Effect of Different Intensities of Ultrasound on Pain and Myoelectric Activities of Upper Trapezius Myofascial Trigger Points

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Abstract

Purpose: This study aimed to investigate the effects of high-power pain threshold ultrasound versus conventional ultrasound on upper trapezius myofascial trigger points. Method: Seventy participants with active trigger points were randomly divided into three groups, groups A, B and C. Group A (n=23) received high-power pain threshold ultrasound twice/week for two weeks. Group B (n=24) received conventional ultrasound twice/week for four weeks. Group C (n=23) (control group) received sham ultrasound twice/week for four weeks. Visual analogue scale (VAS) scores, surface electromyography were used to evaluate participants pre and post-treatment. Results: According to the within-group analysis, there were significant differences in all variables between pre- and post-treatment in the three groups (p<0.05). The between-group analysis revealed a significant decrease (p <0.001) in the normalized resting electromyographic (EMG) activity of the left trapezius after treatment in group A compared with group C. Groups A and B had significantly greater decreases in VAS scores after treatment than group C (P<0.005). In addition, group A had significantly lower VAS score after treatment than group B. Conclusion: Both techniques of ultrasound are effective for the treatment of subjects with active trigger points, but high-power pain threshold ultrasound is superior.

Keywords: High-power pain threshold ultrasound, conventional ultrasound, surface electromyography, myofascial trigger points.

Introduction

Myofascial pain syndrome (MPS) is a type of chronic pain disorder that affects a portion of the population that is characterized by the existence of trigger points. Trigger points are hyperirritable loci inside a tight band of skeletal muscles and are commonly observed in the upper fibres of the trapezius due to overload and microtrauma.1 Trigger points are clinically categorized as latent or active myofascial trigger points (MTrPs), Pain and increased resting myoelectric activity are present for active MTrPs. in individuals with active trigger points, consistent with a previous neurophysiological study.2

The production of heat is the main and most widely recognized effect of ultrasound (US), which is considered one of the most common techniques that used for the treatment of MPS. The thermogenic effect of US leads to a transient increase in the flexibility of dense collagenous structures which subsequently reduces joint stiffness, pain and associated muscle spasms and momentarily increases circulation.3

Previous studies that examined the effect of US for treatment of MPS have commonly administered as
conventional US which is between 0.8-1.5 watt/cm², which has improved MPS.4,5

Some studies have also evaluated another type of US therapy, namely, high-power pain threshold ultrasound (HPPTUS), and have reported that it is effective in the treatment of MPS.3,4,6

To date, few studies have investigated the effect of US on EMG activity in MPS. Therefore, this study provides new insights and major contributions regarding the effect of US on EMG activity in MPS.

The current study aimed to compare the effects of HPPT and conventional US therapy on pain, myoelectric activities in individuals with upper trapezius active trigger points.

Materials and Method

This randomized clinical trial was performed at the Laboratory of Electromyography, Faculty of Physical Therapy, Cairo University. The study protocol was approved by the research ethics committee of the Faculty of Physical Therapy (NO: P. T. REC/012/001519) and registered in the Pan African Clinical Trial Registry. (Registry ID PACTR 201712002882400).

Sample Size Calculation: The minimum required sample size was calculated to be 20 patients per group. This calculation was designed to reveal an effect size of 0.5 with an alpha of 0.05 and a power of 80% considering the visual analogue scale (VAS) score as the primary outcome. Based on the sample size estimation while considering a probable dropout rate (10%) and our available resources for conducting this study, we aimed to include 70 patients. The number of patients was calculated using G*Power (version 3.1.9.2) (Franz Faul, Uni Kiel, Germany).

Participants: Seventy participants their ages ranged from 18 to 30 were provided verbal and written explanations of the purpose of the study. If the participant agreed to participate, he or she signed a consent form that was approved by the Faculty of Physical Therapy. Then, the participants were randomly allocated to the following three groups by software randomization (1:1 allocation ration) using randomly permuted block sizes created with a random number generator: Group (A) received HPPT-US on the bilateral upper trapezius in four sessions at 3-day intervals. Group (B) and group (C) received conventional and sham US respectively on the bilateral upper trapezius for four weeks twice per week.

Inclusion and exclusion criteria:

Participants were included if they had active MTrPs in the upper trapezius muscle bilaterally and complained of pain at rest, jump sign at pressure, had a limited range of motion (ROM), or experienced referred pain.7 Participants were excluded if they had a history of any degenerative disorders, cervical disc hernia or fibromyalgia that might cause pain or if they had MPS and had received any therapy within the previous 6 months. Heavy manual laborers and patients who regularly performed physical exercises, had any systemic diseases, had previous neck or shoulder surgery, or had any contraindication for US therapy were also excluded.5

Instrumentation:

Assessment Instrumentation: Pain intensity was assessed using the VAS. The scale is presented as a line: one end of the line corresponds to no pain, and the other end of the line corresponds to the worst possible pain. Use of the VAS is a valid and reliable method for assessing pain intensity. Each participant was instructed to put a point on the line to identify the pain intensity.8

Myoelectric signals were identified bilaterally from the upper trapezius muscle by using a two-channel digital electromyogram device (Neuro-EMG-Micro, Neurosoft, Ivanovo, Russia).

Treatment Instrumentation: The equipment used for US for all groups was a Med Serve system (England NN114HE, Prosound/ULS-1000, S/N: U0547).

Procedures: Group (B) received a standard dose of US therapy (conventional US) in continuous mode (1 MHz, intensity of 1.0 W/cm²) during which the head of the US device was moved in a circular motion over the trigger point for 5 min.9 Group (C) received sham US, which involved the same procedures as conventional US except that the US device was switched off. Group (A) received HPPT-US using the same device in the same mode and at the same frequency. The probe was held fixed over the trigger point, and the US dose was increased until intolerable pain was felt by the participant. The probe was held fixed for 3 s at the dose at which intolerable pain was felt, and then, the dose was decreased by half. At this dose, the probe was moved in a circular motion over the trigger point and the surrounding...
area for 15 s, and then, the dose was increased a second time in a similar manner. The maximum dose that could be given to this group of patients for 3 s ranged from 1.5 to 2.5 W/cm². The same technique was repeated three times, and the treatment session ended.

The EMG electrodes were two recording electrodes (one active and one reference) placed parallel to the upper trapezius muscle with a 2-3 cm distance between them, and the ground electrode was wrapped around the wrist joint. The skin covering the area of the upper trapezius muscle and the wrist joint was carefully cleaned with alcohol. Then, the recording electrodes were positioned 2 cm lateral to the centre of a line drawn from the c7 spinous process to the posterolateral aspect of acromion bone. The test was performed with the patient seated in a chair, and the participant was asked to maintain the trapezius muscle in a resting position for six seconds followed by elevating both shoulders, retaining this position in isometric contraction for six seconds, supported by suitable verbal commands. The participants had been previously taught how to perform the required tasks. Each task was performed 3 times with one minute rest intervals, and the root mean square (RMS) value was used.

Normalization of EMG activity: Normalized values were calculated as follows: Normalized RMS % = EMG amplitude during resting/(average of EMGMAX for the 3 trials)×100.

Statistical Analysis: Data analysis was performed using the SPSS 23.0 for Windows statistical software. In the beginning, the normality of data distribution was tested through the Shapiro-Wilk test. Descriptive data for participants, characteristics and dependent variables was calculated as mean ± SD. Because of skewed distributions, the EMG parameters were square root-transformed before analysis. 2x3 mixed model MANOVA was carried out to compare the three groups (between-subject effect) at each of the before and after test time periods and between the before and after test time periods (within-subject effect) for each group for the outcome variables. Furthermore, testing for the interaction effects between both independent variables was conducted. The alpha level of significance was adopted at P< 0.05.

Results

The demographic characteristics of the participants are shown in table (1). There was no significant difference in the mean age, weight, height and BMI between the three groups (p > 0.05). Also, there was no significant difference in sex distribution between groups (p = 0.25). Compared group C, mixed-model MANOVA revealed a significant decrease in the mean value for normalized resting EMG after treatment in Group A (HPPTUS) (P =0.017, CI: -0.96 - -0.073). Regarding pain, the decrease in the mean values for VAS score was significant in Group A and B after treatment as compared to group C (Group A VAS: P<0.001, CI: -3.66 - -1.98; Group B VAS: P<0.001, CI: -2.26 - -.60), as shown in table (2). In addition, the results showed significant decrease in the mean values for VAS in Group A as compared to Group B after treatment (VAS: P<0.001, CI: -2.22 - -.56 and NDI: P=.011, CI: -5.47 - - .65), as shown in table (2). Moreover, the mean values for VAS score, normalized resting EMG activity of the right and left trapezius muscle decreased after treatment compared with before in the three groups, as shown in table (2).

<p>| Table 1. Demographic characteristics of participants in the three groups |
|-----------------------------------|-----------------|-----------------|-----------------|-------|</p>
<table>
<thead>
<tr>
<th></th>
<th>HPP US</th>
<th>Conventional US</th>
<th>Sham US</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>21.65 ± 3.61</td>
<td>21.41 ± 2.43</td>
<td>21.65 ± 2.72</td>
<td>0.95</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>67.08 ± 7.65</td>
<td>68.04 ± 6.92</td>
<td>68.26 ± 7.4</td>
<td>0.84</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>162.65 ± 5.19</td>
<td>162.91 ± 6.65</td>
<td>163.34 ± 5.66</td>
<td>0.92</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>25.37 ± 2.84</td>
<td>25.62 ± 2</td>
<td>25.62 ± 2.88</td>
<td>0.93</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td>0.25</td>
</tr>
<tr>
<td>Males</td>
<td>4 (17.4%)</td>
<td>8 (34.8%)</td>
<td>8 (34.8%)</td>
<td></td>
</tr>
<tr>
<td>Females</td>
<td>19 (82.6%)</td>
<td>15 (65.2%)</td>
<td>15 (65.2%)</td>
<td></td>
</tr>
</tbody>
</table>

SD, Standard deviation; p-value, Level of significance
Table (2): Comparison of Mean± SD Normalized resting EMG activity of right and left trapezius and VAS of the three groups at pre and post treatment times

<table>
<thead>
<tr>
<th>Outcomes</th>
<th>Group Time</th>
<th>HPP-US (group A) mean±SD (n=23)</th>
<th>Conventional US (group B) mean±SD (n=24)</th>
<th>Sham US (group C) mean±SD (n=23)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normalized resting EMG of right trapezius</td>
<td>Pre</td>
<td>2.15±.97</td>
<td>2.29±1</td>
<td>2.1±1.1</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>1.15±.44</td>
<td>1.59±.77</td>
<td>1.55±.76</td>
</tr>
<tr>
<td></td>
<td>P value (95%CI)</td>
<td>&lt;0.001 (.55-1.4)</td>
<td>.002 (.26-1.12)</td>
<td>.015 (.11- .99)</td>
</tr>
<tr>
<td>Normalized resting EMG of left trapezius</td>
<td>Pre</td>
<td>2.78±.73</td>
<td>2.92±1.14</td>
<td>2.88±1.80</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>1.43±.37*</td>
<td>1.67±.55</td>
<td>1.95±.82</td>
</tr>
<tr>
<td></td>
<td>P value (95%CI)</td>
<td>&lt;0.001(78.71-1.91)</td>
<td>&lt;0.001(70-1.80)</td>
<td>.002(.37-1.50)</td>
</tr>
<tr>
<td>VAS</td>
<td>Pre</td>
<td>7.69±.63</td>
<td>7.62±.76</td>
<td>7.34±1.02</td>
</tr>
<tr>
<td></td>
<td>Post</td>
<td>1.56±.84* **</td>
<td>2.95±1.12*</td>
<td>4.39±1.43</td>
</tr>
<tr>
<td></td>
<td>P value (95%CI)</td>
<td>&lt;0.001(5.52-6.73)</td>
<td>&lt;0.001(4.07-5.25)</td>
<td>&lt;0.001(2.35-3.56)</td>
</tr>
</tbody>
</table>

SD: Standard Deviation; US: Ultrasound; VAS: Visual Analogue Scale *Significant (P<0.05) compared to Control ** Significant (P<0.05) compared to Group B (Conventional US)

**Discussion**

This study aimed to compare the effect of HPPT-US with that of conventional US in participants with upper trapezius active MTrPs. The present study showed significant improvements in all three groups, but the superiority for the HPPT US group.

Our results are in agreement with those reported by Majlesi and Unalan (2004) who found that HPPTUS is more effective than conventional US for the treatment of MPS according to VAS score and neck active lateral bending ROM. Koca et al. (2014) also compared the effects of US treatment applied at low-, medium, and high-power doses on trigger points and found that, in general, HPPT-US therapy was more effective than other techniques.

In contrast, Esenyel et al. (2007) found no significant difference between HPPTUS and conventional US in the treatment of trigger points with respect to VAS score, as Kim et al., 2014 also reported no significant difference in VAS score between HPPTUS and conventional groups of elderly patients with latent MTrPs. This discrepancy from the results of the current study may be due to different ages and types of MTrPs.

The current study showed decreased normalized resting EMG activity of the muscle in all groups. Few studies have reported decreased basal electrical activity and fewer local twitch responses of the trapezius muscle after treatment with US. The results of these previous studies are in agreement with those of the current study, as we found significantly decreased normalized resting EMG activity after treatment in both treatment groups. In contrast, another study found no effect of static US on EMG activity in the treatment of individuals with chronic neck pain.

The current study showed significant improvements in normalized resting EMG activity of the left side in the HPPT-US compared with control group, on my point of view, the improvements were significant in the left side as most participants were right handed so, the muscle on the left side was more relaxed than right side.

Interestingly, the improvement observed in the HPPT and conventional US groups may be due to the thermogenic effect of US. The effects of HPPTUS may be also due to the high intensity of US stimulation, which has been reported to decrease evoked action potential amplitude and exert an accompanying thermal effect. The improvement observed in the control group may be due to the compression and massaging effect of the US probe.

In the current study, all of the measures that were evaluated showed a significant improvement, while greater improvement was found in the HPPT-US group.
Therefore, HPPT-US is more economical treatment than conventional US treatment due to the reduced number of required treatment sessions.

Limitations: This study was limited by the short treatment time, and there was no follow-up evaluation.

Conclusion

Both conventional and HPPT-US techniques are effective for treating subjects with active trigger points of the upper trapezius muscle, while HPPT-US is more effective.

Funding: Self-funding

Ethical Clearance: Cleared by the ethical committee of, Basic Science Department, Faculty of Physical Therapy, Cairo University, Cairo Egypt.

Conflict of Interest: None.

References

