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ORIGINAL ARTICLE

Evaluation of pain, jaw movements, and psychosocial factors in elderly individuals with temporomandibular disorder under laser phototherapy

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Abstract Few studies have been carried out on the application of laser phototherapy (LPT) for treating painful temporomandibular disorder (TMD) in elderly population that is growing worldwide. The aim of the present study was to evaluate the pain, jaw movements, and psychosocial factors in ten elderly patients with painful TMD before and after LPT. All patients were evaluated before and after LPT by using the Research Diagnostic Criteria for temporomandibular disorders (RDC/TMD) axes I and II. For pain assessment, a visual analogue scale (VAS) was used. The LPT was carried out with an GaAlAs diode laser (780 nm; spot size 0.04 cm^2) in punctual and contact mode. Two settings of irradiations were applied as follows: in patients presenting myofascial pain, 10 mW, 5 J/cm^2, 20 s, 0.2 J per application point; and in patients with joint TMD, 70 mW, 105 J/cm^2, 60 s on five points, 4.2 J per point. Two sessions of LPT were carried out per week over four consecutive weeks, in the total of eight sessions. Data was statistically analyzed ($p < 0.05$). Significant pain reduction was found in all patients. There were increase in maximum mouth opening without pain and reduction in muscle pain during right and left lateral excursion. A significant reduction in chronic pain severity ($p = 0.02$) and significant improvements in depression ($p = 0.038$) and nonspecific physical symptoms with pain ($p = 0.0167$) were observed. The present findings indicate that LPT is able to promote pain relief and improvement of jaw movements in elderly patients with TMD, with a positive effect on psychosocial aspects.

Keywords Temporomandibular disorder · Laser phototherapy · Pain

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Introduction

Temporomandibular disorder (TMD) comprises a heterogeneous group of musculoskeletal disorders affecting the temporomandibular joint and/or muscles of mastication. The main clinical signs and symptoms are joint or muscle pain, limitation or deviation of the jaw movements, and joint noises [1, 2]. TMD is the major cause of facial pain and has a multifactor etiology related to parafunctional habits, malocclusion, and biopsychosocial aspects (e.g., anxiety, depression, and personality disorders) [3, 4]. The psychological aspects are categorized as predisposing, initiating, and perpetuating factors of

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TMD [5]. This disorder can have a negative impact on quality of life and the performance of activities of daily living [6, 7]. Affected individuals may also exhibit depression [6–9]. Such aspects may be even more relevant when TMD occurs in elderly individuals, who often exhibit joint noises accompanied or not by muscle alterations [10, 11].

There is no consensus on the treatment of TMD because the nature of the disease is not well understood [12–15]. A multidisciplinary approach includes the use of physical therapy, drug therapy (anti-inflammatory and anti-depressive agents), occlusal therapy, and psychological therapy. However, these current treatments are basically supportive in nature.

Laser phototherapy (LPT) has been widely employed in the health field because it modulates the inflammatory process, with a consequent reduction in pain and swelling and the enhancement of the healing process [16, 17]. LPT has also been employed for the treatment of TMD. However, conflicting results are reported, likely due to differences in laser irradiation parameters [18–33] or the criteria used for the classification and evaluation of TMD. Clinical studies have demonstrated that LPT can lead to a reduction in muscle and joint pain, [26, 27, 31] a reduction in the number of trigger points, [19, 27, 32, 33], and improvements in jaw movements and chewing function [19, 25, 31, 33].

The evaluation of the effects of LPT for the treatment of TMD requires the analysis of joint pain, mouth opening pattern, and psychosocial factors throughout treatment. Despite the impact TMD can have on elderly individuals and the fact that this population is increasing worldwide, only few studies have been carried out on the treatment of this disorder in this specific population.

The aim of the present study was to investigate the effect of LPT on pain, jaw movements, and psychosocial factors in ten elderly patients with painful TMD.

Materials and methods

Calculation of sample size for laser treatment

Using the variable that will be measured three times at different moments (visual analog scale) and considering time as the block, an analysis of variation scheme for a random block design with at least ten degrees of freedom for the residual was calculated. For a greater degree of freedom, a minimum of 30 observations would be recommended, which, when divided by the moments, resulted in a minimum of ten patients to be followed up throughout treatment.

Using the same scheme for axes I and II of the temporomandibular disorders (RDC/TMD) measured at two different moments (pretreatment and posttreatment), an analysis of variation scheme for a random block design with at least ten degrees of freedom for the residual was calculated and for a greater degree of freedom, a minimum of ten patients were needed.

Patients

Fifty elderly individuals who sought treatment or were in treatment at the dental and physical therapy clinics of a private university in the city of Sao Paulo, Brazil, were enrolled between December 2009 and December 2010. Initially, all the patients were evaluated using axes I and II of the Research Diagnostic Criteria for RDC/TMD. Fifteen individuals exhibited TMD with pain symptoms. However, five of these individuals did not complete all steps of the proposed protocol and were excluded from the assessment. The inclusion criteria were as follows: age 60 years or older, clinical stability, absence of polyarthritis and other rheumatic diseases, agreement to participate by signing a statement of informed consent, and completion of all steps of the data acquisition process. The exclusion criteria were as follows: recent mandibular fracture, current dental or physical therapy treatment that could affect TMD, complete edentulism without use of dentures, neurological impairment, and previous treatment for TMD.

The experimental group was therefore formed by ten elderly patients (nine females and one male), ranging in age from 63 to 82 years (mean±SDM 69±6.59 years). The study received approval from the Universidade Nove de Julho (UNINOVE) Ethics Committee (n. 250122/2009) and was conducted in compliance with Resolution 196/96 of the National Health Council. The study was done during 4 weeks from the diagnosis until the last evaluation time.

Procedures

All ten patients were evaluated with regard to signs and symptoms of TMD and grouped using axes I and II of the RDC/TMD before and after the LPT. The evaluations were done by one researcher previously trained in a specific instructions' course.

Assessment of pain

Pain intensity was evaluated using the visual analogue scale (VAS), consisting of a horizontal line measuring 10 cm (without marks), with "no pain" written at the left extremity, and "unbearable pain" written at the right extremity [34]. The patient was instructed to mark a vertical line on the horizontal line indicating his/her pain intensity. The distance from the 0 point was subsequently measured in millimeters using a digital caliper. The pain was assessed by using the VAS in three time points, as follows: before LPT (baseline), at the end of fourth session, and at the end of eighth session.

RDC axis I: TMD subgroup and assessment of jaw movements

Jaw movements were assessed using axis I of the RDC/TMD, which consisted of the physical evaluation of the patients following the criteria described by Dworkin, LeResche (1992) [3]. Axis I provide information on jaw movements, pain, muscle palpation, and joints noises. In the present study, the decision was made to assess maximum mouth opening without assistance and without pain, maximum mouth opening with pain, maximum mouth opening with assistance and with pain, and lateral excursion and protrusion. Axis I divided TMD into three groups as follows: (GI) muscle disorders, including myofascial pain with and without mandible opening limitation; (G II) displacement of the disk with or without a reduction or limitation in mandible opening; (G III) arthralgia, arthritis, and arthrosis.

The patient was positioned at approximately 90° in relation to the examiner. The examiners wore gloves throughout the exam. Patients with removable dentures were examined with the dentures in the oral cavity, except when the assessment of the mucosa and gingival tissue was necessary or when intraoral palpation was performed. Bite plates and other intraoral appliances that did not replace the teeth were removed for the exam. The exams were performed by the researchers without time constraints. All measures were conducted with the mandibular muscles in the passive state unless the exam specified otherwise. The joints and muscles did not receive any additional load or pressure at any time.

RDC axis II: Assessment of psychosocial aspects

Axis II of the RCD/TMD provides information on psychosocial aspects of TMD. This patient history questionnaire is composed of 31 items addressing general health, oral health, facial pain, limited mouth opening, joint noises, harmful oral habits, bite, ringing in the ears, diseases, joint problems, headache, current behavior, and socioeconomic profile. The questionnaire was administered by an examiner who had undergone a training and calibration process. The questionnaire was fully completed without time constraints to avoid hurried responses. All questions were answered unless the patient refused or was unable to cooperate.

The data were organized following the recommendations proposed by Dworkin, LeResche (1992), [3] which groups the patients into the following four domains: intensity of chronic pain and disability (D1). degree of depression (D2), nonspecific physical symptoms scale (D3), and limited mandibular function (D4). The nonspecific physical symptoms scale was subdivided into nonspecific physical symptoms with pain (D3a) and nonspecific physical symptoms without pain (D3b).

Laser phototherapy

The irradiations were with a continuous wave GaAlAs diode laser emitting in the near-infrared region at 780 nm (spot size 0.04 cm^2; Twin Laser, MM Optics, São Carlos, Brazil) in punctual and contact mode. The output power of the equipment was tested using a power meter (Laser Check; MM Optics Ltda, São Paulo, Brazil).

In cases of muscle TMD, the protocol described by Frare, Nicolau (2008) [23] was used, with modifications: output of 10 mW and energy density of 5 J/cm^2 for 20 s, totaling 0.2 J per application point. The laser was applied on the pain site observed during the muscle palpation exam. Two sessions of LPT were carried out over four consecutive weeks, in the total of eight sessions.

In cases of joint TMD, the protocol described by Carrasco et al. [21] was used as follows: output of 70 mW and energy density of 105 J/cm^2 for 60 s, 4.2 J of total energy per application point, totaling 21 J. The laser was applied to five points in the region of the temporomandibular joint: lateral, superior, anterior, posterior, and posteroinferior points of the condyle position. In cases of combined TMD (both subtypes), both protocols were administered. Two sessions of LPT per week were carried out over four consecutive weeks, in the total of eight sessions.

All patients were reevaluated using the VAS and axes I and II of the RDC/TMD in three time points, as follows: before LPT (baseline), at the end of the fourth session, and at the end of the eighth session.

Statistical analysis

Descriptive and percentage analyses were performed of axes I and II of the RCD/TMD. The chi-square test was used for the comparison of categorical data between baseline and the end of the therapeutic protocol. The paired Student's t test was used for the comparison of quantitative data. A repeated-measure model was used for the comparison of VAS scores over time. Tukey's test (adjusted to the design) was used for multiple comparisons. The level of significance was set to 5 % ($p < 0.05$) on all tests. The analyses were performed with the aid of the SAS program for Windows, v.9.2.

Results

Among the ten patients, seven (70 %) had combined TMD and three (30 %) had muscle TMD. Among those with the combined form, four were classified in the muscle and joint subgroup, two were classified in the muscle subgroup associated with disk displacement, and one had muscle and joint TMD with disk displacement.

Table 1 Comparison of VAS mean (mm) between the three moments of assessment or comparison of VAS mean during experimental time (weeks)

	Baseline	4th	8th
EVA (mm)	57.53±19.47^{A}	30.25±11.18^{B}	10.32±12.75^{C}

Different uppercase letters denote significant difference ($p<0.05$) on Tukey test analysis

Assessment of pain

The VAS data obtained in the three periods of evaluation (baseline, fourth and eighth sessions) is demonstrated in Table 1. All ten patients experienced a significant reduction in pain following the eight sessions of LPT (Table 1).

RDC axis I: TMD subgroup and assessment of jaw movements

The classification of TMD based on axis I revealed that three (30 %) patients exhibited TMD subgroup GI that represents a muscle disorders and seven (70 %) patients showed a mixture of GI (muscle disorders), GII (displacement of the disk disorders), and GIII (arthralgia, arthritis, and arthrosis) diagnosis. Association of GI and GII was observed in two patients, GI and GIII in four patients, and GII and GIII in one patient.

Table 2 displays the data on jaw movements before and after LPT. No significant changes were found in the jaw movements assessed, except by the maximum opening without pain (Table 2). There was a significant increase in the maximum opening without pain ($p=0.0102$).

Psychosocial aspects (axis II)

Table 3 displays the data on axis II of the RDC/TMD before and after LPT. The assessment of psychosocial aspects of TMD demonstrated a significant reduction in pain severity following LPT ($p=0.02$), as well as significant improvement in depression levels ($p=0.038$) and nonspecific physical symptoms with pain ($p=0.0167$).

Domain 4 assessed jaw disabilities based on responses to the questionnaire which is illustrated on Table 4. The functions reported as most adversely affected by jaw disability were chewing, eating hard foods, yawning, smiling, and laughing and talking. After the eighth session of LPT, an improvement of jaw disabilities was observed.

Discussion

The major goal of the treatment of TMD is to relieve pain and improve jaw movements [12, 13]. In this way, LPT is indicated for treating TMD due to analgesic and biomodulative properties, as well as for the relief of muscle tension [19–21]. However, the psychosocial aspects of elderly patients with painful TMD in response to LPT have not yet been established. Now, the present study evaluated the pain, jaw movements, and psychosocial factors in ten elderly patients with painful TMD in response to LPT using internationally validated assessment tools.

Although the amount of patients studied in this research is small (ten patients), one has to have in mind that elderly TMD patients with pain symptoms are relatively rare. Prevalence studies have demonstrated a greater frequency of joint TMD among elderly individuals, which is generally asymptomatic, whereas muscle TMD, which is accompanied by pain, is more common among younger individuals [10]. For this reason, it was decided to treat all of them with LPT without a sham group.

The RDC/TMD is considered the most complete assessment tool for TMD. This system has two axes that allow the clinical diagnosis of TMD (axis I) and the determination of jaw alterations as well as the psychological and psychosocial profile of affected individuals (axis II). Although a number of studies have demonstrated its validity and reliability regarding the clinical diagnosis of TMD, few studies report the concomitant use of both axes in the evaluation of patients [35–37] and very few investigations have employed analyses of patient evolution (before and after therapeutic procedures). In the present study, both axes were used, along with a VAS, which is commonly employed to quantify pain in individuals with TMD. [16, 25].

The administration of axis I of the RDC/TMD revealed that combined TMD was the main type found among the participants of the present study. All participants had muscle involvement with or without joint TMD and/or disk

Table 2 RDC axis I: Assessment of jaw movements (mm) before and after laser phototherapy

Variable	Initial	Final	t	*p* value
Maximum opening without pain	41.80±9.82	44.00±9.56	−3.24	0.0102
Maximum opening with pain	47.20±9.26	47.60±9.32	−0.49	0.6370
Maximum opening with assistance and pain	48.90±10.25	48.40±9.83	0.71	0.4951
Right lateral excursion	6.90±1.85	7.80±1.87	−1.20	0.2620
Left lateral excursion	7.50±3.75	7.40±3.24	0.15	0.8853
Protrusion	4.70±2.36	4.50±2.42	0.56	0.5911

t paired Student *t* test; significant level $p<0.05$

Table 3 RDC axis II: Assessment of psychosocial aspects (domains) before and after laser phototherapy

Domains	D1		D2		D3a		D3b	
Patients	Initial	Final	Initial	Final	Initial	Final	Initial	Final
1	GIII	GIII	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
2	GI	GI	Moderate	Normal	Moderate	Normal	Moderate	Moderate
3	GII	GI	Moderate	Moderate	Severe	Severe	Severe	Severe
4	GII	GII	Normal	Normal	Normal	Normal	Normal	Normal
5	GII	GI	Normal	Normal	Normal	Normal	Normal	Normal
6	GI	GI	Moderada	Moderate	Severe	Severe	Severe	Severe
7	GII	GI	Normal	Normal	Normal	Normal	Normal	Normal
8	GI	GI	Normal	Normal	Normal	Normal	Normal	Moderate
9	GIII	GIII	Moderate	Normal	Normal	Normal	Moderate	Normal
10	GI	GI	Normal	Normal	Moderate	Normal	Severe	Normal
p value		0.02		0.038		0.0167		0.2714

Chi-square test for trend, significant level $p < 0.05$

D1 intensity of chronic pain and disability, *D2* degree of depression, *D3a* nonspecific physical symptoms with pain, *D3b* nonspecific physical symptoms without pain

displacement. These findings may be explained by the fact that pain in TMD occurs mainly among those with muscle TMD and is rare in the other subtypes. The present results show that LPT led to a progressive improvement in pain control among elderly individuals with TMD. This LPT effect could be due to the known effect of such therapy demonstrated in other studies, such as release of endogenous opioids, [38, 39] reduction in the production of COX-2 and prostaglandin, [40] lymphocyte metabolism and the secretion of histamine, kinins and cytokines, such as TNF-α, IL-β, IL-6, and TGF-β [40]. LPT can also influence pain by inducing release of endorphins and encephalin, which modulate nociceptors and alter the conduction of nerve impulses [41] and the permeability of the nerve membrane [42]. However, these effects depend on the laser parameters employed (wavelength, output, energy density, duration, and irradiation site). On the other hand, one cannot exclude the participation of also a placebo effect when using LPT. This must be taken into consideration independently of the use of equipment on or off. But based on the positive effects on pain control observed, and knowing that these patients have had no control of the pain before starting the LPT, accredits this therapy for elderly TMD patients.

The assessment of jaw movements is important to the assessment of the effect of therapeutic protocols for TMD. Limited mandibular movement is a protective reflex in the occurrence of pain. The results of the present study demonstrate that LPT led to a significant reduction in muscle pain during right and left lateral excursion, allowing an increase in maximum mouth opening in only eight sessions of LPT in elderly patients. These results are in agreement with findings reported in previous studies [25–28]. Kulekcioglu et al. (2003) [27] found that cases of muscle and joint TMD responded to 15 sessions of LPT, with a significant reduction in pain and improvement in mouth opening and lateral movements as well as reduction of the amount of trigger points.

Based on studies demonstrating the biomodulation of inflammation and analgesic properties of LPT, with reductions of swelling and pain [40, 41], one may infer that the use of this therapy results in relaxation of the musculature, thereby allowing a greater range of motion of the mandible. The results of this study can support this hypothesis, once the maximum mouth opening without pain was significantly improved and this type of movement represents the maximum physiological limit of distension of the muscles of mastication and joint ligaments. On the

Table 4 RDC axis II: Analysis of jaw disability (D4) checklist and frequency (percentage) of disabilities

What activities does your present jaw problem prevent or limit you from doing?	Baseline	Final
Chewing	8 (80 %)	2 (20 %)
Drinking	1 (10 %)	0
Exercising	1 (10 %)	0
Eating hard foods	8 (80 %)	3 (30 %)
Eating soft foods	0	0
Smiling/laughing	4 (40 %)	1 (10 %)
Sexual activity	0	0
Cleaning teeth or face	2 (20 %)	1 (10 %)
Yawning	7 (70 %)	2 (20 %)
Swallowing	2 (20 %)	0
Talking	4 (40 %)	1 (10 %)
Having your usual facial appearance	3 (30 %)	1 (10 %)

other hand, the other jaw movements studied were not affected by LPT and this could be related to laser irradiation parameters or other reason and deserves further investigation.

A number of studies have demonstrated a close relationship between TMD and psychological, psychosocial, and behavioral factors [5–9]. The present study evaluated chronic pain, nonspecific symptoms with pain and without pain using axis II of the RDC/TMD. LPT demonstrated a tendency toward an improvement in the degree of severity of chronic pain, depression, and nonspecific symptoms with pain among elderly individuals with TMD.

Psychological aspects, such as depression, can be considered predisposing, initiating, and perpetuating factors of TMD [5, 9]. Such patients may have a compromised response to treatment, as depression alters the pain perception threshold, affecting the expression of signs and symptoms. [43] Therefore, patients with depression may have greater problems with TMD than those who seek dental services for treatment.

While there is no consensus on the percentage of patients with TMD in which psychological factors play an important role in the determination of the disorder, the present findings indicate that such factors should be taken into consideration together with other indicators evaluated on the physical exam for the correct diagnosis of this disorder and planning of management strategies. The importance of the psychological assessment tool in the diagnostic criteria for the clinical definition of the subtypes of TMD maybe has been overlooked by authors using more simplified criteria. Our results, however, demonstrate the importance of the joint use of both axes of the RDC/TMD.

Randomized placebo-controlled clinical trials with a greater number of patients should be carried out to validate this treatment protocol. Based on the limitations of this study, it is possible to conclude that LPT is able to promote pain relief and improvement of jaw movement in elderly patients with TMD, with a positive effect on psychosocial aspects.

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