Effect of low-level laser therapy on pain levels in patients with temporomandibular disorders: a systematic review

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ABSTRACT

Temporomandibular disorders (TMD) are characterized by the presence of temporomandibular joint (TMJ) and/or masticatory muscle pain and dysfunction. Low-level laser is presented as an adjuvant therapeutic modality for the treatment of TMD, especially when the presence of inflammatory pain is suspected. Objective: To systematically review studies that investigated the effect of low level laser therapy (LLLT) on the pain levels in individuals with TMD. Material and Methods: The databases Scopus, Embase, Ebsco and PubMed were reviewed from January/2003 to October/2010 with the following keywords: laser therapy, low-level laser therapy, temporomandibular joint disorders, temporomandibular joint dysfunction syndrome, temporomandibular joint, temporomandibular, facial pain and arthralgia, with the inclusion criteria for intervention studies in humans. Exclusion criteria adopted were intervention studies in animals, studies that were not written in English, Spanish or Portuguese, theses, monographs, and abstracts presented in scientific events. Results: After a careful review, 14 studies fit the criteria for inclusion, of which, 12 used a placebo group. As for the protocol for laser application, the energy density used ranged from 0.9 to 105 J/cm², while the power density ranged from 9.8 to 500 mW. The number of sessions varied from 1 to 20 and the frequency of applications ranged from daily for 10 days to 1 time *per* week for 4 weeks. A reduction in pain levels was reported in 13 studies, with 9 of these occurring only in the experimental group, and 4 studies reporting pain relief for both the experimental group and for the placebo. Conclusion: Most papers showed that LLLT seemed to be effective in reducing pain from TMD. However, the heterogeneity of the standardization regarding the parameters of laser calls for caution in interpretation of these results. Thus, it is necessary to conduct further research in order to obtain a consensus regarding the best application protocol for pain relief in patients with TMD.

Key words: Laser therapy. Temporomandibular joint disorders. Review.

INTRODUCTION

Temporomandibular disorders (TMD) is considered the most common cause of pain of non-dental origin[25] in the orofacial region and encompasses a heterogeneous group of disorders with common features of psychophysiological orofacial pain, masticatory dysfunction, or both[30].

Signs and symptoms of this dysfunction are present in 86% of the population, most frequently in women in the 30 year-old age group[5]. The prevalence of TMD (or symptoms suggestive of

TMD) varies from 21.5% to 51.8%[4,12,17,34].

Among the several reported signs and symptoms of TMD, pain has, with no doubt, most debilitating and unbearable effect on the patient's life. It has been found that masticatory muscle pain is the chief complaint of patients with TMD, usually associated with tension and fatigue, ranging from mild sensitivity to extreme discomfort, and frequently worsened by function of the muscles involved[12,17].

Contemporary orofacial pain concepts aim to prevent, cure, or alleviate signs and symptoms of pain morbidity, as well as to reduce their impact on the patient´s quality of life. Because of TMD's multifactorial etiology and variety of clinical presentations, the treatment of this disorder is extensive and diverse, involving professionals from different areas and includes several therapies: low level laser therapy[8,19,27], acupuncture[22], transcutaneous electrical nerve stimulation (TENS)[32], ultrasound[15], massage[2], pharmacotherapy[24], use of occlusal splints[28], and psychological treatment, among others.

The use of laser photobiomodulation to reduce TMD pain and promote anti-inflammatory effects has been of great interest in the recent literature. Currently, its classification is based on the interaction of laser with the target tissue in question. The term LLLT is used when working in compliance with the threshold of cell survival[3]. Karu[18] (2001) stated that this is a non-thermal therapy that can promote cell and tissue alterations caused by different types of metabolic activation, such as: increased activity in the mitochondria and Na(+)/K(+) pump, increased vascularization and the formation of fibroblasts, resulting in an increase in the recovery process and/or tissue healing with non-invasive characteristics.

The use of laser has grown in all areas of dentistry especially for conditions such as TMD that involves obtaining analgesia and reducing inflammation. In general, patients are receptive to LLLT which also has a positive psychological effect especially in chronic patients[31]. The therapeutic properties of lasers, such as tissue repair, mediation of inflammatory processes, and analgesia in acute and chronic pain as well as improvement of local microcirculation have been proven by several authors[31].

Based on that, the aim of this study is to perform a systematic review of the effect of LLLT in the control of pain in patients with TMD.

MATERIAL AND METHODS

Search strategy and inclusion criteria

A literature search was performed to identify interventional studies involving the application of LLLT in patients with painful symptoms caused by TMD. The databases Scopus, Embase, Ebsco, and PubMed were revised from January 2003 to October 2010. Results of previous studies on the same subject were already summarized and reported in a previous publication[3].

The keywords laser therapy, low level laser therapy, temporomandibular joint disorders, temporomandibular joint dysfunction syndrome, temporomandibular joint, temporomandibular, facial pain, and arthralgia, were used either as MeSH (Medical Subject Headings is the NLM controlled vocabulary thesaurus used for indexing papers for PubMed) terms or as free-text in different combinations. We resorted to the logical operator "AND" to combine descriptors and terms used to trace publications. In the present study were only considered papers that used theses descriptors.

Two authors independently screened titles and abstracts for potential eligibility and the full texts for the final eligibility. The data were extracted using a standardized data collection form to record study design and methodological features, patient characteristics, interventions, outcomes, and missing outcome data. We chose not to include theses, monographs, and abstracts presented in events because the conducting of such a systematic search of the same is logistically unfeasible. Studies that focused on intervention in animals and those that were not written in English, Portuguese or Spanish were excluded.

The papers that met the inclusion criteria were carefully examined for the extraction of data, such as: study setting, including site and sample, age range, methods of diagnosis of TMD and pain assessment, sites of laser application, laser type, manufacturer, dose, application time, frequency or number of sessions per week, and pain outcomes.

RESULTS

The results are described in the following sequence (Figure 1):

- progressive selection of the studies and the

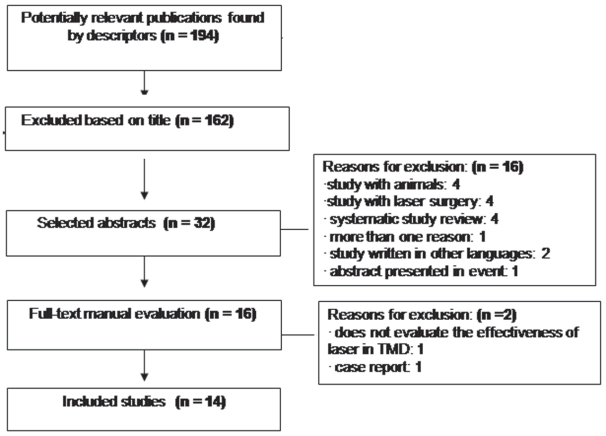

Figure 1- Flowchart of the selection phases of the study

Figure 2- Profile of each study according to journal, research location, age, gender, groups, temporomandibular disorder (TMD) diagnosis

First author and year of publication	Journal	Research location	Age range (years)	n (men x women)	Groups	Evaluation Methods
1. Kulekciouglu, et al.[20] (2003)	Scandinavian Journal of Rheumatology	Bursa/Peru	20-59	35 (7 x 28)	20: laser 15: placebo	Visual Analogue Scale, muscle and joint palpation, auscultation of Temporomandibular Joint (TMJ), mandibular function, and TMJ magnetic resonance imaging
2. Venancio, et al.[37] (2005)	Journal of Oral Rehabilitation	Araraquara-SP/ Brasil	?	30 (5 x 25)	15: laser 15: placebo	Visual Analogue Scale, muscle and joint palpation, electronic pressure algometer, auscultation of Temporomandibular Joint, mandibular function, and panoramic x-ray
3. Çetiner, et al.[9] (2006)	Photomedicine and Laser Surgery	Ankara/Turkey	16-62	39 (4 x 35)	24: laser 15: placebo	Research Diagnostic Criteria for temporomandibular disorders (RDC/TMD)
4. Fikácková, et al.[16] (2007)	Photomedicine and Laser Surgery	Prague/Czech Republic	16-70	80 (9 x 71)	61: laser 19: placebo	Research Diagnostic Criteria for temporomandibular disorders (RDC/TMD)
5. León, et al.[23] (2007)	Revista Cubana de Estomatologia	Havana/Cuba	Above 20	40 (7 x 33)	20: drug 20: laser	Muscle and joint palpation, auscultation of joint clicking, evaluation of mandibular function, report on the pain intensity, Melzack pain scale
6. Mazzetto, et al.[26] (2007)	Cranio	Ribeirão Preto-SP/ Brasil	?	48 (? x ?)	24: laser 24: placebo	Muscle and joint palpation, auscultation of joint clicking, and panoramic x-ray
7. Cunha, et al.[11] (2008)	International Dental Journal	São José dos Campos-SP/ Brasil	20-68	40 (1 x 39)	20: laser 20: placebo	Visual Analogue Scale, muscle and joint palpation, assessment of joint clicking, and craniomandibular index (CMI)
8. Carrasco, et al.[7] (2008)	Cranio	Ribeirão Preto-SP/ Brasil	?	14 (? x ?)	07: laser 07: placebo	Muscle and joint palpation, auscultation of joint clicking, panoramic x-ray, and colorimetric method of chewing the capsule
9. Lassemi, et al.[21] (2008)	Journal of Oral Laser Applications	Tehran/Iran	?	48 (24 x 24)	24: laser 24: placebo	Visual Analogue Scale and assessment of joint clicking
10. Emshoff, et al.[14] (2008)	Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology & Endodontics	Innsbruck/ Austria	18-58	52 (10 x 42)	23: laser 22: placebo	Visual Analogue Scale, Research Diagnostic Criteria for temporomandibular disorders (RDC/TMD)
11. Shirani, et al.[36] (2009)	Lasers in Medical Science	Isfahan/Iran	16-37	16 (4 x 12)	8: laser 8: placebo	Visual Analogue Scale, muscle and joint palpation, auscultation of Temporomandibular Joint, computed tomography (CT), magnetic resonance imaging (MRI), and laboratory test for rheumatoid factor when necessary
12. Carvalho, et al.[8] (2010)	Lasers in Medical Science	Salvador-BA/ Brasil	± 46	74 (15 x 59)	74: laser	Visual Analogue Scale, radiograph
13. Santos, et al.[35] (2010)	Brazilian Journal of Otorhinolaryngology	Aracaju-SE/ Brasil	?	50 (? x ?)	25: laser 25: placebo	Visual Analogue Scale, questionnaire, and physical exam
14. Venezian, et al.[38] (2010)	Journal of Craniomandibular Practice	Ribeirão Preto-SP/Brasil	18-60	48 (5 x 43)	24: laser 24: placebo	Visual Analogue Scale, Research Diagnostic Criteria for temporomandibular disorders (RDC/TMD), and electromyographic analysis

(?)- insufficient information

Figure 3- Profile of each study, as well as data referring to laser application

First author and year of publication	Points of application	Type of laser/ manufacturer/λ	Energy Density (ED)	Power Density (PD)	Application time	Frequency and № of sessions	Assessments – follow up	Results
1. Kulekciouglu, et al.[20] (2003)	Joint and/or muscle	AsGa/Elettronica Pagani/904 nm	3 J/cm²	17 mW		15 sessions	To the end of treatment and after 30 days from the last application	Reduction of pain at end of treatment and for 1 month after end of treatment for both groups.
2. Venancio, et al.[37] (2005)	Joint	AsGaAl/Twin laser/780 nm	6.3 J/cm²	30 mW	10 s	6 sessions: 2x/week for 3 consecutive weeks	At 15, 30, and 60 days after the end of treatment	Reduction of pain in the 2 groups. There was no difference between them and between the periods observed.
3. Çetiner, et al.[9] (2006)	Joint and muscle	AsGaAl/ Medictinedic/830 nm	7 J/cm²	?	162 s	10 sessions: 5x/week for 2 weeks	To the end of treatment and after 30 days from the last application	Reduction of pain in the laser group in relation to the placebo. There was no significant difference between the values obtained after the last session and 1 month after.
4. Fikácková, et al.[16] (2007)	Joint and/or muscle	AsGaAl/BTL Beautyline Technology/830 nm	10 J/cm² and 15 J/ cm²	400 mW	?	10 sessions in 1 month	Only to the end of treatment	Reduction of the pain in the laser group in relation to the placebo with both dosages. There was no signficant difference between the energy densities in the test group.
5. León, et al.[23] (2007)	Acupuncture points: gallbladder and stomach + TMJ	AsGaAl/?/?	0.9 J/cm²	?	300 s	Daily, for 10 days	5th and 10th day of treatment	Laser group had greater remission of symptoms in relation to the drug group. 6 to 10 applications were necessary for pain relief.
6. Mazzetto, et al.[26] (2007)	Joint only/1 point	AsGaAl/Twin laser - MM Optics/780 nm	89.7 J/cm²	70 mW	10 s	8 sessions: 2x/week for 4 weeks	After the 4th application, after the 8th application, and after 30 days from the last application	Reduction of pain in the laser group in relation to the placebo. Less sensitivity to palpation after the 8th application.
7. Cunha, et al.[11] (2008)	Joint and/or muscle	AsGaAl/Biolux laser – Bio Art/830 nm	100 J/cm²	500 mW	20 s	4 sessions: 1x/week for 4 consecutive weeks	Only to the end of treatment	Reduction of pain in the 2 groups. There was no difference between the groups.
8. Carrasco, et al.[7] (2008)	Joint 1 point	AsGaAl/Twin laser - MM Optics/780 nm	105 J/cm²	70 mW	60 s	8 sessions: 2x/week for 4 weeks	After the 8th application and after 30 days from the last application	Reduction of pain in the laser group. Less symptoms and greater mastigatory efficiency after the 8th laser session.
9. Lassemi, et al.[21] (2008)	Joint and/or muscle	AsGa/AZOR-2K/980 nm	2 J: TMJ 1.5 J: musc.	?	60 s	2 sessions in 1 week	After 2 days, after 4 days, at 6 months, and at 12 months	Reduction of pain on the 4th day after the treatment in the laser group. Results (s.s.) for both pain and clicking without recurrence for 2 years.

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Continuation

10. Emshoff, et al.[14] (2008)	Joint	HeNe/Helbo Medizintechnik/ 632.8 nm	1.5 J/cm²	30 mw	120 s	20 sessions: 2 to 3x/week for 8 weeks	In the 2nd, in the 4th, and in the 8th weeks after the first application	In the 8th week both groups presented pain reduction in the TMJ during mandibular function. Differences between the 2 groups were not very evident.
11. Shirani, et al.[36] (2009)	Muscle	InGaAlP/AZOR-2K/660 nm AsGa/AZOR-2K/890 nm	6.2 J/cm² 1 J/cm²	17.3 mW 9.8 mW	360 s 600 s	6 sessions: 2x/week for 3 weeks	To the end of treatment, 1 week after, and on the day of complete relief from pain during the 3 weeks of treatment	Reduction of pain in both groups. The laser group was more effective. One month after end of treatment, 1 patient had recurrence of pain.
12. Carvalho, et al.[8] (2010)	Joint and/or muscle	? /Biowave, Kondortech/660 nm + ? /Twin Flex, MM Optics/780 nm, 790 nm, or 830 nm	1 to 2 J/cm² 14.2±6.8 J/ cm²	30 to 40 mW 40 to 50 mw	Indicated by the equip. according to ED and PD	12 sessions: 2x/week for 6 weeks	Only to the end of treatment	After the treatment, 64% of the patients were asymptomatic or improved. In the asymptomatic patients, it was observed that the association of λ was statistically significant.
13. Santos, et al.[35] (2010)	Joint and/or muscle	AsGaAl/DMC/830 nm	80 J/cm²	40 mW	16 s	1 session only	1 week after the application	There was significant reduction of pain intensity in the patients of the laser group, and in the placebo there was no reduction.
14. Venezian, et al.[38] (2010)	Muscle	AsGaAl/Twin laser - MM Optics/780 nm	25 J/cm² 60 J/cm²	50 mW 60 mW	20 s 40 s	8 sessions: 2x/week for 4 weeks	To the end of treatment and after 30 days from the last application	There was no difference in the electromyography between the groups before and after laser. Only the laser group showed reduction of pain for all muscle palpations. There was no difference between the laser and placebo groups. In the laser group 25 J/cm², the reduction of pain lasted for 30 days after the end of treatment. In the group 60 J/cm², the pain returned after 30 days.

(s.s.) - statistically significant
? – insufficient information

number of items in each stage,

- characteristics of the sample from each study,
- parameters used for the LLLT in each study.

At the end of paper selection process, only 14 met the specific inclusion criteria, being seven from Brazil (studies 2, 6, 7, 8, 12, 13, 14), one from Peru (study 1), one from Turkey (study 3), one from the Czech Republic (study 4), one from Cuba (study 5), two from Iran (studies 9, 11), and one from Austria (study 10) (Figure 2). The number of patients involved in the intervention process ranged from fourteen [8] to eighty [4] *per* group (Figure 2). In all the studies in this systematic review, there was a higher prevalence of women compared to men.

The results showed that, from the 14 selected studies, 12 (1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 13, 14) included a placebo control group, while one (5) compared the intervention with laser to that with pharmacology and did not include a placebo group, and one study (12) evaluated only the experimental group (Figure 2).

Regarding the methods used for the diagnosis of TMD, 4 studies (3, 4, 10, 14) used the diagnostic criteria for TMD proposed by the "Research Diagnostic Criteria" (RDC/TMD). Most studies (1, 2, 7, 9, 10, 11, 12, 13, 14) only evaluated the signs and symptoms of TMD, quantifying pain by the Visual Analogue Scale (VAS) (Figure 2).

Some studies, in addition to performing the TMD diagnosis and assessment of pain intensity, made use of additional tests of the masticatory function, such as electromyographic evaluation (14), pressure pain threshold determination (2), and chewing efficiency (8) (Figure 2).

In terms of sites of laser application, seven studies (1, 3, 4, 7, 9, 12, 13) beamed the laser into the joint and/or the affected muscles. Three others (6, 8, 10) applied the laser only at the TMJ. Laser irradiation only in the affected muscles was performed in two studies (11,14), while one study performed applications at acupuncture points as well as the TMJ (5) (Figure 3). Moreover, it is noteworthy that seven studies (1, 3, 7, 11, 12, 13, 14) made application of laser light at the points of greatest pain of the patient, and the rest of the works irradiated pre-established points, whether or not they were points of greatest pain.

In relation to the wavelengths used in the studies, it was found that six (1, 3, 4, 7, 9, 13) conducted applications in the infrared range, 5 (2, 6, 8, 10, 14) used the red wavelength, 2 studies (11, 12) did a combination of red and infrared, and one study (5) did not specify the wavelength used (Figure 3).

The energy and power density settings, time of laser application, frequency and number of sessions, and periods of re-evaluation/follow-up are shown in Figure 3. A great variability in the parameters utilized can be seen. The energy density used in the studies ranged from 0.9 J/cm² to 105 J/cm², and the power density ranged from 9.8 mW to 500 mW. In relation to application time, some studies suggest the amount of total elapsed time applied to all points in a session, while others seem to inform the time applied to each point; however, this information was not clear in the papers. It is noteworthy that there was insufficient information for the items covered in this paragraph in some studies, as seen in Figure 3.

The number of sessions of laser applications varied from one session (13) to twenty (10), as well as the frequency of applications ranging from daily for 10 consecutive days (5) to 1 time *per* week for 4 consecutive weeks (7). The re-evaluation periods ranged from 1 week (11, 13) to 12 months after the last application (9) (Figure 3).

The effectiveness of laser photobiomodulation is shown in Figure 3. It can be noted that only one study (10) observed that, at the end, both placebo and treatment groups that received laser intervention had shown pain in the TMJ during mandibular function. The other studies showed a reduction of pain after the end of the laser photobiomodulation sessions, of which in 9 (3, 4, 5, 6, 8, 9, 12, 13, 14) pain was significantly reduced only in the group receiving laser intervention, and in 4 (1, 2, 7, 11) relief of painful symptoms occurred in both the laser and placebo groups.

DISCUSSION

Musculoskeletal condition, like TMD are the major cause of non-dental pain in the orofacial region[24]. Epidemiological studies estimate that 40% to 75% of the population, have at least one sign of TMD, while 33% have at least one symptom such as facial or TMJ pain[13]. Currently, it is disturbing to see the number of patients with TMD treated with non-evidence-based therapies[6], often without competent professional assistance[37]. As an alternative therapy, LLLT with its analgesic, anti-inflammatory, anti-edematous, and biostimulatory effects has proven to be effective in reducing pain and muscle tension in patients with TMD[7,9,16,21,23,26,35,38].

LLLT is considered a safe therapeutic procedure, with well-established indications and contraindications well established through positive clinical trials, scientific investigations of the tissue changes that it promotes, and above all a better understanding of its mechanism of action[29].

In 2004, the World Association of Laser Therapy approved an agreement on the format of clinical studies with LLLT for muscle and joint pain. This document established the mandatory presence of a placebo group as part of the study design. Corroborating these guidelines, this review found

that the majority of studies used a placebo group, except for the work done by Carvalho, et al.[8] (2010), who only used the experimental group that received the LLLT, and León, Almagro and García[23] (2007), who compared the group that received laser intervention with another that received pharmacological treatment.

There still no consensus on the way TMD diagnosis and measurement of the presence and severity of pain is used by researchers and clinicians. For diagnosis of individual cases, a detailed history is still the most important procedure in formulating the initial diagnostic impression. Physical examination, consisting of muscle and TMD palpation, measurement of mandibular active range of motion, and joint noise analysis, when performed by trained professionals, are important steps in the diagnosis and formulation of management strategies, as well as in monitoring the effectiveness of proposed treatments[13]. Accordingly, in this review it was found that only four studies[9,14,16,38] diagnosed TMD according to the criteria proposed by the Research Diagnostic Criteria for Temporomandibular Disorders, with are widely used for diagnosis of TMD. However, none of these identified the severity of TMD in their patients which is of paramount importance since TMD may also be present in a sub-clinical form. As can be observed in the papers included in the present review, there are no standardization of the diagnostic criteria, which is a limitation of most of systematic reviews involving musculoskeletal conditions as TMD.

Studies using auxiliary methods of diagnosis, as Shirani, et al.[36] (2009), who made use of computerized tomography and magnetic resonance imaging of the TMJ, and Venancio, Camparis and Lizarelli[37] (2005); Mazzetto, et al.[26] (2007); and Carrasco, et al.[7] (2008), who used panoramic radiography, should be analyzed with caution because there is not always a direct association between the findings of such examinations and the presence of signs and symptoms of TMD[1,33].

The use of LLLT for musculoskeletal disorders is based on the irradiation of some specific and interrelated areas: the painful area, trigger-points and the area of referred pain as well as in acupuncture points. With this in mind, the studies of Kulekcioglu, et al.[20] (2003); Çetiner, Kahraman and Yücetaş[9] (2006); Fikácková, et al.[16] (2007); Cunha, et al.[11] (2008); Santos, et al.[35] (2010); and Carvalho, et al.[8] (2010) did irradiation on the affected area and on areas of referred pain, according to patient symptoms. In contrast, Mazzetto, et al.[26] (2007), Carrasco, et al.[7] (2008), and Emshoff, et al.14 (2008) only performed the application at the TMJ. Shirani, et al.[39] (2009) and Venezian, et al.[38] (2010) made the application only in the muscle region; and León, Almagro and García[23] (2007) made the application on acupuncture points: gallbladder, stomach, and TMJ. Furthermore, it is useful to remind that the antiinflammatory and analgesic effects of laser light occur only in the affected tissue, which explains the importance of muscle and joint palpation for the identification of points causing the patient's pain. Based on this context, only seven studies[9,11,13,19,24,38,42] established laser application at the point of greatest pain, while the rest made the application on pre-established points.

Lasers with an infrared wavelength are the most suitable due to their greater penetration. The most commonly used are located in the electromagnetic spectrum from 780 to 904 nm[37]. The findings of Kulekcioglu, et al.[20] (2003); Venancio, Camparis and Lizarelli[37] (2005); Çetiner, Kahraman and Yücetaş[9] (2006); Fikácková, et al.[16] (2007); Mazzetto, et al.26 (2007); Carrasco, et al.[7] (2008); Cunha, et al.[11] (2008); Lassemi, et al.[21] (2008); Santos, et al.[35] (2010); and Venezian, et al.[38] (2010) corroborate the above data using wavelengths in the infrared range, whose electromagnetic spectra varied from 780 nm to 980 nm. In contrast, Emshoff, et al.[14] (2008) did not corroborate with the above authors and used a wavelength in the red range. However, Carvalho, et al.[8] (2010) performed a combination of the two wavelengths, red and infrared.

The efficacy of adjuvant therapy has been proven by several studies as cited above. However, the interaction of laser light with tissue can lead to different results. These results depend on several factors such as the wavelength, energy density, and power density, as well as the optical properties of tissue[39]. Therefore, many studies have been conducted in order to reach a consensus on the intensity, exposure time, and site of laser application[10].

In terms of frequency and number of laser sessions applied, Mazzetto, et al.[26] (2007), Carrasco, et al.[7] (2008), and Venezian, et al.[38] (2010) argued for eight sessions with applications twice per week. Venancio, Camparis and Lizarelli[37] (2005) and Shirani, et al.[36] (2009) established the use of six sessions with a frequency of twice *per* week. Çetiner, Kahraman and Yücetaş[9] (2006); Fikácková, et al.[16] (2007); and León, Almagro and García[23] (2007) argued for 10 sessions; however, each one established different application frequencies.

Studies that have shown the greatest laser photobiomodulation effectiveness appear to be linked to higher irradiation protocols (energy density and/or power density) as well as to a greater number of sessions and frequency of application. It was also noted that, of the eight studies that showed the best results, four applied laser to the points of greatest pain, whether joint or muscle, while the other four applied laser to pre-established points.

The studies of Çetiner, Kahraman and Yücetaş[9] (2006); Mazzetto, et al.[26] (2007); and Venezian, et al.[38] (2010) did a follow-up of patients 30 days after the last irradiation. Çetiner, Kahraman and Yücetaş[9] (2006) and Venezian, et al.[38] (2010) found that pain reduction remained statistically significant during this period, while Mazzetto, et al.[26] (2007) found that the least tenderness to palpation was seen at the last session of laser application. Lassemi, et al.[21] (2008) followed patients for 2 years and observed significant results for both pain reduction and for clicking. Although most studies of this review did not make use of a patient follow-up period, it may be suggested that for those who carried out the follow-up, the laser applications promoted a relief of painful symptomatology for at least 30 days after the last irradiation.

As can be seen here, there is still no consensus on the best parameters and standards of laser photobiomodulation and, therefore, the definition of the best treatment protocol and clinical recommendation to be used in cases of TMD pain is not possible at the present time.

However, it seems clear that the use of laser brings benefits when properly applied and administered, although the exact mechanism of action is still to be defined. In some studies, it was noted that the results of LLLT were minimum possibly due to the absence of a specific protocol. This difficulty in the establishment of specific irradiation parameters for a particular area is also observed in other fields such as physical therapy and medicine, for example. Recently, for the area of physical therapy, specific guidelines have been published and studies are being performed to test the efficacy of LLLT. Therefore, it is imperative to also draw up specific guidelines for dentistry, as its applicability in this area is extensive, widespread, and extremely important for the control of pain and/or inflammation of the masticatory muscles and temporomandibular joint.

In short, the results allow us to suggest that the effectiveness of LLLT is more accentuated when using the laser in wavelengths in the infrared region of light spectrum, as well as with higher irradiation protocols (energy density and/or power density) and a larger number of sessions and frequency of application.

CONCLUSION

Most papers, including those using a double-blind and placebo-controlled trial, showed that LLLT seemed to be effective in reducing pain from TMD. However, the heterogeneity of the standardization regarding the parameters of laser calls for caution in interpretation of these results. A potential explanation for the LLLT positive results in reducing pain levels could be a dose-specific anti-inflammatory, healing and analgesic effect in TMJ as well as in the masticatory muscle painful area. However, more studies are needed to precisely determine optimal treatment procedures and parameters for LLLT in TMD.

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