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Low Level Laser: Therapeutic Applications in Dentistry- An Informed View Type: Review article

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Abstract

One of the prime purposes in dental treatment is providing a painless treatment for patients. Lasers are used various field of medicine and dentistry. Therapeutic laser treatment, also referred to as low-level laser therapy (LLLT), offers numerous benefits. Along with the chief benefit of being nonsurgical, it promotes tissue healing and reduces edema, inflammation and pain. Laser therapy works on the principle of inducing a biological response through energy transfer. The parameters that used in laser therapy determine the effective depth of penetration. Each wavelength has a unique effect on the target tissue in the oral cavity. In various field of dentistry laser has been used as treatment modality in treating various pathologies. This review summarizes the mode of action, therapeutic application of LLLT in various field dentistry and safety in dental field.

Introduction

One of the prime purposes in dental treatment is providing a painless treatment for patients.

Laser technology is developing with remarkable speed, and new lasers with broad characteristics are available for use in different fields of dentistry. One such type of laser is Low level laser therapy (LLLT) also called as “soft laser therapy” and bio-stimulation. From more than three decades use of LLLT in health care has been documented in the literature.

Both bio-stimulatory and bio-inhibitory effects on irradiated tissues have been noticed with this laser and each of them can have therapeutic applications. Laser therapy is based on induction of biologic response through energy transfer. The device‘s emitted wavelength determines the effective depth of penetration. Wavelengths greater than 800nm (Far-red to infra-red) penetrate deeper tissues and therefore have applications in deep tissue lesions like joint, muscles diseases and pain reduction. Only 5% capacity of subcutaneous penetration and are more absorbed at the surface when the wavelengths are lower than 800nm.Along with the prime benefit of being non -surgical it encourages tissue healing and exhibits reduction in edema, inflammation and pain[1].

Mechanism of action

Though low level laser therapy involves complex mechanism behind them, basically depends upon the absorption of specific visible red and near infrared wave lengths in photoreceptors with insub-cellular components. Primarily the electron transport chain within the membranes of mitochondria. The absorption of light by the respiratory chain components leads to short-term activation of the respiratory chain, and oxidation of the NADH pool. This stimulation of oxidative phosphorylation leads to changes in the redo status of both the mitochondria and the cytoplasm of the cell. The electron transport chain is able to provide increased levels of promotive force to the cell, through increased supply of ATP, as well as an increase in the electrical potential of the mitochondria membrane, alkalization of the cytoplasm, and activation of nucleic acid synthesis. Because ATP is the "energy currency" for a cell, LLLT has a potent action that results in stimulation of the normal functions of the cell[2].Studies have suggested that a range of biological effects were exhibited by the cell culture when initially it was irradiated with laser light. This explains the bio stimulatory effect of the light[3]. But, if these cultures are then irradiated with non mono chromatic and incoherent light, the previous laser-produced biological effects are almost nullified. This suggests that there are more complex mechanisms at work than the simplex citation of polarization-sensitive chromospheres in the cell. Karuet al[4] (1989) research has shown remarkable insight into the effect of wavelength on LLLT. Her findings also reveal that individual spectral bands may give antagonistic effects on the all-important electron transport chain, for example, blue versus red, and ultraviolet versus red, when these respective wavelengths are delivered in sequence[4]. The study highlighted the fact that metabolic processes in the cell can be enhanced using irradiation with monochromatic visible light in the blue, red and far red region. The wavelengths, dose and intensity of the light are the three factors for the stimulation of photo biological effects. By increasing the respiratory metabolism of the cell, LLLT can also affect the electrophysiological properties of the cell. This has relevance in terms of cells such as mast cells which are triggered to respond by ionic gradients.

Cellular effects of LLLT

On wound healing

Vasodilation, with increased local blood flow also been shown by LLLT. This vasoactive effect is of significance in the treatment of joint inflammation, such as may occur in the TMJ. The relaxation of smooth muscle associated with endothelium also been demonstrated by application of LLLT. The wound healing is accelerated by two factors i.e. vasodilatation which brings in oxygen and also by allowance of greater immune cells into tissue. Furthermore, LLLT can exert vaso active effects by its actions on mast cells.

There is a direct evidence that mast cell degranulation can be triggered by laser light. The micro vascular endothelium in skin, oral mucosa and dental pulp are the predominant location for mast cell distribution. Mast cells in these locations contain the pro-inflammatory cytokine-tumor necrosis factor in their granules. Release of this cytokine promotes leukocyte infiltration of tissues by enhancing expression of endothelial-leukocyte adhesion molecules. In addition, mast cell proteases, such as chymase, alter basement membranes and facilitate entry of leukocytes into tissues. Because mast cells play a pivotal role in controlling leukocyte traffic, modulation of mast cell functions by LLLT can be of considerable importance in the treatment of sites of inflammation in the oral cavity[5].

Aarray of bio-stimulation effects have been demonstrated by LLLT in laboratory studies. In case of fibroblasts, increased proliferation, maturation and locomotion have been noted, as well as transformation to myo-fibroblasts, reduced production of pro inflammatory prostaglandin E2, and increased production of basic fibroblast growth factor. Of note, high dose LLLT suppresses both fibroblast proliferation and autocrine production of basic fibroblast growth factor[6].

LLLT effects on macrophages include increased ability to act as phagocytes, and greater secretion of basic fibroblast growth factor. As a part of the demolition phase of wound healing resolution of fibrin is done by macrophages more quickly with the use LLLT. This is due to their enhance dphagocytic activity during the initial phases of the repair response. More rapid demolition of the wound establishes conditions necessary for the proliferative phase of the healing response to begin[7].

More rapid lymphocytes activation and proliferation is seen with the application of LLLT, while epithelial cells become more motile and are able to migrate across wound sites with accelerated closure of defects. A rapid formation granulation tissue by endothelium is also observed. Early epithelialization, increased fibroblastic reactions, leukocyte infiltration, and neovascularization are seen in wounds irradiated using LLLT. Because of the overall impact of these influences, the time required for complete wound closure is reduced. Moreover, the mean breaking strength, as measured by the ability of the wound to resist rupture against force, is increased.

Wound healing consists of several distinct phases, all of which can be affected at the cellular level by LLLT. The initial, pro-inflammatory and vasoactive phases of inflammation include clotting of any cut blood vessels and deposition of a platelet plug, after which the siteis infiltrated by neutrophils and macrophages. These infiltrating cells, together with resident tissue cells such as fibroblasts, release a variety of biologically active substances such as growth factors. Enhanced production of fibroblast growth factor, for example, can occur with LLLT from fibroblasts and macrophages. The second phase of wound healing involves proliferation, with the formation of granulation tissue as a result of new blood vessel growth. This angio-genesis combined with the deposition of new connective tissue requires successful degradation of the wound matrix by macrophages. The final phase of wound healing, which is remodeling, can continue for months or years, and in this context accelerated formation of bone is of great clinical interest[8].

On cytoskeleton

A final aspect of the effect of LLLT on cells relates to the effects of laser light on the cytoskeleton. Several studies have suggested that cell behavior modulation occurs by re-arrangements of the cytoskeleton by the application of LLLT. As shown by Medrado et al., stimulation of connective-tissue cells toward a myoid phenotype can result in the differentiation of my fibroblasts. It is this cell type which mainly responsible for the contraction force during wound healing. Myofibroblasts share morphologic features in common with fibroblasts and smooth muscle cells. These cells are found in normal tissue, granulation tissue, and some pathological conditions. Because LLLT is an effective stimulator of differentiation to myo fibroblasts, the process of wound healing should be enhanced. The shortened exudation phase of wound healing in skin, and stimulated reparative process was seen in sequential semi-quantitative histological examination[9] when laser light was used for the treatment. LLLT showed the greatest wound area reduction between 1 and 3 days after treatment, a finding which correlated with higher numbers of myofibroblasts.

Earlier wound closure is of great concern in compromised patients, such as diabetics, and patients undergoing treatment for malignancies. Because LLLT can enhance the release of growth factors from fibroblasts, and can stimulate cell proliferation, it is able to improve wound healing in such compromised patients. Histological studies have demonstrated that laser irradiation improves wound epithelialization, cellular content, granulation tissue formation, and collagen deposition in laser-treated wounds, compared to untreated sites.

Analgesic effects of laser[10]

Low-power lasers can leave their effects in different parts of the body. Currently the following analgesic effects are recognized:

1. The concentration of chemical agents such as histamine, acetylcholine, serotonin, H+ and K+, all of which are pain mediators is decreased by the low power lasers
2. They cause vasodilatation and increase blood flow to tissues, accelerating excretion of secreted factors.
3. There is decreased transmission of pain impulses and reduced sensitivity of pain receptors are also seen by laser
4. They decrease cell membrane permeability forNa+ and K+ and cause neuronal hyper polarization, resulting in increased pain threshold.
5. Injured tissue metabolism is increased by electromagnetic energy of laser. This is induced by ATP production and cell membrane repolarization. Low-power lasers increase descending analgesic impulses at dorsal spinal horn and inhibit pain feeling at cortex level.
6. The activity of adrenalin and noradrenalin system (autonomous system) as a response to pain is balanced by these lasers.
7. Low-power lasers increase the urinary excretion of serotonin and glucocorticoids, increasing the production of β-endorphin

LLLT and neural tissues

The neural tissues exhibit reduced synthesis of inflammatory mediators, as well as more rapid maturation and regeneration, particularly axonal growth following the application of LLLT. LLLT has also been proven to reduce pain in patients suffering from post-herpetic neuralgia, from cervical dentinal hypersensitivity, or from periodontal pain during orthodontic tooth movement. LLLT may also be of benefit in treating TMJ disorders. Clinical studies of LLLT used on patients with injuries to joints in other locations (ankle, knee, shoulder, and wrist) using either the AlGaAs 830 nm diode laser in continuous wave mode, or the He-Ne laser 632.8 nm combined with a diode laser 904-nm in pulsed mode, have shown clinical benefits in terms ofa reduction in pain and swelling. Patients treated with LLLT obtain pain relief and recover function more rapidly compared to untreated patients[11]. Identical results have been obtained for LLLT of the TMJ. Active and passive maximum mouth opening and lateral motion are significantly improved by LLLT, with similar results in myogenic and arthrogenic cases[12]. The reduction in number of tender trigger points is also seen. Clearly, such effects may be mediated by a combination of both local and systemic effects. Consistent with this, positive reports of the benefit of LLLT used in the dental office to treat disorders including TMJ pain, trigeminal neuralgia, and muscular pain have been presented. LLLT has proven to be very effective when applied to "trigger points" i.e., myofascial zones of particular sensibility and of highest projection of focal pain points, due to ischemic conditions. Results obtained after clinical treatment of patients with pain of varying origin using LLLT have been particularly promising. An additional area of interest in this field is the use of LLLT to achieve an analgesic effect in the dental pulp prior to restorative procedures. First noted with the Nd: YAG laser in the early1990's, the clinical use of "pre-emptive laser analgesia" is becoming more widespread now asa clinical technique with the

Er:YAG and Er,Crt: YSGG laser. When operated at pulse ratesbetween 15- and 20 Hz, at pulse energies below the ablation threshold of tooth structure, the erbium laser energy penetrates into the tooth, and is directed along hydroxyl apatite crystals (which function like waveguides) towards the dental pulp. Here, the pulses of energy coincide with the natural bio-resonance frequency of Type C and other nerve fibers in the dental pulp. The action of this type of LLLT is to cause a disruption in the action of the Na-K pump in the cell membrane, resulting in a loss of impulse conduction, and thus an analgesic effect for around 15 minutes. Direct examination of teeth lased to achieve this analgesic effect have not shown any evidence of adverse pulpal change at thehistological level over the short or long term. There are parallels of the dental laser analgesic effect with several situations in medicine in which simultaneous non-destructive thermal andnon-thermal bioactivation occur at the periphery of the target tissue. In vivo studies of the analgesic effect of LLLT on nerves supplying the oral cavity have demonstrated that LLLT decreases the firing frequency of nociceptors, with a threshold effect seen in terms of the irradiance required to exert maximal suppression. In vivo, LLLT selectively inhibits a range of nociceptive signals arising from peripheral nerves, including neuronal discharges elicited by pinch, cold, heat stimulation, and chemical irritation. In contrast, neuronal discharges induced by brush stimulation are not affected by LLLT. There is some evidence that laser irradiation may selectively target fibers conducting at slow velocities, particularly afferent axons from nociceptors. This explains why the LLLT effect of laser “analgesia” is not a complete “anaesthesia” of the lased tooth[13].

Applications of low level lasers in dentistry[14]

While there is extensive laboratory evidence on the effect of low level laser therapy on stimulating cells, the major interest in this technique clinically has been for accelerated wound healing or pain reduction. It is thought that the wound healing effects are due to local release of cytokines, chemokines and other biological response modifiers, while analgesic effects may result from both local and systemic effects. The latter may include release of endorphins. Detailed and critical analysis of the LLLT literature reveals that the treatment exerts a range of effects,

Post Surgical

Laser irradiation will significantly decreases the pain, swelling, bruising and inflammation after an extraction thus requiring a decreased (or eliminated) need for post-operative analgesics. The speed of healing of the extraction site will also be increased and there will be a reduced likelihood of formation of dry socket .Also in cases where a dry socket does occur, LLLT will dramatically decrease the pain and stimulate the covering of the exposed bone through the stimulation of fibroblasts[15].

Paresthesia

After oral surgery paresthesias may occur as a result of the surgery, in particular in the mandibular region. LLLT has been used to eliminate or reduce such complications[16].

Restorations

LLLT is being used by many dentists and pedodontists for analgesia of primary tooth restorations. Application at the apex decreases the conduction of nerve impulses from the pulp and stimulates the release of endorphins, both which contribute to a decreased pain sensation (analgesia). Though this technique works best on primary teeth, laser irradiation will allow for comfortable air abrasion treatments and crown & bridge cementations. Without the effect of anesthetic, it is easier to accomplish a proper bite adjustment.

Dental Infections

In any case of a dental infection, the laser can be applied to the submandibular lymph nodes to increase the lymphatic flow of the infected area, reduce the inflammatory cells and bring neutrophils to the site of infection for faster healing. Laser therapy will not preclude the use of antibiotics in most cases but will help to potentiate the uptake of the antibiotic into the blood stream[17]. Laser kills bacteria by the known mechanism lethal laser photosensitization.

Dentin Hypersensitivity/Endodontics

LLLT can assist with pain and inflammation after endodontic procedures and surgery, treat pulp hyperemia, help diagnose irreversible pulpitis and reduce the need to post-operative analgesics. Further, laser irradiation is very effective in treating dentine hypersensitivity. A recent study demonstrated that combining laser therapy with a chemical agent produced an average success rate of more than 85%[18].It might be direct effect of LLLT on neural networks within the dental pulp, rather than any accompanying thermal effects[14].

Periodontology

LLLT stimulate fibroblast for faster regeneration of soft tissues while producing analgesia and modulation of the inflammatory chemicals that cause pain and discomfort. LLLT has been used as combination in therapy with Gingivectomies, periodontal surgeries; periodontitis management has shown improved healing and improved clinical outcomes[14].

Orthodontics

The orthodontic treatments are often painful and have long treatment duration. The application of LLLT to orthodontic cases stimulates osteoblasts. The velocity of tooth movement is also increased. There is reduction in inflammation and pain due to pressure on the teeth while tooth movement is also observed. But some studies have shown no immediate pain relieve but effect was evident after 24-48 hours[19].

Implants

Laser irradiation during the preparation and placement of implants will decrease the pain and inflammation of the surgical procedure and improve the integration of the implant into the bone. Many studies investigating the effect of LLLT during implant placement have demonstrated an improved bone formation around the implant with a substantial decrease in post-operative pain[15]

Soft Tissue Lesions

Soft tissue lesions, such as herpes lesions, denture sores, angular chelitis and lichen planus, respond very well to LLLT. Research has indicated that LLLT can prevent cold sores from erupting if treated in the prodromal stage (when the tingling starts) and speed the healing in cases where the sore has erupted. Clinically, light therapy can be used with ease in a dental office. Because laser therapy is non-invasive and has no significant side effects, the treatments can frequently be done by the auxiliary staff and easily integrated into the practice.

Light therapy uses the body's own natural resources to provide pain relief, muscle relaxation, wound healing and nerve. Low Level Laser Therapy offers a dentist the opportunity to better manage treatments that are often deemed painful by patients while enhancing their practice with improved clinical treatments and patient satisfaction[20].

Safety regarding LLLT[14]

At low level the non ionizing radiation contain minimal risk since it does not increase tissue temperature. The major risk associated with laser is damage to eyes. Low level laser receive class III hazard ratings since their therapeutic use poses the potential for retinal damage. LLLT is compulsorily should be used under proper eye precaution and other safety measures.

Conclusion

Low level laser therapy is an evolving technology. A huge benefit of Low Level Laser Therapy is that patients see their dentist doing something additional to reduce the pain or discomfort that may have been caused during the appointment. LLLT requires a paradigm shift; instead of using drugs to treat the pain after it has started, a medical/dental field has the opportunity to treat the pain instantly in the dental office. In an aging population that is becoming wary of the over-prescription of pharmaceuticals which often carry negative and harmful side effects, laser therapy is an effective alternative or adjunctive tool to achieve improved clinical effects. It is a benefit to the patient and dentist to investigate Low Level Laser Therapy, an untapped resource in the dental industry.

References

1. S Parker: Low level laser in dentistry: British Dental Journal: 2007: vol 22: 132-138.
2. Yu W, Naim JO, Lanzafame RJ. Effects of photostimulation on wound healing in diabetic mice. Lasers Surg Med 1997:20:56–63.
3. Karu TI. Molecular mechanism of the therapeutic effect of low-intensity laser radiation. Lasers Life Sci 1988:2:53-74.
4. Karu TI. Photobiology of low-power laser therapy. London: Harwood Academic Publishers. 1989.
5. Walsh LJ. The current status of laser applications in dentistry. Aust Dent J 2003:48:146-155.
6. Yu W, Naim JO, Lanzafame RJ. The effect of laser irradiation on the release of bFGF from 3T3 fibroblasts. Photochem Photobiol. 1994:59:167-17.
7. Reddy GK, Stehno-Bittel L, Enwemeka CS. Laser photostimulation accelerates wound healing in diabetic rats. Wound Repair Regen. 2001:9:248-255.
8. Bisht D, Mehrotra R, Singh PA, Atri SC, Kumar A. Effect of helium-neon laser on wound healing. Indian J Exp Biol. 1999:37:187-189.
9. Mester E, Mester AF, Mester A. The biomedical effects of laser application. Lasers Surg Med 1985:5:31-39.
10. Hamid Reza Khalighi Fahimeh Anbari Jamileh Beygom Taheri Sedigheh Bakhtiari Zahra Namazi Firoz Pouralibaba: Effect of Low-power Laser on Treatment of Orofacial Pain: JODDD, Vol. 4, No. 3 Summer 2010:4(3):75-78.
11. Medrado AR, Pugliese LS, Reis SR, Andrade ZA. Influence of low level laser therapy on wound healing and its Kitsmaniuk ZD, DemochkoVB, Popovich VI. The use of low energy lasers for preventing and treating postoperative and radiation induced complications in patients with head and neck tumors. Lasers Surg Med 2003:32:239–244.
12. Kulekcioglu S, Sivrioglu K, Ozcan O, Parlak M. Effectiveness of low- level laser therapy in temporomandibular disorder. Scand J Rheumatol. 2003:32: 114-118.
13. Simunovic Z, Ivankovich AD, Depolo A. Wound healing of animal and human body sport and traffic accident injuries using low-level laser therapy treatment: a randomized clinical study of seventy-four patients with control group. J Clin Laser Med Surg. 2000:18:67-73.
14. Meenugoyal, Sameer Makkar, Shinam Parischa: Low level laser therapy in dentistry: International Journal Of Laser dentistry: 2013: 82-88
15. Fekrazad R, Chiniforush N, Bouraima SA, Valipour M, Aslani M, Zare M, Ashtiani Safari O. Low Level Laser Therapy in Management of Complications after Intra Oral Surgeries. J Lasers Med Sci 2012; 3(4):135-40.
16. Khullar S M et al. Effect of low-level laser treatment on neurosensory deficits subsequent to sagittal split ramus osteotomy. Oral Surgery Oral Medicine Oral Pathology.1996; 82 (2): 132-8.

17. Ross G, Ross A: Low level lasers in dentistry: Gen Dent 2008: 56(7): 629-634.
18. Sgolastra F, Petrucci A, Gatta R, Monaco A. Effectiveness of laser in dentinal hypersensitivity treatment: a systematic review: J Endod 2011: 37(3): 297-303.
19. Lim HM, Lew KKK, Tay DK. A clinical investigation of the efficacy laser therapy in reducing orthodontic post adjustment pain.Am J orthodondentofacorthop 1995;108 :614-622.
20. Hersheal Aggarwal, Mohit Pal Singh, Prashanth Nahar, Hemanth Mathur, Soumya GV. Efficacy of low level laser therapy in treatment of recurrent apthous ulcers- A sham controlled split mouth follow up study. Journal of clinical and diagnostic research. 2014 febvol 8 (2):218-221.