

# Use of Lasers in the Management of Temporomandibular Disorders

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## ABSTRACT

Laser therapy is commonly used in the management of musculoskeletal disorders. Low-level laser therapy (LLLT) has been found to possess analgesic activity which promotes its use in various painful conditions. Temporomandibular disorders (TMDs) are treated by various modes of management. However, LLLT appears to be an attractive noninvasive mode of treatment for these group of patients. So, need was felt to review the potential uses of lasers in patients affected by TMDs. A literature review for English language articles was conducted using the PubMed and Google Search engine using the following search terms 'laser', 'TMDs', 'dentistry', 'therapy', 'musculoskeletal'. Low-level laser therapy appears to be a promising mode of management in relieving the symptoms of these patients.

**Keywords:** Laser, Temporomandibular disorders, Dentistry, Therapy, Musculoskeletal.

**How to cite this article:** Kumar LSV. Use of Lasers in the Management of Temporomandibular Disorders. *Int J Laser Dent* 2014;4(2):43-48.

**Source of support:** Nil

**Conflict of interest:** None

## INTRODUCTION

The term temporomandibular disorder (TMD) represents a group of painful conditions involving the muscles of mastication and the temporomandibular joint (TMJ).<sup>1</sup> Temporomandibular joint and the masseter muscle are the sites most affected by pain in patients with TMD. The masseter and sternocleidomastoid muscles are frequently the most painful in those with joint noise.<sup>2</sup> The typical clinical finding in patients with TMJ dysfunction is the tenderness of the TMJ during palpation and mandibular lateral excursion.<sup>3</sup> Temporomandibular disorders are treated by variety of method, such as with medicines,

physiotherapy, splints, occlusal adjustment, biting plates and transcutaneous electric nerve stimulation (TENS), etc.<sup>3,4</sup> The acronym LASER stands for light amplification by the stimulated emission of radiation. The science of lasers has progressed enormously in medical and dental field ever since it was first introduced in 1960. Laser therapy is based on induction of biologic response through energy transfer.<sup>5</sup> Lasers differ from ordinary light for having a single wavelength.

## Classification of Lasers

Based on the power, lasers are classified as follows:<sup>6</sup>

- *High power lasers (hard or hot or surgical lasers):* They have output of more than 500 mW. They produce heat. They cause necrosis, carbonization, vaporization, coagulation and denaturation.
- *Intermediate power lasers (soft or cold):* They have output powers ranging from 250 to 500 mW. They do not produce significant heat.
- *Low power lasers:* Output power is less than 250 mW. They do not cause change in tissue temperature and the chemical reactions are dependent on light. They act through photobiostimulation. They are widely used for therapeutic and biostimulating purposes and act as accelerators of healing processes. Low power lasers reduce pain and inflammatory mediators and have analgesic features. In addition to their uses in tooth hypersensitivity, postoperative flare-ups, mucositis, facial myalgia, neuralgias; they are of benefit in management of TMDs.

The critical point that stands alone low-power lasers from high-power ones is photochemical reactions with or without heat. The most important factor to achieve this feature in lasers is not their power but the power density per cm.<sup>2</sup> If the density is lower than 670 mW/cm<sup>2</sup>, it can mimic stimulatory effect of low-power lasers without any thermal effects.

Low-level laser therapy (LLLT) is a local application of a monochromatic, narrow-band, coherent light source. Low-level laser therapy is recommended as a treatment option for TMD guidelines but with limitations, because of heterogeneous laser parameters and a lack of dosage consensus in the LLLT literature. Though the action of LLLT is disputed its analgesic, anti-inflammatory and

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stimulative effects have been confirmed.<sup>7</sup> It has been found in literature that lasers of wavelengths at 830 and 904 nm categorized as low intensity laser therapy (LILT) reduce TMD pain and improve total vertical opening.<sup>8</sup>

Therapeutic lasers range from the visible (red) to invisible (infrared) light, close to the electromagnetic radiation spectrum. The most commonly used wavelengths are those between 600 and 1000 nm. Low-level laser in the infrared spectrum (with a wavelength of over 700 nm) has better penetration into tissue (between 3 and 5 cm), than red laser (between 600 and 700 nm, penetrating 2-5 mm). They are relatively poorly absorbed and are, therefore, transmitted through the skin and mucous membranes. Infrared laser has greater depth of penetration and greater affinity for nonpigmented tissues, such as nerves, providing a photoelectric effect on irradiated cells, increasing the membrane potential and, thus, reducing nerve impulse conduction.<sup>9</sup>

Significant pain reduction with LLLT in acute and chronic musculoskeletal pain conditions, such as rheumatoid arthritis, cervical osteoarthritis, knee osteoarthritis, fibromyalgia, and low-back pain has been observed in literature.<sup>10</sup> Its use in the treatment of muscular and joint dysfunctions is due to its recognized analgesic effect, explained by the increase of beta endorphin and serotonin level, increased ATP production by the mitochondria and improved cellular respiration, increase of pain discharge threshold, decrease of bradykinin and histamine release, increase of lymphatic flow, decrease of edema and algescic substances, increase of local blood supply, reduction of inflammation, and promotion of muscle relaxation.<sup>3,10</sup> For arthrogenic TMD, low doses are required whereas myogenic conditions require an infrared laser and high dosage. Pain, spasm and trismus are relieved rapidly.<sup>5</sup>

### Basics of Laser

Laser equipment consists of the following:

- Laser medium-carbon dioxide, argon, helium-neon, YAG, excimers, dye, ruby, semiconductor diodes, such as arsenide-gallium-aluminum (AsGaAl).
- The excitation source, which can be a flash lamp or an electric arc, will cause the molecules or atoms in the laser irradiation medium to transit from a resting to an excited state; return to the ground state causes the spontaneous emission of a photon.
- Two mirrors set at the two ends of a resonating chamber that reflect the light emitted back to the atoms or molecules in the laser medium.

The interaction of these three elements results in emission of laser. An important factor to consider is energy density, which is the amount of energy stored in a given region of space per unit volume. Also temporal factors,

such as the form of light emission (continuous or pulsed), repetition rate and pulse width for pulsed laser emission should be considered. In order to have clinical effect, it is necessary that the light be absorbed by the tissue. Light that is reflected, transmitted or scattered has no effect. The absorbed energy is measured in Joules/cm<sup>2</sup> and is known as energy density or fluence. Once absorbed, light can have three basic effects: photothermal, photochemical and photomechanical. The absorption of laser light depends on the amount of chromophore present in the tissue and whether the wavelength used corresponds to the absorption characteristics of that chromophore. The longer the wavelength, the deeper the penetration of laser energy.<sup>11</sup>

Lasers have advantages, such as disinfection of the surgical area, no vibration, vaporization of the lesions, heal wounds and ulcers, patient comfort, anti-inflammatory and biostimulating properties, accuracy in tissue destruction, precise incision of the tissues, minimal damage to adjacent tissues, hemostatic effect, reduction of pain and swelling, and the possibility of microscopic and endoscopic control.<sup>5</sup> Lasers in the infrared range, at a wavelength of 632 to 780 nm, are not able to cause tissue damage, such as mutations and carcinogenesis. Lasers activate microcirculation, produce new capillaries, stimulate growth and cell regeneration and have anti-inflammatory and analgesic effects. The effect of lasers on tissues depend upon optical (reflectance, absorption and scattering) and thermal (thermal conductivity and heat capacity) properties of the tissue, and to the wavelength, applied power, peak power, focus area (energy density and power) and exposure time of laser light.<sup>11</sup>

### Laser as a Mode of Managing TMD

Therapeutic LLLT application is achieved through light, static, and direct contact of the probe on the skin. The LLLT should be applied on the selected points considering the presence of nociceptors in the periarticular tissues (discal ligaments, capsular ligaments and retrodiscal tissues), because these structures are involved in the TMJ pain.<sup>3</sup> The probe should be placed perpendicular directly on the skin at the center of the upper joint space, approximately 1 cm in front of the tragus. The laser beam is delivered through a laser probe. Treatment can be applied for 2 minutes at both the closed mouth and maximum mouth opening position. Repeated appointments for at least 8 weeks and three times a week are desired. The laser should be calibrated before use, and the laser probe wiped with alcohol before each treatment. The subjects and the clinician should wear protective glasses. Also, the state of laser instruments should be monitored and reviewed regularly to prevent untoward hazards.<sup>10</sup>

Various studies have supported the use of lasers in managing TMD. The use of 830 nm wavelength laser in several appointments has been found to reduce or eliminate myofascial pain.<sup>5</sup> Kulokciglu et al showed decrease in pain related to TMD. In another study, pain decreased significantly in TMD patients when exposed to 785 nm laser compared to the placebo group. The patients exhibited no signs of pain during the 6-month follow-up period.<sup>12,13</sup> Low-power lasers cause photobiochemical reactions that result in pain relief. Low-power lasers can be used for stimulation of specific points of the body instead of needle. Access to different depths is possible by applying low power lasers with different wavelengths and changing the output power. This may have the same effect as acupuncture. Also, it has advantage of absence of pain, discomfort, inflammation and cross-contamination compared to needle use of acupuncture. Effectiveness of laser acupuncture has also been confirmed in decreasing myofascial pain.<sup>5,6,14</sup>

Low-level laser therapy has been considered effective in reducing pain and muscular tension; thus improving the quality of patients' lives. In the study conducted by Dostalova T et al LLLT was performed in five treatment sessions (energy density of 15.4 J/cm<sup>2</sup>) by semiconductive GaAlAs laser with an output of 280 mW, emitting radiation wavelength of 830 nm. The laser supplied a spot of 0.2 cm<sup>2</sup>. Low-level laser therapy was applied on the selected points considering the presence of nociceptors in the periarticular tissues (discal ligaments, capsular ligaments and retrodiscal tissues), because these structures are involved in TMJ pain. Low-level laser therapy was effective in reducing the painful symptoms following optimal mouth opening. The authors explained that LLLT increased pain tolerance through changes in cellular membrane potency, vasodilatation, reduction of edema, increase in intracellular metabolism, and acceleration of wound healing. The laser therapy was efficient in promoting an increase of mandibular movements in the patients who received the active laser dose. The analgesic effect of low-intensity lasers had a direct effect on mouth opening and decrease in the VAS scores. Lasers can be of great value because of the increase of beta-endorphin level, increase of pain discharge threshold, decrease of bradykinin and histamine release, increase of lymphatic flow, decrease of edema and algogenic substances, increase of blood supply, time reduction of inflammation and promotion of muscle relaxation.<sup>7</sup>

Melchior Mde O et al in their study found that after eight sessions of LILT and, after 30 days of LILT, therapy found significant decrease in subjective pain on palpation.<sup>15</sup>

Another study used lasers of wavelength 780, 790 and 830 nm (30/40 MW, spot = 3 mm), mean dose per

session 14.2 ± 6.8 J/cm<sup>2</sup> for 6 weeks in 3 sessions on patients with TMDs. At the end of the 12 sessions, 64% of patients treated with lasers were asymptomatic or improved based on visual analog scale (VAS) score. The study concluded that the association of red and infrared (IR) laser light was effective in pain reduction on TMJ disorders of several origins.<sup>4</sup>

Four authors evaluated the efficacy of LLLT in the management of patients with myogenic TMDs. The laser group in the study was administered. A pulsed 810 nm low-level laser (average power 50 mW, peak power 80 W, 1,500 Hz, 120 s, 6 J, and 3.4 J/cm<sup>2</sup> per point) was used on painful muscles three times a week for 4 weeks. There was a significant increase in mouth opening and a significant reduction of pain symptoms in the laser group. The study concluded that LLLT can produce a significant improvement in pain level and mouth opening in patients affected with myogenic TMD.<sup>16</sup>

Three authors in their study evaluated the effectiveness of LLLT on the improvement of the mandibular movements and painful symptoms in individuals with TMDs. Patients received effective dose [gallium-aluminum-arsenide laser (GaAlAs laser) λ830 nm, continuous wave, 40 mW, 10 seconds, 5J/cm<sup>2</sup>] in continuous mode on the affected condyle lateral pole: superior, anterior, posterior and posterior-inferior, twice a week during 4 weeks. The results showed significant more improvements in painful symptoms in the treated group. A significant improvement in the range of mandibular movements was observed after 30 days of last application of laser. The study concluded that laser application can be a supportive therapy in the treatment of TMD, since it resulted in the immediate decrease of painful symptoms and increased range of mandibular movements in the treated group. The study also observed that LLLT was effective in attenuating the painful symptoms only during the 4 weeks application period.<sup>3</sup>

Another study compared the effects of low-level laser with occlusal splints in patients with signs and symptoms of myofascial pain (MP) dysfunction syndrome. Low-level laser was applied to patients in the study group 2 times per week, for a total of 10 sessions. Patients in the control group were instructed to wear occlusal splints 24 h/d for 3 months. Vertical movements showed statistically significant improvements after the treatments in both the groups, but when the groups were compared with each other, there were no significant differences between the groups. In both groups, tenderness to palpation of the muscles decreased significantly. Pressure pain threshold evaluations and VAS scores revealed similar results, too. The study concluded that this particular type of LLLT (820 nm, 3 J/cm<sup>2</sup>, 300 mW output power) is as effective as

occlusal splint in pain release and mandibular movement improvement in MP.<sup>17</sup>

A group of authors evaluated the effectiveness of LLLT and transcutaneous electrical neural stimulation (TENS) on the improvement of mouth opening in patients with TMD. LLLT was delivered via a 670 nm diode laser, output power 50 mW, fluence 3 J per site/4 sites (masseter muscle, temporal muscle, mandibular condyle and intraauricular). A significant improvement in the range of motion for both therapies was observed immediately after treatment. Comparing the two methods, the values obtained after LLLT were significantly higher than those obtained after TENS. Both methods are effective to improve mouth opening. The study concluded that comparing the two methods, LLLT was more effective than TENS applications.<sup>18</sup>

A study used two diode laser probes (660 nm, 6.2 J/cm<sup>2</sup>, 6 mins, continuous wave, and 890 nm, 1 J/cm<sup>2</sup>, 10 mins, 1,500 Hz) on the painful muscles of myofascial pain dysfunction syndrome (MPDS) patients. Treatment was given twice a week for 3 weeks. Low-level laser therapy was more effective and the study concluded that LLLT was the effective treatment for pain reduction in MPDS patients.<sup>19</sup>

The effect of diode laser (GaAlAs—780 nm) on pain to palpation and electromyographic (EMG) activity of the masseter and anterior temporalis muscles were evaluated by Venezian GC et al. The laser was applied on the temporalis and masseter muscles twice a week for 4 weeks. Energy densities of 25 J/cm<sup>2</sup> and 60 J/cm<sup>2</sup> were applied. The study concluded that low level laser does not promote any changes in EMG activity. However, the study found reduction of pain symptoms in the laser groups.<sup>20</sup>

A study evaluated the analgesic effect of LILT and its influence on masticatory efficiency in patients with TMD. Infrared laser (780 nm, 70 mW, 60s, 105 J/cm<sup>2</sup>) was applied precisely and continuously into five points of the TMJ area: lateral point (LP), superior point (SP), anterior point (AP), posterior point (PP), and posterior-inferior point (PIP) of the condylar position. This was performed twice per week, for a total of eight sessions. The study found that low intensity laser application is effective in reducing TMD symptoms, and has influence over masticatory efficiency.<sup>21</sup>

Another study used LILT regimes namely 820 nm gallium-aluminum-arsenide (GaAlAs) laser at energy densities of 21.4 J/cm<sup>2</sup>, 107 J/cm<sup>2</sup> and placebo laser on TMD patients. Three LILT treatments in a week were administered. According to this study, 820 nm GaAlAs laser at energy densities of 107 J/cm<sup>2</sup> had a significant improvement of pressure pain threshold and voluntary

clenching EMG in the myofascial pain and TMJ arthralgia patients over the sham laser group.<sup>8</sup>

Another group of authors used AsGaAl laser (red) with a 40 mW power, with 80J/cm<sup>2</sup> (irradiation area 5 mm<sup>2</sup>, wavelength-830 nm) for 16 seconds on patients with TMDs at four selected points for just one session with reassessment after a week. These four points would be those which had the highest sensitivity/pain score among 17 assessed sites: joint capsule (lateral, posterior and superior); masseter (anterior, inferior); temporal (anterior, middle, posterior, origin and insertion); medial and lateral pterygoid, sternocleidomastoid (superior, inferior and middle); trapezius muscle (origin and superior). The study noted that laser therapy increased the mean amplitude of mandibular movements and decreased significantly the pain intensity measured by the VAS. The study concluded that laser decreases the painful symptoms of the patient after application through its analgesic and/or a placebo effect. The results showed that there was a greater mean mandible range of motion after laser administration. Laser therapy caused a reduction in the pain symptom after administration, by its analgesic action.<sup>2</sup>

A study was conducted in patients with chronic TMD to check the analgesic efficacy of infrared low-power GaAlAs diode laser applied to acupuncture points. The therapy was conducted once a week for 3 months. 50 mW continuous radiation was administered for 90 seconds to acupoints. Laser parameters were 4.5 J energy; 1250 W/cm<sup>2</sup> density point; and 112.5 J/cm<sup>2</sup> total density. Significantly faster and lower pain intensity values were observed after the treatment. Higher proportion of patients with remission of symptoms related to the action of laser acupuncture. The study indicated that for patients in whom conservative treatment is adopted, the laser acupuncture is a secure, noninvasive, and effective treatment modality because it improves the chronic pain associated with TMD and has no side effects.<sup>22</sup>

A group of authors evaluated the pain, jaw movements, and psychosocial factors in elderly patients with painful TMD before and after laser phototherapy (LPT). The LPT was carried out with a GaAlAs diode laser (780 nm; spot size 0.04 cm<sup>2</sup>) in punctual and contact mode. Two settings of irradiations were applied as follows: in patients presenting myofascial pain, 10 mW, 5 J/cm<sup>2</sup>, 20 s, 0.2 J per application point; and in patients with joint TMD, 70 mW, 105 J/cm<sup>2</sup>, 60 s on five points, 4.2 J per point. Two sessions of LPT were carried out per week over four consecutive weeks, in the total of eight sessions. Significant pain reduction was found in all patients. There was increase in maximum mouth opening without pain and reduction in muscle pain during right and left lateral excursion.



A significant reduction in chronic pain severity and significant improvements in depression and nonspecific physical symptoms with pain were observed. The study indicated that LPT is able to promote pain relief and improvement of jaw movements in elderly patients with TMD, with a positive effect on psychosocial aspects.<sup>23</sup>

A study assessed the effect of LLLT in reducing pain intensity and improve maximal mouth opening among acute or chronic TMD patients. The sample comprised myogenic. For each patient, 12 LLLT sessions were performed (gallium-aluminum-arsenide;  $\lambda = 830$  nm, power = 40 mW, effective density = 8 J/cm<sup>2</sup>). Significant pain intensity reduction and maximal mouth opening improvement was observed after LLLT. Acute TMD patient had more significant pain intensity reduction and a more significant maximal mouth opening improvement. The study concluded that LLLT can be considered as an alternative physical modality or supplementary approach for management of acute and chronic myogenic TMD; however, patients with acute disease are likely to have a better outcome.<sup>24</sup>

Pereira TS et al in their study evaluated the efficacy of red and infrared laser therapy in TMD patients. Irradiation of 4 J/cm<sup>2</sup> in the TMJ and 8 J/cm<sup>2</sup> in the muscles was used in three sessions. The study used two independent tips, one for each type of wavelength: 660 nm (red laser) and 795 nm (infrared laser). The study found that both lasers were effective in the treatment and remission of TMD symptoms. The immediate improvement obtained in 24 hours lasted 180 days, causing a significant impact on the improvement in quality of life. The infrared laser provided more intense and prolonged analgesic and anti-inflammatory effect than red laser. So, the infrared laser was more effective than red laser in achieving remission of painful symptoms and providing immediate improvement, which was maintained for 180 days of the study.<sup>9</sup>

However, one study found that lasers were no better than placebo. A group of authors assessed the effectiveness of LLLT in the management of TMJ pain. Temporomandibular joint pain patients received direct irradiation on painful TMJs 2 to 3 treatments per week for 8 weeks of active LLLT (helium-neon, 632.8 nm, 30 mW, continuous wave, 1.5 J/cm<sup>2</sup> energy density) or sham LLLT continuous wave. Measures of TMJ pain during function were evaluated at baseline and weeks 2, 4, and 8 after the first laser therapy. At the 8 week point, within group improvements were present for TMJ pain during function, for both the active and sham LLLT groups. Between-group differences were not highly evident. The study suggested that LLLT is not better than placebo at reducing TMJ pain during function.<sup>10</sup>

## PRECAUTIONS

Protective eyewear should be worn by anyone in the vicinity of the laser while using them. This includes the doctor, chairside assistants, patient, and any observers, such as family or friends. It is critical that all protective eyewear worn is wavelength-specific. Warning sign should be posted outside the hazard zone.<sup>25</sup> An unsatisfactory outcome can be due to very low doses, very high doses, incorrect diagnosis, small number of sessions, inadequate energy density, among others.<sup>3</sup>

## FUTURE PERSPECTIVES

Low-level laser therapy appears to have an important role in management of patients with TMD. The use of laser acupuncture is promising and has several benefits. The procedure, dose and type of laser therapy should be standardized for treatment of these patients. More research should be directed toward standardizing of factors involved in laser therapy. This in turn may stimulate the use of lasers in trained hands with evidence-based positive results.

## CONCLUSION

Despite all these benefits brought about by laser treatment, it is not the only definitive treatment for TMD. It is used as an adjuvant in the treatment alleviating pain due to its analgesic effect, which allows the patient to promptly resume functions, providing greater comfort. In most cases, however, better outcome is achieved when multiple therapies are associated and lasers can be of great value. All medical and dental practitioners should be aware of the potential value of lasers in managing TMD patients.

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