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)

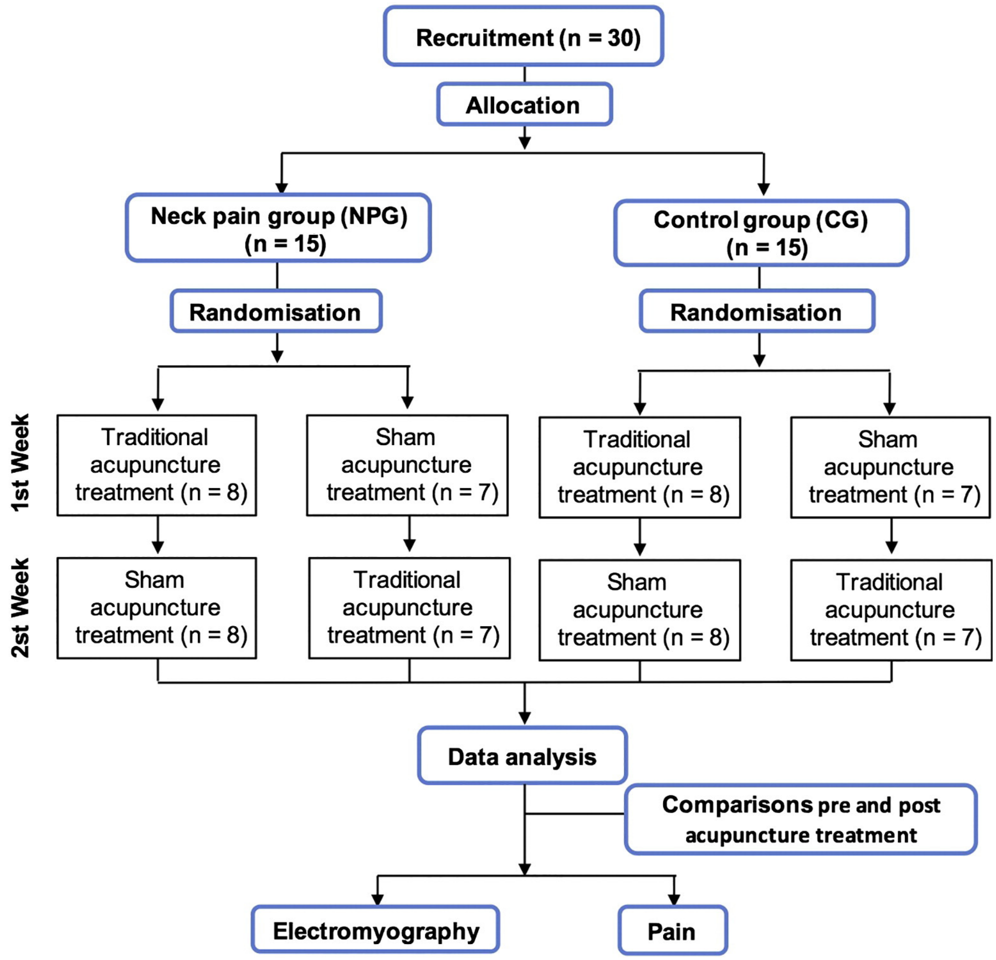

Fig 1. *Flowchart of the study.*

Numeric Rating Scale (NRS) score for perceived pain intensity of 3 to 7 points on an 11-point scale (range 0-10).[31]

The inclusion criteria for the CG were physically active and no self-reported history or positive signs of cervical spine or scapular dysfunction during the physical examination.

Individuals with any of the following were excluded from the present study: history of neurologic disorders (eg, irradiated pain) or neck surgery; systemic disease; connective tissue disorder; body mass index >25 kg/m^2; nontolerance of needles; current pregnancy; medical diagnosis of fibromyalgia; having undergone physical therapy, massage, or ACP in the previous 2 weeks; use of analgesic, muscle relaxant, psychotropic agent, or anti-inflammatory agent in the previous 3 days; chronic neck pain resulting from a traumatic incident; or chronic musculoskeletal condition (eg, muscular disorder, polyarthritis).[29]

Ethical Aspects

The present study was approved by the Human Research Ethics Committee of the Universidade Nove de Julho (Resolution 196/96 of the National Health Council, Research Protocol No. 525.849/2012), registered prospectively at the World Health Organization at Clinicaltrials.gov under number NCT01984021 and the research protocol published.[29] All participants and guardians were properly informed regarding the objectives and procedures and signed a statement of informed consent before testing.

Randomization and Blinding. Figure 1 displays the flowchart of the study. A cross-sectional, randomized, single-blind sham-controlled, crossover clinical trial was carried out. Participants of this study were randomly assigned to receive 2 forms of ACP: a single session of ACP[28] and sham ACP (SACP).

The volunteers were randomly assigned to receive ACP or SACP using the website randomization.com, as described later, and to eliminate carryover treatment effects, there was a 1-week washout period between the treatments.

Five independent researchers performed the measurements as follows: (1) 1 researcher was responsible for screening process, administration of the questionnaire, and

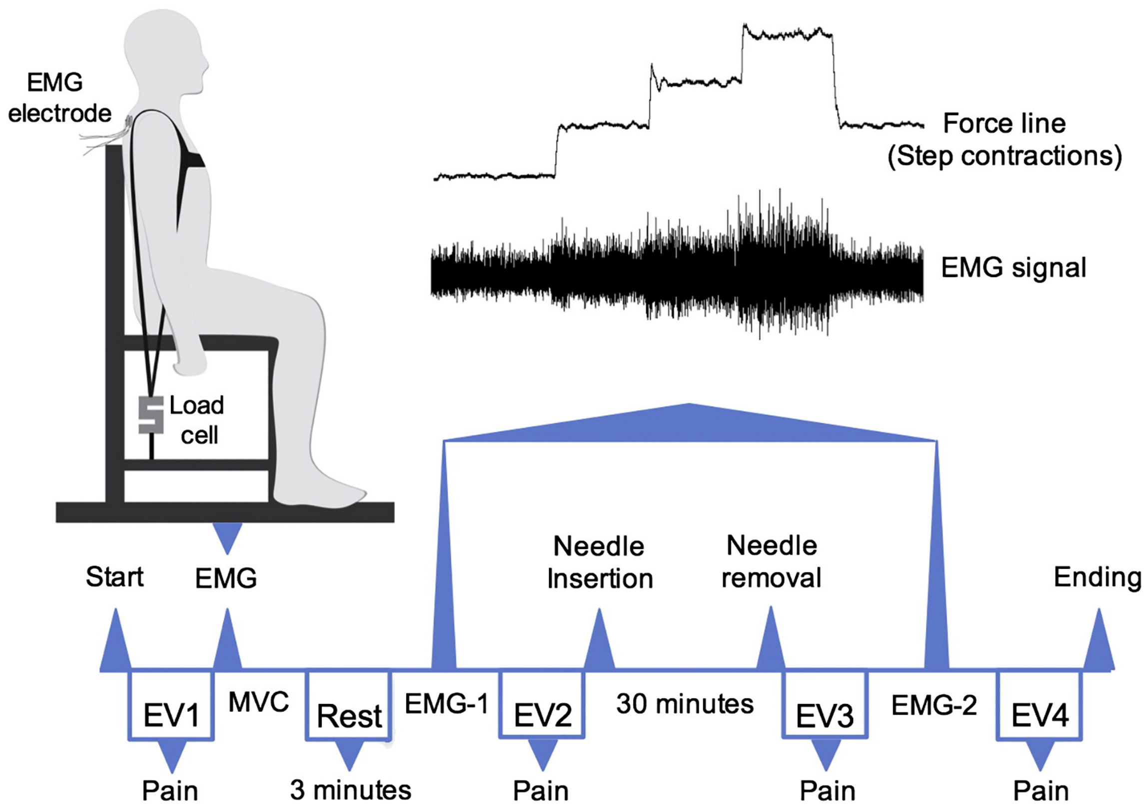

Fig 2. *Flow sequence diagram of data recording.* EMG, *electromyography;* EV, *evaluation;* MVC, *maximal voluntary contraction.*

randomization of the treatments; (2) another researcher was responsible for collecting the EMG data; (3) a physical therapist certified in ACP with 16 years of experience was responsible for administering the ACP treatment; (4) another researcher was responsible for analyzing and processing the EMG data; (5) and the fifth researcher was responsible for statistical analysis of the EMG and pain data.

The volunteers and researchers 4 and 5 were blinded to the type of treatment (ACP or SACP), and all participants were informed that they received treatment with ACP and SACP after tests.

Outcome Measures

Electromyographic activity of the upper trapezius muscle after a single session of ACP was considered the primary outcome and NRS scores for pain and pain area as the secondary outcomes of the study.

Sensory Assessment

Numeric Rating Scale (11-point scale; 0: no pain, 10: the worst possible pain imaginable) translated and cross-culturally adapted for the Brazilian population was used to assess pain intensity in the NPG.[31,32] Pain area was documented on a body chart. The drawings were subsequently digitized and pain areas were measured using open-source software ImageJ (Version 1.43, National Institutes of Health, Bethesda, Maryland). The reproducibility of the measurements has been verified in a previous study, and it was considered acceptable as a pain measurement tool in clinical practice and research.[33]

Electromyography

Surface EMG signals were obtained using an 8-channel module (EMG830C, EMG System do Brazil Ltda, São José dos Campos, São Paulo, Brazil), consisting of a conditioner with a band pass filter at 20 to 500 Hz, 16-bit analog to digital converter, an amplifier gain of 1000, and a common mode rejection ratio >120 dB. The sample size used was 2 kHz. The system included active bipolar electrodes with a preamplification gain of 20×. A channel of the acquisition system was enabled for the use of the load cell (EMG System do Brazil Ltda).

Disposable circular electrodes (Ag/AgCl, Kendall Medi-Trace, Mansfield, Massachusetts) with 10-mm diameter were placed in the upper trapezius muscle with a center-to-center distance of 20 mm. The skin was cleaned with 70% alcohol, the electrodes were attached 2 cm lateral to the midpoint of the line between the C7 spinous process and the acromion,[34] and a reference electrode was attached to the left wrist.

The sEMG signal was recorded in the dominant upper trapezius muscle in the CG and on the side with the greatest self-reported pain in the NPG.

Acupuncture

Sterile ACP needles (0.25 × 13 mm: Suzhou Huanqiu Acupuncture Medical Appliance Co Ltd, Suzhou, Jiangsu, China) were inserted in LI-11 (at the outermost point of the skinfold of elbow flexion, in the direction of the lateral epicondyle) and TE-5 (3 cm above the joint line of the wrist, at the dorsal face of the forearm between the radius and ulna).[35] In the CG, the needles were inserted 1 cm to the side of the each ACP point (LI-11 and TE-5).

In general, SACP needles are applied either on acupoints with a shallower depth or to nonacupoints with a similar or shallower depth[36]; they are designed to prevent the patient from knowing whether or not real ACP was received but are thought to have minimal activity against pain.[37]

The following insertion procedures were carried out: (1) Participant was seated comfortably with the upper limb unclothed; (2) the skin was cleaned with alcohol; (3) in the NPG, a needle was inserted until the participant felt a sensation of *de-qi* (mild shock), whereas needle depth in the CG was superficial (without producing de-qi); (4) in both groups, the needles were rotated in both the clockwise and counterclockwise directions for 10 seconds, every 3 minutes, at an approximate frequency of 60 times per minute. All participants with NS-NP were sent for physical therapy at the rehabilitation clinic of the university.

Experimental Procedures

The sequence of experimental procedures is shown in Figure 2. The participants were instructed to remain seated in a chair, and data on pain (NRS and pain area) were collected at baseline (A1). Disposable electrodes were attached for the collection of the sEMG signal, and a strap to the shoulder was attached to a load cell connected to a support attached to the chair on the same side of the upper trapezius muscle treated with ACP. The strap on the contralateral shoulder was attached directly to the chair.

Before beginning the recording of EMG signals, the volunteer was asked to carry out a series of 3 elevations of the shoulder in maximum voluntary contraction (MVC) against the resistance offered by the load cell for 5 seconds. A 3-minute rest interval was given between efforts.

The first sEMG signal (EMG-1) was collected after 3 minutes of rest after the last MVC. The volunteer was instructed to perform a step contraction, consisting of 4 force levels (15%, 20%, 25%, and 30% MVC) calculated from the maximum value in Newtons (N) obtained during the tree MVC. Feedback of the step contraction was provided from the projection of a 20-inch screen on a white wall in front of the participant. To investigate possible myoelectric manifestations of fatigue, a repetition of the second step (20% MVC) was added as the fifth step to determine differences in the sEMG variables between these 2 steps.[38]

The duration of each force level (15%, 20%, 25%, and 30% MVC) was 11 seconds and the fifth step contraction time was 20 seconds. All participants received training before the shoulder elevations, based on the previously determined force levels.

After 1 minute of rest, a new evaluations of pain (A2) was performed, and the ACP needles were inserted and remained in place for 30 minutes. After the removal of the needles, further evaluations of pain were performed (A3), followed by a second EMG reading (EMG-2) in the same manner as performed during EMG-1. After 2 minutes of rest, a fourth evaluation of pain was performed (A4).

EMG Signal Processing

For the analysis of the sEMG signal, the first second of each step (considered as a transition time between force levels) was discarded and the subsequent 10-second period was divided into 1-second windows. Only the last 10 seconds of the signal were considered compared with the third and fifth contraction steps. The root mean square (RMS) was calculated for each window. All EMG signals were processed using specific routines in the Matlab program, Version 7.1 (MathWorks Inc, Natick, Massachusetts).

Statistical Analysis

All data were analyzed using SPSS 20.0 software (IBM Corp, Armonk, New York). The Shapiro-Wilk test was used to test the normality of the data distribution. Mean, standard deviation, and 95% confidence interval for each pain variable were calculated. Mean age, height, and body mass index were compared between groups using independent-samples *t* tests.

The 2-way repeated-measures analysis of variance design was used to analyze the influence of ACP treatment on the pain considering with factors treatment and intervention.

Surface EMG signals (RMS) were analyzed using 3-way repeated-measures analysis of variance with the following 3 factors: treatment (pre- vs post-treatment), intervention (ACP and SACP), and step contractions of shoulder elevation force (15%, 20%, 25%, and 30% MVC). The paired *t* test was used to test RMS differences between the third and fifth contraction steps with the objective to investigate possible myoelectric manifestations of fatigue on upper trapezius muscle. Specific differences were determined based on post hoc analysis, using the Bonferroni correction and the *t* test for multiple pairwise comparisons, maintaining an α level of .05 for significance in all of the analysis.

Linear regression analysis was applied for each individual to investigate associations between the sEMG variable (RMS) and force (excluding the fifth step). The slopes of the regression lines were normalized for the value at the third force step, and the mean values of the 4 contraction levels were used to measure the sensitivity of the sEMG variables in terms of changes in force pre- and post-ACP treatment.[38] Values close to zero on this sensitivity index were interpreted as representing satisfactory motor control of the upper trapezius muscle.

Cohen *d* and partial η^2 squared (η_p^2) were used to calculate the effect size.[36] The interpretation was based on the values established by Cohen: small effect (less than $d = 0.2$ and $\eta_p^2 = 0.01$); moderate effect (approximately $d = 0.5$ and $\eta_p^2 = 0.06$); and large effect (greater than $d = 0.8$ and $\eta_p^2 = 0.14$).[39]

Results

No systemic adverse effects were noted in any patient after ACP treatment. The demographic data (age, stature, weight, and body mass index) were similar in healthy participants and those with NS-NP ($P > .05$). Differences between the groups related to clinical characteristics were recorded using the NRS and Neck Disability Index (Table 1).

Pain Analysis

In the analysis of pain intensity, the mean values obtained in assessments EV1 and EV2 were considered as pretreatment values, whereas the mean values from assessments EV3 and EV4 were considered as post-treatment values. Significant effects were confirmed after the treatment (ACP and SACP) in the NPG for NRS scores ($F_{1,28} = 51.61$; $P < .0001$, $\eta_p^2 = 0.64$) and the pain area ($F_{1,2} = 32.03$; $P < .0001$, $\eta_p^2 = 0.53$). No significant interaction was identified between treatment (pre- vs post-treatment) and interventions (ACP and SACP) for the NRS ($F_{1,28} = 0.95$; $P = .33$, $\eta_p^2 = 0.03$) and pain area ($F_{1,28} = 1.97$; $P = .17$, $\eta_p^2 = 0.06$). The mean, standard deviation, and post hoc test values for pain area (arbitrary units) and NRS scores (from the NPG) are displayed in Table 2.

EMG Analysis

The interactions between intervention and the amplitude values of the EMG signal considering the first 4 force steps confirmed a significant decrease in the RMS after treatment (ACP and SACP) for NPG ($F_{1,112} = 26.82$; $P < .0001$, $\eta_p^2 = 0.19$) and the HPG ($F_{1,112} = 21.69$; $P < .0001$, $\eta_p^2 = 0.16$). No differences were found between treatments with ACP and SACP for both groups (NPG: $F_{1,112} = 0.47$, $P = .49$, $\eta_p^2 = 0.04$; HPG: $F_{1,112} = 0.75$, $P = .38$, $\eta_p^2 = 0.007$). The mean and standard deviation values, as well as the significant differences in the RMS values before and after treatment, can be seen in Figure 3.

Table 2. *Mean and Standard Deviation (95% Confidence Interval) Values of Pain Intensity and Pain Area Scores From Nonspecific Neck Pain Patients*

Pain Assessment	Treatment Pre	Post	*P*	Effect Size
ACP NRSP	5.33 ± 1.29 (4.61-6.04)	2.96 ± 1.85 (1.93-3.99)	<.0001	1.48
SACP NRSP	4.90 ± 1.18 (4.24-5.55)	3.10 ± 1.28 (2.38-3.81)	.01	1.46
ACP Area pain (au)	1.18 ± 0.57 (0.86-1.50)	0.53 ± 0.42 (0.29-0,76)	<.0001	1.19
SACP Area pain (au)	1.02 ± 0.49 (0.75-1.30)	0.63 ± 0.42 (0.39-0.86)	<.0001	0.85

ACP, acupuncture; *au,* arbitrary units; *NRSP,* Numeric Rating Scale for pain; *SACP,* sham acupuncture.

The fifth step (repetition of the second step) was only higher than the second step in the NPG before treatment with ACP and SACP ($P < .001$, Student *t* test for paired samples). On average, the values referring to the third and fifth steps were very similar after treatment with ACP or SACP (Fig 3).

Concerning the upper trapezius muscle activity, the sensitivity of the sEMG variables regarding changes in force before and after ACP treatment, expressed as the normalized slope of the regression line, was lower in the HPG after treatment with ACP (pretreatment: 0.36 ± 0.76%/N; post-treatment: 0.27 ± 0.68%/N) and SACP (pretreatment: 0.37 ± 0.91%/N; post-treatment: 0.21 ± 0.41%/N). Although the NPG exhibited a higher mean value for sensitivity than the HPG, the values remained lower after treatment with ACP (pretreatment: 0.65 ± 0.70/N; post-treatment: 0.49 ± 0.74%/N) and SACP (pretreatment: 0.72 ± 0.63%/N; post-treatment: 0.43 ± 0.57%/N).

Discussion

Acupuncture is used to treat or alleviate a variety of symptoms, especially pain, and has been reported to be effective and well tolerated.[18,19] It also generates satisfactory results in the treatment of patients with neck pain.[17-19]

These effects were also noted on the pain assessed by the NRS and on the identified area of the pain in the present study. However, the significant decrease in pain symptoms after treatment with ACP was practically the same as that after treatment with SACP. Similar results were previously reported for patients with NS-NP who were treated with auricular ACP[40] for pain control and other musculoskeletal disorders, such as acute and chronic low back pain[41] and fibromyalgia.[42]

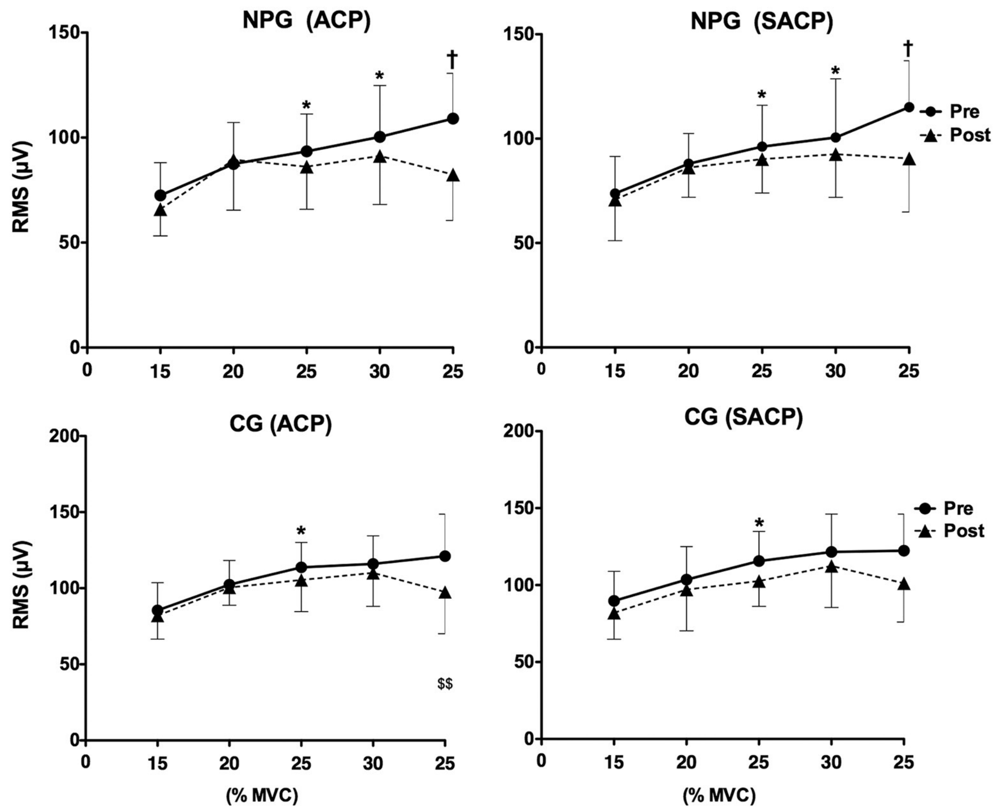

Fig 3. *Mean and standard deviation of the RMS recorded during different step contractions of shoulder elevation force (15%-30% of maximal voluntary contraction). The data were obtained before and after treatment with an ACP intervention at the triple energizer 5 and large intestine 11 points, as well as SACP, with an NPG and a CG, respectively. *Significant difference between pre- and post-ACP treatment.* †*Significant difference between the third and fifth step contractions.* ACP, *acupuncture;* CG, *control group of healthy individuals;* MVC, *maximal voluntary contraction;* NPG, *nonspecific neck pain group;* RMS, *root mean square;* SACP, *sham acupuncture.*

One possible reason for these results could be the fact that the sensory stimulation promoted by the SACP may activate mechanoreceptors in the skin that convey light touch information to the brain.[43,44] In this case, it is suggested that the SACP causes a stronger mechanical stimulus on the skin, after which this information is transmitted to the brain via Aβ afferents and C afferent (non-nociceptive) fibers.[43,44] In addition, several authors have also considered nonspecific factors such as contact time, expectancy, and device-related rituals, rather than needling or other components specific to ACP.[45]

In the present study, the responses of the upper trapezius muscle to the EMG activity did not contribute to a better understanding of the physiological mechanisms of ACP. Similar results were identified for both the ACP and SACP treatment protocols in the 2 groups studied (NPG and HPG). The effects of the treatment (ACP and SACP) were more obvious in the NPG. In this group, there was a significant decrease in the amplitude of the EMG signal for the third and fourth force levels (25% and 30% maximal voluntary contraction), whereas in the HPG this difference only occurred for the third force level.

Although the explanation of these findings is not straightforward, the peripheral stimulus provided by the needles may have caused a physiological mechanism (not yet reported in the literature) that inhibited muscle activity. This physiological effect could be associated with muscle relaxing and a consequent clinical improvement, such as the decrease in pain noted among the individuals in the NPG. Therefore, the fact that the upper trapezius muscle was more hyperactive among individuals in the NPG may have made the effects of ACP more evident in this group compared with the HPG.

This observation could be more adequately explained by the sensitivity of the RMS in relation to changes in force before and after ACP treatment. The sensitivity value recorded among the individuals in the NPG before treatment with ACP (0.65 ± 0.70%/N) and SACP (0.72 ± 0.63%/N) was higher than that found in the HPG (0.36 ± 0.76%/N and 0.37 ± 0.76%/N), indicating that NS-NP leads to a greater variation in EMG activity to maintain the same levels of force as healthy individuals. In addition, the decrease in the sensitivity value after ACP treatment in the NPG was 34.28% after ACP and 37.68% after SACP. In the HPG, this decrease was 25% and 24.32%, respectively.

Concerning the possible effects of ACP on muscle fatigue, a difference between the third level of the step contraction and its repetition (fifth step) was only found in the NPG before treatment with ACP and SACP. At the fifth step, the RMS was significantly higher than the third step. These differences could be correlated with the peripheral alterations caused by muscle fatigue.[38] The fact that these differences were not identified in the NPG after treatment strengthens the hypothesis that the stimulus provided by the ACP may have inhibited a possible hyperactivity of the upper trapezius muscle, thereby improving local blood irrigation. This, in turn, improved the resistance to fatigue after the needle intervention.

The similarities between the ACP and SACP treatment protocols (decrease in EMG in both groups and decrease of pain in the NPG) prevent a precise conclusion regarding the action of ACP at points ACP TE-5 and LI-11 on the upper trapezius muscle. However, the results of the present study, similar to previous studies,[40-42] indicate that many of the points used for the sham group are not inert, which casts doubt on the validity of traditional ACP theories related to point locations and indications. This possibility is strengthened by the fact that clinical trials have failed to identify a reliable difference between true and sham ACP, as defined by traditional ACP theories.[46]

The needle insertion depth is a particularly important detail that could explain the differences between the results of the SACP group in the present study and those reported in a study by Chou et al,[28] in which the ACP needle had contact with the skin (the needle was inserted into a rubber connector) and the patient could feel the sharp needle tip, although the needle did not penetrate the skin.

However, we have found no scientific evidence supporting the distinction between ACP points and non-ACP (ie, sham) points. This lack of understanding of what represents an ACP point hinders our ability to interpret the results of clinical trials,[45] including those obtained in the present study.

It is important to stress that the efficiency of ACP should not be underestimated because of the fact that similar results were found for the SACP treatment protocol. This is a paradox that should be considered and clarified in future studies.

Clinical Implications

Concerning the clinical application of these results, it is only possible to state that there is strong evidence that the peripheral stimulation provided by ACP at points TE-5 and LI-11, or in close proximity, contributes to the decrease in the hyperactivity of the upper trapezius muscle and leads to pain relief and greater resistance to muscle fatigue (upper trapezius) among patients with NS-NP. Therefore, the present study provides the basis for the performance of new studies to assess the efficiency of ACP for NS-NP.

Limitations

The assumption that the SACP points could be used as a control for the possible effects of ACP at points TE-5 and LI-11 after stimulation with a needle, together with the fact that the same needle insertion depth was used for both treatment protocols (ACP and SACP), may have been the greatest limitations of the present study. Thus, future studies should consider another form of control (SACP) for comparisons with treatment using the acupoints TE-5 and LI-11. Furthermore, the results this study refer to the effects identified after a single session of treatment using the TE-5 and LI-11 points, and this can also be considered as another limitation of this study.

Conclusion

The results identified in the true and sham ACP treatment protocols were practically the same. The effect of ACP at acupoints TE-5 and LI-11 TE-5, or in close proximity, contributes to pain relief among patients with NS-NP. 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 NS-NP. These results suggest that further investigations are necessary.

Funding Sources and Potential Conflicts of Interest

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Contributorship Information

Concept development (provided idea for the research): D.A.B.-G., F.P.
Design (planned the methods to generate the results): F.P.
Supervision (provided oversight, responsible for organization and implementation, writing of the manuscript): F.P.
Data collection/processing (responsible for experiments, patient management, organization, or reporting data): S.A.P.C., N.C.D.M.
Analysis/interpretation (responsible for statistical analysis, evaluation, and presentation of the results): M.A.F., C.A.F.d.P.G., C.F.A.
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Practical Applications

- No scientific evidence supported the distinction between ACP points and non-ACP (sham) points.
- Acupuncture at points TE-5 and LI-11, or in close proximity, contributes to a decrease in the hyperactivity of the upper trapezius muscle.
- Acupuncture may activate mechanoreceptors in the skin that convey light touch information to the brain.
- True and sham ACP treatment contributes to pain relief among patients with NS-NP.

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