LOW-LEVEL LASER THERAPY FOR TEMPOROMANDIBULAR DISORDERS (TMD) TREATMENT: A SYSTEMATIC REVIEW OF RANDOMIZED TRIALS

ABSTRACT

AIM: Conducting a systematic review of randomized clinical trials focusing on the efficacy of LLLT on pain control in patients with TMD, diagnosed by the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD). MATERIAL AND METHODS: Search was performed at PubMed/MEDLINE database with the terms: (1) "Laser AND temporomandibular disorders"; (2) "Laser AND temporomandibular disorders AND RDC/TMD"; (3) "Low-level laser therapy AND temporomandibular disorders"; (4) "Low-level laser therapy AND temporomandibular disorders AND RDC/TMD"; (5) "Low-level laser therapy AND temporomandibular joint dysfunction syndrome"; (6) "Low-level laser therapy AND temporomandibular joint dysfunction syndrome AND RDC/TMD"; (7) "Laser AND temporomandibular joint dysfunction syndrome"; (8) "Laser AND RDC/TMD"; (9) "Low-level laser therapy AND RDC/TMD". Inclusion criteria: articles need to be randomized clinical trial performed in humans; evaluate the effect of LLLT in the treatment of TMD diagnosed by the use of RDC/TMD; published in English or Portuguese in the last 10 years. Protocol studies and pilot studies were excluded. RESULTS: Ten studies were included. The type of laser used was Gallium Aluminum Arsenide (GaAlAs) diode, with exception of 1 paper, which used super pulsed Gallium Arsenide laser. Eight studies reported decreased in pain levels, in two articles there was no statistically significant difference between test and placebo groups. CONCLUSION: In most studies, LLLT was effective in pain remission, but there is no standardization in parameters like wavelength, output power and frequency. Studies with more complex experimental designs, standardized diagnostic criteria for TMD and defined protocols for the use of LLLT are needed to determine its efficacy in the treatment of TMD.

KEYWORDS

INTRODUCTION

Temporomandibular disorder (TMD) is a term that includes several disorders involving masticatory muscles, temporomandibular joint (TMJ) and orofacial structures. Besides, TMD is considered as a musculoskeletal disorders subclass. It possesses multifactorial etiology and a multidisciplinary approach is necessary in its therapy.

Nowadays there are two main systems for classification and diagnosis of TMD which are accepted worldwide, the American Academy of Orofacial Pain (AAOP) and the Diagnostic Criteria for Temporomandibular Disorders Research (RDC/TMD). According to the AAOP, TMD is divided into two large groups of disorders: muscle TMD and articular TMD.

Dworkin and LeResche (1992), when published the Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD), suggested defined and validated criteria to classify TMD patients in three diagnostic groups: Group I – Muscle disorders, Group II – Disc displacements and Group III - Arthralgia, osteoarthritis and osteoarthrosis, and this classification is considered the Golden standard in TMD diagnosis research. The diagnosis is given through two axis bringing information on clinical evaluation and TMD classification (Axis I) and psychosocial evaluation (Axis II) of TMD. Hence, the criteria established by RDC/TMD bring a standardization for diagnosis on TMD and it is an effective tool for controlled clinical studies.

For pain treatment of TMD patients, several techniques has been suggested, prioritizing the use of conservative therapies such as physical therapy, acupuncture, occlusal splints, behavioral cognitive interventions, drug therapy and low-level laser therapy. Given that, invasive or irreversible treatments, like complex occlusal therapies, occlusal adjustment and surgeries should be avoided as the first choice in therapy.

Several types of phototherapy devices with different characteristics are available including those which use laser light. Helium-neon laser (HeNe) and Gallium Arsenide and Aluminum laser (GaAlAs) are highlighted. The laser often applied in Dentistry to treat TMD is the GaAlAs laser due to its analgesic and anti-inflammatory effects. Wavelength of choice is infrared, ranging from 780-904 nm, due to its higher penetration power.

The use of Low-level laser therapy (LLLT) presents bio stimulant, regenerative, analgesic and anti-inflammatory efficacy, also providing the possibility to act on the immune system. Due to its alleged analgesic effect, LLLT has been suggested for TMD clinical treatment.

The low power pulse of GaAlAs laser showed significant stimulating effects on the fibroblasts activity, increasing the connective tissue repair. The analgesia was explained...
suggesting there is an effect on the stimulation of peripheral nerves and of micro circulation regulation, interrupting the vicious circle in the pain origin and development⁹.

Regarding to the laser use on TMD treatment, the evidences are relatively recent. There are several differences on regarding research protocols, studied population, diagnostic criteria used, laser type tested, intensity of energy, number and places of applications and use or not of placebo. Many times it generates controversial results and questioning about the real efficacy on the LLLT treatment for pain control in TMD patients. In many studies, the protocols used do not follow scientific rules accepted for clinical investigation and they have little credibility due to the lack of detailing about methodology⁸.

Thus, the purpose of this study was to assess, through a systematic literature review of randomized clinical trials, the effectiveness of LLLT in the treatment of TMD pain, diagnosed by RDC / TMD criteria, verifying the LLLT efficacy on RDC/TMD subgroups, the laser type, number of irradiated points, study duration, interval between applications, applied energy, power and application time with better results. Also, it will try to determine if there is a well defined LLLT protocol for TMD treatment in the current literature.

MATERIAL AND METHODS


Nine searches were performed. On the first, fifth and seventh ones, the filters from the website Pubmed were included to refine the research, such as: clinical trial, randomized clinical trial e 10 years. On the third search, the filters clinical trial and 10 years were used. On the others (two, four, six, eight and nine), the
filters were not used, since only few matches were found. Each article was revised and singly selected by an examiner, based on the inclusion criteria described: (A) randomized clinical trial; (B) research in humans; (C) use of LLLT for TMD treatment; (D) TMD diagnosed by RDC/TMD (Research Diagnostic Criteria for Temporomandibular Disorders) Axis I; (E) published in English or Portuguese; (F) published in the last 10 years. Non-concluded randomized clinical trials were not included.

RESULTS

The final electronic search resulted in 66 matches, as listed on the Table 1. After the revision of all the articles found, the duplicates were removed and the exclusion based on the title and abstract was performed, and 11 studies were selected. Next, they were suited to the inclusion criteria proposed on the methods, and 10 articles were selected, and one study was excluded because it was in the conclusion stage yet (Table 2). The Figure 1 demonstrates how the selection of articles was carried out in this study.

Table 3 presents data extracted from the selected papers: author, year and country where the study was performed, as well as the TMD classification (according to RDC/TMD), study type, number of subjects evaluated, age, presence or absence of control, evaluation period, laser type, laser energy and dose as well as the most significant results.

The TMD classification by RDC/TMD occurred as follows: group I – myofascial pain\(^7,10-15\); group II – disc displacement\(^14,15,17\); group III – arthralgia\(^1,14\). The study by Rodrigues et al.\(^14\) (2013) was the only one which allowed patients with any RDC/TMD classification, in the Group I, II or III.

The number of patients in the researches varied from 10 (Rodrigues et al., 2010) to 99 (Marini, Gatto e Bonetti; 2010), and the female gender were prevalent, what corroborates with several studies that show the high prevalence of TMD in female gender. All the studies presented control group, except for Melchior et al. (2013) and Rodrigues et al. (2013). The period of study and the quantity of sessions applied on the patients varied significantly among the studies, as can be observed on the Table 3.

The standard laser type used was Gallium Arsenide and Aluminum laser (GaAlAs) diode in all the studies, except for Marini, Gatto e Bonetti\(^16\)(2010), who used the super pulsed Gallium Arsenide laser with wave length\(\gamma = 910\) nm. The wave length in the other studies varied from 780 to 830 nm.
Table 1. Number of articles found for each term researched.

<table>
<thead>
<tr>
<th>Term used for search</th>
<th>Number of results</th>
</tr>
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<tbody>
<tr>
<td>laser AND temporomandibular disorders</td>
<td>24</td>
</tr>
<tr>
<td>laser AND temporomandibular disorders AND RDC/TMD</td>
<td>02</td>
</tr>
<tr>
<td>low laser therapy AND temporomandibular disorders</td>
<td>19</td>
</tr>
<tr>
<td>low laser therapy AND temporomandibular disorders AND RDC/TMD</td>
<td>01</td>
</tr>
<tr>
<td>low laser therapy AND temporomandibular joint dysfunction syndrome AND RDC/TMD</td>
<td>06</td>
</tr>
<tr>
<td>low laser therapy AND temporomandibular joint dysfunction syndrome</td>
<td>01</td>
</tr>
<tr>
<td>laser AND temporomandibular joint dysfunction syndrome</td>
<td>08</td>
</tr>
<tr>
<td>Laser AND RDC/TMD</td>
<td>03</td>
</tr>
<tr>
<td>Low laser therapy AND RDC/TMD</td>
<td>02</td>
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</tbody>
</table>

Table 2. Article excluded after complete evaluation.

<table>
<thead>
<tr>
<th>Author and year</th>
<th>Exclusion criteria</th>
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</thead>
<tbody>
<tr>
<td>Godoy et al (2013)</td>
<td>Study in recruiting stage</td>
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</table>

Figure 1. Experimental draw for this study.

About energy (J/cm²) and power (mW), a great variety of parameters used can be seen. The energy used varied from 3 J/cm² to 105 J/cm², and the power from 10 mW to 400 mW.
Table 3. Description of selected articles according to the evaluation criteria proposed.

<table>
<thead>
<tr>
<th>Author</th>
<th>TMD classif</th>
<th>Type of study</th>
<th>Sample</th>
<th>Control group</th>
<th>Quant of sessions/period of study</th>
<th>Laser type</th>
<th>Energy, power and application time</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Çetiner, Kahraman, Yucetas, (2006)¹</td>
<td>Muscle TMD Group I: myofascial pain</td>
<td>Randomized controlled Clinical trial</td>
<td>39 (4 men and 35 women) Test group: 24 patients Control group: 15 (laser turned off) 16 to 62 years old</td>
<td>Yes (15) – placebo laser (turned off) 10 sessions divided into 2 weeks, except weekends</td>
<td>GaAlAs (830 nm – infrared)</td>
<td>7 J/cm²</td>
<td>No information by 162s</td>
<td>Improvement on maximum mouth opening, pain and masticatory difficult reduction were statistically significant in the test group when compared to the control one. Conclusion - LLLT was effective.</td>
</tr>
<tr>
<td>2. De Carli et al., (2013)¹</td>
<td>Muscle and or joint TMD Patients could have other TMD subtypes, inasmuch as diagnosed with changes of Group IIIa - Arthralgia</td>
<td>Randomized double-blind controlled Clinical trial</td>
<td>32 (29 women and 3 men) GI laser+20 mg de piroxicam (11) G2: laser+placebo de piroxicam (10) G3: placebo de laser + piroxicam (11)</td>
<td>Yes (placebo laser and placebo piroxicam) Twice a week during 10 days (4 sessions)</td>
<td>GaAlAs – (808 nm)</td>
<td>100 J/cm² 100 mW by 28s, 10 points each side face total energy 56 J</td>
<td>All the groups had significant improvement on the VAS scores (P&lt;0.05) and there was no group with significant difference. Conclusion – The combination of therapies was no further effective than isolated.</td>
<td></td>
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<tr>
<td>3. Fikácková et al., (2007)¹</td>
<td>Myofascial pain with or without joint TMD Group I: myofascial pain and/or Group IIIa: Arthralgia</td>
<td>Randomized controlled Clinical trial</td>
<td>80 (9 men and 71 women) Group A: 10 J/cm² (33) Group B: 15 J/cm² (28) Group C: 0,1 J/cm² (19) 16 to 70 years old</td>
<td>Yes (19) – Low-laser intensity 0,1 J/cm² 30 days, total 10 sessions twice a week</td>
<td>GaAlAs (830 nm – infrared)</td>
<td>10 J/cm² ou 15 J/cm² 400 mW</td>
<td>Groups A and B: pain reduction (77%), pain increase (3%), without improvement (20%). Group C: pain reduction (n=7), without improvement (n=12). There was no significant difference between TMD types. Conclusion – on the doses studied the laser was effective.</td>
<td></td>
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</tr>
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<tbody>
<tr>
<td>4. Gökçen-Rohlig et al., (2012)</td>
<td>Muscle TMD Group I: myofascial pain</td>
<td>Randomized controlled Clinical trial</td>
<td>40 (28 women and 12 men) Group test: laser (20) Group control: healthy individuals Average 33 years old</td>
<td>Yes (20) Group control: healthy individuals</td>
<td>3 times a week – 10 sessions</td>
<td>GaAlAs (820 nm – infra red)</td>
<td>3 J/cm² 300 mW by 10s No information on the number of application points</td>
<td>There was pain decrease on the group irradiated, but no changes on the bite force. Conclusion - LLLT was effective on pain relief, but it does not provide improvement on the bite force.</td>
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<td>5. Marini, Gatto, Bonetti, (2010)</td>
<td>Joint TMD Changes of Group II – disc displacement without reduction and Group III – osteoarthritis</td>
<td>Randomized double-blind controlled Clinical trial</td>
<td>99 (74 women and 25 men) GL: laser (39) GD: Ibuprofen 800 mg (30) GC: placebo laser (30) 15 to 50 years old</td>
<td>Yes (G3:30) placebo laser</td>
<td>10 sessions along 2 weeks</td>
<td>SLLLT – Arsenide diode gallium, super pulsed laser – 910 nm</td>
<td>No information 400 mW Application of 20kHz por 10 min, 18 kHz by 5 min and 16kHz by 5 min</td>
<td>The pain decreased more with SLLLT than on the medicine groups and control from 5th day until the end of the period. On the mouth opening and side movements, the superiority of SLLLT was evident one month after the treatment. Conclusion - the laser was effective on the pain treatment.</td>
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<tr>
<td>6. Melchior et al., (2013)</td>
<td>Myofascial pain with or without joint TMD Group I – myofascial pain can present other changes of groups II and III</td>
<td>Randomized controlled Clinical trial</td>
<td>12 (all women) All of the group test – laser 18 to 60 years old</td>
<td>No</td>
<td>2 sessions a week during 4 weeks (8 sessions)</td>
<td>GaAlAs (780 nm – infra red)</td>
<td>60 J/cm² 60 mW by 40 s in each point (total 4 points)</td>
<td>There was significant decrease on the values of pain subjective to palpation (p &lt; 0.05). Initial pain (A1) was significant different of A2 (30 days after treatment), but it was no significantly different of A3 (30 days after treatment). Pain improvement did not change the orofacial function of patients.</td>
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<td>7. Öz et al., (2010)</td>
<td>Muscle TMD Group I – myofascial pain</td>
<td>Randomized controlled Clinical trial</td>
<td>40 (34 women and 6 men)</td>
<td>Yes (Control with occlusal splint used 24h hours a day during 3 months)</td>
<td>Twice a week - 10 sessions</td>
<td>GaAlAs diode laser, 820 nm</td>
<td>3 J/cm²</td>
<td>Both of the groups presented decreased sensitivity to palpation of muscles significantly. Conclusion - LLLT is as effective as the occlusal splint on the pain decrease and mandibular movement improvement.</td>
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<tr>
<td>8. Rodrigues et al., (2013)</td>
<td>Muscle TMD and/or joint Allowed patients with any classification of RDC: Group I: myofascial pain, Group II: disc displacement or Group III: Arthralgia, arthritis e arthrithsis</td>
<td>Randomized controlled Clinical trial</td>
<td>10 (9 women and 1 man) all elderly 63 to 82 years old</td>
<td>No</td>
<td>2 sessions a week during 4 weeks (8 sessions)</td>
<td>GaAlAs diode laser, 780 nm</td>
<td>5 J/cm²</td>
<td>The results showed significant pain reduction in all the patients. Conclusion - LLLT was effective on the pain reduction and in the movement in TMD elderly patients.</td>
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<td>9. Silva et al., (2012)</td>
<td>Muscle TMD and/or joint Reports that all the patients should have intra joint TMD. Results are not detailed by RDC diagnosis</td>
<td>Randomized double-blind controlled Clinical trial</td>
<td>45 (30 women and 15 men)</td>
<td>Yes (G3: placebo laser)</td>
<td>2 sessions a week during 5 weeks (10 sessions)</td>
<td>GaAlAs (780 nm – infra-red)</td>
<td>G1: 52.5 J/cm² (30s) G2: 105 J/cm² (60s) G3: 0 J/cm² (30s) 70 mW</td>
<td>The results showed significant statistically difference among the groups. The patients of G2 had faster response. Conclusion - LLLT was effective on the mandibular movement improvement and pain reduction.</td>
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<tr>
<td>10. Venezian et al., (2010)</td>
<td>Muscle TMD Group I – myofascial pain (Ia e Ib)</td>
<td>Randomized controlled Clinical trial</td>
<td>48 (43 women and 5 men)</td>
<td>Yes (G2 and G4 were placebo)</td>
<td>Twice a week during 4 weeks (8 sessions)</td>
<td>GaAlAs diode laser 780 nm</td>
<td>G1:25 J/cm² (50mW by 20s) G2:Placebo 25 J/cm² (20s no laser) G3:60 J/cm² (60mW by 40s) G4:Placebo 60 J/cm² (40s no laser) 50mW and 60mW</td>
<td>The treatment on the doses studied did not provide changes on the electromyography. Muscle pain was reduced on the test and placebo groups, with no statistically difference among them; however, it remained decreased for more time on the test group.</td>
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</table>
The study by Marini, Gatto e Bonetti\textsuperscript{16} (2010) did not inform the energy used and Çetiner, Kahraman e Yucetas\textsuperscript{7} (2006) did not specified the power of application. The time in which the laser is applied is not informed in all the articles. Most articles demonstrated favorable results for LLLT as a treatment protocol for TMD pain. According to Table 3, it was possible to observe that eight studies reported decrease of pain, even though low pain levels were not maintained after LLLT was discontinued\textsuperscript{7,10-14,16,17}. Carli et al\textsuperscript{12} (2013) and Venezian et al\textsuperscript{15} (2010) reported there was no statistically significant difference among the test groups and the placebo.

**DISCUSSION**

It is increasingly frequent find in scientific studies high epidemiological data for TMD. 75% of population presents some TMD signal and 33% presents at least one symptom\textsuperscript{15}. It is suggested that near from 20 to 70% of population present any TMD signal or symptom\textsuperscript{18}. Part of professional attribution about patient treatment is the prudence in the signals and symptoms identification, detailing their causes to perform an adequate plan of treatment\textsuperscript{19}.

Specifically on TMD treatment, LLLT shows, most of studies, as efficient on muscle pain and tension reduction, further to be a safe and non-invasive technique.

To establish the clinical efficacy of LLLT, study protocol should be well delineated. TMD classification should be adequate, studies should be randomized and controlled, and parameters like number of sessions, study period, as well as the type of laser and its parameters (wavelength, energy density, power and exposure time) should be well established.

Regarding to TMD, the most prevalent was the Group I RDC/TMD –myofascial pain (seven studies), two studies classified patients in the Group II – Disc displacements and for only one study the classification in the Group III – Arthalgia was necessary. Group I prevalence corroborates the study by Manfredini et al\textsuperscript{20} (2011) that presents muscle disturbances as most frequent among patients population.

There was female gender prevalence, which agrees with the current literature. Donnarumma et al\textsuperscript{21} (2010) found, the prevalence of female gender in their study was 85,6% of sample. TMD patients populations composed majority by women was also find by Manfredini et al\textsuperscript{20} (2011).

Regarding to the age, there was a variation from 16 to 82 years, comprehending adolescent and elderly with most prevalence from 30 to 40 years old. These data corroborates with studies reviewed by Manfredini et al. (2011)\textsuperscript{20}, where the average found was from 20.2 to 39.4 anos. Carrara,
Conti and Barbosa\textsuperscript{3} (2010) found a prevalence of need of TMD treatment in 15.6\% adult, observing that estimates for young population, from 19 to 45 years, was higher than oldest adults (up to 46 years old).

World Association for Laser Therapy presented a consensus about the format of clinical trials performed on LLLT for joint and muscle pain, establishing a placebo group as part of the trial to be carried out\textsuperscript{7}. Therefore, an experimental group and a control group are of fundamental importance in any kind of research involving human beings, for that will determine whether resource being tested is effective or not, beyond any doubt and without interfering in the final results\textsuperscript{21}.

The quantity of sessions was quite varied and there is no standard among the research. Hence, more studies shall be performed to determine what is the better standard used regarding to the quantity of sessions on TMD treatment. However, it was possible noticed that researches which used higher quantity of sessions and greater period of treatment as protocol obtained better results both regarding to the pain remission and on improvement on mandibular movements. It is clear that post treatment is crucial to see the efficacy of long-term laser therapy on TMD treatment\textsuperscript{1}, but this conduct was presented in few works evaluated in this study\textsuperscript{1,12,15-17}. The most used laser was the Gallium Arsenide and Aluminum laser (GaAlAs) finding that there is standardization evidence, because only one study used another laser type, the super pulsed GaAs laser.

The parameters (doses, power, application time and number of point) used in the studies varied widely, because each researcher elaborates his/her own protocol based on previous studies. Most cases showed improvement on the experimental group when compared to the placebo one, proving LLLT efficacy. However, it is noticeable that protocols that used higher energy and power density of irradiation and a greater number of sessions and frequency of use were more effective in the treatment of pain, although these parameters still need to be established.

The difficulty in establish specific parameters on irradiation is observed also in another health sciences, such as Physical Therapy and Medicine\textsuperscript{7}. Even though laser therapy seemed to be effective for the treatment of TMD pain, it is noticeable that is also additional studies are necessary to establish parameters and confirm or not its effectiveness.

**CONCLUSION**

According to studies used in this research, the protocols of LLLT using seem to show efficacy on pain remission of TMD patients through RDC/TMD. The diagnose subgroup most studied was myofascial pain (group I), showing good results. The most
used laser type was Gallium Arsenide and Aluminum laser (GaAlAs).

There is no standardization on the clinical practice for LLLT use, and it was observed great variation in the therapy employed, mainly regarding to the parameters like wave length, energy frequency and output, what shows the imperative need to standardize a protocol to achieve effective and trustful results.

Performing more studies with most complexes experimental draws, standardized diagnoses for TMD, greater samples, well defined control groups and defined protocols for LLLT use with standardized parameters are necessary to achieve the right evaluation of LLLT effectivity for TMD treatment.

REFERENCES


12. Melchior MO, Venezian GC, Machado BCG, Borges RF, MazzettoMO. Does low intensity laser therapy reduce
pain and change orofacial myofunctional conditions? J Craniomandib Pract 2013;31(2):133-139.


