

Effect of Low Level Laser Therapy (LLLT) on muscle pain in temporomandibular disorders – an update of literature

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Abstract

Introduction: Temporomandibular disorders are complex pathologies with multifactorial aetiology. Due to this matter, different therapeutic approaches have been developed, one of them being physical therapy (also known as physiotherapy). Low-level laser therapy is often used in treating musculoskeletal diseases, TMJ pain and, although the exact mechanism of LLLT has not yet been completely elucidated, it seems that this kind of therapy induces analgesic, anti-inflammatory and bio-stimulating effects. *The aim* of this study was to create an update of scientific literature regarding the clinical use of LLLT in patients with temporomandibular disorders, and to identify the impact of this therapy on reducing pain in the masticatory muscles. **Methods:** A research of literature was performed - articles published over the last 10 years (January 2009 until December 2019) were searched for by introducing a combination of different keywords on the PubMed and ScienceDirect databases. **Results:** A total number of 294 articles were found. After applying inclusion and exclusion criteria, 28 articles were taken into consideration for our study, and among them, 9 were systematic meta-analyses or literature reviews and 19 were clinical studies. **Conclusion:** Low level laser therapy may effectively reduce pain in patients suffering from muscular- and/or joint-specific TMDs, but the effect appears to last only for a short period of time, and can be achieved only in less complex cases. LLLT may also improve oro-facial functions by reducing muscular activity. This research also reveals the need for better-designed clinical trials with larger sample sizes, in order to evaluate the efficacy of LLLT on improving the signs and symptoms of TMDs.

Key words: *Low-level laser therapy, temporomandibular disorders, muscle pain,*

1. Introduction

Temporomandibular muscles and joint disorders (TMDs) represent a complex pathology in the craniofacial region that affects more than 10% of the population worldwide (1). Typical signs and symptoms of this condition include muscle and joint pain, headache, limitation and/or deviation in the range of motion of the mandible, tenderness of masticatory muscles and temporomandibular joints, as well as joint noises (2).

Several classifications of the TMDs can be found in literature. The most common classification is the one proposed by the International Association for the Study of Pain: *myofascial pain, myositis, muscle spasm* and *muscle contracture* are considered to be Temporomandibular Muscle Disorders, while *disk displacements with or without reduction, TMJ subluxation or dislocation, osteoarthritis, ankylosis, traumatic injuries* and *neoplasia* are considered Temporomandibular Joint Disorders (2).

As the aetiology of TMDs is considered to be multifactorial, different approaches have been developed, such as occlusal equilibration, manual therapy, occlusal splint therapy, and physical therapy (1).

Low level laser therapy (LLLT) is a non-surgical treatment that uses a non-thermal type of light, which has been put under the spotlight in the last few years, due to its easy protocol of application, limited number of necessary sessions and minimum contraindications. Low-laser therapy is often used in treating musculoskeletal diseases and TMJ pain. Although the exact mechanism of LLLT is not completely elucidated, it seems that this kind of therapy has an analgesic, anti-inflammatory and bio-stimulating effect (3).

The aim of this study was to create an update of the scientific literature concerning the clinical use of LLLT for patients with temporomandibular disorders, and to identify the impact of this therapy on reducing the pain of the masticatory muscles.

2. Methods

2.1 Search strategy. We systematically searched for scientific articles on the PubMed and ScienceDirect databases. Our search interval included the last 10 years, starting from January 2009 until December 2019. In our electronic search, we used a combination of the following search terms: “temporomandibular disorder”, “TMD”, “temporomandibular joint disorder”, “TMJ disorder”, “TM disorder”, “low-level laser therapy”, “LLLT”, “laser therapy”, “diode laser”. We performed the last search in December 2019.

Before initiating the search, we took into consideration the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement guidelines (4).

2.2 Selection criteria. *Inclusion criteria* were as follows: a) studies in which LLLT was the treatment for TMD; b) meta-analysis studies; c) articles written in English; and d) randomized clinical trials including patients with TMD. *Exclusion criteria* were as follows: a) abstracts that did not report data for the outcomes of interest; b) studies with participants suffering from systemic disease or with pain not related to TMJ.

2.3 Data extraction. A screening of the possible relevant titles and abstracts was performed by all the authors involved in the present research. Afterwards, the full-text was obtained for the articles taken into consideration. We extracted different data like: general information about the publication (year, author), number of the patients taken into consideration, treatment related information (type of device used and its characteristics, duration, number of meetings) and clinical outcomes regarding the effect of low-level laser therapy on patients with TM disorders.

3. Results

A total number of 294 articles were found. After applying the inclusion and exclusion criteria, 28 articles were taken into consideration for the present study.

4. Discussion

Although there is a multitude of treatment options available for TMDs, low level laser therapy is considered to be a promising approach, being able to relieve pain soon after application (a few minutes after) (15).

The aim of this study was to review literature in the above mentioned time frame and to create an update

regarding the clinical use of LLLT for patients with temporomandibular disorders. We also intended to identify the impact of this type of therapy on reducing muscle pain in patients suffering from this pathology.

Out of the 28 articles included, 9 were meta-analysis, systematic reviews, or literature reviews (3,5,6,25,26,28,29,30,32) and 19 were clinical trial studies (7,8,9,10,11,12,13,14,15,16,17,18,19,20,21,22,23,31). Therefore, the authors analyzed the articles included in this research and organized the findings based on topic and on answering on some focused questions.

Which is the mechanism of action and what are the indications for LLL Therapy?

Although the exact mechanism of action of LLL therapy is not clear, there are several theories explaining its function in more detail. One theory suggests that analgesia occurs as a consequence of minimizing the PGE2 level, one of the most important proinflammatory mediators in our body (5). More than that, laser irradiation levels-up the synthesis of ATP and generates reactive oxygen radicals, which leads to the inhibition of COX-2, the enzyme responsible of synthesizing PGE2 (3,6). Another theory is focused on the effect of the laser on neuronal cells by disrupting their physiology and altering the axonal flow, a reversible process that causes no nerve damage and manages to interrupt pain formation (5,7).

LLLT's main indications in TM disorders are: pain in TMD, presence of joint sounds, sensitivity of masticatory muscles and alteration of mandibular function (15).

What are the working protocols for LLL therapy in TMD?

Regarding the working protocols, we noticed different approaches depending on laser type, wavelength and TMD severity. These were summarized in Table 1.

What are the effects of LLL therapy on masticatory muscles?

Muscular activity increases in TMDs, leading to pain and limitation of jaw movements. As a result, sensitivity or pain of the masticatory muscles and TMJs are the main complaints of patients suffering from temporomandibular disorders (11).

One study concentrated on masticatory muscles and used electromyography (EMG) to evaluate muscle activity before and after low-level laser therapy, but no significant differences were found for the masseter and temporal muscle; the only improvement obtained was pain reduction (13). In another study, published by the same authors (11), muscle relaxation for both temporal and masseter muscle was obtained, but only in the case of the superior head of the masseter muscle sensitivity was reduced. Although there were no significant modifications in mouth opening, after scanning the patients with T-Scan™ III (Tekscan, Inc., Boston, USA), even distribution of occlusal contacts (50% on each side) was demonstrated after LLL therapy.

Other studies (12,15) reported an improvement in pain symptoms and EMG activity of both masseter muscles in habitual occlusion, but no significant changes in the temporal muscle or mandibular function were identified.

When evaluating orofacial functions after LLL therapy, Haddad Leal de Godoy et al. (13) obtained pain relief for all fibres of the temporalis and masseter muscle, except for one patient, who continued to report pain in the middle masseter head. They also observed unmodified occlusal loading, maximum bite force and occlusal contact area after LLLT. This data is summarized in Table 2.

What other results can be obtained after LLL therapy in TMDs?

The main effect of this therapy is the reduction of pain, which was demonstrated by many studies (7, 9, 11, 12, 16, 17, 18, 19, 20), but also a positive psychological effect of laser therapy was obtained in the placebo group. Pain relief and an increase of the values of mandibular movement ranges after a single laser application was also observed by Santos et al. (15).

Concerning the duration of pain relief, LLLT is considered to be a rapid means of reducing pain, with effects appearing immediately after treatment, but pain recurrence occurred to some degree, thus no long-term effect has been identified so far (8).

Low-level laser therapy also has the capacity of improving mouth opening, which can be frequently observed in TMD patients. A significant improvement of the maximum mouth opening after treatment was observed (9,17,18,19), except for one study (19) which reported a non-significant increase in the LLLT group, as well as in the placebo group.

Although one research study (16) concluded that only pain reduction was obtained after using LLLT, without any modification of the maximum bite force, occlusal load and occlusal contact area, another study (11) obtained (using T-Scan™ III, Tekscan, USA, after LLLT) important differences regarding the distribution of occlusal contacts after treatment, namely approximately 50% on each side.

Studies also reported the reduction of joint sounds that are frequently present in TMD patients. Sayed et al. (18) observed that, alongside pain relief and an increase of the active range of motion, joint sounds were also reduced after LLLT.

Does the use of LLL therapy cause adverse effects?

One comparative study regarding the effects of LLLT and red and infrared led therapy (9) reported an increase of temperature during irradiation, followed by a cooling for 3-4 minutes, until initial temperature was reached again, concluding that LEDs can be a good alternative to LLLT.

No other studies declared any side effects during or after LLLT, or they were not reported.

5. Future/ongoing research

Many studies are currently ongoing (21,22,23,24,10), evaluating the effects of low-level laser therapy in patients with temporomandibular disorders, all of them containing a large sample size in order to increase the relevance of future data.

6. Conclusion

Based on the findings of this literature research we can conclude that low level laser therapy may effectively reduce pain for patients suffering of muscular and joint TMDs, but the effect appears to be only shortly maintained, and only for less complex cases. Furthermore, LLLT may also improve oro-facial functions, reducing muscle hyperactivity. This literature update also highlights the need for better-designed clinical trials with larger sample sizes, in order to evaluate the efficacy of LLLT on improving the signs and symptoms of TMDs.

Table 1. Working protocols for LLLT

Author	Type	Wavelength (nm)	No. of subjects	Irradiation site	No. of irradiations	Exposure time
Melchior et al.	Gaalas	780	12	4 points: 3 points for the upper, medium and lower thirds of masseter m., 1 point for the anterior region of temporalis m.	8 sessions, 2 sessions/week	40 sec/point
Rodrigues et al.	Gaalas	780	89	3 points: upper, middle and lower masseter m. 3 points: anterior, middle and posterior fibres of the anterior temporal m. 5 points for TMJ, lateral pole.	8 sessions, 2 sessions/week	20 sec/point for the muscles 50 sec/point for TMJ
Panhoca et al.	Led Infrared led	630 850	30	5 points: 3 around TMJ, 1 point for the temporal m., 1 point for the masseter muscle	8 sessions, twice a week	60 sec/point
De Godoy et al.	Diode laser	780	9	4 points: 3 points for the superior, medial and inferior heads of the masseter m., 1 point for the anterior temporal m.	12 sessions, 2 sessions/week	20 sec/point
De Godoy et al.	Gaalas	780	16	4 points: 3 for the superior, medial and inferior heads of masseter m., 1 point for the anterior temporal m.	12 sessions, 2 sessions/week	20 sec/point
Hotta et al.	Gaalas	780	10	Chinese acupuncture points: ig4, c3, e6, e7	10 sessions, once a week	20 sec/point

Table 2. Effects of LLLT on muscles

Author	Masseter m.	Temporal m.	Mandibular function	Follow-up
De Godoy et al.	m. relaxation ↓sensitivity of the superior head of the right masseter m.	m. relaxation no significant difference in m. sensitivity	Nonsignificant increase in mouth opening; ↑distribution of occlusal contacts	6 weeks
Rohlig et al.	↓pain, except from 1 patient—moderate pain in the masseter middle	↓pain for all heads	Unmodified occlusal contact area, occlusal pressure and maximum bite force	4 weeks
De Godoy et al.	↓pain No changes in EMG activity	↓pain No changes in EMG activity	Not evaluated	6 weeks
Hotta et al.	↓pain ↓EMG	No significant changes	No significant improvement	1 month

References

1. Fertout A, Manière-ezvan A, Lupi L, Ehrmann E. Management of temporomandibular disorders with transcutaneous electrical nerve stimulation : A systematic review. *CRANIO® J Craniomandib SLEEP Pract* [Internet]. 2019;00(00):1–12. Available from: <https://doi.org/10.1080/08869634.2019.1687986>
2. Friction RJ. Clinical Updates. *Pain - Clin Updat*. 2004;XII(2):1–6.
3. Petrucci A, Sgolastra F, Mattei A. Effectiveness of Low-Level Laser Therapy in Temporomandibular Disorders: A Systematic Review and Meta-Analysis. *J Orofac Pain*. 2011;25(4):298–307.
4. Shamseer L, Moher D, Clarke M, Ghersi D, Liberati A, Petticrew M, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: elaboration and explanation. *BMJ*. 2015;349:g7647
5. Tuner J, Hosseinpour S, Fekrazad R. Photobiomodulation in Temporomandibular Disorders. *Photobiomodulation Dent*. 2019;XX(XX):1–11.
6. Chang W.D., Lee C.L., Lin H.Y., Hsu Y.C., Wang C.J., Lai P.T. A meta-analysis of clinical effects of low-level laser therapy on temporomandibular joint pain. *J.Phys.Ther.Sci*. 26: 1297-1300, 2014.
7. Carolina Almeida Rodrigues DDS, MS, PhD, Melissa de Oliveira Melchior SLPs, MS, Laís Valencise Magri DDS, MS, PhD & Marcelo Oliveira Mazzetto DDS, MS, PhD (2018) Can the severity of orofacial myofunctional conditions interfere with the response of analgesia promoted by active or placebo low-level laser therapy?, *CRANIO®*, DOI: [10.1080/08869634.2018.1520950](https://doi.org/10.1080/08869634.2018.1520950)
8. Melchior M.O., Venezian G.C., Machado B.C.Z., Borges R.F. MM. Does Low Intensity Laser Therapy Reduce Pain and Change Orofacial Myofunctional Conditions? *J Craniomandib Sleep Pract*. 2013;31(2):133–9.
9. Panhoca VH, Lizarelli Z, Nunez SC, Campi de Anadrade Pizzo R, Grecco C, Paolillo FR, et al. Comparative clinical study of light analgesic effect on temporomandibular disorder (TMD) using red and infrared led therapy. *Laser Med Sci*. 2015;30:815–22.
10. Haddad Leal De Godoy C, Da Costa Silva PF, Araujo DS, Motta LJ, Biasotto-Gonzalez DA, Politti F, et al. Evaluation of effect of low-level laser therapy on adolescents with temporomandibular disorder : study protocol for a randomized controlled trial. *Trials* [Internet]. 2013;14(229):1–6.
11. Haddad Leal de Godoy C, Motta Jansiski L, Fernandes Santos K, Mesquita-ferrari RA, Deana AM, Bussadori SK. Effect of Low-Level Laser Therapy on Adolescents With Temporomandibular Disorder : A Blind Randomized Controlled Pilot Study. *J Oral Maxillofac Surg* [Internet]. 2015;73(4):622–9. Available from: <http://dx.doi.org/10.1016/j.joms.2014.09.018>
12. Hotta T, Hotta TH, Bataglioni SA, Coronatto DS, Sie S, Cecilio S, et al. Emg analysis after laser acupuncture in patients with temporomandibular dysfunction (TMD). Implications for practice. *Complement Ther Med*. 2010;16:158–60.
13. Haddad Leal de Godoy C, Motta LJ, Garcia EJ, Fernandes KPS, Mesquita-Ferrari RA, Sfalcin A, et al. Electromyographic evaluation of a low-level laser protocol for the treatment of temporomandibular disorder : a randomized , controlled , blind trial. *J Phys Ther Sci*. 2017;29:2107–11.
14. Rodrigues M.F., Rodrigues M.L., Bueno K.S., Aroca J.P., Camilotti V., Busato M.C.A., Mendonca M.J. Effects of low-level laser auriculo-therapy on the physical and emotional aspects in patients with temporomandibular disorders: a blind, randomized, controlled clinical trial. *Complementary therapies in medicine*. 2019; 42:340-346.
15. Santos TDS, Piva MR, Ribeiro MH, Antunes AA, Melo AR, Dias DenOliveira e Silva E. Lassertherapy efficacy in temporomandibular disorders: control study. *Braz J Otorhinolaryngol*. 2010;76(3):294–9. Available from: <http://dx.doi.org/10.1590/S1808-86942010000300004>
16. Gökçen-Röhlig B, Kipirdi S, Baca E, Keskin H, Sato S. Evaluation of orofacial function in temporomandibular disorder patients after low-level laser therapy. *Acta Odontol Scand*. 2013;71:1112–7.
17. Salmos-Brito JAL, Menezes RF De, Teixeira CEC, Gonzaga RK, Rodrigues BHM, Braz R, et al. Evaluation of low-level laser therapy in patients with acute and chronic

- temporomandibular disorders. *Lasers Med Sci.* 2012; DOI: 10.1007/s10103-012-1065-8
18. Sayed N, Murugavel C, Gnanam A. Management of Temporomandibular Disorders with Low Level Laser Therapy. *J Maxillofac oral Surg.* 2014;13(4):444–50.
 19. Abbasgholizadeh ZS, Evren B, Ozkan Y. Evaluation of the efficacy of different treatment modalities for painful temporomandibular disorders. *Int J Oral Maxillofac Surg.* 2019;YIJOM-4267:1–8. Available from: <https://doi.org/10.1016/j.ijom.2019.08.010>
 20. Huang Y, Lin J, Yang H, Lee Y-H, Yu C-H. Clinical effectiveness of laser acupuncture in the treatment of temporomandibular joint disorder. *J Formos Med Assoc [Internet].* 2014;113(8):535–9. Available from: <http://dx.doi.org/10.1016/j.jfma.2012.07.039>
 21. Carvalho FR, Barros RQ, Gonçalves AS, Freitas PM. Photobiomodulation therapy on the palliative care of temporomandibular disorder and orofacial / cervical skull pain: study protocol for a randomized controlled clinical trial. *Trials.* 2019;20(200):1–8.
 22. Langella LG, Silva PFC, Costa-santos L, Gonçalves MLL, Motta LJ, Deana AM, et al. Photobiomodulation versus light-emitting diode (LED) therapy in the treatment of temporomandibular disorder : study protocol for a randomized , controlled clinical trial. *Trials.* 2018;19(71):1–7.
 23. Melchior MO, Machado BCZ, Cristina R, Magri LV, Mazzetto MO. Effect of speech-language therapy after low-level laser therapy in patients with TMD : a descriptive study Efeito do tratamento fonoaudiológico após. *CoDAS.* 2016;28(6):818–22.
 24. Herpich CM, Leal-junior ECP, Amaral AP, Tosato JDP, Phillip I, Barbosa M, et al. Effects of phototherapy on muscle activity and pain in individuals with temporomandibular disorder : a study protocol for a randomized controlled trial. *Trials.* 2014;15(491):1–8.
 25. Xu G, Jia J, Jin L, Li J, Wang Z, Cao D. Low-Level Laser Therapy for Temporomandibular Disorders : A Systematic Review with Meta-Analysis. *Pain Res Manag.* 2018;2018:1–13.
 26. Maia M.L.M., Bonjardim L.R., Quintans J.S.S., Ribeiro M.A.G., Maia L.G.M., Conti P.C.R. Effect of low-level laser therapy on pain levels in patients with temporomandibular disorders: a systematic review. *J Appl Oral Sci,* 2012; 20(6):594-602.
 27. Chen J, Huang Z, Ge M, Gao M. Efficacy of low-level laser therapy in the treatment of TMDs : a meta-analysis of 14 randomised controlled trials. *J Oral Rehabil.* 2014;1–9.DOI: 10.1111/joor.12258
 28. Gil-Martinez A, Paris-Aleman A, Lopez-de-Uralde-Villanueva I LTR. Management of pain in patients with temporomandibular disorder (TMD): challenges and solutions. *J Pain Res.* 2018;11:571–87.
 29. Melis M, Di Giosia M, Zawawi KH. Low Level Laser Therapy for the Treatment of Temporomandibular Disorders : A Systematic Review of the Literature. *J Craniomandib Pract.* 2012;30(4):304–12.
 30. Buduru S, Talmaceanu D, Baru O, Culcitchi C, Cosgarea R. Low-level LASER therapy effects vs. placebo in the treatment of temporomandibular joint disorders. *Balneo Res J.* 2018;9(3):281–4.
 31. Buduru S, Baru O, Mesaros A. The low- level laser therapy in temporo-mandibular disorders- an update of the current literature. *Balneo Res J.* 2018;9(3):277–80.