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The Therapeutic Use of Low Intensity Laser in Temporomandibular Disorders: Literature Review

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Abstract

Temporomandibular disorders (TMD) are a group of disorders that damage the temporomandibular joint (TMJ) and the muscles of mastication. They are commonly associated with parafunctional habits and clinical symptoms, such as: headache, clicking, limitation of lateral movement, protrusion and mouth opening, discomfort in the TMJ region and vertigo. These conditions can be caused by a combination of various factors, including trauma, natural wear and tear, dental malocclusion, emotional stress, or musculoskeletal problems. The traditional treatment of TMDs is mostly multidisciplinary and can have a conservative or invasive approach, such as: use of medication, physiotherapy and surgical interventions. However, recent studies and research have shown that Lower level laser therapy (LLLT) is a professional therapeutic alternative for the treatment of TMD. This article aims to review existing studies on the use of LLLT in TMD, including its mechanical action, clinical effects and potential risks. So, the research was carried out in databases and it is concluded that, according to the current bibliography, the use of low power laser is an effective and safe option, non-invasive and without side effects for the treatment of temporomandibular disorders, that can be used as a complementary treatment to other existing therapies.

Keywords: Parafunctional Habits; Temporomandibular Disorders; Temporomandibular Joint; Laser Therapy; Temporomandibular Joint Disc

List of Abbreviations: TMD – Temporomandibular Disorders; TMJ – Temporomandibular Joint; LLLT – Lower-level Laser Therapy; HPL – Hower-power Laser; LLL - Lower-level Laser; GaAlAs - Low-power Gallium-aluminum-arsenide Diode Laser; ATP - adenosine triphosphate

Introduction

The temporomandibular joint (TMJ) is classified as bilateral and synovial, allowing extensive movements of the mandible [1]. These classifications, along with the interdependent relationship that the TMJ has with dental occlusion, highlight the complexity of its functioning and partly explain why approximately 12% of the global population is affected by Temporomandibular Disorders (TMD) [2], while the remaining percentage is attributed to multifactorial causes such as occlusal, structural (musculoskeletal issues), psychological factors, traumatic/degenerative injuries, and especially parafunctional habits and emotional stress [3]. The clinical symptoms and signs include headache, clicking sounds, limited lateral movement, protrusion, limited mouth opening, discomfort in the TMJ region, and dizziness [4]. The treatment is escalated from a conservative approach to more invasive procedures if necessary, with the choice of therapy influenced by each patient's needs and the severity of the dysfunction.

There have been studies and discussions regarding the use of low-level laser therapy as a therapeutic approach for TMD [6]. Laser therapy is a therapeutic technique that has been successfully used in various health fields [7] Laser is a source of monochromatic, coherent, and directional light that can be employed to treat a wide range of medical conditions. Although there are still uncertainties and controversies surrounding its use, laser therapy has proven to be a safe and effective option for treating various diseases, including temporomandibular disorders [8]. Laser is a form of non-ionizing, highly concentrated radiation that, depending on the type of laser, results in thermal, photochemical, and nonlinear effects when it interacts with different tissues [9].

LLLT (Low-Level Laser Therapy) is a non-invasive treatment that reduces pain and inflammation, enhances tissue healing, and generally has few or almost no side effects. Combining LLLT with traditional treatments can be explored to maximize therapeutic benefits, providing pain relief, and promoting tissue recovery [10].

Some authors present the combination of LLLT with physiotherapy exercises, where LLLT can act by reducing pain and inflammation, while physiotherapy can help improve TMJ function and strengthen the surrounding muscles. In other cases, LLLT can be used in conjunction with pain relievers or anti-inflammatory medications prescribed by a physician to provide more comprehensive relief from pain and inflammation [8, 10].

Given the aforementioned points, the aim of this study is to review the literature on the effects of laser therapy in the treatment of TMD.

Material and Methods

The implementation of Low-Level Laser Therapy (LLLT) in clinical practice can pose some challenges and significant considerations, such as cost and accessibility. LLLT equipment can be expensive, potentially restricting access to this therapy in certain clinics and making it financially challenging for some patients. Patient adherence can also be a concern, particularly if the treatment necessitates multiple clinic visits, which can be especially problematic for individuals with busy schedules, as LLLT typically entails several sessions to yield significant results.

For the execution of this study, the following databases were consulted: PubMed, DeCS/MeSH, Scielo, MEDLINE, and LILACS. The search terms employed were "Temporomandibular laser therapy," "Temporomandibular joint dysfunction," "ATM laser treatment," and "Laser therapy dentistry" in both English and Portuguese. Search limits were set between the years 2013 and 2023.

Inclusion criteria encompassed articles written in both Portuguese and English, including comparative studies, clinical trials, literature reviews, and case reports. Exclusion criteria involved animal studies and research conducted before 2013.

Within the aforementioned platforms, wherever possible, the inclusion criteria filters were applied. (Table 1)

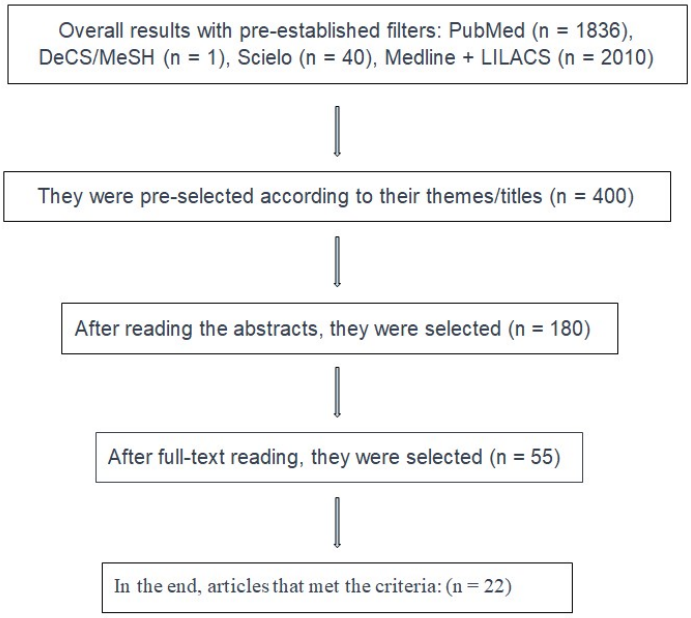

Table 1: Search and Selection Strategy for Reviewed Articles

Literature Review

The temporomandibular joint (TMJ) is a complex joint that connects the mandibular condyle to the temporal bone of the skull. This synovial joint comprises an articular capsule that lines the joint surface, along with a fibroelastic cartilage known as the articular disc situated between the mandibular head and the temporal glenoid cavity. Moreover, the TMJ is supported by a series of ligaments, including the collateral and lateral temporomandibular ligaments, the stylomandibular ligament, and the sphenomandibular ligament, which ensure joint stability [18].

Temporomandibular dysfunction (TMD) is a complex and multifactorial condition affecting the temporomandibular joint (TMJ), potentially causing debilitating symptoms and functional impairment in the craniofacial region. Various factors may contribute to TMD's etiology, including biomechanical, neuromuscular, emotional, and psychological factors, as well as parafunctional habits like bruxism [3,4,5] In a clinical context, diagnosing and treating TMD requires a deep understanding of TMJ anatomy, biomechanics, and the condition's pathophysiology. Recognizing the relationship between bruxism and TMD is crucial for accurate diagnosis and appropriate treatment, underscoring the necessity of a multidisciplinary approach to identify and address the underlying causes of TMD [5]

As a result, the treatment of TMD necessitates a comprehensive and personalized therapeutic approach that takes into account the severity of symptoms, the condition's etiology, and the patient's clinical profile. Common treatment modalities encompass conservative approaches, such as the utilization of restraining devices, physical therapy, acupuncture (Table 2), medication (Table 3), and occlusal adjustments, along with surgical interventions like arthroscopy and open surgery. Furthermore, psychological therapies like cognitive-behavioral therapy and psychological counseling have demonstrated effectiveness in TMD treatment, particularly in cases linked to psychosocial and emotional factors. A thorough and individualized evaluation is paramount for establishing an appropriate treatment plan and enhancing the quality of life for TMD patients [5].

Number of patients → 45	Group 1 (15 people)	Group 2 (15 people)	Group 3 (15 people)
Inclusion Criteria Limited mouth opening, presence of pain in the masticatory muscles and/or temporomandibular joint (TMJ).	Application of the laser alone. It was emitted at a wavelength of 810nm for 30 seconds with an output power of 200mW, perpendicular to the sites of painful symptoms with slight pressure, twice a week for 5 weeks.	Laser application, but in this group, bilaterally on acupuncture points according to those in Chinese medicine (with the exception of the Ashi point that couldn't be located), for relief of facial and cervical pain. A total of 10 sessions were also conducted.	Placebo group where patients underwent a similar treatment, however, with the laser turned off, meaning there was no actual application.
Exclusion Criteria Patients with systemic disorders, those who have used analgesics or antidepressants in the last two weeks, individuals with psychological conditions, those with maxillary bone abnormalities such as TMJ arthropathy or rheumatoid arthritis, pregnant and breastfeeding women, and those who received another form of treatment for temporomandibular disorders (TMD) in the last month were excluded from the study.	**Results:** There was no significant difference between the groups in maximum possible painless mouth opening; There was no significant difference in right and left laterality, but in right and left excursion, G1 and G2 showed a significant difference from G3 at different time intervals; Protrusive movement also exhibited a significant difference at the time intervals referred to in the study as T3 and T4; The average initial pain score (pre-treatment) measured 6.1 to 6.5 in all three groups, and after the 10 sessions, it was respectively reduced to 1.40 (group 1), 1.77 (group 2), and 5.06 (group 3); According to a used Visual Analog Scale (VAS), differences were observed in the origin, body, and insertion of the masseter muscle; There was no significant difference in pain level in the anterior, middle, and posterior parts of the temporal muscle, only in the tendon and insertion of the pterygoid muscle; Using the VAS, significant differences were noted in the resting and functional states of the temporomandibular joint (TMJ) in the study groups.		
Type of laser Low-power gallium-aluminum-arsenide (GaAlAs) diode (DD2, Thor, England)			

Table 2: Article: A randomized clinical trial comparing the efficacy of low-level laser therapy (LLLT) and laser acupuncture therapy (LAT) in patients with temporomandibular disorders

Inclusion Criteria	Nº of patients → 30	Group 1 (15 people)	Group 2 (15 people)	Exclusion Criteria
Mouth opening less than 40mm, joint pain for more than 6 months, audible clicks upon opening and closing the mouth, palpable with calibrated fingertip pressure in TMJ zones (evaluation in both joints), without crepitus sounds or mandibular locking (subluxation or joint locks).	**Type of laser** Gallium Arsenide-Quantum ® IR810, Therapeutic Laser, Laser Systems, Qro, MX.)	Laser application + NSAID (piroxicam). Initially, there were five laser sessions (three in one week and two in the following week). After one month, an additional six sessions were conducted.	Application of inactive laser + NSAID (piroxicam). Initially, there were five sessions of the inactive laser (three in one week and two in the following week). After one month, an additional six sessions were conducted.	Patients with a family history of cancer, pacemakers, hypertension, epilepsy, pregnant or breastfeeding individuals, thyroid disorders, hypersensitivity to the medication formula (piroxicam), gastric ulcers, bleeding disorders, slow-acting anticoagulant treatment, kidney injury, severe lateral gnathia (5mm or more), or patients with systemic hypermobility syndrome were excluded from the study.
	Results: Out of 30 patients, only 28 completed the treatment as two of them missed the follow-up appointment. There were no significant differences in the following aspects: baseline mandibular functional parameters, left and right laterality, protrusion, patient-interpreted pain, and noises. No adverse reactions were reported by any individuals in relation to piroxicam, the non-steroidal anti-inflammatory used. Based on the experiment, no effectiveness was observed in the low-power laser treatment for patients with arthrogenic temporomandibular disorders.			

Table 3: Article: Effectiveness of the Therapeutic Laser in the Syndrome of Dysfunction of the Temporomandibular Joint of Arthrogenic Origin

In addition to the mentioned treatments, the use of Low-Level Laser Therapy (LLLT) has been increasingly studied as a therapeutic option for TMD (Table 4). Laser therapy is a therapeutic technique that has been successfully employed in various healthcare domains. Laser is a source of monochromatic, coherent, and directional light that can be employed to address a wide range of medical conditions. LLLT has been associated with a significant reduction in pain and inflammation in the TMJ region, alongside improved mandibular function in TMD patients. One of the benefits of laser therapy is its ability to penetrate tissues, reaching affected cells without damaging healthy ones. Furthermore, laser therapy has been employed in wound and muscle injury treatment, aiding in expediting the healing process. Recent studies have showcased promising outcomes with LLLT use in TMD patients, deeming it a non-invasive and safe option for condition management. Nonetheless, further research is imperative to ascertain LLLT's effectiveness in TMD treatment, as well as its synergistic utilization with other therapies [6-9].

Inclusion Criteria	Nº of Patients	Group 1 (11 people)	Group 2 (8 people)
jaw muscle and TMJ pain; not having undergone any prior TMD treatment; no history of neurological disorders, heart diseases, surgeries, and/or tumors or traumas in the head and neck region; not being in the gestational period;	**Type of laser** Gallium-aluminum arsenide (GaAlAs), 830nm laser pen, Power output - 70W	Measurement of oral range of motion → laser application → new measurement of oral range of motion → orofacial myofunctional therapy (OMT) → new measurement of oral range of motion. There were 10 laser application sessions distributed twice a week.	Measurement of oral range of motion → application of inactive laser → new measurement of oral range of motion → orofacial myofunctional therapy → new measurement of oral range of motion. There were 10 application sessions distributed twice a week.
Exclusion Criteria The research does not provide specific details; only those who did not meet the inclusion criteria were excluded.	**Results:** Regarding oral range of motion, it was observed that both laser therapy and orofacial myofunctional therapy showed positive progression as the sessions progressed. As for pain, a significant positive difference was noted in the initial sessions, but it ceased in the fourth session and returned in the tenth. The study emphasized that laser therapy alone was not sufficient to produce significant results; however, when combined with orofacial myofunctional therapy, the results were highly satisfactory. This underscores the need for further in-depth study of these combined therapies.		

Table 4: Article: Oral Range of Motion and Orofacial Pain in Patients with Temporomandibular Dysfunction Undergoing Laser Therapy and Orofacial Myofunctional Therapy.

Laser types can be classified in two ways: High-Power Lasers (HPL) and Low-Level Lasers (LLLT) [10]. Lasers classified as low-level possess characteristics of non-invasiveness and are known for their cost-effectiveness, consequently being more extensively explored in the literature. They exhibit anti-inflammatory, analgesic, and regenerative properties [11]. Conversely, high-power lasers entail higher costs and are often associated with the need for surgical precision (incisions, removal, and coagulation), offering benefits like absence of mechanical contact, hemostasis, and reduction of bacterial cells at the application site [12]. Among low-level lasers, diode lasers are the most commonly used, although erbium and CO2 lasers are also present [13]. High-power lasers are alternatively referred to as surgical lasers, and they operate beyond the 500mW range.

Although not a pharmacological treatment, it is also necessary to consider the frequency of application and wavelength. As a therapy that is still extensively studied both in complementary treatments and in isolated forms, these same factors mentioned above can vary from one study to another. Among the selected articles, for low-level lasers, the power varied, and the wavelength ranged from 200nm to 1100nm. In these studies, there were groups that used laser only, laser combined with another associated therapy/-maneuver, and/or placebos [11,14,15].

Discussion

As advances in science continue, society predominantly seeks therapies that tend to be less invasive and/or offer new paths, new treatments for refractory patients derived from chronic pain, mainly [15-20]. Non-invasiveness is certainly a characteristic of low-intensity laser therapy, which is generally applied externally to the skin in the temporomandibular joint area unilaterally or bilaterally [11]. Although the therapeutic benefits of laser therapy have been established, as previously mentioned, promoting improved blood and lymphatic circulation in the area, reducing inflammation, pain, and stimulating cell regeneration, [16,17] it is still unclear whether laser treatment alone is sufficient or if there is a more significant improvement in pain when it is associated with other conventional treatments (medications, physical therapies, surgical therapies, acupuncture, containment devices).

Low-intensity laser therapy can also help release endorphins, which are chemicals produced by the body that aid in pain reduction [18]. Its use can also increase the production of nitric oxide, a molecule that helps dilate blood vessels and improve circulation [19].

In a study comparing the effectiveness of LBP alone and in conjunction with acupuncture in patients [11] with TMD, the first group used a low-power gallium-aluminum-arsenide diode laser (GaAlAs) (DD2, Thor, England). It was emitted at a wavelength of 810nm for 30 seconds with an output power of 200mW perpendicular to the locations of painful symptoms, applied with slight pressure, twice a week for 5 weeks. In the second group, the same laser was used at the same wavelength but this time bilaterally at acupuncture points according to Chinese medicine (except for the Ashi point, which could not be located), aiming to relieve facial and cervical pain, with a total of 10 sessions. The third group was designated to receive the inactive laser (placebo).

The second study presented a meta-analysis that highlighted the effectiveness of LBP with a wavelength range of 910nm - 1100nm. However, there is still divergence in the parameters of wavelength, output power, pulse frequency, and the quantity/frequency of sessions [14].

In a controlled clinical trial, Gallium Arsenide-Quantum ® IR810 therapeutic laser from Laser Systems, Qro, MX was used. The main power was 120V, with an output of 100-200mW, and a wavelength of 810nm. The treatment consisted of five sessions distributed over two weeks (three times in the first week and two times in the second week). However, it was found that possibly due to the applied treatment protocol, there were no significant positive results regarding the effectiveness of the laser [15].

Low-intensity laser therapy acts in various ways to promote these effects. The laser penetrates the tissue through the skin and is absorbed by the joint tissues, including cartilage, muscles, and ligaments. The energy from the laser stimulates the production of adenosine triphosphate (ATP), which is the primary energy source for cells. This increase in energy can accelerate cellular regeneration and reduce inflammation [18].

The most commonly used low-power lasers in dentistry and TMJ therapy are the diode lasers, which emit electromagnetic waves in the red spectrum (632, 660 nm), and those classified as infrared with wavelengths of (820, 940 nm) [16].

Low-intensity laser therapy for the ATM is generally applied externally to the skin in the temporomandibular joint area. The laser's energy is absorbed by joint tissues, including cartilage, muscles, and ligaments. This can help improve blood and lymphatic circulation in the area, reduce inflammation, pain, and stimulate cellular regeneration [16-17].

However, it is important to emphasize that further studies are needed to determine the effectiveness and safety of LLLT in treating TMJ disorders. Although preliminary results from some clinical studies are encouraging [7, 8, 11, 13, 17, 19], most of the studies have been conducted on small sample sizes with heterogeneous treatment protocols, limiting the generalizability of the results. Additionally, there are limited studies comparing LLLT with other commonly used therapies for treating TMJ disorders, such as pharmacological therapy (15) and physiotherapy. More research is required to ascertain the precise role of LLLT in TMJ disorder treatment, identify the patients who would benefit most from this therapy, and establish the optimal conditions for applying LLLT.

Conclusion

In conclusion, studies on the effects of low-level laser therapy (LLLT) in the treatment of temporomandibular disorders, which has been widely utilized in recent years, have shown promising results. The selected clinical studies, among numerous available, have demonstrated that the use of this therapy can reduce pain, restore temporomandibular joint function, and increase range of motion. Furthermore, the application of low-level laser therapy is generally well tolerated and non-invasive, with minimal significant side effects, making it an appealing option for patients seeking non-surgical treatment or alternative therapies for chronic pain. However, it is important to highlight that more research is needed to fully understand its long-term effectiveness and safety, as well as to establish a standardized application protocol that can be incorporated into the literature, providing guidance for professionals in the field.

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Conflict of Interest

The authors declare that they have no conflict of interest.

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