Influence of Electroacupuncture and Laser-Acupuncture on Treating Paresthesia in Patients Submitted to Combined Orthognathic Surgery and Genioplasty

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ABSTRACT

Objective: The goal of this research was to observe the influence of electroacupuncture (EA) and laser-acupuncture on the return of tactile/pain sensitivity in patients who underwent orthognathic surgery.

Materials and Methods: Thirty volunteers subjected to orthognathic surgery were evaluated and randomly divided into 2 groups, in which 3 treatments were evaluated: control ($n=30$) (G0, medication + placebo laser treatment) and 2 experimental treatments ($n=15$) (G1, medication + EA) or G2 (medication + laser-acupuncture). The control group had $n=30$ because for each experimental treatment conducted on a volunteer's hemi-face, there was a control treatment on the other hemi-face. In G1, medication was given with EA, with needles placed at predetermined points (ST 4 [*Dicang*], M-HN-18 [*Jiachengjiang*], CV 24 [*Chengjiang*], ST 5 [*Daying*], ST 6 [*Jiache*], and point A1 [YNSA]). For electrostimulation, the device used delivered transcutaneous electrical nerve stimulation of a burst type, with intensity and frequency variations of $T=220$ ms and $F=4$ Hz (30 minutes, $2\times/\text{week}$). In G2, in addition to the medication, laser irradiation (at 780 nm) was applied on acupuncture points (at 0.04 cm^2 , 70 mW, 6 s/point, 0.42 J/point , 10 J/cm^2 , $2\times/\text{week}$). All volunteers were evaluated before and during the 4 months following the surgery. Tactile sensitivity was assessed by mechanical brushing (brush #s 2 and 12) and by a 2-point discrimination test, using a bow compass. A pain test was performed with a pulp electrical test that stimulates intact nerves of the dentin-pulp complex. A Kaplan–Meier test was performed, and survival curves were plotted for comparison between groups. Cox regression analysis was also conducted ($\alpha=0.05$).

Results: There were no statistically significant differences among the groups for the 2-point discrimination test (brushes #2 and #12) on the buccal mucosa region and for the pulp test on all evaluated regions. However, the tactile test using brush #12 revealed significant differences between G1 and the other groups when considering the lower lip ($P=0.024$) and chin ($P=0.028$) areas.

Conclusions: Only EA was able to influence—using the brushing test (brush #12)—the return of tactile sensitivity on the chin and lower lip positively after combined orthognathic surgery and genioplasty.

Keywords: acupuncture, laser therapy, orthognathic surgery, paresthesia, randomized clinical trial

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INTRODUCTION

SENSORINEURAL DISABILITY is an abnormality, temporary or not, characterized by sensory disturbance commonly associated with orthognathic surgeries involving the maxilla and mandible.¹ The condition is one of the most frequent complaints among patients undergoing orthognathic surgery—there is a loss of sensation; hyperesthesia; gustatory deficiency; bites on the tongue, lips, and cheeks; difficulty with eating, talking, and smiling; inability to control saliva in the mouth; and constant irritability.^{2,3}

The most recommended treatment for the recovery of nervous tissues has been proposed by systemic administration of medication (vitamins B and C, and nonsteroidal anti-inflammatory substances) and local therapy. In addition to these, electrical stimulation, acupuncture, and, more recently, low-power laser applications have been used. According to the literature, the recovery of the affected nerve tissue prognosis varies considerably according to the degree of injury and proposed treatment.^{4,5}

Acupuncture is a technique that belongs to Traditional Chinese Medicine⁶ and consists of inserting needles into specific points on the body to promote local and systemic effects, acting on restoring the balance among the body's various systems.⁷ Among the advantages of this method are the facility of application, patients' acceptance, no side-effects, and controlled risk.⁸⁻¹⁰ Acupuncture has been used to control pain and swelling, to reduce the amount of anesthetic used during surgery, and to act as an analgesic in the postoperative period.⁸⁻¹¹ Acupuncture has been reported to reduce reactions (nausea and vomiting) associated with surgical procedures and to control anxiety in the preoperative period, and has also been discussed as a possibility for treating paralysis and paresthesia, and as a promoter of clinical success in cases of sensorineural disability.^{4,8-11}

Two other therapies currently used for the treatment of paresthesia (neuropraxia and axonotmesis) are electroacupuncture (EA), which has the same basis as acupuncture but is performed with needles connected to electrical devices, and laser-acupuncture, which is the therapeutic use of a low-power laser on acupuncture points.¹² Researchers have reported that EA is more effective for treating facial paralysis, compared to traditional acupuncture.^{4,13}

Up to the present, there have been few studies evaluating the use of laser therapy for addressing post-oral surgery neurosensory disabilities.^{14,15} Protocols have been developed to verify the benefits of this new technology in addressing paresthesia caused by dental surgical procedures. However, to date, there are no longitudinal clinical studies that have evaluated the effects of the treatment with EA or laser-acupuncture on neural changes resulting from combined orthognathic surgery and genioplasty.

MATERIALS AND METHODS

This research project was approved by the local ethics committee of the School of Dentistry—University of São Paulo, Protocol # 179-716.

Sample Selection

The sample size was determined based on a previous study on the use of EA techniques to address paresthesia following surgery.⁴ For this randomized and blinded study, 40 patients were evaluated in physical examinations.

The inclusion criteria were patients: who underwent combined orthognathic surgery and genioplasty; of both genders; and of ages between 17 and 50. The exclusion criteria were patients: who had facial sensory change before undergoing the combined orthognathic surgery and genioplasty; who showed significant differences in sensitivity when their right and left sides were compared; who were under age 17 or over age 50; and who had intraoperative complications and exacerbated complaints of postoperative pain.

Patients who met the inclusion criteria were included as volunteers and were instructed by an informed consent form. Of the original 40, 10 volunteers were excluded after the presurgical sensory evaluation. A total of 30 volunteers were included (11 men and 19 women), between 20 and 37 years' old. Among the patients, 10 were excluded after the presurgical sensory evaluation.¹⁶

Treatment Groups

After the initial sensory evaluation (7 days after orthognathic surgery), the randomization table was determined by a block randomization, in which an envelope was opened to reveal the group in which the volunteer would be included. The intervention consisted of 30 clinical sessions of EA or laser-acupuncture. For each volunteer's hemi-face that has been subjected to an experimental treatment (EA or laser-acupuncture), the other hemi-face was considered a control in which a placebo (G0) was considered. The permutation block of randomization—using opaque envelopes (sequentially numbered and sealed)—was conducted by a researcher (P.M. de F.) who did not participate in the data collection.¹⁷

Before placing needles or performing the laser application, the skins of all volunteers were cleaned. The control treatment (G0) and the experimental treatments (G1/G2) were applied to the same volunteer.

Control group (G0). In G0, the treatment was the conventional drug method. Table 1 describes the medications and their dosages prescribed to patients in the intraoperative and postoperative periods.^{18,19} In order to avoid the interference of psychological factors of volunteers in relation to the side of face subjected only to the treatment with a drug (control, G0), laser therapy was simulated in this

TABLE 1. MEDICATIONS ADMINISTERED TO PATIENTS IN THE INTRA- AND POSTOPERATIVE PERIODS

Parameter	Time periods				
	Intraoperative I.V.	First postoperative day for 24 hours	First postoperative day for 5 days	First postoperative day for 7 days	First postoperative day for 20 days
Medications & dosages	Dexamethasone 10 mg	Dexamethasone 8 mg, every 8 h	Zofran 8 mg, every 8 h	Keflex 500 mg, every 6 h	Cyclobenzaprine hydrochloride 10 mg, 1/d
	Ondansetron 8 mg	Cefazolin sodium 1.0 g I.V., every 8 h	Dipyron 2 mL, every 6 h	—	—
	Cefazolin sodium 1.0 g	Ranitidine hydrochloride 50 mg, every 8 h	—	—	—

h, hours; I.V., intravenous; d, day.

region (placebo), with no therapeutic effect. At the tip of the laser an aluminum paper was placed over the laser tip, avoiding contact of the laser stimulus with the skin.

Electroacupuncture group (G1). Transcutaneous electrical nerve stimulation (TENS; Quark model TensVif 993 Four)—which measures acupuncture mode and burst type, with varying intensity and frequency—was applied in addition to the drug therapy. The T (period) was 220 ms and the frequency was 4 Hz. The intensity was set according to the volunteer's tolerance (strong but tolerable). The maximum output current was 70 mA per channel. To avoid intensities that volunteers would find painful, the TENS was tested primarily on the LI 4 acupuncture point (*Hegu*) at the right side (which had a normal sensory response). The registered intensity was then placed in all 3 channels.^{20,21}

After asepsis of the volunteers' skin, disposable facial acupuncture needles made of stainless steel were placed (caliber 0.20 mm and length of 15 mm, DBC, Dong Bang Acupuncture, Korea). Each facial needle was inserted 7.5 mm deep, with the exception of point A1—in which a disposable needle made of stainless steel acupuncture (caliber 0.18 mm and length of 8 mm) was inserted 8 mm in depth at this point—giving a total of 6 needles. For each needle, one electrode was connected. Electrical stimulation was applied on the following points: ST 4 (*Dicang*); M-HN 18 (*Jiachengjiang*); CV 24 (*Chengjiang*); ST 5 (*Daying*); ST 6 (*Jiache*); and point A1 (YNSA).

After standardization of the current, which was individually determined for each volunteer, the electrodes were activated in that voltage and the volunteer remained in the supine position on a dental chair that tilted 150° with a pillow beneath the neck. Electrical stimulation was applied for 30 minutes.^{22,23} Afterward, the needles were removed and discarded.

Laser-acupuncture group (G2). Low-power laser irradiation was performed twice per week, on the same acupuncture points used for the EA. Prior to irradiation of the face, skin asepsis of volunteers with 70% alcohol was

done, avoiding interference of the laser light with chemicals and sweat. Irradiation was performed with a low-power laser (780 nm, LaserHand, MMOptics, São Carlos, SP, Brazil), in contact mode, with a spot size of 0.04 cm², 70 mW, 6 sec/point, 0.42 J/point, and 10 J/cm².

Acupuncture Techniques

Acupuncture techniques were performed according to preestablished criteria, in accordance with the Standards for Reporting Interventions in Controlled Trials of Acupuncture.²⁴

Sensory Evaluation

Each volunteer included in the study was submitted to initial sensory tests, before the orthognathic surgery; the tests consisted of mechanical evaluation using brushes (#2 and #12) and a 2-point discrimination test (Ice, Silver model, São Paulo, SP, Brazil; calibrated on 5 mm and 10 mm), and an electric pulp test. All volunteers were treated and evaluated from the seventh postoperative day. The evaluation was conducted before the beginning of the proposed treatments and before each clinical session (immediately before the therapeutic intervention). The intervention was applied twice per week for a 4-month period. The tests were performed with each participant keeping the eyes closed, so that the area being evaluated could not be identified by the volunteer. All of the interventions and follow-up evaluations of sensitivity were carried out by a researcher trained in physiotherapy (R.F. de O.).

Mechanical evaluation with brush. The test was done using calibrated brushes (Tigre, model 276, brushes #2 and #12, São Paulo, SP, Brazil), which were applied on the posterior (trigone retromolar paravestibular), medium (next to the second and first lower molars) and anterior (near to the lower first premolar) regions of the buccal mucosa.

External evaluations were performed on the skin, at the jaw's body (posterior, middle and anterior thirds), chin (base) and lower lip (base point) regions.

First, the test was carried out on the unstimulated side (control, G0) and afterward at the stimulated side (G1 or G2). This test was conducted to verify the presence or absence of sensitivity to brushing, to test if the fibers A-Beta (fast adaptation, tactile) were intact, as well as whether pain or shock was present. The responses to the brushing test were categorized on a visual analogue scale (VAS)²⁵ on which each participant classified the severity of the sensitivity on a scale from 0 (complete lack of sensitivity) to 10 (normal sensitivity) points.

2-Point discrimination test. This test was performed before and at the postsurgery period. The test involved using a compass of two dry ends (Trident, Casa Cruz, Rio de Janeiro, RJ, Brazil), calibrated at 5 and 10 mm. The jaw's body (corresponding to the first molar area), mental (between the canine tooth and central incisor) and lower lip (between the canine tooth and central incisor) regions were tested. The purpose of this test was to assess if the neurologic fibers responsible for discriminating the number of points of an object touching the skin of the patient were intact (i.e., the slow [tactile] adaptation of the A-beta fibers).

Electric pulp test. Mandibular second molar teeth, first premolars, and central incisors (bilateral) were tested. An increasing scale (a current of 1–20 mA) was used to assess preoperative and postoperative, inferior, and alveolar nerve response and evolution of their recovery in the postoperative period. The test was performed with a vitality scanner (VCR 200 model, Odous de Deus, BH). A note was made in the digital display when the participant reported a feeling of warmth or tingling.

The normal range of reaction followed the standards: molars from 30 to 50; premolars from 20 and 50; incisors from 20 to 40. If a participant did not respond to the stimulus at the maximum preset value, the maximum value was recorded and the stimulation was stopped, to avoid pulp damage. In this case, the absence of sensitivity was recorded.

Data Collection on the Volunteers' Surgical Procedures

Surgeons who performed the volunteers' surgeries were asked to fill out a questionnaire containing relevant information on the intraoperative procedures for further analysis of the clinical data and possible correlations with the evaluation of sensitive recovery. Each volunteer's age; gender; race; need for advance or retreat of the jaw (and, if so, how much this movement was in mm); need for rotation of the occlusal plane; and, finally, if there were any complications during surgery, such as nerve rupture, profuse bleeding, or unwanted fracture. If any of these complications were detected, the participant would be automatically excluded from the study.

Data Analysis

All data collected in the evaluation sessions and surgeons were transcribed for specific evaluation sheets.²⁶ The Kaplan–Meier survival analysis was performed, and the survival curves were plotted for comparisons among the groups. The median time for return of sensitivity was calculated, and differences among the survival curves of the different treatments were calculated using a log rank test. Cox regression analyses with shared fragility were carried out to evaluate the effect of different treatments on the return of sensitivity. Statistical programs MedCalc 13.1.2.0 (MedCalc bvba software, Mariarke, Belgium) and Stata 13.1 (Stata Corp LP, College Station) were used ($\alpha=0.05$).

RESULTS

Of the 30 volunteers analyzed in this study, 11 volunteers were male and 19 were female (ages 20–37). Gender, age, race, mandibular advancement, mandibular setback, and rotation of the occlusal plane did not influence nerve recovery following the orthognathic surgery. There were no statistically significant differences among the groups for the 2-point discrimination test, tactile test using brush #2, tactile test using brush #12 (in the regions of buccal mucosa), and pulp tester on all evaluated regions. However, for the tactile test using brush #12 there were statistically significant differences between G1 and the other groups for the lower lip ($P=0.024$) and chin ($P=0.028$) regions (Figs. 1 and 2). Table 2 shows the Cox regression analysis to assess the

FIG. 1. Percentage (%) of return of the tactile sensitivity on the lower lip using brush #12 at different time intervals (number of clinical sessions). inf, inferior.

FIG. 2. Percentage (%) of return of the tactile sensitivity on the chin using brush #12 at different time intervals (number of clinical sessions).

effect of the experimental groups and other variables on the return of sensitivity for the 2-point discrimination, tactile, and painful tests on different regions.

The analysis of Kaplan–Meier survival curves showed that, for the tactile sensitivity test using brush #12 on both the lower lip and chin, half of the volunteers of G1 recovered sensitivity in 19 sessions; half of the volunteers of G2 recovered sensitivity in 20 sessions, and half of the volunteers of G0 recovered sensitivity in 24 sessions. The volunteers appeared to have an acceleration of return of neural sensitivity over the 3 weeks of treatment with EA, compared to the control group, according to the brushing test.

DISCUSSION

The results of this research showed that the volunteers who underwent EA achieved a tendency of tactile sensitivity return in the chin and lower lip faster than the laser-acupuncture and medication, according to one of the brushing tests (brush #12).

This finding can be justified by some studies^{27,28} on neurologic fibers that transmit tactile neural sensibility. Tactile fiber (A-beta) is large, myelinated, and adapts rapidly. Mechanical perception is related to these fibers. In EA, the electric current has a strong intensity, which is enough to excite afferent fibers in A-beta and some of the afferent fibers in A-delta.

The fibers in A-beta, when receiving the stimulus had probably accelerated its repair and returned quickly to normalization of neural transmission.^{27,28} In a study using a radiofrequency technique—which harms myelin fine fibers

TABLE 2. COX REGRESSION ANALYSIS TO ASSESS THE EFFECT OF THE EXPERIMENTAL TREATMENTS AND OTHER VARIABLES ON THE RETURN OF SENSITIVITY IN DIFFERENT REGIONS

Evaluation	Hazard ratio (confidence interval 95%)		
	Control	Electroacupuncture	Laser-acupuncture
Compass 5 mm			
Body	1.00	2.62 (0.15–44.4)	0.62 (0.05–7.00)
Chin	1.00	0.93 (0.43–2.01)	0.96 (0.44–2.07)
Lip	1.00	0.86 (0.40–1.86)	0.74 (0.31–1.77)
Compass 10 mm			
Body	1.00	0.76 (0.15–3.92)	2.21 (0.19–25.2)
Chin	1.00	0.70 (0.31–1.58)	1.08 (0.48–2.44)
Lip	1.00	0.78 (0.36–1.70)	0.64 (0.26–1.55)
Brush #2			
Medium buccal mucosa	1.00	1.80 (0.67–4.85)	1.04 (0.37–2.90)
Anterior buccal mucosa	1.00	1.63 (0.58–4.59)	1.13 (0.36–3.47)
Lip	1.00	1.60 (0.74–3.47)	1.22 (0.60–2.54)
Chin	1.00	1.95 (0.95–4.01)	1.21 (0.61–2.38)
Brush #12			
Medium buccal mucosa	1.00	1.82 (0.74–4.48)	0.88 (0.33–2.29)
Anterior buccal mucosa	1.00	1.97 (0.72–5.35)	0.92 (0.32–2.57)
Lip	1.00	2.23 (1.11–4.5)	1.21 (0.63–2.31)
		* <i>P</i> =0.024	
Chin	1.00	2.18 (1.08–4.38)	1.21 (0.63–2.31)
		* <i>P</i> =0.028	
Pulp tester			
Molar	1.00	0.42 (0.08–2.32)	1.68 (0.32–8.78)
Premolar	1.00	0.47 (0.09–2.39)	2.06 (0.44–9.71)
Incisive	1.00	0.55 (0.13–2.40)	2.35 (0.54–10.33)

**p*=0.024 and **p*=0.028 corresponded to the tactile test using brush #12. There were statistically significant differences between G1 and the other groups for the lower lip (*p*=0.024) and chin (*p*=0.028) regions.

and unmyelinated fibers irreversibly by the action of heat²⁹—it was reported that the technique spared nerve fiber average diameter (the A-beta fibers), as had been shown in previous studies.^{30,31} However, it was demonstrated (in an animal model study) that the thick myelinated fibers (type A-beta fibers) are preferably denatured by radiofrequency.³² These researchers showed that the finest fibers were intact and concluded that thick nerve fibers—which involve these fine fibers within the neural tube—are capable of protecting the finest fibers.³² In studies conducted on radiculoganglion balloon compression, it was found that thick fibers suffer most from the effects of compression and that the mandibular branch is the most affected.^{33,34} These findings suggest that thick tactile myelin fiber (A-beta fibers that have quick adaptation), despite being more affected anatomically after orthognathic surgery, when receiving EA stimulation, can accelerate their repair and return more quickly to normalized neural transmission. Consequently, the tactile sensitivity to brushing is enhanced in these fibers, compared to other sensory fibers.

The same response to tactile stimulation using brush #2 did not occur; this was different from what was expected. Although a fiber A-beta that also adapts quickly is responsible for the tactile perception of brush #2, this brush induced a very light perception (epicritic tactile),³⁵ which could have hindered its perception by volunteers. Brush #12, has more bristles and, therefore, is capable of activating more cutaneous receptors to capture the tactile stimulus.³⁵ EA benefited tactile perception of brush #12 probably because of reasons related to the A-beta tactile fibers that adapt rapidly, which require stimuli that vary constantly to be activated and to transmit the neural impulse, unlike the tactile A-beta fibers that adapt slowly, which require continuous stimuli to respond to and send the neural impulse.³⁶

The relation of EA to nerve growth factor (NGF) in the peripheral nervous system structures has been studied.^{5,6} It has been reported that mRNA NGF and the number of neurons that express NGF are increased by EA in cat spinal cord after dorsal rhizotomy,³⁷ indicating an involvement of neurotrophin in the spinal plasticity induced by this therapy. EA also increases both NGF of mRNA and protein levels of the neurons in ganglia L-6 (lumbar 6) of dorsal root after removal of the adjacent ganglion.³⁸

Regarding the technique of laser-acupuncture, no differences in responses between this technique and the control group were seen. The literature supports the use of low-power lasers for sensory peripheral nerve repair.¹⁵ Studies have shown that laser therapy provides immediate protective effects that enhance the functional activity of the damaged nerve and benefits its functional activity over time.^{39,40} Moreover, laser therapy can influence tissue healing positively and prevent or reduce degeneration of neural tissues.^{40,41} Low-power lasers can decrease inflammation and, consequently, pain sensitivity.⁴²

de Oliveira et al.⁴³ conducted a retrospective study on the effectiveness of laser therapy on the recovery of sensitivity after orthognathic surgery or minor oral surgery. Of all the factors that could be related to the positive results of laser therapy, the authors reported that the patients' age and the time interval between surgery and laser therapy were the most important. In this clinical trial, all volunteers were treated on the seventh postoperative day, following some results described in the literature.^{40,44} Some researchers noted that young patients had the most positive results for recovery of nerve sensitivity,⁴³ as was reported by other studies.^{39,45} In the current study, a small number of patients were included, between ages 20–37, and the nerve recovery was not verified as reported by de Oliveira et al.,⁴³ which evaluated 71 young patients.

Currently, little literature exists on the use of laser therapy for neural regeneration, as reported by de Oliveira et al.¹⁵ Despite the limitations regarding the consensus on clinical protocols for laser therapy or laser-acupuncture, it is known that both are capable of accelerating the regeneration of nerve tissue injury^{39,46}—by stimulating the adjacent

nervous tissue (or back side), causing the nerves there to play the role of the transected nerve⁴¹ and biomodulating the nerve response carrying the potential threshold action to normality.^{47,48} The advantages of using laser-acupuncture over conventional laser therapy are reduction of application time (reduced number of irradiation points) and the expected effects that the stimulation of acupuncture points can induce in the target tissue.

Depending on the severity of lesions in the sensory nerve fibers, the time to achieve significant clinical improvement in returning nerve sensitivity can vary considerably. In a study conducted by Yoshimoto et al.,⁴⁹ the researchers observed a minimum time (8 days) and maximum (201 days) time required for neural sensory recovery after treatment with laser therapy. In the present study, 5 sessions (~ 20 days) was the minimum time observed to obtain 100% return of sensitivity (according to the pulp tester) and 30 sessions (120 days) to obtain 100% return of tactile sensitivity that was discriminative and painful. Therefore, the treatments evaluated in the present study demanded less time to reach nerve recovery, compared to the total time observed by Yoshimoto et al.⁴⁹

The tests used in the current study, although considered relatively objective,^{2,50,51} are subjective because they are used to assess a patient's feeling with a VAS. Although the VAS is considered a standard tool for quantifying a patients' symptoms and complaints²⁵ just as the 2-point discrimination test is used,^{50–52} future studies should be carried out using sensory tests that can be measured by specific electronic devices that translate this sense of perception into numbers, giving more objectivity to sensorial tests and allowing researchers to quantify the results.^{50,51}

With respect to the control group, there was an improvement in the evaluated parameters, probably related to the known systemic effects of acupuncture. These effects are unspecific reactions to an acupuncture cure (i.e., a single needle of any acupoint triggers curing reactions that promote homeostasis).⁵³ This systemic effect probably occurred in the control group, causing the untreated side (placebo) to receive the benefits of real stimulation indirectly from the needles with the electric current or laser. This is called contralateral insertion, a traditional acupuncture technique in which needles are placed in contralateral acupuncture points (in the healthy side) to treat the injured or diseased side.^{53–55}

Xu et al.⁵⁶ investigated the relationship between the distribution of analgesia by acupuncture areas when different stimulation intensities were applied to homotopic and heterotopic acupoints and suggested that homotopic acupuncture is effective on the activation of large afferent fibers, whereas analgesia induced by heterotopic acupuncture is only effective at a strong intensity, which excites small afferent fibers. Local analgesic effects following stimulation of acupuncture are related to segmental inhibition, whereas systemic analgesic effects are related to contralateral effects.⁵⁶

The Burst type used in this study, with variation in intensity/frequency, might have induced the stimulation of various afferent fibers, causing systemic effects and acting in the volunteers' contralateral sides (placebo). Use of the contralateral side is a somewhat questionable choice as a control. One can make the argument that, in this way, the individual's pain perception is uniquely able to be studied. Yet, being an individual phenomenon, use of the contralateral side as a control is not entirely consistent with the mechanisms of action of acupuncture stimulation, as they likely involve central mechanisms. Thus, stimulation on one side would be expected to also affect the contralateral side, likely decreasing the observed magnitude of the effect. Researchers conducting future studies should consider a study design in which different subjects are allocated to a control group with patients not given any of the therapies. In addition, laser-acupuncture and laser therapy should be performed on both sides of patients' face (bilaterally) in different subjects, allowing the evaluation of each therapy to be separate.

Recent controversy in acupuncture research was generated when large randomized scales of clinical trials in patients with chronic pain failed to show superiority of acupuncture, compared to placebo.^{57,58} Given that administration of placebo also induces activation of opioid receptors (such as, specifically, the μ -opioid receptor),^{59,60} acupuncture can actually work, in part, by placebo mechanisms. In the current study, the sensory improvement observed in the control side (G0) of the laser-acupuncture group revealed the possible placebo effect. Studies on functional magnetic resonance imaging have shown deactivation of limbic structures—including the amygdala, hippocampus, and cingulate gyrus—through a mechanism that is distinct from pain and placebo stimulation.^{61,62} Therefore, while traditional (i.e., verum) and sham acupuncture may have equivalent analgesic effects, they can differ in the underlying neurobiologic responses that are induced. Based on animal data and measures of *in vitro* μ -opioid receptor binding,⁶³ it is suggested that long-term acupuncture therapy can result in an increase in μ -opioid receptor or receptor availability *in vivo*.

In the current study, to analyze the possible placebo effect alone, it would be interesting to evaluate the two treatment groups in different individuals, in which one group would receive the placebo treatment and the other group would receive the treatment with acupuncture (laser-acupuncture or EA).

With respect to orthognathic surgery and a possible spontaneous sensory return, it could have occurred in the control group, in which the sensitivity returned after 30 sessions (at least 80% improvement). It has been noted that temporary injury (1–7 days) of the inferior alveolar nerve after mandibular osteotomy has an incidence ranging from 20%⁶⁴ to 98%,⁶⁵ compared with the incidence of persistent injury (6–12 months), ranging from 0%^{66,67} to 82%.⁶⁸ Ac-

cording to Poort et al.,⁵⁰ a wide range of temporary and persistent incidences could be explained by the variety of surgical methods. In the studies, reviewed by Rich et al.,⁶⁹ on sensorineural disorder after sagittal split osteotomy of the mandibular ramus, 2%⁷⁰–17%⁷¹ of the operated sides were reported as having neurosensory disorders for 1 year. Three findings of self-reports of patients indicated that >60% of patients reported neurosensory disorders that persisted up to 6 months after surgery,⁷² and that the same change could remain for up to 2 years in >10% of patients.^{73,74} Therefore, the current findings suggest that the proposed treatment techniques were more efficient in relation to spontaneous improvement.

In general, all of the volunteers had return of tactile sensitivity that was painful and discriminative. This occurred in at least 70% of the patients after 30 monitoring sessions, with this sensitivity returning in half of the volunteers of the EA group by 19 sessions.

The present study has an effect in the current context of the use of new therapies for treating paresthesia after orthognathic surgery. These are low-cost therapies that are easy to apply, with no side-effects; the therapies are safe and efficient for reducing the convalescent period. Current scientific literature lacks randomized, blinded clinical trials that can support the use of these therapies for treating oral paresthesias. Future clinical studies, with different parameters, should be conducted, making it possible to compare the effects of different protocols.

CONCLUSIONS

Within the limits of this clinical study, it can be concluded that only EA was able to influence the return of tactile sensitivity positively in the chin and lower lip regions after combined orthognathic surgery and genioplasty.

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AUTHOR DISCLOSURE STATEMENT

No competing financial interests exist.

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