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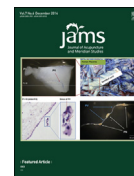
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## RESEARCH ARTICLE

# Could Acupuncture Be Useful in the Treatment of Temporomandibular Dysfunction?

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**Abstract**

In this study, the effects of acupuncture in comparison with flat occlusal plane appliance were evaluated in patient with myogenic temporomandibular dysfunction (TMD). The sample consisted of 40 women with TMD and unbalanced energy predominance of Yang Liver Ascension, selected using the Renying and Cunkou pulses, randomly divided into two groups: acupuncture and splint. The effect of treatments on the masseter and anterior temporal muscles was evaluated after 4 weeks of treatment, by means of electromyographic activity (root mean square) and pain pressure threshold. Pain intensity was measured using the visual analog scale, and range of mouth opening was evaluated using a millimeter ruler. All evaluations were performed at the beginning and end of the treatment. Visual analog scale score was reduced equally in the two groups ( $p < 0001$ ), and the increase in range of mouth opening was significant in both groups. A significant difference

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was detected only in pain pressure threshold of the left masseter in the acupuncture group ( $p < 0.05$ ). Only root mean square in the at rest position of the right temporal muscle diminished in the final stage of the splint group ( $p < 0.05$ ). Both treatments reduced the pain intensity of myogenic TMD in the short term and may be considered strategies for control of chronic pain related to TMD.

## 1. Introduction

Temporomandibular dysfunction (TMD) is a collective term that comprises clinical problems in the masticatory muscles, temporomandibular joints (TMJs), and musculoskeletal structures associated with the head and neck [1], and is the most common form of chronic orofacial pain [2]. Classically described clinical signs that characterize TMD are pain in the muscle and/or TMJ, TMJ noises, restriction of mandibular movements, and deviation or limitation of mouth opening [3].

As there are various factors that affect the masticatory system and pain perception, independently or interacting with other causes, they may interrupt the normal activity of this system and originate the dysfunction, reflecting the multifactorial etiology of TMDs [4]. For situations such as these, reversible therapies are indicated as an approach to treatment [5]. These include physiotherapy, medications, biofeedback, acupuncture, and occlusal appliances [6].

The occlusal appliance is the conservative treatment most indicated for TMD [7]. Its efficacy is explained by an integrated neurobiological model: a change in the mandibular relations leads to a more harmonious pattern of the masticatory muscles, alleviating previously more tense areas [6], and also by the balance of proprioception, especially related to the proprioceptive fibers of the periodontal ligament [8].

Acupuncture is a therapeutic method of traditional Chinese medicine (TCM). Although its history dates back over 3000 years, nowadays it is well known, especially in pain management [9]. This is the reason for the increasing number of scientific studies over the past decade to understand the mechanisms of action of acupuncture and its effectiveness in various biologic systems [10].

Some studies [9,11,12] have related the effects of acupuncture on the control of musculoskeletal pain in the orofacial region. However, in these studies, the acupuncture points were selected based on the location of the points in the face and on points distant from the face, or association of the two, without considering the diagnosis of the patient's energy alteration, which would lead to the specific selection of points of treatment for this syndromic profile or pattern.

In therapeutic interventions involving the masticatory muscles, monitoring of muscle activity by electromyography is an objective form of evaluating the results documenting the changes in function of the muscles before and after the interventions [13]. It is also a way of reaching a deeper understanding of patients with TMD [14].

In view of the foregoing, the aim of this study was to evaluate the effects of acupuncture on patients with myogenic TMD, compared with a control group (flat occlusal plane appliance).

## 2. Materials and methods

The study was conducted at the Specialization Clinic of the Piracicaba Dental School of the University of Campinas, Piracicaba, Sao Paulo, Brazil, between May 2013 and March 2014. The study was approved by the Research Ethics Committee of the Institution (Protocol. 098/2011). All study participants signed the Free and Informed Term of Consent.

The inclusion criteria were as follows: women presenting energy imbalance with predominance of Yang Liver Ascension [15]; women in the age range between 18 years and 45 years, with myogenic TMD (Group Ia or Ib), in accordance with the Research Diagnostic Criteria for TMD – RDC/TMD [16] Axis I, official Portuguese version [17]; and women presenting pain and/or clinical signs and symptoms for longer than 3 months. Additional inclusion criteria were women who made use of contraceptives, had no arthritis, arthrosis, diabetes, or neurological pathologies, Angle's Class I, and no absence of teeth (except third molars).

Thus, 54 patients were evaluated, and of this total 44 were selected, because 10 did not fulfill the inclusion criteria. Four women desisted from participating, leaving a total of 40 individuals who participated in the study (mean age,  $30 \pm 6.59$  years). The participants, the majority of whom (82.50%) were Caucasians, were recruited by means of notices placed on the institution's notice board.

### 2.1. Identification of imbalance with predominance of Yang Liver Ascension

Imbalance was identified via carotid-radial pulsology (Renying and Cunkou) and diagnosed by observation of the tongue. Observations of the tongue and pulse are important diagnostic methods in TCM, because they reflect the basic energy alterations of the entire body, identifying alterations in the Yin/Yang balance, patterns of energy excess, or deficiency [18,19].

### 2.2. Renying and Cunkou pulses

Renying (carotid artery) was measured at the protuberance of the larynx, close to ST9 (Renying), which is the pulse that represents the three channels of Yang energy: Taiyang, Shaoyang, and Yangming. Cunkou (radial artery), located close to LU9 (Taiyuan), represents the three channels of Yin energy: Taiyin, Shaoyin, and Jueyin [20].

According to Ling Shu [19], when the meridian Jueyin of the foot (liver) is unbalanced, the Cunkou pulse is twice as strong as the Renying—in that patients must present Cunkou  $2 \times 1$  Renying, when force of the pulse is assessed.

During pulse evaluation, the patients were instructed to lie down in a prone position in the dental chair, and to remain at rest for 30 minutes [19].

### 2.3. Diagnosis via observation of the tongue

Lingual tremor is one of the characteristics of imbalance observed during the visual examination of the tongue. Other characteristics include headache above the temples, eyes, or side of the head; irritability; facial tick; and insomnia [15].

The exclusion criteria were as follows: patients with history of traumas in the face and TMJ; those undergoing orthodontic treatment; those using anti-inflammatory, analgesic and/or myorelaxation medication; and those with phobia of needles.

The patients were randomly divided into two groups: acupuncture group ( $n = 20$ ; treated with acupuncture) and splint group ( $n = 20$ ; treated with flat occlusal plane appliance).

Both groups underwent the following assessments before and after treatment (designated initial and final, respectively): visual analog scale (VAS), measurement of range of

mouth opening (RMO), pain pressure threshold (PPT), and surface electromyography (Fig. 1).

Patient selection; VAS, RMO, PPT, and surface electromyography evaluations; and application of acupuncture were performed by the same examiner to avoid interexaminer variability, with the examiner being calibrated in RDC/TMD and an experienced acupuncturist. The procedures of impression taking of the dental arches, insertion, and occlusal adjustments of the appliance during the treatment follow-up sessions were performed by another examiner, who happened to be experienced in this area.

### 2.4. Pain intensity

Pain intensity was evaluated using VAS.

### 2.5. RMO

Maximum mouth opening without pain (in mm) was measured using a ruler in the pre- and posttreatment stages, using central interincisor measurements [21].

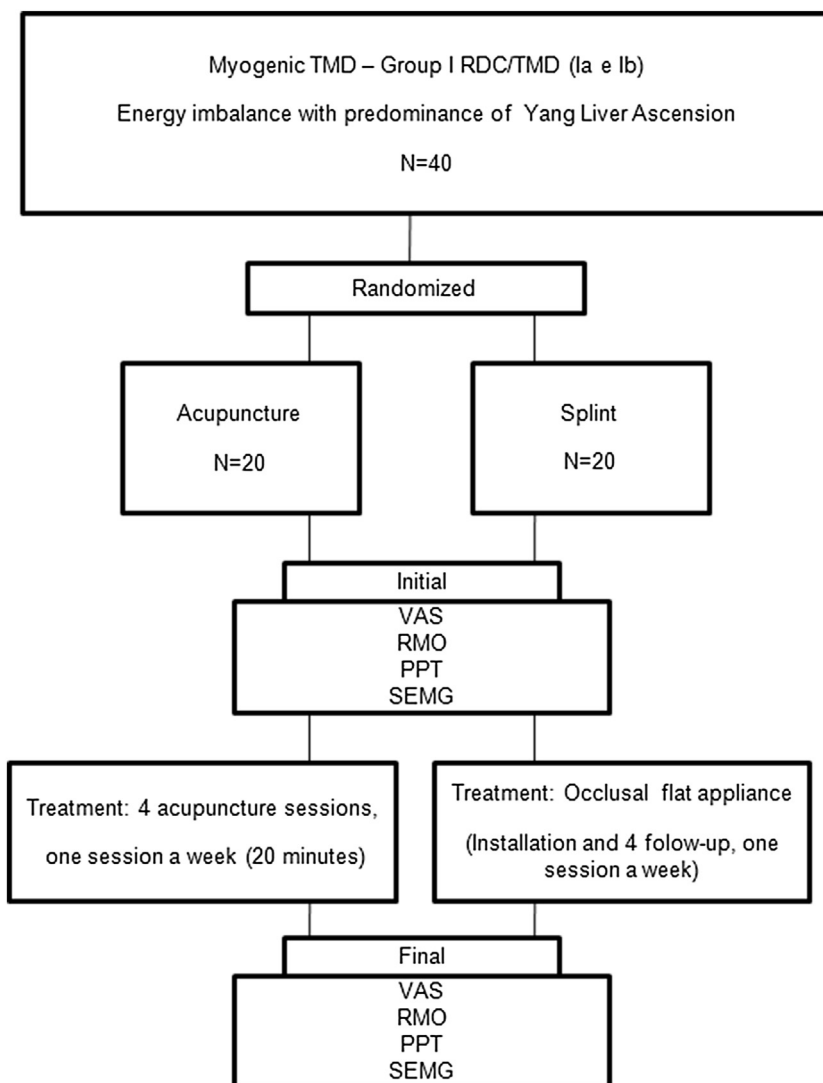


Figure 1 Diagram of development of the study.

## 2.6. PPT

Evaluation of the sensitivity to pressure was performed using a digital algometer (Kratos DDK-20, Sao Paulo, Brazil) with a 1-cm<sup>2</sup> tip and an approximate application of 1 kg/cm<sup>2</sup>, perpendicular to the surface of the skin, using the following sequence: first stage—right anterior temporal, right masseter, left masseter, and left anterior temporal muscles; second stage (5 minutes later)—left anterior temporal, left masseter, right masseter, and right anterior temporal muscles. The mean values of two measurements were used [22].

During the examination, the patients were seated in the dental chair with the seat/backrest angle set at approximately 90°. They were asked to keep their maxillary and mandibular teeth slightly apart, because when they are in contact, this may influence the rigidity of the muscles and alter the measurements [23]. The patients were instructed to inform the moment when the pressure became uncomfortable, identified as the first feeling of pain. At this moment, the numerical value was recorded on the algometer [24].

## 2.7. Electromyographic assessment

To record the electromyographic signal of the anterior part of the right (RT) and left (LT) temporal, and the superficial part of the right (RM) and left (LM) masseter, the handler used the ADS 1200 (Lynx Electronic Technology Ltd, Sao Paulo, Brazil) equipment with eight channels and adjusted gain of 1–16,000, with a band-pass filter of 20–500 Hz and a sampling frequency of 2000 Hz for each channel calibrated. A preamplifier with 20× gain was coupled to the passive bipolar Ag/AgCl double electrodes, which were circular in shape, with an interelectrode distance of 1 cm (Hal Ind. Com. Ltda, Sao Paulo, Brazil). The electrodes were fixed in the center of the muscle venter after the function test [25], and the reference electrode was placed on the manubrium of the sternum of the volunteers. The software Lynx AqDados 7.02 (Lynx Electronic Technology Ltd, Sao Paulo, Brazil) was used for the acquisition of simultaneous signals, and the software Lynx AqD Analysis 7.0 (Lynx Electronic Technology Ltd, Sao Paulo, Brazil) was used to process the root mean square (RMS) values (expressed in  $\mu$ V).

To ensure that the location of the electrodes would be equal in both evaluated periods (before and after the treatment), an acetate plate was fabricated for each patient; it was perforated at the points where the electrodes were placed, using anatomic reference lines (external angle of the eye, tragus of the ear, and external angle of the mandible) with the purpose of reproducing the position as exactly as possible when making future recordings [26]. Before the electrodes were placed, the skin was cleaned with cotton wool and 70% alcohol.

The electrical activity of the RM, LM, RT, and LT muscles was recorded in two activities: mandibular postural position (Rest) and maximum intercuspitation (MI). Three repetitions of each mandibular position were performed for 5 seconds. To avoid fatigue effect [27], a 2-minute period of rest between collections was allowed. To perform MI, Parafilm M (American National Can, Chicago, IL, USA) was

placed bilaterally in the region of the molars. The patients were instructed to clench their jaw to the maximum possible extent and to maintain the same level of contraction for 5 seconds; during this activity, they were verbally encouraged (clench...clench ...clench) by the examiner [27].

The RMS value of each acquisition, both in the position of Rest and MI, was obtained in the interval between 2 seconds and 4 seconds (Fig. 2). For greater reliability of results, the RMS of the arithmetic mean of the three acquisitions (Rest and MI) were calculated.

## 2.8. Acupuncture group

The acupuncture group was treated with four sessions of traditional acupuncture, one session per week of 20 minutes duration. The following acupuncture points were selected: LI4 (Hegu), LI11 (Quchi), SI19 (Tinggong), LR2 (Xingjian), GB20 (Fengchi), GB21 (Jianjing), GB34 (Yanglingquan), BL2 (Zanzhu), CV23 (Lianquan), and TE23 (Sizhukong), based on their energy functions [28], related to the imbalance.

The needles used were disposable, sterile, individually packed, and made of stainless steel (Huan Qiu; Suzhou Huanqiu Acupuncture Medical Appliance Co. Ltd., Suzhou, China), in sizes 0.22 mm × 13 mm (for insertion in the points of the face) and 0.25 mm × 30 mm (for insertion in the distal points). Asepsis of the skin was performed with cotton wool and 70% alcohol. The depth and angle of needle insertion were adjusted in accordance with the literature [28]. Insertion was unilateral (right side of the face); the needles were inserted and rotated manually in the clockwise and counterclockwise directions until the patient related the sensation of deqi [9].

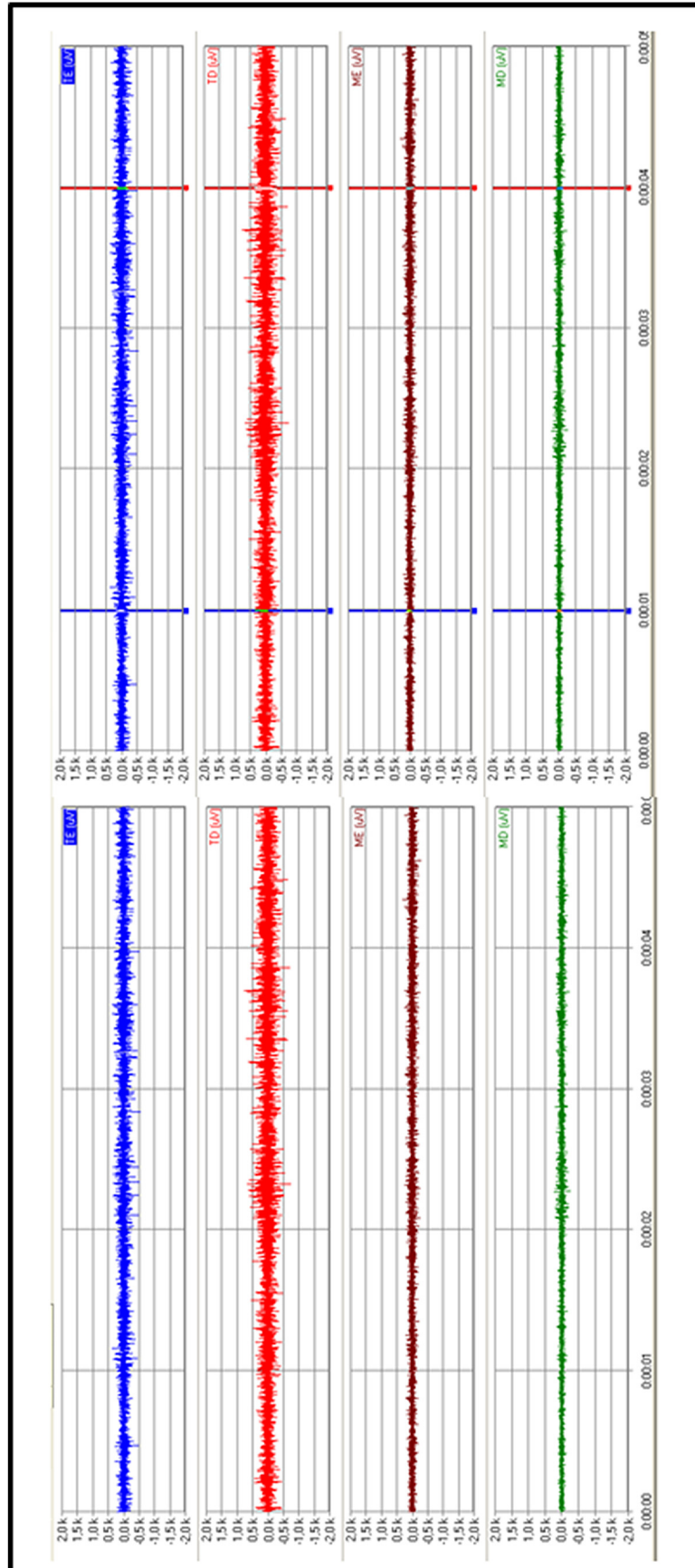
## 2.9. Splint group

The splint group was treated with a flat occlusal plane appliance. As part of this treatment, to ensure that the patient is largely aware of her dysfunction and to emphasize the importance of using the appliance, information was provided about TMD, diet food (of soft consistency), and possible parafunctional activities (yawning with mouth wide open, nail biting, etc.) [7].

The flat occlusal plane appliance was constructed using the conventional method, using colorless heat polymerizing acrylic resin [29], by a single dental prosthesis technician. The appliance was adjusted with regard to fit and comfort after it was delivered to the patients, who were then instructed to put it into place before they go to sleep and remove it upon waking. They were asked return for four sessions (1 session/wk) to verify and undergo any adjustment of the occlusal contacts of the flat appliance when necessary. At the end of four sessions, the final evaluations were made.

## 2.10. Statistical analysis

The Shapiro–Wilk test revealed normal distribution of the data. A descriptive analysis was made; the *t* test for paired and independent samples and the binomial test between two proportions were used for comparisons between the



**Figure 2** The maximum intercuspitation (MI) acquisition signal of the muscles studied and selection of the time interval (2–4 seconds) used for calculating root mean square (RMS).



treatments. The level of significance considered was 5%. The software BioEstat 5.0 (Mamirauá Institute of Sustainable Development, 2013, São Paulo, Brazil) was used for the statistical analysis.

### 3. Results

The groups were similar in terms of the variables shown in Table 1 ( $p > 0.05$ ). The majority of patients were in the age range 23–33 years. Bilateral mastication scored highest in terms of frequency (40% in the acupuncture group and 55% in the splint group). Half of the patients in the Acupuncture group presented limitation of mouth opening (Table 1).

There was a reduction in pain in each group (Table 2), with the reduction in pain intensity occurring equally in both groups ( $p < 0.001$ ). The mean time from onset of pain was  $4.82 \pm 3.79$  years for the acupuncture group and  $4.05 \pm 5.08$  years for the splint group.

The increase in RMO was significant in both groups, which indicated better response to the treatments. PPT LM increased in the final stage in the acupuncture group (Table 2).

RMS at Rest RT diminished in the final stage in the splint group ( $p < 0.05$ ). For the other variables in the Rest and MI positions, the values were not statistically significant, but clinically a reduction in RMS in the Rest position (LM, RT, and LT) was observed in the Acupuncture group (Table 3).

### 4. Discussion

Acupuncture is used for pain relief [9], as are other therapeutic strategies that are directed toward the

**Table 2** Mean (standard deviation) of the VAS, PPT (kgf), and RMO (mm), studied as a function of groups and phases.

Variables	Group	Phases	
		Initial	Final
VAS	Acupuncture	5.96 (1.29) A	1.09 (1.29) B
	Splint	6.41 (1.89) A	1.19 (1.59) B
PPT RT	Acupuncture	0.71 (0.32) A	0.75 (0.18) A
	Splint	0.70 (0.24) A	0.68 (0.24) A
PPT LT	Acupuncture	0.61 (0.21) A	0.67 (0.22) A
	Splint	0.68 (0.16) A	0.64 (0.17) A
PPT RM	Acupuncture	0.71 (0.26) A	0.75 (0.18) A
	Splint	0.72 (0.20) A	0.69 (0.22) A
PPT LM	Acupuncture	0.62 (0.19) B	0.70 (0.18) A
	Splint	0.66 (0.20) A	0.66 (0.16) A
RMO	Acupuncture	36.95 (8.50) B	42.35 (4.28) A
	Splint	36.95 (8.32) B	41.30 (6.50) A

$t$  test for paired and independent samples ( $p > 0.05$ ). Means followed by different letters differ ( $p \leq 0.05$ ).

LM = left masseter; LT = left temporal; PPT = pain pressure threshold; RM = right masseter; ROM = range of mouth opening; RT = right temporal; VAS = visual analog scale.

symptomatic relief of TMD, in which pain is the main characteristic [4,7,21]. It is important for treatments to act on pain control, and in this study, the reduction in pain intensity occurred equally in both treatment groups, considering the period of treatment of 1 month.

Niemelä et al [30] reported that no significant difference in VAS was found after 1 month of treatment, a result that did not foresee the use of acupuncture. This difference

**Table 1** Distribution of the sample according to treatment group.

<i>n</i>	Groups				<i>p</i>
	Acupuncture		Splint		
	20		20		
Variables	<i>n</i>	%	<i>n</i>	%	
Age (y)					
18–22	1	5	3	15	0.8699*
23–33	15	75	13	65	
34–45	4	20	4	20	
Marital status					
Single	14	70	9	45	0.1098*
Married	5	25	10	50	
Divorced	1	5	1	5	
Occurrence of pain					
All the time	4	20	4	20	1.0000†
Appears and disappears	16	80	16	80	
Preferred side for chewing					
Bilateral	8	40	11	55	0.3422*
Right	7	35	5	25	
Left	5	25	4	20	
Limitation mouth opening					
Yes	10	50	6	30	0.1967†
No	10	50	14	70	

\*  $t$  test for independent samples ( $p > 0.05$ ).

† Binomial test between two proportions ( $p > 0.05$ ).

**Table 3** Mean (standard deviation) of the RMS ( $\mu$ V) in positions Rest and MI studied as a function of groups and phases.

Variables Group		Phases	
		Initial	Final
Rest LT	Acupuncture	3.08 (2.86) A	2.74 (1.29) A
	Splint	3.12 (1.42) A	3.24 (1.18) A
Rest RT	Acupuncture	3.91 (2.40) A	3.69 (2.18) A
	Splint	4.93 (1.91) A	3.86 (1.70) B
Rest LM	Acupuncture	1.66 (0.72) A	1.54 (0.82) A
	Splint	2.18 (1.49) A	1.76 (0.87) A
Rest RM	Acupuncture	1.87 (1.03) A	1.54 (0.57) A
	Splint	2.10 (1.42) A	1.70 (0.69) A
MI LT	Acupuncture	155.27 (119.46) A	149.50 (114.56) A
	Splint	98.33 (49.25) A	109.86 (73.14) A
MI RT	Acupuncture	150.78 (96.29) A	124.45 (58.59) A
	Splint	119.36 (71.18) A	113.79 (68.15) A
MI LM	Acupuncture	149.54 (135.17) A	152.44 (147.51) A
	Splint	86.98 (32.45) A	92.19 (54.15) A
MI RM	Acupuncture	121.95 (92.79) A	124.11 (120.00) A
	Splint	85.49 (41.21) A	90.59 (71.06) A

t test for paired and independent samples ( $p > 0.05$ ).

Means with same letters do not differ significantly ( $p > 0.05$ ).

LM = left masseter; LT = left temporal; MI = maximum intercuspitation; RM = right masseter; RMS = root mean square; RT = right temporal.

probably occurred because their study sample consisted of men and women with TMD, with a higher mean age than that of the participants in our study, who were divided into two groups: controls (mean age,  $43 \pm 13.3$  years), who received counseling and masticatory muscle exercises, and the splint group (mean age,  $44 \pm 13.1$  years), who received the splint, counseling, and masticatory exercises. The prevalence of symptomatic TMD is considered to be rather higher in women, and this factor may represent a bias in the experimental results. We selected only women using contraceptives, so that there would be no influence of female hormones present in the menstrual cycle.

Another study [31] compared the effectiveness of acupuncture and splint in TMD patients who had pain for more than 6 months. The study sample consisted of 110 individuals (23 men and 87 women) who were randomly divided into three groups: acupuncture, splint, and control, assessed before and immediately after the treatment period. The acupuncture group received six sessions of acupuncture (1 session/wk, 30 min/session), using local and distal points. Both treatments (acupuncture and splint) showed reduced symptoms compared with the control group, in which the symptoms were unchanged. However, in this short-term study, acupuncture showed better subjective outcomes than the splint therapy. After 1 year, these patients were called for follow up [32]; however, only 80 patients (22 men and 58 women) returned, and those patients who have not responded to any of the modes of treatment were offered several additional therapies such as physiotherapy, psychotherapy, and other occlusal adjustments. Furthermore, subjective clinical benefits were observed in 57% of patients who received acupuncture and

68% of patients treated with splint from the treatment over a period of 12 months. Compared to patients who received acupuncture in addition to the splint and additional therapies, the outcome was favorable in some cases; acupuncture and splint had a positive effect and similar results were noted in patients with TMD symptoms (mainly myogenic) over a follow-up period of 1 year. These results are consistent with ours, as acupuncture and splint reduced the symptoms of patients with myogenic TMD.

In the acupuncture group, there was a significant increase in the mean PPT LM, although the application of acupuncture had been performed on the right side. This response on the contralateral side may be explained from the energy point of view—that the effect generated in the acupuncture meridian is ipsi- and contralateral [33], because the meridians are bilateral and symmetrical, and have cross-circulation of Qi, which unites the right side (Yin) with the left side (Yang), harmonizing the flow of Qi [34]. Furthermore, this effect was proven by the report of deqi of one of the patients, who felt deqi on the left side of the body, the side that was initially pointed as being the origin of the pain in the face.

Only the RT muscle showed a significant reduction in RMS in the Rest position in the splint group. There was no significant difference between the groups in RMS MI; this may be attributable to the short period of treatment, which was not sufficient to produce more effects, apart from the reduction in pain intensity. Rancan et al [13] observed a reduction in pain and decrease of RMS at rest, clenching, protrusion, and right and left laterality of the anterior masseter and temporal muscles of patients with TMD treated with acupuncture in local points (ST6, ST7, BL2, GB14, GB20, SI18, SI19) and distal points (LR3, ST36, GB34, ST44, KI3, HN3 (extra point)).

The strong point of this study, from the aspect of knowledge, is that it evaluated the effect of acupuncture on patients with syndromic diagnosis with symptoms of chronic pain, and featured the use of carotid-radial pulsology for identification of the predominant imbalance, which enabled the identification of the energy level affected (Jueyin of the foot: liver), and selection of specific points for restoring the balance.

In TCM, pain is associated with a syndrome of fullness, in which a biologic response occurs, which consists of stagnation of the Qi and may develop into stagnation of the Xue [35]. Because the meridian of the liver has a relationship with the Xue that nourishes the tendons (tendons, ligaments, and cartilages, which are essential for the adequate functioning all joints, including the ATM) [15], the protocol of points in this study harmonized the Qi/Xue flow, relaxing and strengthening the tendons and muscles [28], and regularizing the mandibular mobility, which is mainly observed in the significant increase of RMO measurement.

Two patients (10%) presented discrete hematoma in point CV23, in agreement with a previous study [12], which reported the appearance of hematomas after needling.

One limitation of this study is that the obtained results cannot be extrapolated to men, because we did not analyze patients of the male sex. Therefore, we did not evaluate the effects of acupuncture for a lengthy period.

Acupuncture reduced the intensity of TMD pain and promoted the benefits of mandibular movement. When the



treatments were compared, both reduced pain intensity and increased mouth opening equally, and may be considered strategies for control of chronic pain related to TMD.

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