

Low Level Laser Therapy in Modern Dentistry

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Abstract

The purpose of writing this article is to evaluate the anti-inflammatory and analgesic effects of intraoral application of low-level laser therapy. Authors have positive treatment outcomes which allow to reduce prescribing antibiotics and pain killer medications.

Keywords: Laser; Dentistry; Pain management; Wound healing

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Introduction

LASER is an acronym for: Light Amplification by Stimulated Emission of Radiation. Laser therapy has a long history of medical applications and has begun to show great promise in dental applications. There is evidence that laser therapy is a useful adjunct to conventional routine dental care and is rising in popularity among dentists. Lasers are devices which generate electromagnetic radiation that is uniform in wavelength, phase and polarization [1]. They can be classified as a high-powered, low powered, surgical or therapeutic. There is evidence that low-powered or therapeutic laser have analgesic, anti-inflammatory and biostimulatory properties on live tissue. Laser technology has the unique advantage of improving treatment techniques as well as aiding in the healing process.

Some of the major benefits associated with Laser Dentistry are:

1. Laser assisted procedures performed on soft tissue may not require suturing through a process called tissue welding. This is a process that uses laser energy to anastomose tissues.
2. Minimizes bleeding by helping tissue coagulation.
3. Minimizes or even eliminates the need for anesthesia in certain clinical procedures.
4. Bacterial decontamination of deep periodontal pockets, root canal systems.
5. Removal of the smear layer after tooth preparations.
6. PDL regeneration? (LANAP protocol)
7. Stimulate healing of injured tissues.
8. Attenuate pain.
9. Enhance remodeling and repair of bone.

The focus of the article will be Low Level Laser Therapy, commonly known as LLLT. Low Level Laser Therapy, or laser Photobiostimulation, is a form of phototherapy which involves the application of monochromatic and coherent light to injuries and lesions to stimulate healing [2]. It is a non-thermal laser and operates in a wavelength range of 630-980 nm with typical irradiance of 5 mW/cm² to 5 W/cm² and generated by devices with as little power as 1 mW, and up to 10 W with either pulsed or continuous waves. The main absorber for these wavelengths are hemoglobin and melanin. Mucosa does not absorb light well. It transparent comparison to muscles which have the greatest absorption [3].

Penetration depths vary from 3 cm to 5 cm. The most challenging part to find the optimal dosage and dose at target. We talking about therapeutic window than optimal dose. For LLLT to be effective, the applied irradiation parameters including wavelength, power, irradiance, exposure time, and pulse need to be applied within limits. Unlike many other laser treatments LLLT is more analogous to photosynthesis in its mode of action [4,5]. LLLT also differs from photodynamic therapy (PDT). It is a combination of using laser with dye to kill bacteria. Produced singlet oxygen has a strong bactericidal effect.

PDT appears to be a useful adjunctive tool for treating oral infections in the dental specialties of oral surgery, endodontics and periodontitis.

Mechanism of Action

After laser absorption by any cell in the body nitric oxide is removing from the respiratory chain in the mitochondria and level of ATP and ROS are increasing. ATP is the energy currency for a cell. Cell potential increases for normal functioning. This process starts the chain reaction inside the cell followed by gene transcription and cellular signaling. Extracellular or bystander effects also occur [6-8].

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The use of LLLT as a treatment method was first described by Dr. Endre Mester. Dr. Mester's publications on the biostimulatory effects of the low intensity laser began in 1967. These molecular effects of LLLT are generally described as Photobiostimulation. This process describes an event in which photons are absorbed by chromophores. Chromophores are the parts of a molecule responsible for its color. The color arises when a molecule absorbs certain wavelengths of visible light [9-11]. Examples of chromophores in humans include melanin and hemoglobin. Photobiostimulation increases DNA and RNA synthesis and for laser therapy to be used safely and effectively, applied knowledge of tissue anatomy, laser physics and cell biology are necessary. As mentioned, lasers can augment tissue but the response of that tissue will depend on that particular tissue's healing mechanism.

Laser Effects on Cells and Wound Healing

Fibroblasts

Low doses of LLLT stimulates the proliferation of fibroblasts resulting in the higher tensile strengths of tissue needed for proper wound healing. Laser can also initiate the differentiation of fibroblasts into myofibroblasts.

Immune cells

LASER potentiates the proliferative response of peripheral blood lymphocytes. LASER enhances phagocytic activity of macrophages during initial phases of repair response. It may affect immune cells which secrete cytokines and growth factors. Laser affects the local immune system, blood and lymph circulations, cell metabolism. By releasing prostaglandins and endorphins it influences pain perception.

Epithelial cells

LASER has been shown to increase the migration of human epidermal keratinocytes resulting in accelerated wound closure.

Bone cells

Proliferation, differentiation and calcification of osteoblastic cells when cells are in a phase of active growth. Increasing the level of calcium and phosphorus contents.

Blood vascular system

LLLT may reduce tension of vascular smooth muscle and contribute to analgesic effects. Blood is the major absorber of light.

Neuronal Cells

Reduce synthesis of inflammatory mediators, restore function in injured nerves.

Wound healing

Accelerate vasodilation and relaxation of smooth muscles, increased granulation tissue, early epithelialization, and increased fibroblast proliferation, improvement in scar formation (scar thickness, pain occurrence).

Effects on Pain Mechanisms

Analgesia can be achieved with wavelengths from 632 nm to 904 nm. Various biological mechanisms are involved: reducing level of prostaglandin, tumor necrosis factor, interleukin-1 and COX-2 expression, reduce edema and post-trauma hemorrhagic formation, improved microcirculation.

Post-surgical pain

Effective for apical periodontitis following RCT and post-extraction pain.

Dentin hypersensitivity

Changes in pulpal neural transmission. Most effective when tooth crown and root apex is irradiated. For cavity preparation and caries removal we are using hard tissue or hot laser but to sterilize cavity and dentinal tubules LLLT protocol can be applied with conjunction with methylene blue. Treatment of mucositis and recurrent aphthous ulcers show promising results and positive alternative to other treatments better than currently used palliative care methods.

Herpes simplex virus

LLLT is most effective during prodromal stage, but actually can be used in active stage also. More visits will be needed. The future of LLLT is promising. There are no absolute contraindications for LLLT.

Contraindications

- * Eyes of everybody in operative should be protected when laser is in use.
- * Pregnancy- treat with caution, does not apply over fetus. Not enough data.
- * Epileptics - light might trigger the seizure.

Conclusion

LLLT is a safe effective treatment to enable enhanced healing, better tissue remodeling, reduced inflammation and analgesia for use in a wide range of oral pathologies. It is drug free and relatively side-effect free and appears to be efficacious where many current pharmaceuticals are not. Apart from an enhanced rate of postoperative healing and better tissue remodeling, LLLT is also a major benefit for patients who are in pain, are needle phobic or cannot tolerate non-steroidal inflammatory drugs (NSAIDs). Laser devices used for LLLT is classified as a Class III or Class IIIb in comparison with hot lasers (Class IV). Eye protection is necessary by using special glasses. We deeply believe that Laser and LLLT are widespread in Dentistry in near future when more studies and researches will be published.

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