Short-term effects of self-massage combined with home exercise on pain, daily activity, and autonomic function in patients with myofascial pain dysfunction syndrome

YUAN-CHI CHAN1, 2), TZYY-JIUAN WANG3), CHENG-CHIANG CHANG1, 2), LIANG-CHENG CHEN1, 2), HENG-YI CHU1, 2)a, SHOU-PING LIN4, 5)a, SHIN-TSU CHANG2, 5)a

1) Department of Physical Medicine and Rehabilitation, Tri-Service General Hospital, Taiwan
2) Department of Physical Medicine and Rehabilitation, School of Medicine, National Defense Medical Center: 325, Sec. 2, Cheng-Kong Road, Neihu District, Taipei 114, Taiwan
3) Department of Physical Therapy and Assistive Technology, National Yang-Ming University, Taiwan
4) Department of Physical Medicine and Rehabilitation, Hsin-Chu Armed Force Hospital, Taiwan
5) Department of Physical Medicine and Rehabilitation, Taichung Veterans General Hospital, Taiwan

Abstract. [Purpose] The aim of the present study was to investigate the short-term effects of a program combining self-massage and home exercise for patients with myofascial pain dysfunction syndrome (MPDS). [Subjects and Methods] In this retrospective study, 63 patients were allocated to the experimental (n = 32) and control (n = 31) groups. Both groups received 6 sessions of treatment with physical modalities over the course of two weeks. The experimental group completed an additional program with a combination of self-massage and home exercise. The outcome measurements included a pain scale, pressure pain threshold (PPT), neck disability index (NDI), patient-specific functional scales (PSFS), and heart rate variability (HRV). The interactions between the groups and over time were analyzed using two-way repeated measures ANOVA. [Results] Only the experimental group demonstrated significant improvements in the pain scale with varying conditions. The PPTs of the trigger points increased significantly in the experimental group, and significant functional improvements in NDI and PSFS were observed in the same group. There were significant increases in high-frequency HRV and high-frequency % in the experimental group. [Conclusion] Treatment with physical modalities plus combination of self-massage and home exercise is more effective than the physical modalities treatment alone.

Key words: Myofascial pain dysfunction syndrome, Pressure pain threshold, Heart rate variability

INTRODUCTION

Myofascial pain dysfunction syndrome (MPDS) is defined as chronic skeletal muscle pain caused by multiple trigger points and fascial constrictions. People with MPDS have limited daily activity functions due to the severe and chronic pain they experience1–4). When trigger spots are activated, referred pain and other autonomic nervous system (ANS) reactions are induced5–7). The ANS dysfunction symptoms include abnormal sensation, neuromuscular function attenuation, and heart rate alternation5, 8–10). Together with pain expression, the augmentation of pain can increase the sympathetic nervous system activity9). The goals of treating MPDS are reduction of muscle tension and pain, amelioration of the myogenic dysfunction, recovery from muscle imbalance, increase of muscle flexibility, and finally normalization of muscle activity2, 11, 12). The common treatments for MPDS are analgesic drugs, dry needle therapy, laser exposure, ultrasonic treatments, and physical therapy1, 6, 7, 13–17).

Massage and exercise are excellent for improving muscle activity and flexibility. The combination of massage and home exercise treatment programs helps to ensure continuous improvement of patient symptoms18, 19). Nonetheless, the literature mainly focuses on the improvement in pain reduction, rather than addressing the improvements in patients’ daily activities brought on by the reduction of pain20–22). Past research focused on how to increase treatment efficiency and reduce the number of sessions required to treat MPDS patients. Additionally, there has been little study on ANS dysfunction during treatment of MPDS patients23). We repurpose a combination of self-massage and home exercise as a teaching and therapeutic program to educate patients and interns in clinical practice, and this program was implemented over a period of two weeks by a guest lecturer, Pro-
Subjects and Methods

This was a retrospective study. We enrolled patients from our data bank in the Department of Physical Medicine and Rehabilitation at Tri-Service General Hospital, from March 2009 to March 2010. All of the patients were diagnosed as having MPDS for 6–18 months and had undergone physical therapy, combination therapy or physical modalities only, or both. The inclusion criteria were a clinical diagnosis confirming MPDS with 1) two consecutive weeks of symptoms in the upper back, 2) symptoms painful enough to affect daily activities, and 3) at least one active trigger point in the neck or upper back musculature.

The exclusion criteria were 1) patient age younger than 20 and older than 65 years, 2) previous surgery in the cervical/thoracic vertebrae or shoulder, 3) rheumatoid arthritis or systemic lupus erythematosus, 4) medical history of cervical disc herniation, cervical spondylolisthesis, nostalgia paresthetica, or cervical radiculopathy, 5) cognitive dysfunction impairing cooperation with treatment and testing, and 6) incomplete recording of outcome measurements.

The patients were categorized into two groups according to the treatment they received. The control group only received 6 sessions of physical therapy modalities (heating and transcutaneous electrical nerve stimulation (TENS) over a period of 2 weeks (three times a week)). The patients in the experimental group completed a program consisting of a combination of self-massage and home exercise therapy, as well as the same 6 sessions of heating and TENS as the control group. The self-massage performed by the patients themselves was taught by our instructor. Each patient massaged the muscles known to have trigger points with the aid of a baseball by rolling the ball on the specific neck and upper back muscles and associated trigger points. This massage technique induces ischemic pressure at the trigger point and also massages the adjacent taut band. The home exercise program consisted of stretching the muscles specifically to the trigger point locations on the patients’ upper backs.

The study conformed to the principles of the Declaration of Helsinki, and was approved by the Institutional Review Board (IRB) of Tri-Service General Hospital (TSGHIRB No. 1-103-05-108). With the approval of our IRB, informed consent was waived due to the retrospective nature of our study.

The treatment outcomes were measured using a pain scale, pressure pain threshold (PPT), neck disability index (NDI), patient specific functional scales (PSFS), and heart rate variability (HRV) before and after the therapeutic programs.

The patients were asked to indicate the highest level of pain they were experiencing on a 10-cm visual analogue scale (VAS), where 10 cm represented the maximum pain. Pain was evaluated during rest and daily activities; additionally maximal pain intensity was evaluated.

Nine trigger points on each side of the body were selected for the PPT measurements; these points included one point on the pectoralis major, two points on the levator scapulae, one point on the latissimus dorsi, two points on the subscapularis, and three points on the infraspinatus. We used a pressure threshold algometer (FG-5005, RS232, Lutron Electronic Enterprise, Taipei, Taiwan) to measure the PPT of all nine trigger points in the upper back. Before starting, the procedure was clearly explained to the patients. We applied the algometer to the trigger point area with a metal rod perpendicular to the skin surface and performed compression slowly enough to induce MPDS symptoms or a myotatic reflex. If any increase in pain intensity or discomfort occurred, and the procedure was stopped immediately. The average value (expressed as kg/cm²) of three repeated measurements was taken for each trigger point, and the average values for all nine trigger points (expressed as kg/cm²) were used for PPT analysis.

We used the NDI and PSFS to evaluate patients’ daily activity functions. The total score for the NDI is 50 points for 10 items, and each item is rated on a scale of 0 to 5, with the lowest score of 0 representing no effect on daily activities and the highest score of 5 representing the greatest effect on daily activities resulting in the least daily activity function. The PSFS assessed the three daily activities most affected by MPDS symptoms and asked patients to assign points to the extent they were affected, with 0 meaning most affected and 10 meaning unaffected.

To explore the relationship between MPDS and ANS dysfunction, heart rate variability (HRV) was examined. To minimize the influence of other factors on HRV, all patients were prohibited from using drugs, caffeine, tobacco, and alcohol for 4 h before the measurements. Before HRV measurement, patients sat in a room at room temperature (25°C) for 20 min. HRV was assessed before and after the treatment/control period. During measurement, the patients were asked to refrain from talking, falling asleep, making exaggerated body movements, and/or intentionally altering their respiration. HRV analyzed in the frequency domain can be used to assess vagal activity. HRV was measured using an HRV analyzer (SSIC, Enjoy Research Inc., Taiwan). Analysis was based on a 10-min period of ECG signal acquisition, followed by computerized Fourier analysis of the ECG waves. Patients were carefully monitored using the HRV analyzer to ensure there were no significant respiratory pattern changes during ECG measurement. HRV parameters were then obtained from the analyzer, which included high frequency (HF), low frequency (LF), high frequency percent (HF%), low frequency percent (LF%), and low frequency and high frequency ratio (LF/HF). LF spectral power reflects the sympathetic influence, whereas HF power reflects the parasympathetic influence; the LF/HF ratio reflects the global sympathovagal balance. Increases in the LF/HF ratio signify sympathovagal predominance. HF% and LF/HF were the main parameters of interest in...
our study.

The data processing and statistical analysis were performed using the Statistical Package for the Social Sciences software (SPSS 16.0). The independent t-test was used to determine the differences in continuous variables between the two treatment groups. The chi-squared test was used to determine the differences in categorical variables between the two treatment groups. Furthermore, two-way repeated-measures analysis of variance (ANOVAs) was used to compare outcome measures before and after the treatments between the control and experimental groups, and to observe any interactions between the two treatment groups. In this study, the statistical significance level was set at α < 0.01.

RESULTS

A total of 63 patients were enrolled in the study; the control group contained 31 patients, and the experimental group contained 32 patients. The demographic analysis showed no significant difference between the two groups in terms of age, body height, average weight, averaged body mass index, or gender (Table 1).

The experimental group experienced significant decreases in pain levels after treatment during rest and daily activities and in maximal pain intensity (all p < 0.001). The control group experienced no significant difference in pain levels after treatment (Table 2).

As shown in Table 2, prior to treatment, the PPT values of the control and experimental groups did not differ significantly between the two groups (p>0.01). By the end of the treatment sessions, the two groups showed significant improvement in PPT (p < 0.001). The PPT values for all nine trigger points increased in both the control and experimental groups. The control group demonstrated significant improvement of PPT before and after treatment (p<0.01), and the experimental group did as well (p < 0.001).

The NDI results did not differ significantly between the control and study groups prior to treatment (p>0.01). After treatment, the NDI results for the control group showed no significant difference when compared with the values obtained before treatment (p>0.01). The experimental group showed a significant decrease (p < 0.001) of NDI compared with the values obtained prior to treatment (Table 3).

The PSFS results did not differ significantly between the two groups prior to treatment (p>0.01). By the end of the treatment sessions, the control group demonstrated significant improvement in PSFS (p<0.01). After the treatment, the PSFS increased significantly in the experimental group (p < 0.001) as well (Table 3).

There was no significant difference in LF HRV between the control and study groups prior to treatment (p>0.01) and no significant difference after treatment (p>0.01) (Table 4). There was no significant difference in HF HRV between the two groups prior to treatment (p>0.01). After treatment, the control group showed no significant difference in HF (p>0.01). However, the experimental group had a significant increase in HF HRV (p<0.01) compared with the pre-treatment values (Table 4).

Prior to treatment, the LF% and HF% did not differ significantly between the control and experimental groups (p>0.01 and p>0.01, respectively). After treatment, the control group showed no significant difference in LF% (p>0.01). However, the experimental group showed a significant decrease in LF% (p < 0.001) after treatment (Table 4).

Prior to treatment, the HF% did not differ significantly between the two groups (p>0.01). After the treatment, the

<table>
<thead>
<tr>
<th>Table 1. Demographic information of the control and experimental groups</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>Age (years)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>Body height (cm)</td>
</tr>
<tr>
<td>Body weight (kg)</td>
</tr>
<tr>
<td>BMI</td>
</tr>
</tbody>
</table>

SD, standard deviation. BMI, body mass index.

<table>
<thead>
<tr>
<th>Table 2. Comparison of various pain scales and the pressure pain threshold in the control group (n=31) and experimental group (n=32)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>VAS, resting (cm)</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>VAS, during daily activities (cm)</td>
</tr>
<tr>
<td>VAS, maximal pain intensity (cm)</td>
</tr>
<tr>
<td>Pressure pain threshold (kg/cm²)</td>
</tr>
</tbody>
</table>

* Statistically significant (p<0.01), VAS, visual analogue scale.

<table>
<thead>
<tr>
<th>Table 3. Comparison of two daily activity indices in the control group (n=31) and experimental group (n=32)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>NDI</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>PSFS</td>
</tr>
</tbody>
</table>

*Statistically significant (p<0.001), NDI, neck disability index, PSFS, patient-specific functional scale.
control group showed no significant difference in HF% (p = 0.035). However, the experimental group showed a significant increase in HF% (p = 0.008) after treatment (Table 4).

Prior to treatment, the LF/HF ratio did not differ significantly between the control and experimental groups (p>0.01). After treatment, the LF/HF in the control group (p>0.01) did not significantly differ from the LF/HF (p=0.008) of the experimental group (Table 4).

The difference in NDI correlated negatively with the pain scale when patients were at the maximal pain intensity (r = 0.34, p = 0.008), but the difference in PSFS correlated positively with the pain scales when patients were at rest and at the maximal pain intensity (r = 0.55, p < 0.001, and r = 0.54, p < 0.001, respectively). The LF% and LF/HF correlated positively with the pain experienced by patients during their daily activities (r = 0.34, p = 0.008, and r = 0.37, p = 0.004, respectively) but negatively with HF% (r = -0.42, p = 0.001; Table 5).

**DISCUSSION**

In this study of treatment of MPDS patients with a combination of self-massage and home exercise, patients experienced a reduced maximal pain intensity during daily activities when compared with control exercise. The PPT of the experimental group increased significantly after treatment (pain index) correlated negatively with the NDI; thus, a reduction in the maximal pain intensity effectively improved patients’ daily activity functions. The PSFS results suggest that the application of heat and TENS stimulation improved the PSFS in both the control and experimental groups. We did not make any comparison with other studies because there are few, if any, reports on PSFS expression. The difference in maximum pain intensity index correlated positively with the PSFS, which indicates that a reduction in the maximal pain intensity effectively improved patients’ specific activity functions.

The experimental group outscored the control group in both the PSFS and NDI. This result suggests that the standard modalities, when combined with a program of home exercises and self-massage, are more effective in improving patients’ daily activity functions than treatments that consist solely of the standard modalities.

HRV has been demonstrated as a valuable tool for evaluation of ANS23, 28, 29. A higher value for HF, one of the parameters of HRV, has been demonstrated in patients with back pain associated with myofascial trigger points29. In that study, which investigated the immediate effects of traditional Thai massage on HRV in 36 patients with back pain associated with myofascial trigger points, the results indicated that Thai massage is associated with significant increases in HRV (increased both LF and HF, but HF by more29). Our study also showed that the combination program enhanced parasympathetic nervous system activity and decreased sympathetic nervous system activity. Our results are consistent with other studies conducted in healthy adults23, 28. Our study also showed that there were significant relationships with respect to the pain experienced daily activities, which correlated with the LF%, HF%, and LF/HF differences. These results indicate that the enhancement in parasympathetic nervous system activity and reduction in sympathetic nervous system activity together result in the reduction in pain experienced by the patients in their daily activities.

The combination treatment program had several effects

### Table 4. Comparison of heart rate variability (HRV) in the control group (n=31) and experimental group (n=32)

<table>
<thead>
<tr>
<th></th>
<th>Control group (n=31)</th>
<th>Experimental group (n=32)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-test Mean±SD</td>
<td>Post-test Mean±SD</td>
</tr>
<tr>
<td>LF (ms²)</td>
<td>5.93±0.70</td>
<td>6.40±0.79</td>
</tr>
<tr>
<td>HF (ms²)</td>
<td>5.83±0.88</td>
<td>5.98±0.88</td>
</tr>
<tr>
<td>LF%</td>
<td>52.9±11.4</td>
<td>53.4±9.3</td>
</tr>
<tr>
<td>HF%</td>
<td>43.5±12.2</td>
<td>37.4±11.3</td>
</tr>
<tr>
<td>LF/HF</td>
<td>0.22±0.55</td>
<td>0.53±0.32</td>
</tr>
</tbody>
</table>

*Statistically significant (p<0.01), LF, low frequency; HF, high frequency; LF/HF, low and high frequency ratio

### Table 5. Relationships between the various indices and the pain scale

<table>
<thead>
<tr>
<th>Parameters (differences between pre- and post-test values)</th>
<th>Pain test conditions</th>
</tr>
</thead>
</table>
| NDI difference r value | At rest
|                | Daily activities
|                | Maximal pain intensity |
| HF difference r value | 0.29
|                | -0.34
|                | -0.34*
| LF% difference r value | 0.32
|                | 0.37*
|                | 0.28

*Statistically significant (p<0.01), LF, low frequency; HF, high frequency; LF/HF, low and high frequency ratio, NDI, neck disability index, PSFS, patient-specific functional scale
that increased muscle flexibility and blood circulation and decreased the conditions of muscle guarding. We assumed that the reason for the effect of the combination therapy being better than that of the single-therapy treatment for MPDS was blockage of trigger point activation by the combination therapy1, 2.

The treatment was designed with suggestions based on comparable reports and included heat application, electrical stimulation, exercise, and massage. Because our study combined self-massage with home exercise in the experimental group, we could not clearly indicate the source of the treatment effect nor could we compare our results directly with other studies. Furthermore, the study period was short (2 weeks only), and no other follow-up was done after treatments. Therefore, we cannot report the long-term effect of the combination program with self-massage and home exercise.

The combination program in this study resulted in improvements in pain, PPT, pain during daily activities, and ANS dysfunction. The physical therapy modalities plus combination program with self-massage and home exercise was more effective than the physical therapy modalities alone for improving pain-free daily activity functions. The assessments performed in this study, for instance, those for pain, daily activity functions, and ANS function, seem valuable references for MPDS studies that address the pain management of patients and use at-home therapies as supporting therapies in treating MPDS.

ACKNOWLEDGEMENTS

This research project was supported by Scientific Research Grant No. TSCH-G116-174 (2011) provided by the Ministry of National Defense-Medical Affairs Bureau, Taiwan.

REFERENCES