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ORIGINAL ARTICLE

Laser acupuncture in patients with temporomandibular dysfunction: a randomized controlled trial

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Abstract A prospective, double-blind, randomized, and placebo-controlled trial was conducted in patients with chronic temporomandibular disorder (TMD) to check the analgesic efficacy of infrared low-power GaAlAs diode laser applied to acupuncture points. Forty female subjects, ranging in age from 20 to 40 years, with diagnoses of chronic myofascial pain and arthralgia were randomly allocated to two groups: an experimental group (EG) who received the laser acupuncture as adjunct to reversible occlusal splint therapy and a control group (CG) who received a placebo laser associated with occlusal splint therapy. Both approaches were applied once a week for 3 months. Laser acupuncture was defined by the following parameters: 50-mW continuous radiation for 90 s to acupoints ST6, SI19, GB20, GB43, LI4, LR3, NT3, and EX-HN3; defining 4.5-J energy; 1250-W/cm^2 density point; and 112.5-J/cm^2 total density. The outcome measurements included a symptom evolution assessment carried out by checking spontaneous and palpation pain intensity, which was indicated on a visual analog scale (VAS). All evaluations were made by an assessor who was blind to the treatment. The symptom reduction was significant in both groups (EG: VAS=0, n=20; CG: VAS between 2 and 4, n=18). The measurements showed significantly faster and lower pain intensity values in the EG ($p \leq 0.002$), where there was a higher proportion of patients with remission of symptoms related to the action of laser acupuncture. For patients in whom conservative treatment was adopted, the laser acupuncture is a secure, noninvasive, and effective treatment modality because it improves the chronic pain associated with TMD and has no side effects.

Keywords Laser therapy · Low level · Acupuncture · Temporomandibular joint dysfunction syndrome · Chronic pain

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Introduction

Temporomandibular disorders (TMDs) are a group of related disorders that represent a major cause of nondental pain commonly around the orofacial region and are a subclass of musculoskeletal disorders [1, 2]. The pain reported by TMD patients is typically in the muscles of mastication, in the preauricular area, or in the temporomandibular joint (TMJ).

TMD patients may also report headache, other facial pains, earache, dizziness, ringing in the ears, and pain in the neck, shoulder, and upper and lower back. Reported problems other than pain include locking in the open or closed position and clicking, popping, and grating sounds [1–4].

TMD most often affects women between the ages of 20 and 40 [4, 5]. Its etiology has been discussed and related to occlusal disharmony, parafunctional habits, postural changes, orofacial macrotrauma, and hormonal alterations [1, 4, 6]. Around 75 % of patients with TMD suffer from chronic symptoms [7], with unfavorable biopsychosocial repercussions such as depression and somatization [8–10].

Standardization of TMD diagnosis has been realized by research diagnostic criteria for temporomandibular disorders (RDC/TMD) that constitute a multidimensional diagnostic research tool adopted worldwide [8, 11, 12].

Initial therapeutic approaches for TMD aim to control pain and dysfunction by means of reversible therapies, such as neuro myorelaxing occlusal splint (NMOS) [2, 10, 13, 14]. Other therapeutic methods are usually used for pain control and classified as "adjuvant." Among them are a vast range of drugs and complementary integrative resources, such as acupuncture in its diverse forms of application [15–17]. The acupuncture analgesic action is mediated by the opioid system [18] with involvement of other endogenous systems, such as the monoaminergic and dopaminergic systems [19]. However, traditional needle stimulation is not completely accepted because of the possibilities of infection or accidental visceral trauma [20]. For this reason, the studies use the low-level laser light on acupoints [20–23], following the principles of Traditional Chinese Medicine (TCM). It reported that this therapeutic resource requires less application time on the acupoint, and it may be applied in anatomic areas where insertion of an acupuncture needle is always considered dangerous for stimulation [23, 24].

The clinical reports and studies also confirmed that laser acupuncture is comparable to traditional needle acupuncture from a clinical point of view. Laser acupuncture has been employed to treat allergic diseases like allergic rhinitis, bronchial asthma, and neurodermatitis; neurological diseases like migraines, trigeminal neuralgia, herpes zoster neuralgia, hemiparesis, phantom pain, and paresis after stroke; orthopedic diseases like cervical syndromes, gonarthritis, rhizarthritis, epicondylitis, tendonitis, fibromyalgia, polyarthritis, and spine syndromes; and pediatric diseases like bronchitis, bronchial asthma, otitis media, bladder inflammations, enuresis, and others [25].

Studies reported the analgesic efficacy of traditional acupuncture to the treatment of chronic TMD symptoms [3, 17, 21]; however, studies on laser acupuncture regarding this specific theme are scarce, in spite of the reported advantages of this technique over the use of needles. The aim of this trial was to evaluate the analgesic efficacy of this therapy when used as an adjuvant to reversible occlusal intervention.

Methods

Patient recruitment and allocation

The study subjects were recruited by the Diagnostic and Guidance Center for Patients with Temporomandibular Disorders of the Federal University of Juiz de Fora, Brazil. The number of subjects was estimated by a sample calculation, which considered a difference of at least 2.6 units in the pain measurement by visual analog scale (VAS) and a standard deviation of 3.6 [26], value of α=0.05 and β=0.08, defining the smallest size for each group as 18 subjects.

The study sought the sample following the inclusion criteria: women in the age range of 20 to 40 years with diagnoses of myofascial pain and arthralgia present for a period of at least 6 months, without any treatment, and a pain intensity equal to or higher than 4.0 indicated by VAS. The exclusion criteria were as follows: presence of systemic musculo-articular pathologies, radiographic signs of TMJ osteoarthritis, dermatological alterations at the acupoints, under other treatment for TMD, pregnant women, history of facial trauma, and those previously submitted to the evaluated treatments.

The subjects were submitted to the RDC/DTM axis I [11] diagnostic exam for research of arthralgia and chronic myofascial pain. A simple random allocation procedure among the selected subjects, by means of a randomization table (Software SPSS for Windows 13.0), divided them into two groups defined by the therapeutic modality applied: experimental group (EG), who received reversible occlusal splint and laser acupuncture, and control group (CG), who received reversible occlusal splint and laser placebo. The volunteers were aware of and agreed to the possibility of receiving one of the two forms of therapy; however, they were not informed about the nature of these therapies. On concluding application of the modalities, a total of 40 volunteers characterized the total sample of this research (20 subjects to each group) (Fig. 1).

Interventions and therapies evaluated

The study was a single-blind, randomized, placebo-controlled clinical trial with two parallel arms: in the first, it evaluated the adjuvant action of laser acupuncture therapy, while in the second, it observed the effects resulting from the placebo therapy.

The reversible occlusal intervention was uniformly used in all the patients in both groups, with follow-up adjustments made by a single dentist. The purpose was to control

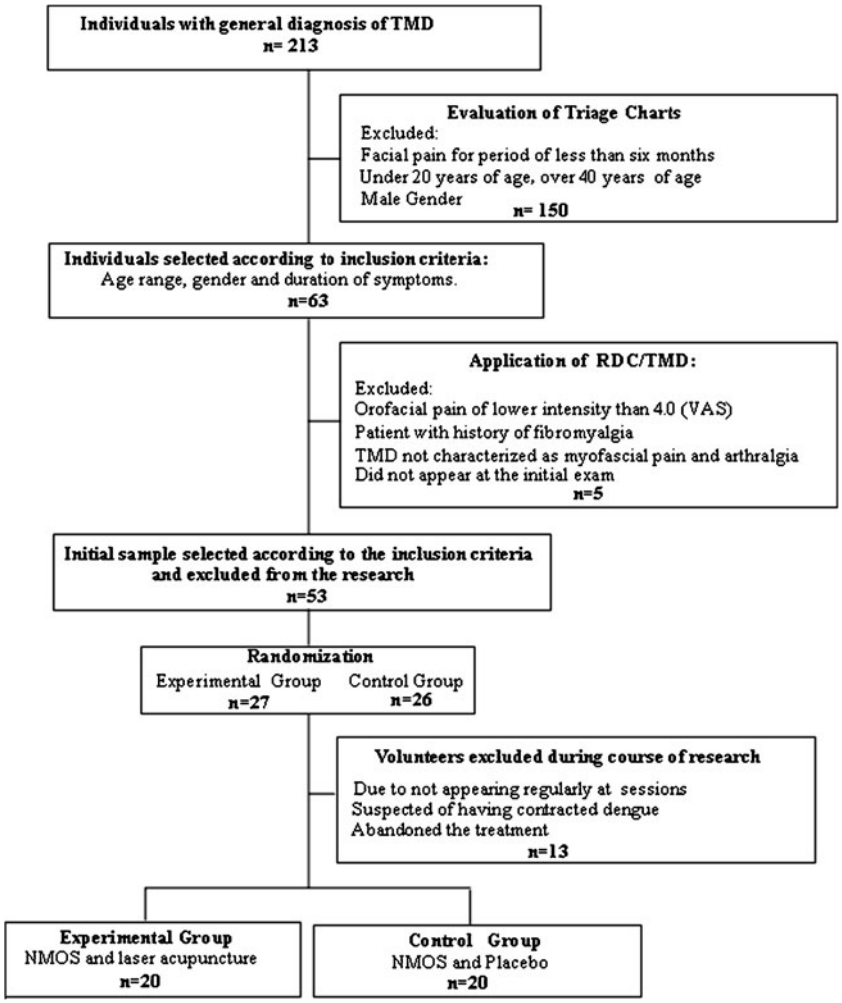

Fig. 1 Trial profile

the malocclusion variable by NMOS, traditionally indicated for TMD [13].

Active laser acupuncture

Active laser acupuncture therapy was performed upon the EG, which was conducted by a dentist acupuncturist. The dental laser therapy equipment used was the TWIN FLEX II (MM Optics, São Carlos, SP, Brazil), in the infrared spectrum (780 nm), with a power of 50 mW and an irradiation time of 90 s per acupoint, in an area of 0.04 cm^2, defining the energy of 4.5 J, total irradiance of 1,250 W/cm^2, and total energy density of 112.5 J/cm^2. The use of continuous infrared irradiation, with the time and energy dose, defined the sedative stimulus of the acupoints [27, 28].

Acupoint stimulation was repeated weekly over 12 sessions. Both the patient and professional wore protective goggles (Fig. 2).

The acupoints selected were those most used and recommended by the literature for orofacial pain and TMD treatments with traditional acupuncture [3, 17], which involved local, adjacent, and distal acupoints: ST6, SI19, GB20, LI4, LR3, TE3, GB34, and EX-HN3 (Fig. 3). The following order of acupoints was adopted: upper limb, thorax, head, and lower limbs [29]. For standardization and control of interventions performed in this clinical trial, the recommendations of the

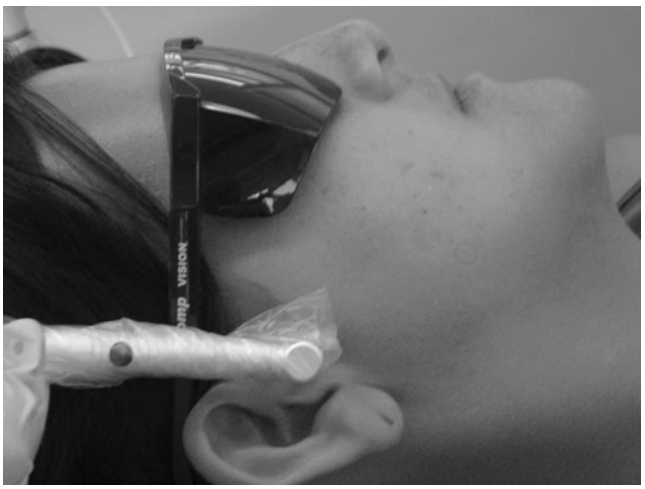

Fig. 2 Laser acupuncture therapy on the acupuncture point SI19. Googles and biosafety protection

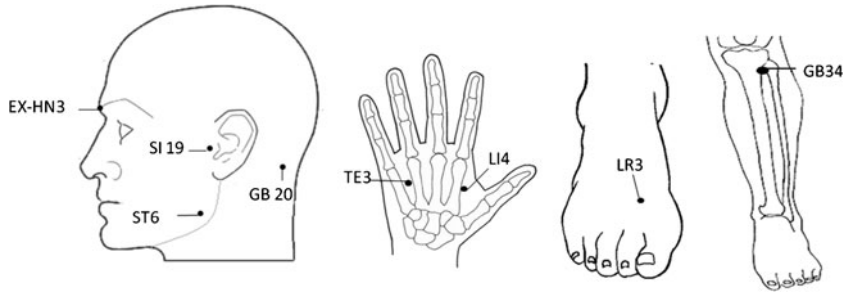

Fig. 3 The locations of acupuncture points: ST6, SI19, GB20, EX-HN3, LI4, TE3, LR3, and GB34

Standards for Reporting Interventions in Clinical Trials of Acupuncture were adopted [30].

Placebo laser acupuncture

For the placebo laser acupuncture, researchers used the same specific pointer for laser acupuncture, which remained on the acupoint for the same period of 90 s, without the use radiation. The equipment simulated the sounds of the appliance and directed towards the regions outside of the patient's and operator's fields of vision, which was one of the methods used for masking.

Measurements

A second evaluator blinded to both treatments and trained for application of VAS and RDC/TMD measured the TMD symptoms. A radiologist (doctor) interpreted the data collected by RDC/TMD and evaluated the radiographic images.

The VAS provided the evaluation of symptoms and analgesic efficacy, on which the subjects marked the intensity of pain experienced, considering 0 for the absence of pain and 10 for the greatest pain felt. The VAS evaluation was issued once before any intervention (baseline) and then monthly until 12 therapeutic interventions had been completed. It recorded the spontaneous pain intensity and pain on palpation of the structures: temporalis (2 lb); masseter (2 lb); posterior mandibular region, including the stylohyoid and posterior digastric (2 lb); submandibular region, including the medial pterygoid, suprahyoid, and anterior digastric (2 lb); lateral pole of the mandibular condyle (1 lb); posterior attachment of the TMJ (1 lb); lateral pterygoid (1 lb); and tendon of temporalis (1 lb) [11].

Methods of evaluation of results

The study recorded and compared the mean pain intensity values of each group before and after the treatment by means of the Wilcoxon paired nonparametric test (intragroup assessment). During the assessment, the levels of pain intensity considered were absent (VAS=0), mild (1–4), moderate (5–7), or severe (8–10) [31].

The pain measurement values were compared in each time among the groups, indicating the intervention with the greatest analgesic efficacy. For this purpose, the Mann–Whitney nonparametric test of independent variables was used.

After therapeutic intervention, patients of both groups were classified considering the variation of symptoms: remission (final VAS=0), relief (partial reduction of pain intensity), stabilization (no change from baseline VAS and final VAS), and increase (increase of the intensity of pain). For this, the Fischer's exact test was used.

A pilot project with eight participants in each group directed the evaluation, adjustment, and confirmation of the proposed methodological strategies. The reproducibility and reliability of pain measurement was verified by VAS and examiner calibration by comparison of the results initially obtained, revealing excellent reproducibility and reliability (ICC≥0.75).

Ethical and legal aspects of the research

This study was submitted to the Research Ethics Committee of Federal University of Juiz de Fora (CAAE 0253.0.180.000-08). All participating subjects recorded their conditions as volunteers by means of a Free and Informed Term of Consent. This study was submitted to the Clinical Trials Registry Platform of the World Health Organization by means of the Australia and New Zealand Clinical Trials Registry platform (ACTRN12611000088943) and to the Brazilian Clinical Trials Registry (RBR-7sw5hf) [32].

Results

In the initial time interval, the clinical and demographic characteristics of the two groups were similar. The mean age of the sample was 34.17 years (±8.83), and there were no differences between the two groups ($p<0.05$) in gender, age, duration of symptoms, initial intensity of pain, diagnosis and site of myofascial pain, and arthralgia (Table 1).

Intragroup symptom evaluation

The graphics below represent the physical symptoms progression in the EG (Fig. 4) and the CG (Fig. 5). Note that the

Table 1 Distribution of the patients in each group according to baseline variables

	Gender (female/male)	Age (years)		Duration of symptoms (years)		VAS baseline spontaneous pain		Myofascial pain (uni/bilateral)	Arthralgia (uni/bilateral)
		MV	SD	MV	SD	MV	SD		
EG	20/0	32.2	8.2	4.92	3.40	7.65	1.63	8/12	10/10
CG	20/0	36.2	9.3	5.17	4.01	7.30	2.0	6/14	9/11

Independent Student's *t* test, chi-square test, and Mann–Whitney ($p<0.05$) were used

VAS visual analog scale, *EG* experimental group, *CG* control group, *MV* mean value, *SD* standard deviation

pain intensity before the treatment was severe for most structures evaluated in both groups.

In the CG, there was a significant reduction in symptoms at the end of the treatment for all structures evaluated, classified as mild level (VAS between 1 and 4). In the EG, there was remission of symptoms after the treatment. The assessment by palpation of structures revealed an average pain intensity smaller than 0.5 as indicated by VAS. The mean of symptom intensity and standard deviation showed a significant reduction in both groups ($p<0.001$, Wilcoxon test) (Table 2).

Intergroup symptom evaluation

The Mann–Whitney statistical test revealed an equal first level of symptoms (baseline) in the two groups ($p>0.05$). After the first month (M1) of therapy application, all evaluations exhibited discrepant and lower symptom values for the EG ($p<0.05$). Statistically different values from the second and third months (M2 and M3) were equally observed for all the evaluations (Table 3).

The Fischer's statistical test revealed that most of the patients in the EG ($n\geq16$) achieved total remission of symptoms after the treatment for the following structures: temporalis, masseter, posterior mandibular region, submandibular region, pole side of the mandibular condyle, retrodiscal tissue, lateral pterygoid, and tendon of temporalis. In the CG, most only achieved a partial reduction of symptoms of the same structures ($n\geq12$). None of the patients showed an increase or stabilization of painful symptomatology (Table 4).

Discussion

So that pain intensity evaluation would be faithful, strict inclusion and exclusion criteria were adopted to control external variables [33]. The predilection for the female gender [4, 5] and greater prevalence of TMD in adults [4, 5, 34] were the bases for control of sociodemographic variables, which were adopted to achieve greater internal validity of the results.

Laser acupuncture is a modality resulting from scientific exploration of TCM [33–35]. Some studies [16, 36] mentioned that the combination of acupuncture and NMOS resulted in a significant improvement in the orofacial symptoms of TMD and diminished muscular hyperactivity.

In the same way as in traditional needle stimulation, studies involving TMD and laser acupuncture had different approaches to criteria for the acupoints selected and frequency of sessions [33, 36]. The variety of acupoints related

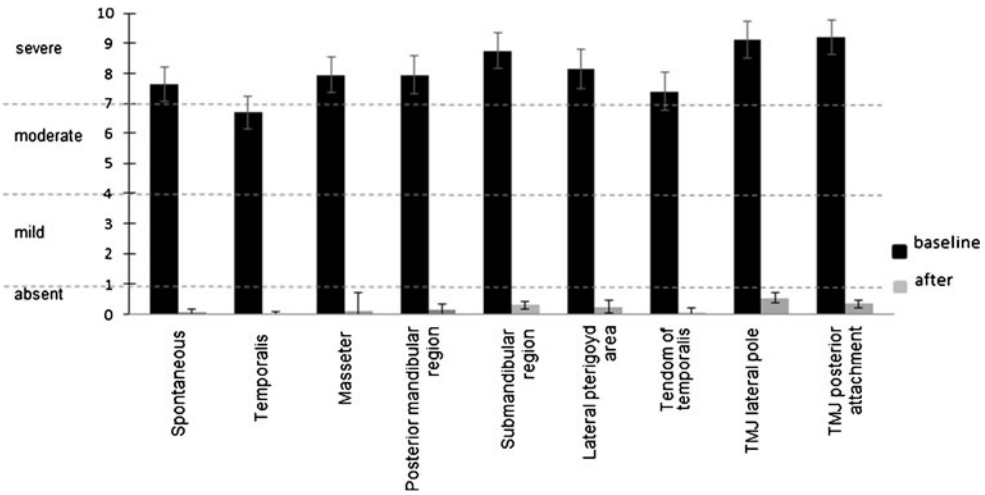

Fig. 4 Physical symptoms progression in EC

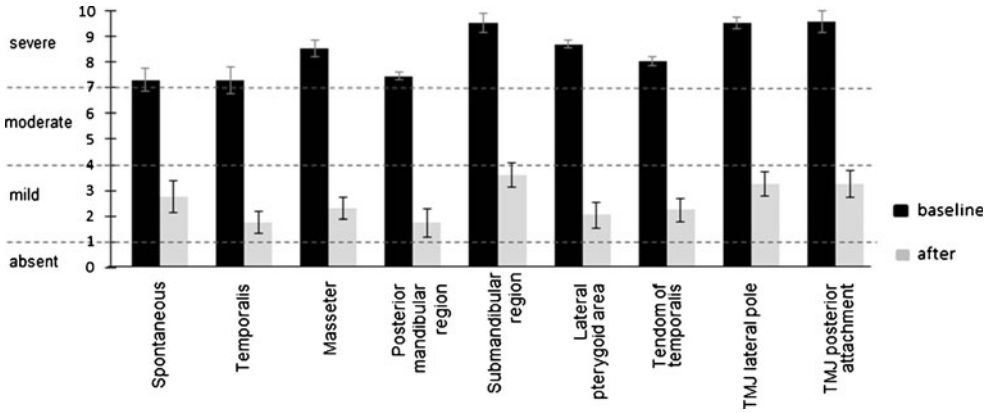

Fig. 5 Physical symptoms progression in CG

in the literature and the absence of standardization appear to be the justification by the large number of points distributed over the meridians related to the orofacial region and by the different techniques applicable on such points attributed to TCM [29]. In view of this fact, some publications [37] have suggested that the standardized treatment by acupuncture,

Table 2 Intragroup evaluation: evolution of symptoms by monthly checking spontaneous and palpation pain intensity in EG and CG

Region evaluated	Group		Baseline	M1	M2	M3	B × M3
Spontaneous pain	EG	MV	7.65	2.25	0.45	0.05	0.001
		SD	1.63	2.38	1.35	0.22	
	CG	MV	7.30	3.65	4.20	2.75	0.001
		SD	2.0	1.71	2.7	2.71	
Temporalis	EG	MV	6.70	1.50	0.40	0.00	0.001
		SD	1.89	1.31	0.82	0.00	
	CG	MV	7.30	4.05	3.05	1.75	0.001
		SD	2.29	2.66	2.45	1.91	
Masseter	EG	MV	7.95	2.90	1.00	0.10	0.001
		SD	1.53	1.77	1.12	0.44	
	CG	MV	8.55	6.20	5.20	2.30	0.001
		SD	1.50	2.41	2.68	1.86	
Posterior mandibular region	EG	MV	8.75	3.15	1.45	0.3	0.001
		SD	1.25	1.49	1.39	0.73	
	CG	MV	9.55	6.45	4.95	3.60	0.001
		SD	0.68	2.16	2.79	2.45	
Submandibular region	EG	MV	7.95	2.45	0.75	0.15	0.001
		SD	1.72	1.76	1.55	0.48	
	CG	MV	7.45	4.30	2.70	1.75	0.001
		SD	0.97	2.41	2.28	2.16	
Lateral pterygoid area	EG	MV	9.10	4.20	1.95	0.55	0.001
		SD	1.07	1.93	2.45	0.82	
	CG	MV	9.55	7.10	6.05	3.25	0.001
		SD	0.68	1.99	2.25	2.24	
Tendon of temporalis	EG	MV	9.20	4.20	1.85	0.35	0.001
		SD	1.01	2.26	2.18	0.74	
	CG	MV	9.60	7.10	5.90	3.25	0.001
		SD	0.75	1.91	1.86	1.99	
TMJ lateral pole	EG	MV	8.15	2.30	0.70	0.25	0.001
		SD	1.53	1.17	1.08	0.71	
	CG	MV	8.70	5.05	3.95	2.05	0.001
		SD	0.97	2.41	2.28	2.16	
TMJ posterior attachment	EG	MV	7.40	2.10	0.60	0.05	0.001
		SD	1.71	1.25	0.94	0.22	
	CG	MV	8.05	3.75	3.55	2.25	0.001
		SD	1.87	2.88	2.37	2.38	

Wilcoxon nonparametric test ($p \leq 0.01$) was used

B baseline, *M1* month 1, *M2* month 2, *M3* month 3, *VAS* visual analog scale, *MV* mean value, *SD* standard deviation, *EG* experimental group, *CG* control group

Table 3 Intergroup evaluation: statistical comparisons between groups for average pain intensity rated (VAS) at each moment evaluated

		Baseline	M1	M2	M3
Experimental group × control group	Spontaneous pain	0.296	0.046*	0.001**	0.001**
	Posterior temporalis	0.312	0.002***	0.001**	0.001**
	Middle temporalis	0.699	0.001**	0.001**	0.001**
	Anterior temporalis	0.750	0.001**	0.001**	0.001**
	Superior masseter	0.618	0.001**	0.001**	0.001**
	Middle masseter	0.638	0.001**	0.001**	0.002***
	Inferior masseter	0.221	0.001**	0.001**	0.001**
	Posterior mandibular region	0.190	0.001**	0.001**	0.001**
	Submandibular region	0.327	0.005***	0.003***	0.001**
	Lateral pterygoid area	0.192	0.001**	0.001**	0.001**
	Tendon of temporalis	0.245	0.001**	0.001**	0.001**
	TMJ lateral pole	0.346	0.001**	0.001**	0.001**
	TMJ posterior attachment	0.232	0.044*	0.001**	0.001**

M1 month 1, *M2* month 2, *M3* month 3, *VAS* visual analog scale

*$p<0.05$; **$p<0.001$; ***$p<0.01$ (Mann–Whitney nonparametric test)

characterized by a systematized technique, is safe for clinical studies. For TMD treatment, the following points are commonly recommended: ST6, ST7, SI18, GV20, GB20, BL10, and LI4, as well as those indicated for orofacial dysfunction or similar pathologies, such as stress. The study suggested that for conditions of pain, sedative stimulus and consecutive weekly intervals during the first six sessions would be desirable in 3 months of therapy, with the goal being total symptom remission.

In view of this guidance, this research used the following local acupoints: ST6, SI19, and GB20 with the goal of obtaining their analgesic properties on the areas of the masseter musculature, TMJ region, and posterior cervical musculature, respectively [29]. The function of harmonizing disturbances in the temporal area is attributed to the distal point TE3 and systemic muscular relaxation to points LI4 and GB34. In TCM, pain occurs when the normal cyclic flow of blood and/or *qi* was interrupted in a meridian. These distal acupuncture points used to treat pain are at or below the elbow or knee joints. This stimulation of acupoints distant from the site of pain to improve it is perhaps the greatest difference between Eastern and Western approaches for treating pain [38].

The research selected the points EX-HN3 and the combination LI4 and LR3 to act on conditions of stress, depression, and anxiety, as well as acting on remission of painful symptoms by promoting the free flow of energy and emotions [29].

With reference to the methodological parameters of laser acupuncture, the literature consulted was not uniform in opinion. This diversity is found in laser acupuncture trials directed towards treatment of musculoskeletal disorders. Shen and collaborators [39] used a thermal CO_2 laser and an infrared laser with a 36-mW power, directed on point ST35 in the knee for 20 min, whereas Aigner and collaborators [40] used a red laser with a 5-mW power, directed on 22 acupoints, stimulated for 15 s each, for the whiplash treatment. With reference to TMD, Hotta and collaborators [36] adopted laser acupuncture therapy using the infrared wavelength, with a 70-mW power, for 20 s on each acupoint, generating an energy density of 35 J/cm^2. Katsoulis and collaborators [33] recommended a 40-mW power at the red wavelength, producing an energy density close to 1 W/cm^2. Huang and collaborators [41] adopted the infrared laser light output of 1.5 W with a 0.025-s intermittent pulsing and a frequency of 20,000 Hz, which is equal to 0.75 W/cm^2, applied for 134 s to each selected acupuncture point, with an energy density of 100.5 J/cm^2. These studies demonstrated positive effects of the therapy, with myorelaxing action being found in the first study mentioned [36], verified by electromyography.

Although the parameters described resulted in efficacy and safety in the mentioned research studies, the present research used other parameters compatible with the need for in-depth tissue penetration, wavelength, and type of means suitable for conducting a laser for sedative stimulation, which was recommended by multiple authors [20, 27, 28].

Regarding the double-blind model adopted in this study, it was possible to get results of the efficacy of experimental therapy, considering the psychological effects inherent to the patient and the control of the evaluator's measurements. In the CG, one can perceive the extent to which a placebo/psychological action could be added to the therapeutic activity of NMOS, whereas in the EG, it is the extent to which its real analgesic mechanism potentiated the effects of reversible occlusal therapy. In the study, it was observed that the results promoted by laser acupuncture in the chronic TMD treatment were superior to that of the placebo, in the same way as in studies that compared the results of traditional acupuncture

Table 4 Statistical comparisons between groups for improvement of pain after the treatment

Region evaluated	Spontaneous pain		Temporalis		Masseter		Submandibular region		Posterior mandibular region		Lateral pterygoid area		Tendon of temporalis		TMJ lateral pole		TMJ posterior attachment	
	EG *n* (%)	CG *n* (%)	EG *n* (%)	CG *n* (%)	EG *n* (%)	CG *n* (%)	EG *n* (%)	CG *n* (%)	EG *n* (%)	CG *n* (%)	EG *n* (%)	CG *n* (%)	EG *n* (%)	CG *n* (%)	EG *n* (%)	CG *n* (%)	EG *n* (%)	CG *n* (%)
Remission	19 (95)	8 (40)	20 (100)	8 (40)	19 (95)	4 (20)	18 (90)	8 (40)	16 (80)	3 (15)	13 (65)	3 (15)	16 (80)	1 (5)	17 (85)	7 (35)	19 (95)	7 (35)
Relief	1 (5)	12 (60)	0 (0)	12 (60)	1 (5)	16 (80)	2 (10)	12 (60)	4 (20)	17 (85)	7 (35)	17 (35)	4 (20)	19 (95)	3 (15)	13 (65)	1 (5)	13 (65)
Stabilization	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Increase	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
p*	0.0002		0.0000		0.0000		0.001		0.0000		0.001		0.0000		0.001		0.0001	

EG experimental group, *CG* control group

*$p \leq 0.001$ (Fischer's test)

with the placebo directed towards headache, lumbar pain, and knee joint pain [42].

Although the mechanisms involved in acupuncture therapy, or even laser acupuncture, are not completely known [43], this study defends the idea that analgesia by acupuncture really works with a physiological effect and not exclusively by a placebo/psychological effect.

In laser acupuncture research studies, the double-blind model is possible and highly recommended in view of the great therapeutic power of stimulation inherent to the characteristics of the therapy itself: painless, athermal, atraumatic, without any side effects observed [21, 23, 24, 44], and with the need for both the patient and therapist to use protective goggles, inhibiting the visual perception at the time of intervention [23, 24, 33, 39, 43].

The results of the interventions adopted in this study determined the progression of the TMD symptoms, either of spontaneous pain or pain stimulated by palpation exam. Initially, as a null hypothesis, this study considered that the values of pain intensity obtained in all time intervals would be constant and equal for the two groups. However, a reduction in spontaneous pain intensity and pain on palpation was found in the two research groups, occurring more significantly and faster in the EG.

The highly favorable results obtained by the experimental group are explained by the laser acupuncture action on neurotransmitters and neurophysiologic mechanisms of pain [21]. The experimental evidence of other studies reinforces the idea of the participation of descendent adrenergic and serotonergic pathways that stimulate interneurons of the posterior horn of the spinal cord gray matter or of the spinal tract and nucleus of the trigeminal nerve. In these sites, the neurotransmitter action is responsible for the passage of pain from the first to the second neuron of the chain, which would be blocked through the substances such as enkephalin [18, 19, 37, 43].

Although variable and not entirely predictable, the action of the occlusal devices seemed to contribute to symptom reduction, since there was diminishment of symptoms in both groups. Nevertheless, this reduction appeared more significantly in a shorter time ($p \leq 0.01$) in the EG. The action of the occlusal devices provided the reduction in excessive loads on the TMJ, granted by the free movement of the mandible in a harmonious and mutually protected occlusal condition [13].

Tunér and Hode [28] affirmed that in clinical practice and in some studies involving laser acupuncture, there is a methodological association with local laser therapy. It is known that the laser in the irradiated region is also capable of promoting punctiform analgesia, particularly when the specific adjustment of the equipment occurs [39]. Therefore, the present study considered that the analgesic results on orofacial, muscular, and articular regions were mainly promoted

by the sedative stimulation on the acupoint and, secondarily, by the action of the laser on the irradiated area. This idea is a justification for the finding that the orofacial structures that did not receive the direct and place action of laser (intraoral musculature, temporalis muscle, submandibular and posterior mandibular regions) also presented reduction/remission of the algic symptom in the EG.

However, the opioid analgesic mechanisms of laser acupuncture acted in the central and synaptic regions [18, 43], optimizing the results of conventional occlusal therapy [36]. Its adjuvant and synergic action was found here by the diminishment of symptoms in a faster and more significant manner in the EG from the first month of evaluation. The results of studies involving headaches and laser acupuncture [44] corroborate those of the present research. They verified that the intensity, duration, and frequency of pain were considerably reduced in the group that received active laser acupuncture from the first month of evaluation.

It was found that in the EG of this study, complete remission of symptoms in some structures occurred soon after the second month and remained stable up to the last evaluation. In this period, the subjects who received active laser acupuncture no longer complained of spontaneous orofacial pain and pain on palpation of the temporalis, masseter, and submandibular regions, TMJ posterior attachment, and TMJ lateral pole. The evaluation made after the third month of therapy revealed that the other structures experienced pain intensity values equal to or close to zero in this same group. The short period of these results is compatible to those of other studies [41, 42]. Nevertheless, evaluations of laser acupuncture therapy for TMD should be conducted with the intention of finding the long-term stability of symptoms.

Based on the clinical planning of the study and the results obtained and supported by pertinent statistical analysis, it could be concluded that laser acupuncture was efficient in obtaining complete remission of the symptoms of temporomandibular and myofascial pain after 3 months of treatment and promoted greater and faster reduction of the symptoms in comparison with the placebo. The higher proportion of patients with remission of symptoms relates to the active therapy laser acupuncture after 3 months of treatment. For patients in whom conservative treatment was adopted, the laser acupuncture is a secure, noninvasive, and effective treatment modality because it improves the chronic pain associated with TMD and has no side effects.

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