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CLINICAL TRIAL

Neurophysiological and clinical effects of dry needling in patients with upper trapezius myofascial trigger points

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KEYWORDS
Myofascial trigger point;
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Summary *Introduction:* Dry needling (DN) is a widely used in treatment of myofascial trigger points (MTrPs). The purpose of this pretest-posttest clinical trial was to investigate the neurophysiological and clinical effects of DN in patients with MTrPs.
Methods: A sample of 20 patients (3 man, 17 women; mean age 31.7 ± 10.8) with upper trapezius MTrPs received one session of deep DN. The outcomes of neuromuscular junction response (NMJR), sympathetic skin response (SSR), pain intensity (PI) and pressure pain threshold (PPT) were measured at baseline and immediately after DN.
Results: There were significant improvements in SSR latency and amplitude, pain, and PPT after DN. The NMJR decreased and returned to normal after DN.
Conclusions: A single session of DN to the active upper trapezius MTrP was effective in improving pain, PPT, NMJR, and SSR in patients with myofascial trigger points. Further studies are needed.

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Introduction

Myofascial trigger points (MTrPs) are a primary source of pain in skeletal muscle, and are defined as localized, hyperirritable spots in a palpable taut band of skeletal muscle fibers (Simons et al., 1999). They commonly occur in the neck and shoulder muscles, and among these, the trapezius is the most frequently involved (Chang et al., 2011). Myofascial TrPs are categorized into active or latent. Active trigger points are spontaneously painful and symptomatic. In the latent MTrPs, pain is induced only on compression (Shah and Gilliams, 2008; Simons et al., 1999). In addition to sensory symptom (pain), TrPs can cause motor (taut band formation due to dysfunctional end plates) and autonomic (changes in skin temperature, sweating, pilomotor activity) symptoms (Lavelle et al., 2007; Majlesi and Unalan, 2010). It is hypothesized that excessive motor activity in the neuromuscular junction initiates several mechanisms to form MTrPs in a skeletal muscle. Involvement of sympathetic system contributes to increase motor activity in trigger point and muscle pain (Chung et al., 2004; Hubbard, 1996).

Based on the underlying mechanisms of motor, sensory and autonomic dysfunction of trigger points, there are many non-invasive (stretching, lasertherapy, ultrasound) and invasive (acupuncture and/or dry needling) methods to manage MTrPs. Dry needling (DN) is an effective, safe and minimally invasive technique used by physical therapists to treat patients with MTrPs (Dommerholt et al., 2006; Vulfsons et al., 2012). DN is performed by needling without injected substances directly into the trigger points (Tekin et al., 2013). We found no previous study on neurophysiological effect of DN on neuromuscular junction response (NMJR) and autonomic responses in patients with MTrPs. Therefore, the aim of this study was to investigate the effects of DN on sensory, motor, and autonomic components of trigger point of trapezius muscle.

Methods

Study design

This pretest-posttest clinical trial was accomplished in patients with upper trapezius MTrPs to investigate the effectiveness of DN on the clinical and neurophysiological outcomes. The protocol of the study was approved by the Review Board of School of Rehabilitation, and the Ethical Committee of Tehran University of Medical Sciences (TUMS). Written informed consent was obtained prior to initiation of the study.

Participants

Twenty patients ranged in age between 20 and 50 who had experienced muscle pain for more than six month, due to active upper trapezius trigger points on right side, participated in this study. Presence of taut band, increased tenderness with palpation, and referred pain pattern was used to detect active trigger points in the upper trapezius muscle. Participants with history of neck and upper extremity injury or surgery, muscle disease, epilepsy, pregnancy, use of sedative or anticoagulant medication, needle phobia, skin lesion, and infection or inflammatory swelling at the MTrPs site were excluded. The treatment protocol and examination process was explained to the participants before starting the study.

Protocol

Details of the examination and treatment protocol of this study have been described before (Abbaszadeh-Amirdehi et al., 2013). Each patient was asked to rest in a supine position on the treatment table for 10 min before data collection. Then, baseline measurements for sympathetic skin response (SSR), neuromuscular junction response (NMJR), pain intensity (PI) and pressure pain threshold (PPT) were recorded by a trained physiotherapist (PT) who also performed the intervention. Following baseline measurements, patients underwent one treatment session with deep DN. A sterile acupuncture needle (0.30 $\times$ 50 mm, Seirin, Japan) was inserted into the identified active trigger points in the upper trapezius muscle. Upon insertion, the needle was moved up and down repeatedly to elicit as many LTRs as possible in the muscle. Each trigger point was needled for 2 min. Right after the needle was removed, post treatment measurement for SSR, NMJR, PI and PPT were repeated by the same PT.

Measurements

Sympathetic skin response (SSR)

We used surface electrodes to assess SSR by an electromyography instrument (Tonnies, Neuroscreen Plus-Germany), using sensitivity of 500 micV/div, sweep speed of 1000 m/div, and filtering of 0.08—20 Hz. All patients were in supine position, in a silent, semidark room. The median nerve was stimulated at the wrist level by a single square-wave electric stimulus, and SSR was recorded with a surface active electrode attached to the palm and reference electrode placed on the back of the hand. Electrical stimulation was delivered three times with 1 min intervals. The mean latency and amplitude of the SSR across the three trials was used for data analysis. The room temperature was maintained at 24 °C (Abbaszadeh-Amirdehi et al., 2013).

Neuromuscular junction response (NMJR)

In this study, we used Repetitive Nerve Stimulation (RNS) for assessing NMJR. Repetitive nerve stimulation to the spinal accessory motor nerve was delivered by a Tonnies electromyography instrument (sensitivity 5 mV/div, sweep speed 5 m/div and filtering of 5 Hz—5 KHz). Surface stimulating electrodes were placed over the spinal accessory motor nerve, located on the posterior border of the sternocleidomastoid muscle at the level of the upper border of the thyroid cartilage. Surface recording electrodes were placed over the upper trapezius muscle 5 cm from the C7 spinous process. The changes in amplitudes of the first and fifth compound muscle action potentials (CMAP), created by the trains of 9 supramaximal electrical stimulation at a rate of 3 Hz, was used to measure percent decrement or increment changes in CMAP (Abbaszadeh-Amirdehi et al., 2013).

Pain intensity

Numerical rating scale (NRS) from 0, representing no pain, to 10, representing worst imaginable pain, was used to assess pain intensity (Abbaszadeh-Amirdehi et al., 2013).

Pressure pain threshold (PPT)

A pressure algometer (Digital Instrument-Lutron, Taiwan) was used to measure PPT at the site of trigger point identified in the upper trapezius muscle. With the patient in supine position, perpendicular pressure was applied to the trigger point through the metal rod of the algometer. The pressure was increased at the rate of 1 kg/cm^{2}until the patient reported an increase in pain intensity or discomfort. Measurements were performed three times with an interval of 40 s. The average of three trials was used for data analysis (Abbaszadeh-Amirdehi et al., 2013).

Statistical analysis

We used SPSS V.17 (*SPSS* Inc., *Chicago*, Illinois) for data analysis. Kolmogorov–Smirnov test confirmed normal distribution of the measured data ($p > 0.05$). Paired t-test was used to assess SSR, NMJR and PPT changes. Wilcoxon rank test was used to assess changes in pain intensity before and after treatment. Statistical significance was accepted at 0.05.

Results

Twenty patients (17 Women, 3 men) with a mean age of 31.7 years, and mean illness duration of 21 months were included in this study. Demographic characteristics of the patients is presented in Table 1.

Table 2 shows the data for outcome measures. Our data represented a statistically significant increase in SSR latency ($p = 0.005$) and a significant decrease in SSR amplitude ($p = 0.001$). We found about 8.5% decrease in NMJR in the trapezius muscle in response to RNS. Changes in NMJR are clinically notable. We found a significant increase in PPT ($p = 0.0001$) as well as a significant decrease in NRS score ($p = 0.0001$).

Table 1 Demographic and clinical characteristics of patients (n = 20).

	Mean ± SD	Minimum	Maximum
Age (years)	31.7 ± 10.8	20	50
Height (cm)	1.64 ± 0.65	1.52	1.77
Weight (kg)	63.4 ± 9.5	48	79
BMI (kg/m^2)	22.5 ± 2.2	19	26
Duration of illness (month)	21 ± 13.3	6	48

Table 2 Comparison of the values of variables of 20 patients before and after dry needling.

	Before DN Mean ± SD	After DN Mean ± SD	t or z	*P*
SSR latency (sec)	1.15 ± 0.4	1.34 ± 0.3	−3.2	**0.005**[a]
SSR amplitude (mv)	2.5 ± 1.4	1.3 ± 1.0	3.9	**0.001**[a]
PPT (kg/cm^2)	1.1 ± 0.5	1.5 ± 0.6	−5.1	**0.0001**[a]
PI (NRS score)	5 (median)	2 (median)	−3.9	**0.0001**[a]
NMJR			3.4	**0.003**[a]
$CMAP1_{amplitude}$	5.3 ± 1.2	4.4 ± 1.5	3.9	**0.001**[a]
$CMAP5_{amplitude}$	5.5 ± 1.5	4.3 ± 1.8	**It was in the normal range after DN**	
Changes%	5.6 ± 26.7	−2.9 ± 13.8		

[a] Statistically significant, CMAP1 = first Compound Muscle Action Potential, CMAP5 = fifth Compound Muscle Action Potential.

Discussion

Summary of main findings

This study evaluated the effectiveness of DN on sensory, motor and autonomic dysfunction of myofascial trigger points in patients with upper trapezius trigger point. Our findings indicated a significant improvement in pain intensity, pressure pain threshold, sympathetic skin response and neuromuscular junction response after one session of dry needling.

After DN, all patients showed statistically and clinically significant improvements on all outcome measures.

The effect of DN on sensory component

Our findings indicated significant decrease in pain intensity and increase in PPT. Many studies and recent systematic reviews on the management of MTrPs showed that DN was effective in relieving pain and improving PPT (Cummings and White, 2001; Edwards and Knowles, 2003; Kietrys et al., 2014; Tekin et al., 2013; Tough et al., 2009). The measurement of PPT has been reliable and widely used method in clinical treatment for assessing of trigger point sensitivity (Wang et al., 2014). Many studies on PPT of trapezius MPS indicated that the PPT of trapezius muscle in normal adults and in patients after DN was higher than before treatment (Kwon et al., 2001; Lee et al., 1997, 2008). The significant increase in PPT reported in our results was consistent with those cited above. An increase in the PPT value implies a decrease in pain sensitivity due to the existence of a strong correlation between PPT and pain perception (Srbely et al., 2010). Although the exact mechanism of the therapeutic effect of DN remain unknown, needling of trigger points for alleviation of pain is well accepted. It is possible that rapidly moving a needle into a MTrP might stimulate the large diameter-sensory afferent fibers, which could lead to an inhibition in the dorsal horn of spinal cord by blocking the pain information generated in the MTrP's nociceptors through a "gate control" mechanism (Abbaszadeh-Amirdehi et al., 2013; Cagnie et al., 2013).

The effect of DN on motor component

Similar to previous reports (Gerwin et al., 2004; Simons, 2008) the patients in this study also demonstrated increased motor end plate activity at the site of active trigger points (5.6% increment in amplitude of CMAP of The

fifth to the first). Following dry needling, motor end plate hyperactivity decreased by 8.5% in the upper trapezius muscle (Table 2). Therefore, based on documents that accept 8—10% decrease in the amplitude of compound muscle action potential (CMAP) following Repetitive nerve stimulation (RNS) test, as normal (Oh, 1988), it is suggested that motor end plate activity was normalized after DN. Some authors have attributed such decreased motor end plate activity following DN to mechanical disruption of the integrity of dysfunctional end plate (Simons et al, 1999), and the others have considered it to a rapid drop in release of chemicals, such as substance P and calcitonin gene-related peptide (CGRP) (Shah and Heimur, 2012; Shah and Gilliams, 2008). Consequently, deactivation of trigger points may be attributed to mechanical and biochemical changes around needle insertion. There is only one study on the effectiveness of DN on motor end plate function that demonstrated a decrease in motor end plate hyperactivity in patients with MTPS (Chen et al., 2001).

The effect of DN on autonomic component

The main findings were a significant increase in the latency and a decrease in amplitude of SSR immediately after DN. Such findings indicate down-regulation of sympathetic activity after DN. Sympathetic hyperactivity in patients with MTrPs alters the skin resistance by affecting sudomotor fibers. Such changes in skin resistance can be detected by measuring the latency and amplitude of the SSR (Bolel et al., 2006), which has been proven to be a useful electrophysiological technique for examining function of the sympathetic system (Lee et al., 2011). We could not find any other studies that have used SSR for assessing sympathetic activity in patients with active myofascial trigger points in the upper trapezius muscle to compare with the findings of this study.

Some studies have reported increased sympathetic activity following acupuncture treatment due to fear of the needles and induced pain during the treatment (Kang et al., 2011; Lee et al., 2013; Napadow et al., 2013; Paulson and Shay, 2013), but the findings of this study showed that DN treatment reduced sympathetic activity in patients suffering from pain related MTrPs. These findings suggest that the therapeutic effects of needling can act through the sympathetic system regulation following needle insertion. Inhibition or blockade of the sympathetic nervous system might be explanatory mechanism for the reduction of sympathetic response following DN. SSR is a polysynaptic reflex with spinal and supraspinal control (Vetrugno et al., 2003). Different parts of brain cortex, thalamus, hypothalamus, limbic system have been shown to be involved in facilitation or inhibition of pain and the autonomic system (Sakai et al., 2007). It was shown that patients with upper trapezius myofascial pain syndrome have increased limbic system activity (Niddam et al., 2007). It is possible that needle stimulation of an active TrPs through Aδ and C fibers ascend to higher centers modulating dynamic balance between supraspinal descending facilitation and inhibition of autonomic system. This study suggests that descending inhibitory autonomic effects, may cause local deactivation of the MTrP.

Conclusion

The current study showed that the one session of DN applied to an active MTrP of upper trapezius muscle improved the pain intensity, PPT, and reduced the sympathetic hyperactivity and the motor end plate irritability of trapezius muscles, measured by SSR and the RNS, respectively. Further studies with a control group are suggested.

Study limitations

The absence of control group to assess the placebo effects was the main limitation of the present study. Second, there was no follow-up to evaluate the long-term effects of DN. Third, this study did not measure the patients' functional abilities.

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