, we evaluated the upper trapezius muscle, which is considered a superficial muscle that is easy to palpate. It seems that ultrasonographic imaging would be more practical and useful for deeper muscles, where palpation, clinical examination, and evaluation of the referral pain pattern are difficult. We recommend designing further studies including deeper muscles, such as those in the lumbar region, for either the diagnosis or evaluation of efficacy of different treatment strategies.

The limitation of our study was a small sample size of the study population. Though this study was designed to provide baseline information for further interventional studies, it seems that the results, especially with regard to estimating the sensitivity and specificity of ultrasonography, would be more conclusive if a larger sample had been studied. It is also advisable to determine reliability of the indexes for latent MTrPs. Furthermore, biochemical evaluation would be helpful for better understanding of the pathophysiology of MPS. Due to time limitations, it was difficult to train two radiologists to a sufficient expert level in the facilities of our center to determine inter-observer reliability. Thus an expert radiologist in this field cooperated in this study

## CONCLUSIONS

1. Our findings indicated that ultrasonography is a useful method for the diagnosis of MPS due to its high sensitivity.
2. Appropriate reliability of the studied quantitative ultrasonographic indexes, especially area of MTrPs and their echogenicity, could be applicable for long-term monitoring and designing interventional studies for better management of MPS.

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