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FASCIA SCIENCE AND CLINICAL APPLICATIONS: ORIGINAL CLINICAL STUDY

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Myofascial triggerpoint release (MTR) for treating chronic shoulder pain: A novel approach

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Summary *Background:* This study comprehensively evaluated a myofascial triggerpoint release (MTR) technique for shoulder pain.
Methods: Twenty-three (from an initial sample of 25) patients experiencing shoulder pain received MTR, in four 10-min sessions over a period of 2 weeks, applied exclusively on the more painful shoulder, with assessments being recorded both before and after treatment (and for pain at 1 and 13 months). Measures of stiffness and elasticity were collected to monitor the process of therapy, while subjective measures of pain and objective measures of pressure pain thresholds tracked primary outcomes. Secondary outcomes focused on suffering, stress, and quality of life.
Results: A statistically significant decrease in stiffness and increase in elasticity was observed post intervention for the treated side only, while pressure pain thresholds improved on the untreated side as well. Reports of pain significantly decreased after treatment, with gains being maintained at 1 and 13 months following treatment. Levels of suffering, stress, and quality of life revealed statistically significant improvement as well.
Conclusions: MTR resulted in clinically significant improvements in the primary measures of

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pain, objective mechanical tissue properties, and secondary measures in patients with chronic shoulder pain.

Introduction

Shoulder pain is a highly prevalent musculoskeletal problem. For example, it is the third most common musculoskeletal disorder observed in primary care consultations (Mitchell et al., 2005) and is one of the major reasons patients consult with primary healthcare providers (Feleus et al., 2008; Reilingh et al., 2008; Schellingerhout et al., 2008). In western societies, the one-year prevalence of shoulder disorders is estimated to range from 20% to 50% (Bongers, 2001). Some studies suggest that subacromial impingement syndrome (SIS) might be a common cause of shoulder pain (Faber et al., 2006; Michener et al., 2004; Schroder et al., 2001). SIS syndrome is associated with inflammation, degeneration of subacromial bursae and tendons (Bigliani and Levine, 1997). SIS has been implicated as the triggering mechanism for physiopathological alterations in the rotator cuff (Michener et al., 2003; Stevenson and Trojian, 2002). However, accumulating evidence reveals a lack of consistency in clinical diagnosis of SIS (Calis et al., 2000; Litaker et al., 2000) and effectiveness of treatments (Green et al., 2000; Paternostro-Sluga and Zoch, 2004). By contrast, some authors believe myofascial triggerpoint syndrome of rotator cuff tendonitis provides a more adequate alternative explanation for shoulder pain (Bron et al., 2011a; Hidalgo-Lozano et al., 2010; Simons, 2004).

In fact, myofascial triggerpoints (MTPs) can play a relevant role in the pathophysiology of musculoskeletal shoulder pain (Bron et al., 2011b; Hidalgo-Lozano et al., 2010; Hidalgo-Lozano et al., 2011; Myburgh et al., 2008; Simons and Travell, 1999). MTPs are defined as hyperirritable nodules in a taut band of skeletal muscle that are painful upon contracting and stretching, which gives rise to a referred distant pain (Simons and Travell, 1999). Active MTPs are the ones in which local and referred pain reproduced symptoms familiar to the patient. Latent MTPs reveal the same clinical findings as active MTPs, but they are not associated with symptoms that are familiar to the patient (Simons and Travell, 1999). Biochemical findings support the clinical distinction between active and latent MTPs because higher levels of chemical mediators, such as bradykinin, substance P, or serotonin, have been found in active MTPs in comparison with latent MTPs and non-MTPs (Shah et al., 2005).

A new noninvasive handheld diagnostic device, the MyotonPRO, allows objective measurements of superficial skeletal muscles and bio-mechanical properties of MTPs to be obtained, such as stiffness and elasticity. Accurate assessment of mechanical tissue properties — such as logarithmic decrement (indication of elasticity) and stiffness — might play a key role in rehabilitation and evaluation of treatment efficacy in musculoskeletal disorders such as myofascial pain syndrome (MPS). Its inter-rater reliability has been established in a published study (Aird et al., 2012).

Different treatments have been proposed for deactivating MTPs, e.g., manual techniques, active exercises and postural corrections (Aguilera et al., 2009; Hong, 2006; Simons et al., 2002). Myofascial triggerpoint release (MTR) therapy (Gordon et al., 2011) is often prescribed for treating low back pain, but only a few studies have examined this treatment for chronic shoulder pain (Bron et al., 2011a; Hains et al., 2010). For example, Bron et al. (2011a) demonstrated that a 12-week comprehensive treatment of MTPs induced clinically relevant improvements in 55% of the patients with shoulder pain. However, studies systematically and objectively measuring the efficacy of these techniques are lacking, especially as regards muscle stiffness and elasticity.

Design overview

Guided by this limited prior research, the general aim of the present study was to investigate the efficacy of the MTR technique for reducing chronic shoulder pain. It was hypothesized that the MTR technique would induce changes to myofascial tissue that lead to reductions in muscle stiffness and increases in elasticity (decrease of logarithmic decrement) and consequent reductions in pain and related symptoms. Three sensitive sites were identified on each side of the upper trapezius. The three sites on the more painful side were treated with a single standardized maneuver of MTR technique. Multiple measures were obtained at various time points to permit a comprehensive assessment of treatment process as well as outcome.

Materials and methods

Patients

The participant pool consisted of the first 25 consecutive patients presenting to the practice of a local Orthopedic Specialist upon completion of an initial screening for the presence of chronic shoulder pain. The referred patients were reported as having diverse causes of pain (local as well as radiation pain). Twenty-three of the 25 patients fulfilled the following criteria upon referral to our clinic: (1) chronic shoulder pain for at least 3 months; (2) a shoulder pain rating of at least 4 on a numerical rating scale ranging from 0 (no pain) to 10 (strongest pain) on the affected side (as determined by the referring Orthopedist); (3) presence of at least 2 sensitive sites on the same shoulder out of 6 predetermined points bilaterally in the upper trapezius (3 for each side); and (4) age between 18 and 70 years. As regards inclusion criterion #1, all patients were found to have only unilateral pain. Exclusion criteria consisted of the presence of an acute prolapsed disc, acute inflammation and degenerative neurological illnesses, or major psychiatric or other neurological condition. These patients had a mean age of 47.4 $\pm$ 11.48 years. Informed consent was obtained for all procedures that patients received and the study was conducted in a manner consistent with the Declaration of Helsinki.

Assessment

We included a variety of measures to permit us to examine processes underlying treatment (changes in muscle stiffness and elasticity) as well as outcome. Primary outcome measures consisted of subjective pain ratings and objective measures of pain pressure and depth. Subjective ratings of suffering, stress, and quality of life served as secondary measures of outcome (and were not directly targeted). These measures are explained in greater detail below.

Myometer (MyotonPRO) and algometer

Measurements at all MTP sites were obtained pre- and post-treatment using a MyotonPRO (Myoton AS; Estonia) and a pressure pain threshold algometer (PainTest™ FPN 100 Algometer, Wagner Instruments, Greenwich, USA) while the patient remained in a stable sitting position (see Fig. 1C). Assessors, all credentialed physical therapists, received 6 weeks of intensive training prior to conducting the assessments, with ongoing supervision provided throughout the investigation.

The MyotonPRO was placed on the skin above the muscle being measured perpendicular to the skin surface over the MTPs (Fig. 1C). The device was then lowered into the measurement position and held steady while the device automatically performed the predefined measurement series (10 single measurements with a recording interval of 1 s for each of the 6 MTP's, with the average value for each site being used in subsequent analyses). The method of myometry developed for measuring superficial skeletal muscles consists of: a) creating a brief (15 ms) mechanical tap of 0.58 N to the surface of the skin; b) recording the tissue's response in the form of an acceleration graph; and c) subsequently computing frequency (by use of a tone), elasticity (by determining the logarithmic decrement), and stiffness of the underlying muscle (based on equations calculated from the acceleration graph of the muscle damping oscillation, recorded

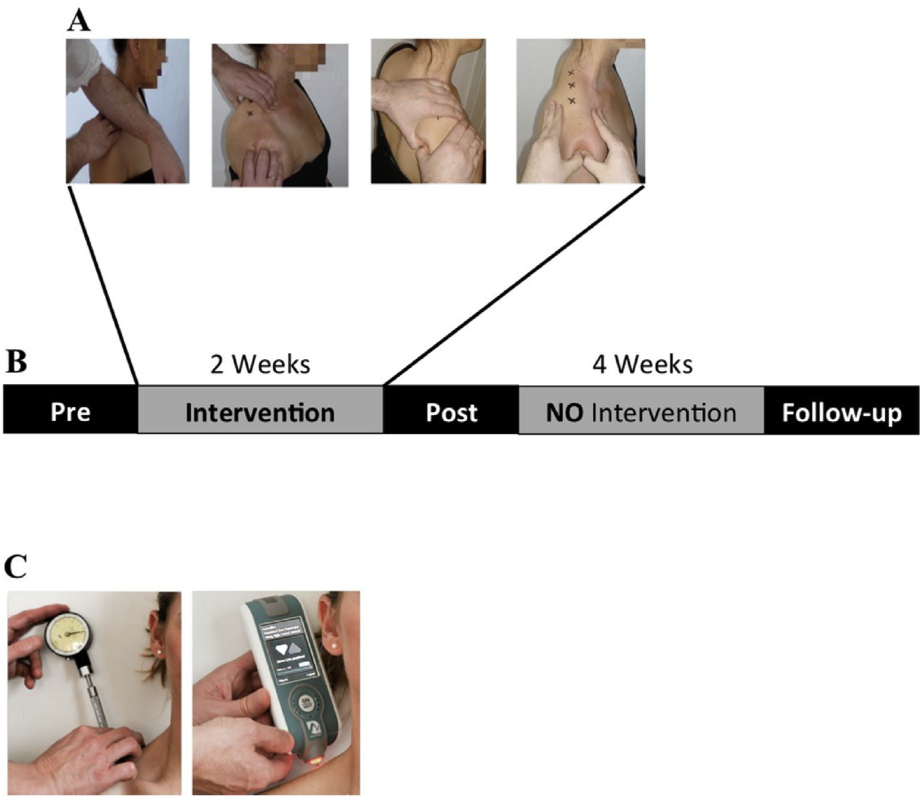

Figure 1 A) Maneuver of MRT technique involved four different muscles: deep myofascial release and rhythmical undulation of the trigger points of the m. Trapezius and m. Deltoideus, m. Rhomboideus, m. Infraspinatus, and m. Deltoideus (see pictures from left to right respectively) were applied and constantly repeated in four 10-min sessions over a period of 2 weeks. Three sensitive trigger point sites marked on one side of the upper trapezius with an "X" using a black permanent marker (first picture from the right side). B) Schematic illustration of the procedure of study for chronic shoulder rehabilitation. C) Assessment measurements were executed with the pressure algometer (left) and MyotonPRO (right).

by the device testing end and accelerometer) (Aird et al., 2012; Bizzini and Mannion, 2003; Gavronski et al., 2007; Korhonen et al., 2005).

The logarithmic decrement of a tissue's natural oscillation — as measured with the MyotonPRO — indicates its elasticity. Elasticity is understood as the biomechanical property of a tissue that characterizes its ability to recover its initial shape after removal of an external force of deformation. Elasticity then is inversely proportional to the decrement. A high elasticity score indicates that there is very little dampening in the passive oscillations of the tissue following the brief indentation. The inverse of elasticity is plasticity. Dynamic stiffness [N/m] is the biomechanical property of a tissue that characterizes the resistance to an external force that deforms its initial shape (Roja et al., 2006). Greater effort is required from the agonist muscle to stretch the antagonist muscle with high stiffness, which leads to inefficient economy of movement. The inverse of stiffness is Compliance. The term Dynamic stiffness is originated from the dynamic measurement method applied in MyotonPRO (for more details see Supplemental Data File 1).

By contrast, the pressure algometer measures deep pressure pain threshold or tenderness resistance. More specifically, the algometer measures the pressure pain threshold when a particular site of the body is pressed with a rubber disk having an area of 1 cm^2 (Park et al., 2011). In the present study, two different units—pounds (pressure pain threshold) and millimeters (depth)—were used for pressure pain thresholds. The pressure algometer was also placed over the triggerpoints. The depth and pressure pain threshold were then recorded by use of the pressure algometer. Patients were instructed and extensively trained to verbally indicate the point of "uncomfortableness". At this point, the pressure pain threshold (pounds) and depth (mm) were recorded. Increase in pressure and depth indicates reduction of pain. All myometry and algometer measurements were completed 5 min after all 3 MTPs had been treated.

Pain and related symptoms

The Brief Pain Inventory (BPI) (Cleeland and Ryan, 1994) scale was completed at all 3 measurement periods (See Fig. 1B). The BPI asks questions about pain relief, pain quality, and the patient's perception of the cause of pain using 0 to 10 numeric rating scale over the last 24 h. Low scores indicate low levels of pain.

Analog scales (ranging from 0 to 10) of suffering, stress, and quality of life were also recorded, wherein low scores indicated low levels of stress, quality of life and suffering respectively.

Intervention: MTR technique

The three most sensitive MTP sites identified on each side of the upper trapezius were marked with an "X" using a black permanent marker (Fig. 1A). The three sites on the more painful side were then treated with a standardized maneuver of the MTR technique (see Fig. 1A), in four 10-min sessions spaced over a period of 2 weeks. Two physical therapists were involved in the treatment of the patients. The therapists were experienced in the identification and treatment of MTPs and had successfully completed a standardized training program in MTR therapy (Gordon et al., 2011). Palpatory skills were used to localize and detect the triggerpoints as specified by Simons and Travell (1999).

Data analysis

The obtained data permitted the investigators to examine treatment process as well as outcome. The first set of analyses focused on the 2 process measures (Stiffness, Elasticity), which were subjected to separate two-way ANOVAs (shoulder site: treated versus not-treated × measurement period: pre versus post).

The second set of analyses focused on outcome. The objective outcome measures (pressure and depth), which were subjected to separate two-way ANOVAs (shoulder site: treated versus not-treated × measurement period: pre versus post), in the manner described for the process analyses. The subjective measures of outcome were not normally distributed, so they were analyzed by Wilcoxon signed-rank tests. Mean scores for level of pain (the remaining primary outcome measure; assessed by the BPI) compared pre, post, and follow-up values obtained at 1 and 13 months. The 3 secondary outcome measures (Suffering, Stress, and Life Quality) compared only pre and post values.

Paired sample *t*-tests comparisons were applied when the data were normally distributed (Kolmogorov-smirnov test) (as was the case for stiffness, elasticity, pounds, and mm scores) to analyze pre and post treatment effects. The values reported in the text and figures are expressed as mean ± standard error of the mean. Strength of effect measures using Cohen's *d* statistic (Cohen, 1988) are reported for statistically significant findings, wherein values are labeled as follows: small = 0.20, moderate = 0.50, large = 0.80, and very large = 1.30.

Results

MyotonPRO (assessment of process)

As previously stated, mean values were computed for each of the measures collected on the 3 MTP's on the treated and non-treated sides, for the 2 process measures yielded by this device, pre- and post-treatment: stiffness and logarithmic decrement, which provides an indication of elasticity.

Stiffness

No significant main effects were observed for side of treatment ($F(1,22) = 4.038$, $p = 0.057$) or measurement period ($F(1,22) = 0.620$, $p = 0.440$). However, the interaction for side and period was significant ($F(1,22) = 16.498$, $p = 0.001$). Post-hoc comparisons using two-tailed paired-samples t-tests revealed a significant improvement in stiffness scores for the treated side comparing pre- (322.32 ± 10.97) and post- (300.66 ± 9.43) MTR treatment ($t(1,22) = 2.722$, $p = 0.012$; $d = 0.44$). By contrast, a two-tailed paired-samples t-test comparing the pre- (324.42 ± 11.39) to post- (334.68 ± 11.1) treatment values for the non-

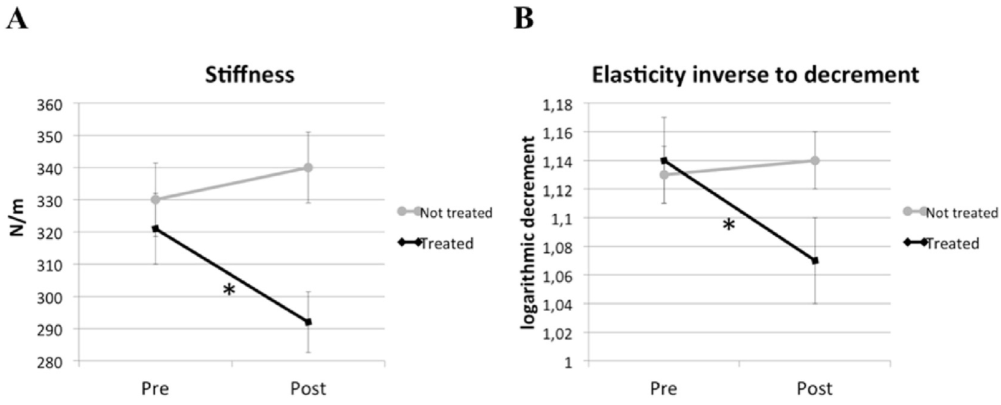

Figure 2 Myometer results. A) Dynamic stiffness reduction: On treated side pre- and post- treatment significant decrease of stiffness was observed. On non-treated side no significant difference of stiffness was noticed. B) Logarithmic decrement of a muscle's natural oscillation indicates the elasticity of the muscle: e.g., its ability to recover its shape after contraction. Elasticity is inversely proportional to the decrement. The graph shows a significant increase of elasticity on treated side between pre- and post-treatment. On non-treated side no significant difference was noticed.

treated side did not reveal a significant decrease of stiffness [t(1,22) = −1.204, p = 0.241] (See Fig. 2).

Elasticity (as determined by the logarithmic decrement)
Significant effects were found for measurement period (F(1,22) = 7.389, p = 0.013) and the interaction of side of treatment x period (F(1,22) = 19.380, p = 0.001). The main effect for side of treatment was not significant (F(1,22) = 2.306, p = 0.143). Paired-samples *t*-test comparisons revealed a significant improvement in elasticity scores (decrease of logarithmic decrement indicates increase of elasticity) for the treated side comparing pre- and post- MTR treatment (t(1,22) = 4.402, p = 0.001; *d* = 0.50). Specifically, the average elasticity total score decreased from 1.14 ± 0.03 before treatment to 1.07 ± 0.03 after treatment. By contrast, a two-tailed paired-samples t-test comparison did not reveal a significant decrease of elasticity from pre (1.13 ± 0.02) to post (1.14 ± 0.02) for the non-treated side (t(1,22) = −0.578, p = 0.569) (See Fig. 2).

Algometer

Three measurements were recorded on each side (1 single measurement for each of the MTP's on the treated and non-treated side), pre- and post-treatment, for 2 separate measures: pressure pain threshold, reported as pounds, and depth, reported as mm values.

Pain outcome measures

Pressure pain threshold (pounds)
Significant effects occurred for measurement period (F(1,22) = 48.406, p = 0.001) and the interaction of side of treatment x period (F(1,22) = 11.732, p = 0.002). The main effect of side of treatment was not significant (F(1,22) = 3.663, p = 0.069). Paired-samples *t*-test comparisons revealed a significant improvement in pounds scores for the treated side comparing pre- and post- MTR treatment (t(1,22) = −7.327, p = 0.001; *d* = 1.63). Specifically, average pounds scores increased from 4.13 ± 0.32 before treatment to 7.91 ± 0.65 after treatment. Moreover, a two-tailed paired-samples t-test comparison also revealed a significant increase of average pounds scores from pre (4.35 ± 0.36) to post (6.97 ± 0.53) MTR intervention for the non-treated side (t(1,22) = −5.672, p = 0.001; *d* = 1.23) (See Fig. 3).

Depth (millimeters)
Significant effects were found for measurement period (F(1,22) = 27.723, p = 0.001) as well was the interaction of side of treatment x period (F(1,22) = 23.669, p = 0.001). The main effect for side of treatment once again was not significant (F(1,22) = 1.880, p = 0.184). Paired-samples *t*-test comparisons revealed a significant improvement in mm scores for the treated side comparing pre- and post-MTR treatment (t(1,22) = −5.846, p = 0.001; *d* = 1.11). Specifically, average mm scores increased from 10.29 ± 0.66 before treatment to 14.42 ± 0.55 after treatment. Moreover, a two-tailed paired-samples t-test comparison revealed a similar significant increase of average mm scores from pre (10.52 ± 0.7) to post (13.09 ± 0.63) MTR intervention for the non-treated side (t(1,22) = −4.268, p = 0.001; *d* = 0.81) (See Fig. 3).

Self report of pain

Brief pain inventory
The Wilcoxon Test showed that the MTR technique elicited a statistically significant change in BPI scores (z = −4.217, $p < 0.0001$; *d* = 0.47). Average pain scores decreased from 6.0 ± 1.51 before intervention to 2.26 ± 1.84 immediately after the intervention (See Fig. 4). The decrease in pain scores remained stable after 4 weeks from the intervention as no difference was observed in the average Pain scores between post (2.26 ± 1.84) and the 4-weeks follow-up (1.64 ± 1.84) (z = −1.955, p = 0.051, Wilcoxon signed

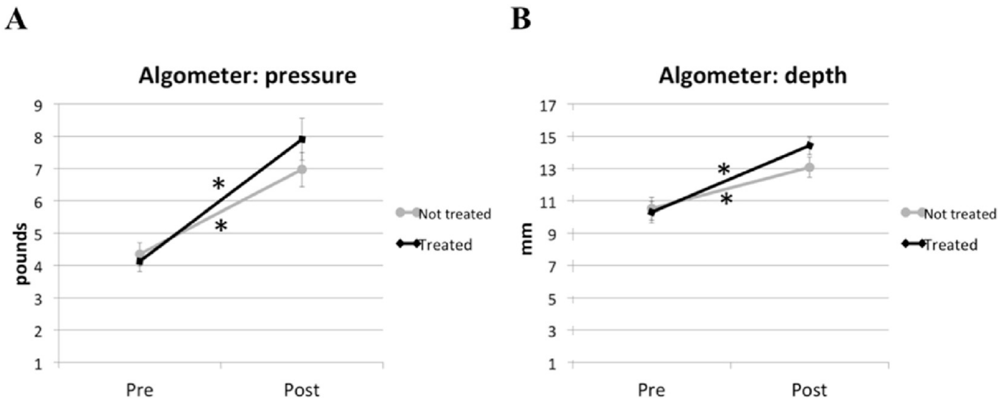

Figure 3 Algometer results. A) Desensitization of tissue and the triggerpoints [in lbs. (A) and in mm (B)] and subjective pain reduction on the treated shoulder. On treated and not treated side before 1st and before 4th treatment significant increase of desensitization was observed.

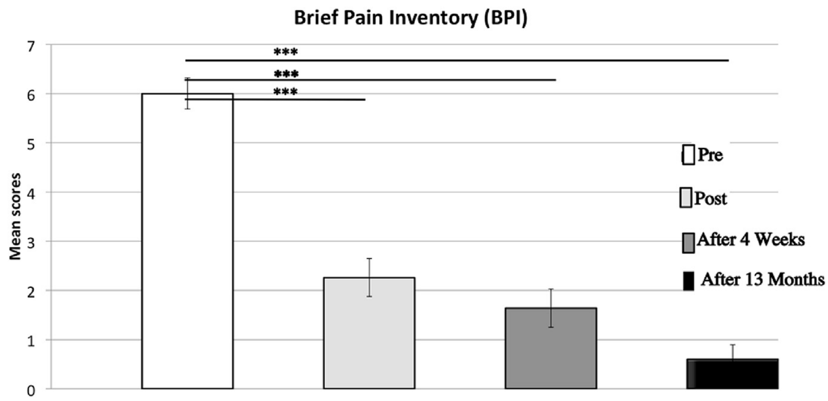

Figure 4 Brief pain inventory scale: between Pre and Post intervention a significant decrease of pain scores was observed. The decrease of pain scores remained stable after 4 weeks from the 4th treatment and 13 months Follow-up. ***$p < 0.0001$.

rank test), while average pain score decreased from 6 ± 1.51 before intervention to 1,64 ± 1.84 4 weeks after intervention ($z = -4.031$, $p < 0.0001$, Wilcoxon test; $d = 0.53$). Average pain scores decreased from 6.0 ± 1.51 before intervention to 0.6 ± 1.84 at the 13 month followup ($z = -1.955$, $p = 0.051$, Wilcoxon test; $d = 0.67$).

Secondary outcome measures

The intervention elicited a statistically significant change in level of stress scores ($z = -2.260$, $p = 0.024$; Wilcoxon Test; $d = 0.12$), with pretreatment values (5.7 ± 2.01) decreasing to a value of 4.52 ± 2.21 after the intervention (See Fig. 5). Moreover, average suffering score decreased significantly as well from 5.26 ± 1.6 before intervention to 2.17 ± 1.72 after intervention (See Fig. 5) ($z = -4.002$, $p < 0.0001$; Wilcoxon Test; $d = 0.39$). A Wilcoxon Test showed also that the MTR technique elicited a statistically significant change in reduction of quality of life scores ($z = -4.217$, $p < 0.0001$; $d = 0.39$). Average reduction quality of life score decreased from 4.96 ± 1.58 before intervention to 1.96 ± 1.64 after intervention, indicating improved quality of life as a result of the intervention (See Fig. 5).

Discussion

The general aims of the present study were to assess the effectiveness of the myofascial triggerpoint release technique for reducing pain in patients with chronic shoulder pain and simultaneously to examine processes potentially underlying treatment effectiveness. It was hypothesized that the MTR technique would decrease pain perception (the primary outcome measure) and improve shoulder function by reducing muscle stiffness and increasing muscle elasticity (process measures). To further this aim a standardized maneuver of MTR technique was used to treat three sites on the more painful trapezius muscle of patients. Positive effects for the MTR technique in treating patients with chronic shoulder pain were found, as evidenced by the significant reductions for muscle pain and muscle stiffness and the increase for muscle elasticity (with effect sizes ranging from small to very large). Moreover, secondary measures of pain outcome demonstrated a

Figure 5 Behavioral assessment: between Pre and Post intervention a significant decrease of level of suffering and stress and significant increase of life-quality scores was observed. ***p $<$ 0.0001; *p $<$ 0.05.

significant increase for quality of life and significant decreases for levels of suffering and stress (although effect sizes with respect to these parameters were more limited). These later measures were obtained only immediately upon treatment completion. We suspect greater effects would have been found with more extended follow up.

The findings of reduced muscle stiffness and increased elasticity indicate that MTR therapy may be helpful in improving shoulder mobility and inducing reorganization of healthy muscle functioning. Accumulating evidence suggests that MTPs can cause muscle weakness of the involved painful muscle and restricted range of motion (Falla et al., 2007; Lucas et al., 2010). Other investigators have found impairments in the lower division of the trapezius muscle in people with painful shoulder conditions (Cools et al., 2003; Lin et al., 2005). Interestingly, it has been shown that progressively increased muscle pain intensity leads to a gradual decrease in motor unit discharge rate during isometric contractions that are not associated with a change in muscle membrane properties (Farina et al., 2004). Moreover, Chuang and colleagues (Chuang et al., 2012) indicated that improved muscle functioning is associated with an increase in elasticity. These convergent sources of evidence suggest that direct treatment of MTPs may be a useful treatment for disorders that go along with loss of muscle strength.

These findings demonstrated statistically significant increases in pressure pain threshold and depth (algometer) between pre and post intervention. Effects with respect to these parameters were found to be very large. A recent study (Park et al., 2011) evaluated the inter-rater reliability and usefulness of a pressure algometer to measure pressure pain threshold (PPT) in the upper extremity muscles. This study showed that PPT is a useful parameter for assessing the effects of treatment for musculoskeletal pain and myofascial pain syndrome (MPS). In agreement with their results, the present data support the clinical usefulness of algometry. Additionally, the BPI scores demonstrated that reduction of pain remained stable at 4 weeks and continuing for a full year later. These findings are in line with a recent study (Hains et al., 2010) suggesting that ischemic compression of MTPs in shoulder muscles decreases symptoms in patients with chronic shoulder pain. Moreover, another study (Bron et al., 2011a) showed that a 12-week comprehensive treatment of MTPs in shoulder muscles decreased the amount of muscles with active MTPs in patients with chronic shoulder pain. Findings from the present study suggest, at least for certain patients, a briefer course of treatment might be equally effective (and durable over time).

Patients with MPS have been found to have higher scores for anxiety and depression (Esenyel et al., 2000). MTPs can also be influenced by factors such as emotional stress. Further, EMG activity in MTPs can be reduced by means of sympathetic antagonists (Chen et al., 1998), and MTP increases after stress (McNulty et al., 1994). The formation of MTPs may result from psychological stress (Simons et al., 1999). Therapies able to reduce stress level and to improve the quality of life of patients may be crucial, but their precise role remains uncertain. The immediate improvements found in this investigation for quality of life, suffering, and stress are encouraging in this regard.

An interesting observation in the present study was the finding that measured pain and comfort associated aspects changed for both sides of the shoulder—the treated as well as untreated side of the patient. In contrast the stiffness and elasticity tissue aspects as measured with myometry changed on the treated side only. Possibly this indicates that the MTR treatment induced at least two different somatic responses: (a) a direct and locally specific effect on tissue properties of the treated tissue spot and (b) a less locally specific effect. This could include a neural signal transmission at a segmentally specific spinal cord level and/or involvement of supraspinal mechanisms such as activation of the descending pain modulatory network (Bialosky et al., 2009). Further studies — e.g., with application of MTR under anesthesia — may be helpful in exploring these potential explanatory mechanisms.

The small number of the patients and the absence of a control group serve as study limitations. While the local stiffness and elasticity values of the treated tissue area are probably more robust against a positive expectation bias of the patient, such influence cannot be excluded for pain-associated variables. Follow-up studies including a comparable control group seem warranted (Mehling et al., 2005). Follow-up periods of greater length are needed to help determine the stability of effects over time, especially as regards secondary measures of outcome. Examination of the efficacy of MTR technique with different clinical pain populations, such as professional athletes, seems worthy of pursuit as well.

In summary, our results demonstrated that this MTR technique was able to induce clinically relevant improvements in pain reduction and objective changes in mechanical tissue properties in patients with shoulder chronic pain. Moreover, a decrease in stiffness and increase in elasticity only for the treated side indicate a specificity of our intervention in improving shoulder mobility and inducing reorganization of healthy muscle functioning.

Disclosure

This study was undertaken in accordance with the Declaration of Helsinki and was financed through patient donations.

Conflicts of interest

None.

Acknowledgments

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Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.jbmt.2016.01.009.

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