Low-level laser therapy in dentistry: A review

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Abstract

Laser is an acronym for “light amplification by stimulated emission of radiation.” Laser has a wide range of application in medical and dental field. High dose of laser has certain limitation and side-effects on the dental tissue. To overcome these issues extensive research is going on low-level laser therapy (LLLT). LLLT is also known as “soft laser therapy” and bio-stimulation. The use of LLLT in health care has been documented in the literature for more than three decades. Numerous studies have documented that LLLT is effective for some specific applications in dentistry.

Keywords: Dentistry, hard tissue, low-level laser therapy, soft tissue

Introduction

Lasers have been used widely in medicine and dentistry since its development by Maiman in 1960. Laser is an acronym for “light amplification by stimulated emission of radiation.” The name of the low-level laser is an abbreviation of its active medium such as gallium, aluminum and arsenide (GaAlAs) or helium and neon laser. Low-level laser therapy (LLLT) is also known as “soft laser therapy” and bio-stimulation. The use of LLLT has been documented in the literature for more than 30 years. Numerous research studies have demonstrated that LLLT is effective for some specific applications in dentistry.[1]

The use of LLLT has been shown to have a beneficial effect on pain relief,[2] wounds,[3] and nerve injury.[4] Endre Mester in Budapest in the late 1960’s pioneered the biostimulatory effect of low-level laser, who demonstrated an increase in collagen synthesis in skin wounds.[5]

The mechanisms of LLLT are complex, but essentially rely upon the absorption of particular visible red and near infrared wavelengths in photoreceptors within electron transport (respiratory) chain within the membranes of mitochondria.[6] Absorption of LLLT by mitochondria will cause activation of the adenosine triphosphate (ATP) that is the main energy source for the stimulation of normal cell function.

Basic Principles and Mechanism of Action of LLLT

The simplest way to categorize these lasers is according to their wavelength. Several parameters characterize LLLT. These are as follows;

1. Laser power: Ranges from $10^{-3}$ to $10^{-1}$ W
2. Wavelength: Ranges from 300 to 10,600 nm
3. Pulse rate: Range from 0 to 5000 Hz
4. Intensity: Ranging from $10^{-2}$ to 102 J/cm²
5. Electromagnetic spectrum: Therapeutic lasers are within visible red to near visible red ranging from 630 to 980 nm.

Biostimulation is supposed to be the main mechanism of action for LLLT, and it was introduced more than 20 years back when LLLT was used in dermatology for wound healing. There are various mode of action of LLLT has been proposed, some of them which are accepted explained here; Biological effects caused due to the deposition of low energy into tissues where deposited energy results in therapeutic effects. This results in the analgesic and anti-inflammatory effects as well as shows improvement in healing.[7] According to some investigator if the stimulation is to weak, no effect is seen. Increased stimulation and optimal dose lead to the optimal effect; while, further dose increase leads to a decreased effect. Other propose that LLLT can act analgesic since they cause the release of endorphin and therefore inhibit nociceptive signals and control pain mediators in the nerves.[8]
LLLT also has a stimulatory effect on stimulate lymphocytes, macrophages, activate mast cells, and increase production of ATP in the mitochondria and proliferation of various cell types, which are anti-inflammatory agents. LLLT also has the effect on the microcirculation that will reduce the edema by changing hydrostatic pressure of the capillary. Optimum dose of LLLT leads to the formation of new endothelium and new blood vessels that will help in formation granulation tissue and accelerated healing. LLLT lead to the relaxation of the smooth muscles of the various system, which decreases pain and spasm on the affected muscles.

Use of laser is contraindicated in a certain condition like; coagulation disorders because they interfere with blood circulation in a way still unknown. Presences of malignant disease as well as precancerous lesions because LLLT stimulates cell growth. During pregnancy, menstrual cycle, febrile conditions the use of lasers is contra-indicated. Therapeutic lasers weaker than 500 mW are considered to be devices of low risk, but naturally, the use of protective glasses both for the patient and the clinician is a must.

**Application of LLLT in Dentistry**

LLLT has a range of dental, medical, physiotherapy applications. Low-level laser applications in dentistry include the promotion of wound healing in a range of tissues and lesions.

**Soft tissue application**

1. Aphthous ulcers: Various studies stated that; the patients reported significantly less pain as well as less functional complications after LLLT therapy. Furthermore, they stated that they experienced faster healing compared with the usual medication therapy. There is no adverse effect reported on the cells of the epithelium.

2. Herpes simplex infections: Results of the studies have shown that LLLT has a beneficial effect on the healing of Herpes simplex infections. In one of the studies patients were given LLLT therapy every day for 2 weeks for the treatment of Herpes simplex infections. The average interval without herpes lesions was 37.5 weeks in patients who received laser therapy and 3 weeks in patients who received placebo, and the difference was significant. It has also been concluded that it not only increase healing but also will prevent the recurrence of the lesion.

3. Oral lichen planus: Studies have concluded that treatment of oral lichen planus by LLLT shows reduction in pain and a significant decrease in the size of the lesions. Laser was equally effective in the treatment of oral lichen planus as was topically applied corticosteroids, and that is also without any side-effects.

4. Xerostomia: Use of infrared laser shows a significant increase in salivary flow in cases of xerostomia. When a laser with wavelength 904 nm applied to the both parotid and submandibular glands, then the result showed that it was efficient in reducing xerostomia by stimulating these glands.

5. Mucositis: Mucositis is common finding in the patients who were exposed to chemotherapy and radiotherapy for the treatment of malignancy. When LLLT was applied daily within the oral cavity, it showed significantly decreased in the findings of oral mucositis as well as daily mucositis index. It also resulted in decreased pain scores and decreased xerostomia symptoms whereas their swallowing abilities were improved as compared with non-laser therapy patient.

6. Paresthesia: In dentistry paresthesia is one of the complications of surgical treatment, most commonly seen after the surgical extraction of third molars. Investigators based on their study concluded that there was a significant improvement in the mechanoreceptive perception in the damaged alveolar nerve when GaAlAs diode laser of wavelength 820-830 nm was used during every treatment for 90 s in 20 applications.

7. Periodontitis: It is one of the most common diseases of the attachment apparatus of the tooth. It is the major cause of tooth loss in the later part of life. Study conducted by Obradović et al. showed that when the patients of periodontal disease treated with LLLT (670 nm) together with conventional periodontal treatment healing was improved as well as there was improvement in collagenization and homogenization in gingival lamina propria on the basis of histopathological findings. Theodoro et al. used photodynamic therapy by use of LLLT in patients with chronic periodontitis. They concluded that there was a significant difference in periodontal pathogens in patients treated with conventional periodontal therapy as well as with laser as compared to only conventional therapy. Other investigators concluded that LLLT is a potent additional therapy to non-surgical periodontal treatments because it enhances periodontal healing.

**Hard tissue application**

1. Dentinal hypersensitivity (DH): DH is one of the most common causes of dental pain. Use of LLLT to reduce hypersensitivity relies upon laser-induced changes to neural transmission networks within the dental pulp. Most studies to treat DH have used GaAlAs laser treatment and have demonstrated desensitization of hypersensitive cervical dentine, with an efficacy rate of approximately 90%.

2. Temporomandibular disorders: Patients with myofascial pain dysfunction syndrome showed significant improvement in mandibular movement when treated with LLLT (820 nm). It has also been reported that active and passive mouth opening as well as right and left lateral movements were improved after LLLT.

3. Pain during orthodontic tooth movement: Studies have shown that LLLT is beneficial in controlling orthodontic post-adjustment pain. Investigations have shown that LLLT reduces secretion of highly pro-inflammatory molecules.
prostaglandin E2 and interleukin-1 from fibroblast cells that reduced pain after orthodontic tooth movement.  

4. Sterilization of hard tissue: High-power lasers are well recognized for their destructive effects on bacteria. In contrast, if low power laser energy is coupled with dyes into the bacterial cell wall, the energy required for destruction of bacteria would be quite small and would prevent damage to the dentin, pulp and periodontal ligament. Lethal laser photosensitization (LLP) is a term which denotes a process of laser radiation emission from a low power laser device and activation of dye which in turn exerts a lethal effect on particular cells, such as bacteria. These LLP have the potential role in the sterilization of root canal and management of dental caries.

5. Bone implant interphase: Bone implant interphase is a topic of concern to the clinician because success of the implant completely depends on osseo-integration. Khadra et al. from their study concluded that LLLT might have a favorable effect on healing and attachment of titanium implants with the alveolar bone.

6. Lasers in orthodontics: LLLT currently being followed in all the specialties including orthodontics, wherein it has resulted in a better and patient satisfaction practice, including decreased treatment timings and better results along with pain reduction procedures. It helps in etching, contouring of the soft tissue, curing, laser holography and laser welding.

Conclusion

LLLT is useful adjunctive treatment modality in various field of dentistry. It has a beneficial effect on both hard tissue and soft tissue of the oral cavity with less adverse effect. Future trials of LLLT applications in dentistry should make use of standardized, validated outcomes. Effectiveness of the LLLT should also be explored depending on wavelength, treatment duration, dosage, and the site of application.

References