ORIGINAL ARTICLE

The Short-Term Effects of Acupuncture on Myofascial Pain Patients After Clenching

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■ **Abstract**

Aim: Short-term pain reduction from acupuncture in chronic myofascial pain subjects was evaluated using an 11-point (0 to 10) numeric rating scale, visual analog scale (VAS), and pain rating of mechanical pressure on the masseter muscle.

Methods: A single-blind, randomized, controlled, clinical trial with an independent observer was performed. Fifteen chronic myofascial pain subjects over the age of 18 were randomly assigned into groups: nine subjects received real acupuncture; six subjects received sham acupuncture. Each subject clenched his/her teeth for 2 minutes. Acupuncture or sham acupuncture was administered at the Hegu Large Intestine 4 acupoint. Sham acupuncture was conducted by lightly pricking the skin with a shortened, blunted acupuncture needle through a foam pad, without penetrating the skin. The foam pad visually conceals the needle's point of the entry, so that the subject cannot discern which technique is being used. The subjects rated their general pain on a numeric rating scale. A mechanical pain stimulus was applied with an algometer and the subject rated his/her pain on a VAS. Statistical analysis was performed using the repeated measures ANOVA, paired *t*-tests, and Fisher's exact test as appropriate.

Results: There was a statistically significant difference in pain tolerance with acupuncture ($P = 0.027$). There was statistically significant reduction in face pain ($P = 0.003$), neck pain ($P = 0.011$), and headache ($P = 0.015$) with perception of real acupuncture.

Conclusion: Pain tolerance in the masticatory muscles increased significantly more with acupuncture than sham acupuncture. ■

Key Words: acupuncture, myofascial pain syndrome, dry needling, alternative medicine, myofascial pain, pain tolerance

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INTRODUCTION

Myofascial pain, one of the temporomandibular disorders (TMD), is a frequently encountered pain syndrome of muscle/connective tissue that is characterized by localized, hypersensitive spots in one or more palpable taut bands of skeletal muscle fiber, also known as myofascial trigger points. The etiology of trigger points may involve muscle overload, either from trauma or from repetitive activities, placing abnormal stresses on specific muscle groups.[1] Trigger points develop at the motor end plates, where sensitization of sensory and autonomic nerve endings leads to excessive release of acetylcholine, preventing normal functioning of the calcium pump mechanism, resulting to sustained contraction of sarcomeres.[1] This leads to decreased capillary flow into the muscle secondary to the increased muscle tension, lowering of the local pH, and release of sensitizing

substances into the muscle that can cause activation of muscle nociceptors and pain.[2] When normal healing does not occur, sensitization of peripheral nociceptors by endogenous substances becomes prolonged, leading to increased local tenderness and referred pain. Sensitization of peripheral nociceptors ensues, leading to increased local tenderness and referred pain. The sensitization can also take place at the spinal level, where receptive fields in the dorsal horn extend and become sensitive to a lesser stimulus.[3] Some clinical features of myofascial pain disorder include localized tenderness in a taut band of muscles, headaches, restricted movement, stiffness of muscles, weakness of muscles, and autonomic dysfunction.[4]

Several treatment modalities for myofascial pain, including acupuncture, spray and stretch technique, trigger point injection, Botulinum toxin injection, dry needling, pharmacological agents, massage, self-management, relaxation therapy, stress management, physical therapy, heat, ultrasound, exercise, electrical stimulation, transcutaneous electric nerve stimulation, biofeedback, and splint therapy, have gained varying degrees of acceptance.[5–14] Unfortunately, the therapeutic effect of these treatments has been poorly quantified, and the mechanisms underlying these treatments are not well understood. Thus, definitive treatment protocols for myofascial pain syndrome have not been determined.

Acupuncture is becoming increasingly widespread in the U.S.A. The U.S. Food and Drug Administration estimated that 9 million to 12 million acupuncture treatments are provided each year and at least 80 private insurers and Medicaid programs in some states are covering acupuncture for certain disorders.[15] In 1996, the U.S. Food and Drug Administration promoted acupuncture needles from the investigational and experimental medical device category to the regular medical-device category,[16] and the following year the U.S. National Institutes of Health (NIH) consensus statement on acupuncture supported the treatment efficacy of acupuncture for specific conditions such as pain, nausea, and vomiting control.[17] Despite this increased recognition of acupuncture as a treatment for pain, evidence for its efficacy has been largely anecdotal or based on poorly designed studies.[18]

Acupuncture has been used in the treatment of disease or pain for thousands of years. Traditional acupuncturists believe that every disease or complaint is caused by an imbalance of energy flow ("chi") throughout the body and that this imbalance can be corrected by inserting needles into specific acupoints that are mapped along meridians on the human body. Such philosophical concepts are not compatible with modern Western medicine understanding of physiology; and modern acupuncturists have attempted to explain acupuncture in terms of Western science. They suggest that the mechanical action of needling causes receptors to send neural impulses to the spinal cord to act on ascending pathways to the brain and cause the release of neurotransmitters that subsequently modulate pain processing in the brain. This alternative theory of the mechanism of acupuncture is based on studies that have used acupuncture to treat head and neck pain.[19–28] It has also been suggested that acupuncture-induced analgesia is mediated by the release of endogenous opioids.[29] Results from human and animal studies, with the help of positron emission tomography and functional magnetic resonance imaging, support these suggestions.[30–33]

Although laboratory evidence supports a physiological basis for acupuncture analgesia, the efficacy of acupuncture for chronic pain relief in humans remains questionable. The purpose of this study was to assess the short-term effects of acupuncture on myofascial pain. We hypothesized that acupuncture at Hegu Large Intestine 4 (LI4) acupoint would reduce the general symptoms of myofascial pain more than sham acupuncture. LI4 acupoint was chosen because it has been associated with analgesic effects.[25,32,34–36]

METHODS

Approval was obtained by the University of California San Francisco Committee on Human Research. Patients currently seeking treatment at the UCSF TMD Center were recruited to participate in this study. Fifteen subjects diagnosed with chronic myofascial pain meeting the following inclusion criteria were invited to participate in the study: at least over 18 years of age; diagnosed with chronic myofascial pain syndrome of the masticatory muscles; chronic pain (at least 4 times/week) in the jaw muscles for at least 12 weeks; pain severity of at least 4 on an 11-point (0 to 10) numeric rating scale (NRS) lasting at least 1 hour per day; pain in the jaw, temples, face, preauricular area, or in the ear at rest or during function. Exclusion criteria were: current opioid use; metabolic disease (eg, diabetes, hyperthyroidism); coagulopathies (eg, hemophilia, anticoagulants); neurological disorders (eg, dyskinesia, trigeminal neuralgia); vascular disease (eg, migraine, hypertension); or neoplasia.

Randomization

Treatment (ie, acupuncture or sham acupuncture) was randomly assigned to study subjects based on order of involvement. Twenty subjects were screened for participation. Of these, five failed to qualify; the remaining 15 subjects completed the study.

Blinding

Because this study involved acupuncture, it was not possible to blind the acupuncturist to the treatment (ie, acupuncture or sham acupuncture); therefore, an independent observer, who was blinded to the treatment, collected the data from the study subjects, who were also blinded to the treatment.

Materials

Acupuncture needles (Seirin 30 gauge) were used for all subjects. To apply sham acupuncture, the needles were shortened by 10 mm and blunted to avoid actual piercing of the skin. To maintain blinding to the study subjects and the data collector, the needles were inserted through a poly foam pad, 10 mm × 10 mm × 10 mm thick (Ace weather strip, Oak Brook, IL, U.S.A.).

Hegu Large Intestine 4 Acupoint

Large Intestine 4 acupoint is located at the highest point of the adductor pollicis muscle between the thumb and index finger. The radialis nerve innervates this site. This acupoint is commonly used for head and neck pain. A neuroimaging study of this acupoint observed that stimulation of this acupoint activated jaw and face projection areas of the brain, suggesting that this acupoint might be appropriate for treatment of head and neck pain.[37] A single needle acupuncture treatment modality was used for this study because past studies have shown this to be enough to obtain a clinical result.[38,39]

Procedure

All subjects were asked to discontinue analgesic medication 24 hours prior to study. Informed consent to participate in the study was obtained from all subjects. All experiments were performed by a state certified dental acupuncturist, who was instructed not to discuss the treatment during interventions.

Psychophysical responses were recorded before and after treatment (Figure 1). Each subject rated severity of jaw and face pain, jaw and face tightness, headache, neck pain, and tooth pain on an 11-point (0 to 10) NRS. A mechanical stimulus was applied with a pressure algometer placed on the right masseter muscle at the angle of the right mandible. A sticker dot was placed onto each subject's right masseter to mark the placement of the algometer. With the subject comfortably supported and relaxed, the stimulus was applied directly over the right masseter, at a rate of 1 lb/min until the subject raised his/her hand at maximal tolerable pain. The pressure algometer reading was recorded and the subject was asked to rate his/her pain to the mechanical stimulus on a visual analog scale (VAS). The subjects were instructed to clench at maximal force 2 minutes. There was a 30-second rest period after clenching. After a 30-second rest, following the clench, the acupuncturist performed the acupuncture/sham protocol by inserting the needle through the foam pad. The acupuncturist used a clear guide tube to insert the needle through the foam pad to ensure accurate penetration depth.

Actual acupuncture consisted of needle insertion through the sterile foam pad into the left hand LI4 acupoint to a depth of 10 to 20 mm. The depth of the needle into tissue was estimated by subtracting the 10 mm thickness of the foam pad from the 30 mm length of the needle. Sham acupuncture consisted of a blunted needle insertion through the sterile foam pad, positioned 1 cm distal to LI4 acupoint, until the needle touched and did not penetrate the skin. Other studies have used similar control methods that were found to be valid.[40,41] The needle was twirled for 5 seconds after 5 minutes into treatment. After a total of 15 minutes of either real or sham treatment, the acupuncturist removed the needle and foam pad, and then wiped the skin with an alcohol pad.

Subjects were re-evaluated for general jaw and face pain, jaw and face tightness, headache, neck pain, and tooth pain on a NRS. Mechanical stimulation with the algometer was repeated, using the same pressure at the same location determined at the beginning of the experiment. Finally, subjects were asked whether they believed they received real or sham acupuncture.

Statistical Analysis

Ninety-five percent confidence intervals were compared for mean outcome per group and used to perform significance tests at the 5% level of significance ($\alpha = 0.05$). Fisher's exact test was used to determine whether what the subjects thought they received had a relationship with what they actually received. A *t*-test assuming equal variances was used to determine whether age, baseline facial pain, baseline neck pain, and baseline headache were significant variables between real and

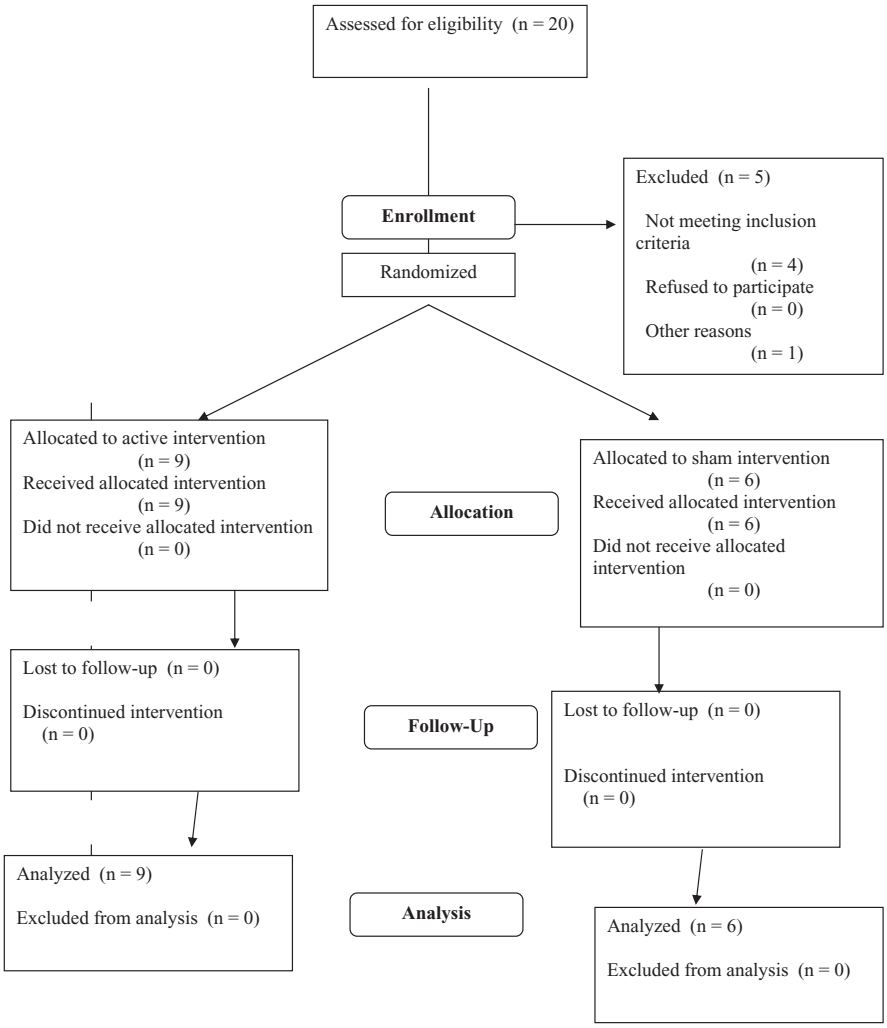

Figure 1. The consort E-flowchart August 2005.

sham acupuncture groups. To determine if there were significant differences between groups or between pre-treatment and post-treatment measures, two-way repeated measures ANOVAs with one within subjects factor (time) and one between subjects factors (group) were performed for each dependent variable measured (ie, face pain, headache, neck pain, pain with mechanical stimulation). To answer the question of whether the subject's belief that he/she received acupuncture is a more important predictor for improvement in pain than whether or not he/she actually received real acupuncture, the same ANOVAs were performed, except that the between-subject factor consisted of those who believed they had received acupuncture and those who believed they had received sham acupuncture. As this study involved multiple comparisons (face pain, headache, neck pain, and masseter muscle tolerance), the alpha level was set at 0.0125 (i.e., 0.05 ÷ 4) for a Bonferroni-type correction.

RESULTS

A total of 15 (one male and 14 female) subjects participated in the study. There were no significant differences in demographic characteristics between acupuncture and sham acupuncture groups (Table 1). A majority of the subjects correctly identified as having received acupuncture and half of the subjects correctly identified as having received sham acupuncture (Table 2). The subjects were not able to predict which experimental condition they received (Fisher's exact test; $P = 0.132$).

Because many of the subjects reported no toothache, there were insufficient data to analyze, so toothache was omitted from analysis. Face tightness was also dropped from analysis because subjects rated facial tightness the same as facial pain, indicating a lack of differentiation between the two variables.

Acupuncture treatment was significant for increasing the pain tolerance of the masseter muscle ($P = 0.027$)

Table 1. Subject Demographics

	Acupuncture (Average ± SD)	Sham Acupuncture (Average ± SD)	Total (Average ± SD)	Paired *t*-Test *P* Value
Age (year)	45.2 ± 12.3	41.8 ± 14.9	43.1 ± 13.6	0.653
Male/female	1/9	0/6	1/15	
Baseline facial pain	5.78 ± 1.92	6.17 ± 2.79	5.93 ± 2.22	0.753
Baseline neck pain	5.78 ± 3.15	6.50 ± 2.59	5.20 ± 3.34	0.914
Baseline headache	6.33 ± 3.04	4.30 ± 3.72	6.4 ± 2.77	0.433
Pain to mechanical pressure (VAS; cm)	7.47 ± 1.48	7.23 ± 0.85	7.37 ± 1.23	0.734
Pain after clench (VAS; cm)	8.79 ± 1.55	8.73 ± 1.39	8.76 ± 1.42	0.950

Facial pain, headache, and neck pain were measured on an 11-point (0 to 10) numeric scale. Mechanical pressure to pain and pain after clenching were measured on a visual analog scale (VAS) scale.

Table 2. Actual Treatment vs. Perceived Treatment

Perceived Treatment	True Treatment		
	Real	Placebo	Total
Real	8 subjects	3 subjects	11 subjects
Placebo	1 subject	3 subjects	4 subjects
Total	9 subjects	6 subjects	15 subjects

Table 3. Real Acupuncture Group Pain Readings

	Pretreatment Pain Level (Average ± SD)	Post-Treatment Pain Level (Average ± SD)	Change in Pain Level (Average)
Facial pain	5.78 ± 1.92	4.56 ± 2.35	–1.22
Headache	6.33 ± 3.04	3.67 ± 3.32	–2.11
Neck pain	5.78 ± 3.15	4.33 ± 3.35	–2.0
Mechanical pressure pain (VAS; cm)	7.47 ± 1.48	5.69 ± 2.5	–1.78

Facial pain, headache, and neck pain were measured on an 11-point (0 to 10) numeric scale. Mechanical pressure to pain was measured on a visual analog scale (VAS) scale. A negative number indicates a decrease in pain level. A positive number indicates an increase in pain level.

Table 4. Sham Acupuncture Group Readings

	Pretreatment Pain Level (Average ± SD)	Post-treatment Pain Level (Average ± SD)	Change in Pain Level (Average)
Facial pain	6.17 ± 1.33	6.17 ± 1.33	0
Headache	4.33 ± 3.72	5.17 ± 3.20	1
Neck pain	6.5 ± 2.59	5.67 ± 3.20	–0.833
Mechanical pressure pain (VAS; cm)	7.23 ± 0.85	7.83 ± 1.65	0.6

Facial pain, headache, and neck pain were measured on an 11-point (0 to 10) numeric scale. Mechanical pressure to pain was measured on a visual analog scale (VAS) scale. A negative number indicates a decrease in pain level. A positive number indicates an increase in pain level.

(Figure 2, Table 3). For the other general symptoms of myofascial pain, acupuncture and sham acupuncture were not significant for decreasing facial pain, headache, and neck pain (Figure 2, Tables 3 and 4).

Table 5. Perceived Acupuncture Treatment

	Pretreatment Pain Level (Average ± SD)	Post-treatment Pain Level (Average ± SD)	Change in Pain Level (Average)
Facial pain	6.0 ± 2.1	4.36 ± 1.5	–1.63
Headache	5.36 ± 3.78	3.09 ± 2.7	–2.27
Neck pain	6.55 ± 3.11	3.73 ± 2.83	–2.82
Mechanical pressure pain (VAS; cm)	7.39 ± 1.40	6.1 ± 2.4	–1.3

Facial pain, headache, and neck pain were measured on an 11-point (0 to 10) numeric scale. Mechanical pressure to pain was measured on a visual analog scale (VAS) scale. A negative number indicates a decrease in pain level. A positive number indicates an increase in pain level.

Table 6. Perceived Placebo Acupuncture Treatment

	Pretreatment Pain Level (Average ± SD)	Post-treatment Pain Level (Average ± SD)	Change in Pain Level (Average)
Facial pain	5.75 ± 2.87	7.5 ± 1.91	1.75
Headache	4.75 ± 2.06	7.75 ± 2.06	3.0
Neck pain	6.0 ± 1.83	8.0 ± 2.16	2.0
Mechanical pressure pain (VAS; cm)	7.33 ± 0.78	7.8 ± 2.20	0.48

Facial pain, headache, and neck pain were measured on an 11-point (0 to 10) numeric scale. Mechanical pressure to pain was measured on a visual analog scale (VAS) scale. A negative number indicates a decrease in pain level. A positive number indicates an increase in pain level.

The effect of the perception of treatment was also considered. When subjects believed that real acupuncture was received, there was a significant decrease in facial pain ($P = 0.003$), neck pain ($P = 0.011$), and headache ($P = 0.015$) (Figure 3, Table 5). Tolerance of the masseter muscle to mechanical pressure did not increase significantly (Figure 3). When subjects believed that sham acupuncture was received, there was an average increase in facial pain, neck pain, headache, and tolerance to mechanical pressure (Table 6).

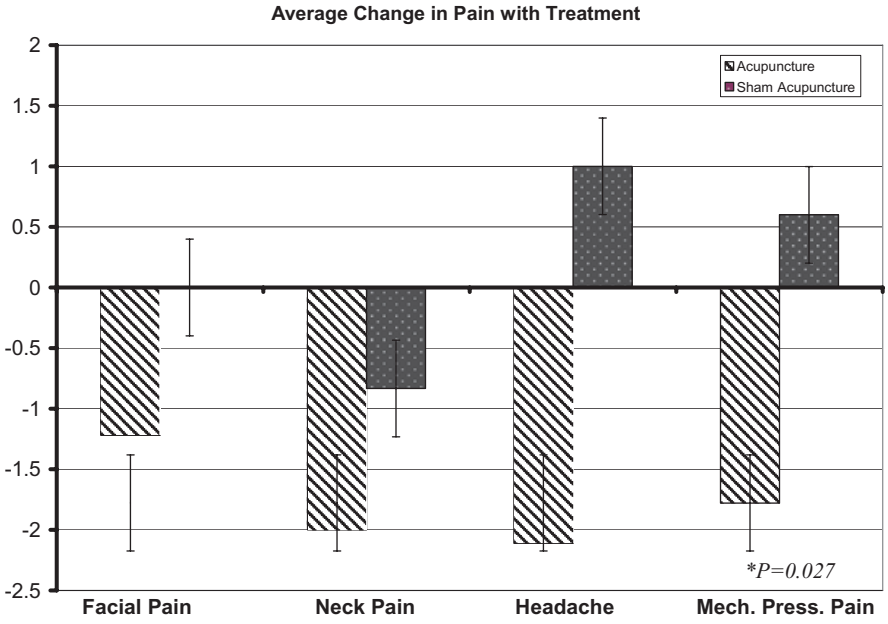

Figure 2. Actual treatment effect on pain readings. This figure indicates the average change for facial pain, neck pain, headache, and mechanical pressure pain. A negative number indicates a decrease in pain level. A positive number indicates an increase in pain level.

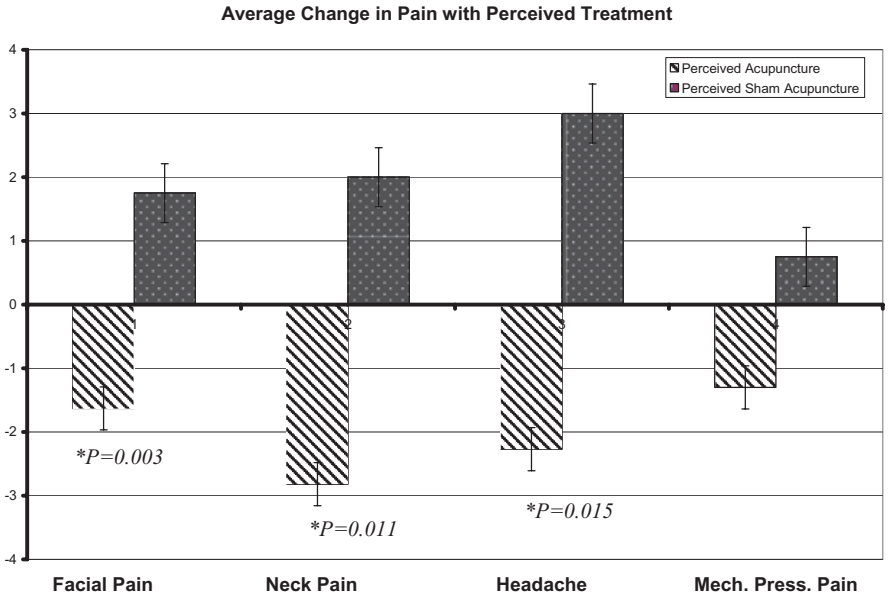

Figure 3. Perceived treatment effect on pain readings. This figure indicates the average change for facial pain, neck pain, headache, and mechanical pressure pain. A negative number indicates a decrease in pain level. A positive number indicates an increase in pain level.

DISCUSSION

Overall, acupuncture demonstrated a significant efficacy beyond sham acupuncture for increasing masseter muscle pain tolerance. This confirms past evidence where local tenderness and referring pain diminished postacupuncture treatment using general points and trigger points with dry needling.[42] Furthermore, there is evidence that diffuse noxious inhibitory controls may be involved in the analgesic mechanism of acupuncture.[43] Diffuse noxious inhibitory controls are when one noxious mechanical, thermal, or chemical stimulus is applied to a region of the body from the neuron's excitatory receptive field and inhibits multireceptive neurons in the dorsal horn of the spinal cord.[44,45] This results in a decrease in pain by modulation of the activity of nociceptive neurons in the dorsal horn.[46] Specific to this study, the noxious stimulus of the acupuncture needle penetration at Hegu LI4 may have inhibited the pain response to clenching via the diffuse noxious inhibitory control pathway. Although the pain threshold increased in our study, the

subjects still suffered low to moderate levels of pain due to the continued excitability in peripheral tissues or central neural areas, which may contribute to the persistence of jaw muscle tenderness.[47]

Acupuncture, however, did not demonstrate a significant efficacy beyond sham acupuncture for facial pain, neck pain, and headache, which was similar to the findings of previous studies that showed a lack of significant effect from acupuncture for the treatment of acute pain.[48–50] The facial pain, neck pain, and headache of the acupuncture group did reduce, but these were not statistically significant effects, perhaps because the effect size was too small to detect with the number of participants. Past studies have shown that a larger sample size and more treatment sessions yielded significant relief with acupuncture in myofascial pain syndromes.[51–56]

Although the effect size did not reach significance levels for both treatments, there was supportive evidence that acupuncture had a slightly greater efficacy than sham acupuncture for facial pain, neck pain, and headache. The individuals who received sham acupuncture on average had no change in facial pain level, minimal decrease in neck pain, and greater headache and pain to mechanical pressure. The placement of the blunted acupuncture needle at a nonacupoint site minimized the possibility for any real acupuncture effect in these subjects. The 2-minute clench may have aggravated the masseter muscle and temporalis, thereby causing an increase in headache and decreasing the pain threshold to the same mechanical stimulus received prior to treatment.

In this study, the subjects' perception of sham acupuncture as real acupuncture significantly reduced facial pain, neck pain, and headache. Because the sham needles were placed away from the acupoint and nonpenetrating, this decreased the chance for an acupuncture effect and more likely represents a placebo effect. Also, the subjects were not able to predict which experimental condition they were going to receive, so the placebo effect was produced because the administration of sham acupuncture closely mimicked the administration of true acupuncture. Expectations can provide the basis for the generation of placebo analgesia.[57–60] Several subjects asked whether acupuncture has been used to treat myofascial pain, and the response that acupuncture has been used for myofascial pain may have been positive information that induced stronger expectations rather than neutral information.

The overall change for all subjects in facial pain, neck pain, headache, and pain to mechanical pressure may actually be greater than what was measured by VAS and NRS because of the pain stimulus. Having clenched for 2 minutes, the masseter muscles may have briefly exacerbated the pain of the facial muscles. This would cause myofascial pain to be briefly elevated to a state of allodynia or hyperalgesia, which was greater than the baseline pain readings. Because subjects were asked after treatment to recall their pain level after clenching by memory, there was no accurate measurement of the elevated pain state immediately after clenching, so the true acupuncture effect could not be determined.

Other limitations to this study include asking subjects the reason for their perception of treatment and their prior expectations and beliefs toward acupuncture. To further exaggerate the acupuncture effect, the patients could have received bilateral acupuncture treatment of Hegu LI4. Furthermore, a VAS could have been given for patients to rate their face pain and headache to keep the pain ratings consistent. Besides testing the masseter muscle threshold, the functional capacity after acupuncture treatment should be tested as well. By measuring the range of motion in opening the jaw, this is of more importance to the subjects because often times this is limited with myofascial pain. The inclusion of more subjects would have increased the power of this study.

In summary, this study found that acupuncture significantly increased the pain tolerance of the masseter muscle ($P = 0.027$). This study also found evidence of a placebo effect when the perception of receiving acupuncture significantly reduced facial pain ($P = 0.003$), neck pain ($P = 0.011$), and headache ($P = 0.015$).

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REFERENCES

1. Simons DG, Travell JG, Simons PT. *Travell & Simons' Myofascial Pain & Dysfunction. The Trigger Point Manual. Upper Half of Body*. Vol. 1, 2nd ed. Baltimore, MD: Williams & Wilkins; 1999.

2. Gerwin RD, Shannon S, Hong CZ. Interrator reliability in myofascial trigger point examination. *Pain.* 1997; 69:65–73.

3. Mense S. Nociception from skeletal muscle in relation to clinical muscle pain. *Pain.* 1993;54:241–289.

4. Travell JG, Simons DG. *Myofascial Pain and Dysfunction: The Trigger Point Manual*. Vol. 1. Baltimore, MD: Williams & Wilkins; 1983.

5. Han SC, Harisson P. Myofascial pain syndrome and trigger-point management. *Reg Anesth*. 1997;22:89–101.

6. Aronoff GM. Myofascial pain syndrome and fibromyalgia: a critical assessment and alternate view. *Clin J Pain*. 1998;14:74–85.

7. Calderhead RG. Basics in low-level laser therapy: a practical introduction. In: Ohshiro T, Calderhead RG, eds. *Low Level Laser Therapy: A Practical Introduction*. New York: John Wiley & Sons; 1998:3–18.

8. Carlson CR, Okeson JP, Falace DA. Reduction of pain and EMG activity in the masseter region by trapezius trigger point injection. *Pain*. 1993;55:397–400.

9. Cassisi JE, Sypert GW, Lagana L. Pain, disability, and psychological functioning in chronic low back pain subgroups: myofascial versus herniated disc syndrome. *Neurosurgery*. 1993;33:379–386.

10. Turk DC, Zaki HS, Rudy TE. Effects of intraoral appliance and biofeedback/stress management alone and in combination in treating pain and depression in patients with temporomandibular disorders. *J Prosthet Dent*. 1993;70:158–164.

11. Eisenberg DM, Kessler RC, Foster C. Unconventional medicine in the United States. Prevalence, costs, and patterns of use. *N Engl J Med*. 1993;328:246–252.

12. Prudden B. *Myotherapy Bonie Prudden's Complete Guide to Pain Free Living*. New York: Dial Press; 1984.

13. Hong C. Considerations and recommendations regarding myofascial trigger point injection. *J Musculoskelet Pain*. 1994;2:29–59.

14. Lang AM. Botulinum toxin therapy for myofascial pain disorders. *Curr Pain Headache Rep* 2002;6:355–360.

15. Acupuncture. *Consum Rep* 1994;59:54–59.

16. Lytle CD. History of the food and drug administration's regulation of acupuncture devices. *J Altern Complement Med* 1996;2:253–256.

17. Acupuncture. NIH consensus statement. *JAMA* 1998;280:1518–1524.

18. Audette JF, Blinder RA. Acupuncture in the management of myofascial pain and headache. *Curr Pain Headache Rep*. 2003;7:395–401.

19. Kerr NW. Acupuncture for therapy and analgesia. A possible application in dental surgery. *Br Dent J*. 1973; Mar 6;134(5):201–204.

20. Brandwein A, Corcos J. Extraction of incisors under acupuncture anesthesia: a standardized method. *Am J Acupunct*. 1975;3:352–354.

21. Goddard G, Karibe H, McNeil C, Villafuerte E. Acupuncture and sham acupuncture reduce muscle pain in myofascial pain patients. *J Orofac Pain*. 2002;16:71–76.

22. Lao L, Bergman S, Hamilton GR, Langenberg P, Berman B. Evaluation of acupuncture for pain control after oral surgery: a placebo-controlled trial. *Arch Otolaryngol Head Neck Surg*. 1999;125:567–572.

23. Lee MHM, Teng P, Zaretzky HH, Rubin M. Acupuncture anesthesia in dentistry. A clinical investigation. *N Y State Dent J*. 1973;39:299–301.

24. Mann F. Acupuncture analgesia in dentistry. *Lancet*. 1972;i:898–899.

25. Rosted P. The use of acupuncture in dentistry: a review. *Comp Med Int*. 1996;3:18–21.

26. Silva SA. Acupuncture for the relief of pain of facial and dental origin. *Anesth Prog*. 1989;36:244–245.

27. Tany M, Matsudaira K, Sawatsugawa S, Manaka Y. Acupuncture analgesia and its application in dental practice. *Am J Acupunct*. 1974;2:287–295.

28. Harris RE, Clauw DJ. The use of complementary medical therapies in the management of myofascial pain disorders. *Curr Pain Headache Rep*. 2002;6:370–374.

29. Shen J. Research on the neurophysiological mechanisms of acupuncture: review of selected studies and methodological issues. *J Altern Complement Med*. 2001;7(suppl 1): S121–S127.

30. Biella G, Sotgiu ML, Pellegata G, Paulesu E, Castiglioni I, Fazio F. Acupuncture produces central activations in pain regions. *Neuroimage*. 2001;14:60–66.

31. Bowsher D. Mechanisms of acupuncture. In: Filshie J, White A, eds. *Medical Acupuncture: A Western Scientific Approach*. London: Churchill Livingston; 1998:69–82.

32. Han JS. Neurochemical basis of acupuncture. *Annu Rev Pharmacol Toxicol*. 1982;22:193–220.

33. Yoshida T, Tanaka C, Umeda M, Higuchi T, Tukunaga M, Naruse S. Non-invasive measurement of brain activity using functional MRI: toward the study of brain response to acupuncture stimulation. *Am J Chin Med*. 1995;23:319–325.

34. Chiang CY, Chang CT, Chu HL, Yang LF. Peripheral afferent pathway for acupuncture analgesia. *Scientia Sin*. 1973;16:210–217.

35. Brockhaus A, Elger CE. Hyperalgesic efficacy of acupuncture on experimental pain in man. Comparison of laser acupuncture and needle acupuncture. *Pain*. 1990;43:181–185.

36. Mayer DJ, Price DD, Rafu A. Antagonism of acupuncture analgesia in man by the narcotic antagonist naloxone. *Brain Res*. 1977;121:368–372.

37. Hui KK, Liu J, Makris N, et al. Acupuncture modulates the limbic system and subcortical gray structures of the human brain: evidence from fMRI studies in normal subjects. *Hum Brain Mapp*. 2000;9:13–25.

38. Stacher G, Wancura I, Bauer P, Lahoda R, Schulze D. Effect of acupuncture on pain threshold and pain tolerance determined by electrical stimulation of the skin: a controlled study. *Am J Chin Med*. 1975;3:143–149.

39. Audette JF, Wang F, Smith H. Bilateral activation of motor unit potentials with unilateral needle stimulation of active myofascial trigger points. *Am J Phys Med Rehabil*. 2004;83:368–374.

40. Goddard G, Shen Y, Steele B. A controlled trial of placebo vs. real acupuncture. *J Pain*. 2005;6:237–242.

41. Streitberger K, Kleinhenz J. Introducing a placebo needle into acupuncture research. *Lancet*. 1998;352:364–365.

42. Nugaibekov AG, Khabirov FA. The effects of acupuncture and dry needling on myofascial trigger points. *J Musculoskelet Pain*. 1998;6:49.

43. Murase K, Kawakita K. Diffuse noxious inhibitory controls in anti-nociception produced by acupuncture and moxibustion on trigeminal caudalis neurons in rats. *Jpn J Phys*. 2000;50:133–140.

44. Le Bars D, Chitour D, Clot AM. The encoding of thermal stimuli by diffuse noxious inhibitory controls (DNIC). *Brain Res*. 1981;230:394–399.

45. Price DD, McHaffie JG. Effects of heterotrophic conditioning stimuli on first and second pain: a psychological evaluation in humans. *Pain*. 1988;34:245–252.

46. Light AR, Perl ER. Spinal termination of functioning identified primary afferent neurons with slowly conducting myelinated fibres. *J Comp Neurol*. 1979;186:133–150.

47. McMillan AS, Blasberg B. Pain-pressure threshold in painful jaw muscles following trigger point injection. *J Orofac Pain*. 1994;8:384–390.

48. Sculpher MJ, Buxton MJ. The episode free days as a composite measure of effectiveness. *Pharmacoeconomics*. 1993;4:345–352.

49. Mason L, Moore RA, Edwards JE, et al. Systematic review of efficacy of topical rubefacients containing salicylates for the treatment of acute and chronic pain. *BMJ*. 2004; 328:995.

50. Dowson DI, Lewith GT, Machin D. The effects of acupuncture versus placebo in the treatment of headache. *Pain*. 1985;21:35–42.

51. Junnila SY. Long-term treatment of chronic pain with acupuncture. *Acupunt Electrother Res*. 1987;12:23–36.

52. Smith P, Mosscrop D, Davies S, Sloan P, Al-Ani Z. The efficacy of acupuncture in the treatment of temporomandibular joint myofascial pain: a randomised controlled trial. *J Dent*. 2007 Mar;35(3):259–267. Epub 2006 Nov 13.

53. Wang C, Long X, Zhu X. A study on the clinical curative effect by acupuncture for myofascial pain dysfunction syndrome. *Zhonghua Kou Xiang Yi Xue Za Zhi*. 1998;33: 273–275.

54. Kalisch R, Wiech K, Critchley HD, et al. Anxiety reduction through detachment: subjective, physiological, and neural effects. *J Cogn Neurosci*. 2005;17:874–883.

55. Melzack R, Wall PD. Pain mechanisms: a new theory. *Science*. 1965;50:971–979.

56. Johansson A, Wenneberg B, Wagersten C, Haraldson T. Acupuncture in treatment of facial muscular pain. *Acta Odontol Scand*. 1991;49:153–158.

57. Montgomery GH, Kirsch I. Classical conditioning and the placebo effect. *Pain* 1997;72:107–113.

58. Benedetti L, Colloca E, Torre M, Lanotte A, Pesare M. Placebo-responsive Parkinson patients show decreased activity in single neurons of subthalamic nucleus. *Nat Neurosci*. 2004;7:587–588.

59. Flaten MA, Aslaksen PM, Finset A, Simonsen T, Johansen O. Cognitive and emotional factors in placebo analgesia. *J Psychosom Res*. 2006;61:81–89.

60. Reiss S. Pavlovian conditioning and human fear: an expectancy model. *Behav Ther*. 1980;11:380–396.