Review Article

Low Level Laser Therapy in Management of Complications after Intra Oral Surgeries

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Abstract:

One of the basic purposes in dental treatment is providing a painless treatment for patients. This purpose may be achieved by the application of laser in dentistry. Low-level laser therapy (LLLT) is an internationally accepted title for biomodulation with low-level lasers which we use to achieve ideal therapeutic effects. Low-level laser therapy is a painless, reproducible, non-invasive, and without need of anesthesia treatment which is used to treat a variety of pain syndromes, injuries, wounds, fractures, neurological conditions and pathologies. 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. We can mention anti-inflammatory effects, stimulation of wound healing, stimulation of immune system, increase of blood flow and activation of vasodilatation, increase of cellular metabolism and analgesic effects as advantages of the application of this type of laser. The aim of this review study was to evaluate the effect of low-level laser therapy after oral surgeries.

Keywords: LLLT; complications; oral surgical procedure

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Introduction

Laser technology is developing with phenomenal speed, and new lasers with broad characteristics are available for use in different fields of dentistry.

Various names for low level laser therapy (LLLT) like cold laser, soft laser and laser therapy are employed. This laser can have both biostimulatory and bioinhibitory effects on irradiated tissues, where 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 therefore have applications in deep tissue lesions (Joint, muscles diseases and pain reduction) and deep points for acupuncture. Wavelengths lower than 800nm (Visible red) have only 5% capacity of subcutaneous penetration and are more absorbed at the surface. Thus they are used in skin diseases and superficial points (1).

Mechanism

The principle behind the application of low level

lasers is the direct application of light energy with biomodulatory capacity on body cells. Photoacceptors (Cytochrome c oxidase) can absorb low level lasers irradiation and transfer it inside mitochondria in order to provide cell energy (ATP) which is the product cytochrome c oxidase and Krebs cycle. In final the stimulation of ATP synthesis results in increased cell activity. These changes influences macrophages, fibroblasts, endothelial cells, mast cells, bradykinin and nerve conduction speed. (2, 3).

Biomodulatory effects of LLLT comprise the following:

Macrophages, lymphocytes, fibroblasts, endothelial cells and keratinocytes proliferation; increase ATP synthesis and cell respiration, growth factors and other cytokines release, change of fibroblasts to myofibroblasts; change in inflammatory mediators level (histamine and prostaglandins); increase in oxygen transport and improve in glucose consumption; changes in cell membrane potential and permeability, sodium/potassium pomp excitation and more calcium removal; vasodilation and angiogenesis (improve in tissue nutrition); collagen synthesis.

Probable mechanisms involved in pain control

The first mechanism of LLLT which was described was that of increased proliferation in tissue repair. However, this mechanism is unlikely to be responsible for pain relief in the short term.

Some authors describe a possible stabilization of nerve cell membranes, probably due to the more stable conformation of the lipid bilayers induced by LPT, and the associated integral proteins of the nerve cell membrane, which have already been reported in the literature. The enhanced redox systems of the cell and an increase in ATP production have also been shown to restore neuronal membranes and decrease pain transmission.

- Reduction of Inflammation and edema (-releasing of inflammatory cytokines like prostaglandin E2 and plasminogen activator could be reduced- less inflammatory cells were present in irradiated samples-
- Reduction of inflammatory cell migration,
- Reduction of edema and inflammatory cytokines like TNF-α, interleukins 1 and 6)
- The laser acts by inhibiting cyclooxygenase,
- Interrupting the conversion of arachidonic acid into prostaglandin and also increases the production of B-endorphin.
- A novel mechanism of nerve block in small diameter peripheral nerves after high output LLLT has recently been described.

In addition to these, analgesic effects of lasers can be explained by the increase synthesis of endorphin and bradykinin which results in decreased activity of C fibers and change in pain threshold, and also in reduction of serotonin and suppress of nociceptors (4-7).

The objective of this review article is to evaluate the effects of LLLT after oral surgery. For a more precise evaluation oral surgeries are divided in four groups of impacted wisdom tooth surgery, periodontal surgeries, implant surgeries, endodontic surgeries.

Impacted wisdom tooth surgery

Extraction of impacted lower third molar teeth is one of the most frequent surgeries of the oral region. Despite the use of correct principles for patient preparation and use of new surgical techniques and precise control of soft and hard tissues, which reduce post surgical complications, there still will be unavoidable determined complications after surgery. Important factors in the occurrence of these complications are complexes, and most of the time related to the inflammatory process. This inflammation is due to surgical traumas. Pain, swelling, and mouth opening limitation are the most frequent problems after surgery. In oral surgical treatments control of patients' pain either in a physical point of view or in a psychological one is very important, because it influences the treatment success rate and the patient's satisfaction. The most severe pain is experienced 3 to 5 hours after surgery following the end of local anesthesia's effects, and lasts 2 to 3 days after what it decreases gradually till the 7 day (8,9), and is usually controlled by the use of pain relief or NSAID.

One of the new methods for control of impacted wisdom tooth surgery complications is the application of LLLT.

In the study performed by Sevil Altundag Kahraman in 2008 with the aim of determination of LLLT effects on pain reduction and post surgical discomfort of lower jaw third molar surgery as well as its part in the healing, 60 healthy patients with bilateral third molars covered by lower jaw bone were selected. The laser

used was Diode GaAlAs with 830nm wavelength and 2.25J energy which was applied for 15 seconds before and right after surgery on one side, while on the other side it was only apply as a placebo. The results didn't show any significant statistical difference between the laser and placebo groups, and based on the data they gathered from this investigation they concluded that LLLT has no beneficial effect on pain and healing after third molar surgery (10).

In another study carried out by Mutan Hamdi Aras et al in 2009, the aim was to evaluate the effect of LLLT on trismus and edema after lower jaw third molar surgery. For this purpose 32 patients were divided in two groups, LLLT and placebo. Patients in the LLLT group received 12J (4J/cm²) intra orally right after surgery on the operated part with a 1 cm distance. The masseter muscle was also irradiated extra orally just after surgery. In the placebo group a similar hand piece to the LLLT group was placed intra and extra orally, but the laser device was off. The amount of mouth opening and face swelling at the second and seven days after surgery were evaluated. The results demonstrated the efficacy of LLLT on trismus and edema reduction at days 2 and 7 after surgery compared to placebo group (11). The reason for the difference in the results of these studies was the use of different parameters. Since the effects of lasers are dose related, it can also be the reason for the contradiction in these results.

Many studies with different designs, wavelengths and parameters have been accomplished, that are presented briefly in table 1 (12-20).

The mechanism of the analgesic effect of lasers is not very clear but evidences exist on the treatments effects of low level lasers on the synthesis, release and metabolism of various chemical nervous mediators like serotonin and acetylcholine in central nervous system, histamine and prostaglandin in peripheral nerves. The increase in production of endorphin, the reduction of C fibers activity, the decrease of bradykinin and the change in pain threshold can also explain the effects of low level lasers on pain (21).

The anti inflammatory effects of LLLT can be due to the augmentation of phagocytosis and increase of number and diameter of lymphatic vessels, decrease in permeability of blood vessels, repair of capillary flow and reduction of edema (22, 23).

Controversial results were obtained from studies because of various variables like classification of teeth impaction, duration of surgery, different wavelength, different parameters, etc.

Periodontal surgeries

In the assessment of the application of LLLT after

Table 1. Studies on the application of LLLT for reduction of complications after impacted wisdom surgery.

Author (Year)	Wavelength	Power/Energy/Dose	Results	Final results
Carrillo(1990)	He-Ne 633 nm	10 J/cm^2	No difference between laser and placebo groups	=
Taube(1990)	He-Ne 633 nm	8mW	No difference between laser and placebo groups	=
Wahl & Bastanier(1991)	He-Ne 633 nm	-	No difference between laser and placebo groups	=
Fernando (1993)	GaAlAs 830 nm	30 mW	No difference between laser and placebo groups	=
Roynesdal (1993)	GaAlAs 830 nm	40 mW	No difference between laser and placebo groups	=
Neckel (2001)	GaAlAs 670 nm	11 J/cm^2	Positive effect of laser	+
Goran Jovanovic(2004)	GaAlAs 670 nm	10 mW	Positive effect of laser	+
Aleska B.Markovic (2006)	He-Ne 633 nm	-	No difference between laser and placebo groups	=
Sevil Altundag Kahraman (2008)	GaAlAs 830 nm	2.25 J	No difference between laser and placebo groups	=
Mutan Hamdi Aras (2009)	GaAlAs 880 nm	100 mW	Laser is efficacious	+
E.Dario Amarillas -Escobar (2010)	GaAlAs 810 nm	100 mW	No difference between laser and placebo groups	=
Marta López-Ramírez (2011)	GaAlAs 810 nm	500 mW	No difference between laser and placebo groups	=

periodontal surgeries, some studies exists which are presented in table 2 (24-28).

Ozcelik et al used Diode laser 588nm in the evaluation of the recovery of wounds by irradiation of LLL after gingivectomy on 20 patients. They irradiated one of operated sides in a randomized way for 7 days. They concluded that the irradiation of LLL accelerated the epithelialization and wound healing (27).

Amorim et al also, performed an evaluation of the effect of LLLT after gingivectomy in a clinical trial. They used a Diode laser 685nm with output power of 50mW in continuous mode right after surgery, 1 day, 3 days and 7 days after surgery. The results demonstrated the positive effect of laser in tissue healing and repair processes (26).

In opposition to the above results, Damante in the assessment of the effects of LLL in wound healing after gingivectomy, didn't reach positive conclusions. One of the reasons for this was the use of power lower than 15mW, as following studies showed that more power is needed to stimulate the wound healing process. In addition the wavelength used is of importance. It seems that the use of wavelengths in the red region is very appropriate (25).

After gingivectomy, collagen formation and gingival tissue organization decreases for 3 to 4 weeks after the reduction of inflammation and vascularity of granulated tissue. Collagen formation takes place after fibroblasts proliferation. Acceleration of wound healing after laser irradiation happens with more collagen synthesis in fibroblasts and vessels proliferation in conjunctive tissues and is accompanied by an increase in cell division in epithelial cells as well(26).

Implant surgeries

The rate of success of dental implant is directly related to the level of osseointegration. Many efforts were made in order to achieve higher percentage of implant osseointegration in a shorter time.

Some studies have assessed the effects of LLLT on the recovery rate of hard and soft tissues around the placed implants in human and animals samples, some of them are briefly mentioned in table 3 (29-35).

J.M Garcia et al in 2011 via a randomized double blind trial investigated the stability of dental implants after LLL irradiation with 830nm wavelength. In total they placed 30 implants in the posterior region of the mandible of 8 patients who had the inclusion criteria and also needed bilateral implants, and during 14 days

Table 2. Studies on the application of LLLT for reduction of post complications after periodontal surgery

Author (Year)	Type of study	Wavelengths used	Type of surgery	Power/Dose used	Results	Final results
In de Braekt et al. (1991)	Animal	Diode 830nm	Palatal surgery	30mW	Absence of effect of laser on wound healing	-
Damante et al.(2004)	Human	Diode 670nm	Gingivoplasty	4 J/cm^2	No difference between laser and placebo groups	=
Amorim et al. (2006)	Human	Diode 685nm	Gingivectomy	50mW	Positive effect on wound healing	+
Ozcelik et al. (2008)	Human	Diode 588nm	Gingivectomy - Gingioplasty	120mW (5 minutes)	Positive effect on wound healing and epithelialization	+
Alipanah et al.(2011)	Human	Diode 685nm	Flap surgery	45mW	Reduction of inflammation in laser group	+

Table 3. Studies on the effects of application of LLLT for osseointegration and wound healing after implant surgery.

Author (Year)	Type of study	wavelength used	Power used	Results	Final results
Dorbudak et al. (2002)	Animal	Diode 670nm	100 mW	Presence of more vital bone around implants	+
Guzzardella et al. (2003)	Animal	Diode 780nm	-	Increase of bone micro hardness	+
khadra et al. (2004)	Animal	Diode 830nm	150mW	Increased contact Implant-Bone	+
Jakse et al. (2007)	Animal	Diode 680nm	75 mW	Increased rate of implants osseointegration and implant-contact in the involved side.	+
Lopes et al. (2007)	Animal	Diode 830nm	10 mW	Increased bone repair	+
Salah. A et al. (2011)	Animal	Diode 904nm	5 mW	Reduction of pain and swelling in the irradiated side. Increased bone opacity in the irradiated side.	+
Garcia M et al. (2011)	Animal	Diode 830nm	86mW	Absence of significant difference in the implant stability rate after laser irradiation.	=

after surgery every 48 hours one side was irradiated with Diode GaAlAs with 830nm wavelength and 86mW power. They measured the implants' primary stability via Resonance frequency analysis (RFA) on the day of surgery, 10 days, 3, 6, 9 and 12 weeks after surgery and found that laser irradiation doesn't make a significant difference on the stability rate of implants (35).

Dorbudak et al in 2002 assessed the effect of laser irradiation on osteocytes and bone retraction around dental implants. Right after they drilled the jaw bone of 5 male baboons in order to place the implants, the regions involved were irradiated for 1 minute with 690nm wavelength and 100mW power, and then they placed the implants. They found that in irradiated regions the ability of osteocytes to stay alive was far greater than in control regions and that the presence of more vital bone around the implants could accelerate the recovery process, but bone retraction under laser irradiation didn't show significant difference (29).

It is difficult to arrive at an overall definitive conclusion because studies differed markedly in design, different animal model used, number, type and location of implants placed, surface of the implants used, length of integration time allowed, different protocols, outcome measurements and analysis.

Endodontic surgeries

There are a few studies on the application of LLLT in the reduction of post endodontic surgery complications.

The study that Michael Payer et al have carried out in 2005 with the title of "Effect of LLLT in endodontic surgery: prospective study of 72 patients" has investigated the possibility of positive clinical effects of LLLT in endodontic surgery. They divided 72 patients in 3 groups, placebo, LLLT and control. In the LLLT group, laser was applied during and after surgery on days 1, 3 and 7 with a total energy of 3 to 4J/cm² in every irradiation. The results showed that there was no relevant clinical effect on the inflammatory response or wound healing process in the LLLT group. Patients in the control group reported more severe pain (36).

In a study done by M.B Kreisler et al in 2004 titled "Effect of LLLT in pain reduction after endodontic surgery: a randomized double blind clinical trial", they assessed the effects of LLL on pain reduction after endodontic surgery. They used GaAlAs laser with 809nm wavelength and a total energy of 7.5J (50mW, 150ms). Their study results demonstrated that LLLT was efficacious in pain reduction after surgery (37).

Conclusion

According to invitro and animal studies in molecular level, low level laser has positive effect on analgesic, anti-inflammatory, metabolic and immunologic reactions but in human studies, differences in types of disease and interventional variables affect the results. So, patient selection and choosing appropriate parameters is very difficult. Also, patient race and specially knowledge and experience of practitioner are very important. So, further standard studies are needed for more accurate suggestions.

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