

1 The effects of active myofascial trigger point on anticipatory postural control

4 Abstract

5 **Aim:** The purpose of this study was to investigate the effects of arm movement on anticipatory
6 postural control in patients with upper trapezius active myofascial trigger point (MTP).

7 **Methods:** Fifteen women (aged 24.5 ± 2.7 years) with one active MTP in the upper trapezius and
8 fifteen normal women (aged 23.30 ± 1.6 years) were participated in this study. Participants were
9 asked to flex their arms in response to a sound stimulus preceded by a warning sound stimulus.

10 **Results:** There were significant differences in motor times, and for reaction time ($P < 0/001$)
11 between two groups.

12 **Conclusions:** EMG were changed in patients with MTP. These patients have less compatibility
13 with environmental stimulus and respond to a specific stimulus. The present study shows that
14 EMG can be a new method for evaluation of the MTP.

15 **Key words:** Myofascial trigger point, Electromyography, Upper Trapezius Muscle

17 Introduction

18 Mechanical pain in cervical region has a prevalence of about 45 to 55 percent. This type of pain
19 causes different disabilities in patients. In spite of the lack of enough reasons for mechanical pain
20 in the mentioned region, the researchers believe that myofascial trigger point (MTP) of the
21 shoulder and the cervical region can be responsible for this category of mechanical pain[1]. MTP
22 is also introduced as the significant source of musculoskeletal pain[2, 3]. MTP has a high
23 prevalence among individuals with regional pain complaints. The prevalence differs from 21
24 percent in patients perceived in a general orthopedic clinic, to 30 percent in general medical
25 clinic patients with regional pain up to as high as 85 percent to 93 percent in patients observed in
26 specialty pain management centers[2]. The new theory of pain expresses the hypothesis of

accordance which is attributed to pain in the system. This mechanism consists of alterations that occur in the excitability and organization of the motor cortex[4]. They may, also, comprise more complicated changes that occur in the motor responses and when repairing motor cortex[5]. Changes in the sensory function can deeply affect the movement control of the musculoskeletal system, especially in painful conditions [6, 7]. There are numerous studies in this field including shoulder pain[8], back pain[9]and cervical pain[10]. The reported changes include reduced sensory perception[11], increased repositioning errors[12], reduced responsiveness to sensory input[13], and restructuring of the somatosensory areas of the motor cortex[14, 15]. Another study were displayed that pain is reduced sensory processing before motor output is changed [7].

Therefore, considering pain and its probable impacts on the control mechanisms of movement and posture are of great significance.

Preceding activation of postural muscles occurs in anticipation of postural perturbation caused by upper limb motion[16, 17].

Clinical studies have revealed that this kind of postural control, identified as anticipatory postural control, is possibly related to the higher levels of the central nervous system (CNS), mainly the premotor area and supplementary motor area[18]. The supplementary motor area has a significant relationship with anticipatory postural control which is closely related to upper limb motion[19]. The results of further examinations show that preceding activation of postural muscles cannot be happened in patients with injuries in supplementary motor area[18].

Thus, the aim of the present study was to investigate the effects of arm movement on nticipatory postural control in patients with MTP of the upper trapezius muscle.

Methods

Subjects

A convenience sample of fifteen women (aged 24.5 ± 2.7 years) who were known with one type of MTP accessible in the upper trapezius muscle together with fifteen normal women (aged 23.30 ± 1.6 years) were recruited.

All participants were given a clear explanation of all the steps of the test approved by Tehran University of Medical Sciences. They all signed the informed consent before taking part in this

study. After this step, participants were investigated from inclusion criteria point of view to make sure there was no severe postural disorders, they didn't suffer from epilepsy, depression, migraine, and other mental health disorders, there was no history of surgery in the shoulder and cervical area in the past six months prior to these tests, no treatment of trigger point was performed in the past month prior to experiments, there was the visual analogue scale (VAS) two or three during the experiment period for the patients, there was no special sign of headache, dizziness, squint, and nausea during the movement or in the special positions, and they had not any symptom of arthrogenic pain, osteoarthritis and radiculopathy of cervical area and upper limb, and the disorders of temporomandibular joint (TMJ). The healthy participants should not have any active MTP in other muscles of their head and cervical. And, on the day of experiment, participants should not consume any food or drink having caffeine, such as coffee[23].

Participants who were in the period of menstrual cycle, those for whom appropriate recording of electromyography (EMG) had not been accomplished in the session of experiment, those who had pain in the cervical and shoulder area in the session of the test, or had used sleep aids and sedative drugs 24 hours prior to starting the experiment, and those who their cooperation with examiner had not been carried out because of pain and over exhausting were excluded from the study.

The existence of MTP in upper trapezius muscle was determined using the diagnostic measures including; presence of a palpable taut band, local twitch response activated by the snapping palpation of the taut band, presence of at least one hypersensitive tender point in the taut band in response to 25N of pressure, spontaneous presence of the typical referred pain pattern and/or patient recognition of the referred pain as familiar[24, 25]

If only the three first criteria were satisfied, the MTP was considered to be latent. If all of the aforesaid criteria were present, the MTP was considered to be active [25].

Equipment

EMG

In order to record electromyographic activity of the studied muscles a surface EMG equipment(Biometric Ltd, UK) with sampling rate: 1000Hz, Band pass filtered:20-450Hz and

sensitivity: 100 μ v/div was used. The electrode placement was as follows: anterior deltoid (AD); cervical paraspinal (CP) at the level of the C4; lumbar paraspinal (LP) at the level of the iliac crest; upper trapezius (UT) at the midway between acromioclavicular joint and C7; sternocleidomastoid (SCM) a third of the distance from sternal notch to mastoid processes; and the medial head of gastrocnemius (GC).

After shaving and cleaning the skin with alcohol, electrodes were set at fixed positions[26]. Surface electrodes (Biometrics Ltd, UK) were mounted in bipolar pattern and were allied along the major axis of the muscle with a 2 centimeters inter-electrode distance. All recordings were made of the involved side in the MTP group, and from dominant hand in the control group.

Procedure

Participants were asked to stand in an erect comfortable standing position with feet 10 centimeter apart on the force platform (Bertec Columbus, Ohio, USA) for 10 seconds. The force platform parameters for data acquisition were as follows: Sampling Rate: 1000 Hz, Sensitivity: 10 μ v/div, Height: 15.2 centimeters, Size: 90 $\times$ 90 centimeters. The standing position on the force platform was repeated for 5 times with 30 seconds inter trial intervals. When the displacement of the center of the foot pressure (CFPy) was around ± 1 centimeters in anterior-posterior direction, the substantial steps of experiments were accomplished[26].

After this stage, participants were asked to stand in front of the designed system which was utilized for lifting the weights. This weight was set at 2% of the body weight and was hung from lower section of the designed system[26, 27]. The subjects stood on the force platform once again, while the shoulder of participants was flexed to 60 degrees[27], their elbow was extended and pronated. To examine the movement initiation, the researchers employed a sensor in the designed system. When the weight was lifted off the sensor, a trigger was recorded on EMG signal. Range of arm motion was calculated from the first height of the hands to shoulder height[26].

Three seconds after maintaining quiet standing, S1 was presented followed by S2 after two seconds. Participants were asked to flex their shoulder as fast as conceivable to minimize the response time to onset of S2, stopping the hand at shoulder level. This position was, then, held for about three seconds. Speed of movement was accentuated over precision[27]. For recording

and quantifying the speed, a sensor was placed on the shoulder of participants. The initial position of the sensor was at 60 degrees of shoulder flexion and had shown by the event marker on the signals of EMG. Speed of shoulder flexion was estimated after 10 repetitions to be about 100 degree per seconds.

Analysis and Interpretation of Data

EMG analysis

EMG signals were filtered (20Hz) then the RMS (Root Mean Square) values were calculated. The average amplitude of baseline activation was calculated for the period of five- hundred milliseconds before the S1. Afterwards the average amplitude of baseline activity plus 3 standard deviations (SD) was used as a threshold of activity to determine the onset of muscle activation. All stages were performed by the data log software and finally the EMG output data consisted of onset of preparatory activity of muscles.

The reaction time of motion was the interval between S2 and the onset of motion. . Onset of motion was calculated based on the triggering signal synchronized with EMG signal. This variable consisted of pre-motor and motor times. Pre-motor time was the interval between S2 and the onset of electrical activity of the muscle. Motor time was the interval between the onset of electrical activity and the onset of motion.

Statistical Analysis

A Kolmogorov-Smirnov (K-S) test was used to determining the normal distribution of each variable.

To investigate if there was an accurate matching between the two groups for various variables such as age, height and weight, the statistical independent *t*- test was used. The statistical independent *t*- test was, also, applied to compare variables between two groups.

The confidence level was set at $\alpha \leq 0.05$ for statistical significance. All statistical calculations were accomplished by SPSS statistical software, Version 17.0.

Results

The K-S test was not significant for all variables. No statistical differences were found between the two groups for mean age, weight, and height ($P > 0.05$). Anthropometric characteristics of participants are listed in table 1.

The results of the independent *t*-test for EMG variables are presented in Table 2. For all of the studied muscles, although there were no significant differences in pre motor times ($P > 0.05$), motor times were significantly different ($P < 0.001$) except for gastrocnemius ($P > 0.05$). Finally there was significant difference in reaction time ($P < 0.001$) between two groups.

Discussion

Due to the lack of relevant studies about the impact of pain on EMG signals, it is not possible to compare the results of this study with any other studies. Premotor time of muscles' perceptual part of movement is one of the variables that have been investigated in this study. Absence of meaningful difference in this parameter between two groups may be due to lack of difference between receiving and processing of the information.

The time of movement is another variable that shows the utilization of motor commands from different muscle groups; in other words, this is the muscle synergy that shows significant difference between two groups. The time of movement showed an increasing trend in patients' group, which is in agreement with variations in arousal level of CNS, and growth in CNS parameters and response stimulus. It can be claimed that patients with high irritability may have encountered higher inputs that caused an increase in motor response and time of movement. This process takes place with specific impacts in brain activities. The first reasoning for abnormal response to peripheral stimulation can be attributed to disturbance in information processing. It is verified that the patients with trigger points have disorders in control of movement at level of limbic system, especially at planning level and our findings proved this phenomenon by evaluation of supplementary motor area.

Another variable that represents an increasing trend, is the reaction time of muscles in shoulder flexion. This increase can be attributed to the reduction in neuromuscular control in patients'

group. The reduction in neuromuscular control or neuromuscular coincidence may result from an increase in cervical muscle tone due to the trigger point. Moreover, there is an increase in sympathetic response in patients with trigger point. This element can increase cutaneous afferent input which finally affects gamma fusimotor in muscle spindle and cervical proprioception.

Besides, after each stimulus, more time is needed for CNS to accept the new stimulus; that is to say. The process of hyperactivity in control centers leads to lack of self-regulation which finally results in the application of an unusual muscular pattern or different co-activation. This behavior can undoubtedly affect the parameters of reaction and movement control. This can be regarded as one of the most important indicators in patients; since, after applying particular stimulus, individuals can be expected to respond correctly. However, it takes a long time for CNS to react; consequently the extent of coincidence declines. This occurrence is because of reducing the habituation of the control system after applying a specific motor command. Patients involve more sources of attention and then it led to abundance (degree of freedom). So increase of degree of freedom can cause variation of muscular behavior and reaction time (increase of SD). In conclusion, these patients had less compatibility with environmental stimulations, and responded to a specific stimulation with many degrees of freedom and variability in EMG. These findings suggest in physical therapy approach, motor control treatment design is very important and plan of some specific concepts of motor control techniques in these patients are may be useful.

Study Limitations

Because another postural muscles were not evaluated and only women were recruited, performing new research in both sexes and considering an other muscles is proposed.

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Table1 Anthropometric characteristics of participations in the control group (N=15) and MTP group (N=15)(mean $\pm$ SD)

	N	Age(y)	Weight (Kg)	Height (cm)
Control	15	23.30 $\pm$ 1.6	56.53 $\pm$ 6.2	164.76 $\pm$ 6.45
MTP	15	24.5 $\pm$ 2.7	57.5 $\pm$ 5.47	163.35 $\pm$ 5.4

Table2 Results of EMG variables

Variables	Control group (mean$\pm$ SD)	MTP group (mean$\pm$ SD)	P- Value (T-test)
Pre motor time(AD)	211.33 $\pm$ 40.48	256.79 $\pm$ 144.46	0.259
Pre motor time(CP)	219.85 $\pm$ 59.13	240.77 $\pm$ 87.32	0.460
Pre motor time(LP)	235.47 $\pm$ 42.13	235.31 $\pm$ 77.77	0.454
Pre motor time(UT)	234.45 $\pm$ 59.46	271.46 $\pm$ 130.84	0.333
Pre motor time(UT with MTP)	132.31 $\pm$ 44.22	175.75 $\pm$ 117.35	0.198
Pre motor time(SCM)	179.90 $\pm$ 59.45	202.08 $\pm$ 125.39	0.545
Pre motor time(GC)	169.97 $\pm$ 81.21	245.245 $\pm$ 110.30	0.193
Motor time(AD)	110.11 $\pm$ 42.35	188.26 $\pm$ 90.05	0.006*
Motor time(CP)	106.16 $\pm$ 35.90	191.55 $\pm$ 114.50	0.014*
Motor time(LP)	68.03 $\pm$ 56.00	176.13 $\pm$ 137.24	0.011*
Motor time(UT)	89.80 $\pm$ 36.78	166.15 $\pm$ 121.98	0.034*
Motor time(UT with MTP)	184.28 $\pm$ 66.53	268.17 $\pm$ 118.51	0.028*
Motor time(SCM)	145.69 $\pm$ 39.12	239.57 $\pm$ 115.51	0.008*
Motor time(GC)	128.71 $\pm$ 90.68	188.15 $\pm$ 115.42	0.137
Reaction time	326.02 $\pm$ 69.70	445.66 $\pm$ 175.29	0.025*