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MYOFASCIAL PAIN (RD GERWIN, SECTION EDITOR)

Trigger Point Needling: Techniques and Outcome

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Abstract In this review we provide the updates on last years' advancements in basic science, imaging methods, efficacy, and safety of dry needling of myofascial trigger points (MTrPs). The latest studies confirmed that dry needling is an effective and safe method for the treatment of MTrPs when provided by adequately trained physicians or physical therapists. Recent basic studies have confirmed that at the site of an active MTrP there are elevated levels of inflammatory mediators, known to be associated with persistent pain states and myofascial tenderness and that this local milieu changes with the occurrence of local twitch response. Two new modalities, sonoelastography and magnetic resonance elastography, were recently introduced allowing noninvasive imaging of MTrPs. MTrP dry needling, at least partially, involves supraspinal pain control via midbrain periaqueductal gray matter activation. A recent study demonstrated that distal muscle needling reduces proximal pain by means of the diffuse noxious inhibitory control. Therefore, in a patient too sensitive to be needled in the area of the primary pain source, the treatment can be initiated with distal needling.

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Introduction

Dry needling (intramuscular stimulation, Western acupuncture, medical acupuncture) is a relatively new method in the arsenal of pain medicine. Its widespread use started after Lewit's publication more than 30 years ago [1], where the author emphasized that the needling effect is distinct from that of the injected substance. Since the beginning of the twenty-first century, serious scientific attention has been paid to this method. A PubMed search, using the keywords "dry needling" or "intramuscular stimulation," for the period of 1 January 2000 till 8 February 2012, yielded 99 articles.

Several previous reviews described different methods, pathophysiological basis, and efficacy studies of dry needling [2–6]. In this review we have attempted to provide the latest updates on basic science regarding the dry needling of myofascial trigger points (MTrPs), treatment methods, efficacy, and safety studies.

Update on Imaging of MTrPs

One of the major problems that prevent the common acceptance of MTrPs by the medical community is the lack of imaging methods that allow objective visual inspection (examination) of the painful nodes in the muscle, that till now have been diagnosed solely by palpation. In addition, reliable diagnostic methods for MTrPs should allow the accurate evaluation of the treatment outcome. Two recent studies introduced novel imaging methods that allow the visualization

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of MTrPs. In their feasibility study Sikdar et al. [7••] introduced an ultrasound imaging technique, sonoelastography, enabling visualization of muscular tissue containing MTrPs. They simultaneously applied external vibration in order to differentiate tissue stiffness and ultrasound color variance mode to image the relative distribution of the vibration amplitude in the myofascial tissue. On ultrasound imaging the MTrPs in the upper trapezius muscle appeared as elliptically shaped, focal heterogenic areas of hypoechogenicity that corresponded with the location of the palpable nodule and were found to be the size of 0.16 ± 0.11 cm^2. Both active and latent MTrPs demonstrated distinct blood flow waveform patterns while active MTrPs were significantly associated with retrograde flow in diastole, an indication of a highly resistive vascular bed. The study limitations included difficulties concerning operator technique in controlling the amount of pressure and angle at which the ultrasound transducer was held and not having a control group of pain-free subjects. Nevertheless, this preliminary finding seems promising for using an accessible low-risk technique, such as ultrasound, for differentiating MTrPs from the surrounding tissue.

In a study by Chen at al. [8], the method of magnetic resonance elastography (MRE) was used to identify and quantify the myofascial taut band, one of the main features of myofascial pain. MRE is a relatively recent advancement in magnetic resonance imaging (MRI), coupling MRI with an external source introducing cyclic shear waves into the tissue being studied. Since shear waves travel more rapidly in stiffer tissue material, once a wave speed has been determined from phase MRI it can be used to calculate tissue stiffness. The authors found that the stiffness of the taut bands in a patient with myofascial pain were almost 50 % greater than that of the surrounding muscle tissue. The authors concluded that MRE can quantitate asymmetries in muscle tone that could previously only be identified subjectively on clinical examination. Since in this preliminary study only two patients were evaluated and the muscular pathophysiological target was the taut band and not the trigger points, a further study on a larger sample might be needed in order to isolate trigger points using this technique.

Updates in Basic Research of Myofascial Pain and Dry Needling

The pathophysiology of MTrPs remains relatively unclear despite endeavors to define its presence objectively. In this section we shall review the new basic science evidence attempting to demonstrate the evolution of MTrPs.

Shah et al. [9] have demonstrated significantly higher concentrations of bradykinin, calcitonin gene-related peptide, substance P, tumor necrosis factor, interleukin-1, serotonin, and norepinephrine as well as a significantly lower pH in the internal muscular tissue milieu of subjects with active MTrPs. This local tissue milieu appears to change with occurrence of elicited local twitch response (LTR). Using a novel microdialysis needle as a surrogate for the acupuncture needle (designed by the investigators themselves), the authors collected samples continuously during routine treatment of MTrPs. The confirmation of the presence of elevated levels of these inflammatory mediators, known to be associated with persistent pain states, myofascial tenderness, intercellular signaling, and inflammation, in the vicinity of active MTrPs, may help to explain the pathogenesis, amplification, and persistence of myofascial pain. The microdialysis system presented in this article proves that the local milieu does appear to change with the occurrence of LTR.

Two recent papers have demonstrated segmental involvement in pain modulation following MTrP stimulation. In the first paper, the hypothesis that dry needling of MTrPs evokes a segmental antinociceptive effect was tested in a randomized controlled trial (RCT) on 40 human subjects receiving either real or sham intramuscular dry needling to the supraspinatus muscle [10•]. Pain pressure thresholds (PPTs) were recorded from the ipsilateral infraspinatus muscle and the ipsilateral gluteus medius muscle. By examining the change in the PPT values of the infraspinatus (neurologically linked to the supraspinatus at the C5 spinal segment) and the gluteus medius (segmentally unrelated to the supraspinatus) following needling, a significant yet short lasting pain threshold increase representing segmental antinociceptive effects of the supraspinatus MTrP needling has been demonstrated. These results strengthen the authors' hypothesis of MTrPs formation in which trigger points are discrete secondary peripheral neurogenic manifestations of central sensitization caused by primary pathology within the common networked spinal circuits.

In the second paper, Hsieh et al. [11] tried to elucidate neural mechanisms underlying the remote effect produced by dry needling of rabbits' skeletal muscle MTrPs. In this study, the rabbits were divided into four groups (no intervention, transected tibial nerve, transected spinal cord at the level of L5–6, and transected spinal cord at the level of T1–2). These groups were further divided into four subgroups receiving either ipsi- or contralateral dry needling or ipsi- or contralateral sham needling of the gastrocnemius MTrPs. All subgroups had their end plate noise recordings of the biceps femoris MTrPs analyzed afterwards. The authors have found that either ipsilateral or contralateral dry needling of a distal MTrP could initially increase the irritability of a proximal MTrPs as reflected in its end plate noise amplitude followed by a suppression effect after cessation of the needling probably through influence of supraspinal centers such as the descending pain inhibitory system.

This study helps in understanding the mechanism for the beneficial effect of dry needling at remote MTrPs for myofascial pain control. This effect appears as long as there are intact nerves from the stimulating site to the spinal cord and a normally functioning spinal cord

In the context of the above-mentioned article pointing toward a central spinal mechanism, it seems appropriate to mention the study conducted by Niddam et al. [12]. In this study, 24 patients with myofascial pain syndrome (MPS) while undergoing functional MRI scan received a painful (high intensity) intramuscular electrical stimulation, delivered at random intervals within an MTrP of the trapezius muscle. In between scanning sessions, low intensity electrostimulation was applied to the same area (the intervention). The effect of the intervention on the periaqueductal gray matter area was scanned in addition to a whole brain search. The authors have concluded that the above intervention within an MTrP at least partially involves supraspinal pain control via midbrain periaqueductal gray matter activation. However, it remains to be established to what degree descending and ascending pain control tracts are involved.

Itoh et al. [13] evaluated the effect of depth of needle penetration on muscle pain. Following repeated eccentric contraction to induce muscle soreness in their extensor digitorum muscle, 22 healthy subjects were assigned to 4 groups, namely, control, skin (3 mm depth of needle insertion to the extensor digitorum muscle), muscle (10 mm depth of needle insertion to the extensor digitorum muscle), and non-segmental group (10 mm depth of needle insertion to the tibialis anterior muscle). PPT using algometry and electrical pain threshold (EPT) of the skin, fascia, and muscle (using pulse algometry with insulated needle electrode) were measured at a point 20 mm distal to the maximum tender point on the second day after the exercise. The authors have found that the PPTs of the skin and muscle groups were significantly higher than the control group, whereas the EPT of the muscle group was significantly higher than the other groups. The authors have concluded that needling stimulation of muscle increases the PPT and EPT of fascia as well as that the depth of needle penetration is important for the relief of muscle pain. Thus we can learn from this study that superficial needling that penetrates just skin most probably will be less effective than deep needling that penetrates fascia and muscular tissue in relieving the pain of myofascial origin.

Efficacy and Effectiveness of Dry Needling

Various studies were performed over the past few years testing the efficacy and effectiveness of dry needling in treating patients suffering from MPS. In the study authored by Huang et al. [14], a prospective cohort design was used to examine the effects of an 8-week protocol of dry needling followed by stretching of the involved muscles in a final total of 92 patients. The patients fulfilled the following inclusion criteria: chronic musculoskeletal pain for 3 months or longer due to nonspecific muscle pain, physical examination revealing tender spot in a palpable taut band, ability of the patient to distinguish between varying degrees of pain intensity, referred pain pattern and LTR, Chinese speaking, and age at least 18 years. Exclusion criteria were fibromyalgia, neurological pain, infection, drug or alcohol abuse, rheumatological disease, pregnancy, and any other disease that might interfere with participation. The interventions used were dry needling or intramuscular stimulation. Appropriate placement of the needle was confirmed by reproduction of recognizable pain or by observation of LTR. MTrPs were inactivated by a recurrent thrust and release method until no further twitches were elicited. Each patient received 8 weekly treatments and was followed up at 2, 4, and 8 weeks. Outcome measures included a general demographic questionnaire and the Taiwanese version of the Brief Pain Inventory. The results showed that worst pain intensity and average pain intensity decreased from pretreatment levels at every time point (i.e., 2, 4, and 8 weeks) with the effect size of reduction particularly pronounced in the first 2 weeks. Pain interference, a measure of quality of life, also showed significant reduction, thus indicating an improved outcome. Prognostic factors associated with poorer outcomes of treatment were longer duration of symptoms, repetitive work, and sleep deprivation. A serious limitation of the study includes lack of a control group.

The effectiveness of dry needling in comparison to another well-established needling technique, percutaneous electrical nerve stimulation (PENS), on patients suffering from chronic low back pain (LBP) was studied by Pérez-Palomares et al. [15]. PENS has been studied and in previous studies found to be effective in relieving chronic LBP. In the present study, 122 patients (91 women, 31 men) with chronic LBP were randomized to undergo either 9 treatments of PENS (3 treatments for 3 weeks) or 3 treatments of dry needling and post-needling stretch (1 a week for 3 weeks). Inclusion criteria were age above 18 with 4 months or more of LBP. Exclusion criteria were fibromyalgia and suspected or diagnosed structural lesions in the lumbar spine. Outcome measures included perceived pain measured by visual analogue scale (VAS), pain tolerance measured by pressure algometer on selected MTrPs, sleep quality (also measured using VAS), and quality of life measured by the Oswestry Disability Index (ODI). The study outcome variables were measured before the study and on completion of treatment. Patients treated by dry needling were assessed by trained physiotherapists for evidence of MTrPs in the deep lumbar paraspinal muscles, the quadratus lumborum, and gluteus medius muscles bilaterally. Patients treated by PENS had four needles positioned bilaterally at the dermatomal level of L2–5 bilaterally. These needles were connected to a pulse generator. The results of the study showed that the differences between the initial and the final score for perceived pain (VAS), pain tolerance, sleep (VAS), and ODI were favorable for both PENS and dry needling treatment. There were no significant differences between the results of the two groups. There was a slightly higher drop-out rate from the dry needling group (three for the PENS group versus seven for the dry needling group). Thus it appears that both therapies are equally effective for reducing pain at 3 weeks for patients suffering from chronic LBP.

In an RCT comparing MTrPs injection with dry needling for cervical pain, Ay et al. [16] reconfirmed various previous reports in that there is no specific long-term effect to the substance injected and that the needling by itself constitutes the therapeutic effect. In their study, 80 patients (52 women, 28 men) were randomly split into two groups of 40 patients. Patients in group one were treated with 2 ml lidocaine 1 %, whereas patients in the other group received no injected substance but were needled in the same fashion (dry needling). Inclusion criteria were presence of at least one active MTrP located in the upper trapezius muscle, age between 19 and 58 years, and symptom duration for 1 month. The diagnosis of MPS was based on the criteria defined by Travell and Simons [17]. Excluded were patients with fibromyalgia, systemic disease, cervical disk lesion, trigger point injection, physical treatment within the recent 6 months, pregnancy, having undergone neck and shoulder surgery, drug allergy, and abnormal laboratory results. Outcome measures were VAS for pain, cervical range of motion (ROM) in flexion, extension, rotation, and lateral bending as measured by goniometry, and Beck's Depression Inventory. Patients were evaluated before treatment and at 4 and 12 weeks. The results showed significant decreases in all outcome measures, from baseline through weeks 4 and 12. There were no differences between the two groups; thus the authors concluded that dry needling was shown to be clinically and statistically beneficial in treating patients suffering from MPS of the trapezius.

Another RCT comparing needling techniques and substances dealt with the comparative efficacy of dry needling, lidocaine injections, and botulinum toxin injections for patients suffering from myofascial pain and headaches [18]. In this study 45 patients were recruited. Inclusion criteria were moderate to severe headache present for at least 6 months with MTrPs in the orofacial or cervical region sensitive to palpation and responsible for setting off the headache. Exclusion criteria were arterial hypertension, diabetes, hypoglycemia, blood dyscrasias, tumors, lupus, fibromyalgia, rheumatoid arthritis, allergy to the solutions, and use of anticoagulants. The patients were randomized into three groups, dry needling, lidocaine 0.25 %, and botulinum toxin 25 or 50 U. MTrPs were localized and treated with 0.2 ml injection volume in up to three MTrPs per patient. Outcome measures included a modified symptom severity index, pain diary, and pain questionnaire. The patients were assessed before, 10 min after, and 1, 4, and 12 weeks after the injections (one session). The results showed that from baseline there were improvements in all three groups at all time points for symptom severity. Significant differences between the groups were not observed. The results of this study are interesting in light of the study by Kamanli et al. [19] where similar comparisons were done with three injection protocols: dry needling, lidocaine 0.5 %, and botulinum toxin 10–20 U. In that study lidocaine injection proved to be more effective for PPT (increased) and pain scores (decreased). The concluding recommendation made by Venancio Rde et al. [18] was to use lidocaine injections with no reference to dry needling, although no differences were found between the two groups. Although this seems unfounded in light of the results presented, it is in accordance with the recommendations made by Hong in 1994, when he randomized patients to receive either lidocaine injections or dry needling into trapezius MTrPs and found the results comparable between the two groups but with less post-needling soreness in the lidocaine treatment group [20].

Treatment of myofascial pain due to active trapezius muscle trigger points was performed on distal MTrPs in the unassociated ipsilateral extensor carpi radialis longus muscle. This study by Tsai at al. [21••] was designed to explore the effect of distal hyperstimulation analgesia on MTrPs in a sham-controlled RCT. Thirty-five patients suffering from unilateral neck pain attributed to MTrP of the midsection of the horizontal fibers of the upper trapezius muscle were randomized into two groups. The control group ($n=18$) received sham subcutaneous dry needling of the tissue above the MTrP of the extensor carpi radialis longus muscle, whereas the patients in the study group ($n=17$) were needled into the MTrP to achieve deactivation via LTR. Outcome measures included pain intensity as measured by VAS, PPT, and increased ROM measured by contralateral neck bending. Measurements were taken before the needling and immediately after. Results showed that there was a statistically significant improvement in all parameters in the study group compared to the control group. The discussion focused on the speculated mechanism of a non-segmentally associated hyperstimulation analgesia effect via the diffuse noxious inhibitory control. This has been shown in previous studies [22, 23], but this study is the first sham-controlled study to show MTrP deactivation. The implications are important as many patients are too sensitive to needling in involved muscles and this might be an adjunctive method for treating MPS. More studies on other pain areas and syndromes are warranted.

Safety of Dry Needling

Several adverse effects associated specifically with dry needling have been reported: post-needling soreness [24], hemorrhages at the needling site [24], syncopal responses [25], and acute cervical epidural hematoma [26]. However, adverse effects of acupuncture performed by physicians and therefore similar to those of dry needling are well described [27–29]. In a prospective study of 229,230 patients who received on average 10.2 ± 3.0 acupuncture treatments from 13,679 German physicians with acupuncture training [28], 8.6 % of the patients reported at least one adverse effect and 2.2 % reported one which required treatment. Common adverse effects were bleedings or hematoma (6.1 % of patients, 58 % of all adverse effects), pain (1.7 %), vegetative symptoms (0.7 %), and two patients who experienced a pneumothorax. In a British study on acupuncture performed by physicians and physical therapists [29], no serious adverse effects was reported and the frequency of minor adverse effects was 671 per 10,000 acupuncture sessions including 14 per 10,000 events that were reported as "significant," but even in those events pain resolved within 1 week. Several cases of pneumothorax caused by acupuncture or dry needling were recently reviewed by McCutcheon and Yelland [27]. The authors concluded that the incidence of acupuncture-induced pneumothorax is very low, less than 1/10,000 [30]; however, they still were able to find reports of more than 100 cases of pneumothorax, including 4 cases of death due to acupuncture or dry needling [27], and recently some additional cases that were not included in this review were published [31, 32]. Most pneumothoraces associated with acupuncture and dry needling are unilateral, although cases of bilateral pneumothoraces have been reported [31, 33, 34].

Concluding the aforementioned results, the dry needling provided by trained physicians or physical therapists can be considered as a safe treatment. Serious adverse effects of dry needling are very rare and, as suggested Yamashita et al. [35], results of therapists' negligence. Special caution is needed while needling in a thoracic and cervical region. Therapists should consider the relevant anatomy and not use dry needling in these areas without adequate training.

Conclusions

Significant endeavors have been invested in recent years in the research of myofascial pain in general and in dry needling as a treatment for myofascial pain in particular. Two new imaging modalities were introduced (sonoelastography and MRE) that allow noninvasive imaging of MTrPs. Future studies are needed to assess the validity, reliability, and clinical application of these methods.

The latest updates on the pathophysiology of myofascial pain included the confirmation of elevated levels of inflammatory mediators known to be associated with persistent pain states and myofascial tenderness in the vicinity of active MTrPs. It was also proven that this local milieu appears to change with the occurrence of LTR.

The central nervous system response to MTrPs dry needling was recently presented in a few articles. MTrPs were found to be discrete secondary peripheral neurogenic manifestations of central sensitization, and it was found that intervention within an MTrP at least partially involves supraspinal pain control via midbrain periaqueductal gray matter activation. As long as there are intact nerves from the stimulating site to the spinal cord and a normally functioning spinal cord there is a beneficial effect for remote MTrPs dry needling on myofascial pain control. It was also found that the depth of needling is of great importance in order to achieve a lasting relief of myofascial pain. The needle must not only penetrate the skin, but also underlying fascia and most importantly the muscle tissue.

The latest studies on effectiveness of dry needling confirmed the conclusions of previous studies and reviews that dry needling is an effective method of treatment of MTrPs. The substance injected, if at all, seems to be unimportant compared to the needle effect. A recent study, utilizing distal muscle stimulation for proximal pain, has given evidence for an effect on the diffuse noxious inhibitory control. This has important implications for it is not uncommon to treat a patient who is too sensitive to be needled in the area of the primary pain source. In these cases, it might be prudent to initiate treatment with distal needling using the effect of diffuse noxious inhibitory control.

Most studies and reviews that evaluated the safety of dry needling concluded that it is a safe treatment, but must be provided only by adequately trained physicians or physical therapists. Special caution is needed while needling in a thoracic and cervical region.

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