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LOW LEVEL LASER THERAPY: AN INSIGHT TO THE PERIODONTAL APPLICATIONS

Periodontology

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ABSTRACT

Low-level laser treatment, also called 'Soft Laser Therapy' has been used for more than three decades in the health system. It was first introduced by Mester and his colleagues. In-vivo and in-vitro experiments have shown that low-level laser is capable of speeding up repair process and also reduce post-operative pain. The application of low-level laser along with gingivectomy would result in improved clinical conditions and faster repair. Low level laser application following coronally advanced flap may enhance treatment prognosis in cases of gingival recession. Low-level laser would also be useful in pain reduction and wound healing in case of gingival grafting procedures. The differences in research results may be attributed, bearing in mind that low-level laser radiation depends on various parameters such as wavelength used, power, energy density, radiation duration, radiation model and the distance from the site under radiation. Hence, this review focuses on the mechanism of low level lasers, their effects on various tissues and the applications in the field of periodontology.

KEYWORDS

low level laser, diode, periodontology

INTRODUCTION:

The term 'LASER' means light amplification by stimulated emission of radiation or empowerment of excited light distribution. Photon radiation is excited by atoms, which then results in the release of the next photons and finally ends up in the generation of a strip of homologous, mono-colour and parallel light, which is named as 'LASER'. The basic theory of laser was first explained in an article by Albert Einstein.[1] However, it took relatively a long time till industry and technology could provide the grounds for manufacturing the first laser tool. Based on the theories put forth by Einstein, the first instrument for producing laser beams was invented by Maiman.[2]

Laser therapy in dentistry is an innovative potential molecular pathway mediating the nexus between inflammation and wound healing in oral tissues. Amongst recent advances, low-level laser therapy (LLLT) is highly recommended for its pain reducing, improved wound healing and anti-inflammatory effects.[3]

Low-level laser treatment, also called 'Soft Laser Therapy' has been used for more than three decades in the health system. It was first introduced by Mester and his colleagues. They pointed out that laser application with 1j/cm4 would result in lesion repair in mice.[4] Low level laser is red light or infrared light, whose wave length has a low absorption power in water and is capable of penetrating into soft and hard tissues in a depth of 3mm-15mm.[5] In-vivo and in-vitro experiments have shown that low-level laser is capable of speeding up repair process.[6] It also reduces the post-operative pain and promotes stability of nerve cell membrane and increases ATP production amongst many other beneficial effects. Hence this review focuses on the mechanism of low level lasers, their effects on various tissues and the applications in the field of dentistry.

Mechanism of Action of Low- Level Lasers:

LLLT works on the principle of bio-stimulation and bio-modulation. Biostimulatory effect of laser irradiation acts directly on antenna pigments of respiratory chain and will increase ATP production. This effect will induce intracellular metabolic changes, faster cell division proliferation, fibroblast migration and accelerate matrix production.[7] Most frequently used is gallium-aluminium-arsenide lasers that operates in spectrum between 780 and 830 nm (Output is between 10 and 500 mW). Advantages are small size, works in continuous mode, but can be electronically or mechanically pulsed.[8]

Low-Level Laser Impact Mechanism on Inflammation:

Low-level laser is capable of reducing inflammation and induces the production of MMP8 (Matrix Metallopeptidase 8) following scaling. It can also prevent increased activity of plasminogen and prostaglandin synthesis. Studies have shown that low-level laser may lower IL-1ß, and this effect depends on radiation duration. In the meantime, it can reduce IFN-γ, while having stimulating effect in the production of PDGF and TGF-ß. All these changes would result in anti-inflammatory effect of low-level laser, and can justify its impact on wound repair. Lasers with wavelength of 670nm when used as an adjunct to periodontal treatment result in improvement of treatment outcomes, as well as reduction in treatment time.[9]

Low-Level Laser Impact Mechanism on Repair:

Many studies have reported that low level laser, with a specified wavelength results in fibroblast reproduction. In higher densities, no reproductive effects are observed. By moderating the inflammatory reactions, low-level lasers will start the proliferation phase sooner, and therefore it will increase collagenous fibers.[10] In many experimental and clinical studies which emphasized on speeding up the repair process, cell reproduction has been reported as the reason for laser impact.

Low-level laser may result in vasodilation, thereby enhancing local blood circulation, as well as relaxing the soft vascular muscles. This vascular dilation is responsible for blood perfusion, and an increase in the immunity cell migration to the tissues, these two effects can speed up repair. On the other hand, low-level laser can activate vessels by affecting the mast cells.[11] There is clear evidence proving that 820nm, 940nm, and 660nm lasers can stimulate mast cell degranulation[12] resulting in the release of pro-inflammatory TNF-α that in turn stimulate the diffusion of leucocytes in to the tissue; and on the other hand, the protease released from mast cells can change the basic membrane and facilitate leucocytes penetration into the tissue.[13] Low-level laser activates lymphocytes and speeds up their reproduction. The impacts of low-level laser on fibroblasts include fibroblast reproduction increase and maturation, fibroblast conversion into myofibroblast, reduction in reproduction of E2 prostaglandin, and an increase in fibroblast growth factor (bFGF).[14] The very vital point here is that such impacts on the skin, buccal and gingival mucosa may be observed under low-level laser doses; while high doses result into reduction of fibroblast reproduction and growth factor release.[14]

Low Level Laser Therapy In Wound Healing:

Periodontal wound healing is necessary when periodontitis and gingivitis or trauma, have affected the composition and integrity of the periodontal structures. LLLT has also been shown to cause vasodilation, with increased local blood flow. This vasoactive effect is of relevance to the treatment of joint inflammation. LLLT causes the relaxation of smooth muscle associated with endothelium. This vasodilation brings in oxygen and also allows for greater traffic of immune cells into tissue. These two effects contribute to accelerated healing.[15,16]

Faster wound closure is of great importance 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.[17,18] These findings have been confirmed in oral mucosal wound healing in clinical studies in humans.[19]

Effects Of Low Level Laser Therapy On Bone Cells:

In a study of wound healing after tooth extraction in a rat model, LLLT delivered on a daily basis for one week using a gallium-aluminium-arsenide (Ga Al As) laser, both increased fibroblast proliferation and accelerated formation of bone matrix were found.[20] In the laboratory setting, LLLT using a HeNe laser exerts pronounced effects on proliferation, differentiation and calcification of cultured osteoblastic cells, although there is a specific therapeutic window for these effects. Cell proliferation and DNA synthesis are increased by LLLT only when the cells are in a phase of active growth. LLLT causes increased accumulation of calcium and accelerates calcification in vitro. If the in vivo parallel holds true, LLLT of healing sites within bone would be expected to increase bone deposition and promote bone regeneration.

For the treatment of intrabony defects, the use of barrier membranes and different types of grafting materials are usually indicated. In the study of effect of LLLT on the healing of bone defects associated with autologous bone grafts, bone remodelling was both quantitatively and qualitatively more evident in irradiated animals than in non-irradiated animals.[21]The association of matrix protein derivative with the LLLT irradiation has shown a reduction in post-operative pain, which suggests that LLLT may improve the effects of matrix protein derivative by reducing post-operative complications.[22] LLLT biostimulation of bone tissue attachment to implant surfaces has also been reported. It has been shown that LLLT influences the expression of osteoprotegerin, receptor activator of nuclear factor Kb ligand and receptor activator of nuclear factor k B, and results in the expansion of bone cells metabolic activity.[23,24]

Low-Level Laser Impact on Pain:

Low-level laser has been suggested as a pain-control protocol, which has more advantages over oral analgesics and anti-inflammatory non-steroidal drugs; the reason is that the treatment protocol of the anti-inflammatory effect of this kind of laser overlaps with its potential in the advancement of wound repair. The analgesic mechanism of low-level laser is not yet clear; however, numerous studies have pointed out the physiological changes from light interference with various cells as the cause. The offered mechanisms include: stability of the lipid double membrane and its proteins, the enhancement of revival system and the increase in ATP production. Low-level laser can modify the inflammatory process in a dose-related mechanism; and thus it can reduce the inflammatory pain. In acute pains, superior outcome is reached when the low-level laser is prescribed within the first 72 hours following the operation.[25]

Applications Of Low Level Laser Therapy:

- LLLT has also been proven to reduce pain in patients suffering from post-herpetic neuralgia, from cervical dentinal hypersensitivity[26] or from periodontal pain during orthodontic tooth movement.[27] LLLT may also be of benefit in treating TMJ disorders.
- The antimicrobial effect low-power lasers is achieved by association with extrinsic photosensitizers, which results in the production of highly reactive oxygen species[28] that cause damage to membranes, mitochondria and DNA, culminating in the death of the microorganisms.[29,30,31] This is the process of PDT, and its use is being increasingly studied with the aim of complementing the microbial reduction achieved by conventional mechanical periodontal therapy.
- It promotes wound healing in sites like surgical wounds, extraction sites, recurrent aphthous ulcerations, etc.

Effect of LLLT on periodontal therapy:

1. Low-Level Laser and Gingivectomy:

Gingivectomy is used to remove the supra-bony periodontal pockets, or the pockets not extending from the mucogingival junction. Moreover, among other gingivectomy applications, one may refer to removing diseased tissue for prosthetic or aesthetic purposes; or even in order to restore the normal gingival structure. Following gingivectomy, an open wound is formed whose repair may take more than five weeks; the period in which the patient may experience pain due to the open wound and secondary repair.[5]

In a split mouth randomized clinical trial, "Clinical Study of the Gingiva Healing after Gingivectomy and Low-Level Laser therapy", Amorim et al.[32] studied 20 patients. The patients had two-sided increased gingival volume on premolar teeth. Soon after gingivectomy was performed in the test group, low-level laser was used for 80 seconds onto the target area; 24 hours later, and also three and seven days post-op, low-level laser was used again. The parameters used in the study included Diode laser with a wavelength of 685nm, and a power of 50mW in continuous mode.

Photographic images were taken 3, 7, 14, 21, and 45 days following surgeries. The photographs were reviewed by three periodontists based on the tissue colour and contour, as well as the clinical condition of the wound repair. After the third day post-op, the clinical visits showed better wound repair in the laser group; furthermore, the biometric assessments revealed more improvements in the laser group on days 21 and 28. In general, it was concluded that the application of low-level laser along with gingivectomy would result in improved conditions and faster repair.[32]

2. Low-Level Laser and Periodontal Flaps:

There are numerous ways for the treatment of gingival recession, one of which is Coronally Advanced Flap (CAF).[33]Numerous models have been suggested to increase the CAF potential as a treatment protocol, one of which is the low-level laser.

Ozturan et al.[34] conducted a study on Coronally advanced flap adjunct with low intensity laser therapy. In this split mouth study, 10 patients with 74 symmetrical gingival recessions of Miller's Classes I and II were recruited. The patients had at least two buccal gingival recessions of Miller's Classes I and II which had been adjacent to each other and had occurred due to traumatic brushing. The clinical parameters which were calculated included the depth and width of the gingival recesion, probe depth, keratinized gingival thickness, and joint commissure, prior to surgery and 12 months post-op.

After CAF, and before suturing, laser was radiated to the targeted area. The laser parameters used included a wavelength of 588nm, with a power of 120mW, continuous mode, and 5 minutes radiation duration. Following suturing, the targeted area was radiated with laser. No dressing was used. The patients underwent laser therapy every day for 5 minutes for 7 days. In the control group, following CAF surgery, laser (in switched off form) was used to blind the patients' mind. Significant differences were found for the width, and depth of the gingival recession, keratinized gingival thickness, and finally clinical attachment level and root coverage in the test was more than that of the control group. Considering the study limitations, including low sample volume, lack of study of aesthetical aspects, and lack of potential for daily laser radiation protocols, the authors suggested that laser application following CAF may enhance treatment prognosis.[34] Periodontal disease is not a painful process, but the studies have shown that 30% of the patients suffer pain, especially following the first week of periodontal post-op.[35,36]

3. Low-Level Laser and Free Gingival Graft:

Free gingival graft has got various uses, including increasing keratinized gingival width; increasing the vestibule depth; [37] reducing gingival erosion;[38] and replacement of pigmented gingiva.[39] Graft includes epithelium and a thin layer of connective tissue, which would result into an open wound being healed between 2-4 weeks. This condition may cause discomfort and tissue damage during and after operation. In 2009, Almeida et al.[40] conducted the following study: "Utilization of low-intensity laser during healing of free gingival grafts". In this "split mouth" randomized clinical trial, 10 patients who needed double-sided gingival graft in the mandible underwent surgery by the same surgeon in one month. In the test group, following grafting, Diode Aluminum-Galium-Arsenide laser with a wavelength of 780nm (infrared) for anti-pain effect, and a wavelength of 660nm (red) for fast repair effect was used. The laser parameters used included a power of 40mW, with an energy dose of 10j/cm² which was continuously emitted onto each side. Laser was used twice, immediately after surgery and 48 hrs. post-op. In the control group, following the free gingival graft, a switched-off laser was used to make them believe it was working. Photographic images were produced at 7, 15, 30, and 60 days post-op. All photographs were studied by 5 periodontists for their morphology, texture, and shade. The patients were asked to record their pain on a scale from 0-10 on the Visual Analogue Scale 3 hrs., 24 hrs., and 7 days post-op. No significant differences were found between the two groups, and it was concluded that low-level laser would not be useful in pain reduction and wound healing.[40]

DISCUSSION:

The lasers have been used in the medical procedures extensively recently. Low level lasers have been associated with better healing in the various specialties like dermatology, ophthalmology, etc. These are known to work at molecular levels and are dose dependent. Biostimulation is reported with the LLLT at 0.001 and 10 J/cm2. The perceptions of patients' desire regarding painless minimally invasive treatment have gained LLLT a lot of interest in field of dentistry.[41]

Previous studies showed that production of fibroblast growth factors by macrophages and fibroblasts was boosted following LLLT application. It has been suggested that LLLT application improved wound healing through increasing keratinocytes' proliferation, stimulating early epithelisation and improving neovascularization. Following gingivectomy, collagen production and organized tissue alignment occur gradually within 3–4 weeks. Thus, acceleration of the wound healing process with laser can be interpreted by a greater collagen production and vascular proliferation in the connective tissue combined with higher proliferative activity in epithelial cells. LLLT has been found to promote growth factors release in the blood stream, which can reach adjacent and distant sites of the body. Therefore, it can be speculated that the application of laser to one site in the mouth may affect the adjacent site as well.[42]

The mechanism by which LLLT acts are complex but mainly depends on the stimulation of normal cell functions that is induced by low levels of laser energy. This result is due to modifying the mitochondrial respiratory chain or the calcium channels which consequently stimulates cell proliferation and metabolism. Enhancement of cell proliferation and decreasing the levels of inflammatory cytokines, the healing of the oral mucosa would be accelerated. Numerous studies demonstrate the ability of LLLT in stimulating human fibroblasts, immune cells, and epithelial cells along with enhanced angiogenesis, growth factor release, and decreasing post-operative pain which ultimately leads to improved wound healing.[42]

Bearing in mind that low-level laser radiation depends on various parameters such wavelength used, power, energy density, radiation duration, radiation model, and the distance from the site under radiation, the differences in research results may be attributed to such parameters. It seems that numerous future studies with adequate samples and various parameters have to be conducted, so more comprehensive conclusions of the low-level laser effect following periodontal surgery would be obtained.

CONCLUSION:

Low level laser therapy provides an attractive, painless and non-invasive therapeutic way to modulate inflammation in dentistry. LLLT is a useful adjunctive treatment modality in various fields of dentistry as it has positive effects on both hard and soft tissues of the oral cavity. It is proven that LLLT encourages the behaviour of various cell types and the future prospects are promising. Nevertheless, the usefulness of LLLT depends on the wavelength, the duration of treatment and the site of application. Therefore, efforts should be focused on the standardisation of the LLLT treatment protocols.

REFERENCES:

1. Einstein A. Zur Quantentheorie der Strahlung. Phys Z.1917; 18:121–8.
2. Maiman TH. Stimulated optical radiation by ruby. Nature. 1960; 187:493-4.
3. Karlsson MR, Diogo Lo¨fgren CI, Jansson H. The effect of laser therapy as an adjunct to non-surgical periodontal treatment in subjects with chronic periodontitis: A systematic review. J Periodontol 2008; 79:2021-2028
4. Mester E, Korényi-Both A, Spiry T, Tisza S. The effect of laser irradiation on the regeneration of muscle fibers (preliminary report). Z Exp Chir. 1975;8(4):258-62.
5. Sobouti F, Khatami M, Heydari M, Barati M. The Role of Low-Level Laser in Periodontal Surgeries. J Lasers Med Sci 2015;6(2):45-50
6. Oton-Leite AF, Silva GB, Morais MO, Silva TA, Leles CR. Effect of low-level laser therapy on chemo radiotherapy- induced oral mucositis and salivary inflammatory mediators in head and neck cancer patients. Lasers Surg Med. 2015; 47:296–305. https://doi.org/10.1002/lsm.2234 PMid:25824475
7. Arbabi-Kalati F, Arbabi-Kalati F, Moridi T. Evaluation of the effect of low level laser on prevention of chemotherapy induced mucositis. Acta Med Iran. 2013; 51:157–62. PMid:23605599
8. Midda M. Innovation et technologie en biologie et medicine. Actes du deuxienne congre modial. L, impact deslasers en sciences odontologiques. Paris, France; 1990. p.105.
9. Pejcic A, Kojovic D, Kesic L, Obradovic R. The effects of low level laser irradiation on gingival inflammation. Photomed Laser Surg. 2010; 28(1): 69-74.
10. Yasukawa A, Hrui H, Koyama Y, Nagai M, Takakuda K. The effect of low reactive-level laser therapy (LLLT) with helium-neon laser on operative wound healing in a rat model. J Vet Med Sci. 2007; 69(8): 799-806.
11. Walsh LJ. Ultraviolet B irradiation of skin induces mast cell degranulation and release of tumour necrosis factor-alpha. Immunol Cell Biol. 1995; 73(3): 226-33.
12. el Sayed SO, Dyson M. A comparison of the effect of multiwavwlenght light produced by a cluster of semiconductor diodes and of each individual diode on mast cell number and degranulation in intact and injured skin. Laser Surg Med. 1990; 10(6):559-68.
13. Walsh LJ, Kaminer MS, Lazarus GS, Lavker RM, Murphy GF. Role of laminin in localization of human dermal mast cells. Lab Invest. 1991; 65(4): 433-40.
14. Yu W, Naim JO, Lanzafame RJ. The effect of laser irradiation on the release of bFGF from 3T3 fibroblasts. Photochem Photobiol. 1994; 59(2): 167-70.
15. Grzesik WJ, Narayanan AS (2002) Cementum and periodontal wound healing and regeneration. Crit Rev Oral Biol Med 13 (6):474–484
16. Pitaru S, McCulloch CA, Narayanan SA (1994) Cellular origins and differentiation control mechanisms during periodontal development and wound healing. J Periodontal Res 29(2):81–94
17. Yu W, Naim JO, Lanzafame RJ. Effects of photostimulation on wound healing in diabetic mice. Lasers Surg Med 1997:20:56–63.
18. Lyons RF, Abergel RP, White RA, Dwyer RM, Castel JC, Uitto J. Biostimulation of wound healing in vivo by a helium-neon laser. Ann Plast Surg. 1987:18(1):47-50.
19. Marei MK, Abdel-Meguid SH, Mokhtar SA, Rizk SA. Effect of low-energy laser application in the treatment of denture-induced mucosal lesions. J Prosthet Dent. 1997:77(3):256-264.
20. Takeda Y. Irradiation effect of low-energy laser on alveolar bone after tooth extraction. Experimental study in rats. Int J Oral Maxillofac Surg 1988:17:388-391.
21. Weber JB, Pinheiro AL, de Oliveira MG, Oliveira FA, Ramalho LM (2006) Laser therapy improves healing of bone defects submitted to autologous bone graft. Photomed Laser Surg 24 (1):38–44.
22. Ozcelik O, Cenk Haytac M, Seydaoglu G (2008) Enamel matrixderivative and low-level laser therapy in the treatment of intrabony defects: a randomized placebo-controlled clinical trial. J Clin Periodontol 35(2):147–156.
23. Kim YD, Kim SS, Hwang DS, Kim SG, Kwon YH, Shin SH, Kim UK, Kim JR, Chung IK (2007) Effect of low-level laser treatment after installation of dental titanium implant – immunohistochemical study of RANKL, RANK, OPG: an experimental study in rats. Lasers Surg Med 39(5):441–450.
24. Lopes CB, Pinheiro AL, Sathaiah S, da Silva NS, Salgado MA (2007) Infrared laser photobiomodulation (lambda 830 nm) on bone tissue around dental implants: a Raman spectroscopy and scanning electronic microscopy study in rabbits. Photomed Laser Surg 25(2):96–101.
25. de Paula Eduardo C, de Freitas PM, Esteves-Oliveira M, Aranha AC, Ramalho KM, Simões A, et al. Laser phototherapy in the treatment of periodontal disease. A review. Lasers Med Sci. 2010; 25(6): 781-92.
26. Sandford MA, Walsh LJ. Thermal effects during desensitization of teeth with gallium-aluminiumarsenide lasers. Periodontol 1994:15: 25-30.
27. Wahl G, Bastanier S. Soft laser in postoperative care in dentoalveolar treatment. ZWR 1991:100:512-515
28. Wainwright M (1998) Photodynamic antimicrobial chemotherapy (PACT). J Antimicrob Chemother 42(1):13–28
29. Bhatti M, MacRobert A, Meghji S, Henderson B, Wilson M (1998) A study of the uptake of toluidine blue O by Porphyromonas gingivalis and the mechanism of lethal photosensitization. Photochem Photobiol 68(3):370–376
30. Bhatti M, Nair SP, Macrobert AJ, Henderson B, Shepherd P, Cridland J, Wilson M (2001) Identification of photolabile outer membrane proteins of Porphyromonas gingivalis. Curr Microbiol 43(2):96–99.
31. Harris F, Chatfield LK, Phoenix DA (2005) Phenothiazinium based photosensitisers – photodynamic agents with a multiplicity of cellular targets and clinical applications. Curr Drug Targets 6(5):615–627
32. Amorim JC, de Sousa GR, de Barros Silveira L, Prates RA, Pinotti M, Ribeiro MS.. Clinical Study of the Gingiva Healing after Gingivectomy and Low-Level Laser Therapy. Photomed Laser Surg. 2006; 24(5): 588-94.
33. Cairo F, Pagliaro U, Nieri M. Treatment of gingival recession with coronally advanced flap procedures: a systematic review. J Clin Periodontol. 2008; 35(8 Suppl): 136-62.
34. 26. Ozturan S, Durukan SA, Ozcelik O, Seydaoglu G, Haytac MC. Coronally advanced flap adjunct with low intensity laser therapy: a randomized controlled clinical pilot study. J Clin Periodontol. 2011; 38(11): 1055-62.
35. Matthews DC, McCulloch CA. Evaluating patient perceptions as short-term outcomes of periodontal treatment: a comparison of surgical and non-surgical therapy. J Periodontol. 1993; 64(10): 990-7.
36. Curtis JW Jr, McLain JB, Hutchinson RA. The incidence and severity of complications and pain following periodontal surgery. J Periodontol. 1985; 56(10): 597-601.
37. Pfeifer J. The growth of gingival tissue over denuded bone. J Periodontol. 1963; 34: 10-6.
38. Mlinek A, Smukler H, Buchner A. The use of free gingival grafts for the coverage of denuded roots. J Periodontol.1973; 44(4): 248-54.
39. Dello Russo NM. Esthetic use of a free gingival autograft to cover an amalgam tattoo: report of case. J Am Dent Assoc.1981. 102(3): 334-5.
40. Almeida AL, Esper LA, Sbrana MC, Ribeiro IW, Kaizer RO. Utilization of low-intensity laser during healing of free gingival grafts. Photomed Laser Surg. 2009; 27(4): 561-4.
41. Abdul Rahman Khan Mohammed. Efficacy of Low Level Laser Therapy in Periodontal Surgery-An Original Research. Annals of R.S.C.B., ISSN:1583-6258, Vol. 25, Issue 4, 2021, Pages. 8667 - 8673
42. Madi and Mahmoud. The evaluation of healing effect of low level laser treatment following gingivectomy. Journal of Basic and Applied Sciences (2020) 9:25