# Remote Therapeutic Effectiveness of Acupuncture in Treating Myofascial Trigger Point of the Upper Trapezius Muscle

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**ABSTRACT**

**Objective:** To investigate the remote effect of acupuncture (AcP) on the pain intensity and the irritability of the myofascial trigger point (MTrP) in the upper trapezius muscle.

**Design:** Forty-five patients were equally divided into 3 groups: patients in the "placebo control (PC)" group received sham AcP; "simple needling (SN)" group was treated with simple needling, and "modified acupuncture (MAcP)" received AcP with the rapid "screwed in-and-out" into multiple sites to elicit local twitch responses. The acupoints of *Wai-guan* and *Qu-chi* were treated. The outcome assessments included changes in subjective pain intensity (PI), pressure pain threshold (PPT), range of motion (ROM) and mean amplitude of endplate noise (EPN) in the MTrP region.

**Results:** Immediately after acupuncture, all measured parameters improved significantly in the SN and MAcP groups, but not in the PC group. There were significantly larger changes in all parameters in the MAcP group than that in the SN group.

**Conclusions:** The MTrP irritability could be suppressed after a remote acupuncture treatment. It appears that needling to the remote AcP points with multiple needle insertions of MAcP technique is a better technique than simple needling insertion of SN technique in terms of the decrease in pain intensity and prevalence of EPN and the increase in PPT in the needling sites (represented either AcP points and or MTrPs). We have further confirmed that the reduction in EPN showed good correlation with a decreased in pain.

**Key Words:** Acupuncture, Endplate Noise, Myofascial Trigger Point, Pain Control, Remote Effects

## INTRODUCTION

Clinically, a myofascial trigger point (MTrP) is the most tender (hyperirritable) spot in a taut band of skeletal muscle fibers, and is characterized by a specific pattern of referred pain and local twitch responses (LTRs)[1, 2]. Based on both human and animal studies, it has been suggested that there are multiple sensitive loci in an MTrP region[3, 4]. These sensitive loci are probably nociceptors located in the endplate zone[5]. The prevalence of endplate noise (EPN), as recorded by an electromyographic (EMG) equipment, is significantly higher in an MTrP region than in a non-MTrP region[6, 7] and is highly correlated with the irritability (sensitivity) of an MTrP[8]. Recently, it was found that changes in EPN amplitude correlated significantly with changes in MTrP irritability[9]. Therefore, MTrP irritability can be assessed objectively by EPN prevalence or amplitude changes in the MTrP region.

Traditional acupuncture (AcP) therapy is probably the oldest type of dry needling. Dry needling (including AcP) has been reported to control the pain due to MTrPs [10-16]. Acupuncture has been widely used for treating patients with acute or chronic pain. Previous reports on the efficacy of traditional acupuncture for pain control have yielded conflicting results[17-22]. Birch[23] claimed that the controversy stems from the variety of acupuncture therapies, and that it is important to use standardized treatment methods, appropriate sham needle controls, and blind assessment to draw definitive conclusions (as in any therapeutic study).

In addition to direct needling of the painful MTrP, clinical studies have demonstrated a suppressive effect on MTrP after dry needling at a remote MTrP or acupuncture point either proximal or distal to the painful region[24-28]. A similar remote effect in pain control has also been documented in acupuncture therapy[9, 29, 30]. In clinical practice, patients often report severe pain in the upper trapezius muscle (shoulder and neck ache) but prefer not to have direct needling on this muscle. In such cases, remote needling can be a valuable therapeutic alternative. Indeed, remote needling therapy can also be used if there is another pathological lesion in the painful region precludes direct needling at the painful site.

For dry needling of MTrP, practitioners have been advised to obtain as many LTRs as possible to obtain rapid and maximal pain relief [12, 13, 31-33]. Multiple needle insertions into various sites in the MTrP regions are required to elicit multiple LTRs [1, 3]. Recently, a modified acupuncture (MAcP) therapy similar to MTrP injection[34] has been developed and has excellent effectiveness on a patient with fibromyalgia[34]. This modified technique includes simultaneous twists of the acupuncture needle during "multiple rapid needle insertions" to facilitate the needle insertion. Many previous studies with dry needling also applied the multiple needle insertion technique using injection needles or EMG needles [12, 13, 15]. However, in this technique an acupuncture needle was used and screwing technique was also added to facilitate the needle movement since it is very difficult to move the AcP needle by only direct needle insertion. In a recent study on its therapeutic effectiveness, the irritability (as measured by subjective pain intensity, pain threshold, and amplitude change of EPN) of the MTrP in the upper trapezius muscle was suppressed after needling remote acupuncture points[9]. This newly developed AcP method is referred to as the "screwed in-and-out" technique[9]. However, the effectiveness of this technique has not been compared with the other needling techniques.

In this study, using the changes in the mean amplitude of endplate noise (EPN) recorded from the MTrP region as an objective outcome measurement, we compared the effectiveness of this new AcP technique with the simple needling techniques for treating MTrPs of the upper trapezius muscle in patients with chronic shoulder pain.

## MATERIALS AND METHODS

### Design and Setting

Patients were equally divided into three comparable groups: patients in the first group were treated with modified acupuncture (MAcP group), the second group with simple needling (SN group), and the third group with a placebo (control; PC group). All patients were treated on two AcP points (also MTrPs) following a predetermined sequence (Figure 1). For every patient, the subjective pain intensity, pressure pain threshold, and objective changes in the ROM of the cervical spine were assessed before and after treatment. End plate noise in the MTrP region of the upper trapezius muscle was monitored and assessed before, during, and after treatment (Figure 1). The acupuncturist performing the intervention did not perform outcome assessment. Investigators conducting the outcome assessment were blind to the group assignment.

## Participants

Patients for this study were selected from the rehabilitation department of a university hospital by a physiatrist who was not involved in the outcome measure. Inclusion was based on three criteria: (1) patients suffered from chronic pain at a subjective pain levels greater than 5/10 (0/10 = no pain; 10/10 = worst pain; 5/10 or lower = tolerable pain) on one side of the shoulder due to active MTrPs in the ipsilateral upper trapezius muscle; (2) patients had no previous acupuncture treatment; and (3) patients demonstrated poor response to previous conservative and non-invasive treatments such as oral medicine or physical therapy.

The exclusion criteria include the following: (1) patients with conditions of contraindication for needling, such as intake of anticoagulant medicine, local infection, malignancy, or pregnancy with threatened abortion; (2) patients with conditions that might interfere with assessments of pain intensity or pain threshold, such as use of analgesics or sedatives, substance abuse (including alcohol and narcotics), or cognitive deficiency; (3) those with previous trauma or surgery to the neck, upper back, or upper limb regions; and (4) patients with a history of significant neurological disease involving the neck or upper limb (either central or peripheral in origin).

Assessment of patient suitability using the inclusion and exclusion criteria was based on the patients' detailed medical history and a physical examination. Selected patients were divided equally into 3 groups matched by gender and side of involvement. Patients were assigned to the modified acupuncture (MAcP), simple needling (SN), or to the placebo control (PC) groups using a computerized randomization program. All patients gave informed consent and the study was approved by the Institutional Review Board of the university.

## Identification of Myofascial Trigger Points

Active MTrP in the upper trapezius muscle was identified by the examiner using palpation examinations as recommended by Travell and Simons [1, 2, 35] and defined by the following criteria: (1) the most sensitive (tender) spot in a palpable taut band, (2) compression of this spot induced pain qualitatively similar to the patient's usual clinical complaints (pain recognition), and (3) typical referred pain pattern elicited by compression of this spot as described by Travell and Simons [1, 2, 35]. The identified active MTrP of the upper trapezius muscle was marked on the skin within an area approximately 1 cm in diameter for the assessment of pressure pain threshold and EPN.

**Identification of Acupuncture Points**

Two acupuncture points were selected for treatment in this study. The first AcP point, TE-5 (*Wai-guan*), is located in the extensor indicis muscle of the dorsal forearm between the radius and ulna and 3 cm superior to the dorsal transverse wrist crease. The second AcP point, LI-11 (*Qu-chi*), is located in the extensor carpi radialis longus muscle and on the lateral side of the cubital crease when the elbow is at its full flexion (Figure 2). These two AcP points were determined and marked for subsequent study by a well-trained licensed acupuncture instructor who was not involved in the outcome assessment. Both AcP points have been selected frequently for neck and shoulder pain treatment [36-38]. The LI-11 AcP point is located in the meridian of the large intestine, and the TE-5 AcP point is located in the meridian of the triple heater (San-Jiao). Both meridians pass through the upper trapezius muscle in the shoulder. Using these two points for treating pain in the upper trapezius muscle was reasonable because we obtained satisfactory results needling these two AcP points in a previous study[9, 34]. These two AcP points were also MTrPs (Ah-Shi points) as confirmed by a careful palpation examination and the occurrence of LTRs during needling.

**Treatment Procedures**

The same acupuncturist who initially identified the AcP points performed all treatment procedures. Patients were treated in a comfortable prone position, with the head turned toward the contralateral side and the ipsilateral upper limb placed near the side of the examination table (Figure 2). In this position, acupuncture needling to the forearm muscle and recording of EPN from the MTrP of the upper trapezius muscle on the same side could be performed simultaneously. During acupuncture treatment, patients were not able to observe either the treatment procedure on the forearm or the EMG recording of EPN from the MTrP of the upper trapezius muscle (Figure 2).

Before the insertion of the acupuncture needle, the skin over the marked acupuncture point was cleaned with alcohol. For every patient in the MAcP or SN group, disposable acupuncture needles with a size of #30 and a length of one-inch or $1^{1}/_{2}$-inch (37-mm) were used.

For treating patients in the MAcP group**,** a newly modified technique was used for acupuncture therapy. Acupuncture needles were inserted into the regular depth in the subcutaneous layer. Similar to the technique of MTrP injection as suggested by Hong [2, 3, 13], the needle was moved “in-and-out” into different directions at a speed of about 2 cm/sec to elicit LTRs. Simultaneous rotation of the needle was also performed to facilitate the “in-and-out” movement (“screwing in-and-out” technique [9]). With this rapid needle movement (high pressure), the LTRs were much easier to elicit (inducing the “*De-qi*” effect). This technique continued for 15 seconds to further elicit as many LTRs as possible, and then the needle insertion was maintained without any movement for 3 minutes or longer for the temporary relief of pain accompanied with LTRs. The sequence of treatment is presented in Figure 1. For each subject, the TE-5 AcP point was treated first. About 5 minutes after the completion of the needle manipulation (screwing in-and-out) at TE-5 point, the LI-11 point was treated with the same procedure while the acupuncture needle remained motionless in the TE-5 point. Five minutes after the completion of the needle manipulation at the LI-11 point, both needles were manipulated (“screwed in-and-out”) simultaneously for 15 seconds and then maintained in a steady position for another 3 minutes. The acupuncturist simultaneously used two hands for the manipulation of the two needles. This procedure required a significant period of practice to avoid needle bending or cork-screw deformity.

For treatment of patients in the SN group, acupuncture needles were inserted into the regular depth at both acupuncture points. Then, the needle was maintained without movement throughout the course of treatment. Theoretically, an LTR should be elicited only occasionally in response to a single needle insertion. However, in our study, we did not observe any LTR during simple needling therapy.

In the PC group, each patient was treated with an acupuncture needle inserted into a rubber connector that was firmly taped onto the marked point for acupuncture [9, 39]. There was needle-to-skin contact, and the patient would be able to feel the sharp needle tip; the needle, however, did not penetrate the skin. The needle was maintained in the abovementioned position throughout the course of the treatment.

**Assessment of Subjective Pain Intensity**

Patients reported pain intensity based on a numerical rating scale from 0 to 10, with zero representing “no pain” and ten representing “worst imaginable pain.” Pain intensity in the upper trapezius region was assessed before and after the completion of acupuncture therapy (Figure 1). Pain intensity was not assessed during treatment beacuse severe pain at the acupuncture site during needle manipulation in some patients of the MAcP group might interfere with feeling in the upper trapezius region. The duration of pain relief after treatment was assessed by phone follow-up one month after completion of the study, since we expected that the duration of effectiveness might be similar to that observed following treatment of MTrP with dry needling[13].

**Assessment of Pressure Pain Threshold**

Pressure algometry was used to measure pain threshold. The procedure was similar to that recommendation of Fischer [40, 41]. For each patient, pressure pain threshold at the marked MTrP in the upper trapezius muscle was measured by a well-trained assistant who was blind to the treatment (MAcP, SN, or PC).

After the tests were explained, the patient was asked to completely relax in a comfortable chair. The metal rod of the algometer was placed perpendicularly on the skin surface of the marked area, and the pressure of compression was increased gradually at a speed of approximately 1 kg/sec. The patient was instructed to say ”PAIN” as soon as any increase in pain intensity or discomfort was felt; compression was stopped as soon as the patient said “PAIN”. The patient was asked to remember this level of pain or discomfort and use the same criterion for the next measurement. Three repetitive measurements were performed at intervals of 30-60 seconds at one site. The average value of the three readings (expressed as $kg/cm^2$) was recorded for data analysis of the pressure pain threshold measurement.

**Assessment of Range of Motion**

The ROM of neck bending to the contralateral side (stretching of the ipsilateral upper trapezius muscle) was measured with a large-scale goniometer. The patient was asked to sit straight with the back of the head just in front of the goniometer, which was fixed to the sliding bar of a body-height measuring device. This height was adjusted so that the center of the goniometer was level with the C7 spinous process. An indicator was fastened perpendicularly to the occipitus using a strap around the forehead and occipitus; the indicator was fixed to the patient’s head by a velcro fastener. The patient was then asked to bend the neck to the side and the angle was recorded. To measure the maximum active ROM, each patient was also requested to bend the neck fully toward the non-painful side without moving the trunk.

**Assessment of Changes in Endplate Noise**

***Equipment***

A portable, miniature, two-channel digital EMG (Neuro-EMG-Micro, © Neurosoft, Ivanovo, Russia) was used for this study. Intramuscular EMG activity was recorded using 37 mm, disposable, monopolar Teflon-coated EMG needle electrodes. The length of the exposed needle tip ranged from 0.4-0.5 millimeters. The gain was set at 20 μV per division for recordings both the first and second channels. The low-cut frequency filter was set at 100 Hz and the high-cut at 1,000 Hz. Sweep speed was 10 ms per division. The first channel recorded the EMG activity from the active electrode, which was moved around the MTrP site to find the optimal position for EPN recording. The second channel recorded the EMG activity from the active (recording) electrode at the control site (electrically silent site) in the muscle tissue adjacent to the MTrP site where no EMG activity could be recorded and no pain could be elicited at the insertion site of the recording needle connecting the second channel (so that it was not a latent MTrP). A third needle electrode served as the common reference electrode by connecting it to channels one and two through "Y" connectors (Figure 3). The common reference needle electrode was placed in the subcutaneous tissue approximately 2-3 cm from the active recording site. In such an arrangement, action potentials recorded from the first channel can be confirmed as those recorded exactly from the recording needle tip of the first channel if the recording from the second channel is flat (electrically silent with no baseline fluctuations higher than 5 μV). A ground electrode was placed on the skin of the ipsilateral shoulder. Recordings were performed at room temperature (21 ± 1°C).

***Procedure for Searching for the EPN Loci***

The active recording needle in the first channel was inserted into the MTrP region of the upper trapezius muscle to search for the EPN. The electrode tip was initially placed in the subcutaneous layer under the margin of the marked region at a depth of approximately 1-2 mm into the muscle. The needle was moved into the muscle tissue gently and slowly through the least possible distance (usually 1-2 mm) with simultaneous rotation in order to facilitate smooth entry while not eliciting an LTR similar to that used in previous studies [6-8, 42]. As soon as an EPN with a maximal amplitude (higher than 10 μV) could be recorded, the examiner stopped moving the needle to ensure that this EPN could run continuously on the recording screen with constant amplitudes. The recording needle was then fixed firmly onto the skin with tape to avoid any further movement. The acupuncturist began the acupuncture therapy (Figure 1) as soon as the EPN amplitude was stable. Continuous EPN traces were recorded throughout the course of the treatment (acupuncture or placebo) to provide opportunities for continuous visual observation of EPN changes.

***Measurement of EPN Amplitude***

Selected EPN recordings (100 ms sweeps) were analyzed by the same investigator who conducted the EPN assessment before treatment. Sweeps were recorded at the initiation of treatment, during acupuncture, and 3 minutes after the completion of the acupuncture treatment (Figure 1). The mean amplitude of the EPN was calculated using embedded software in the Neuro-EMG-Micro equipment.

### Statistical Analysis

Mean and standard deviations for pain intensity, pressure of pain threshold, range of neck side bending (ROM), and mean EPN amplitude were calculated. For the assessment of pain intensity, pressure of pain threshold, and range of neck motion, the paired t-test was used to assess the differences between the means before and after acupuncture treatment, whereas one way ANOVA was used to compare means among the three groups. Temporal changes in mean EPN amplitude before, during, and after acupuncture were assessed using repeated measures ANOVA. The threshold for statistical significance was $P < 0.05$. All data were analyzed using the Statistical Package for the Social Sciences version 10.0 for Windows.

## RESULTS

### Demographic Information

A total of 45 patients (15 in each group) with unilateral MTrPs in the upper trapezius muscle were enrolled in this study (Figure 4). Every patient reported pain intensity greater than 5/10 for a period longer than three months. Patients usually sought treatment when the pain level reached 5/10 or higher. Table 1 shows the patient demographic information. There were no significant differences in demographic parameters between the three groups.

### Pain Intensity (Verbally Reported Numerical Pain Scale)

Compared with the baseline data before the treatment, the pain intensity of the upper trapezius muscle significantly decreased after the completion of treatment in the MAcP and SN groups ($P$ <0.05) (Table 2). However, in the PC group, there was no significant change in pain intensity after treatment ($P >$ 0.05). The mean verbally reported pain scale in the MAcP group was significantly lower than that in any of the other two groups following treatments ($P < 0.05$). Based on the follow-up phone call, the duration of pain relief lasted significantly longer ($P < 0.05$) in the MAcP group than in either the SN or PC group.

**Pressure Pain Threshold**

As shown in Table 2, there was a significant increase in pain threshold after completion of the MAcP and SN treatments ($P < 0.05$), but not after PC treatment ($P > 0.05$). The degree of improvement in the pressure pain threshold was significantly higher in the MAcP group than that in either the SN or PC groups ($P < 0.05$).

**Range of Motion of the Neck**

As listed in Table 2, there were significant increases in the mean ROM after both MAcP and SN treatments ($P < 0.05$), but not following sham (PC) treatment ($P > 0.05$). The degree of improvement (expressed as % increase = [(data after treatment – data before treatment) / data before treatment] x 100%) of ROM during neck side bending was significantly higher in the MAcP group than that in the SN or PC groups ($P < 0.05$).

**Mean Amplitude of Endplate Noise**

The changes in the mean EPN amplitude before, during, and after treatment in the three groups are presented in Figure 5. In the MAcP group, every patient exhibited an increased EPN amplitude upon initiation of the needle manipulation ("screwing in-and-out") that decreased within a few seconds following completion of the needle movement. In the MAcP treatment group, there was a tendency for the simultaneous two-needle manipulation to exert larger changes in mean EPN amplitude than needle manipulation at only one AcP point. Changes in EPN amplitude were more modest in the SN group, while EPN amplitude did not change significantly in the PC group.

Statistical analyses of the changes in the mean EPN amplitude in all three groups are listed in Table 3. After the completion of the treatments, the mean EPN amplitudes were reduced ($P < 0.05$) in the MAcP and SN groups but not in the PC group ($P > 0.05$). The percentage of amplitude change (% increase = [(data after treatment – data before treatment) / data before treatment] x 100%) was significantly higher ($P < 0.05$) in the MAcP group than that in the SN or PC groups during needling treatment and three minutes after needle manipulation was stopped (Figure 6).

## DISCUSSION

### Summary of the Important Findings in This Study

This study demonstrates that the MAcP treatment provided better effectiveness than simple needling therapy for suppressing irritability (i.e., pain intensity, pain threshold, and EPN amplitude) of a remote MTrP and releasing muscle tightness in the shoulder and neck. We further confirm that the changes in mean EPN amplitude are a good objective outcome measurement.

### Dry Needling and Acupuncture For Pain Control

The multiple insertion technique was originally developed by Travell[1], who performed this procedure slowly. Considering the time consuming and the possibility of cutting muscle fibers due to the side movement of the needle, Hong suggested a "fast-in and fast-out technique" to keep the straight needle insertion (avoiding side movement) easily and shorten the time of injection, and found that LTRs could be elicited much more easily than with slow needle insertion[13, 43]. It has also been suggested that LTRs should be elicited by dry needling during treatment of MTrPs [12, 13]. In order to elicit many LTRs, the needle should be inserted into multiple sites (tiny loci) in the MTrP region. Fast needle movement is required to produce high pressure (force = mass x acceleration) to facilitate LTR occurrence and to avoid side movement of the needle that may cause traction injury to the muscle fibers [3, 13, 43]. Considering the greater possibility of muscle fiber damage from multiple fast needle insertions, Chu suggested the use of an EMG needle for fast movement [12]. However, EMG needles are relatively large and may not be tolerable for some patients. Furthermore, EMG needles are expensive. Instead, Gunn used a small-size acupuncture needle for dry needling, but he did not emphasize multiple needle insertions at a fast speed [16].

In regular acupuncture therapy, immediate pain relief can be obtained only if the patient experiences the "*De-qi*" reaction during therapy, which has been described as soreness, numbness, heaviness, tingling, and sometimes muscle twitching [14, 17, 44, 45]. These "*De-qi*" sensations can be elicited from some but not all acupoints during needling; this is probably related to the characteristics of the acupoints or the needling method used by the acupuncturist. Muscle twitching during the occurrence of "*De-qi*" is similar to the LTRs elicited by the high-pressure stimulation to nociceptors during MTrP injection [3, 31-33, 43]. Melzack considered it as hyperstimulation analgesia [46]. Some authorities have suggested that the mechanism of acupuncture is probably similar to that of MTrP injections or dry needling of MTrPs [3, 12, 15, 32, 43, 46]. The mechanism of immediate local pain relief at the site of needling after acupuncture or dry needling has been considered to be mediated via the neural pathway [10, 32] because the biochemical reaction would be much slower than neural impulses. It has been suggested that strong (high pressure) stimulation from the needle tip to the nociceptor evokes a strong spinal cord reflex that elicits an LTR. In turn, this deactivates the "MTrP circuit" in the spinal cord[31, 33] via the descending pain inhibitory system elicited by strong painful stimuli (hyperstimulation analgesia). Accompanied phenomena with pain relief in this study included increased pressure pain threshold, increased ROM due to decreased tightness of the involved muscle fibers (taut bands), and decreased EPN amplitudes. Simons suggested that EPNs are due to the excessive leakage of acetylcholine from the muscle endplates that causes focal depolarization (non-propagated potentials) of sarcomeres within the endplate zone without spreading out (no action potentials) to the whole muscle fiber [2, 47]. Therefore, sarcomere shortening will only occurs around the endplate zone with a relative lengthening of the sarcomeres in the two ends and concomitant tightness in the muscle fibers (taut band). The reduced EPN amplitude after needling in this study suggests reduced acetylcholine leakage after treatment, thus relieving muscle tightness.

In recent studies [48, 49], Shah found that the concentrations of all analyzed biochemical substances were significantly higher in active than latent or normal subjects. He has further found that those biochemicals levels were remarkably elevated in the MTrP region during LTRs, followed by a slow return to baseline. However, substance P (SP) and calcitonin gene-related peptide (CGRP) were the only two biochemicals for which concentrations during the recovery period after the LTRs were significantly below the baseline concentrations [48]. This reduced SP and CGRP may explain the immediate pain relief experienced following LTRs during MTrP injection. Therefore, the possible mechanism of pain relief after LTR could be central (as mentioned above), local (as suggested by Shah), or both. Furthermore, the EPN changes could also be affected by sympathetic tone [42, 50] through mechanisms that again could be mediated centrally, locally, or both.

**Mechanism of the Remote Effect of Acupuncture**

In many cases, the sites of acupuncture needling are remote to the painful site [36-38, 51]. Based on the principle of traditional acupuncture, Tseng et al. [26] and Tsai et al. [28] demonstrated an effective way to inactivate a severe (hyperirritable) MTrP by the injection of other MTrPs remote to this MTrP. The injected MTrP was also an AcP point (*A-Shi* point).

According to the theory of traditional Chinese acupuncture, needling of an acupuncture point can induce specific therapeutic effects both locally or at a distance through the acupuncture "meridians" system [44, 52]. Regarding the mechanism of remote acupuncture effects, it is probably related to a spinal cord mechanism similar to the MTrP mechanism [4, 32]. A recent study by Hsieh et al. [27] demonstrated that dry needle-evoked inactivation of a primary [25] MTrP could inhibit the activity of satellite MTrPs situated in the zone of pain referral of this primary MTrP. It is possible that activation of the nociceptors in the skin or muscles by needle stimulation (high pressure) can send strong sensory impulses to the spinal cord or higher centers to activate the descending pain inhibitory system for the central desensitization of all the related "neural circuits" of pain modulation (similar to "MTrP circuits" described by Hong [31, 33]).

**Modified Acupuncture (MAcP) Therapy**

Nabeta and Kawakita [53] applied an acupuncture technique, called "*sparrow pecking*" that utilized an alternative pushing and pulling of the needle on the tender points for neck and shoulder pain. However, they did not apply the technique of multiple insertions, and only performed "in-and-out" in one track.

Using this modified acupuncture therapy, we can combine the advantages of both MTrP injection (rapid multiple insertions to elicit many LTRs) and acupuncture (small-diameter needle without a sharp cutting-end edge to avoid tissue damage and excessive pain). Since the small-diameter needle is too flexible to do fast-in and fast-out movements smoothly, simultaneous twisting (screwing) of the needle is used to facilitate needle movement. Pain caused by MAcP therapy is lower than that elicited by MTrP injection with Hong's technique [3, 43], but the pain is still higher than that caused by regular AcP treatment. However, the effectiveness is superior to regular AcP. The pain caused by this procedure is usually tolerable for most patients, even the patient with fibromyalgia [34]. Therefore, most patients could accept this new procedure.

Based on the traditional acupuncture viewpoint, simultaneous stimulation of two AcP points can enhance efficacy due to the "accumulation of energy" [36-38], similar to the enhancement of central desensitization through multiple afferent stimuli as a consequence of hyperstimulation analgesia [46]. This is probably the reason why simultaneous needle manipulation at two AcP points can provide a better anagesic effect than a single-needle stimulation.

In this study, we compared the MAcP technique with a simple needling (SN) technique. The "simple needling" technique is similar to Badry's superficial needling[11], which is actually a hybrid of "sham" needling and the "simple acupuncture" technique. In our clinical observation in oriental countries, many so-called "traditional acupuncturists" just provide a simple needle insertion with no attempt to elicit "*De-qi*" effectiveness (similar to local twitch response), but they still claimed satisfactory effects after therapy. In old Chinese acupuncture books [54], "*De-qi*" effectiveness was mentioned and considered a good indicator of a satisfactory acupuncture result. However, it was never emphasized that every single acupuncture therapy should obtain the "*De-qi*" effectiveness. Using a single insertion technique, it appears difficult to obtain the "*De-qi*" effect or local twitch responses. This is probably the major reason to explain that acupuncture therapy may or may not be effective for pain control in previous studies [17-22]. We have emphasized the importance of multiple needle insertions for acupuncture similar to that originally suggested by Travel for the MTrP injection [1]. The facilitation to obtain LTRs (or *De-qi* effects) by using this technique was probably the major reason why this technique was superior to the traditional simple needling technique.

**Short-term Effectiveness of Acupuncture therapy**

In most occasions, acupuncture or MTrP dry needling (or injection) was used for a temporary pain control which, sometimes, is very important in clinical practice [3, 31]. Hong has emphasized that the underlying cause of muscle pain (or myofascial pain) should be eliminated completely before considering MTrP injection. However, in some occasions (such as difficulty in or delay of identification of the underlying etiology of muscle pain, difficulty in or delay of successful therapy of the underlying etiology of muscle pain, severe or intolerable muscle pain, persistent pain after elimination of underlying etiology of muscle pain, etc.), MTrP needling or injection is a viable alternative. Therefore, a very long-term effectiveness of acupuncture or MTrP dry needling was usually not expected, and they were usually performed clinically for temporary pain control. Hong found that MTrP injection or needling was effective for up to 2 weeks [13]. In this study, we found that pain relief following remote acupuncture using this new technique lasted for only one week or less on average. This appears to be much shorter than the effects observed following direct needling to an MTrP [3, 32, 43]. Pain relief for few days may be clinically significant, however, if it allows the patient to reduce oral medication (especially narcotic drugs) or if the patient can be treated repetitively. However, it is unclear if this new technique can provide longer pain relief than other techniques when used repeatedly.

**Limitation of This Study**

The first and most critical limitation is the small sample size due to the difficulty of patient selection. The statistical analyses showed significant changes in both subjective and objective assessments compared with a control group; thus, the information still provided a significant demonstration of the superior efficacy of this new technique over simple needling.

A second limitation is the difficulty in pain intensity assessment on the proximal MTrP of the upper trapezius muscle *during* acupuncture on the remote sites because the pain elicited by remote needling could mask the pain in the proximal MTrP. Therefore, only the pain intensity *before* and *after* needling was assessed in this study.

The third issue is the difficulty in performing a blind study on AcP therapy. We tried to select patients with no prior AcP treatment for this study to reduce bias. However, the sharp pain produced when LTRs were elicited during multiple needling insertions could indirectly inform a patient about the "real needle treatment". Therefore, a patient who received MAcP therapy may be aware of receiving the real needling treatment, while this probably did not occur in the other two groups. The blindness in this study might not be validated.

The fourth limitation is the difficulty in the continuous monitoring of EPN. Although the recording electrode is tightly taped on the skin, a slight movement of the needle is still possible and may interfere with the changes in EPN amplitude. During the treatment with MAcP, severe pain in the needling region of the forearm may cause a slight movement in the ipsilateral shoulder, although most of the subjects could tolerate the pain and remain relaxed. Therefore, the increase in EPN amplitude immediately after MAcP could be related to the pain from peripheral needling. However, the subsequent decrease in EPN amplitude following treatment was definitely related to the MAcP therapy. One may question the possibility of eliciting LTRs when the peripheral (remote) pain occurred and caused a slight movement of the recording needle. However, in the whole experiment, we never observed any LTR accompanied with the monitored EPN tracings. Therefore, the therapeutic effectiveness manifested with reduced EPN amplitude should not be related to the pain caused by the remote MAcP therapy. It may also be further questioned that the EMG needle for EPN recording may have the effect of a superficial dry needle [11] so that the upper trapezius pain can be treated in this way. However, this effect can be ignored due to the significant differences in all outcome measures among the three groups.

In the future, similar studies should be conducted on a large sample with a better control group and a better way to assess the pain intensity and a long-term follow-up after repeated treatments is strongly suggested. It is also important to try needling on other AcP points in remote regions.

**CONCLUSIONS**

We have further confirmed that the mean amplitude of endplate noise, as recorded by EMG, is highly correlated with the irritability (sensitivity) of an MTrP. Furthermore, changes in EPN amplitude can be used as an objective outcome measurement. We have also found that the MTrP irritability can be suppressed after a remote acupuncture treatment. It appears that needling to the remote AcP points with multiple needle insertions of MAcP technique is a better technique than simple needling insertion of SN technique in terms of the decrease in pain intensity and prevalence of EPN and the increase in PPT in the needling sites (represented either AcP points and or MTrPs).

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**FIGURE LEGENDS**

**Figure 1:** Sequences of acupuncture therapy and assessment in the whole course of the experiment.

**Figure 2:** The patient was treated with acupuncture on the forearm while EPN was recorded from the MTrP in the ipsilateral upper trapezius muscle.

**Figure 3:** Placement and connection of electrodes for EPN assessment and the recorded EPN traces from the first channel (top in right) compared to a control trace recorded from the second channel (bottom in right).

**Figure 4:** Flow chart summarizing follow-up on clinical outcomes and treatment preferences.

**Figure 5:** The changes of the mean EPN amplitude in the three treatment groups.

**Figure 6:** The percentage amplitude change during and after needle manipulation (needle retained for 3 minutes) in the three groups.