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Comparison of acupuncture and low-level laser for myofascial pain: A pilot study randomized trial

Comparação da acupuntura e do laser de baixa intensidade para dor miofascial: Um estudo piloto randomizado

Comparación de la acupuntura y el láser de baja intensidad para el dolor miofascial: Un estudio piloto aleatorizado

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Abstract
Myofascial pain in Temporomandibular Disorder (TMD) involves hypersensitive facial muscle trigger points, affecting quality of life. This trial aimed to evaluate the efficacy of acupuncture and low-level laser therapy for TMD-related pain relief. A randomized controlled trial with 14 participants (10 females, 4 males; mean age 29.5 years) divided into two groups (n=7). Group 1 received ten 20-minute acupuncture sessions every 48 hours, while Group 2 underwent low-power infrared laser therapy (790 nm, 120 mW) on the same schedule. Pain was assessed using a 0–10 Visual Analog Scale (VAS), and neuromuscular activity via bilateral electromyography (EMG) of the temporal and masseter muscles. Statistical analysis used SPSS 22.0 with Wilcoxon and paired t-tests ($p<0.05$). Both treatments significantly reduced subjective pain perception (VAS: Acupuncture 6.57 to 0.14; Laser 6.00 to 1.20), with no significant difference between groups. However, neither therapy significantly decreased neuromuscular activity in the temporal and masseter muscles, although acupuncture showed a trend toward reduced temporal muscle activity during clenching. Acupuncture and low-level laser therapy effectively reduced pain in patients with myofascial TMD. Despite differences in neuromuscular patterns, neither treatment significantly altered muscle activity, warranting further research to explore their underlying mechanisms.
Keywords: Myofascial pain syndromes; Acupuncture; Laser therapy; Electromyography.

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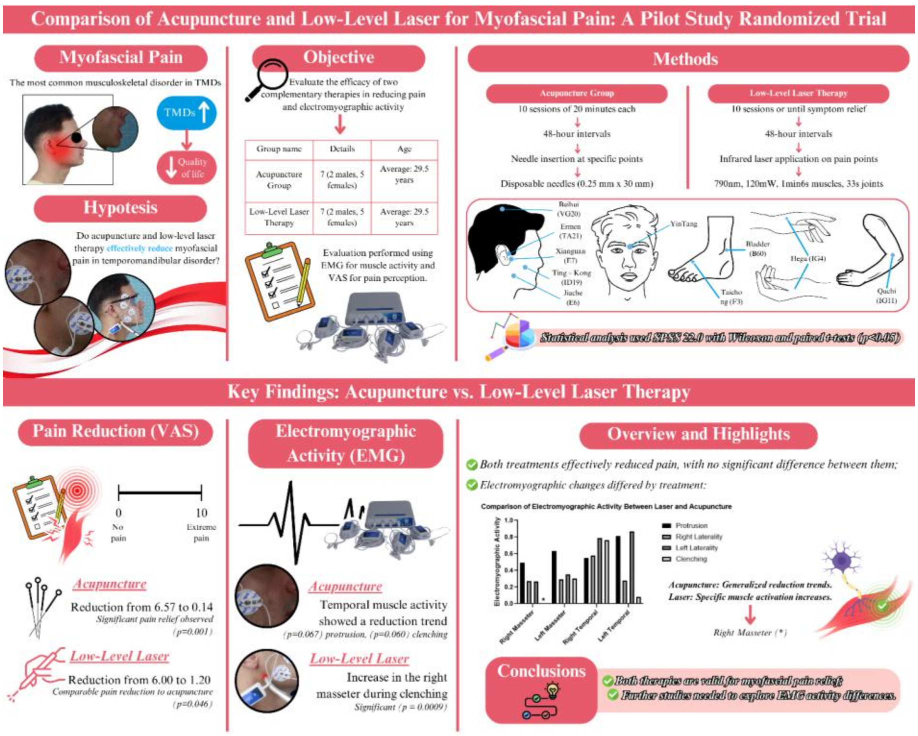
Resumo

Os pontos-gatilho musculares hipersensíveis da dor miofascial no Distúrbio Temporomandibular (DTM) afetam a qualidade de vida. O objetivo deste estudo foi avaliar a eficácia da acupuntura e da terapia com laser de baixa intensidade no alívio da dor relacionada à DTM. Foi realizado um ensaio clínico randomizado com 14 participantes (10 mulheres, 4 homens; média de 29,5 anos) divididos em dois grupos (n=7). O Grupo 1 recebeu dez sessões de acupuntura de 20 minutos a cada 48 horas, enquanto o Grupo 2 foi submetido à terapia com laser infravermelho de baixa potência (790 nm, 120 mW) na mesma frequência. A dor foi avaliada por meio da Escala Visual Analógica (EVA) de 0 a 10, e a atividade neuromuscular por eletromiografia (EMG) bilateral dos músculos temporal e masseter. A análise estatística foi realizada com o software SPSS 22.0, utilizando os testes de Wilcoxon e t pareado (p<0,05). Ambos os tratamentos reduziram significativamente a percepção subjetiva da dor (EVA: Acupuntura de 6,57 para 0,14; Laser de 6,00 para 1,20), sem diferença significativa entre os grupos. No entanto, nenhuma das terapias reduziu significativamente a atividade neuromuscular dos músculos temporal e masseter, embora a acupuntura tenha mostrado uma tendência à redução da atividade do músculo temporal durante o apertamento. A acupuntura e a terapia com laser de baixa intensidade foram eficazes na redução da dor em pacientes com DTM. Apesar das diferenças nos padrões neuromusculares, nenhum dos tratamentos alterou significativamente a atividade muscular, indicando a necessidade de mais pesquisas para explorar seus mecanismos subjacentes.
Palavras-chave: Síndromes da dor miofascial; Acupuntura; Terapia a laser; Eletromiografia.

Resumen

El dolor miofascial en el Trastorno Temporomandibular (TTM) implica puntos gatillo musculares hipersensibles, afectando la calidad de vida. Este estudio evaluó la eficacia de la acupuntura y del láser de baja intensidad en el alivio del dolor relacionado con el TTM. Se realizó un ensayo clínico aleatorizado con 14 participantes (10 mujeres, 4 hombres; edad promedio de 29,5 años), divididos en dos grupos. El Grupo 1 recibió diez sesiones de acupuntura de 20 minutos cada 48 horas, y el Grupo 2 fue tratado con láser infrarrojo (790 nm, 120 mW) con la misma frecuencia. El dolor se evaluó mediante la Escala Visual Analógica (EVA), y la actividad muscular por electromiografía (EMG) bilateral de los músculos temporal y masetero. El análisis estadístico se realizó con SPSS 22.0, utilizando las pruebas de Wilcoxon y t pareada (p<0,05). Ambos tratamientos redujeron significativamente el dolor (EVA: acupuntura de 6,57 a 0,14; láser de 6,00 a 1,20), sin diferencias significativas entre los grupos. No se observaron reducciones significativas en la actividad neuromuscular, aunque la acupuntura mostró una tendencia a disminuir la actividad del músculo temporal durante el apretamiento. En conclusión, la acupuntura y el láser de baja intensidad fueron efectivos para reducir el dolor en pacientes con TTM miofascial. No obstante, se requieren más estudios para comprender mejor sus mecanismos de acción sobre la función muscular.
Palabras clave: Síndromes del dolor miofascial; Acupuntura; Terapia por láser; Electromiografía.

Graphical Abstract - Pilot trial comparing acupuncture and low-level laser therapy for myofascial pain: effects on pain intensity and muscle activity.



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1. Introduction

Myofascial pain is a musculoskeletal disorder devoid of inflammation, characterized by hypersensitive trigger points. These trigger points are associated with both local and referred pain. Myofascial pain in the maxilla fascial region is usually related to the temporalis, masseter, lateral, and medial pterygoid muscles (Coyle, 2022; Manolopoulos et al., 2008). Electromyographic studies show that muscle soreness can shift the peak activity of the muscle involved and alter its distribution (Dommerholt et al., 2018; Lee et al., 2022).

Myofascial pain is the most common condition encountered in patients diagnosed with Temporomandibular Disorder (TMD), which is the second most common musculoskeletal condition, second only to lower back pain (Bashir et al., 2020; Conti et al., 2016). A probable correlation between myofascial pain and psychological states such as anxiety, depression, stress, and mood disorders can be established, having a significant impacting the patient's quality of life (Blanco-Aguilera et al., 2017; Georgoudis et al., 2018; Nielsen et al., 2022; Wieckiewicz et al., 2017). This relationship underscores the importance of a comprehensive treatment approach that addresses the disorder's physical and psychological aspects.

Diagnosis of myofascial pain primarily relies on the palpation of trigger points; however, advanced imaging techniques such as ultrasound and magnetic resonance imaging may also be utilized in some instances (Gerwin, 2014; Zhang et al., 2019). Treatment strategies for myofascial pain are diverse, including occlusal splint therapy, pharmacological interventions, physical therapy, and exercises to enhance flexibility (Büyükşireci et al., 2022; Fricton, 2016). Electromyography (EMG) is a diagnostic tool employed for assessing neuromuscular electrical activity that, combined with a detailed clinical examination, can provide objective, verifiable, and reproducible insights into the functional status of the masticatory muscles (Hugger et al., 2013). Studies have used EMG to evaluate the efficiency of treatments for conditions involving muscle disorders, such as myofascial pain (Palinkas et al., 2016; Rancan et al., 2009; Salles-Neto et al., 2020; Saraspuri et al., 2022; Tardelli et al., 2024).

The literature supports the integration of complementary therapies in managing myofascial pain due to their positive outcomes, although there is a scarcity of clinical studies directly comparing these therapies (Dietrich et al., 2020; Randhawa et al., 2016; Tardelli et al., 2024). Significant progress has been made in recent years in diagnosing and treating myofascial pain. However, despite these advancements, a standardized management protocol for this condition has yet to be established (Saxena et al., 2015; Wang et al., 2018).

Therefore, this study aimed to assess the effectiveness of acupuncture and low-level laser therapy, as evaluated by EMG, in patients suffering from myofascial pain associated with TMD. Additionally, pain levels were measured using a scale before and after the treatments.

2. Methodology

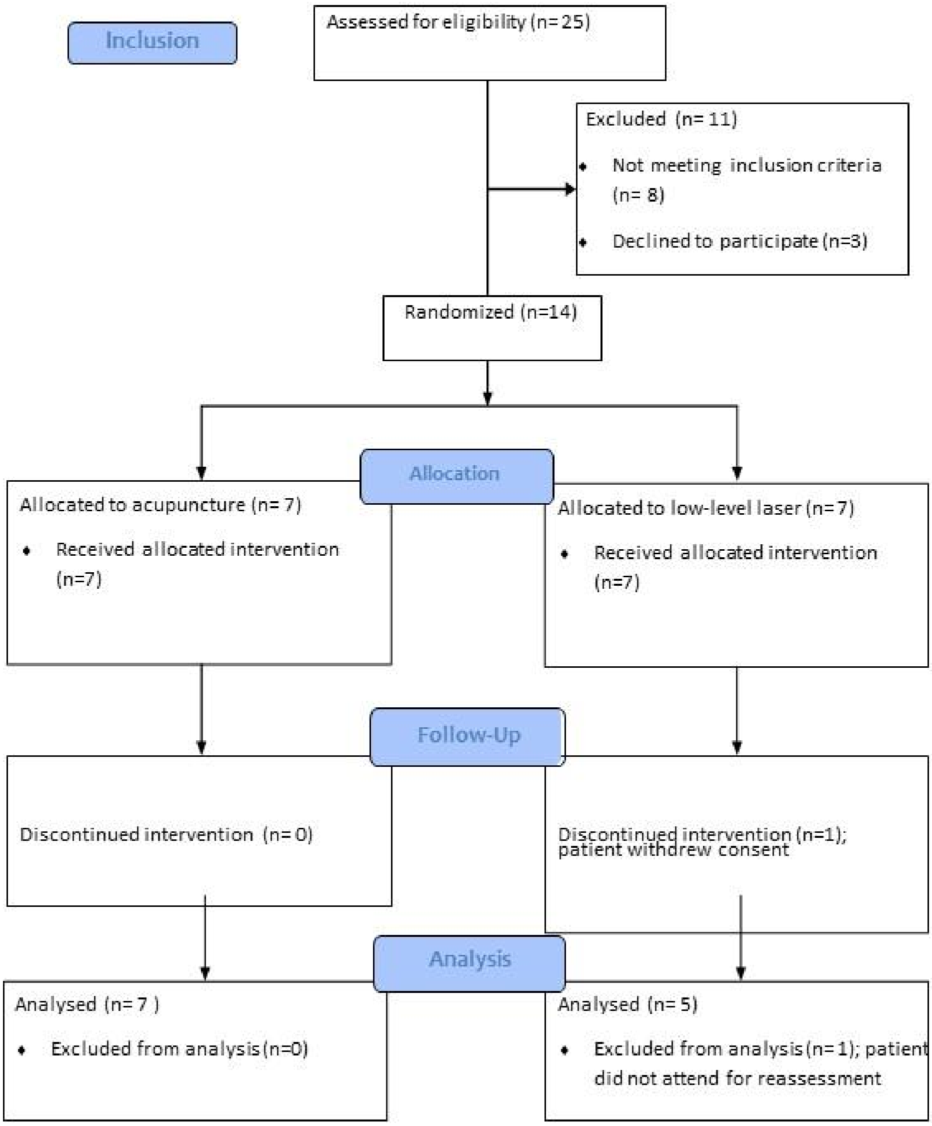
Epidemiological research of a quantitative nature was carried out (Toassi & Petry, 2021; Pereira et al., 2018) using descriptive statistics with mean values, standard deviation and frequency (Shitsuka et al., 2014) and statistical analysis (Vieira, 2021).

2.1 Study Design and Ethical Issues

A single-blind, parallel-group randomized clinical trial was conducted in the city of Diamantina, Minas Gerais, Brazil in 2018. This study adhered to the Consolidated Standards of Reporting Trials (CONSORT) (Cuschieri, 2019) checklist for clinical trials (Figure 1 and Frame 1) and obtained approval from the Human Research Ethics Committee of the Federal

University of the Jequitinhonha and Mucuri Valley (UFVJM) under approval number 2,640,273. All research participants signed a Consent Form (CF) after reading it.

Figure 1 - CONSORT Flow Diagram.



Source: Created by the Authors.

Frame 1 - CONSORT 2010 checklist with the Non-pharmacological Trials Extension to CONSORT (with STRICTA 2010 extending CONSORT Item 5 for acupuncture trials).

Section/Topic	**Item #**	**CONSORT 2010 Statement*: Checklist item. Describe:**	**Details**
TITLE AND ABSTRACT			
	1.a	Identification as a randomized trial in the title	*The title includes "Randomized Trial."*
	1.b	Structured summary of trial design, methods, results, and conclusions; for specific guidance see CONSORT for Abstracts	*The abstract details the trial design, participant characteristics, interventions (acupuncture vs. laser), outcomes, and main findings.*
INTRODUCTION			
Background and objectives	2.a	Scientific background and explanation of rationale	*The study compares acupuncture and low-level laser therapy for Temporomandibular Disorder (TMD).*
	2.b	Specific objectives or hypotheses	*Hypothesis: Acupuncture and laser therapy have distinct effects on TMD-related pain and muscle function.*
METHODS			
Trial design	3.a	Description of trial design (e.g., parallel, factorial) including allocation ratio	*Single-blind, parallel-group randomized clinical trial. Allocation ratio: 1:1 (7 patients in each group).*
	3.b	Important changes to methods after trial commencement (e.g. eligibility criteria), with reasons	*No significant changes were made after the trial started.*
Participants	4.a	Eligibility criteria for participants	*Adults diagnosed with TMD have a pain score ≥ 5 on the Visual Analogue Scale (VAS). Exclusions included long-term medication use and other treatments.*
	4.b	Settings and locations where the data were collected	*Temporomandibular Disorder Clinic, Dental School, Federal University of the Jequitinhonha and Mucuri Valley (UFVJM), Diamantina, Brazil.*
Interventions	**5**	**The interventions for each group with sufficient details to allow replication, including how and when they were actually administered**	*Group 1: Acupuncture (10 sessions, 48 hours - 7 days apart). Group 2: Low-level laser therapy (10 sessions, every 48 hours).*
Outcomes	6.a	Completely defined pre-specified primary and secondary outcome measures, including how and when they were assessed	*The primary outcome is pain reduction (0-10 scale). The secondary outcome is electromyographic activity of the masseter and temporal muscles.*
	6.b	Any changes to trial outcomes after the trial commenced with reasons	*No changes to trial outcomes were made.*
Sample size	7.a	How sample size was determined	*The sample size was calculated with a 95% confidence level, 7% standard error, and 14 participants (7 per group).*
	7.b	When applicable, explanation of any interim analyses and stopping guidelines	*No interim analyses were planned or performed.*
Randomization			
Sequence generation	8.a	Method used to generate the random allocation sequence	*They are randomized through drawing from opaque envelopes.*
	8.b	Type of randomization; details of any restriction (e.g., blocking and block size)	*Simple randomization without blocking or stratification.*
Allocation concealment	9	Mechanism used to implement the random allocation sequence (e.g., sequentially numbered containers), describing any steps taken to conceal the sequence until interventions were assigned	*Allocation was concealed using opaque envelopes, which gave the assessment researchers no access.*

Section/Topic	Item #	CONSORT 2010 Statement*: Checklist item. Describe:	Details
Implementation	10	Who generated the random allocation sequence, who enrolled participants, and who assigned participants to interventions	*A separate researcher generated the random sequence, while others enrolled participants and assigned interventions.*
Blinding	11.a	If done, who was blinded after assignment to interventions (e.g. participants, care providers, those assessing outcomes) and how	*Outcome assessors (electromyographic evaluators) were blinded, while participants and intervention providers were not.*
	11.b	If relevant, description of the similarity of interventions	*Not applicable—acupuncture and laser therapy were distinct interventions.*
Statistical methods	12.a	Statistical methods used to compare groups for primary and secondary outcomes	*Shapiro-Wilk test for normality; Wilcoxon test for non-parametric data; paired t-test for parametric data; significance level set at p<0.05.*
	12.b	Methods for additional analyses, such as subgroup analyses and adjusted analyses	*No additional analyses were conducted.*
RESULTS			
Participant flow (A diagram is strongly recommended)	13.a	For each group, the numbers of participants who were randomly assigned, received intended treatment, and were analyzed for the primary outcome	*G1 (acupuncture) and G2 (laser therapy): Each group had 7 participants, who were analyzed for both primary and secondary outcomes.*
	13.b	For each group, losses and exclusions after randomization, together with reasons	*No losses or exclusions occurred after randomization.*
Implementation of intervention			
Recruitment	14.a	Dates defining the periods of recruitment and follow-up	*Recruitment and treatment were conducted in 2018, with follow-ups at one month and three months post-treatment.*
	14.b	Why the trial ended or was stopped	*The trial was completed as planned, with no premature stopping.*
Baseline data	15	A table showing baseline demographic and clinical characteristics for each group	*View Table 1.*
Numbers analyzed	16	For each group, number of participants (denominator) included in each analysis and whether the analysis was by original assigned groups	*All 14 participants (7 per group) were analyzed per the original group assignment.*
Outcomes and estimation	17.a	For each primary and secondary outcome, results for each group, and the estimated effect size and its precision (e.g., 95% confidence interval)	*Both groups showed significant pain reduction, with no significant difference in electromyographic results varied by muscle and movement.*
	17.b	For binary outcomes, presentation of both absolute and relative effect sizes is recommended	*Not applicable—no binary outcomes.*
Ancillary analyses	18	Results of any other analyses performed, including subgroup analyses and adjusted analyses, distinguishing pre-specified from exploratory	*No additional analyses were performed.*
Harms	19	All important harms or unintended effects in each group; for specific guidance see CONSORT for Harms	*No adverse effects were reported in either group.*
DISCUSSION			
Limitations	20	Trial limitations, addressing sources of potential bias, imprecision, and, if relevant, multiplicity of analyses	*Small sample size and possible operator bias due to non-blinded interventions.*
Generalizability	21	Generalizability (external validity, applicability) of the trial findings	*Results may be generalizable to TMD patients but are limited by the small sample size.*

Section/Topic	Item #	CONSORT 2010 Statement*: Checklist item. Describe:	Details
Interpretation	22	Interpretation consistent with results, balancing benefits and harms, and considering other relevant evidence	*Both acupuncture and laser therapy reduced pain significantly, with no adverse effects, consistent with previous research.*
OTHER INFORMATION			
Registration	23	Registration number and name of trial registry	*Registered with the Human Research Ethics Committee of UFVJM under approval number 2640273.*
Protocol	24	Where the full trial protocol can be accessed, if available	*It is not publicly available but follows CONSORT and STRICTA guidelines.*
Funding	25	Sources of funding and other support (e.g., supply of drugs); role of funders	*Funded by Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG - APQ-00332-16).*

Source: Adapted from Cuschieri (2019).

To ensure the robustness and transparency of our study, in addition to following the CONSORT guidelines, we also adopted the Standards for Reporting Interventions in Clinical Trials of Acupuncture (STRICTA) (MacPherson et al., 2010) guidelines to report the acupuncture intervention, ensuring that all relevant aspects of the practice were adequately documented (Frame 2).

The sample was selected from the clinical records of patients treated at the TMD Clinic of the Dental School at UFVJM. Patients diagnosed with TMD through the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) (Pereira et al., 2014) and who had a pain score ≥ 5 according to the Visual Analogue Scale (VAS) related to the masseter muscle and/or pain related to the tendon of the temporalis muscle. Patients who made long-term use of analgesic, anti-inflammatory, and antidepressant medications, were under orthodontic treatment, had a previous history of facial trauma, or had undergone any TMD treatment in the last year were excluded.

Frame 2 - STRICTA 2010 checklist of information to include when reporting interventions in a clinical trial of acupuncture (Expansion of Item 5 from CONSORT 2010 checklist).

Item	Detail
1. Acupuncture rationale	1a) Style of acupuncture (e.g. Traditional Chinese Medicine, Japanese, Korean, Western medical, Five Element, ear acupuncture, etc). *Traditional Chinese Medicine (TCM). Points were selected based on TCM theories related to temporomandibular disorders (TMD).*
	1b) Reasoning for treatment provided, based on historical context, literature sources, and/or consensus methods, with references where appropriate *The rationale for selecting acupuncture was informed by historical practices, a robust body of literature, and consensus within the field of TCM. Acupuncture has a longstanding history of efficacy in managing various pain conditions, including TMD. Recent studies highlight the effectiveness of specific acupuncture points for alleviating TMD symptoms; for example, Hegu (IG4) is well-regarded for its analgesic properties (Zhang et al., 2017), while combinations of points like Ermen (TA21) and Taichong (F3) are effective in reducing muscle tension (Lee et al., 2018). Additionally, a consensus report from the World Health Organization (WHO) supports acupuncture for musculoskeletal disorders, reinforcing its role as a complementary treatment modality (WHO, 2002). These historical and contemporary references validate the choice of acupuncture as a therapeutic intervention in this study, aiming for a holistic treatment of TMD symptoms.*
	1c) Extent to which treatment was varied *Treatment was standardized for all participants in Group 1 (G1) with minimal variation across sessions. Points and protocols were tailored but consistently applied.*

2. Details of needling	2a) Number of needle insertions per subject per session (mean and range where relevant) *Each session involved eight needle insertions, consistent across all participants.*
	2b) Names (or location if no standard name) of points used (uni/bilateral) *Points included:* *Bilateral: Ermen (TA21), Hegu (IG4), Ting-Kong (ID19), Quchi (IG11), Taichong (F3), Jiache (E6), Xianguan (E7), Bladder 60 (B60),* *Unilateral: Baihui (VG20), YinTang.*
	2c) Depth of insertion, based on a specified unit of measurement, or on a particular tissue level *Needles were inserted between 0.5 to 2 inches (1.3 to 5 cm) based on the anatomical location.*
	2d) Response sought (e.g. *de qi* or muscle twitch response) *The "De Qi" sensation and muscle twitch were sought during the procedure.*
	2e) Needle stimulation (e.g. manual, electrical) *Manual stimulation after 10 minutes of insertion, retained for 20 minutes.*
	2f) Needle retention time *Needles were retained for 20 minutes per session.*
	2g) Needle type (diameter, length, and manufacturer or material) *Disposable needles, 0.25 mm in diameter, 30 mm long, sourced from DUX Acupuncture (RS, Brazil).*
3. Treatment regimen	3a) Number of treatment sessions *Participants in G1 underwent ten treatment sessions, scheduled with intervals of at least 48 hours and a maximum of 7 days between sessions. Participants in Group 2 (G2), who received low-level laser applications, also had ten sessions conducted every 48 hours until symptom remission or completion of the treatment.*
	3b) Frequency and duration of treatment sessions *Sessions occurred every 48 hours to 7 days, each lasting approximately 20 minutes.*
4. Other components of treatment	4a) Details of other interventions administered to the acupuncture group (e.g. moxibustion, cupping, herbs, exercises, lifestyle advice) *No additional interventions (e.g., cupping, herbs, exercises) were administered.*
	4b) Setting and context of treatment, including instructions to practitioners, and information and explanations to patients *Conducted at the Temporomandibular Disorder Clinic, UFVJM, with comprehensive instructions provided to patients.*
5. Practitioner background	5) Description of participating acupuncturists (qualification or professional affiliation, years in acupuncture practice, other relevant experience) *Acupuncturists have at least ten years of clinical experience and specific training in TMD-related treatments.*
6. Control or comparator interventions *Low-level laser therapy applied to pain points with a 790 nm infrared laser for up to 10 sessions (1 minute 6 seconds on muscle points, 33 seconds on joint points).*	6a) Rationale for the control or comparator in the context of the research question, with sources that justify this choice *Low-level laser therapy was selected as the comparator based on literature supporting its effectiveness in pain management.*
	6b) Precise description of the control or comparator. If sham acupuncture or any other type of acupuncture-like control is used, provide details as for Items 1 to 3 above. *Low-level laser therapy applied to pain points with a 790 nm infrared laser for up to 10 sessions (1 minute 6 seconds on muscle points, 33 seconds on joint points).*

Source: Adapted from MacPherson et al. (2010).

2.2 Sample and eligibility criteria

The number of patients was determined by calculating the sample size with a confidence level of 95%, a standard error of 7%, and a maximum percentage of 1, based on the study by Rancan, 2009 (Rancan et al., 2009) and Cazal et al., 2016 (Cazal et al., 2016), totaling 07 patients per group. Patients were randomly divided into two groups. In Group 1 (G1=7), patients received acupuncture, while in Group 2 (G2=7), they underwent low-level infrared laser treatments.

2.3 Randomization

The patients included in the study were randomized according to the therapeutic protocol that would be administered. One of the researchers performed the randomization by drawing in an opaque envelope containing fourteen references to the treatments and seven papers for each protocol.

The random draw was conducted in the researcher's absence, aiming to preserve randomization concealment and ensure that the researcher conducting the electromyographic evaluation remained blinded; the professionals assigned to each stage of the study conducted follow-ups. The lead researcher, assessors, and operators did not have access to randomization.

2.4 Interventions

2.4.1 Acupuncture

G1 received ten acupuncture sessions conducted by a specialized acupuncturist, with a minimum interval of 48 hours and a maximum of 7 days between sessions. The application site was disinfected with 70% alcohol (Ethyl Alcohol, Rioquímica, SP, Brazil). Disposable acupuncture needles in 0.25 mm x 30 mm (DUX Acupuncture, RS, Brazil) were inserted with a specific depth at each point, activated after 10 minutes of insertion, and removed after 20 minutes.

Acupuncture points were selected according to specific literature that demonstrated a direct relationship with the impact of temporomandibular disorder. These points were based on the theory of "Point function," which determines that each point has its function in the human body (List & Helkimo, 1987). The following points were selected for each patient: Ermen (TA21), Hegu (IG4), Ting Kong (ID19), Quchi (IG11), YinTang, Taichong (F3), Jiache (E6), Xianguan (E7), bladder 60 (B60), and Baihui (VG20). The selected points are graphically described in Figures 2, 3, and 4.

Figure 2 - Scheme of the points Baihui (VG20), YinTang, Ermen (TB21), Xianguan (ST7), Ting-Kong (SI19), Jiache (ST6).

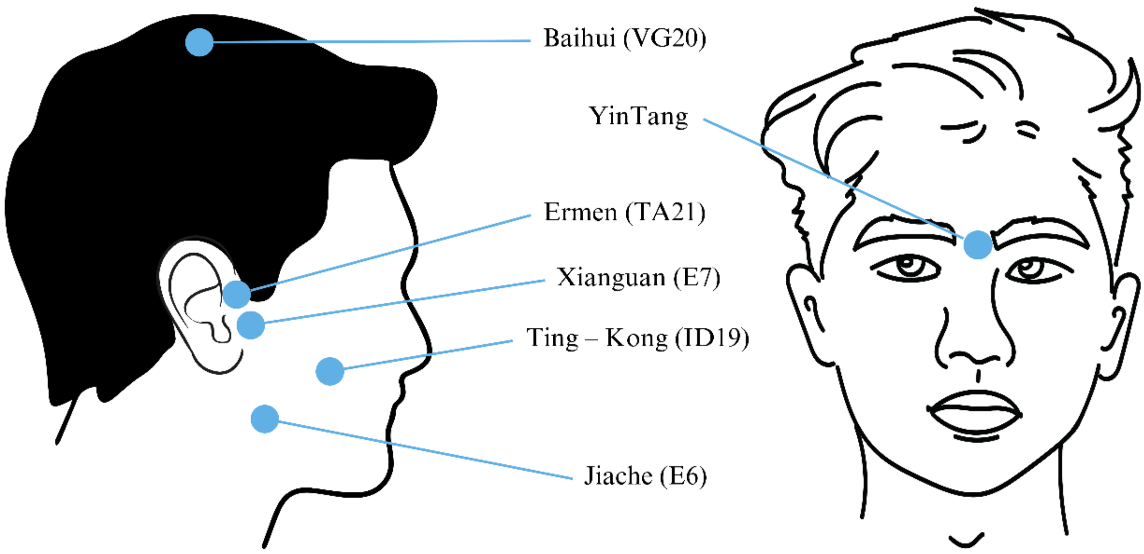


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Figure 3 - Scheme of the points Bladder (B60) and Taichong (F3).

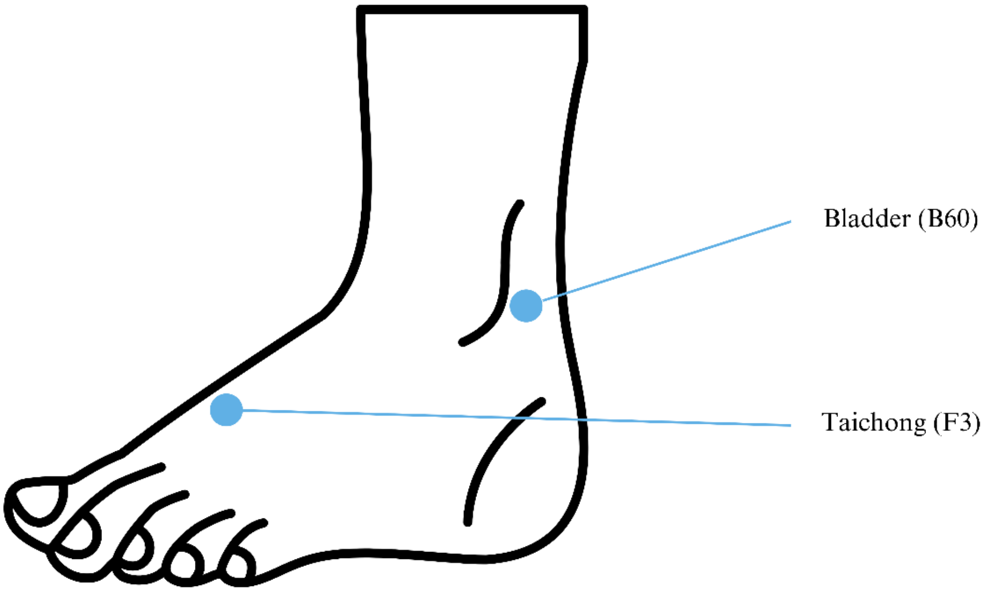

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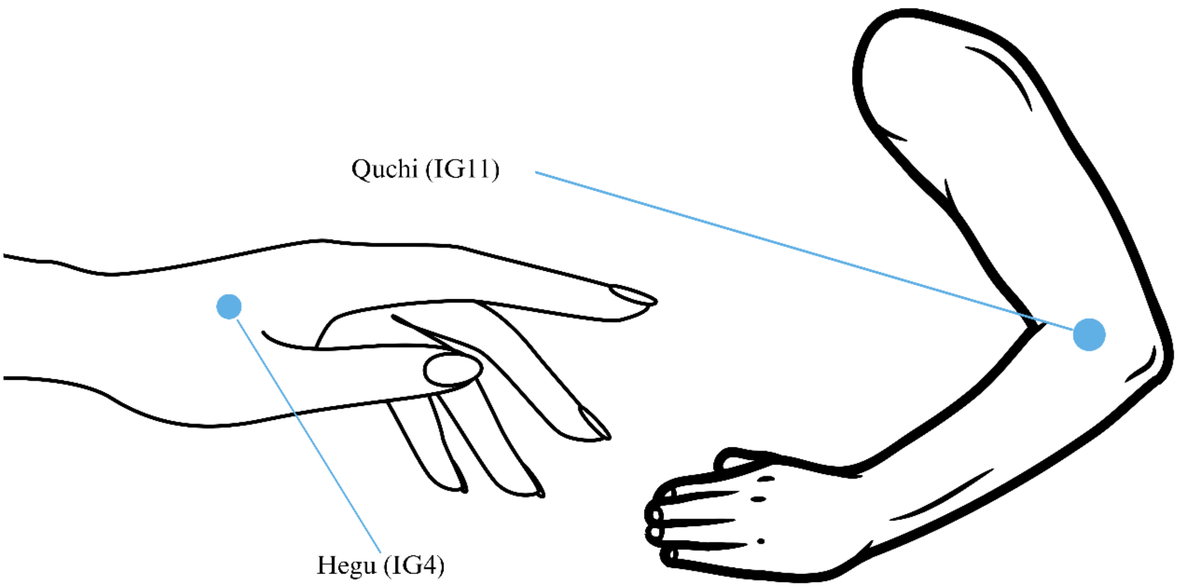
Figure 4 - Scheme of the points Quchi (IG11) and Hegu (IG4).



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2.4.2 Low-level laser

The participants in G2 were submitted to laser applications on the pain points by palpation by the RDC, where the low-intensity device Clean Line Easy Laser - LILT (Low-level Laser Treatment) was used (Clean Line, Taubaté, SP, Brazil).

The laser was applied according to the manufacturer's recommendations with a wavelength of 790nm (infrared laser), power energy density of 120mW for 1 minute and 06 seconds on the muscle points, and power of 120mW for 33 seconds on the joint points, with applications every 48 hours until the symptoms went into remission or until ten sessions were completed. All patients and the operator wore goggles with black lenses and followed biosafety standards. A single trained researcher conducted all sessions. 〖8J/cm〗^2, 〖4J/cm〗^2

The low-level laser application sites followed the same points as acupuncture, which were selected for each patient: Ermen (TA21), Hegu (IG4), Ting Kong (ID19), Quchi (IG11), YinTang, Taichong (F3), Jiache (E6), Xianguan (E7), bladder 60 (B60), and Baihui (VG20) (Figures 2, 3, and 4).

2.5 Electromyography

A previously calibrated electromyograph was used at Miotec Equipamentos Biomédicos Ltda, Brazil. EMG data were filtered at 20-500Hz. The signals were converted analog-to-digital using a hardware A/D input with a 14-bit resolution and a 2000 Hz sampling frequency. The signal was captured by 3M single disposable surface electrodes and recorded by the square root of the mean in μv and mean frequency in Hz.

A reference electrode (ground electrode) was placed on the bony prominence of the lateral epicondyle of the humerus, following the SENIAM (Surface Electromyography for the Non-Invasive Assessment of Muscles) guidelines.

A single trained professional accurately positioned the electrodes on both sides of the temporal muscles (anterior branch) and masseter, ensuring a consistent 20 mm distance and alignment perpendicular to the direction of muscle fibers. Before electrode placement, the patient's skin underwent thorough cleaning with alcohol to remove any residual grease, makeup, or pollutants, and any hair present was carefully shaved using a disposable razor blade. Digital palpation guided specific maneuvers involving maximal voluntary contraction to ensure optimal electrode adherence to the targeted muscles. Electromyographic activity was analyzed by recording masticatory muscles, following the protocol highlighted in Table 1, established by Rancan et al., 2009 (Rancan et al., 2009).

Table 1 - Electromyographic protocol for the evaluation of muscle activity.

Muscles	Clinical Conditions	Normalization
	Resting (4s)	
Masseters	Protrusion (10s)	
and	Right side (10s)	Maximal voluntary contraction (MVC)
Temporal	Left side (10s)	(normalization factor) (4s)
	Parafilm M® Dental Clenching (4s)	

Source: Created by the Authors.

The electromyographic recordings were made in a quiet and noiseless environment, and the patients were asked to remain in their calmest state possible, breathing slowly. The participant assumed an upright seated position, with feet flat on the ground and palms resting on the thighs. The head was erect, maintaining the Frankfurt plane parallel to the ground.

All data were normalized after collection, allowing comparison between patients. The intermediate four seconds of the movements were considered to evaluate the mean values. Patients underwent evaluation both before and immediately after completion of their assigned treatment. They were also evaluated at intervals of one month and three months after the interventions.

2.6 Self-perception of pain

The VAS measured pain perception, which ranged between 0 (no pain) and 10 (extreme pain).

2.7 Statistical analysis

The data were analyzed using the Statistical Package for Social Science (SPSS), version 22.0. Descriptive statistics and association tests were performed to compare the means of the therapeutic protocols. The Shapiro-Wilk normality test assessed data distribution, followed by parametric or non-parametric association tests. For non-normally distributed data, the Wilcoxon test for paired samples was employed, while the paired t-test was used for normally distributed data to evaluate differences between group means. The significance level adopted was 5% ($p < 0.05$).

3. Results

Table 2 shows the baseline demographic and clinical characteristics of participants in the Acupuncture (G1) and Laser Therapy (G2) groups.

Table 2 - Demographic and clinical baseline characteristics of the Acupuncture group (G1) and the Laser Therapy group (G2).

Characteristic	Acupuncture Group (G1) (n=7)	Laser Group (G2) (n=7)
Age (Years)	Average: 29.5	Average: 29.5
Gender (Male/Female)	2/5	2/5
TMD Diagnosis	All confirmed	All confirmed

The table displays average participant data, including age, gender proportion, and confirmation of Temporomandibular Disorder (TMD) diagnosis per group. Source: Research data.

In the acupuncture group, the electromyographic activity of the left temporal muscle decreased during protrusion and clenching, although this decrease was not statistically significant: protrusion (p=0.067) and clenching (p=0.060) (Table 3).

Table 3 - Mean values and standard error of electromyographic activity in the acupuncture-treated group.

Muscle		Protrusion	Right side	Left side	Clenching
Right Masseter	Before	23.13±5.27	16.70±7.07	16.56±4.57	66.61±7.66
	After	21.64±6.40	17.55±7.60	18.89±4.24	67.82±3.29
	p-value	0,841	0,936	0,715	0,888
Left Masseter	Before	22.07±6.68	13.88±5.20	14.39±4.50	54.21±3.98
	After	14.11±5.43	11.43±3.15	12.87±4.08	68.40±8.65
	p-value	0,374	0,694	0,806	0,162
Right Temporalis	Before	7.40±1.96	8.92±2.44	8.30±2.24	64.98±9.33
	After	6.64±0.87	8.07±1.74	10.00±2.90	71.30±2.64
	p-value	0,535	0,620	0,620	0,902
Left Temporalis	Before	11.62±2.73	12.60±3.69	20.76±7.99	82.35±6.02
	After	5.65±1.14	9.98±3.17	9.33±2.33	68.24±3.11
	p-value	0,067	0,593	0,195	0,060

*T-test. Source: Research data.

Table 4 shows the mean neuromuscular activity before and after treatment with low-level laser. Following treatment, the right temporalis muscle showed a statistically significant increase in activity during clenching.

Table 4 - Mean values and standard error of electromyographic activity in the low-level laser-treated group.

Muscle		Protrusion	Right Laterality	Left Laterality	Clenching
Right Masseter	Before	19.41±7.42	6.55±1.76	5.62±1.48	52.24±3.22
	After	14.26±7.05	6.49±3.28	9.90±6.85	52.90±2.89
	p-value	0,629	0,986	0,558	0,882
Left Masseter	Before	23.14±7.36	5.19±1.12	12.84±8.72	55.50±4.92
	After	17.78±4.53	6.81±2.06	7.45±3.17	54.92±8.04
	p-value	0,553	0,512	0,578	0,953
Right Temporalis	Before	11.93±3.52	11.06±2.27	7.33±1.96	40.98±7.43
	After	9.11±4.58	9.95±3.06	8.70±3.75	73.99±9.79
	p-value	0,639	0,775	0,754	0,028*
Left Temporalis	Before	8.90±2.27	6.22±1.32	10.27±1.63	49.93±7.56
	After	6.23±2.44	5.28±1.77	10.30±5.80	54.06±7.56
	p-value	0,449	0,775	0,996	0,709

*T-test. Source: Research data.

When comparing the results between the two groups, there was a statistically significant difference during clenching in the right masseter muscle (Table 5).

Table 5 - Comparison of electromyographic activity between the Laser x Acupuntura groups.

Muscle	Protrusion	Right Laterality	Left Laterality	Clenching
Right Masseter	0,491	0,272	0,266	0,009*
Left Masseter	0,631	0,292	0,354	0,301
Right Temporal	0,545	0,579	0,787	0,764
Left Temporal	0,815	0,276	0,865	0,081

*T-test. Source: Research data.

Both treatments showed statistically significant reductions in pain when assessing the pain reported by patients via the VAS. However, the treatments had no discernible difference (Table 6).

Table 6 - Mean and standard deviation of patient-reported pain.

Groups	Before	After	p-value
Acupuncture	6.57±0.48Aa	0,14±0,14Bb	0,001*
Laser	6.00±0.54Aa	1,20±1,20Bb	0,046*
p-value	0,432	0,876	

*Wilcoxon test. Source: Research data.

4. Discussion

In this study, the therapies used to treat myofascial pain could not reduce the neuromuscular electrical activity of the muscles evaluated, corroborating the literature (Sattayut & Bradley, 2012). Orofacial disorders can modify the physiological structure of the muscles since frequent muscle contractions cause lactate accumulation and a decrease in pH. As a result, the number of active motor units has increased progressively over time, accompanied by a decreased firing rate of motor neurons and reduced myoelectrical activity due to prolonged neuromuscular activity (Palinkas et al., 2016).

Studies show that women are more affected by myofascial pain, as observed in this study (Fikácková et al., 2007). Reports in the literature suggest that women exhibit more significant concern for their health and tend to seek medical care more frequently than men, resulting in a higher frequency of diagnoses among women (Pereira et al., 2014). In addition, a hormonal factor contributes to the increase in cases since estrogen aggravates temporomandibular joint (TMJ) inflammation or pain by inducing pro-inflammatory cytokines in the synovial membrane (Vilanova et al., 2015).

Dentists have used complementary therapies to treat conditions related to the TMJ. Among the practices, acupuncture has been described as an effective therapy in treating TMD (List & Helkimo, 1987). The positive effects on pain, with tension reduction and muscle relaxation, may be associated with the release of endorphins (List & Helkimo, 1987).

The present study observed a trend that may decrease the variation of electromyographic recordings during all movements performed by the mandibular arch. However, the changes are small and do not present statistically significant differences between the values collected after and before acupuncture. Rancan et al., 2009 (Rancan et al., 2009) reported a similar outcome, demonstrating that acupuncture induces alterations in electromyographic activity patterns and modifications in bite force potential and alleviates pain symptoms.

After acupuncture treatment, individuals exhibited reduced electromyographic activity in nearly all clinical conditions involving laterality and protrusion movements, except for the right masseter muscle during right and left laterality and the right temporal muscle during left laterality. The activity of the muscles in this condition demonstrates a pattern of basal muscle contraction (neuromuscular tone), which maintains posture. However, individuals with temporomandibular disorders present conditions of muscle hyperactivity in clinical postures such as laterality, which may explain the non-decrease in electromyographic signals after acupuncture treatment (Rancan et al., 2009).

Low-level laser therapy represents a promising adjunctive or complementary physical intervention for both acute and chronic temporomandibular disorders. In the study by Salmos-Brito et al., 2013 (Salmos-Brito et al., 2013), patients with acute pain showed statistical differences after treatment. This difference is justified by the type of pain since patients with acute illnesses are likely to have a better outcome. The values of neuromuscular electrical activity in the present study did not differ between before and after treatment.

Acupuncture has been shown to provide immediate relief for subjective pain and during palpation of orofacial structures when compared to placebo acupuncture, highlighting its effectiveness as a therapeutic intervention (Tardelli et al., 2024). The discrepancy between subjective pain perception and EMG results can be attributed to neurological and psychological factors (Manolopoulos et al., 2008). Pain is not merely a physiological response to stimuli but is also modulated by emotional and cognitive factors, as highlighted by Wager et al. 2013 (Wager et al., 2013) and Loeser et al. 2024 (Loeser & Ballantyne, 2024). Changes in brain connectivity and central sensitization processes can amplify pain perception, even without detectable changes in muscle activity, as observed by Sanzarello et al. 2016 (Sanzarello et al., 2016). Furthermore, interventions such as pain neuroscience education have shown effectiveness in recontextualizing and reducing pain perception by altering beliefs and emotional responses associated with pain, as noted by Witt et al. 2011 (Witt et al., 2011). These findings emphasize the need for integrated therapeutic approaches that address both the physical and psychological aspects of pain for more effective treatment.

A statistically significant difference was observed during clenching, likely due to the patient's chronic condition. Mohammed et al. 2022 (Mohammed et al., 2022) reported that low-level laser therapy significantly increased TMD patients' EMG activity in the masseter and temporalis muscles. This finding aligns with studies by Venezian et al. 2010 (Venezian et al., 2010) and Shukla and Muthusekhar 2016 (Shukla & Muthusekhar, 2016). These studies suggest that low-level laser may stimulate muscle activity by increasing blood flow and reducing pain, with the likely mechanism involving photobiomodulation, fibroblast proliferation, and collagen production (Yassaei et al., 2022).

In the TMJ, the nerve fibers that innervate the region are excited by painful mechanical and chemical stimuli that result in pain. It is suggested that many of these afferent fibers are nociceptors. In acupuncture, pain relief can be achieved by "closing the pain gate" through a central polarization mechanism thought to be located in the reticular formation of the brainstem. This mechanism controls the release of endorphins, neurotransmitters known for their analgesic properties (Melzack, 1981). Meanwhile, the low-level laser acts to increase the levels of acetylcholinesterase, lymphatic drainage, adenosine triphosphate, and beta-endorphin, and this therapeutic modality is suggested to reduce chronic and acute pain (Sattayut & Bradley, 2012). Although they act differently on the mechanism of pain and, consequently, on muscle relaxation, both types of treatment are efficient in reducing pain, and there is no difference between the two types of established protocols.

Although no significant differences were observed in pain perception, the methods showed a statistically significant difference in the right masseter muscle during clenching (p=0.0009). This finding suggests that specific muscles and movements may respond differently to therapeutic interventions due to biomechanics and each muscle's workload during functional activities like mastication (Mohammed et al., 2022; Shukla & Muthusekhar, 2016).

Furthermore, sample heterogeneity involving age, gender, and pre-existing health conditions can influence treatment outcomes (Kothari et al., 2021; Venezian et al., 2010). The chronicity of temporomandibular dysfunction should also be considered a key factor affecting the effectiveness of therapies, as chronic conditions can alter muscle activation patterns and response to treatment. Alghadir et al. 2016 (Alghadir et al., 2016) emphasize the importance of assessing factors such as condition severity, pain duration, and prior treatment history when determining the efficacy of therapeutic interventions (Shukla & Muthusekhar, 2016).

This study is essential to help dentists choose effective therapeutic techniques for controlling myofascial pain, providing better patient outcomes. Although few studies have compared the efficacy of complementary therapies through EMG, this work presents a promising preliminary view, indicating that acupuncture and laser may improve TMD in patients with myofascial pain. Future studies with larger sample sizes and more significant heterogeneity will be crucial for robustly validating these therapies, strengthening these conclusions, and addressing existing gaps.

5. Conclusion

The acupuncture and laser utilized in managing myofascial pain among patients with TMD effectively reduced the subjective perception of pain. However, it is noteworthy that these treatments did not decrease the neuromuscular electrical activity observed in the temporal and masseter muscles.

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