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MYOFASCIAL PAIN

Effect of ischemic pressure using a Backnobber II device on discomfort associated with myofascial trigger points☆

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KEYWORDS
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Summary *Objective:* The purpose of this study was to assess the effectiveness of ischemic pressure on myofascial trigger point (MTrP) sensitivity.
Design: Randomized, controlled study with the researcher assessing MTrP sensitivity blinded to the intervention.
Participants: Twenty-eight people with two MTrPs in the upper back musculature.
Intervention: The sensitivity of two MTrPs in the upper back was assessed with a JTECH algometer. One of the two MTrPs was randomly selected for treatment with a Backnobber II, while the other served as a control.
Outcome measures: Pre- and post-test pressure–pain thresholds of the MTrPs
Results: There was a significant difference between the pre- and post-test sensitivities of the treated and non-treated MTrPs ($p = 0.04$).
Conclusions: The results of this study confirm that the protocol of six repetitions of 30-s ischemic compression with the Backnobber II rendered every other day for a week was effective in reducing MTrP irritability.

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Introduction

Travell and Simons (1989, p. 5) clinically define a myofascial trigger point (MTrP) as "a hyperirritable spot in skeletal muscle that is associated with a hypersensitive palpable nodule in a taut band." MTrPs can develop from a number of conditions including: genetics, aging, and performing a strenuous activity (Cheng, 1987). MTrPs can be brought on by macrotrauma or by cumulative microtrauma. Abnormal posture, repetitive motion, or psychological stresses are examples of cumulative microtrauma (Fishbain et al., 1986; Horowitz and Sarkin, 1992; Travell and Simons, 1989). Formation and presence of a MTrP is correlated with muscle pain, weakness, and movement dysfunction (Graven-Nielsen et al., 1991; Hong and Simons, 1998; Liley, 1956; Mense, 1991, 1993, 1994, 1996; Simons et al., 1995a,b; Simons, 1996; Travell and Simons, 1989).

There are a variety of modalities purported to relieve or diminish the symptoms associated with MTrPs, including ischemic compression (Kostopoulos et al., 2008; Travell and Simons, 1989), massage (Cantu and Grodin, 1992; Ebel and Wisham, 1952; Fernandez-de-las-Penas et al., 2006; Pemberton, 1939; Prentice, 1982; Sjolund and Eriksson, 1976; Tappon, 1988; Travell and Simons, 1989), needling (Hammeroff et al., 1981; Hong and Simons, 1998; Jaeger and Skootsky, 1987; Lewit, 1979; Melzack and Wall, 1965; Melzack et al., 1977; Rantanen et al., 1999; Sjolund and Eriksson, 1976; Tappon, 1988; Travell and Simons, 1989), vapocoolant spray and stretch (Kostopoulos and Rizopoulos, 2008; Melzack, 1981; Simons, 1996; Travell and Simons, 1989), electrical stimulation (Castel, 1982; Clement-Jones, 1980; Hooker, 1998; Hsueh et al., 1997; Malizia, 1979), laser therapy (Castel, 1982; Cheng, 1987; Laakso et al., 1967; Saliba and Foreman, 1998; Snyder-Mackler and Bork, 1988), ultrasound (Aguilera et al., 2009; Draper and Prentice, 1998; Draper, 1996; Gam et al., 1998; Gulick et al., 2001; Mardimen et al., 1995; McDarmid and Burns, 1987; Srbely et al., 2008; Williams et al., 1987), and diathermy (McCray and Patton, 1984).

Anecdotal reports have supported the efficiency of the use of ischemic compression tools in the treatment of MTrPs. However, randomized controlled studies are lacking. In addition, there are no standardization protocols regarding the appropriate amount of pressure, the duration of the compression, or the frequency of treatments. This study was intended to be the first in a series to develop a clinical protocol for use of an ischemic compression tool in the treatment of MTrPs. The purpose of this study was to determine the effectiveness of a home program of ischemic compression using the Backnobber II device.

Methods

Instrumentation

An algometer (JTECH Medical, Salt Lake City, UT) with a 1-cm diameter tip was used to measure pressure sensitivity (in Newtons) of the participants' myofascial trigger points (Figure 1). Steinbroker was the first to adapt a push—pull gauge called the "palpometer" to quantify articular tenderness. McCarty et al. (1965) developed

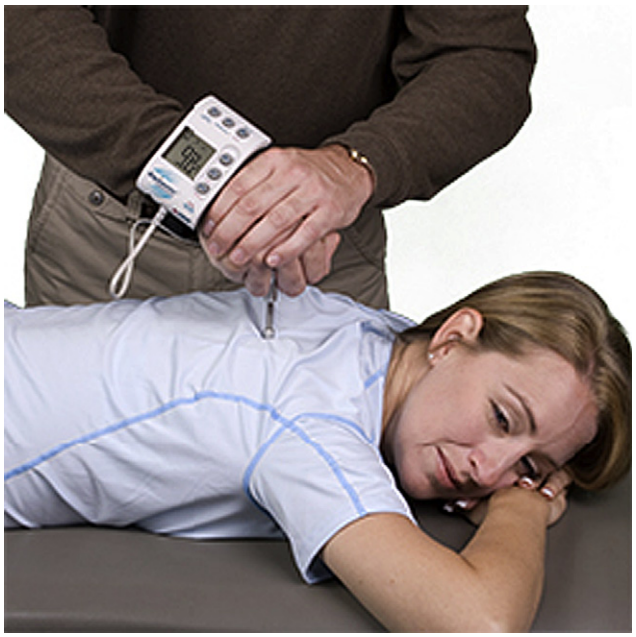

Figure 1 JTECH algometer.

a similar instrument, the "dolorimeter," which was used in the evaluation of anti-inflammatory therapy. Test—retest correlations of various forms of this instrument have been reported to be $r = 0.91—0.95$ (Gulick et al., 1996; McCarty et al., 1965; Meserlian, 1995). Specific use of the JTECH by Kinser et al. (2009), Fischer (1987), Antonaci et al. (1998), Farella et al. (2000), and Sciotti et al. (2001) demonstrated high values of reliability for a variety of muscles.

A Backnobber II (Pressure Positive, Gilbertsville, PA) was used to render the ischemic compression treatment (Figure 2). This molded plastic device has two different size

Figure 2 Ischemic pressure technique using the Backnobber II device.

knobs on each end that are designed to correspond to the size of a MTrP and to facilitate personal access to the MTrPs.

Pilot

All testing occurred at the Institute for Physical Therapy Education, at Widener University, Chester, PA. Testing took place from July 2009 to November 2009. The Widener University Institutional Review Board for the protection of human subjects approved the examination procedures prior to data collection. Because of the challenges in quantifying pain perception, a protocol development phase was conducted. Testing was performed using the JTECH to fine tune the technique and assess the intrarater reliability. After several practice sessions, intra-rater reliability of one investigator (KP) was assessed for pressure–pain tolerance on the upper back muscles as 0.82–0.94.

Two additional phases were conducted to discern the best way to assess trigger point discomfort. Pressure threshold (P-threshold) was described by Kostopoulos et al. (2008) as the maximum pressure that can be tolerated. Using a maximal amount of pressure on a MTrP resulted in increasing the subject's level of discomfort. Pressure–pain threshold (PPT) was described as the minimum pressure required to cause pain (Kostopoulos et al., 2008). PPT allowed the investigators to evaluate the participant's pressure tolerance without imparting additional discomfort. Thus, PPT was accepted as the outcome measure of choice for the current study.

The protocol development phase yielded data to calculate the sample size needed for a power of 0.80 at an alpha of 0.05. The target number of participants was 25. This study was a cohort design, where each subject served as his/her own control. Data were collected in two sessions, pre-test and post-test.

Participants

Healthy participants over the age of 18 years were recruited by a flyer and/or word-of-mouth on a university campus. Potential participants who contacted one of the investigators were asked if s/he had "knots" (i.e., MTrP) in the back and if s/he was receiving any treatment to these areas. Answers to these questions determined eligibility for participation. If MTrP were not present or if the individual was receiving treatment to the neck or back regions, the individual was excluded from the study. In addition, individuals with sensory deficits or skin lesions in the area of the trigger points, or a personal history of cardiovascular problems, cancer, fibromyalgia, diabetes mellitus, tuberculosis, or the possibility of pregnancy were excluded. Individuals who had any shoulder, cervical, or thoracic surgeries or were taking any medication for musculoskeletal pathology were excluded. After providing informed consent, a total of 10 male and 18 female participated in this study. Two potential participants were excluded due to an absence of trigger points on palpation. Data regarding age, sex, height, and weight were collected.

Trigger points/procedure

For the data collection process, each participant was positioned prone on a plinth with pillows and wedges under the head, chest, and/or abdomen to achieve a comfortable, anatomically neutral position. The detection of MTrPs was accomplished via manually palpating for taut muscle bands in the upper and mid-back in a double-blind process as per the procedure described by Sciotti et al. (2001). A jump sign/local muscle twitch was observed when palpating some participants but this was not a part of the inclusion criteria, as a local muscle twitch is not deemed a reliable sign for trigger point confirmation (Gerwin et al., 1997). All researchers were Pennsylvania licensed physical therapists with decades of experience in muscle palpation. Researcher #1 palpated for MTrPs and marked each one with a marker. When completed, researcher #2 (blinded to the trigger points identified by researcher #1) also palpated for MTrPs and selected those MTrPs with which there was agreement. When possible, two MTrPs were selected in a corresponding muscle on both the right and left sides, e.g., right and left levator scapula muscles. If this is not possible, an adjacent muscle on the contralateral side was used, e.g., right middle trapezius and left rhomboid muscle. Common MTrPs identified by both researcher #1 and #2 were circumscribed with a permanent black marker.

Both MTrPs were assessed using a JTECH algometer with a 1-cm diameter tip. The JTECH was used to measure pressure sensitivity to the pressure–pain threshold (PPT) of the participants' myofascial trigger points (Figure 1). The protocol was for the investigator (KP) to place the algometer on each MTrP and slowly apply pressure until the participant reported that the pressure reached the PPT. The technique was performed twice on each MTrP in an alternating fashion with a minimum of 30-s between tests, i.e., right, left, right, left. This was consistent with the research of Kostopoulos et al. (2008). Levels achieved for each MTrP were recorded on the data collection form in Newtons (N).

Intervention

After testing, the participant was instructed in the use of the Backnobber II (Pressure Positive, Gilbertsville, PA) in order to render the ischemic compression treatment (Figure 2). This is a molded plastic device with two different size knobs on each end that are designed to correspond to the size of a MTrP and to facilitate personal access to the MTrPs. A coin was flipped to determine the treatment side (heads = right; tails = left) for each subject. A total of 16 subjects treated the right side and 12 treated the left side. The ball of the Backnobber II was placed on the MTrP on the treatment side. The participant delivered a "trigger point pressure release" as defined by Simons et al. (1999) for 30-s. A rest period of 30-s was provided (Kostopoulos et al., 2008) and the pressure reapplied five more times (a total of six repetitions). Participants were provided with standardized instruction (JBL) to repeat the treatment procedure three times (every other day) in the upcoming week; a treatment log was provided. Upon confirmation of compliance, subjects were retested in the same manner as the pre-test. The investigator using the algometer to assess MTrP sensitivity was blinded to the

treatment protocol. All records of the subjects were locked in a filing cabinet in an investigator's (DTG) office.

Data analysis

Descriptive statistics were performed on all demographic variables. The means of the two trials of PPT measurements taken with the JTECH algometer were used for the data analysis. Although a one-way ANOVA with repeated measures is a more stringent statistical analysis, a paired *t*-test was performed on the dependent variable, PPT. The paired *t*-test was chosen as the statistic because the pairing of the data allows for the acknowledgment of smaller differences between groups relative to the variations within groups. Given a unidirectional hypothesis, a one-tailed *t*-test was implemented. The significance was set at an alpha level of $p = 0.05$.

Results

The demographic data were as follows: age 24.5 ± 4.1 yrs; height 170 ± 8 cm; weight 71.4 ± 15.3 kg. The means and standard deviation pressure—pain thresholds for the MTrPs are displayed in Table 1. The one-tailed *t*-test results were $p = 0.00998$ (critical $t = 1.7056$). The MTrPs treated with ischemic compression using the Backnobber II yielded an increase in pressure—pain threshold as compared to the non-treated MTrPs.

Discussion

The implementation of an efficacious treatment for MTrPs is a challenge when the pathophysiology remains in question. Observation of the electrical activity of a MTrP has suggested that the taut band formation is the result of an end plate dysfunction with excessive acetylcholine release (Simons, 1996; Simons et al., 1995a,b). Hence the hypothesis that MTrPs are an "energy crisis" that perpetuate until the vicious cycle is interrupted (Simons, 1996; Simons et al., 1995a,b). Ischemic compression is one of many options that can be used to interrupt the cyclic pathology of a MTrP.

The results of this study support that this particular protocol of ischemic compression was effective in reducing MTrP irritability. The participants reported a significantly greater decrease in the sensitivity of the MTrPs after the four treatment sessions with the Backnobber II than on the untreated MTrPs. The current protocol of six repetitions of 30-s ischemic compression treatments performed every other day for one week effectively reduced the MTrP sensitivity. The choice of six repetitions was modeled after the research of Kostopoulos et al. (2008). Whereas, 30-s of compression were consistent with the work of Bandy and Irion (1994) and Bandy et al. (1997) who determined 30-s as the optimal time for tissue elongation. Although the prior work was related to muscle stretching/elongation, the ischemic compression process is a form of tissue elongation. However, it is not known if altering the number of repetitions or the frequency of treatment would result in a better outcome. Furthermore, there is a paucity of data regarding the quantification of ischemic pressure. In the current study, the application of ischemic pressure was managed by the participant with the instructions of pressing to the point of mild discomfort. The rationale is consistent with the intended independent use of the Backnobber II.

Table 1 Mean and standard deviation of treated and non-treated MTrP.

	Pre-test	Post-test
	Mean ± Standard deviation	Mean ± Standard deviation
Treated MTrP	31.73 ± 11.28 N	44.02 ± 13.31 N
Non-treated MTrP	34.10 ± 12.72 N	31.83 ± 11.65 N

The current data is consistent with the study by Hanten et al. (2000). The researchers compared the effects of ischemic pressure and stretch to active range of motion in participants with MTrP of the neck and upper back. The 5-day treatment protocol evaluated PPT, visual analogue scale (VAS), and percentage of time the participants experienced pain. The intervention of ischemic pressure was administered via a Thera Cane (Thera Cane Co., Denver, CO). The researchers reported that the participants were instructed to gradually increase the pressure until a "release was felt," i.e., "letting go" or "melting." Ischemic pressure applications were repeated until no further release was obtained. In addition, a neck and upper back stretching protocol of 30—60 s durations were completed two times per day. There was a significant reduction in PPT and VAS reported but there was no difference in the percentage of time the participants experienced pain. The research of Nordez et al. (2006) brings into question the factors that may have yielded these results. Nordez et al. (2006) demonstrated significant improvement in knee range of motion and a reduction in hamstring stiffness with five 30-s static stretching. Thus, since Hanten et al. (2000) studied ischemic pressure with stretching, it is not known if the reduction in MTrP discomfort was a result of the compression, the stretching, or a combination of the two interventions.

Lake et al. (2009) compared the treatment of ischemic compression and ischemic compression with stretching to a control group. The researchers examined 40 active MTrPs in 13 subjects. Ischemic compression was applied for 90-s and the stretching techniques were performed for 30-s. Both treatments were performed twice per week for three weeks and demonstrated significant improvement in discomfort and referral patterns when compared to control. However, the researchers did not define the magnitude of the compression applied.

Fernandez-de-las-Penas et al. (2006) compared the immediate effect of ischemic compression to that of transverse friction massage in 40 subjects. The protocol for ischemic compression involved gradual application of pressure to an MTrP by a physiotherapist. The pressure was maintained until the pain—pressure sensation decreased by 50% and then the pressure was increased. This procedure was repeated for 90 s. Outcome data were collected 2-min after the completion of the intervention. Although PPT and VAS improved with treatment, there were no between group differences.

A study by Kostopoulos et al. (2008) was the first to look at the effect of ischemic compression (IC), passive stretching (PS), and the combination of compression and stretching on pain perception from myofascial trigger points ($n = 30$ in each group). The IC group received three 60-s bouts of trigger point compression with 30-s between treatments. The PS group received static stretching for 45-s intervals with 30-s rest periods. Whereas the combination treatment alternated between IC and PS. All treatments were administered three times. The results were that although all treatments demonstrated a decline in pain perception and spontaneous intramuscular electrical activity, the combined treatment of IC and PS was better than either of the treatments performed individually. The authors theorized that IC causes a temporary local ischemia followed by a reactive hyperemia. The enhanced blood supply helps to restore aerobic metabolism and increase the amount of energy (ATP) available to the muscle to meet the metabolic demands. Furthermore, PS applied slowly inhibits the gamma spindle response and permits muscle relaxation. Together, the treatments appear to have a complementary effect.

Fryer and Hodgson (2005) explored the use of manual pressure release versus sham intervention to latent trigger points in the upper trapezius muscle in 37 student volunteers. PPT was recorded using a capacitance pressure sensor attached to the palpating thumb. PPT was recorded and then 20 subjects underwent one 60-s treatment of manual pressure release held to produce a pain rating of 7/10, which the researchers deemed greater than PPT, but less than maximum pain tolerance. The control group received light pressure of no greater than 2 N/cm^2. The PPT increased significantly in the treatment group as compared to the control. Additionally, the pressure recorded during manual pressure release significantly increased to maintain the 7/10 pain rating. This study is similar to the present study in that it quantified pressure and recruited young, healthy subjects with latent trigger points. However, the present study provided a home program similar to one that would be given to patients with active trigger points versus providing a single treatment session.

Likewise, Aguilera et al. (2009) explored the immediate effects of 90 s of ischemic compression, 2 min of 1-w/cm^2 1-MHz ultrasound, and 5 min of sham ultrasound in 66 subjects. Outcome measures included active range of motion (ROM), basal electrical activity (BEA) of the trapezius, and PPT. There was an immediate decrease in BEA and MTrP sensitivity after both modalities. In addition, the ischemic compression group also improved in cervical ROM.

Thus, several studies have employed different protocols to effectively reduce MTrP sensitivity. Some examined the immediate effects (Aguilera et al., 2009; Fernandez-de-las-Penas et al., 2006) and others administered repeated treatments (Hanten et al., 2000; Lake et al., 2009). Only one study reported utilizing a device to administer the ischemic compression (Hanten et al., 2000). The current study demonstrated that the Backnobber II is a device that can be effectively used to administer the ischemic compression treatment. This is particularly helpful when the MTrP cannot be independently palpated. The device is compact, portable, and easily managed for home use.

Nevertheless, the current study has two limitations. First, the study was performed on latent MTrPs in healthy subjects. It is not known if the response would be the same on active MTrPs in symptomatic individuals. Second, although the model of allowing the subjects to self-regulate the amount of pressure administered with the Backnobber II is consistent with a home exercise program, it does not allow for generalization about the quantity of pressure needed to reduce the sensitivity of a MTrP.

Conclusion

Although there are numerous anecdotal reports of successful pain relief using ischemic compression with the Backnobber II (http://www.pressurepositive.com/index.aspx), there are currently no other research studies assessing this product. The current study is the first step towards establishing a protocol for the use of the Backnobber II in the management of MTrPs. Release of a MTrP can be instrumental in the reduction of pain and the increase in muscle flexibility. The systematic manipulation of each of the treatment parameters including duration of compression, amount of pressure, and number of repetitions is needed to discern the most effective method for the interruption of the cyclic pattern of discomfort associated with MTrPs.

References

Aguilera, F.J.M., Martin, D.P., Masanet, R.A., Botella, A.C., Soler, L.B., Morell, F.B., 2009. Immediate effects of ultrasound and ischemic compression techniques for the treatment of trapezius latent myofascial trigger points in healthy subjects: a randomized controlled study. Journal of Manipulative and Physiological Therapeutics 32, 515—520.

Antonaci, F., Sand, T., Lucas, G.A., 1998. Pressure algometry in healthy subjects: inter-examiner variability. Scandinavian Journal of Rehabilitation Medicine 30, 3—8.

Bandy, W.D., Irion, J.M., 1994. The effects of time on static stretch on the flexibility of the hamstring muscles. Physical Therapy 74 (9), 845—850.

Bandy, W.D., Irion, J.M., Briggler, M., 1997. The effects of time and frequency of static stretching on flexibility of the hamstring muscles. Physical Therapy 77 (10), 1090—1096.

Cantu, R., Grodin, A., 1992. Myofascial Manipulation: Theory and Clinical Applications. Aspen, Gaithersburg, MD.

Castel, V., 1982 Nov. Pain management with acupuncture and transcutaneous electrical nerve stimulation technique and photo simulation (laser). In: Symposium on Pain Management. Walter Reed Medical Center.

Cheng, R., 1987 (Mar). Combination laser/electrotherapy in pain management. In: Second Canadian Low Power Laser Conference, Ontario, Canada.

Clement-Jones, V., 1980. Increased B-endorphin but not meten-kephalin levels in human cerebral spinal fluid after acupuncture for recurrent pain. Lancet 8, 946—948.

Draper, D.O., Prentice, W.E., 1998. Therapeutic ultrasound. In: Zollo, S., Touboul, P. (Eds.), Therapeutic Modalities for Allied Health Professionals. McGraw-Hill, New York, pp. 263—309.

Draper, D.O., 1996. Ten mistakes commonly made with ultrasound use: current research sheds light on myths. Athletic Training 2 (2), 95—106.

Ebel, A., Wisham, L., 1952. Effect of massage on muscle temperature and radiosodium clearance. Archives of Physical Medicine and Rehabilitation 33, 399—405.

Farella, M., Michelotti, A., Steenks, M.H., Romeo, R., Cimino, R., 2000. The diagnostic value of pressure algometry in myofascial pain of the jaw muscles. Journal of Oral Rehabilitation 27, 9—14.

Fernandez-de-las-Penas, C., Alonso-Blanco, C., Fernandez-Carnero, J., Miangolarra-Page, J.C., 2006. The immediate effect of ischemic compression technique and transverse friction massage on tenderness of active and latent myofascial trigger points: a pilot study. Journal of Bodywork and Movement Therapies 10 (1), 3—9.

Fischer, A.A., 1987. Pressure algometry over normal muscles. Standard values, validity, and reproducibility of pressure threshold. Pain 30, 115—126.

Fishbain, D.A., Goldberg, M., Meagher, B.R., et al., 1986. Male and female chronic pain patients categorized by DSM-III psychiatric diagnostic criteria. Pain 26, 181—197.

Fryer, G., Hodgson, L., 2005. The effect of manual pressure release on myofascial trigger points in the upper trapezius muscle. Journal of Bodywork and Movement Therapies 9, 248—255.

Gam, A., Warming, S., Larser, L., Jenson, B., Hoydalsmo, O., Allon, I., Anderson, B., Gotssche, N.E., Peterson, M., Mathiesen, B., 1998. Treatment of myofascial trigger-points with ultrasound combined with massage and exercise — a randomized controlled trial. Pain 77, 73—79.

Gerwin, R.D., Shannon, S., Hong, C.Z., Hubbard, D., Gervirtz, R., 1997. Interrater reliability in myofascial trigger point examination. Pain 69, 65—73.

Graven-Nielsen, T., Svensson, P., Arendt-Nielson, L., 1991. Effects of experimental muscle pain on muscle activity and co-ordination during static and dynamic motor function. American Journal of Physiological Pharmacology 69 (5), 683—694.

Gulick, D.T., Barsky, J., Bersheim, M., Katz, K., Lescallette, M., 2001. Effect of ultrasound on pain associated with myofascial trigger points. Journal of Orthopedic and Sports Physical Therapy 31 (1), A-19.

Gulick, D., Kimura, I., Sitler, M., Paolone, A., Kelly, J., 1996. Various treatment techniques on signs and symptoms of delayed onset muscle soreness. Journal of National Athletic Training Association 31 (2), 1—9.

Hammeroff, S., Crago, B., Blitt, C., et al., 1981. Comparison of bupivacaine, etidocaine, and saline for trigger point therapy. Anesthesia and Analgesia 60, 752—755.

Hanten, W.P., Olson, S.L., Butts, N.L., Nowicki, A.L., 2000. Effectiveness of a home exercise program of ischemic pressure followed by sustained stretch for treatment of myofascial trigger points. Physical Therapy 80 (10), 997—1003.

Hong, C.Z., Simons, D.G., 1998. Pathophysiologic and electrophysiologic mechanisms of myofascial trigger points. Archives of Physical Medicine and Rehabilitation 79, 863—872.

Hooker, D.N., 1998. Electrical stimulating currents. In: Zollo, S., Touboul, P. (Eds.), Therapeutic Modalities for Allied Health Professionals, vol. 74. McGraw-Hill, New York, p. 105.

Horowitz, L., Sarkin, J.M., 1992. Video display terminal operation: a potential risk in the etiology and maintenance of temporomandibular disorders. Journal of Craniomandibular Practice 10 (1), 43—50.

Hsueh, T.-C., Cheng, P.-T., Kuan, T.-S., Hong, C.-Z., 1997. The immediate effectiveness of electrical nerve stimulation and electrical muscle stimulation on myofascial trigger points. American Journal of Physical Medicine and Rehabilitation 76, 471—476.

Jaeger, B., Skootsky, S., 1987. Double blind, controlled study of different myofascial trigger point techniques. Pain 4 (Suppl.), 292.

Kinser, A.M., Sands, W.A., Stone, M.H., 2009. Reliability and validity of a pressure algometer. Journal of Strength and Conditioning Research 23 (1), 312—314.

Kostopoulos, D., Nelson, A.J., Ingber, R.S., Larkin, R.W., 2008. Reduction of spontaneous electrical activity and pain perception of trigger points in the upper trapezius muscle through trigger point compression and passive stretching. Journal of Musculoskeletal Pain 16 (4), 266—278.

Kostopoulos, D., Rizopoulos, K.J., 2008. Effect of topical aerosol skin refrigerant (spray and stretch technique) on passive and active stretching. Journal of Bodywork and Movement Therapies 12 (2), 96—104. Epub 2008 Jan 2.

Laakso, E., Richardson, C., Cramond, T., 1967. Pain scores and side effects in response to low level laser therapy for myofascial trigger points. Laser Therapy 9, 67—72.

Lake, D.A., Wright, L.L., Cain, J., Nail, R., White, L., 2009. The effectiveness of ischemic pressure and ischemic pressure combined with stretch on myofascial trigger points. Journal of Orthopedic and Sports Physical Therapy 39 (1), A-70.

Lewit, K., 1979. The needle effect in relief of myofascial pain. Pain 6, 83—90.

Liley, A., 1956. An investigation of spontaneous activity at the neuromuscular junction of the rat. Journal of Physiology 132, 650—686.

Malizia, E., 1979. Electroacupuncture and peripheral B-endorphin and ACTH levels. Lancet 8, 535—536.

Mardimen, S., Wessel, J., Fisher, B., 1995. The effect of ultrasound on the mechanical pain threshold of healthy subjects. Physiotherapy 81 (12), 718—723.

McCray, R.E., Patton, N.J., 1984. Pain relief at trigger points: a comparison of moist heat and shortwave diathermy. Journal of Orthopedic and Sports Physical Therapy 5 (4), 175—178.

McCarty, D.J., Gatter, R.A., Phelps, P., 1965. A dolorimeter for quantification of articular tenderness. Arthritis and Rheumatology 8, 551—559.

McDarmid, I., Burns, P., 1987. Clinical applications of therapeutic ultrasound. Physiotherapy 73, 155.

Melzack, R., Wall, P., 1965. Pain mechanics: a new theory. Science 150, 971—979.

Melzack, R., Stillwell, D., Fox, E., 1977. Trigger points and acupuncture points for pain: correlation and implications. Pain 13, 3—23.

Melzack, R., 1981. Myofascial trigger points: relation to acupuncture and mechanism of pain. Archives of Physical Medicine and Rehabilitation 62, 114—117.

Mense, S., 1991. Considerations concerning the neurological basis of muscle pain. Canadian Journal of Physiological Pharmacology 69, 610—616.

Mense, S., 1993. Nocioreception from skeletal muscle in relation to clinical muscle pain. Pain 54, 241—289.

Mense, S., 1994. Referral of muscle pain: new aspects. American Pain Society Journal 3, 1—9.

Mense, S., 1996. Biochemical pathogenesis of myofascial pain. Journal of Musculoskeletal Pain 4, 145—162.

Meserlian M., 1995. National Bureau of Standards. pp. 187—191.

Nordez, A., Cornu, C., et al., 2006. Acute effects of static stretching on passive stiffness of the hamstring muscles calculated using different mathematical models. Clinical Biomechanics 21 (7), 755—760.

Pemberton, R., 1939. The physiologic influence of massage. In: Mock, H., Pemberton, R., Coulter, J. (Eds.), Principles and Practice of Physical Therapy, vol. 1. WF Prior, Hagerstown, MD.

Prentice, W., 1982. The use of electroacutherapy in the treatment of inversion ankle sprains. Journal of National Athletic Training Association 17 (1), 15—21.

Rantanen, J., Thorsson, O., Wollmer, P., Hurme, T., Kalimo, H., 1999. Effects of therapeutic ultrasound on the regeneration of skeletal myofibers after experimental muscle injury. American Journal of Sports Medicine 27 (1), 54—59.

Saliba, E., Foreman, S., 1998. Power laser. In: Zollo, S., Touboul, P. (Eds.), Therapeutic Modalities for Allied Health Professionals. McGraw-Hill, New York, p, pp. 325—326.

Sciotti, V.M., Mittak, V.L., DiMarco, L., Ford, L.M., Plezbert, J., Santipadri, E., Wigglesworth, J., Ball, K., 2001. Clinical

precision of myofascial trigger point location in the trapezius muscle. Pain 93, 259—266.

Simons, D.G., Hong, C.-Z., Simons, L.S., 1995a. Prevalence of spontaneous electrical activity at trigger spots and at control sites in rabbit skeletal muscle. Journal of Musculoskeletal Pain 3, 35—48.

Simons, D.G., 1996. Clinical and etiological update of myofascial pain from trigger points. Journal of Musculoskeletal Pain 4, 93—121.

Simons, D.G., Hong, C.-Z., Simons, L.S., 1995b. Nature of myofascial trigger points: active loci. Journal of Musculoskeletal Pain 3 (Suppl.), 124.

Simons, D.G., Travell, J.G., Simons, L.S., 1999. Myofascial Pain and Dysfunction: The Trigger Point Manual, Second ed. Williams and Wilkins, Baltimore, USA.

Sjolund, B., Eriksson, M., 1976. Electroacupuncture and endogenous morphines. Lancet 2, 1085.

Snyder-Mackler, L., Bork, C., 1988. Effect of helium neon laser irradiation on peripheral nerve sensory latency. Physical Therapy 68, 223—225.

Srbely, J.Z., Dickey, J.P., Lowerison, M., Edwards, A.M., Nolet, P.S., Wong, L.L., 2008. Stimulation of myofascial trigger points with ultrasound induces segmental antinociceptive effects. Pain 139, 260—266.

Tappon, F., 1988. Healing Massage Techniques: Holistic, Classic and Emerging Methods. Appleton & Lange, East Norwalk, CT, USA, pp. 43—51.

Travell, J.G., Simons, D.G., 1989. Myofascial Pain and Dysfunction: the Trigger Point Manual, vol. 1. Williams & Wilkins, Baltimore, MD, p. 80, 87, 89, 99.

Williams, A., McHale, I., Bowditch, M., 1987. Effects of 1 MHz ultrasound on electrical pain threshold perception in humans. Ultrasound in Medicine and Biology 13, 249.