



Changes of neck lateral flexion in responses to upper trapezius muscle fatigue in subclinical myofascial pain syndrome participants versus healthy control

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Abstract

Background: Myofascial Trigger Points is a hyperirritable spot in a taut band of skeletal muscle that is the main reason for pain and dysfunction in the upper limb. Trapezius muscle has three different portions: the upper trapezius that originates from the superior nuchal line to the ligamentum nuchae above C7 spinal process and attaches the posterior border of the distal third of the clavicle. There is evidence for a relationship between highly repetitive work and neck and neck/shoulder musculoskeletal disorders. Repetitive work for the neck as work activities which involve sustained arm or hand movements can affect the neck/shoulder musculature and generate loads on the neck/shoulder area.

Objectives: We hypothesis that fatigue can alter cervical spine range of motion because of transferring loads to the passive connective tissues and also increasing muscle activity.

Methods: This is a Randomized controlled trial study. Thirty-six volunteers were recruited to determine EMG signal slopes in submaximal trial of the trapezius muscle during shoulder shrug.

Results: The behavior of the upper trapezius muscle was seen to be similar when assessment was based.

Improvements in pain and left-lateral flexion were found to be greater in the upper trapezius muscle-Group compared to the control group ($p < 0.05$). Fatigue applied to the upper trapezius muscle reduce pain and disability, and increase ROM and disability in individuals with myofascial pain syndrome.

Conclusions: This treatment may therefore be considered for use as an alternative method in treating trigger point.

Keywords: upper trapezius muscle, electromyography, myofascial trigger point, fatigue

Introduction

Myofascial trigger points (MTrPs) are hyperirritable points inside a taut band of skeletal muscle, which may be one of the primary reasons of pain and illness inside the upper limb.

Simons (1996) described MTrPs as a gentle point within a taut band of a skeletal muscle that is awful and starts is with compression, contraction, or stretch and normally responds with a referred pain sample away from the factor. The maximum diagnosed MTrPs in the frame are located in the upper trapezius muscle ^[1].

The neck muscular tissues have plenty of sensory receptors which are vital for proprioception ^[2, 3]. The everyday approach used for assessment of proprioception is joint position sense (JPS), that is defined as the attention of the position of numerous body sections for each passive and active moves in an open or closed chain environment ^[1].

JPS, someone's potential to recreate and pick out preceding predetermined positions or ranges of motion (ROM) of a joint, is a basic for proprioception ^[4]. The error human beings make while reproducing the predefined role is described as the joint position sense error (JPSE). The principal measure for useful cervical proprioception is the JPSE ^[5, 6].

The exact head-on-trunk orientation may be executed without vestibular facts. Which means proprioceptive statistics of the cervical spine is important for head-on-trunk orientation. The cervical JPSE is classed through measuring the capability of a blindfolded volunteer to accurately relocate his/her head to the trunk relative to a predefined point (regularly the neutral position of the head) after a cervical motion. Different examples of joint regions in which JPSE has been used for examining proprioception are the shoulder ^[7], the knee ^[8] and ankle ^[10].

Travel and Simons (1999, p.39) suggested that "restricted ROM is a feature of MTrP". Latest research show that cervical ROM is impaired in disorders associated with MTrP. There's no evidence indicating an affiliation of fatigue with restricted ROM and nonspecific myofascial pain syndrome without underlying disease ^[9]. This study evaluates cervical ROM in flexion/extension, aspect bending and rotation before and after fatigue ^[10].

It has been shown that fatigue of the neck muscle groups can cause trade in upper limb proprioception, motor patterns and kinematics ^[11]. This may be because of the excessive density of sensory receptors within the neck muscular tissues which have neural networks to the vestibular and oculomotor structures, and play a prime role in postural regulation ^[9, 12]. Muscle fatigue is proven to regulate afferent feedbacks from muscular tissues and cervical extensor muscle (CEM) fatigue alters sensory feedback from the neck muscle tissue to the central nerves system (CNS) and the architecture of the upper limb with regards to the neck ^[13, 14].

Prolonged presence of pain can also Have an effect on postural stability and head motion control. Similarly, the presence of muscle fatigue has been advised to Indirectly become worse the reliability of the proprioceptive alerts due to altered muscle spindle afferent input ^[3, 8].

With altered Muscle contractile efficiency, the postural and cortical manage is negatively prompted. Spontaneous discharge in robotically sensitive non-spindle groups II and III muscle afferents sensitizes their reaction to muscle stretch and surface pressure, and every so often muscle contraction, which may be improved following submaximal muscle fatigue. It turned into shown that free nerve endings that had end up sensitized to contraction remained sensitized for 20–30 min after fatiguing muscle stimulation; this suggests that afferents might play a vital position in the inhibition of motoneuron output following fatigue ^[13].

In anesthetized cat, responses of groups III and IV afferents in reaction to sustained muscle contraction were recorded ^[14,15]. One type of afferent confirmed a graded response to muscle contraction accompanied by unexpected onset as well as stretch (contraction-touchy mechanism) and changed into particularly composed of group III as compared group IV afferents, even as the other form of afferent had a delayed onset and continued to fire even after the duration of muscle contraction (unknown mechanism) ^[13, 16].

Given those outcomes of extended muscle contraction and fatigue on muscle afferent feedback, it's miles very likely that fatigue will result in altered afferent feedback to sensorimotor integration areas ^[13].

previous studies have shown that altered input from the neck can have an effect on cervical proprioception, and it's essential to apprehend how fatigue, which takes place in a myriad of place of work and recreational settings, might affect head and neck proprioception ^[17].

Given the regarded consequences of fatigue at the firing of muscle afferents, neck muscle fatigue could lead to altered afferent input from the neck for numerous mins following cessation of the fatiguing project. If neck ache and altered postures may have impact on neck role feel, it is very in all likelihood that the altered afferent input as a consequence of neck muscle fatigue could also have impact on head and neck JPS ^[13, 17].

The purpose of this study was to determine whether a submaximal fatigue protocol targeting the higher trapezius muscle could modify the potential to recreate a formerly presented cervical angle. This study protected an isometric submaximal fatigue protocol at eighty% MVC until failure. It is assumed that the alternate in body schema because of altered neck afferent feedback could lead to an altered perception of the neck relative to the trunk and therefore increase absolute error of neck JPS and joint role sense error modifications is different in the upper trapezius muscle of healthy people with myofascial cause factor in this muscle.

There's no look at on impact of fatigue on JPSE in subclinical Myofascial pain syndrome sufferers. The cause of this observe was to investigate adjustments of cervical range of motions in response to upper trapezius muscle fatigue.

Methods

Ethical standards and study type

This randomized control trial study reports baseline data from current perspective trials which were approved by the Tehran University of Medical Science ethical committee.

Each subject signed written informed consent prior to participant in the experiment.

Participants

Thirty-six healthy right -volunteers (20 males and 16 females) aged 18 years and older from a physical therapy clinic in rehabilitation faculty participated in the study. These patients initially presenting with chronic nonspecific neck pain were screened for MTrP.

Demographic characteristics of the patients are presented in table 1. Diagnostic criteria for detection of MTrP encompassed ^[1] presence of a painful nodule in a taut band, ^[2] patient's pain recognition, ^[3] referred pain pattern and jump sign. These signs were selected as they, according to Lucas *et al.* (2009), display the highest reliability ^[18]. Besides manual palpation, pressure pain threshold (PPT), is defined as the minimal amount of pressure that replaces the sense of pressure in to pain measured by a hand held algometer. It should be noted that the PPT for inclusion should been with values of <3 kg/cm². VAS or visual analogue scale also has determined with values of <30. The presence of latent MTrPs was determined by an examiner with more than 7 years of experience in the diagnosis of MTrPs. Exclusion criteria encompassed radicular symptoms, acute traumata, and severe neurological, cardiovascular, psychological or inflammatory-rheumatic diseases.

Table 1: Demographic and clinical characteristics of patients (n = 36)

	Patients	Control group	P value
Age	27.16	28.22	>0.05
Sex	7 female, 10 male	7 female, 8 male	>0.05
Body Mass Index	21.90	21.03	>0.05

Instrumentation

Angular variables had been estimated by means of a digital camera (Sony Crop. Model quantity. DSC W390. Made in Japan) positioned 1 meter away from the subject at C7 level with an instantaneous view of the subjects back in the frontal plane. The camera amassed range of motion and kinematics information on the rate of 25 frames per second. The markers used to measure the segment angles have been connected to the subjects as follows: three circular markers had been connected to the C7, proper and left acromion system.

Measures

Surface EMG recordings

Eight-channel EMG system (Data Log P3 x 8, Biometrics Ltd., Gwent, UK) (CMRR: 496 dB at 60Hz, input impedance 41012 Ω , gain:1000 and band-pass filter: 20Hz low cut-off, 450Hz high cut-off).

Electrodes: integral dry reusable electrodes (SX230, Biometrics Ltd, Gwent, UK) (Diameter: 10mm, bipolar configuration and inter electrode distance: 20mm).

The electrode was positioned 2 cm lateral to the midpoint of the line between the C7 spinous process and the acromion ^[19].

The inter electrode distance (center to center) was 20 mm. Before electrode placement, Skin impedance was decreased by shaving and washing of the skin with 70% alcohol pads. A sampling rate of 1000 Hz and a filtered band pass at 20-480 Hz (amplified with common mode rejection ratio >110 dB, overall gain 1,000, noise <1 mV root mean square (RMS) was used.

Surface recording electrodes were placed over the muscles as described by Cram ^[20] while the ground electrode was placed on the ipsilateral wrist.

To ensure good surface contact and to reduce skin resistance, a standard skin preparation procedure of disinfection, shaving and abrading was performed for each electrode placement site. Pre-gelled self-adhesive surface electrodes (Biometrics Ltd, electrode model SX230, 20 _ 38 mm) were then secured over the belly of the experimental muscles and aligned with their fibers' orientation on the dominant side of the participants ^[21, 22].

Experimental procedures

The evaluations were performed with the patient seated comfortably in a chair with both feet flat on the digital balance, hips and knees flexed at 90°, buttocks positioned against the back of the chair and treated shoulder unclothed.

Volunteers were asked to sit on the chair in an upright position with relaxed arms positioned at the sides of their body.

The head was kept in the same position as the trunk and the vertebral column. During the test, the subjects were asked to look forward with no cervical and trunk rotation, extension or flexion. Such was the position of the subjects.

Identification of LMTrPs.

The presence of latent MTrPs was determined using the diagnostic criteria described by Simons *et al.*, (1999a, b) by an examiner with more than 10 years of experience in the diagnosis of MTrPs:

1. presence of a palpable taut band in a skeletal muscle,
2. presence of a hypersensitive tender spot in the taut band
3. local twitch response provoked by the snapping palpation of the taut band
4. reproduction of the typical referred pain pattern of the MTrPs in response to Compression

These criteria have a good inter examiner reliability (k) ranging from 0.84 to 0.88 ^[23].

Protocol

The volunteers sited on a chair; their wrists hanged in the side in their body. The upper trapezius, levator scapula, and sternocleidomastoid (SCM) muscle groups have been examined bilaterally for MTrPs. To define a MTrP, the examiner palpated the muscle groups on the lookout for a taut band within the muscle, within which they looked for a nodule. If a nodule was located in angular place of upper trapezius muscle in dominate side, the examiner pressed the nodule for few seconds and asked the subject whether it evoked pain. The examiner instructed the situation as following: "I'm going to use pressure, tell me when you feel a minimal quantity of pain", then applied pressure to the MTrP with the algometer, at a price of about 1 kg/cm²/ second. After introducing the project to the subjects and making sure of the accuracy of the maneuver, subjects MTrP performed three 10 sec trials separated by using 20 s between them. The maximum numbers of MVC contractions have been limited to three. Mean of the achieved numbers selected as an MVC.

Earlier than doing the test PPT and pain depth and alignment of head and neck changed into assessed. Photography of the patient neck position in impartial and maximum opposite side bending turned into accomplished for 3 trials.

The pressure stage similar to 80% of the MVC turned into chosen due to the fact the protocol aimed to cause muscle fatigue.

The head was kept in the same position as the trunk and the vertebral column. At some stage in the test, the subjects had been requested to look ahead without a cervical and trunk rotation, extension or flexion. The subjects have been asked to preserve a unilateral 80% MVC isometric shoulder elevation till the force gauge reveal confirmed 50% of MVC at the least for three minutes.

Comments of the force level changed into provided. The perceived exertion was rated by using the situation at the start and after every minute of the contraction. Force and EMG signals have been recorded for the duration of the MVC and sustained contractions.

Despite the fact that no subjective assessment of fatigue turned into made, the topics showed exhaustion at the end of the protocol. Following fatigue protocol, the recordings of pain threshold and intensity and kinematics have been all repeated. Figure 1 indicates trials for obtain ROM and kinematic data.

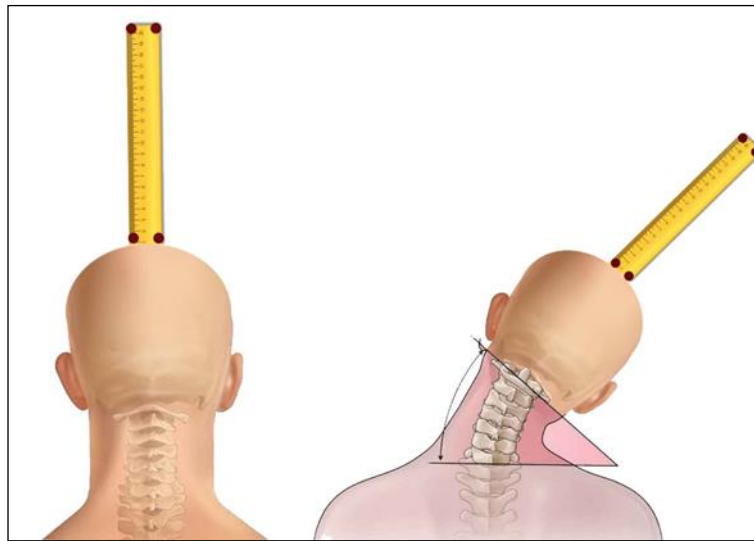


Fig 1: showed the test protocol

Cervical JPS

JPS changed into measured because the participant's capability to recreate a previously provided angle on the cervical.

After the two pre-fatigue sets, participants performed the fatigue protocol. At once following the fatigue protocol, contributors accomplished one set of 3 post-fatigue cervical JPS trials with three separate target angles. We chose three trials according to set due to the fact the opportunity existed that player may begin to get over the fatigue protocol if additional trials were accomplished. Three trials still allowed for the calculation of the average error, while minimizing learning consequences and making sure that any adjustments because of the neck muscle fatigue were likely still present.

Statistical Analysis

Repeated measures analysis of variance (ANOVA) with pre-planned contrasts to the first baseline was performed for each variable and used to measure JPS between pre-and post-fatigue conditions (SPSS v19, IBM Corporation, Armonk, New York, USA). Statistical significance was set at $p \leq 0.05$. Microsoft Office Excel 2010 (Microsoft Corporation 2010; Redmond, Washington, USA) was used to calculate lateral flexion angle. In addition, two sample t tests for data with unequal variances were calculated to evaluate force level and time to fatigue.

All the participants have been in a position to finish the experiment, with no problems or interaction with the experimenter. No substantial differences among gender and intervention parameters had been observed in any of the 2 groups. Neck muscle fatigue had extraordinary effects on neck kinematics for every group. JPSE in neck side bending repositioning become appreciably extra following the upper trapezius muscle fatiguing protocol in a frontal plane (i.e., lateral bending) ($p < 0.001$).

Results

Joint Range of Motion (ROM): Active ROM contralateral was measured using a universal force gauge. Maximum ROM for each test was measured in degrees [24, 25]. Reliability testing of the cervical ROM yielded ICC ranging from 0.79 to 0.97 (26). The MDC across the three movements ranged from 3.6° to 6.5° [27]. Table 2 shows participant and baseline characteristics

Table 2: Participant Baseline sociodemographic and baseline characteristics

	Patient group	Control group
Age	0.73	0.88
Weight	0.42	0.59
Height	0.27	0.26
BMI	0.22	0.17
Mean Lat Bending	0.11	0.19

Reliability of the three repeated measures for each trial. The reliability of the three trials for neck side bending was very high, with interclass correlations ranging from 0.82 to 0.99. table 3 shows the effect of fatigue on variables.

Table 3: Paired Samples Test

		Paired Differences					t	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference			
					Lower	Upper		
Pair 1	PPT. before - PPT. after	-1.56761	.97674	.14401	-1.85766	-1.27755	-10.885	.000
Pair 2	VAS. before - VAS. after	7.76087	8.78176	1.29480	5.15301	10.36873	5.994	.000
Pair 3	Mean LatB - Mean LatA	6.02863	4.86794	.71774	4.58303	7.47423	8.399	.000

PPT: pressure pain threshold/ VAS: visual analogue scale/LatB: contralateral bending

Neck muscles, specially the small suboccipital deep muscle mass have a totally high density of muscle groups spindles and are, consequently, critical contributors to neck proprioception [28].

It's been proven that afferent input from muscle spindles is vital for most useful movement precision [29-31].

Without except different contributing factors, it's been advised that disturbed proprioceptive input, as a result of altered input from the muscle spindles, may want to represent an essential pathophysiological mechanism in persistent musculoskeletal pain situations of various origin [32].

Discussion

It is known that muscle spindle afferents convey role and movement information in ensembles of afferents [33] and that the information content material in such ensembles is reduced when the fusimotor manage of the muscle spindles is disturbed by way of excessive interest in group III and IV muscle afferents [31, 34].

In an animal version it turned into discovered that excitation of chemo sensitive nociceptors in cervical side joints and muscle mass induce reflex activation of fusimotor neurons which modify the static and the dynamic sensitivity of the muscle spindles [35].

Thus, the diminished mechanoreceptor and muscle spindle function, and the important misinterpretation of the proprioceptive inputs could lead to the loss of cervicocephalic kinesthetic acuity.

Several mechanisms may additionally contribute to the altered neck function feel, inclusive of: the outcomes of ache itself on both nociceptors and mechanoreceptor pastime locally, on the spinal cord and within the important apprehensive device [36]; disturbed sensitivity of the cervical joint and muscle receptors (37) Or via inflammatory mediators [38].

In addition, central sensitization (as advised by the PPTs and different findings of the existing have a look at discussed within the previous paragraph), is assumed to be associated with reorganization of the somatosensory cortex in persistent ache syndromes, inclusive of modifications within the cortical illustration of painful frame websites [39].

This disruption of the frame map may additionally affect proprioception [36, 40]. Based on the prevailing observe effects, pain traits seem unrelated to joint function error, in step with research in adults [41].

This has a look at explored the location accuracy at some point of frontal head reposition moves as well as the corresponding EMG responses of higher trapezius muscle fatigue in topics with and without neck pain. Previous studies have revealed the location accuracy of the sagittal head-to-impartial tests in young healthy topics (18–30 years antique) and in center-aged subjects with neck pain (forty–65 years old) [42].

The results of the prevailing study imply that cervical kinesthetic mistakes were significantly greater after subjects had passed through fatiguing of the myofascial trigger point groups. Curiously, a significant difference was seen in sagittal movement. The possible reason for increased repositioning errors in the frontal plane is because of be the dorsal neck muscles are more responsible for cervical spine stabilization in the frontal plane, and fatiguing these muscles may have changed the discharge of sensory receptors such as muscle spindles and Golgi tendon organs, thus leading to an alteration in kinesthetic sense [43]. The isometric dorsal neck muscle fatiguing protocol used in this have a look at become capable of fatigue the dorsal neck muscles, as found out

through a big decrease in dorsal neck muscle power changed into validated following the fatiguing protocol. The consequences of the present study led us to postulate that localized muscle fatigue of the dorsal neck muscle mass may regulate sensory inputs, affecting primary mechanisms of postural manipulate. This may be attributable to ionic or metabolic adjustments in loose nerve endings, including accelerated interstitial potassium attention, or reduced oxygen enter because of reduced blood go with the flow [25, 30, 44].

The upper trapezius muscle contract concentrically during side flexion and eccentrically during contralateral side bending, and provide a steady proprioceptive input, thereby preserving a stable spine [45, 46]. When the upper trapezius muscle was fatigued, proprioceptive repositioning errors were more apparent in the frontal plane only. A recent study has investigated the effects of localized neck muscle fatigue on postural control.

Upper trapezius muscle may significantly influence side flexion and rotation movements, as the surrounding muscles may have provided feedback on position and movement information. Most of the subjects in the present study who showed repositioning errors in the frontal plane following upper trapezius muscle fatigue showed the phenomenon of overshooting. This may be due to overcompensation by the surrounding muscles and an increased effort to reach the target.

Clinical implications

We believe that the results from this study have clinical relevance. The subjects' ability to recognize joint position was hindered after a bout upper trapezius muscle fatiguing exercise. The implications of the decreased proprioception are twofold. First, afferent proprioceptive feedback incorporated in the central nervous system elicits efferent neuromuscular responses that are important to the practical stability of the cervical joints. Because fatigue hinders proprioceptive feedback from the cervical to the central nervous system, the neuromuscular responses responsible for joint balance may be hindered, leading to joint instability and eventually cervical impairment.

Second, if someone's potential to understand joint role, mainly at the extremes of its variety, is hindered, he or she can be at risk of harm due to elevated mechanical pressure placed on both the static and the dynamic systems accountable for keeping balance of the cervical spine. Within the assessment of neck pain, it is able to be critical to assess cervical muscle power and cervical proprioception alongside neck range of motion, segmental mobility, soft tissue mobility and flexibility. Strengthening the upper trapezius muscle may also lessen the negative impact of muscle fatigue on cervical proprioception, but this can require in addition investigations.

conclusion

In conclusion, fatigue applied to the upper trapezius muscle, together with conventional physiotherapy, has been shown to reduce pain and levels of disability, whilst increasing lateral flexion angel and endurance in individuals with MTrP. Fatigue applied to the upper trapezius muscle may therefore be considered as an alternative treatment method for individuals with MTrP.

Author's contribution

RM wrote the manuscript and designed the study. GhRO developed the original idea and did critical revision of the manuscript for important intellectual content. STM studied concept and design. Go and ASH contributed.

Conflict of interest

The authors have no personal or financial relationships with other peoples or organizations that could present the potential conflict of interests in their works.

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