Role of low-level laser therapy in treatment of orofacial pain: A systematic review

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Abstract
Lasers have gained an upper hand in almost every field of dentistry. Utilization of low-level laser therapy (LLLT) which uses a power of <500 mW have matured over time. Its advantages surpass its pitfalls and hardly have any contraindications. Low lasers interact photo-chemically leading to a change in the biochemical and molecular processes that normally occur in tissues such as healing or repair without the thermal effects, a process called bio-stimulation. It has been implied that low power lasers affects cellular metabolic processes and promotes beneficial biological effects such as analgesic, anti-inflammatory, and healing. Research suggests an analgesic effect, through the central release of serotonin and acetylcholine, and peripheral release of histamine and prostaglandins, with the use of LLLT. LLLT improve endorphin release and thereby impede nociceptive signals and control pain mediators. This article aims to review the interesting clinical applications of LLLT in different orofacial pain conditions in details so that we can help patients to live a pain-free life.

Keywords
Analgesic, low level laser therapy, orofacial pain

Introduction
To get rid of the curse of pain, man has left no stone unturned to discover different possible ways to alleviate pain. It is true that the desire to eliminate pain is as old as the human race itself. People through ages have explored to find out the attainable ways to purge pain. This could be explained by the length of time from the caveman people who used herbs to ease their suffering to modern day man who makes use of the wonders of medicine and present time equipment.

Photo biotherapy is an old method which has been used from years for treatment. This dates back to when sunlight radiations were being used, but because normal light has the natural properties of releasing and distributing in all directions, it is unable to penetrate enough living tissues. Thus limiting its role only for biologic stimulation in limited dermal treatments. Laser, on the other hand, can be easily localized due to its property of monochromaticity and directionality and the power of penetration helps to accelerate tissue growth and development via cellular stimulation without the use of any drug.¹

Laser stands for “light amplification by stimulated emission of radiation” and has been studied largely in dentistry. The power of laser used in the medical field can range from as low as 5 mW to as high as 500 mW, but the wavelength is an important factor which should be considered by the clinician for producing the desired effects within the living tissue as the penetration into the soft and hard tissues is from 3 to 15 mm depending on the wavelengths used.²³

Lasers are classified into the three categories based on power:
1. High-power lasers also known as hard, hot or surgical laser (power more than 500 mW): They work through photothermal interactions with the tissues and cause necrosis, carbonization, vaporization, coagulation, and denaturation of the tissues due to the production of heat.
2. Intermediate-power lasers (powers ranging from 250 to 500 mW): These lasers produce therapeutic effects without producing significant heat.
3. Low-power lasers also known as soft, cold, and therapeutic or athermic lasers (power <250 mW): These use cold energy emitted as wavelength, without the use of thermal energy on tissues and produce a reaction in cells, called photobiostimulation or photo biochemical reaction.⁴

The amount of laser energy delivered to a target tissue is termed fluence, or energy density and is measured in J/cm².
The power of the laser light=fluence×time, which for a free-running emission mode can result in peak power values of several thousand Watts, though for periods of micro-seconds. With surgical or cutting lasers, vaporization occurs at fluence levels of 1000 J/cm² of intra-cellular and inter-cellular water. In clinical practice, low-level laser therapy (LLLT) is more effective by stimulatory rather than ablative mechanisms, delivers fluence of 2-10 J/cm², depending on the target tissue as follows:
- Oral epithelium and gingival tissue – 2-3 J/cm²
- Trans-osseous irradiation (target – periapical area) – 2-4 J/cm²
- Extra-oral muscle groups/temporomandibular joint (TMJ) – 6-10 J/cm²

Mechanism of Analgesic Effects of Lasers
It is the low power lasers that are mainly used for analgesic purposes. LLLT supplies direct biostimulative light energy to the body cells. Cellular photoreceptors (e.g., flavoproteins, cytochrome C oxidase, riboflavins, and porphyrin rings) can absorb the low laser light and transfer it onto mitochondria, which promptly produce adenosine triphosphate. A chain of events occurs and finally results in photoresponse. Evidence support that LLLT have significant neuropharmacologic effects on the synthesis, release and metabolism of a range of neurochemicals including histamine, serotonin and acetylcholine, all of them being the mediators of pain. Laser reduces cell membrane permeability for Na⁺ and K⁺ and cause neuronal hyperpolarization resulting in increased pain threshold. Low-power lasers increase the urinary excretion of serotonin and glucocorticoids, increasing the production of β-endorphin. LLLT can help in removing metabolites and increase blood flow to muscles in painful condition through local vasodilatation. All these results in analgesic effects.

Effect of Low-Level Laser on Maxillofacial Pain
Pain in the maxillofacial region can originate from the teeth, the nerves, muscles, and vessels. Low-level lasers can be helpful in a variety of conditions which affect the above-mentioned tissue. The uses of LLLT in orofacial pain are summarized in Table 1.

Clinical Applications
Dentine hypersensitivity
It is the common type of dental pain and is defined as a short and sharp pain arising from exposed dentin, in response to chemical, thermal, tactile or osmotic stimuli, that cannot be explained as arising from other forms of old dental defect or pathology. Dentine hypersensitivity can be eliminated by narrowing or occlusion of the tubules opening resulting in reducing the fluid movement inside the dentinal canalicules.

Diode lasers in the range of 660-830 nm have been tried in the treatment of dentinal hypersensitivity. Significant reduction in dentine sensitivity has been seen using diode laser in noncontact mode during treatment sessions after 15 min and 7 days of first application.

When comparing the efficacy of the two lasers (660 nm wavelength red, and 830 nm wavelength infrared), it was found that amongst the two, 660 nm red diode laser was more effective for dentine hypersensitivity and a higher level of reduction in sensitivity was observed at the 15 and 30 min post-irradiation examinations. Aranha et al. also showed gradual reduction in dentine hypersensitivity using low-intensity laser (660 nm/3.8 J/cm²/15 mW).

After surgical removal of third molars
LLLT has been shown to modulate the inflammatory process, by reducing pain and swelling and promoting the repair of damaged tissues without any harmful effects. Because pain, swelling, and muscle spasm are problems arising in virtually all patients following oral surgery for the removal of impacted teeth, LLLT can be widely used to evaluate the effects on the inflammatory process involving bone, connective tissue and the muscles of mastication. It can be given both intraoral and extraorally. Research is still on to find its role postoperatively following extraction. It is necessary to standardize the intervention and outcomes evaluation and to carry out adequately powered, well-designed trials to evaluate its efficacy.

Table 1: Treatment recommendation for LLLT application in orofacial pain

<table>
<thead>
<tr>
<th>Conditions</th>
<th>Dosage recommendations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teeth</td>
<td></td>
</tr>
<tr>
<td>Dentine hypersensitivity</td>
<td>1 J, 30 s, 2-3×/week until pain reduction</td>
</tr>
<tr>
<td>After surgical removal of third molars</td>
<td>75 mW, 1-2 J, 40 s, irradiation before the operation, during the operation (empty alveola) and after suture</td>
</tr>
<tr>
<td>For orthodontic treatment</td>
<td>Shortly before and after activating orthodontic forces, irradiation should be done. He-Ne laser: λ=832.8 nm, 6 mW, labial and lingual at the apex 30 s, Ga-Al-As laser: 75 mW, λ=680 nm, 1-2 J, 30 s in the apex region buccal and palatinal. Repeat the irradiation when pain returns</td>
</tr>
<tr>
<td>Trigeminal neuralgic pain</td>
<td>Irradiation on the site of the nerve exit at the foramina and the points which are painful. 75 mW, 680 nm, 2-3 J, 40 s, 2×/week</td>
</tr>
<tr>
<td>Mucositis pain</td>
<td>75 mW, 1-2 J/cm², irradiation depends on the severity of inflammation</td>
</tr>
<tr>
<td>Myofacial pain</td>
<td>1-2 J, 3-4×/week, perhaps acupuncture points, speedy relaxation of the musculature</td>
</tr>
<tr>
<td>Temporomandibular joint disorder pain</td>
<td>Ga-Al-As laser, λ=680 nm, 75 mW, 1.5-2 J, 40 s, 2-3×/week surface irradiation transdermal, perhaps acupuncture points, resulting in prompt pain reduction</td>
</tr>
</tbody>
</table>

LLLT: Low-level laser therapy
For orthodontic treatment

The effectiveness of LLLT on the pain caused by orthodontic forces, such as caused by elastomeric separators has been studied. Studies support that exposure from 670 to 830 nm wavelength laser helped to reduce tension pain. Irradiation to laser should be done just before and after activating the orthodontic forces to give best pain relief. Various authors have studied LLLT in comparison to placebo and have found that orthodontic pain can be relieved by up to 40%. It has a good analgesic effect and the use for orthodontic pain appears hopeful.[13-15]

Trigeminal neuralgia (TN) pain

TN is mainly a periodic, unilateral, sharp, and electric shock-like pain which affects trigeminal nerve branches. LLLT also has been tried to relieve pain in TN patients. Studies have shown to increase nerve function and capacity for myelin production using LLLT. LLLT has also been shown to be effective for promoting growth of axons in injured nerves in animal models. Studies comparing the effect of laser with placebo irradiation or medicinal or surgical treatment modalities have been tried. It is found in most studies that laser therapy is associated with significant reduction in the intensity and frequency of pain compared with other treatment options, a few studies revealed that between laser and placebo group there was no significant difference according to the analgesic effect. Hence, LLLT could be considered in the treatment of TN without any side effects.[16]

Mucositis pain

Oral mucositis is one of the most frequent and distressing complications seen in patients undergoing cancer treatment or hematopoietic stem cell transplantation (HSCT). Oberoi et al. carried out a meta-analysis to determine whether prophylactic LLLT reduces the risk of mucositis when compared to placebo or no therapy. The results showed that prophylactic LLLT reduced the overall risk of severe mucositis at the time of expected maximal mucositis, overall mean grade of mucositis, duration of severe mucositis and incidence of severe pain. Thus, it was concluded that prophylactic LLLT helped in reducing severe mucositis and pain in patients with cancer and HSCT recipients.[17] It is recommended to have a 780-830 (nm) (infrared) Wavelength for analgesia with output between 10 and 100 (mW) which could be fixed or variable depending on the equipment and dose of 0.08-2 (J).[18]

Myofascial pain

Myofascial pain syndrome is characterized by hypersensitive points called trigger points found in one or more muscles and/or connective tissues causing pain, muscle spasm, sensitivity, stiffness, weakness, limitation of range of motion, and rarely autonomic dysfunction. The effects of LLLT for eliminating pain are investigated frequently. Shirani et al. evaluated the efficacy of an LLLT using 660 and 890 nm wavelengths and concluded LLLT was an effective treatment for pain reduction in MPDS patients.[16] Ilbuldu et al. compared placebo laser, dry needling and laser for upper trapezius muscle. Significant decrease in pain at rest, at activity, and increase in pain threshold in the laser group was seen compared to other groups. Hence, it can be concluded that laser therapy could be useful as a treatment modality in myofascial pain syndrome because of its non-invasiveness, ease, and short-term application.[20]

Temporomandibular joint disorder pain

Temporomandibular disorders (TMD) are characterized by the presence of TMJ and masticatory muscle pain and dysfunction. LLLT is presented as an adjuvant therapeutic modality for the treatment of TMD pain. Maia et al. did a careful review on the effect of LLLT on pain levels with TMD’s and found that as for the protocol for laser application, the energy density used ranged from 0.9 to 105 J/cm² and the power density ranged from 9.8 to 500 mW. The number of sessions varied from 1 to 20 and the frequency of applications varied from daily for 10 days to 1 time per week for 4 weeks. A reduction in pain levels was reported in 13 studies, with 9 occurring only in the experimental group, and 4 studies reporting pain relief for both the experimental and placebo group. The conclusion was in most studies LLLT seemed to be effective in reducing pain from TMD.[21]

Aphthous ulcers

LLLT has also been tried to reduce pain in aphthous ulcers. LLLT is supposed to modulate inflammatory response and reduce healing times in aphthous ulcers. Vale et al. in his review concluded that only two controlled clinical trials have been published in the literature concerning LLLT for the treatment of minor aphthous ulcers and it is not possible to dictate a specific protocol that should be used.[22]

Briefly, LLLT has various applications in orofacial pain conditions. The effectiveness of laser therapy in pain relief depends on the condition, type of pain. It depends on the number of sessions and wavelengths and duration of irradiations.

Contraindications

LLLT is considered relatively harmless. Although no reports of harmful effects have been reported, protection of eye of the operator and the patient should be considered. Patients with coagulation disorders require special attention as laser light affects several rheologic properties. Because of the unknown effects of laser on pregnancy, it is recommended to avoid laser in pregnant patients.

Conclusion

Low-level lasers due to their photo biochemical reactions can cause pain relief and can be used for their analgesic, anti-inflammatory, and healing properties to eliminate pain. Although low-level lasers have shown to be effective in diminishing oral and maxillofacial pain, they are not used widely as they need several
appointments and also the technical skill of the procedure limit the widespread use of lasers. Thus, LLLT should be considered as a treatment modality in different orofacial pain conditions.

References