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RESEARCH ARTICLE

Dry Needling to a Key Myofascial Trigger Point May Reduce the Irritability of Satellite MTrPs

ABSTRACT

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 myofascial trigger points. Am J Phys Med Rehabil 2007;86:397–403.

Objective: To investigate the changes in pressure pain threshold of the secondary (satellite) myofascial trigger points (MTrPs) after dry needling of a primary (key) active MTrP.

Design: Single blinded within-subject design, with the same subjects serving as their own controls (randomized). Fourteen patients with bilateral shoulder pain and active MTrPs in bilateral infraspinatus muscles were involved. An MTrP in the infraspinatus muscle on a randomly selected side was dry needled, and the MTrP on the contralateral side was not (control). Shoulder pain intensity, range of motion (ROM) of shoulder internal rotation, and pressure pain threshold of the MTrPs in the infraspinatus, anterior deltoid, and extensor carpi radialis longus muscles were measured in both sides before and immediately after dry needling.

Results: Both active and passive ROM of shoulder internal rotation, and the pressure pain threshold of MTrPs on the treated side, were significantly increased ($P < 0.01$), and the pain intensity of the treated shoulder was significantly reduced ($P < 0.001$) after dry needling. However, there were no significant changes in all parameters in the control (untreated) side. Percent changes in the data after needling were also analyzed. For every parameter, the percent change was significantly higher in the treated side than in the control side.

Conclusions: This study provides evidence that dry needle–evoked inactivation of a primary (key) MTrP inhibits the activity in satellite MTrPs situated in its zone of pain referral. This supports the concept that activity in a primary MTrP leads to the development of activity in satellite MTrPs and the suggested spinal cord mechanism responsible for this phenomenon.

Key Words: Dry Needling, Myofascial Trigger Point, Referred Pain

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A myofascial trigger point (MTrP) has been defined as a hyperirritable (hypersensitive) spot in a taut band of skeletal muscle fibers.[1,2] It has been shown that a latent MTrP (i.e., one that is exquisitely tender but not a source of pain) can be identified in most skeletal muscles.[1,2] A latent MTrP can be activated to become an active MTrP, which is painful and very tender. In clinical observations, when an active MTrP is suppressed, it is still tender but not painful, and it becomes a latent MTrP. The latent MTrP may be activated to become an active one secondary to or associated with various pathologic conditions.[3–10] After appropriate treatment or control of this condition, the activated MTrP can be suppressed to become inactive. The MTrPs do not disappear; rather, they change from active to latent. There are two important characteristics of an active MTrP. One is pain referred from a distant site, the referred pain (ReP). The other is a local twitch response (LTR), which is a brisk contraction of a group of muscle fibers in a taut band, in response to a rapid, brief mechanical stimulation at an active MTrP site.[1,2]

Recent studies have helped make the pathophysiology of MTrP much clearer.[1,6,7] In an animal model, Hong and Torigoe[11] have observed that when pressure was applied at a hyperirritable site in the skeletal muscle of a rabbit, the animal showed evidence of severe discomfort. The latter, however, did not occur when similar pressure was applied at a nonsensitive site. In addition, at a hyperirritable site of this type, many LTRs could be elicited. On the basis of this animal model, there is reason to believe that an LTR is a spinal cord–mediated reflex.[11,12] There are a large number of sensitive loci in the region of an MTrP. When a sensitive locus is mechanically stimulated by a needle tip (high-pressure stimulation), an LTR can be elicited. This locus has been defined as an LTR locus.[7,13] An LTR locus has been shown to be one in which there are numerous nociceptive nerve endings.[14] These LTR loci are most frequently found in a muscle's endplate zone.[13] Endplate noise has been recorded much more frequently at MTrP sites than at any other parts of skeletal muscle in both human[15,16] and animal studies.[17,18] Simons and colleagues[1,16,18,19] have suggested that the taut bands found at MTrP sites may develop as a result of excessive acetylcholine leakage from dysfunctional motor nerve terminals.

In humans, stimulation of the LTR locus can elicit pain (low-pressure stimulation), ReP (moderate-pressure stimulation), and LTR (high pressure stimulation).[20–23] However, when the MTrP is hyperirritable, even low-pressure stimulation can elicit ReP and LTR.[20,22,23] It has been suggested that the degree of irritability is proportionate to the number of LTR loci (sensitized nociceptors) in the MTrP region.[6,23] It has been demonstrated that dry needling of MTrP is effective for pain relief.[21,23–30] In a human study on humans, Hong[21] has demonstrated that either injection of a local anesthetic agent into or dry needling carried out at an MTrP site are similarly effective in alleviating MTrP pain, as long as LTRs are elicited while carrying out either of these procedures. The pain-relieving mechanisms brought into action, however, are still unclear, even though many authors have stressed the importance of eliciting LTRs while carrying them out to obtain immediate and complete pain relief.[21,25,26,28–30]

In our clinical practice, we have observed the phenomena of interactions among primary (key) and satellite MTrPs situated in the zone of pain referral.[1,2,8,29,30] When a patient has multiple MTrPs, if a certain MTrP (primary or key MTrP) has been inactivated by means of needle stimulation, other MTrPs (secondary or satellite MTrPs) also can be suppressed.[1,2,8,29] To our knowledge, no clinical trial has previously been carried out to provide objective evidence of this phenomenon. The purpose of this study, therefore, was to do this by means of a single blinded study in which active bilateral infraspinatus MTrPs would be dry needled in a group of patients suffering from bilateral shoulder pain.

MATERIALS AND METHODS

General Design

Patients who had bilateral shoulder pain with active MTrPs in the infraspinatus muscles on both sides were recruited for this study. Each patient received treatment with dry needling of the MTrP in the infraspinatus muscle in a randomly selected side, but no treatment of the MTrP on the control side. The range of motion (ROM) of shoulder internal rotation, the pain intensity in the shoulder (including MTrPs in infraspinatus), and the pressure pain thresholds of MTrPs in the infraspinatus, anterior deltoid, and extensor carpi radialis longus muscles were assessed in both sides (experiment = treated side; control = untreated side) before and immediately after dry needling. Each subject was served for both control and experimental groups, with no treatment on one side and dry needling on the other side. In this way, the homogeneity (similar tissues in one human body) of the samples could be improved. Normalization of data (percentage of differences between the pre- and posttreatment data) for statistical analysis was also performed to eliminate the bias from the differences in the pretreatment data between two groups.

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Subjects

For this study, 14 patients (eight males and six females, average age: 60.2 ± 13.2 yrs) with bilateral shoulder pain were selected from a pain-control clinic of a university hospital for this study. The causes of shoulder pain included fibromyalgia (three males and three females), subacromial bursitis (four males and three females), and rotator cuff tendonopathy (one male). Each subject signed the consent form, which had been approved by our university's institutional review board. The inclusion/exclusion criteria of selection included:

1. Having bilateral shoulder pain without treatment other than oral medication for at least 3 mos.
2. Having active MTrPs in the infraspinatus muscles in both sides.
3. Having no contraindication for needling of infraspinatus muscle, such as local infection, serious medical problems, recent multiple trauma, or pregnancy with threatened abortion.
4. Having no condition such as substance abuse (including alcohol) that might interfere with the assessment of pain or pain threshold.
5. Having had no previous surgery to the neck or upper limb.
6. Having no significant differences in clinical presentation (such as pain intensity) between two sides.

Assessment of ROM

For the measurement of ROM, each patient was placed in a comfortable sitting position with the shoulder abducted at 90 degrees and elbow flexed at 90 degrees. Then, the patient was asked to move his or her hand forward and downward (internal rotation of shoulder) as far as possible. The arc of this movement was measured with a large goniometer. After this, the passive ROM was measured in both shoulders by pushing the internal rotation movement further to the endpoint (limited either by pain or by tightness). Active and passive ROMs were measured in bilateral shoulders before and immediately after dry needling of the infraspinatus MTrP.

Assessment of Pain Intensity

The subject was requested to describe the pain intensity in both shoulders before and immediately after dry needling. Pain intensity was assessed by means of the use of a visual analog pain scale, which is a card with an uncalibrated scale ranging from zero to ten on one side (with zero representing no pain and ten representing the worst imaginable pain) and a corresponding 10-cm ruler on the other side (with each centimeter representing one pain level). The patient subjectively estimated his/her pain level by moving the pointing device along the uncalibrated scale between zero to ten. Then, the exact value of pain intensity could be obtained by referring the uncalibrated scale to the ruler on the back side.

Assessment of Pressure Pain Threshold

The MTrPs of bilateral infraspinatus, anterior deltoid, and extensor carpi radialis longus muscles were identified by finger palpation of the hyperirritable spots in taut bands, as described by Simons et al.[1] The selection of these muscles was based on the fact that both anterior deltoid and extensor carpi radialis longus muscles are in the ReP zone of the infraspinatus MTrP.

These MTrPs were marked for the measurements of pressure pain threshold, so that the three consecutive measurements could be performed over the same site. The pressure pain thresholds of these MTrPs were measured by a well-trained assistant who was blinded to the side of treatment. A pressure-threshold algometer developed by Fischer[31,32] was used for measuring this, because this algometer has proved to be both reliable and valid.[33–35] The procedure of pain-threshold measurement recommended by Fischer[31,32] was applied in this study. First, the procedure was explained clearly to the patient, who was then placed in a comfortable sitting position and encouraged to maintain complete relaxation. The algometer was applied on the marked site with the metal rod perpendicular to the surface of the skin. The pressure of compression was increased gradually at a speed of approximately 1 kg/sec. The subject was asked to say "yes" as soon as he or she began to feel pain or discomfort (for latent MTrPs) or an increase in pain intensity or discomfort (for active MTrPs). The compression was then stopped, and the subject was asked to remember this level of pain discomfort and to apply the same criterion for the subsequent measurements. The subject might demonstrate pain by pulling away or grimacing, indicating that the pain threshold had been exceeded.[31,32] In such cases, the instruction was repeated and another measurement was taken to ensure that the "real" threshold was obtained. Three repetitive measurements at an interval of 30–60 secs were performed at each site. The average value of the three readings was used for data analysis. The pressure pain threshold is measured in kilograms per squared centimeter.

Procedure of Dry Needling

The MTrP dry needling procedure employed was similar to the MTrP injection described by Hong.[21,29] The MTrP was located by palpating the

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taut band and identifying the point of maximal tenderness. This was then firmly compressed by the index finger or middle finger of the nondominant hand to direct the placement of the needle tip while inserting the needle. A 5-ml syringe connected with a #25 hypodermic needle, 1.5 inches in length, was held by the dominant hand. The needle was inserted into the skin at a point above the taut band, approximately 1 cm from the MTrP region. After penetration of the needle into the subcutaneous layer, it was kept there and obliquely (about 45 degrees) directed to the MTrP region under the fingertip of the nondominant hand. Then, the needle was inserted rapidly into the MTrP region and withdrawn rapidly. With rapid movement of needle, an LTR can always be elicited if the needle tip encounters a sensitive locus (LTR locus). The reason for employing rapid needle movements is to provide high-pressure stimulation for eliciting LTRs and to avoid side movement of the needle that may side cut (stretch) the muscle fibers. The needle insertions were repeated to elicit as many LTRs as possible. Usually, 1–2 mins were required for the complete procedure in each MTrP region. As soon as the needle was pulled out of skin, the MTrP region and the open wound of the needle-insertion site were compressed firmly for at least 3 mins to prevent excessive bleeding.

Data Analysis

The mean and standard deviation of the values measured for ROM, pain intensity, and pressure pain threshold were calculated. The paired Student's t test was used to assess the differences between the data before and after needling, and the differences in the data between the treated and untreated sides. The differences in ROM, pain intensity, and pain threshold after needling were further normalized as follows: percentage of changes = [(data after treatment − data before treatment)/data before treatment] × 100%. After data normalization, as described above, the differences in the changes of ROM, pain intensity, or pain threshold between the two sides (treated and untreated) were compared with paired t test. The confidence interval was set at 95% ($P < 0.05$). All data were analyzed using Statistical Package for the Social Sciences version 8.0 for Windows.

RESULTS

The changes in the investigated parameters are listed in Tables 1-3.

Increase in Mobility of Shoulder after Needling

As shown in Table 1, there were significant increases in both active and passive ROMs in the treated shoulder after dry needling ($P < 0.01$), and there were no significant changes in active or passive ROMs in the untreated shoulder. After normalization of data, the percent increases were significantly bigger in the treated side than in the untreated side ($P < 0.01$).

Reduced Pain Intensity

Subjectively, all patients had remarkably reduced pain of the shoulder in the treated side but only little (if any) pain relief in the untreated side. No subject had pain in the MTrPs of anterior deltoid and extensor carpi radialis longus muscles; they were latent MTrPs. After dry needling, the pain intensity was significantly reduced in the treated shoulder ($P < 0.001$) but not in the untreated shoulder ($P > 0.005$). Comparing the normalized data, the mean percent decrease in pain intensity was significantly higher in the treated shoulders than in the untreated ones ($P < 0.001$).

Increase in Pressure Pain Threshold of MTrPs

As shown in Table 3, after dry needling, there were significant increases ($P < 0.01$) in pressure

TABLE 1 Active and passive range of motion of shoulder internal rotation (degrees) before and after dry needling

	Before Needling	After Needling	% Changes (Normalized Data)	P Values (Before *vs.* After)
Active range of motion				
Treated side	47.5 ± 16.4	70.7 ± 16.5	55.1 ± 31.0 (%)	<0.01
Untreated side	50.4 ± 13.7	54.3 ± 16.3	7.1 ± 8.8 (%)	>0.1
P values (treated *vs.* untreated)			<0.01	
Passive range of motion				
Treated side	51.8 ± 15.5	77.5 ± 15.3	55.1 ± 28.3 (%)	<0.01
Untreated side	52.5 ± 14.2	61.4 ± 18.2	16.6 ± 12.0 (%)	>0.05
P values (treated *vs.* untreated)			<0.01	

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TABLE 2 Pain intensity of shoulders before and after drying needling

	Before Needling	After Needling	% Changes (Normalized Data)	*P* Values (Before *vs.* After)
Treated side	7.8 ± 1.2	2.8 ± 1.1	−64.8 ± 12.6 (%)	<0.001
Untreated side	7.7 ± 1.4	6.8 ± 1.3	−14.7 ± 7.8 (%)	>0.05
P values (treated *vs.* untreated)			<0.001	

pain threshold of the active MTrPs in the infraspinatus (average increase: 1.8 ± 0.5 kg/cm^2) and the latent MTrPs in the anterior deltoid (average increase: 1.0 ± 0.5 kg/cm^2) and extensor carpi radialis longus (average increase: 0.7 ± 0.4 kg/cm^2) muscles in the treated sides. However, there were no significant changes ($P > 0.05$) in the pressure pain threshold of infraspinatus (average increase: 0.3 ± 0.1 kg/cm^2), anterior deltoid (average increase: 0.2 ± 0.1 kg/cm^2), or extensor carpi radialis longus (average increase: 0.2 ± 0.1 kg/cm^2) in the untreated sides. The percent increases in the pressure pain threshold of infraspinatus (80.2 ± 30.7%), anterior deltoid (30.8 ± 15.0%) and extensor carpi radialis longus (18.2 ± 10.0%) in the treated sides were significantly higher ($P < 0.001$) than in the untreated sides (11.3 ± 6.1, 5.2 ± 4.4, and 4.0 ± 2.1%, respectively).

DISCUSSION

In this study, we have demonstrated that after dry needling of an MTrP in the infraspinatus muscle, the pressure pain thresholds of the MTrPs in the treated infraspinatus muscle and the ipsilateral anterior deltoid and extensor carpi radialis longus muscles (located in the ReP zone of the MTrP in the infraspinatus) were significantly increased, in addition to the significant improvement in the ROM and pain intensity of the treated shoulder. This important finding further supports the concepts of key MTrP and satellite MTrPs and the possible spinal cord mechanism of this phenomenon, as explained below. We also have further confirmed the effectiveness of dry needling, as has been well demonstrated in the previous studies.[1,24–30]

On the basis of clinical as well as basic studies, Hong and colleagues[6,7,11–13,21,29] have shown that there are multiple sensitive loci in an active MTrP region. A region's irritability is probably proportionate to the number of sensitive loci (LTR loci) and sensitized nociceptors it contains. Furthermore, these sensitized nociceptors are capable of sending enough neural impulses to the spinal cord to induce central sensitization of some dorsal horn cells to which MTrPs in the referred zone project. This active MTrP is the key MTrP, and the sensitized MTrPs in the referred zone are the satellite MTrPs. In this way, the receptive fields of the key MTrP are expanded.[36–39] Therefore, the pressure pain threshold of the satellite MTrPs are reduced because of central sensitization. When the irritability of a key MTrP is suppressed after appropriate treatment, the irritability of the satellite MTrPs in the referred zone can also be reduced because of the removal of central sensitization. This mechanism can explain the phenomenon observed in our current study.

Simons et al.[1] and Travell and Simons[2] have shown that the MTrP pain referral pattern for each

TABLE 3 Pressure pain threshold (kg/cm^2) of myofascial trigger points before and after dry needling

	Before Needling	After Needling	% Changes (Normalized Data)	*P* Values (Before *vs.* After)
Infraspinatus				
Treated side	2.3 ± 0.5	4.1 ± 0.5	80.2 ± 30.7 (%)	<0.01
Untreated side	2.5 ± 0.5	2.7 ± 0.5	11.3 ± 6.0 (%)	>0.05
P values (treated *vs.* untreated)			<0.001	
Anterior deltoid				
Treated side	3.5 ± 0.5	4.5 ± 0.4	30.8 ± 15.1 (%)	<0.01
Untreated side	3.5 ± 0.5	3.6 ± 0.5	5.2 ± 4.4 (%)	>0.05
P values (treated *vs.* untreated)			<0.001	
Extensor carpi radialis longus				
Treated side	4.2 ± 0.5	4.7 ± 0.4	18.2 ± 9.9 (%)	<0.01
Untreated side	4.0 ± 0.5	4.1 ± 0.5	3.9 ± 2.1 (%)	>0.1
P values (treated *vs.* untreated)			<0.001	

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individual muscle is the same in everyone. This also is true in animal studies.[36–39] In other words, the connection of dorsal horn neurons among the key MTrP and satellite MTrPs consistently follows a certain pattern for each individual muscle. The ReP patterns of MTrPs in some muscles are similar to the distribution of traditional Chinese acupuncture meridians.[30] The mechanism responsible for the pain-relieving effects of dry needling (including acupuncture) an MTrP and of injecting a local anesthetic into it must be similar.[21,29,30,40,41]

In acupuncture therapy, remote effectiveness in pain control has been documented.[42–45] Needling of a point in the first dorsal interosseous muscles (Ho-Ku point) can effectively control headache or toothache. This phenomenon also may be related to the spinal cord mechanism described above. The effects of acupuncture also may spread to contralateral side. In our study, we have observed a trend of changes in the contralateral side, although the changes are not statistically significant. Those changes could be attributed to repeated measures with the algometer. However, in the previous studies on pressure pain threshold, no such phenomena have been observed.[20,31,32] It is very likely that needling to the MTrP has an expanding effect to the opposite side, as is sometimes seen in acupuncture therapy.

The importance of eliciting LTRs to suppress MTrP pain is still unclear. It was found that after several LTRs had been elicited by the needling of an MTrP, no more LTRs could be elicited from the same region,[11] and the irritability of the MTrP could be suppressed.[46] It seems that there are certain neural connections in the spinal dorsal horns that control the irritability of an MTrP. These neural connections in the spinal cord may play an important role for ReP[36–39,47] and LTR.[11–13,21,29,48] The whole unit of these neural connections has been defined as an *MTrP circuit*.[49] A strong pressure stimulation to the nociceptors in the MTrP region could elicit an LTR and could probably provide very strong neural impulses to the MTrP circuit to break the vicious cycle so that the MTrP pain could be relieved.[30,49]

The limitations of this study include the small sample size and the lack of appropriate controls. There was no dry needling to the untreated side, and there was no comparable "sham" procedure. This raises the possibility of nonspecific findings, such as a placebo effect, associated with the supposedly beneficial findings, and not effects of the treatment per se. For a subjective measurement such as pain intensity, the placebo effect would be critical. The measurement of ROM is an objective assessment, and the measurement of pressure pain threshold can be considered semiobjective if it is performed appropriately.[31–35] Furthermore, this study was not designed to examine the therapeutic effectiveness of dry needling. We are more concerned with the changes in pressure pain threshold. For this semiobjective measurement, the blinded design is more important than the placebo design. In a future study, we should increase our sample size and apply a sham acupuncture procedure to confirm the current findings.

CONCLUSION

Immediately after dry needling of MTrP in the infraspinatus muscle, the pressure pain thresholds of MTrPs in the treated infraspinatus muscle and the ipsilateral anterior deltoid and extensor carpi radialis longus muscles (located in the referred zone of MTrP in the infraspinatus) can also be suppressed, in addition to the significant improvement in ROM and pain intensity of the treated shoulder. It is possible that, in some situations, inactivation of a key MTrP can suppress the irritability of its satellite MTrPs. These important findings further support the concepts of primary (key) MTrP and secondary (satellite) MTrPs, and the hypothetical spinal cord mechanism of this phenomenon.

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