THE EFFECT OF 4 WEEKS MANUAL COMPRESSIVE THERAPY ON LATENT MYOFASCIAL TRIGGER POINT PRESSURE PAIN THRESHOLDS.

by

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I would first like to thank God for allowing me to get to this point in my life and have the opportunity to follow my dreams. I would also like to thank my family for supporting me in so many ways and helping me to achieve all of my goals I have set for myself. In addition, I would like to thank my committee for guiding me through this process and helping this work become all that it can be. Also, I would like to thank all the people and institutions that have paved my path for me to get to where I am now. I could not have done it without everyone that has entered my life at some point or another. I am humbly thankful for all of you and hope to move forward in life with as many blessings that I have already received.

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CHAPTER I

INTRODUCTION

The Effect of 4 Weeks Manual Compressive Therapy on Latent Myofascial Trigger Point Pressure Pain Thresholds.

Abstract

Context

Manual Compressive Therapy (MCT) is thought to have the best results for treating latent myofascial trigger points (LTPs) and increasing the pressure pain threshold (PPT) associated with them. There have been few investigations that have investigated MCT over an extended period of time to determine if PPTs continue to increase or resolve the LTP altogether.

Objective

To compare three MCT treatments over 90 seconds between separate groups, and each subject's individual PPT on their LTP for 4 weeks.

Design

Randomized, controlled, observational investigation, single-blinded.

Setting

University Athletic Training Room.

Patients or Other Participants

A total of 30 (15 men, 15 women; age = 22 ± 4 y/o, height = 175 ± 18 cm, weight = 162.5 ± 57.5 kg) healthy individuals with LTPs volunteered.

Intervention(s)

Manual Compressive Therapy was introduced for 90 seconds to three different groups of subjects, each of which had their own intervention. Group 1 received MCT on their LTP at low pressure (1/10 on verbalized analog scale). Group 2 received MCT on their LTP at extensive pressure (7/10 on verbalized analog scale). Group 3 received MCT in close-proximity to their LTP with moderate pressure (5-7/10 on verbalized analog scale).

Main Outcome Measure(s)

Pre and post-therapy PPTs for each week of treatment.

Results

There was a significant increase in the measures from the first through the twelfth session of treatment (Greenhouse-Geisser epsilon = .33, $F(12, 324) = 47.1$, $p < .0001$, partial $eta^2 = .914$). There was also a significantly greater increase in measures from the second through the twelfth session of treatment for the treatment groups that were either on-trigger-point or in close-proximity to the trigger point, compared to the control group. A significant overall increase in measures of PPTs was observed from the pre-therapy tests (5.44 ± 1.65) to the post-therapy tests (5.94 ± 1.81) as a result of

the treatment sessions. The differences between the pre- versus post-MCT measures for each type of treatment (group) indicated a significant difference between the on-trigger-point treatment and the control group, $p < .0001$, as well as between the close-proximity treatment and the control group, $p = .007$.

Conclusions

This investigation has shown evidence that there was a significant benefit during on-trigger-point to control ($p < .0001$) and close-proximity to control ($p = .007$) after performing MCT for an extended period of time (four weeks), both on the LTP, and in close-proximity for a resulting higher PPT for the subject.

Key Words

Muscular knot, manual therapy, tender point, palpation.

Manual compressive therapy (MCT) has been found to be a reliable method in increasing pressure pain thresholds (PPT) in subjects with latent myofascial trigger points (LTP).[1,2] Little empirical data exists on measured PPTs over an extended period of time, such as longer than one week, or with multiple treatment sessions.[3] Previous literature showed an acute effect of MCT through few treatment sessions. It was recommended that treatment periods and durations needed to be investigated to determine the appropriate duration of treatment to be applied to maintain heightened PPTs in subjects with LTPs.[1] This indicates that PPTs may have decreased once treatments had ended.

There has been little research involving MCT and the duration of treatment to be applied to a myofascial trigger point (MTrP) to either maintain a heightened PPT, or for the MTrP to heal completely. This investigation aimed to bridge that gap by determining if a subject's PPT increased over time, specifically four weeks, after MCT had been applied to their LTP, or if their LTP resolved all together. This investigation helps practitioners develop an understanding and treatment plan for LTPs for their subject population that suffers from them. There were many potential benefits that arose from this investigation, as well as the advancement of the research that has already been done on this topic and related topics. This investigation helps to provide a piece of the overall literature to help make proper treatment plans. This investigation has also determined that PPTs continue to rise with further treatment, as it shows evidence that PPTs continued to grow over four weeks in both experimental groups of this investigation. This investigation has given practitioners more evidence to determine the best route or form of treatment to effectively reduce subject discomfort and sensitivity.[4]

Purpose of the Study

The purpose of this investigation was to determine the effect of MCT on the PPT of LTPs in skeletal muscle of the upper back and posterior neck on collegiate-aged males and females over four weeks.

Hypotheses

It was hypothesized that:

1. The PPTs of the experimental group's subjects would increase with MCT over four weeks, or their LTP would resolve.
2. The PPT of the pre-therapy test will be lower than the PPT of the post-therapy test.
3. The on-trigger-point therapy will result in a greater PPT than the close-proximity therapy.

Operational Definitions

Upper Back - the inferior angle of the scapulae up to the clavicles, including the entire trapezius muscle, infraspinatus, teres minor, teres major and latissimus dorsi superficially.

Posterior Neck – the superior nuchal line down to the upper back and posteriorly from the back of the ear lobe, including the upper trapezius.

Latent Myofascial Trigger Point (LTP) - a taut band of muscle with a hyperirritable point on that taut band of muscle that may produce a pain pattern upon palpation, but no other symptoms without palpation.

Delimitations of the Study

While designing this investigation, certain delimitations were accepted, which possibly could compromise the outcome.

1. Inclusion Criteria: 1) There must have been the presence of a LTP in the upper back or posterior neck. 2) The subject must have been a collegiate-aged male or female.

3) The subject must have had no signs of musculoskeletal disorders in the posterior neck or upper back.

2. Exclusion Criteria: 1) Each subject must not have had a history of fibromyalgia, back or neck surgery, systemic diseases, or neuropathies resulting in paresthesia in the upper back or posterior neck. 2) 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.

Limitations of the Study

The limitations of this investigation reflect the effect of the delimitations on the collection and interpretation of the data and on the ability to expand the scope of inference beyond the sample population. Generalizations made from the results will be compromised by the following limitations:

1. Generalizations should not be made outside the investigation population of subjects younger than 18 years of age or older than 30 years old.
2. Another investigation found that some of the subjects expressed difficulty in rating their exact level of pain immediately after treatment due to post-treatment soreness.[5]
3. LTPs in subjects were decided entirely by the primary investigator as to whether or not they met the criteria of actually having a LTP. The primary investigator determined a subject as having a LTP through prior literature and overall experience in dealing with LTPs on a weekly basis in his practice as a certified athletic trainer.
4. One shortcoming of the manual pressure algometer was the difficulty in assessing objectively the rate in pressure exerted by the examiner. It was rather difficult to

increase the pressure gradually at any predetermined rate without appropriate training.[8]

Assumptions

The basic assumptions for this investigation include:

1. The subjects were randomly distributed among the treatment groups
2. The investigator's attitude and assistance was not biased towards a particular group
3. The treatment duration was long enough and was at sufficient intensity to elicit differences, if present, between each of the test groups.
4. The subjects stated when their pressure turned to pain during the assessment of the PPT.
5. The subjects' verbalized analog scale (VAS) was representative to their respective treatment group and randomly allocated for the duration of treatment.

Significance of the Study

Most people, due to postural positions or sport, accumulate LTPs due to overuse and continued stretch upon postural muscles. The investigation may impact a majority of the population that has encountered a LTP. The literature on LTPs has conducted investigations to determine if PPTs rise after one or only a limited number of applications of MCT. However, there was a gap considering no investigations were conducted that looked at applying MCT over a period of time, or greater than three treatments, to determine if PPTs in subjects continued to rise.[7] Most investigations have done one to very few treatment sessions of MCT.[1,5,8-12] One investigation stated that it was

recommended that future investigations include symptomatic subjects with a longer treatment and assessment period (at least four weeks), which would have enabled the duration of the treatment effect to be investigated.[1] Furthermore, time could be a critical factor, because of the stickiness of the titin molecules, releasing them could be expected to take time.[4] When a muscle relaxes, the sarcomeres immediately tended to return to their previous state unless further treatment took place,[4] which in this investigation was four weeks of MCT as compared to one to few treatments like many other investigations.[1,5,9-13]

This investigation added to what was already known about LTPs and has had an impact on the future research on LTPs, as well as the PPTs associated with them. With heightened PPTs, people within the population may have better function with the muscles that are impacted by their LTPs, or may have reduced pain altogether. One investigation suggested that treating LTPs in subjects with chronic musculoskeletal pain may not only decrease mechanical hyperalgesia and allodynia, but also prevent them from transforming into active MTrPs.[14] There was also some evidence that these lesions are prevalent in the community, rendering LTPs as relevant lesions to investigate, as understanding their potential effects would be useful for many community members.[4,15] This investigation allows the advancement of the literature of MCT on subjects with LTPs over an extended period of time, and has furthered the knowledge that was already known about the shorter duration of treatments on PPTs. With this knowledge practitioners can better apply treatment to subjects to produce a more desirable outcome. These desirable outcomes include the complete cessation of LTPs in the area treated, or at the very least a heightened PPT that sustains itself with multiple treatments over time.

CHAPTER II

REVIEW OF LITERATURE

Myofascial trigger points (MTrP) have been described as a common cause of pain in clinical practice and an overlooked source of musculoskeletal pain.[1-4,7,10-12,14,16-19] Furthermore, MTrPs have been defined as hyperirritable points located within a taut band of skeletal muscle.[1-3,7,9-11,14,16-30] They are classified as "active" (producing a clinical pain complaint) or "latent" (non-symptom producing but tender on palpation).[1-4,7,9-11,14,16,18,19,21,23,24,26,28,30] Evidence exists to suggest that MTrPs are common in subjects with non-specific neck pain.[4,5,20] Additionally, MTrPs are also thought to be very prevalent in subjects with chronic unilateral, non-traumatic shoulder pain.[7,10,12] Further investigations[21,25] have reported that referred pain elicited by MTrPs from the upper trapezius, sternocleidomastoid, suboccipital, and extra-ocular muscles contributes to pain perception in chronic tension type headache. Current evidence also shows that LTPs contribute to the development of muscle cramps, restricted joint range of motion, muscle weakness and accelerated fatigability.[14,17,22] Furthermore, LTPs in the scapular rotator muscles are thought to alter the timing and decrease the consistency of the muscle activation patterns.[15,19] Muscle strength was found to be significantly lower on both sides in subjects who have MTrPs in comparison with healthy subjects.[10,17,21] In addition, the prevalence of LTPs is similar in neck pain subjects and healthy subjects.[20] The formation of MTrPs may result from a variety of factors, such as severe trauma, overuse, mechanical overload, or psychological stress.[14,18,20-23,25-27]

Etiology

Motor unit hyperexcitability can induce muscle pain, which can increase motor unit excitability.[4,14,15,25,26] Thus, there is a self-sustaining positive feedback loop between motor unit hyperexcitability and muscle pain associated with the MTrPs.[4,14,15,25,26] The concept of the etiology used here is based on the endplate (integrated) hypothesis that is fully described in Simons et al[31] by abnormal depolarization of motor endplates and sustained muscular shortening giving rise to a localized "ATP energy crisis" associated with sensory and autonomic reflex arcs that are sustained by central sensitization.[4,16,21] Central sensitization is an amplification of neural signaling within the central nervous system that elicits pain hypersensitivity. One demonstrated cause of the shortening of an affected muscle fiber is the presence of a contraction knot, or MTrP, that would be in the region of a motor endplate of a muscle fiber.[31]

Diagnosis

Palpation is still considered a reliable clinical method of diagnosing MTrPs.[2,3,9,10,17,23,26] Many investigations[2,9,10,12,17,23] have also deemed it reliable and a potentially useful diagnostic tool for myofascial pain in subjects with non-traumatic shoulder pain.

Pressure Algometry

The quantification of pain becomes important and pressure algometry has proven useful for identifying tender spots and MTrPs and, furthermore, in the assessment of treatment results.[8,13,32] Pressure algometry is the measurement of pain by means of an

algometer, which is an instrument for determining sensitivity produced by pressure. This investigation used pressure algometry to objectively measure a subject's PPT. In this investigation, PPT was defined as the minimum pressure which induces pain or discomfort.[12,18,21,23,27,29,30,33] Pressure algometry has had a remarkable reputation of quantifying PPTs. The validity and reproducibility of pressure algometry to measure pressure sensitivity and PPTs in the evaluation of MTrPs has been well established by many researchers.[1,29,33] Previous papers reported a moderate to strong intra-rater reliability of pressure algometry ranging from an I.C.C value of 0.6 to 0.97[6,20,22,23,29] and an inter-rater reliability ranging from a weak to strong I.C.C value of 0.4 to 0.98.[1,5,6,8,12,16,20,22,23,29,33] Investigations have also shown excellent intra-rater repeatability for using pressure algometry to quantify PPTs.[8,20,22] Algometric measurements have been shown to have good inter-rater and intra-rater reliability when the measurements were performed once or repeatedly (2-50 repetitions) on a single day, at weekly intervals (1-5 weeks), and at longer intervals (8-12 week~).[33]

There is some speculation on the reliability of the older manual pressure algometric gauges as compared to the newer digital electric pressure algometric gauges. However, numerous investigations have found that the performance of the rather inexpensive algometer, both in terms of inter-rater reliability and cost/benefit, seems promising as compared to the more expensive electronic device that has been used in many recent PPT investigations.[8,22] In most investigations the pressure was steadily increased at a rate of 1 $kg/cm^2/s$, which was thought to be the most reliable method.[5,6,13,20,27-29,32] Only one investigation increased pressure at 2 $kg/cm^2/s$.[8]

There are some shortcomings with pressure algometry. One shortcoming of the manual pressure algometer is the difficulty in assessing objectively the rate in pressure exerted by the examiner. In fact, it is rather difficult to increase the pressure gradually at any predetermined rate without appropriate training.[8] In previous investigations, the inter-rater reliability was good, although it was lower than the intra-rater reliability.[8,16,23] In conjunction, traditional pressure algometers are ideal for measuring PPTs of superficial muscles and bony landmarks, but may be of limited value for measuring deeper muscles.[1] It was also suggested that reliability is higher when one examiner takes all measurements.[5,33]

Manual Compressive Therapy

For an extensive period of time, MCT has been commonly used in treating LTPs. For the purpose of this investigation, MCT is the gradual increase in pressure (1 kg/cm^2/s) until the subject reaches a certain threshold ('moderate but tolerable' pain, such as 7 on a scale of 1–10, where 1 = no pain, 10 = severe pain) and pressure is maintained until the pain is reduced to a lesser value (such as 3 or 4). In the experience of some authors,[1,18,19] subjects often report a reduction of tenderness after approximately 20–30 seconds of sustained MCT application, and this allowed the pressure to be increased to restore the pain to the original value of 7.[1,18,19] Evidence suggests that the higher pressure MCT, applied for 90 seconds, produced the most significant change.[1,18] It has been found that MCT decreased the sensitivity of MTrPs.[1,12,14,15,18,19,22,23] However, since most of the previous studies were short in duration and treatment sessions, this finding is thought to be acute in nature. Significant increases were observed in PPTs following the application

of MCT.[1,2] During application of sustained manual pressure, the local MTrP tenderness decreased and this appeared to be due to a change in tissue sensitivity rather than an unintentional release of pressure by the practitioner.[1]

Treatment Applications

Numerous investigations have investigated multiple different treatments to decrease the sensitivity of MTrPs. One author[4] cited many investigations with different techniques/treatments for the treatment of MTrPs that included: movements to augment release (exhalation, eye movement), reciprocal inhibition (voluntary contraction of antagonist muscle), dry needling (acupuncture technique), therapeutic ultrasound, strain–counterstrain, microcurrent application, laser irradiation, and injection. One investigation[16] cited spray and stretch technique along with shockwave therapy. At the same time, another investigation[22] listed diathermy as an option. Myofascial release was also listed by another investigation[18] as a possible treatment. Finally, one investigation[11] used transverse friction massage as a technique to reduce the sensitivity of MTrPs. These different treatment options provide a number of ways that have been used to try and decrease the sensitivity of LTPs. Some were found to be successful, but MCT has become the most reliable way to treat LTPs.

Conclusion

It is clear that MCT is a reliable treatment in increasing PPTs in subjects with LTPs in the short term. It is also clear that many investigations have found significant change in the PPT of subjects after the application of MCT.[1,2,12,15,18,19,22,23,25] Many investigations

have shown this significant change over short periods of time or in just one application of treatment.[1,5,9-12,30] It has been stated that the need for an investigation with a longer treatment duration is needed to further the research.[1] Many other treatments have been studied,[4] and this investigation will allow practitioners more evidence on MCT to determine the best treatment to effectively reduce subject discomfort and sensitivity. Further research might help to explain how MTrPs form. This is important because most research is based on a single accepted theory and hypothesis that has not been fully proven.[14-16,21,25,26,31] In addition, further research can also determine if even longer duration investigations, that are more longitudinal in design, show that subject's LTPs have remained at a heightened PPT or have remained non-present over a span of months to years. Finally, future investigations may also determine other forms of treatment that may result in a more significant change or better result as compared to previous investigations.

CHAPTER III

METHODS

The purpose of this investigation was to determine the effect of MCT on the PPT of LTPs in skeletal muscle on collegiate-aged males and females over four weeks of MCT. The investigation compared three different sets of treatments on three different groups, thus comparing the PPTs of all the subjects to determine the difference between the three different treatments applied. The PPTs were obtained from a pressure algometer dynamometer. All subjects in the investigation met specific criteria to be admitted into the investigation and continued to meet criteria throughout the investigation to the treatment group they were randomly allocated.

This investigation utilized the subject's VAS during 90 seconds of MCT on their LTP. The subject had their PPT objectively measured using an algometer. They continuously reported for the same treatment for four weeks, unless their LTP had resolved. The investigation came to the conclusion after four weeks that PPTs in subjects changed over time.

Subjects

This investigation contained collegiate students of both genders who had a LTP in the upper back or posterior neck. The investigation was conducted at multiple universities with 30 randomly selected participants with 15 men and 15 women. The subjects volunteered or were recruited by the primary investigator by word of mouth for the investigation and picked on a first come first served basis depending on if they met the

inclusion criteria and did not meet the exclusion criteria for the investigation. The collegiate-aged (18-30 y/o) subject population was selected because of the high number of potential participants at the university level. In addition, the ease of application within a clinical setting close to the population base, as well as the ease for the examiner to apply the procedures was also considered. Each subject signed a consent form (Appendix A) and health/history questionnaire (Appendix B) approved by the Texas State University Institutional Review Board.

Instruments

Pressure Algometer Dynamometer - The investigation used an algometer dynamometer by Fabrication Enterprises Incorporated (White Plains, NY) to determine each participant's PPT. The algometer consisted of an apparatus that had a 1 cm diameter hard metal tip, attached to the plunger of a pressure (force) gauge. The dial of the gauge was calibrated in kg/cm^2 units, up to 30 kg/cm^2.[8] Each subject's PPT was determined by locating the palpable hyperirritable point on the taut band of muscle marked by a permanent marker on the skin. The algometer dynamometer was placed on that point. Pressure was placed on that point, within the muscle, with the algometer dynamometer and the subject then had let the tester know when they felt pain by saying "now." At that point the pressure that was indicated by the dynamometer was recorded as a baseline, but also for pre- and post-therapy treatment sessions, the last of which, was the final reading used for data collection.

Procedures

Each subject was admitted to the investigation upon meeting the inclusion criteria and not meeting the exclusion criteria. The investigation demonstrated a PPT difference over four weeks of MCT. A pressure algometer was used to note the changes of each subject's PPT over the course of the investigation.

Each subject completed or sign approved consent forms (Appendix A), health/history questionnaire (Appendix B) and demographic values (gender, age, weight, height) (Appendix C) upon reporting to the laboratory prior to initiating treatment. A baseline recording was taken along with subsequent recordings pre- and post-MCT session received, the last of which was used as their final recording. The participants were randomly divided evenly into three groups: a control group receiving a sham treatment of minimal pressure placed upon the LTP, an experimental group receiving the on-trigger-point treatment and an experimental group receiving the treatment within close-proximity, one inch, but not upon the hyperirritable point.

Researcher Procedures

The examiner took all PPT measurements for baseline recordings, pre- and post-therapy treatment recordings, and will applied all treatments to each individual subject. The examiner was the only one who knew the PPT recordings. Therefore, since the examiner knew the treatment and the outcome recordings this was a single-blinded investigation. Only the subjects were blind to their treatment and the results of the treatment.

Random Allocation

Each treatment group was randomly allocated by a lottery-style drawing of randomly assigned numbers. Ten number "1's", "2's" and "3's" on a piece of paper was placed in a hat and drawn out to determine which treatment group each individual in the investigation was placed in. Group one received the control treatment; group two, the experimental treatment on-trigger-point; and group three, the experimental treatment in close-proximity, one inch, to the hyperirritable point.

Measurements

The examiner provided the actual MCT and the PPT recordings. The examiner conducted the PPT testing as illustrated by Blikstad.[5] Each subject's PPT was determined by locating the palpable hyperirritable point on the taut band of muscle and placing the algometer dynamometer on that point. Pressure was placed on that point with the algometer dynamometer and the subject had let the examiner know when they felt pain, at which point that pressure, indicated by the dynamometer, was recorded as a baseline or pre-/post-therapy treatment session measurement.

Treatment Sessions

Each subject received their selected treatment, as allocated by the group they were in, three times over the course of a week for four weeks. All treatment sessions were done after a period of inactivity for three hours. During the baseline readings, a mark was placed on the skin where the LTP was present using a permanent marker as described by Blikstad.[5] This mark served as the location of the LTP for the remainder of the

investigation, and was used to assess PPT throughout. Marking test sites was thought to be one method of improving the reliability of PPT measurements according to Nussbaum.[33] In addition, PPT measurements were repeated three times and a mean taken in order to ensure that the value was reliable, as explained by Lucas.[15] All three PPTs were taken in quick succession (within approximately 30 s) due to the fact that LTPs can be inactivated by sustained pressure.[15,18] At least one full 24 hour day of rest for each day of 90 second MCT received was implemented. Before each treatment session three PPT measurements were taken by the examiner with the algometer dynamometer. The pre-treatment measurements were taken two minutes prior to the treatment being given. After each session of applied MCT for 90 seconds, the subject's PPT was measured after five minutes with the algometer dynamometer on the hyperirritable point. At which point, the three recordings had took place and the mean reading was recorded as the PPT for that day of 90 second MCT. Each subject's baseline PPT was attained one day prior to their first 90 second session of MCT. Subjects had a final PPT mean measured at the end of their last 90 second MCT session.

The control group received very minimal pressure placed upon their LTP for 90 seconds that did not affect the trigger point in any way, thus resulting in a sham or placebo treatment. The control group maintained a 1-2 perceived rating of pain on a 1-10 verbalized analog scale (VAS), 1 being no pain, and 10 being the worst pain they had ever felt.

The experimental group that received 90 second MCT on the hyperirritable point notified the tester when the pressure placed upon the hyperirritable point reached a 7 on a VAS of 1-10. A 7 on the VAS was maintained throughout the 90 second session of MCT

with the subject notifying the tester when to apply more pressure when the point began to subside in pain on the VAS.

The final experimental group had the 90 second session of MCT placed upon a point on the taut band that was not on the hyper-irritable point, but was in close-proximity or one inch to the hyperirritable point. Pressure was applied by the tester to where the subject felt that there was a 5-7 perceived rating of pain on the 1-10 VAS.

Design and Analysis

The test-retest reliability of the pre- and post-therapy PPT measures was determined by the Chronbach Alpha coefficient over three trials. Table 1 reports the reliability for both the pre- and post-therapy trials for each week of treatment. The reliability of the pre-therapy PPT measures ranged from .94 to .99, and the reliability of the post-therapy PPT measures ranged from .96 to .99, all very high. Based on this very high test-retest reliability, all of the pre- and post-therapy PPT measures were determined to be appropriate for analysis.

A three-way repeated measures ANOVA was used to determine the differences in the type of treatment (groups) across the treatment sessions as well as pre- to post-therapy PPT trials for each week of treatment. The dependent variable was the PPT. The three independent variables were: 1) the type of treatment (groups), either control, on-trigger-point, or in close-proximity to the trigger point; 2) the treatment sessions, from the first to the twelfth session: and 3) the pre- and post-therapy PPT measures for each week of treatment. Type of treatment (groups) is a between-subjects variable, while the treatment sessions and the pre- and post-therapy PPT measures were within-subjects (repeated)

variables, with the pre- and post-therapy PPT measures nested within the treatment sessions.

Scheffe post-hoc tests were used to determine any differences among types of treatment (groups), for either main effects or interactions with the other independent variables. Paired t-tests were used to determine differences between within-subjects trials. Greenhouse-Geisser epsilon was used to adjust probability values for any variation in sphericity among the treatment sessions. Partial eta^2 was used to determine effect size for each statistical test. All statistical significance was defined as $p < .05$.

CHAPTER IV

MANUSCRIPT

Manual compressive therapy (MCT) has been found to be a reliable method in increasing pressure pain thresholds (PPT) in subjects with latent myofascial trigger points (LTP).[1,2] Increasing PPTs have beneficial effects on subjects by allowing them to withstand more pressure upon palpation before it turns to a feeling of pain, which indicated the LTP was resolving. Little empirical data exists on measured PPTs over an extended period of time, or 12 weeks.[3] It was recommended that treatment periods and durations needed to be investigated to determine the appropriate duration of treatment to be applied to maintain heightened PPTs in subjects with LTPs.[1]

There is little research involving MCT and the duration of treatment to be applied to a myofascial trigger point (MTrP). This investigation aimed to bridge that gap by determining if a subject's PPT increased over time, specifically four weeks, after MCT had been applied to their LTP, or if their LTP resolved all together. The results of this investigation might further help practitioners develop an understanding and treatment plan about how to treat LTPs for their subject population that suffers from them. There are many potential benefits that can arise from this investigation, as well as helping to advance the research that has already been done on this topic and related topics. This investigation helps to provide a piece of the overall literature to help make proper treatment plans. This investigation has also determined that PPTs continue to rise with further treatment. This investigation allows practitioners more evidence on MCT to determine the best route or form of treatment to effectively reduce subject discomfort and

sensitivity.[4] The purpose of this investigation was to determine the effect of MCT on the PPT of LTPs in skeletal muscle on collegiate-aged males and females over four weeks of MCT.

Methods

The investigation compared three different sets of treatments on three different groups, thus comparing the PPTs of all the subjects to determine the difference between the three different treatments applied. The PPTs were obtained from a pressure algometer dynamometer (Fabrication Enterprises Incorp, White Plains, NY). All subjects in the investigation met specific criteria to be admitted into the investigation, and continued to meet criteria throughout the investigation to the treatment group they were randomly allocated.

This investigation utilized the subject's perceived rating of pain during 90 seconds of MCT on their LTP. The subject then had their PPT objectively measured using an algometer. They continuously reported for the same treatment for four weeks, unless their LTP had resolved. The investigation came to the conclusion after four weeks and looked at how the PPTs in subjects changed over time, if at all.

Manual Compressive Therapy is sustained pressure, on or near a MTrP, usually at a level of seven out of ten on a VAS. It was performed with either the thumb(s) or other digits of the hand. If the level of pain fell below a seven at any time, it was imperative to keep increasing the pressure to bring the level back up to a seven on the VAS. For this investigation, the sustained pressure was held for 90 seconds on or near the subjects' LTP. This sustained pressure allowed for limited to no blood flow to the area of the LTP.

All this was performed while the subject was completely relaxed and lying prone on a table with his or her arms at their side.

Pressure Pain Threshold is the exact moment when the subject goes from a feeling of pressure to a feeling of pain. This threshold was measured using the pressure algometer dynamometer. Once the subject relayed that he or she felt pain at the first instant by saying "now," the reading was recorded for his or her PPT. Since this was a dependent variable, it changed over time according to the subject, which was presumed to be because of the MCT on the subjects' LTPs. The primary investigator slowly increased pressure by approximately 1 $kg/cm^2/s$ and kept going until the subject indicated that he or she felt pain at the first instant.

Each subject filled out a consent form (Appendix A), that was approved by the Texas State University Institutional Review Board, a medical history (Appendix B) indicating no other conditions that contraindicated the treatment or results, and a demographic summary of themselves (Appendix C). This information was collected to keep the scope of the investigation in accordance with Texas State University for research on human subjects, as well as provide information of the subjects being tested so that they would not skew any data collected and the results could represent the population on a larger scale.

The subjects in this investigation were solicited randomly and were sought out by the primary investigator. The primary investigator verbally asked participants if they would be willing to participate in the investigation. Each of the three groups of the investigation were filled randomly, but there was an even amount of men and women taken for the

investigation and each group was filled on a first come first served basis by a hat draw as to which group they would be placed in.

Subjects

This investigation contained 30 collegiate students (15 men and 15 women (age = 22 ± 4 years, height = 175 ± 18 cm, weight = 162.5 ± 57.5 kg)) who had a LTP in the upper back or posterior neck. The investigation was conducted at multiple universities with 30 randomly selected participants. The subjects volunteered or were recruited by the primary investigator by word of mouth for this investigation and picked on a first come first served basis depending on if they met the inclusion criteria and did not meet the exclusion criteria for the investigation. In addition, the ease of application within a clinical setting close to the population base, as well as the ease for the examiner to apply the procedures was also considered.

Each subject met specific inclusion criteria to be included in the investigation: 1) There must have been the presence of a LTP in the upper back or posterior neck. 2) The subject must have been a collegiate-aged male or female. 3) The subject must have had no signs of musculoskeletal disorders in the posterior neck or upper back.

In addition, each subject was screened for the exclusion criteria that meant they could not be included in the investigation: 1) Each subject must not have had a history of fibromyalgia, back or neck surgery, systemic diseases, or neuropathies resulting in paresthesia in the upper back or posterior neck. 2) 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.

Instruments

Pressure Algometer Dynamometer - The investigation used an algometer dynamometer to determine each participant's PPT. The algometer consisted of an apparatus that had a 1 cm diameter hard metal tip, attached to the plunger of a pressure (force) gauge. The dial of the gauge was calibrated in kg/cm^2 units, up to 30 kg/cm^2.[8] Each subject's PPT was determined by locating the palpable hyperirritable point on the taut band of muscle and then marked by a permanent marker on the skin. The algometer dynamometer was placed on that point. Pressure was placed on that point, within the muscle, with the algometer dynamometer and the subject then letting the tester know when they felt pain by saying "now." At that point the pressure indicated by the dynamometer was recorded as a baseline, but also pre- and post-therapy treatment session, the last of which, was the final reading used for data collection.

Procedures

Each subject was admitted to the investigation upon meeting the inclusion criteria and not meeting the exclusion criteria. The investigation demonstrated a PPT difference over four weeks of MCT. A pressure algometer was used to note the changes of each subject's PPT over the course of the investigation.

A baseline recording was taken at the very beginning of the investigation with subsequent recordings both pre- and post- MCT sessions received, the last of which was used as their final recording. The participants were randomly divided evenly into three groups: a control group that received a sham treatment of minimal pressure

placed upon the LTP, an experimental group on-trigger-point that received the treatment and an experimental group that received the treatment within close-proximity, one inch, but not upon the hyperirritable point.

Researcher Procedures

The examiner took all PPT measurements for baseline recordings, pre- and post-therapy treatment recordings, and applied all treatments to each individual subject. The examiner was the only one who knew the PPT recordings. Therefore, since the examiner was the only one who knew the treatment and the outcome recordings, this was a single-blinded investigation. Only the subjects were blinded to their treatment and to the results of the treatment.

Random Allocation

Each treatment group was randomly assigned to treatment groups by a lottery-style drawing of randomly assigned numbers. Ten number "1's", "2's" and "3's" on single pieces of paper were placed in a hat and drawn out to determine which treatment group each individual in the investigation was to be placed in. Group one received the control treatment; group two, the experimental treatment on the hyperirritable point; and group three, the experimental treatment in close-proximity, one inch, to the hyperirritable point.

Measurements

The examiner provided the actual MCT and the PPT recordings. Each subject's PPT was determined by locating the palpable hyperirritable point on the taut band of muscle and placing the algometer dynamometer on that point.[5] Pressure was placed on the point with the algometer dynamometer and the subject then let the examiner know when they felt pain by saying "now," at which point, the pressure indicated by the dynamometer was recorded as a baseline or pre-/post-therapy treatment session measurement.

Treatment Sessions

Each subject received their selected treatment, as allocated by the group they were in, three times over the course of a week for four weeks. All treatment sessions were done after a period of inactivity for three hours. During the baseline readings a mark was placed on the skin where the LTP was present using a permanent marker as described by Blikstad.[5] This mark served as the location of the LTP for the remainder of the investigation, and was used to assess PPTs throughout. Marking test sites was thought to be one method of improving the reliability of PPT measurements.[33] In addition, PPT measurements were repeated three times and a mean taken in order to ensure that the value was reliable.[15] All three PPTs were taken in quick succession (within approximately 30 s) due to the fact that LTPs could be inactivated by sustained pressure.[15,18] At least one full 24 hour day of rest for each day of 90 second MCT received was implemented. Prior to each treatment session, three pre-therapy PPT measurements were taken by the examiner with the algometer dynamometer.

The pre-therapy measurements were taken two minutes prior to the therapy being given. After each session of applied MCT for 90 seconds, the subject's post-therapy PPT was measured after five minutes with the algometer dynamometer on the hyperirritable point. At which point, the three recordings took place and the mean reading was recorded as the post-therapy PPT for that day of 90 second MCT. Each subject's baseline PPT was attained one day prior to their first 90 second session of MCT. Subjects had a final PPT mean measured at the end of their last 90 second MCT session.

The control group received very minimal pressure placed upon their LTP for 90 seconds that did not affect the LTP in any way, thus resulting in a sham or placebo therapy. The control group maintained a 1-2 perceived rating of pain on a 1-10 VAS, one being no pain and ten being the worst pain they had ever felt.

The experimental group that received 90 second MCT on the hyperirritable point notified the tester when the pressure placed upon the hyperirritable point reached a seven on a VAS of 1-10. A seven on the VAS was maintained throughout the 90 second session of MCT with the subject notifying the tester when to apply more pressure when the perceived rating of pain began to subside in pain on the VAS.

The final experimental group had the 90 second session of MCT placed upon a point on the taut band that was not on the hyperirritable point, but was in close-proximity or one inch to the hyper-irritable point. Pressure was applied by the tester to where the subject felt that there was a 5-7 perceived rating of pain on the 1-10 VAS.

Design and Analysis

The test-retest reliability of the pre- and post-therapy PPT measures was determined by the Chronbach Alpha coefficient over three trials. Table 1 reports the reliability for both the pre- and post-therapy trials for each week of treatment. The reliability of the pre-therapy PPT measures ranged from .94 to .99, and the reliability of the post-therapy PPT measures ranged from .96 to .99, all very high. Based on this very high test-retest reliability, all of the pre- and post-therapy PPT measures were determined to be appropriate for analysis.

TABLE 1

Test-Retest Reliability for Pre- and Post-Therapy

	Pre-Therapy	Post-Therapy
Week 1	0.97	0.97
Week 2	0.97	0.96
Week 3	0.98	0.98
Week 4	0.99	0.97
Week 5	0.94	0.96
Week 6	0.98	0.97
Week 7	0.97	0.97
Week 8	0.98	0.98
Week 9	0.97	0.98
Week 10	0.96	0.98
Week 11	0.98	0.99
Week 12	0.99	0.99

A three-way repeated measures ANOVA was used to determine the differences in the type of treatment (groups) across the treatment sessions as well as pre- to post-therapy PPT trials for each week of treatment. The dependent variable was the PPT. The three independent variables were: 1) the type of treatment (groups), either control, on-trigger-point, or in close-proximity to the trigger point; 2) the treatment sessions, from the first to the twelfth session: and 3) the pre- and post-therapy PPT measures for each week of treatment. Type of treatment (groups) is a between-subjects variable, while the treatment sessions and the pre- and post-therapy PPT measures were within-subjects (repeated) variables, with the pre- and post-therapy PPT measures nested within the treatment sessions.

Scheffe post-hoc tests were used to determine any differences among types of treatment (groups), for either main effects or interactions with the other independent variables. Paired t-tests were used to determine differences between within-subjects trials. Greenhouse-Geisser epsilon was used to adjust probability values for any variation in sphericity among the treatment sessions. Partial eta^2 was used to determine effect size for each statistical test. All statistical significance was defined as $p < .05$.

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 = .33, $F(12, 324) = 47.1$, $p < .0001$, partial $eta^2 = .914$, a very large effect. This trend indicated a significant general increase in the

measures from the first through the twelfth session of treatment. A significant interaction between type of treatment (groups) and treatment sessions was also observed, Greenhouse-Geisser epsilon = .33, F(24, 324) = 2.5, p = .0167, partial eta^2 = .529, another very large effect. Scheffe post-hoc analysis for comparison of the first session with subsequent sessions for each type of treatment (group) indicated significant differences between the on-trigger-point treatment and the control group for sessions eight, p = .040, session ten, p = .028, session eleven, p = .012, and session twelve, p - .006. Significant differences between the close-proximity treatment and the control group were also observed for sessions two p = .021, session three p = .015, session five p = .020, session six p = .045, session seven p = .025, session eight p = .009, session ten p = .047, session eleven p = .048 and session twelve p = .043. No significant differences between the on-trigger-point treatment and the close-proximity treatment were observed for any of the treatment sessions. This trend indicated a significantly greater increase in measures from the second through the twelfth session of treatment for the treatment groups that were either the on-trigger-point or in close-proximity to the trigger point, compared to the control group (figure 1).

FIGURE 1

PPTs Over 12 Sessions

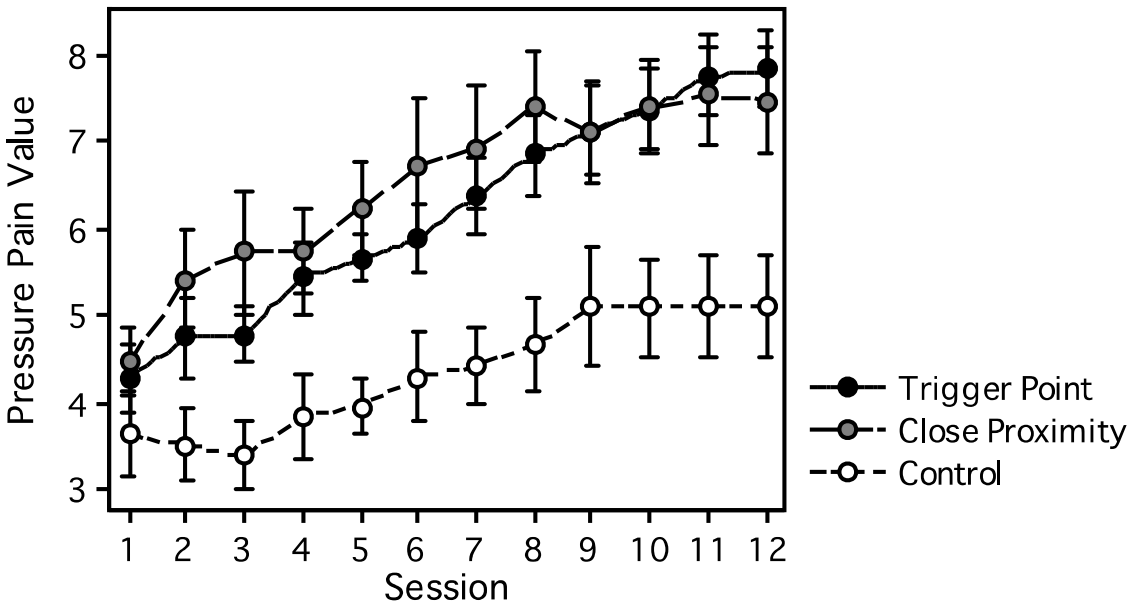


Table 2 reports the descriptive values for the pre- and post-therapy trials, both overall and within each type of treatment (group). A significant main effect for pre- versus post-therapy measures for the treatment sessions was observed, $F(1, 27) = 110.4$, $p < .0001$, partial $eta^2 = .400$, a very large effect. This trend indicated a significant overall increase in measures from the pre-therapy (5.44 ± 1.65) to the post-therapy (5.94 ± 1.81) as a result of the treatment sessions. A significant interaction between type of treatment (groups) and the pre- versus post-therapy measures was also observed, $F(2, 27) = 14.5$, $p = .0001$, partial $eta^2 = .146$, a large effect. Scheffe post-hoc analysis for the differences between the pre- versus post-therapy measures for each type of treatment (group) indicated a significant difference between the on-trigger-point treatment and the control group, $p < .0001$, as well as between the close-proximity treatment and the control group, $p = .007$. No significant difference in the pre- versus post-therapy measures was

observed between the on-trigger-point treatment and the close-proximity treatment, p = .215 (figure 2).

TABLE 2

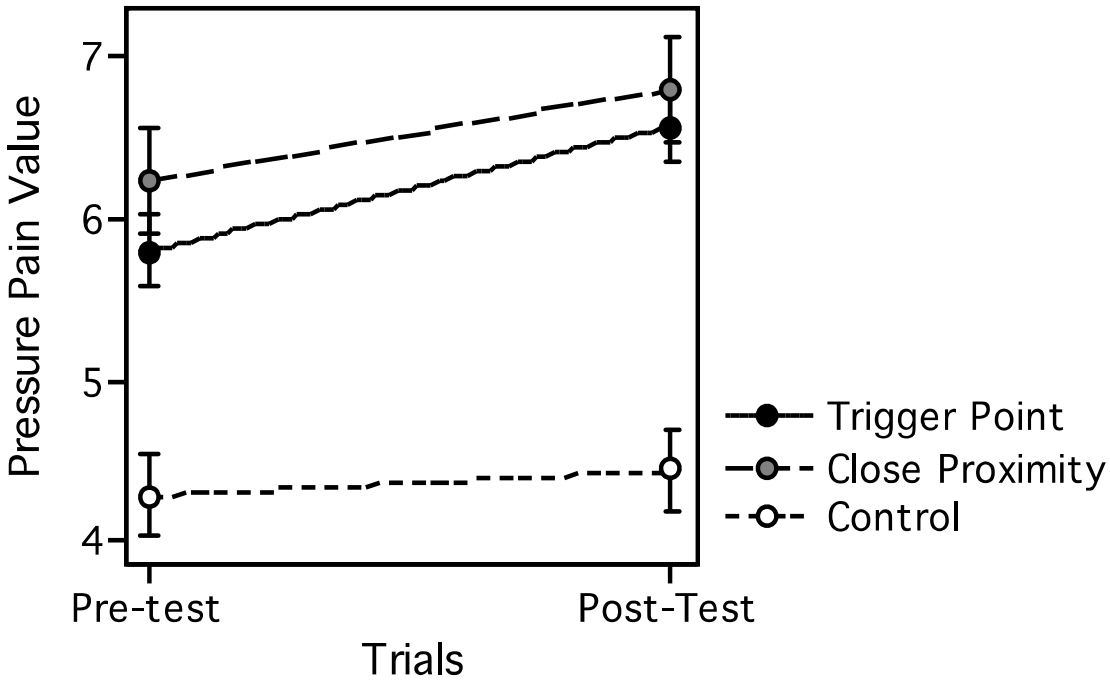
Overall Differences from Pre- to Post-Therapy Measures

	Pre-Therapy		Post-Therapy	
	Mean	SD	Mean	SD
Control	4.28	1.39	4.44	1.45
On-Trigger-Point *	5.8	1.19	6.58	1.17
Close-Proximity *	6.24	1.74	6.81	1.80
All Groups	5.44	1.65	5.94	1.81

* $p<.05$ versus Control Group for Pre- and Post-therapy

FIGURE 2

Overall PPTs from Pre- to Post-Therapy

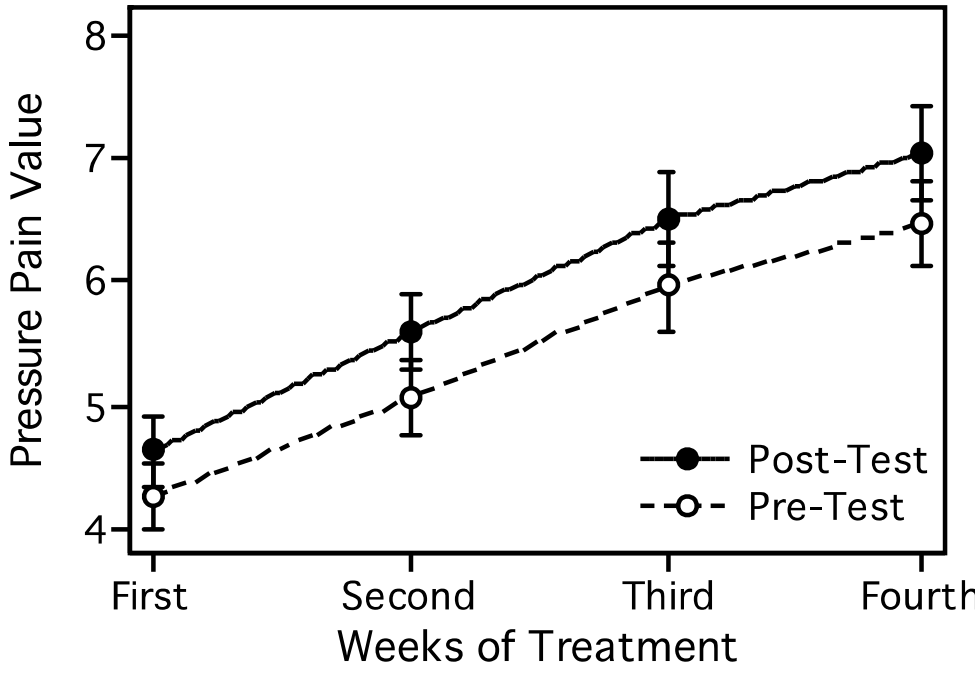


A significant interaction between pre- versus post-therapy measures and the treatment sessions was observed, Greenhouse-Geisser epsilon = 0.569, $F(12, 324) = 2.4$, $p = .0227$, partial $eta^2 = .082$, a moderate effect. Post-hoc paired t-tests indicated that post-therapy values were significantly higher than pre-therapy values for each session except for the third session, $t(29) = 1.45$, $p = .0783$. The trend for the pre- to post-therapy differences across sessions indicates that as the treatments progressed from the first to twelfth session, the differences between the pre- and post-therapy values increased. The average difference between the pre- and post-therapy measures for the first week of treatment, or the first three sessions (0.37 ± 0.474) was not significantly different from the second week of treatment, or sessions four through six (0.5331 ± 0.521), $t(29) = 1.61$, $p = .0591$, but was significantly different from the third week of treatment, sessions seven through nine (0.5333 ± 0.531), $t(29) = 1.74$, $p = .0461$, and fourth week of treatment, sessions ten

through twelve (0.5759 ± 0.473), t(29) = 1.99, p = .0279. This trend is demonstrated in figure 3. Lastly, no three-way interaction among groups, treatment sessions, or pre- to post-therapy measures was observed, Greenhouse-Geisser epsilon = 0.569, F(24, 324) = 1.1, p = .3618, partial eta^2 = .075, a moderately small effect.

FIGURE 3

PPTs by Week from Pre- to Post-Therapy



Discussion

Most people, due to postural positions or sport, accumulate LTPs due to overuse and continued stretch upon postural muscles. The investigation has impacted a majority of the population that has encountered a LTP. The literature on LTPs appears to indicate that PPTs rise after one or only a limited number of applications of MCT; however, no investigations have applied MCT over a period of time to determine if PPTs in subjects continue to rise.[7] Most investigations have involved one to very few treatment sessions

of MCT.[1,5,8-12] One study recommended that future investigations include symptomatic subjects with a longer treatment and assessment period (at least four weeks), which would enable the duration of treatment effect to be investigated.[1] Furthermore, Simons[4] reported that time can be a critical factor, because of the stickiness of the titin molecules, releasing them can be expected to take time. This means, unfortunately, as soon as the muscle relaxes, the sarcomeres immediately tend to return to their previous state unless something more is done,[4] which in this investigation was four weeks of MCT as compared to one to few treatments like many other investigations.[1,5,9-13]

With heightened PPTs, people within the population may have better function with the muscles that are impacted by their LTPs, or may have reduced pain altogether. One investigation suggested that treating LTPs in subjects with chronic musculoskeletal pain may not only decrease mechanical hyperalgesia and allodynia, but also prevent them from transforming into active MTrPs.[14] There was also some evidence that these lesions are prevalent in the community, rendering LTPs as relevant lesions to investigate, as understanding their potential effects would be useful for many community members.[4,15] With this knowledge we can better apply treatment to subjects to produce a more desirable outcome. These desirable outcomes include the complete cessation of LTPs in the area treated, or at the very least a heightened PPT that sustains itself with multiple treatments over time.

This investigation examined three groups of subjects that received different interventions for the duration of the investigation. Manual compressive therapy was performed on all three groups with varying degrees of pressure placed on the LTP during a MCT session. A significant difference between pre- and post-tests existed after 12

sessions of MCT treatments over four weeks on the LTP and in close-proximity to it ($p < .0001$). Manual compressive therapy started to provide relief of the pain produced by a LTP when pressure was placed on it as early as the first session of treatment and continued to increase through the twelfth session of treatment. The investigation found the third week of treatment, or sessions seven through nine, to be significantly different in the PPTs of our subjects in the two experimental groups, but not in the control group, as they remained the same for the entirety of the investigation all the way through the twelfth session. The investigation found a trend that the PPTs of the subjects continued to increase into the fourth week of MCT, or sessions ten through twelve. In a general sense, both experimental groups, MCT on the LTP and in close-proximity, both displayed significant increases in the PPTs of subjects from the start of the investigation through the end of the investigation. For practitioners, this is important that even though the best MCT to be applied in the treatment of LTPs is on-trigger-point MCT, there is investigation still shows evidence that you will get a significant effect from doing MCT in close proximity to the LTP. This means you can be inexperienced in treating LTPs with MCT and you will still see significant results as long as you are within an inch of the LTP during MCT.

Previous research recommended that treatment periods and durations needed to determine the appropriate durations of treatment to maintain heightened PPTs in subjects with LTPs.[1] Our investigation strengthens the conclusion that 90 second MCT exceeded previous investigations of one or few treatment settings to determine the results MCT had on a subject's LTP.[1,5,8-12] This investigation suggests that four weeks was sufficient to see significant change in PPTs of subjects, but did not know if further treatment for a

longer duration of sessions would have continued to increase PPTs in subjects or if complete cessation of LTPs eventually took place, although the evidence suggests that it would. We also do not know if our subjects' PPTs decreased from the tested LTPs after our investigation concluded and treatment sessions had stopped. It is recommended that future investigations follow up with their subjects around a month after the treatment has stopped to determine if PPTs had started to decrease, or if they remained at a heightened level similar to the results when the investigation ended.

Another control this investigation could have had is taking a PPT reading in an area with no LTP to determine the subject's baseline PPT reading where there was no lesion or MTrP present, whether it is active or latent. This would allow future researchers to obtain the highest amount of pressure required before normal tissue interjects with pain, and thus could be more readily compared to the results of the LTP's PPT to determine when that LTP has been resolved completely.

For future investigations, we determined that taking a baseline PPT reading where there was no LTP present, would be a good baseline measurement to determine the subjects' initial PPT over healthy tissue that wasn't anywhere near a MTrP, whether it be active or latent. In turn, it would allow future researchers to compare the results of healthy tissue to the treatment site over the LTP that was being tested throughout the investigation to determine when that LTP had been resolved completely. This came about because of the difficulty in determining if the subject still in fact had a LTP by the fourth week of treatment sessions during this investigation. This also explains why some PPT readings were so high as compared to other investigations, which was initially thought to not be within the average readings one would see, based on prior evidence.

Soreness upon palpation, beginning in the third and fourth treatment weeks, was noted in the subjects of this investigation. This may be in due to the rest cycles that were allotted for this investigation. It is recommended that more rest between sessions be allotted and extending the investigation for a longer duration of more than four weeks. An exact time would be hard to gauge considering most of the subjects started to see increased PPTs to the point where they felt minimal to no pain upon palpation of the LTP, thus questioning whether the LTP was actually present. Treatment times for LTPs will be better determined by future investigations that are longer in duration and help to determine whether this is the best viable option in the treatment of LTPs, which at the present has already been determined by past evidence.[1,2]

The original components of this investigation that were specifically unique were that this investigation still found significant results with close-proximity MCT, and there was no other literature with evidence that specifically looked at close-proximity MCT or used it as an experimental group compared to a control. In addition, this investigation was spanned out over four weeks where other studies only did one or few treatment sessions of MCT during their investigations. This study started to see significant differences from the two experimental groups compared to the control in as early as three weeks of treatment, which had not previously been known or investigated.

Further research may investigate MCT done in close-proximity to the LTP as this investigation found that it still has a significant change in PPTs with multiple treatments, similar to MCT directly on the LTP.

This investigation may impact a vast majority of the population who suffer with LTPs. With the results of this investigation, treatments of MCT to individuals with an LTP can

be provided to rid the individual of their pain or at least heighten the PPT. This investigation serves as another puzzle piece in the treatment of LTPs by the use of MCT, and all the other research before this investigation was conducted and yet to follow.

Conclusions

This investigation has enhanced what is already known about LTPs and has had an impact on the future research on LTPs, as well as the PPTs associated with them. This investigation allowed the advancement of the literature of MCT on subjects with LTPs over an extended period of time, and furthered the knowledge that was already known about the shorter duration of treatments on PPTs.

Significant increases in PPTs were observed after doing 90 second MCT on subjects' LTPs directly on the LTP and in close-proximity to the subjects' LTPs. No significant difference was observed in the control group. Manual compressive therapy appeared to have an effect on the pain produced by LTPs in the upper trapezius and posterior neck, and is recommended in the treatment of LTPs.

CHAPTER V

SUMMARY, CONCLUSIONS, RECOMMENDATIONS

This investigation has enhanced what is already known about LTPs and has had an impact on the future research on LTPs, as well as the PPTs associated with them. This investigation allowed the advancement of the literature of MCT on subjects with LTPs over an extended period of time, and furthered the knowledge that was already known about the shorter duration of treatments on PPTs.

Significant increases in PPTs were observed after doing 90 second MCT on subjects' LTPs directly on the LTP and in close-proximity to the subjects' LTPs. No significant difference was observed in the control group. Manual compressive therapy appeared to have an effect on the pain produced by LTPs in the upper trapezius and posterior neck, and is recommended in the treatment of LTPs.

After four weeks, it was found that our subjects' PPTs significantly changed for the better, as we saw a significant increase in those PPTs. However, it was undetermined if further sessions and more weeks of MCT would have led to a continued increase in those PPTs, or if complete cessation of those LTPs would eventually have taken place. Through previous evidence and the results of this investigation, it is likely that we would have seen that continued increase in PPTs, and possibly complete cessation of the subjects' LTPs altogether.

For future investigations, we determined that taking a baseline PPT reading where there was no LTP present would be a good baseline measurement to determine the subjects' initial PPT over healthy tissue that wasn't anywhere near a MTrP, whether it be

active or latent. In turn, it would allow future researchers to compare the results of healthy tissue to the treatment site over the LTP that was being tested throughout the investigation to determine when that LTP had been resolved completely. This came about because of the difficulty in determining if the subject still in fact had a LTP by the fourth week of treatment sessions. This also explains why some PPT readings were so high as compared to other investigations, which was initially thought to not be within the average readings one would see.

Soreness upon palpation, beginning in the third and fourth treatment weeks, was noted in the subjects of this investigation. This may be in due to the rest cycles that were allotted for this investigation. It is recommended that more rest between sessions be allotted and extending the investigation for a longer duration of more than four weeks. An exact time would be hard to gauge considering most of the subjects started to see increased PPTs to the point where they felt minimal to no pain upon palpation of the LTP, thus questioning whether the LTP was actually present. Treatment times for LTPs will be better determined by future investigations that are longer in duration and help to determine whether this is the best viable option in the treatment of LTPs, which at the present has already been determined by past evidence. [1,2]

Further research may also investigate MCT done in close-proximity to the LTP as this investigation found that it still has a significant change in PPTs with multiple treatments, similar to MCT directly on the LTP. This investigation is thought to be the only one of its kind that has done an experimental intervention of MCT in close-proximity to the LTP.

Sample size is also recommended to be larger as it will more closely resemble the population and make results more concrete in their findings. This investigation was random and controlled, but because of limited resources, was only single blinded. Therefore, it is recommended that double blinded investigations take place as this more closely fits the golden standard in research.

APPENDIX A

Consent Form for Participation in:
Do Pressure Pain Thresholds in Collegiate Aged People Increase After 4 Weeks of Manual Compressive Therapy on Latent Myofascial Trigger Points?
Department of Health and Human Performance
Texas State University-San Marcos

IRB Approval #: **2013N929**

The principal investigator is Jeffrey Schmidt ATC, LAT, Texas State University. Jeffrey Schmidt may be contacted by email: jeff@sthedwig.net, or phone: 210-385-1673.

INTRODUCTION AND PURPOSE OF THE STUDY
You have been asked to participate in a research study to assess your pressure pain threshold in relation to your latent myofascial trigger point. You will be chosen based on completion of the initial pre-participation questionnaire admitting no previous injuries to the upper back or posterior neck, having surgery on those same areas, no history of fibromyalgia, no systemic diseases, no numbness or tingling, and received no physical therapy. The investigation will help to determine if manual compressive therapy will increase your pressure pain threshold or resolve your trigger point all together. Your participation is strictly voluntary and you may choose to stop any of the procedures at any time for any reason without question.

You will be evaluated in the Athletic Training Research Lab at Texas State University in the Jowers building, room D112, or in the Texas Lutheran University Athletic Training Room located on their campus in Seguin TX. The following form includes more details regarding the research. If you have any questions or concerns about the study, please ask before you decide to participate.

PROCEDURES
Each subject will be instructed to wear a shirt that is easy to take off. Men will take off their shirt and women will be in a sports bra to expose the area being tested. Exposing the testing area is necessary for the completion of testing, which will be explained in detail below. The following are the procedures for the study, which will take approximately 10 minutes to complete:

1. **Pre-participation information**: Before participation in the study, each subject will complete a questionnaire with 14 questions about the subject's general health and history of injuries. A certified athletic trainer will also determine if the subject has the physical capability to complete the study by assessing their upper back and neck for any previous injuries.

2. **Assessment**: The certified athletic trainer will determine if you have a latent myofascial trigger point in your upper back or posterior neck. If so, a mark will be

placed on your latent myofascial trigger point using a permanent marker, and you will be asked to be admitted to the study.

3. **Control/treatment**: The subjects will be asked to remove their shirt for the study to commence. The subject will lie on a treatment table, stomach down. A finger from the tester will apply pressure on your upper back or posterior neck for a period of 90 seconds. At which point your pressure pain threshold will be assessed by applying the algometer to that same point. The order will be randomly assigned.

4. **Test Protocol**: A baseline recording will be taken in advance of the treatment being received. The subject will be tested 3 times, every week, for 4 weeks. The testing will take approximately 10 minutes each session. After the pressure pain threshold recording the subject will be done for the day and will be told when to report back to the testing facility for their next treatment session.

POTENTIAL RISKS AND DISCOMFORTS

Subjects will be informed about the nature of what is involved as a participant of this study, including a description of anything they might consider to be unpleasant or a risk. The potential risks for this experiment are very minimal because the principal investigator will apply the treatment on the subjects during the duration of the study; however, some discomfort may be experienced with the pressure placed on the treatment site. With that, there is a very small potential risk for injury. Following the study as it is designed and answering the health questionnaire will minimize those risks for injury even further.

If an emergency occurs during testing, the subjects will be instructed to exit the building immediately. If it is a medical emergency, then emergency services will be contacted. The primary investigator is Professional Rescuer Certified and will assist with all emergency situations until EMS arrives on the scene. In the event that the participant will require medical attention, the participant will be responsible for covering all medical expenses.

POSSIBLE BENEFITS

The benefits from this investigation will provide information for the athletic and medical community. Also, the results from this investigation may help you learn about:

- Latent trigger points and the affect they have on your body
- Pressure pain thresholds

CONFIDENTIALITY

Each subject in this study will be issued a number to differentiate the results found between subjects and to maintain the confidentiality of the subject's information and results. Name, social security numbers, telephone numbers, and address are not required for testing; however, name and phone number are required for this form. Results from the study may be shared for future research except for the consent forms. If consent from

material is needed for research purposes, then the subjects will be contacted for additional written consent for release of their information. All data from this project will be kept at the supervisor's place of residence in a locked file cabinet to avoid loss of confidentiality. In order to maintain confidentiality, the recorded data will be kept for up to 5 years total. After this 5-year period, all information and data will be destroyed.

PARTICIPATION

Your participation in this study is voluntary; you may decline to participate without penalty. You may choose to stop the exercise at any time for any reason. If you decide to participate, you may withdraw from the study at any time without penalty and without loss of benefits to which you are otherwise entitled. If you withdraw from the study before data collection is completed, your data will be returned to you or destroyed. If you have any other questions regarding the research, research participants' rights, and or research-related injuries to participants, please contact the IRB chair, Dr. Jon Lasser, (512) 245-3413, lasser@txstate.edu or Ms. Becky Northcut, Compliance Specialist, (512) 245-2102.

AUTHORIZATION

The Athletic Training Program supports the practice of protection for human subjects participating in this research and related activities. The consent form is provided so that you can decide whether you wish to participate in the present study. A summary of the findings will be provided to participants upon completion of the study, if requested.

"I have read the above statement and have been fully advised of the procedures to be used in this project. I have been given sufficient opportunity to ask any questions I had concerning the procedures and know that I am free to ask questions as they may arise. I likewise understand that I can withdraw from the study at any time without being subjected to reproach."

Please contact Jeffrey Schmidt, Principal Investigator, at 210-385-1673 or email at jeff@sthedwig.net if you have any questions or would like a summary of the findings of this study.

_____	_____
Participant Name Printed (18 yrs or older)	Phone #
_____	_____
Signature	Date

_____

Principal Investigator Signature

APPENDIX B

PRE-PARTICITPATION PHYSICAL EVALUATION- MEDICAL HISTORY

Answer all questions. Explain any yes answers below.

Yes	No	General Information:
⬭	⬭	1. Have you had an upper back or neck injury in the past?
⬭	⬭	2. Have you been hospitalized overnight in the past year for an upper back or neck injury?
⬭	⬭	3. Have you had surgery on your upper back or neck?
⬭	⬭	4. Are you currently taking any prescription or non-prescription (over the counter) medication pills or using an inhaler?
⬭	⬭	5. Do you have any health issues that may warrant physician approval before engaging in this study?
⬭	⬭	6. Do you have any numbness or tingling in your upper back or neck?
⬭	⬭	7. Do you have fibromyalgia?
⬭	⬭	8. Have you had a diagnosed systemic disease (cancer, diabetes, etc.)?
⬭	⬭	9. Have you had any previously diagnosed slipped discs or bulging discs in your upper back or neck
⬭	⬭	10. Do you have any current skin problems (ex: itching, rashes, acne, warts, fungus, or blisters)?
⬭	⬭	11. Have you had any swelling in your upper back or neck?
⬭	⬭	12. Have you ever broken or fractured any bones or dislocated any joints?
⬭	⬭	13. Have you partaken in physical therapy for any neck or upper back pain in the past 6 weeks?
⬭	⬭	14. Have you ever had any sprains, strains, or bruises in your upper back or neck?

Explain all yes answers:

Emergency Contact: Name_____ Phone Number_____

I certify that all that all the information on this form is correct.

_____ _____

Date Signature of Participant

_____ _____

Date Signature of Primary Investigator

APPENDIX C

Participant Demographic Values

Circle or fill in the following demographic values that represent you.
Gender: M F
Age: _____
Weight: _____
Height: _____

_____ _____
Participant Signature Date

_____
Principal Investigator Signature

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