Immediate Effect of Acupuncture on Electromyographic Activity of the Upper Trapezius Muscle and Pain in Patients With Nonspecific Neck Pain: A Randomized, Single-Blinded, Sham-Controlled, Crossover Study

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Abstract

Objective: The objective of this study was to assess changes in upper trapezius myoelectric activity and pain in patients with nonspecific neck pain after a single session of acupuncture (ACP).

Methods: A blinded randomized clinical trial was conducted. Fifteen patients with nonspecific neck pain and 15 healthy participants were enrolled in a randomized, single-blinded, crossover study. Each participant was subjected to a single session of ACP and sham acupuncture (SACP). The electromyography (EMG) signal of the upper trapezius muscle was recorded during different step contractions of shoulder elevation force (15%-30% maximal voluntary contraction) before and after ACP treatment.

Results: Significant effects were confirmed after the treatment (ACP and SACP) for Numeric Rating Scale scores ($F_{1,28} = 51.61$; $P < .0001$) and pain area ($F_{1,2} = 32.03$; $P < .0001$). Significant decreases in the EMG amplitude were identified for the nonspecific neck pain group (NPG) ($F_{1,112} = 26.82$; $P < .0001$) and the healthy participant group (HPG) ($F_{1,112} = 21.69$; $P < .0001$) after ACP treatment. No differences were identified between the ACP and SACP treatment protocols for Numeric Rating Scale score (NPG: $F_{1,28} = 0.95$; $P = .33$), pain area (NPG: $F_{1,28} = 1.97$; $P = .17$), or EMG amplitude (NPG: $F_{1,112} = 0.47$; $P = .49$; HPG: $F_{1,112} = 0.75$; $P = .38$).

Conclusion: The effect of ACP at acupoints triple energizer 5 and large intestine 11 triple energizer 5, or in close proximity, contributes to pain relief among patients with nonspecific neck pain. The electromyographic analysis indicated a greater resistance to muscle fatigue and decrease of activity of the upper trapezius muscle among healthy participants and patients with nonspecific neck pain. (J Manipulative Physiol Ther 2018;41:208-217)

Key Indexing Terms: *Rehabilitation, Neck Pain; Acupuncture; Electromyography; Pain; Clinical Trial*

Introduction

Neck pain is a common painful musculoskeletal complaint and can cause varying levels of disability for the affected individual. The overall prevalence of neck pain in the general population is 23% (ranges between 0.4% and 86.8%), and it is generally higher among women and in urban areas. It is also higher in high-income countries than in middle- and low-income countries.[1] In many cases, this clinical condition can lead to a lower quality of life, reduced productivity and disabilities (in more severe cases), and high socioeconomic costs for patients and society as a whole.[2-4]

For the majority of neck disorders, there is no identifiable underlying disease or abnormal anatomic

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structure. For this reason, the term *nonspecific neck pain* (NS-NP) has been commonly used in its classification.[5] Individuals with NS-NP exhibit symptoms similar to those of grade I and II whiplash-associated disorders,[6] without traumatic impairment. They experience increased sensitivity, fatigue, and stiffness in the muscles of the neck and shoulder,[7] with pain that can irradiate to the upper limbs.[8]

Concerning muscular impairment, studies have confirmed the correlation between neuromuscular control and cervical pain that is acquired[9,10] or induced experimentally.[11] A number of authors have explored the possibility that an abnormality in cervical motor control could contribute to the persistence of pain in this region as a result of factors that perpetuate a mechanical nociceptive mechanism in cervical structures, as well as muscle fatigue, which is inherent to these patients.[9,11,12]

The results of these studies offer preliminary support for the use of treatment methods for NS-NP that emphasize the reestablishment of function in the neck muscles. Several techniques for treating NS-NP have been reported to achieve a clinical improvement in patients, including specific therapeutic exercises, scapular movements, muscular massage, stretching, and acupuncture (ACP).[13-16] However, there is still no consensus on the best form of treating NS-NP.

Although the use of ACP to treat neck pain has been accepted and recommended,[17,18] the arguments used to indicate this therapeutic resource, as well as the understanding of its physiological mechanisms, remain unclear in the literature. Concerning the therapeutic approach, different quantities of acupoints, the number of sessions,[17-19] the direct application of needles at trigger points,[20] or the treatment technique to be used (systemic, auricular, and cranial ACP),[17,18,20] limit the indication of ACP for the treatment of neck pain.

Among the possible physiological effects, it has previously been suggested that ACP increases local blood flow,[21] cerebral blood flow,[22] oxidation of tissues,[23] and metabolic exchanges,[24] while also affecting motor control through its action on α and γ motor neurons (inhibition of the pain-spasm-pain cycle) and the induction of different neurologic reflexes.[21]

These results suggest that the recovery noted after treatment of neck pain[17,18,20] with ACP could be attributed to the decrease in pain caused by inhibiting the excitability of α motor neurons,[21] improvements in muscle fatigue resulting from a possible increase in local blood irrigation,[21] or a combination of these 2 responses. This hypothesis is strengthened by the differences found in surface electromyography (sEMG) measurements of upper trapezius muscle activity among patients with neck pain and healthy controls.[25,26]

Considering that variations and/or reductions of the motor units reflect muscle activity,[27] sEMG can be used to assess whether the stimulus from ACP has an effect on the activity of skeletal striated muscles. The real action of ACP on the electromyographic activity of the upper trapezius muscle has been reported in individuals with myofascial trigger points, after the acupoints known as triple energizer 5 (TE-5; "Wai-guan") and large intestine 11 (LI-11; "Qu-chi") were stimulated with needles.[28] However, no studies have addressed the possible clinical benefits of the treatment of NS-NP using these acupoints (TE-5 and LI-11).

Table 1. *Descriptive Statistics (Mean and Standard Deviation) and t Tests Results Comparing Participants' Baseline Scores*

Characteristics	Health Participants (n = 15)	NS-NP Patients (n = 15)	*P* [a]
Age, y	25.65 (0.68)	27.13 (1.02)	.24
BMI, kg	23.06 (1.38)	23.93 (1.22)	.08
Height, m	1.63 (0.05)	1.66 (0.07)	.33
Sex, M/F	10/5	11/4	—
UT, R/L	13/2	14/1	—
NDI	—	17.02	—

BMI, body mass index; *F,* female; *L,* left; *M,* male; *NDI,* Neck Disability Index; *NS-NP*, nonspecific neck pain; *R,* right; *UT*, upper trapezius muscle.
[a] Independent *t* test ($P > .05$).

The clinical benefit of possible alterations in the activity of the upper trapezius muscle after the stimulation of acupoints TE-5 and LI-11 in patients with NS-NP would be the possibility of standardizing these acupoints as stimuli for the treatment of abnormalities in the upper trapezius muscle stemming from a mechanical injury or myofascial tension, with and without the presence of trigger points and systemic diseases, such as fibromyalgia. Hence, the hypothesis of this study was that the peripheral stimulus provided by the needles in acupoints TE-5 and LI-11 can act directly on the upper trapezius muscle activity in healthy participants and in patients with NS-NP as well on pain in these patients.

Therefore, the objective of this study was to assess changes in upper trapezius myoelectric activity and pain in patients with NS-NP after a single session of ACP.

Methods

Participants

This study included 15 health participants (control group [CG]) and 15 patients with NS-NP (NS-NP group [NPG]) recruited from the surrounding community and the university (Table 1). The sample size was calculated considering data on the amplitude of the electromyography (EMG) signal in the study by Chou et al,[28] and the details were described in the research protocol previously published.[29] An $\alpha = .05$, a statistical power of 99%, and a sample loss of 20% were considered. The sample size calculation resulted in a sample of 15 participants per group, totaling 30 participants.

Inclusion criteria for the NPG were as follows: (1) history of neck pain for a minimum of 3 months; (2) restricted neck movement (active or passive) in at least 1 direction; (3) Neck Disability Index score range of 15 to 24 (out of 50)[30]; (4)