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Original article

The effect of the combination of dry needling and MET on latent trigger point upper trapezius in females

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ABSTRACT

Aim: The purpose of this clinical trial experiment was to compare the effects of the combination of dry needling (DN) and the muscle energy technique (MET) on the upper trapezius latent myofascial trigger point.

Method: Sixty female patients, aged 18–30 with latent myofascial trigger points in the upper trapezius muscle were randomly divided into three groups: group 1 ($n = 20$) received DN and MET, group 2 ($n = 20$) received only MET, and group 3 ($n = 20$) received only DN. The visual analogue scale (VAS), pressure pain threshold (PPT), and range of active contra lateral flexion (CLF) were measured before each treatment. The patients were treated for three sessions in a one-week period with at least a two-day break between each session, and in session four, an assessment of primary outcomes was conducted without any treatment.

Results: All three treatment groups showed decreases in pain ($p = 0.001$) and increases in PPT levels ($p = 0.001$) as well as increases in CLF ($p = 0.001$). But the group receiving trigger point DN together with MET showed more significant improvement than the other two groups in VAS, PPT and ROM. No significant differences were found between the MET-only group and the DN-only group.

Conclusion: Our results indicate that all three treatments used in this study were effective for treating MTP. According to this study, DN and MET is suggested as a new method for the treatment of MTP.

1. Introduction

Myofascial pain syndrome (MPS) is one of the most common musculoskeletal pain diseases and is characterized by myofascial trigger points (MTPs) (Chaiamnuay et al., 1998). MTP is a hyperirritable nodule of tenderness in a palpable taut band of skeletal muscle that can refer pain to a distant point and also causes distant motor and autonomic effects (Simons and Travell, 1992; Simons et al., 1999a, 1999b). Studies conducted in pain clinics indicate that the incidence of MPS "Occurs in 30%–85% of patients". A report from a clinic specializing in head and neck pain reported a myofascial aetiology in 55% of cases and 30% of the patients had active MTPs (Skootsky and Oye, 1989; Han and Harrison, 1997). The exact cause of MTP is still unknown, but Simons et al. (1999a, 1999b) hypothesized that some muscle fibers shorten and form taut bands in response to the release of calcium ions from damaged fibers or excessive amounts of acetylcholine from the motor end plate. In the upper quadrant, postural muscles in general and the upper trapezius muscle in particular are most affected by MTP (Luime et al., 2004; Meleger and Krivickas, 2007; Chang et al., 2011). There are two categories of trigger points (TPs): active and latent. Active TP are spontaneously active and produce local or referred pain to remote structures. Latent TPs, however, are not spontaneously active and would not produce any symptoms unless evoked by an external stimulant (Simons et al., 1999a, 1999b; Travel and Simons, 1999; Simons, 2004a, 2004b). According to Travel and Simons

Abbrevations: DN, dry needling; MET, muscle energy technique; MTP, MyofascialT rigger point; VAS, visual analogue scale; PPT, pressure pain threshold; IC, ischaemic compression; SCS, Strain–counter strain; INIT, integrated neuromuscular inhibition technique.

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(1999), latent MTPs are more common than active MTPs. This is based on the fact that voluntary skeletal muscles account for 40% or more of body weight, of which the majority are postural muscles (Bogduk, 1987) and hence the high prevalence of pain originates from latent MTP in these muscles (Gatterman, 1990). Studies highlight the importance of the presence of latent muscular MTP because this can cause a possible dysfunction in the muscle activation pattern and could be a determining factor in the appearance of future injuries (Simons et al., 1999a, 1999b). A large variety of both manual and non-manual interventions exist for the deactivation of TPs. Non-manual interventions may include botulism toxin injections, dry needling, acupuncture, and ethyl chloride spray and stretch techniques. Manual approaches may include MET, strain–counterstrain (SCS), myofascial release, proprioceptive neuromuscular facilitation, and ischaemic compression (Alvarez and Rockwell, 2002).

Dry needling is a minimally invasive procedure in which an acupuncture needle is inserted directly into an MTP (Kalichman and Vulfsons, 2010a). The advantages of DN are being increasingly documented and include an immediate reduction in local, referred, and widespread pain (Lewit, 1979; Hsieh et al., 2007; Fernández-Carnero et al., 2010; Affaitati et al., 2011), and restoration of range of motion and muscle activation patterns (Lucas et al., 2004; Fernández-Carnero et al., 2010; Lucas et al., 2010).

METs have been recommended as a means of managing TPs (Chaitow, 2001; Niel-Asher, 2005). METs are a commonly utilized method for achieving tonus release (inhibition) in a muscle before stretching. This involves the introduction of an isometric contraction to the affected muscle, producing post-isometric relaxation through the influence of the Golgi tendon organs (autogenic inhibition). It may also be applied to the antagonistic muscle group, producing reciprocal inhibition in the offending agonistic muscle(s) (Kuchera and Kuchera, 1992; Niel-Asher, 2005). The post-isometric relaxation of MET has been reported as an effective treatment in reducing muscle stiffness caused by MTP (Chaitow and DeLany, 2002). Fryer and Fossum (2008) http://www.ncbi.nlm.nih.gov/pubmed/18254895 have hypothesized that third-sequence muscle and joint mechanoreceptor activation evokes firing of local somatic efferents. This in turn leads to sympatho-excitation and activation of the periaqueductal grey matter, which plays a role in the descending modulation of pain. Owing to stimulation of the mechanoreceptors, simultaneous gating of the nociceptive impulses takes place in the dorsal horn of the spinal cord (Nagrale et al., 2010).

Despite the high prevalence of MPS and all the research done on MPS, the clinical efficacy of this treatment has not been well established. Several studies have shown that manual therapy treatments make no significant difference in comparison with a placebo (Fernandez et al., 2005). The effectiveness of dry needling is disputed. In some studies, it had been shown to be effective (Jaeger and Skootsky, 1987; Itoh et al., 2007; Venancio Rde et al., 2008; Ay et al., 2010; Kalichman and Vulfsons, 2010b; Tekin et al., 2013), while in other studies, no beneficial effect was observed (Cummings and White, 2001; Tough et al., 2009). In most studies, due to the multiplicity of factors that cause myofascial pain syndrome, multilateral treatment is mentioned as a desirable method (Fleckenstein et al., 2010). In order to treat the trigger point of the upper trapezius muscle more completely, in the present study performed the dry needling technique and MET consecutively, on the trigger point. Our assumption is that MTP pain can be quickly reduced by needling and then the trigger point will be destroyed. On the other hand, in most cases, releasing tight muscles after deactivation of MTP has been recommended because it improves local circulation and subsequently facilitates healing of the underlying cause of damage and breaks the vicious cycle is in the energy crisis, increases ROM and improves the functional condition of the muscle as well (Simons et al., 1999a, 1999b).

2. Method

This study was a randomised, clinical trial conducted at the Physical Therapy Research Center (PTRS) of the Shahid Beheshti University of Medical Sciences in Iran from September 2013 to February 2014. Approval for the study was obtained from the PTRS Research Ethics Sub-Committee. To determine the number of participants required with test Type I error .05, and test Type II error .02 (expected power 80%), and extracting the required parameters from the article Kim et al. (Kim et al., 2013), using the software PASS11, it was estimated that 20 subjects in each group were required.

In the study, sixty female students from a college at Shahid Beheshti University of Medical Sciences between the ages of 18 and 30 years with the diagnosis of MTP of the upper trapezius muscle took part. For subjects with more than one TP, the one most painful TP was assessed. All subjects were given a clear explanation of tests and treatments before taking part in this research and written consent was obtained from all patients. A diagnosis of latent MTP was confirmed after manual palpation and patient feedback (Chaitow and DeLany, 2002). Table 1 lists patients' inclusion and exclusion criteria.

After the first evaluation session, subjects were randomly divided into three groups: DN & MET, MET, DN ($n = 20$ in each group). To find the MTP region in each session, at first, we highlighted the MTP spot by a marker, then located its coordinates in respect to the neck vertebrae and marked the horizontal axis from the MTP itself to the neck vertebrae and the MTP spot by the vertical axis from where the hair grows to the C_7 vertebrae and wrote down the coordinates. The MTP was determined each time by using this scale.

Pain intensity, PPT, and active range of motion were evaluated before each treatment by an experienced physiotherapist in all four sessions for all groups. Treatment groups were treated by using the aforementioned techniques (DN & MET, MET, DN) in sessions 1 to 3, whereas in session 4, only assessment of primary outcomes was conducted without treatment. Patients were treated three times in a one-week period with at least a two-day break between treatments (Rowley, 2001).

The range of active CLF of the cervical spine was measured by using a cervical range of motion (CROM) goniometer (Youdas et al., 1991). Subjects were asked to sit upright. The fulcrum of the goniometer was placed on the spinous process of the first thoracic spine with the center of the goniometer arm on the occipital protuberance at right angles. Then the device's horizontal arm was stabilized manually and its vertical arm was placed on the occipital protuberance to the measure lateral flexion angle (Unalan et al., 2011). Subjects were asked to laterally flex their head towards the opposite side. The motion was stopped once the available ROM had been completed and care was taken to disallow shoulder elevation. The degree of contralateral flexion was recorded. The CROM device demonstrated good to excellent inter-rater reliability ($ICC = .73–.89$) (Rowley, 2001). This procedure was performed three times at 30-s intervals, and the average value was determined as the ROM of the cervical spine.

PPT is the degree of compression intensity at which the patients feel discomfort or pain rather than pressure. The International Association for the Study of Pain defines PPT as the stimulation of the weakest intensity which a subject feels as pain (Fryer and Hodgson, 2005). PPT value of this definition has been proved to be reliable, reproducible and valid (Reeves et al., 1986; Fischer, 1987a; Brennum et al., 1989). An algometer (Taiwan,

Table 1
Inclusion and exclusion criteria (Sciotti et al., 2001; Simons, 2001; Fernandez et al., 2006).

Inclusion criteria	Exclusion criteria
Diagnosed fibromyalgia	Women between 18 and 30 years
Cervical radiculopathy	Presence of a palpable taut band in a skeletal muscle
Facial neuralgia	Presence of a nodule
Coagulation alteration	Presence of at least 1 hypersensitive tender spot in a taut band in response to 25N of pressure
Cancer	
Allergy (including to needles)	
History of cervical or shoulder surgery	
History of deep vein thrombosis	
History of myopathy	
History of infiltration at upper trapezius trigger point	
Anticoagulant medication	
Aspirin intake during the last 3 days	
Drug intake (AINES, narcotics, antiepileptics, or any other analgesic medication)	
Pregnancy	
Myofascial therapy within the past month before the study	
Presence of spontaneous referred pain pattern (Active TP)	
Presence of jump sign	
Being in the menstruation period of the menstrual cycle	
Presence of postural disorders	

model 5120) was used in this study. This device consists of a round rubber disk (area, 1 cm^2) that was pressed vertically on the MTP. To provoke the patient's pain, pressure was increased with a speed of 1 $kg\cdot cm^2\cdot s.\_1$ (Fernandez-de-las-Peas et al., 2006a; Gemmell et al., 2008). This procedure was performed three times at 10-s intervals, and the average value was determined as the PPT (Fischer, 1987b; Nussbaum and Downes, 1998; Potter et al., 2006; Fernandez-de-las-Peas et al., 2006b; Ylinen et al., 2007). To evaluate pain intensity, a pressure of 25N was exerted on the MTP using the algometer, and patients were asked to show their pain on the VAS. The VAS was a 10-cm horizontal line divided into 10 equal parts. After introducing candidates to the VAS, the evaluation took place and pain intensity was recorded (Nussbaum and Downes, 1998). To evaluate the magnitude of pain, the VAS was used simultaneously with the algometer, but for determining PPT, the algometer was used alone (Fernandez-de-las-Peas et al., 2006b; Gemmell et al., 2008). The VAS is a reliable and valid outcome measure and has been used extensively in neck pain research (Chaitow, 1996; Fernandez-de-las-Penas et al., 2007; Gemmel et al., 2008).

All patients were placed in a prone position, and the neck was placed in a neutral position during the study.

3. Intervention

3.1. Dry needling

The treatment groups were treated with a 25 mm, 0.25G acupuncture needle. All acupuncture needles were used only once. The area needled was sterilized with an alcohol swab and the physiotherapist wore surgical gloves throughout the treatment. The latent MTP was identified by using pincer palpation. The needle was then inserted between the fingers that had located the MTP, and the needle penetrated the MTP at an angle of about 30° to the skin whilst the patient was in a supine position. The fanning technique was used, in which the needle is repeatedly withdrawn from the MTP and reinserted to penetrate a new part of the MTP at a different angle while maintaining the original entry point to the skin (Sola, 1981; Travel and Simons, 1983) to elicit any local twitch responses. Care was taken to limit fanning so as to minimize post-needling soreness (Simons et al., 1999a, 1999b). Hereafter, the needle was kept still for a few seconds so that it could exert its analgesic effects (Hong, 1994).

3.2. Muscle energy technique

Subjects randomized to the MET group received treatment as per Lewit's post-isometric relaxation approach. The subjects were placed supine and the practitioner stabilized the shoulder on the affected side with one hand, while the ear/mastoid area of the affected side was held with the opposite hand. The head and neck were then side bent towards the contralateral side, flexed, and rotated ipsilaterally, placing the subject just short of their upper trapezius restriction barrier (Nagrale et al., 2010). The subjects then shrugged the involved/stabilized shoulder towards the ear with a sub maximal, pain-free, effort (20% of their available strength). The isometric effort was held for 7–10 s while a normal breathing rhythm was maintained. During the relaxation phase, the head and neck were eased into increasing degrees of side bending, flexion and rotation to increase the stretch placed on the muscle. Each stretch was held for 30 s, and this was repeated for three to five times per session (Travell and Simons, 1992).

3.3. Statistical analysis

A normal distribution of quantitative variables was assessed by means of the one sample Kolmogorov–Smirnov test (K–S). A one-way ANOVA was used to determine whether there was a difference among the 3 groups regarding age, BMI and all three outcome measures (PPT, VAS, and lateral flexion of cervical) at baseline. Due to differences in baseline values of variables, to eliminate the effect of differences in the groups, Group × Time mixed ANOVA models were used to reveal the effects of the three interventions on PPT, VAS, and lateral flexion of the cervical spine, after adjusting for the baseline values. For multiple comparisons a Tukey procedure was used. The statistical analysis was conducted at a 95% confidence level. p-values of less than .05 were considered to be statistically significant.

4. Results

4.1. Characteristics of subjects

Sixty women were divided into three groups: a DN followed by MET group (20 patients), an MET group (20 patients), and a DN group (20 patients).

4.2. Visual analogue scale findings

The VAS value measured after treatment was significantly lower than before the treatment in every group ($p < 0.001$) (see Table 2). The VAS in the group receiving DN together with MET showed significant improvement as compared with the groups receiving only MET or DN ($p < 0.05$). The VAS value of group MET and group DN decreased but there were no significant differences between group MET and group DN ($p = 0.994$).

4.3. Pressure pain threshold findings

PPT value increased significantly after treatment rather than before treatment in every group ($p < 0.001$) (see Table 2), but PPT in the group receiving DN together with MET showed significantly more improvement than the groups receiving only MET or DN

($p < 0.05$). There were no significant differences between group MET and group DN ($p = 0.550$).

4.4. Range of motion of the neck findings

Active range of motion (ROM) of the neck increased significantly after the treatment in every group ($p < 0.001$) (see Table 2), But ROM in the group receiving DN together with MET showed significantly more improvement than the groups receiving only MET or DN ($p < 0.05$). There were no significant differences between group MET and group DN($p = 0.964$).

5. Discussion

Participants in all three groups were homogeneous in terms of age and BMI, and the number of women in each group was the same ($n = 20$). A total of 60 subjects participated in the study. According to the data presented in the results section, the effect of combined DN and MET and separate DN and MET on latent MTP upper trapezius was as follows: Increased ROM ($p < 0.001$), increased PPT ($p < 0.001$) and decreased VAS ($p < 0.001$). According to the results, the combination group received a significantly more effective treatment of the latent upper trapezius trigger point. The differences in dependent variables between the MET group and the DN group were not significant.

Pain reduction in the treatment groups can be attributed to several factors. The short length of sarcomeres and hypoxia in the area is a cause of pain in trigger points. Generally, in the treatment of MTPs, two factors require special attention (Simons, 2004a, 2004b):

1. Increasing blood supply to the MTP
2. Increasing the length of Sarcomeres.

The results of studies on DN indicate that it can obviously and meaningfully lead to an increase in local tissue blood circulation (Cagnie et al., 2012). In this regard, studies conducted by Shah and other researchers using Doppler sonography indicate that inserting a needle into the tissue, and its entry into the trigger point will increase the tissue blood circulation of that area (Shah, 2008; Yen et al., 2009). Therefore, the effects of applying dry needling to the trigger point in reducing pain can be seen in this study. Dommerholt also reported that AΔ fibres are stimulated 72 h after needle insertion. Prolonged AΔ stimulation causes enkephalinergic to function in inhibitory interneurons in the posterior horn of the spinal cord, and this reduces pain. Activation of Serotonergic and noradrenergic inhibitory systems is another mechanism which blocks out any disturbing stimulation on the posterior horn (Dommerholt, 2004; Dommerholt et al., 2009). Dry needling also creates a local stretch in contracting cytoskeletal structures which causes Sarcomers to return to their relaxation length by reducing the amount of overlap between actin and myosin in the muscle with trigger point (Dommerholt, 2004; Dommerholt et al., 2009).

The findings on the therapeutic effects of dry needling were consistent with Edwards and Knowles (2003) findings. In her study, she argued that DN with stretching is more effective than stretching alone in pain relief (Edwards and Knowles, 2003). Hyuk (2007) also found that dry needling on the upper trapezius of the elderly effectively reduces pain, and that if this treatment was combined with Paraspinal muscle dry needling it was more effective in reducing pain (Ga et al, 2007). Rayegani (2013) conducted a study comparing the effect of dry needling (a single treatment session) and physiotherapeutic modalities (10 sessions including TENS, US, HP, STRETCHING) in the treatment of MTP of the upper trapezius. Rayegani's results indicate that physical therapy and dry needling have similar effects in the treatment of MTP of the upper trapezius, but because of reduced time and cost requirements, dry needling technique was preferred over physical therapy (Rayegani et al., 2010).

The effectiveness dry needling on myofascial pain is a controversial issue. In some studies, the effect of this method has been demonstrated (Jaeger and Skootsky, 1987; Itoh et al., 2007; Venancio Rde et al., 2008; Ay et al., 2010; Kalichman and Vulfsons, 2010b; Tekin et al., 2013), whereas in some cases the treatment was ineffective or did not differ from placebo (Cummings and White, 2001; Tough et al., 2009). Investigations in relation to previous studies on the treatment of trigger points indicate that dry needling or trigger point inactivation is rarely a stand-alone intervention and is just one aspect of a comprehensive manual physical therapy process. Dry needling is usually combined with other manual therapies (Edwards, 2005; Gerwin et al., 2006; Fernandez-Carnero et al., 2009; Pérez-Palomares et al., 2010) and should be considered an instrument-assisted manual therapy technique (Hammer, 2008; Looney et al., 2011). In most studies, due to the multiplicity of factors that cause the myofascial pain syndrome, a multilateral approach to treatment is mentioned as desirable (Fleckenstein et al., 2010). In this study, the MET technique was used after treatment with dry needling with the intention of providing a more comprehensive treatment.

The muscle energy technique reduces pain and increases range of motion including (Chaitow, 2001): reflex inhibition, visco-elastic and plastic changes in muscle structure. Another mechanism called

Table 2
Statistical indicators of the dependent variables along with age and BMI, in separate groups and different sessions.

Variable	Time point	DN & MET		MET		DN	
		Mean	Std. Error of mean	Mean	Std. Error of mean	Mean	Std. Error of mean
Age	Session 1(Baseline)	25.60	.799	24.78	.717	24.60	.925
BMI	Session 1(Baseline)	21.088	.4300	22.156	.5123	22.744	.5744
VAS	Session 1	8.1500	.43088	6.8000	.32927	6.5500	.32016
	Session 2	6.3000	.47072	5.8500	.31014	5.7000	.35615
	Session 3	5.3500	.47725	5.3000	.34868	4.7500	.42843
	Session 4	3.4500	.41974	4.6000	.31954	4.3500	.43695
ppt	Session 1	9.7395	.42908	11.7765	.67570	11.9545	.50165
	Session 2	14.2395	.62655	14.2700	.81335	14.4660	.59381
	Session 3	16.4715	.69931	14.7770	.79588	17.1865	.92241
	Session 4	19.9015	.61614	16.2075	.88530	19.0640	.83730
ROM	Session 1	22.8135	1.07696	23.8150	.78408	24.1650	.80301
	Session 2	28.0145	1.31804	26.9300	.96540	26.7975	.84324
	Session 3	31.3635	1.29140	29.4305	1.12490	29.6820	.91586
	Session 4	33.8150	1.25825	31.0805	1.35998	32.5970	.97635

"enhancement of tissue elasticity tolerance" has been proposed in recent literature as a major factor in reducing pain and increasing the range of motion due to the application of muscle energy techniques. Also, based on a review of the available literature, it is said that by applying muscle energy techniques, blood and lymphatic circulation in muscles increases, and pro-inflammatory factors and the excretories arising from the contraction depart from the area and the stimulation of nociceptors is reduced (Chaitow, 2001).

Nambi et al. (2013) compared ischaemic compression treatment and MET treatment on upper trapezius trigger points. There were no significant differences between the two groups in VAS, however ROM in the second group revealed more improvement. The authors of this study concluded that MET was more effective in reducing pain and improving ROM (Nambi et al., 2013). Also in 2010, Nargrale et al. conducted a study comparing MET and INIT manual treatment (MET, SCS and IC) on trigger points in the upper trapezius. In both groups, significant reductions in pain intensity and disability and increased lateral flexion of the neck were reported. However, intergroup analysis indicated significantly greater improvement in the group treated with the INIT. The findings of this study showed the potential impact of an integrated approach on deactivation of upper trapezius trigger points (Nagrale et al., 2010). Due to its integrated approach, the present study also showed that a combination of MET and DN techniques has a better therapeutic effect than MET alone. An advantage of our study was that so far, no studies have compared MET and DN techniques, and also no study has applied these two techniques together for the treatment of trigger points. Each of these techniques reduces pain and increases range of motion. Combining the two techniques provided added efficacy and better results than using either technique separately.

5.1. Limitations of the study

Limitations included the small sample size, the short duration of therapy and the fact that the subjects were all women. In future research, it is recommended that the effects of combining these two techniques be studied with both sexes with longer treatment periods and larger sample sizes.

6. Conclusion

According to the present study, all three treatment groups (group1: MET & DN, group 2: MET and group 3: DN) were given suitable treatments for latent MTP, but the combination group showed significantly more improvement in increased ROM and PPT and decreased VAS in treatment sessions in women between 18 and 30 years old with latent upper trapezius trigger points. So combined MET and DN is recommended as a more effective and suitable method of treatment of these patients. It is assumed that increasing the number of sessions would result in further improvement.

References

Affaitati G, Costantini R, Fabrizio A, Lapenna D, Tafuri E, Giamberardino MA. Effects of treatment of peripheral pain generators in fibromyalgia patients. Eur J Pain 2011;15(1):61–9.

Alvarez D, Rockwell P. Trigger points: diagnosis and management. Am Fam Physician 2002;65:653–60.

Ay S, Evcik D, Tur BS. Comparison of injection methods in myofascial pain syndrome: a randomized controlled trial. Clin Rheumatol 2010;29(1):19–23.

Bogduk N. Clinical anatomy of the lumbar spine. Edinburgh, Scotland: Churchill Livingstone; 1987.

Brennum J, Kjeldsen M, Jensen K, Jensen TS. Measurements of human pressure-pain thresholds on fingers and toes. Pain 1989;38:211–7.

Cagnie B, Barbe T, De Ridder E, Van Oosterwijck J, Cools A, Danneels L. The influence of dry needling of the trapezius muscle on muscle blood flow and oxygenation. J Manip Physiol Ther 2012;35(9):685–91.

Chaiamnuay P, Darmawan J, Muirden KD, Assawatanabodee P. Epidemiology of rheumatic disease in rural Thailand: a WHO-ILAR COPCORD study. Community oriented programme for the control of rheumatic disease. Rheumatol 1998;25: 1382–7.

Chaitow L. Modern neuromuscular techniques. Edinburgh: Churchill Livingstone; 1996.

Chaitow L. METs. Edinburgh: Churchill Livingstone; 2001.

Chaitow L, DeLany JW. Clinical application of neuromuscular techniques. the lower body, vol. 2. Edinburgh, Scotland: Churchill Livingston, Elsevier Science Limited; 2002, ISBN 0443 06284 6. p. 598.

Chang CW, Chang KY, Chen YR, Kuo PL. Electrophysiologic evidence of spinal accessory neuropathy in patients with cervical myofascial pain syndrome. Arch Phys Med Rehabil 2011;92:935–40.

Cummings TM, White AR. Needling therapies in the management of myofascial trigger point pain: a systematic review. Arch Phys Med Rehabil 2001;82(7): 986–92.

Dommerholt J. Dry needling in orthopedic physical therapy practice. Orthop Phys Ther Pract 2004;16(3):15–20.

Dommerholt J, Mayoral del Moral O, Gröbli C. Trigger point dry needling. Myofascial trigger Points: pathophysiology and evidence-informed diagnosis and management. 2009. p. 159–90.

Edwards J. The importance of postural habits in perpetuating myofascial trigger point pain. Acupunct Med 2005;23:77–82.

Edwards J, Knowles N. Superficial dry needling and active stretching in the treatment of myofascial pain—a randomised controlled trial. Acupunct Med 2003;21(3):80–6.

Fernandez C, Campo MS, Fernandez J. Manual therapies in myofascil trigger point treatment: a systematic review. J Bodyw Mov Ther 2005;9:27–34.

Fernandez C, Alonso-Blanco C, Fernandez J. immediate effect of ischemic compression technique and transvers friction massage on tenderness of active and latent myofascial trigger points; A pilot study. Bodyw Mov Ther 2006;10: 3–9.

Fernandez-Carnero J, Fernández-de-las-Peñas C, Cleland JA. Mulligan's mobilization with movement and muscle trigger point dry needling for the management of chronic lateral epicondylalgia: a case report. J Musculoskelet Pain 2009;17: 409–15.

Fernández- Carnero J, La Touche R, Ortega-Santiago R, Galan-del-Rio F, Pesquera J, Ge HY. Short-term effects of dry needling of active myofascial trigger points in the masseter muscle in patients with temporomandibular disorders. J Orofac Pain 2010;24:106–12.

Fernandez-de-las-Penas CF, Alonso-Blanco C, Miangolarra JC. Myofascial trigger points in subjects presenting with mechanical neck pain: a blinded, controlled study. Man Ther 2007;1:29–33.

Fernandez-de-las-Peas C, Alonso-Blanco C, Fernandez-Carnero J, Miangolarra JC. The immediate effect of ischemic compression technique and transverse friction massage on tenderness of active and latent myofascial trigger points: a pilot study. J Bodyw Mov Ther 2006;10:3–9.

Fernandez-de-las-Peas C, Alonso-Blanco C, Fern⌡ndez-Carnero J, Miangolarra JC. The immediate effect of ischemic compression technique and transverse friction massage on tenderness of active and latent myofascial trigger points: a pilot study. J Bodyw Mov Ther 2006;10:3–9.

Fischer AA. Pressure algoMETry over normal muscles: standard values, validity and reproducibility of pressure threshold. Pain 1987;30:115–26.

Fischer AA. Pressure algometry over normal muscles. Standard values, validity and reproducibility of pressure threshold. Pain 1987;30:115–26.

Fleckenstein J, Zaps D, Rüger LJ, Lehmeyer L, Freiberg F, Lang PM, et al. Discrepancy between prevalence and perceived effectiveness of treatment methods in myofascial pain syndrome: results of a cross-sectional, nationwide survey. BMC Musculoskelet Disord 2010;11(1):32.

Fryer G, Fossum C. Therapeutic mechanisms underlying muscle energy approaches. Cephalalgia 2008;28:264–75.

Fryer G, Hodgson L. The effect of manual pressure release on myofascial trigger points in the upper trapezius muscle. J Bodyw Mov Ther 2005;9: 248–55.

Ga H, Choi JH, Park CH, Yoon HJ. Dry needling of trigger points with and without paraspinal needling in myofascial pain syndromes in elderly patients. J Altern Complement Med 2007;13(6):617–24.

Gatterman MI. Chiropractic management of spine related disorders. Williams and Wilkins; 1990. p. 437.

Gemmel H, Miller P, Nordstrom H. Immediate effect of ischaemic compression and trigger point pressure release on neck pain and upper trapezius trigger point: a randomized controlled trial. Clin Chiropract 2008;11:30–6.

Gemmell H, Miller P, Nordstorm H. Immediate effect of ischemic compression and trigger point pressure release on neck pain and upper trapezius trigger points: a randomised controlled trial. Clin Chiropract 2008;11:30–6.

Gerwin RD, Dommerholt J. Treatment of myofascial pain syndromes. In: Boswell MV, Cole BE, editors. Weiner's pain management; a practical guide for clinicians. Boca Raton, FL: CRC Press; 2006. p. 477–92.

Hammer WI. The effect of mechanical load on degenerated soft tissue. J Bodyw Mov Ther 2008;12:246–56.

Han SC, Harrison P. Myofascial pain syndrome and trigger point management. Reg Anaesth 1997;22(1):89–101.

Hong CZ. Lidocaine injection versus dry needling to myofascial trigger points: the importance of the local twitch response. Am J Phys Med Rehabil 1994;73(4):256–63.
Hsieh Y-L, Kao M-J, Kuan T-S, Chen S-M, Chen J-T, Hong C-Z. Dry needling to a key myofascial trigger point may reduce the irritability of satellite MTrPs. Am J Phys Med Rehabil 2007;86(5):397–403.
Itoh K, Katsumi Y, Kitakoji H. Randomized trial of trigger point acupuncture compared with other acupuncture in treatment of chronic neck pain. Complement Ther Med 2007;15:172–9.
Jaeger B, Skootsky SA. Double blind, controlled study of different myofascial trigger point injection techniques. Pain 1987;4(Suppl):S292.
Kalichman L, Vulfsons S. Dry needling in the management of musculoskeletal pain. J Am Board Fam Med 2010;23(5):640–6.
Kalichman L, Vulfsons S. Dry needling in the management of musculoskeletal pain. Am Board Fam Med 2010;23(5):640–6.
Kim SA, Young Oh Ki, Hyuck Choi Won, Kyum Kim In. Ischemic compression after trigger Point injection affect the treatment of myofascial trigger points 2013;37(4):541–6.
Kuchera WA, Kuchera ML. Osteopathic principles in practice. Kirksville, MO: Kirksville College of Osteopathic Medicine Press; 1992.
Lewit K. The needle effect in the relief of myofascial pain. Pain 1979;6(1):83–90.
Looney B, Srokose T, Fernandez-de-las-Penas C, Cleland JA. Graston instrument soft tissue mobilization and home stretchingfor the management of plantar heel pain: a case series. J Manip Physiol Ther 2011;34:138–42.
Lucas KR, Polus BI, Rich PA. Latent myofascial trigger points: their effects on muscle activation and movement efficiency. J Bodyw Mov Ther 2004;8(3):160–6.
Lucas KR, Rich PA, Polus BI. Muscle activation patterns in the scapular positioning muscles during loaded scapular plane elevation: the effects of latent myofascial trigger points. Clin Biomech 2010;25(8):765–70.
Luime JJ, Koes BW, Hendriksen IJ, Burdorf A, Verhagen AP, Miedema HS. Prevalence and incidence of shoulder pain in general population: a systematic review. Scand J Rheumatol 2004;33:73–81.
Meleger AL, Krivickas L. Neck and back pain: musculoskeletal disorders. Neurol Clin 2007;25:419–38.
Nagrale AV, Glynn Paul, Joshi Aakanksha, Ramteke Gopichand. The efficacy of an integrated neuromuscular inhibition technique on upper trapezius trigger points in subjects with non-specific neck pain: a randomized controlled trial. J Man Manip Ther 2010;18(1):37–43.
Nambi GS, Sharma R, Inbasekaran D, Vaghesiya A, Bhatt U. Difference in effect between ischemic compression and muscle energy technique on upper trepezius myofascial trigger points: comparative study. Int J Health & Allied Sci 2013;2(1):17.
Niel-Asher S. The concise book of trigger points. Chichester: Lotus Publishing; 2005.
Nussbaum EL, Downes L. Reliability of clinical pressure pain algometric measurements obtained on consecutive days. Phys Ther 1998;78:160–9.
Pérez-Palomares S, Olivá n-Blá zquez B, Magalló n-Botaya R, de-la-Torre-Beldarraín M, Gaspar-Calvo E, Romo-Calvo L, et al. Percutaneous electrical nerve stimulation versus dry needling: effectiveness in the treatment of chronic low back pain. J Musculoskelet Pain 2010;18:23–30.
Potter L, McCarhy C, Oldham J. Algometer reliability in measuring pain pressure threshold over normal spinal muscles to allow quantification of anti-nociceptive treatment effects. Int J Osteopath Med 2006;9:113–9.
Rayegani SMB, Masoumeh Bahrami, Mohammad Hassan Elyaspour, Daryoush Azhar, Amin Valaei, Nase R. Comparison of dry needling and physical therapy modalities in treatment of myofascial pain of upper trapezius muscle. Pejouhesh 2010;34(3):157–63.
Reeves JL, Jaeger B, Graff-Radford SB. Reliability of the pressure algometer as a measure of myofascial trigger point sensitivity. Pain 1986;24:313–21.
Rowley NC. The relative effectiveness of a single dry needle insertion compared to multiple fanning dry needling insertions in the treatment of myofasciitis of the cervical and upper thoracic spine. M.Tech. Chiropractic Dissertation, Technikon Natal, Durban, South Africa. 2001.
Sciotti VM, Mittak VL, DiMarco L, Ford L, Plezbert J, Santipadri E, et al. Clinical precision of myofascial trigger point location in the trapezius muscle. Pain 2001;93(3):259–66.
Shah JP. Integrating dry needling with new concepts of myofascial pain, muscle physiology, and sensitization. Integr Pain Med 2008:107–21.
Simons DG. Do endplate noise and spikes arise from normal motor endplates? Phys Med Rehabil 2001;80:134–40.
Simons DG. Review of enigmatic MTPs as common cause of enigmatic musculoskeletal pain & dysfunction. Electromyogr Kinsiol 2004a;14:95–107.
Simons DG. New aspects of myofascial trigger points: etiological and clinical. J Musculoskelet Pain 2004b;12:15–21.
Simons DG, Travell J. Myofascial pain and dysfunction: the trigger point manual. Baltimore: Williams & Wilkins; 1992.
Simons DG, Travell J, Simons LS. Travell & Simons' myofascial pain and dysfunction. upper half of body Baltimore. Williams& Wilkins; 1999a.
Simons DG, Travell J, Simons LS. Myofascial pain and dysfunction: the trigger point manual. 2nd ed. Baltimore: Williams and Wilkins; 1999b.
Skootsky SAJB, Oye RK. Prevalence of myofascial pain in general internal medicine practice. West J Med 1989;151(2):157–60.
Sola AE. Myofascial trigger point therapy. Aug Resid Staff Physician 1981:38–45.
Tekin L, Akarsu S, Durmuş O, Cakar E, Dinçer U, Kıralp MZ. The effect of dry needling in the treatment of myofascial pain syndrome:a randomized double-blinded placebo-controlled trial. Clin Rheumatol 2013;32(3):309–15.
Tough EA, White AR, Cummings TM, Richards SH, Campbell JL. Acupuncture and dry needling in the management of myofascial trigger point pain: a systematic review and meta analysis of randomized controlled trials. Eur J Pain 2009;13(1):3–10.
Travel JG, Simons DG. Myofascial pain and dysfunction: the trigger point manual, vol. 1. USA: Williams and Wilkins; 1983. p. 713. ISBN O-683-08366-X.
Travel JG, Simons DG. Myofascial pain and dysfunction: the trigger point manual. Second ed. USA: Williams and Wilkins; 1999.
Travell J, Simons DG. Myofascial pain and dysfunction – the trigger point manual. Baltimore, MD: Lippincott Williams & Wilkins; 1992.
Unalan Halil, Majlesi Javid, Aydin Filiz Yildiz, Palamar Deniz. Comparison of high-power pain threshold ultrasound therapy with local injection in the treatment of active myofascial trigger points of the upper trapezius muscle. Arch Phys Med Rehabil 2011;92:657–62.
Venancio Rde A, Alencar Jr FG, Zamperini C. Different substances and dry-needling injections in patients with myofascial pain and headaches. Cranio 2008;20(2):96–103.
Yen R-H, Danoff J, Gebreab TM, Gerber NLH, Shah JP, Sikdar S. Poster 147: novel use of ultrasound imaging to investigate myofascial trigger points and the effects of dry needling: a case series. PM&R 2009;1(9, Supplement):S167–8.
Ylinen J, Nykanen M, Kautiainen H, Hakkinen A. Evaluation of repeatability of pressure algometry on the neck muscles for clinical use. Man Ther 2007;12.192-.
Youdas JW, Carey JR, Garrett TR. Reliability of measurements of cervical spine range of motion-comparison of three METhods. Phys Ther 1991;71:98–106.