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MYOFASCIAL PAIN AND TREATMENT: Original Research

# Effect of manual compressive therapy on latent myofascial trigger point pressure pain thresholds

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ABSTRACT

*Objective:* This study compared the effects of 90 s of manual compressive therapy (MCT) on latent myofascial trigger points (LTPs) for 3 sessions per week for 4 weeks to determine changes in individual pressure pain threshold (PPT). A total of 30 (15 males, 15 females; age = 22 ± 4 y/o, height = 175 ± 18 cm, weight = 162.5 ± 57.5 kg) symptomatic subjects with LTPs volunteered for the study.
*Methods:* PPT was measured at baseline and pre- and post-treatment for all 12 sessions with a pressure algometer across the 4-week treatment time frame. The MCT was applied to the control group on their LTP at pressure intended to provide a sham condition (1/10 on verbalized analog scale (VAS)). Two experimental groups had MCT applied either directly on the LTP (d-TP) or in close-proximity to their LTP (cp-TP) at moderate pressure (7/10 on VAS).
*Results:* There was a significant increase in PPT from the first through twelfth treatment sessions ($p < 0.001$, partial $\eta^2 = 0.914$). A significant increase in PPTs between treatment groups was acutely observed from pre- to post-therapy tests ($p = 0.001$, partial $\eta^2 = 0.146$). The differences between pre- versus post-treatment PPT measures indicated significant differences (d-TP vs. control, $p < 0.001$; cp-TP vs. control, $p = 0.007$). No differences were observed between experimental groups ($p = 0.215$).
*Conclusions:* PPT continued to increase after several weeks of MCT when applied directly on or within 2.5 cm of an identified LTP compared to control.



## 1. Introduction

Latent myofascial trigger points (LTP) are a hyperirritable point in a taut band of skeletal muscle and typically result in localized regions of pain or tenderness when pressure is applied (Celik and Mutlu, 2013; Simons et al., 1999). The prevalence of trigger points is quite common with some authors suggesting a prevalence of 85% in the general population (Fleckenstein et al., 2010). Moreover, the locations of trigger points can vary within the entire body, including in the triceps surae (Grieve et al., 2013), low medial longitudinal arch (Zuil-Escobar et al., 2015), and in the hip of patients with patellofemoral pain (Roach et al., 2013). A recent systematic review reported that myofascial trigger points are a prevalent clinical finding, especially in patients with neck pain, reportedly occurring in up to 60% of subjects (Lluch et al., 2015). The trapezius, levator scapulae, and suboccipital muscles were the most prevalent locations for LTPs. Not only were LTPs present in patients presenting with neck pain, but no significant differences were observed in the prevalence rate of LTPs between symptomatic patients and healthy controls in various back muscles including the upper trapezius, levator scapulae, or semispinalis muscles (Lluch et al., 2015). However, significant differences in the prevalence rate of LTPs were observed between healthy and symptomatic patients in sternocleidomastoid, rhomboid, suboccipital, and scalene muscles (Lluch et al., 2015).

Today, manual rehabilitative therapy has become a common practice utilized in the treatment of some musculoskeletal pathologies, such as muscle strain injury (Kim et al., 2017; Torres et al., 2012), chronic low back pain (Netchanok et al., 2012; Ulger et al., 2017), and neck and shoulder pain (Kong et al., 2013; Paanalahti et al., 2016; Sefton et al., 2011). Manual compressive therapy (MCT) has been shown to reduce neural transmission and reduce pain when compared to placebo (Jonsson, 2012; Morikawa et al.,

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2017) and has been proposed to be a reliable method in increasing soft tissue pressure pain thresholds (PPT) in subjects with acute LTP (Fryer and Hodgson, 2005; Jonsson, 2012).

Pressure pain thresholds are frequently used as an indirect measure of tissue stiffness, which if allowed to progress, can result in significant joint range of motion limitations and become painful devoid of external pressure stimulus (Fernández de las Peñas et al., 2005; Weerasinghe et al., 2017). Increasing PPTs with manual therapies may have beneficial effects on musculoskeletal tissues leading to possible increases in joint flexibility (George et al., 2006), muscle contractile facilitation (Ge et al., 2014) and activation during rehabilitation (Kalichman and David, 2017).

The improvement of joint range of motion with corrective stability exercises while addressing functional impairments reportedly reduces abnormal stress placed upon joints (Chiu et al., 2012; Earl and Hoch, 2011). By treating LTPs prior to their becoming symptomatically painful and restricting movement, functional patterns for daily activities may be improved, and injury risk caused by improper movement compensations may be minimized. MCT often receives little investigative attention in preventative injury care, despite some research reporting the presence of LTPs resulting from many overuse injuries (Bron et al., 2011; Fryer and Hodgson, 2005; Jonsson, 2012). Moreover, there is little empirical evidence investigating the effects of MCT and the number of treatments necessary needed to elicit sustained benefits on PPT and therefore determine the efficacy of this treatment modality (De Meulemeester et al., 2017; Kojidi et al., 2016; Moraska et al., 2017). Thus, treatment periods and proximity to LTPs need further investigation to provide practitioners objective evidence to determine if MCT is effectively reducing pain sensitivity (Bron et al., 2011; Fryer and Hodgson, 2005), thereby improving overall tissue and joint health and function.

The extensive use of manual therapy in rehabilitation and the lack of information supporting the longitudinal effects of this modality led to this investigation of MCT. The purpose of this investigation was to determine the effects of MCT application to LTPs on PPT in collegiate-aged males and females over four weeks of treatment. Herein, this investigation was designed to bridge the gap in the scientific literature by determining if a subject's PPT increased over time, specifically four weeks, after MCT had been applied to their LTP. Additionally, this investigation examined the effects of MCT applied either directly on a subject's LTP or within close proximity on PPT changes over the course of treatment. The results of this investigation might help practitioners further develop a better understanding and treatment plan for patients with LTPs.

## 2. Methods

### 2.1. Subjects

Based on pilot data, for a medium effect size, partial $\eta_p^2 = 0.10$, power = 0.80 and alpha = 0.05 a power analysis determined that a total of 28 subjects would be needed to detect this effect. Thirty subjects volunteered and were evenly distributed between men and women ($22 \pm 4$yrs, $175 \pm 18$ cm, $162.5 \pm 57.5$ kg) who had an LTP in the upper back or posterior neck as determined by an initial assessment and orthopedic evaluation by a state licensed and national certified health care professional specializing in McKenzie Method (Spinal Publications, New Zealand LTD) and Mulligan Concepts (bmullian.com) with ~10 years in clinical practice. Each subject completed a consent form approved by the University Institutional Review Board, a medical history revealing conditions that contraindicated the treatment effect, and anthropometric measurements.

The inclusion and exclusion criteria were chosen to assess the efficacy of MCT on LTP characteristics as noted by changes in PPT. Subjects reported tightness and tenderness in regional areas of the neck and upper trunk or persistent pain that usually resulted in decreased muscle or joint range of motion. Subjectively perceived neck pain was assessed by the visual analogue scale (VAS) (Bird and Dixon, 1987). Each subject met specific inclusion criteria to be included in the investigation: 1) an LTP in the upper back or posterior neck must and 2) the subject must have had no signs of significant musculoskeletal disorders in the posterior neck or upper back as determined by surgical history. In addition, each subject was screened for the exclusion criteria: 1) subjects must not have had a history of fibromyalgia, back or neck surgery, systemic pathology, or neuropathies resulting in paresthesia in the upper back or posterior neck; 2) subjects must not have been previously diagnosed and/or treated for LTPs or associated symptoms of tightness, tenderness, and/or pain in the posterior neck or upper back within the past 6 weeks; and, 3) subjects must not have received physical therapy and/or rehabilitation because of musculoskeletal disorders in the posterior neck or upper back in the last 6 weeks prior to participation within the study.

### 2.2. Instruments

A pressure algometer dynamometer (Fabrication Enterprises Inc., White Plains, NY) was used to determine each participant's PPT. The algometer consisted of an apparatus with a 1 cm diameter hard metal tip attached to the plunger of the gauge. The algometer force gauge had increments of 0.25 kg with a listed operating range up to a 30 kg maximum. Each subject's PPT was determined by the specialist by locating one palpable hypertonic point with a dominant finger on the taut band of muscle tissue of the posterior neck or upper back and then marked by a permanent marker on the skin. This served as the landmark location of the LTP for PPT measurements and MCT application and was reapplied as the mark faded over the remainder of the investigation. Marking test sites was thought to be one method of improving the reliability of PPT measurements (Nussbaum and Downes, 1998). The algometer dynamometer was then placed on that location for all subsequent PPT measurements.

### 2.3. PPT assessment procedures and treatment sessions

Pressure pain threshold was defined as the exact moment when the subject experienced a shift from feeling of pressure to a sensation of pain. Pressure pain threshold was assessed by applying the algometer perpendicularly along the muscle belly in the same location where MCT was performed. The same examiner applied all treatments across all subjects. The primary investigator slowly increased pressure by approximately 1 kg/s until the subject indicated the first instant that they felt pain. The reading on the algometer was recorded once the subject relayed they felt pain by saying “now”. The examiner was the only investigator who was aware of the PPT recordings. Measurements were taken at baseline, 24 h prior to the first treatment, and pre- and post-therapy for each treatment session.

For baseline measurements and prior to each treatment session, the examiner took three PPT measurements and calculated the mean in order to ensure that the value was reliable (Antonaci et al., 1992; Lucas et al., 2004). The Cronbach Alpha reliability coefficients (Cronbach, 1951; de Vet et al., 2017) for the first three weeks of treatment ranged from 0.96 to 0.99, for the second three weeks of treatment 0.94 to 0.99, for the third three weeks of treatment 0.97 to 0.98, and for the fourth week of treatment 0.96 to 0.99. All of these values are very high and the PPT measurements were

determined to be appropriately consistent and accurate for analysis.

All three PPTs were taken in quick succession of each other (within approximately 30 s) due to the fact that sustained pressure could influence PPT due to tissue relaxation or increased neural drive (Hou et al., 2002; Lucas et al., 2004). The pre-therapy measurements were taken 2 min prior to the therapy being given, which is consistent with previous investigations (Abu Taleb et al., 2016). After each session of MCT, the subject's post-therapy PPT was measured in the same manner as the pre-therapy and baseline measures following 5 min of rest and a mean reading was recorded.

The participants were randomly divided into three even groups via a randomized table: a control group that received a sham treatment of minimal pressure placed upon the LTP (Control); an experimental group that received MCT directly on the LTP (d-TP); and an experimental group that received MCT within close-proximity (cp-TP) as measured within a 2.5 cm radius of the LTP. Subjects continuously reported for the same treatment for 3 times per week for 4 weeks with each treatment session performed after a period of inactivity for 3 h. Consecutive MCTs were separated by at least one full 24-hr period of rest for each day of treatment. If a subject was unable to complete all 3 treatment sessions within one week, they were excluded from the investigation.

Manual compressive therapy consisted of sustained pressure directly on or in close proximity to the LTP for a total of 90 s at a level of 7 out of 10 on a VAS with 1 being equivalent to no pain and 10 being the worst pain they had ever felt (Bird and Dixon, 1987; Takamoto et al., 2015, 2009). The subjects were positioned in a relaxed sitting position providing feedback of their perceived rating of pain to the examiner of MCT application for all treatments. If the level of pain fell below 7 at any time, the examiner increased the pressure to bring the level back up to a 7 on the VAS. The Control group received minimal sustained pressure placed upon their LTP for 90 s, which corresponded to a 1-2 perceived rating of pain on the VAS. This pressure was thought to have no effect on the LTP in any way, thus providing a sham or placebo therapy. All experimental procedures were performed while the subject was completely relaxed and lying prone on a table with his or her arms at their side and neck stabilized in a neck bolster.

### 2.4. Design and analysis

To determine whether the responses met the assumptions of parametric testing, the Shapiro-Wilk test for normality was calculated across each three weeks of treatment. The PPT measurements for the first ($p = 0.576$), second ($p = 0.128$), third ($p = 0.864$) and fourth ($p = 0.212$) three sessions of treatment were not significantly different from normal. Bartlett's test for equal variances determined that the PPT measurements for the first ($p = 0.159$), second ($p = 0.403$), third ($p = 0.399$) and fourth ($p = 0.090$) three sessions of treatment had statistically equal variances. Based on the results of these tests, the PPT measurements were determined to meet the assumptions of parametric testing. A three-way repeated measures ANOVA was used to determine the differences in the type of treatment (groups) across the sessions as well as pre- to post-therapy PPT trials for each week of therapy. The dependent variable was the PPT. The three independent variables were the treatment groups (Control, d-TP, or cp-TP), the treatment sessions including the baseline measure, and pre- and post-therapy PPT measures for each session of treatment, where the pre- and post-therapy PPT measures were nested within the treatment sessions.

Scheffe post-hoc tests were used to determine any differences among treatment groups, for either the main effects or interactions with the other independent variables. Greenhouse-Geisser epsilon ($\widehat{\varepsilon}$) was used to adjust probability values for any variation in sphericity among the treatment sessions. Partial eta$^2$ ($\eta_p^2$) was used to determine effect size for each statistical test. Magnitudes of $\eta_p^2$ effects sizes were defined as minimal ($\eta_p^2 < 0.01$), small ($0.01 < \eta_p^2 < 0.06$), moderate ($0.06 < \eta_p^2 < 0.14$), large ($0.14 < \eta_p^2 < 0.29$), and very large ($\eta_p^2 > 0.30$). All statistical significance was defined *a priori* as $\alpha < 0.05$.

## 3. Results

Repeated measures ANOVA indicated several main effects and interactions among the three independent variables. A significant main effect for treatment sessions was observed (Greenhouse-Geisser epsilon ($\widehat{\varepsilon}$) = 0.33, $F_{12,324} = 47.1$, $p < .0001$, $\eta_p^2 = 0.914$), indicating a general increase in the consecutive post-treatment PPT measures (kg) from the first through the twelfth treatment session (Fig. 1). A significant interaction between treatment groups and treatment sessions was also observed ($\widehat{\varepsilon} = 0.33$, $F_{24,324} = 2.5$, $p = 0.0167$, $\eta_p^2 = 0.529$). Scheffe post-hoc analysis for comparisons between the sessions and each treatment group indicated significant differences between the d-TP and the Control group for session 8 ($p = 0.040$), session 10 ($p = 0.028$), session 11 ($p = 0.012$), and session 12 ($p = 0.006$) (Fig. 1). Significant differences between the cp-TP and the Control group were also observed for session 2 ($p = 0.021$), session 3 ($p = 0.015$), session 5 ($p = 0.020$), session 6 ($p = 0.045$), session 7 ($p = 0.025$), session 8 ($p = 0.009$), session 10 ($p = 0.047$), session 11 ($p = 0.048$), and session 12 ($p = 0.043$). No significant differences between the d-TP and cp-TP groups were observed for any of the treatment sessions ($p > 0.05$).

A significant main effect for pre- versus post-therapy measures after the 12 treatment sessions was observed ($F_{1,27} = 110.4$, $p < 0.0001$, $\eta_p^2 = 0.400$), indicating an overall increase in acute PPT measures (kg/cm$^2$) from pre-therapy to post-therapy. A significant interaction between treatment groups and the pre- versus post-therapy PPT measures was also observed ($F_{2,27} = 14.5$, $p = 0.0001$, $\eta_p^2 = 0.146$). Group means and standard deviations are reported in Table 1. Scheffe post-hoc analysis for the changes in PPT following MCT or sham treatment indicated a significant difference between d-TP and Control group ($p < 0.0001$) and between cp-TP and Control group ($p = 0.007$). No significant difference was observed between the d-TP treatment and cp-TP treatment groups ($p = 0.215$) (Fig. 2).

A significant interaction between pre- versus post-therapy measures and the treatment sessions was observed ($\widehat{\varepsilon} = 0.569$, $F_{12,324} = 2.4$, $p = 0.023$, $\eta_p^2 = 0.082$). Post-hoc tests indicated that post-therapy values were significantly higher than pre-therapy values for each session except for the third session ($p = 0.078$). The average difference between the pre- and post-therapy PPT measures for the first week of treatment (sessions 1-3: $0.37 \pm 0.47$)

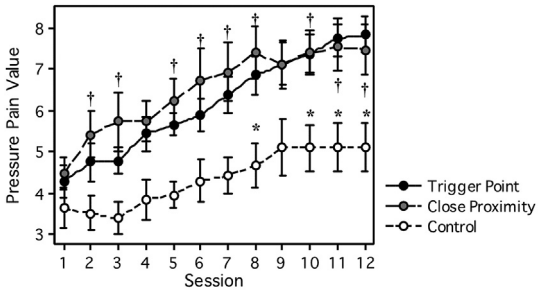


**Fig. 1.** Pressure pain thresholds (PPTs) over 12 consecutive sessions. * = Directly on trigger point (d-TP) group significantly different from control ($p < 0.05$). † = Close-proximity trigger point (cp-TP) significantly different from control ($p < 0.05$). No differences were observed between d-TP and cp-TP for any treatment session.

**Table 1**
Pressure pain threshold (PPT) average measures from pre- to post-treatment for all sessions. * = changes from pre- to post-treatment significantly different from control ($p < 0.05$).

| | Pre-Treatment | | Post-Treatment | | Difference | |
|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Mean | SD |
| Control | 4.28 | 1.39 | 4.44 | 1.45 | 0.16 | 0.54 |
| On-Trigger Point* | 5.8 | 1.19 | 6.58 | 1.17 | 0.78 | 0.79 |
| Close-Proximity* | 6.24 | 1.74 | 6.81 | 1.80 | 0.57 | 0.68 |

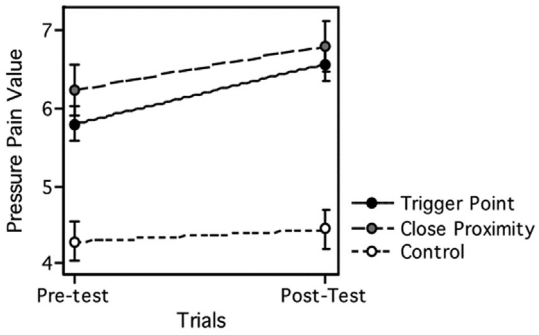


**Fig. 2.** Average pressure pain threshold (PPT) changes following MCT or sham treatment. PPT acutely increased in both experimental groups and in comparison, to the control group. No changes were observed in the control group over the course of the study.

was not significantly different from the second week of treatment (sessions 4-6: $0.533 \pm 0.521$) as shown in Fig. 3 ($p = 0.059$, 95% CI = −0.370, 0.044). However, the post-treatment PPT measures for the first week were significantly different from the third week of treatment (sessions 7-9: $0.533 \pm 0.531$; $p = 0.0461$, 95% CI = −0.354, 0.028) and the fourth week of treatment (sessions 10-12: $0.576 \pm 0.473$; $p = 0.028$, 95% CI = −0.416, 0.005). Lastly, no three-way interactions among groups, treatment sessions, or pre- to post-therapy measures were observed ($\hat{\varepsilon} = 0.569$, $F_{24,324} = 1.1$, $p = 0.362$, $\eta_p^2 = 0.075$).

## 4. Discussion

This study investigated the effects of MCT application on LTPs and the corresponding changes in PPT after a 4-week intervention (12 total treatments). Acute increases in PPTs were observed after MCT where a constant moderate pressure relative to individual pain perception was applied for 90 s directly on the LTP and in close-proximity to the subjects' LTP. Furthermore, continued increases in PPT were observed after multiple treatment sessions in both experimental groups (d-TP and cp-TP) compared to the control group.

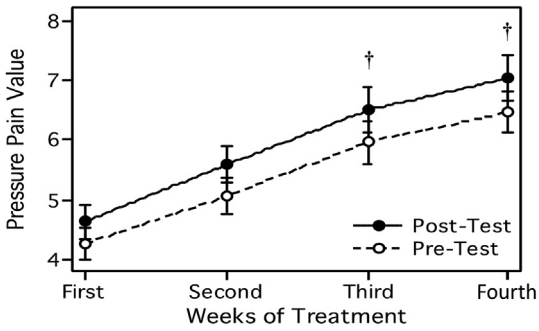


**Fig. 3.** Changes in pressure pain thresholds from pre- to post-therapy throughout 4-week study. Differences between pre- and post-treatment PPT measures for the first week were significantly different from the third week and fourth weeks of treatment. † = significantly different from Week 1.

Most people accumulate LTPs due to overuse and increased muscle activation due to poor anatomical joint positions or repetitive movements (Lucas et al., 2004; Meseguer and Fernández-de-las-Peñas, 2006). Identification and treatment of LTPs are particularly important to muscle tissue health since movement dysfunction and limited joint range of motion may result if left unaddressed (Calvo-Lobo et al., 2017; Grabowski et al., 2018). Some evidence suggests that LTP lesions are common, thereby warranting further investigation and understanding of LTPs as it relates to muscle function and stiffness (Lluch et al., 2015; Simons, 2002). Previous investigations have observed that LTPs respond to MCT resulting in a reduction of perceived pain (Hou et al., 2002; Morikawa et al., 2017). One investigation suggested that treating LTPs in subjects with chronic musculoskeletal pain may not only decrease mechanical sensitivity to pain and allodynia (Xu et al., 2010), but also prevent the LTPs from transforming into an active LTP (Celik and Mutlu, 2013; Ge and Arendt-Nielsen, 2011). Since LTP prevalence is equivalent in both symptomatic and asymptomatic subjects (Fernández-de-las-Peñas et al., 2007; Lluch et al., 2015), preventative care of LTPs with MCT may be a viable treatment in maintaining tissue and joint health.

Previous research on LTPs appears to indicate that PPTs rise after one or only a limited number of applications of MCT (Blikstad and Gemmell, 2008; Fernández-de-las-Peñas and Alonso-Blanco, 2006; Fryer and Hodgson, 2005; Hidalgo-Lozano et al., 2011). The findings in the current investigation are consistent with these previous investigations, as well as previous studies on the acute effects of manual therapies on tissue stiffness (Crawford et al., 2014; Haas et al., 2012), in that MCT increased PPT acutely (pre- and post-tests). However, no previous investigations applied multiple MCT treatments within one week with the total treatment time spanning over several weeks to determine if PPTs in subjects continued to rise. Bron et al. (2011) performed combined treatments of manual compression, stretching, and intermittent cold application with ice cubes spanning over a 12 week period. However, treatment sessions were only performed once per week. In the current investigation, treatment consisted of 3 sessions per week for 4 weeks of MCT (12 treatments), thereby matching the total number of treatments performed by Bron et al. (2011) but conducting the study in one third of the time. Moreover, the current investigation found that PPT increased acutely over the course of the study with the third and fourth weeks of treatment having significantly higher PPT differences between pre- and post-treatment compared to the first week. The findings from this current investigation could greatly influence clinical care by reducing patient pain measures in a shorter timeframe.

MCT treatments produced significant differences in PPTs when applied both directly on the LTP and in close-proximity to the LTP (within 2.5 cm). Furthermore, multiple sessions of MCT resulted in continued increases in PPT in the treatment groups compared to the control group. These data suggest that MCT started to provide relief of the pain produced by an LTP, as indicated by increased PPT, as early as the first session of treatment and continued to increase throughout the twelfth therapy session. Investigations of daily applications of massage showed similar findings of acute changes in tissue stiffness, but did not appear to elicit sustained recovery (Crawford et al., 2014). One factor that may affect the sustained adaptations to ongoing applications of MCT may be related to stiffness of the muscle protein titin or other cytoskeletal components (Meyer et al., 2011), wherein applied pressure results in

tissue relaxation (Bosboom et al., 2001; Van Loocke et al., 2008). However, as soon as the pressure is released, the sarcomeres immediately tend to return to their previous state unless a subsequent treatment is performed since tissue relaxation behavior is time-dependent (Van Loocke et al., 2008).

Of clinical significance, it is important for practitioners to identify the best MCT parameters to be applied in the treatment of LTPs. In the current study, improvements in PPT were found between both MCT experimental groups versus the control group, but no differences were observed between the experimental groups. This suggests that improved results should be obtained if constant and sustained pressure is placed within 2.5 cm of the LTP during MCT. This result may be particularly applicable to rehabilitators who might have little experience or formal training in MCT. Additionally, it is proposed that pressure above the minimum used in this study (1-2 out of 10 on the VAS) is needed to elicit an increase in PPT and result in beneficial adaptations from the potentially debilitating effects of LTPs. Previous work has suggested that there is a dose-response effect with compressive force applied to muscle tissue following injury (Haas et al., 2013). However, this work was performed in an animal model and following a damaging protocol of eccentric exercise. Therefore, this concept would need to be validated in human subjects identified with an LTP. Previous human investigations applied various compressive therapy treatment intensities and durations, but further investigations still need to determine the optimal treatment time and pressure to maintain heightened PPTs in individuals with LTPs (Aguilera et al., 2009; Fryer and Hodgson, 2005). From the current findings, we conclude that four weeks is sufficient to see significant change in PPTs. Future studies should investigate treatment for a longer duration of sessions to determine if PPT continues to increase. Additionally, future investigations should follow up with subjects a few weeks or months post-treatment to determine long-term treatment sustainability.

### 4.1. Limitations

Our findings should be noted in the context of study limitations. Participants in the study were healthy subjects in that their LTPs did not result in debilitating pain and loss of function so the results may be difficult to extrapolate to patients with chronic pain and/or disability. Moreover, previous manual therapy treatments for symptoms of tenderness and pain associated with LTPs may have confounding effects on treatment outcomes. Although we attempted to mitigate these confounding factors with our exclusion criterion, it is difficult to completely rule out previous treatment outside our 6-week timeframe. Soreness upon palpation was noted, particularly beginning in the third and fourth treatment weeks. The addition of pain not directly associated with the MCT may influence the perceived level of pain used as the primary metric to determine applied pressure. And although all measures were taken to maintain constant pressure by having an experienced practitioner perform all MCT sessions and for the subjects to provide real-time feedback, it is possible that the applied pressure was not constant throughout the session or between subjects. Despite this fact, we used PPT as our measure of pressure rather than a more standardized measure of pressure for several reasons. First, therapists typically do not have tools to apply standardized levels of pressure. Secondly, a standardized measure of pressure may in fact be unfeasible since pain is inherently a subjective measure. Finally, manual therapists typically prefer to use their hands when providing treatments. Therefore, it was more clinically relevant to perform the MCT based upon pain measures since this is consistent with procedures used in the clinic. Finally, due to the nature of the study, blinding of the participants and investigators was not possible. Future studies will attempt to elucidate the effects of standardized pressure applied to LTPs rather than using perceived pain as an indirect measure of pressure.

## 5. Conclusion

Manual compressive therapy decreases the effect of pain produced by LTPs in the upper trapezius and posterior neck by increasing PPT and could be recommended in the treatment of LTPs. MCT started to provide relief of pain as early as the first session of treatment and continued to increase throughout the 4-week study. Furthermore, it was observed that PPT increased irrespective of whether the pressure was applied directly on or in close-proximity (within 2.5 cm) to the LTP. However, there were no differences between the treatment groups, indicating that similar outcomes can be expected even if pressure is not applied directly on the LTP. The results of this study suggest that MCT is effective for relieving latent myofascial trigger point pain, even by professionals that are not well-trained in MCT. Athletic trainers or other health care providers who have no formal training in MCT might not be able to identify the exact location of a latent myofascial trigger point; however, these data indicate that MCT in close proximity to the trigger point is just as effective as MCT directly on the trigger point itself.

## Clinical relevance

- Manual compressive therapy decreases the effect of pain produced by LTPs in the upper trapezius and posterior neck assessed by increased PPT and could be recommended in the treatment of LTPs.
- Manual compressive therapy in close proximity to the trigger point is just as effective as MCT directly on the trigger point itself.
- Multiple treatments (3 times per week) of manual compressive therapy have continued benefits in pain management of LTPs.

## Conflicts of interest

In accordance with Elsevier's policy and my ethical obligation as a researcher, I am reporting that I have no financial and/or business interests within an incorporated industry endorsing MTP. I have disclosed those interests fully, and I have in place an approved plan for managing any potential conflicts arising from any unforeseen involvement.

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