LASERS: A GUIDING LIGHT IN PERIODONTICS AND IMPLANT DENTISTRY

Abstract

Lasers have become ubiquitous. They have been used for different purposes based on their wavelength and other characteristics. Newer properties of lasers are being discovered still, making them a wonder tool. A lot of innovative and new methods of use of lasers have been developed in the last 3 decades. Lasers have unlocked novel vistas and prospects that can augment periodontal and implantology treatment procedures. The current standard regulations of lasers allow them to be used for disinfection of periodontal pockets, elimination of calculus, enhancement of healing and also in the treatment of diseased implants.

Keywords: Laser, Photobiomodulation, Photodynamic therapy, LANAP, LLLT.

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I. INTRODUCTION

Chronic inflammation known as periodontitis is brought on by the biofilm disrupting the integrity of the periodontium and ultimately leading to its destruction.[1] The primary goal of treating periodontal disorders, most notably periodontitis, is to eradicate the biofilm, which is their primary cause. The ultimate goal of non-surgical periodontitis care is to eliminate the supragingival and subgingival biofilm, which will reduce the inflammation.[2]

Periodontal and peri-implant disorders have been treated using a variety of techniques, including surgical and nonsurgical approaches. These treatments' main goals are to achieve periodontal and peri-implant health and to diminish the risk of an impending disease relapse. Managing these situations clinically involves reducing the pathogenic bacterial load and, consequently, the risk of future inflammation and disease relapse.[3]

The advent of laser technology has led to the development of novel treatment strategies and techniques for the management of periodontal and peri-implant disorders. Laser beams are categorised according to their coherence, collimation, ,monochrome and intensity. One of these characteristics, such as reflection, scattering, absorption, or transmission, may be demonstrated when the laser makes contact with a tissue. The wavelength of the light affects how much energy is absorbed. Certain proteins, chromophores, and water exhibit specific absorption characteristics at a particular laser wavelength. Some wavelengths are even absorbed by bacterial chromophores. The power of penetration and the nature of interaction are thus determined by the laser's wavelength. Compared to Co2, erbium-doped Ytrium aluminium garnet lasers (Er: YAG) and diode lasers, erbium-doped YAG lasers have greater depths of penetration.[4]

The first laser was designed in 1960 by Theodore Maiman.[5] The use of Nd: YAG laser in oral surgical procedure was proposed by Myers and Myers in 1989.[6] LASERS are efficient in eradicating periodontal pathogens. Laser use in the therapy of periodontal disease has offered an array of benefits. Laser treatment is recommended for patients who experience problems with bleeding during surgical treatment or with use of anaesthesia.

Lasers bestow the capacity to supply enormous quantities of energy into comparatively tiny affected regions of hard or soft tissue. The appropriate choice of laser wavelength and considerations is essential in attaining a required alteration of tissues.[7]

II. CALCULUS DETECTION

A Commercially available device called DIAGNODENT uses a Laser wavelength of 655 nm marked for detection of calculus. It uses a separate tip for the uncovering of subgingival calculus which glows contrarily to healthy tissue. This is picked up by the device which is indicated in the numerical display.[8,9]

III. ASSESSMENT OF MOBILITY

Mobility of teeth can be assessed through Lasers. This technique is centered on the estimation of tooth mobility degree by way of the use of dynamic loads and the resultant dislodgement dimensional change by Laser Doppler Vibrometer(LDV)[10]

IV. LASERS IN REMOVAL OF SUBGINGIVAL CALCULUS

The gold standard of care in the non-surgical treatment of periodontitis is considered to be scaling and root planing. The effectiveness of doing this manually versus using ultrasonic devices does not differ significantly.

Scaling procedures also involve the use of lasers. In addition to removing the calculus from the root surface, this changes the cemental surface to make it easier for fibroblasts to adhere.

Due to the thermal characteristics of the co2 laser, the root will become carbonised and damaged.[11] The Nd:YAG lasers and Diode lasers, according to Schwarz et al., are typically ineffective at removing calculus and may cause harmful root surface modifications like grooves and craters.[12]

Since they have a larger water absorption coefficient than carbon dioxide and Nd:YAG lasers, Er:YAG and Er, Cr: YSGG lasers are employed in SRP. Additionally, it absorbs calcium and phosphorus, the two primary ingredients of subgingival calculus. By absorbing the laser energy through the water molecules, the calculus warms up and bursts, making it easier to separate.[13] According to a meta-analysis of the available research on the clinical efficacy of the Er:Cr: YSGG Laser in the non-surgical treatment of chronic periodontitis, the Laser, when used in conjunction with SRP, provided noticeably greater clinical efficacy at a three-month follow-up. At a six-month follow-up, there was no discernible difference.[14]

According to the American Academy of Periodontology, The Er: YAG laser exhibited excellent usage of laser on hard tissue, causing minimum thermal injury and producing a biocompatible coating for the attachment of soft tissues.[15]

V. LASERS IN TREATMENT OF HYPERSENSITIVITY

It has been demonstrated that low-level laser therapy (LLLT) has palliative, anti-inflammatory, and cellular effects in the treatment of hyperemia and dental pulp inflammation. A 780 nm, 30 mW, diode laser or a Nd: YAG laser at low power can be employed to treat hypersensitivity. The following effects on hypersensitive teeth are caused by the laser treatment:

Initially, it lessens the painful symptoms. Later, a powerful cellular metabolic activity, production of odontoblasts and dentin formation occurs. The treatment inhibits the nerve signal communication from periphery to the central nervous system. The dentinal tubules are sealed, blocking the communication, serving to sustain the analgesia. The seal is formed by the coagulation of the hydroxyapatite crystals and creation of reparative dentin.[16, 17]

VI. PHOTODYNAMIC THERAPY

The utilization of photoactive compounds to produce photodestruction of oral bacteria has been proven. The photodynamic method is built on the process of adapting light energy to chemical energy, aided by a supplementary vehicle to convert the light energy, the photosensitizer. This procedure is called photodynamic therapy or antimicrobial photo disinfection. In this, the dye is put on to the area to be treated. The dye (photosensitizer) after light absorption, generates highly reactive oxygen species, sensitizing the bacteria to visible light and causing damage. The resulting free radicals have extremely short half-lives because of their unstable electrical alignment.[18]

In photodynamic therapy, a variety of photosensitizing substances, including toluidine blue, methylene blue, tolonium chloride, and phenothiazine chloride, have been employed. For toluidine blue and methylene blue, a wavelength of 660 nm is required to stimulate the photosensitizer. The wavelength of indocyanine green is 805 or 810. Depending on their affinities for various cellular components, these molecules may interact with them when they are released in a periodontal pocket.[19]

As plaque biofilm is the root cause of periodontitis, photodynamic treatment may be effective in treating the condition. Some microorganisms, such as P. g. and A. a., are able to cross the epithelial barrier and enter the deeper connective tissues, where they can survive. Therefore, traditional mechanical debridement won't be very useful in these circumstances. Because it will have a bactericidal impact on these microorganisms, photodynamic treatment will be a helpful adjuvant in these situations. Numerous research have demonstrated that PDT treatment is effective against periodontal pathogens such as Pg, Fn, Pi, and Pm.[20, 21]

A.a. and P.G. counts significantly decreased after low level laser treatment and APDT as an adjuvant to SRP in the treatment of periodontitis, according to a recent study by Gandhi et al.[22]

VII. PHOTOBIOMODULATION THERAPY

Lasers are used in a type of therapy called photobiomodulation therapy (PBMT) to hasten tissue repair and healing. This treatment can be used to treat a variety of conditions include inflammation, pain, and wounds. Even though the exact mechanism of action is still not fully understood, it is thought to involve the stimulation of cellular processes that promote healing and reduce inflammation. PBMT has been used successfully to treat chronic inflammation, oral mucositis, muscle soreness, and discomfort.

PBMT has been demonstrated to mainly activate an enzyme called cytochrome c oxidase(CCO) , which translates energy into electrons. This enzyme activation intensifies the mitochondrial activity, ATP Production and cellular activities. Besides, PBMT modulate the reactive oxygen species hindering the respiratory chain of stressed cells.[23, 24]

VIII. SURGICAL PERIODONTAL THERAPY

Certain lasers and laser protocols are thought to aid in more effective subgingival curettage, targeted and/or overall decreases in subgingival bacteria, reductions in inflammation, and quick wound healing in addition to the root surface cleansing and detoxification for which they are used.

Flap surgery has been tried with Diode, Carbon Dioxide, Nd: YAG, Er: YAG, and ER: Cr: YSGG lasers as a supplemental therapy. Er: YAG and Diode lasers have been combined with mechanical debridement in access flap surgery for pockets of 5 mm or deeper, and their effectiveness was contrasted with that of mechanical debridement alone. After 3 or

6 months, the clinical findings for the Lasers demonstrated comparable or higher improvements.[25, 26] the results of one study were positive even three years later.[27]

After a 15-year follow-up, a controlled clinical research using a coronally advanced flap, a carbon dioxide laser, and a modified Widman flap as a control revealed excellent outcomes. In locations with an initial probing depth of 5 mm or more, a significant decrease in probing depth and an increase in clinical attachment level were sustained throughout a 15-year period. [28]

The reduction in volatile sulphur compound values in the laser group at 3 and 6 months after treatment was found to be statistically significant, according to the authors of a study using the Er: Cr: YSGG laser to assess the elimination of oral malodor and periodontal disease. BOP values at three and six months after treatment, as well as pocket depth values at one month after treatment, all significantly decreased in the laser group[29].

Triantafyllia Vadgouti et al. conducted a systematic evaluation on the long-term clinical effects of Er: YAG or ER, Cr: YSGG lasers used as monotherapy or as adjuvant to mechanical therapy in the treatment of chronic periodontitis. They came to the conclusion that Er: YAG and Er, Cr: YSGG lasers appear to work better in terms of CAL and PPD reduction, particularly in deep pockets≥ 7 mm, when used as monotherapy or as an addition to SRP.[30]

IX. LANAP (LASER ASSISTED NEW ATTACHMENT PROCEDURE)

This treatment involves the removal of the Junctional epithelium and the gingival sulcus epithelial lining. After the laser application,, it has been observed that epithelial downgrowth is slowed, giving connective tissue more time to adhere to the root surface. Gregg and McCarthy, the people who developed it, outlined a set of standards for LANAP. The FDA gave their approval in 2004. Patients who need specific periodontal therapy and have pockets that are less than 4 mm deep are designated for LANAP. This is accomplished using a 1064 nm free-running pulsed Nd: YAG (6W Periolase MVP)[31.]

The steps are as follows:

- The patient is first given a local anaesthetic to anesthetize the area
- To remove the epithelial lining of the pocket, a 0.3 to 0.4 diameter optic fibre tip is placed parallel to the root surface and pushed in a coronal to apical motion. The 100 millisecond free flowing pulse from the first pass laser scatters energy at 4 w, removing the unhealthy pocket lining.
- The calcified plaque that was adhered to the root surface is removed.
- Through selective photothermolysis, the diseased, contaminated epithelium of the pocket is eliminated while protecting the connective tissue.
- The second pass is carried out using a 4 w 650 millisecond pulse for energy dissipation. Through the formation of an adhesive fibrin blood clot, this promotes internal healing.
- The gingival tissues are compressed against the root surface to seal the space and form a solid fibrin clot.

Instructions for recovery are provided. Recall intervals for patients are every week, every month, and then every three months for maintenance.[32]

Evidence of periodontal regeneration, including new cementum, new bone, and periodontal ligament, has been clearly demonstrated by histologic verification of the cases completed with LANAP.[33] On teeth thought to have a hopeless prognosis, a case series for the management of periodontitis utilising LANAP and a Nd: YAG laser demonstrated good histologic verification of periodontal regeneration. After a 9-month follow-up, a mean clinical attachment level gain of 3.8 ± 2.38, which is mm and a mean probing depth reduction of 5.4 ± 2.65 mm were noted.[34] The completion of a split mouth randomised multicenter study by Harris et al. took place in 2014. He argued that LANAP could have a systemic impact on how subgingival wounds heal.[35]

X. LAPIP PROTOCOL

McCarthy developed the Laser-assisted Peri-implantitis Procedure (LAPIP) concept, which can be applied to failing implants. Utilising laser technology, inflammatory pockets are removed, biofilms are disturbed, and the implant surface is cleaned. The LAPIP technique is carried out on the implant without causing any harm to it. A single appointment can be sufficient to produce the desired outcomes.[36]

XI. LASER ASSISTED REGENERATION (LAR)

It has been demonstrated that using the Nd:YAG laser to treat periodontitis improves clinical periodontal parameters overall and promotes bone regeneration. Later, research was conducted leading to the idea known as "laser-assisted periodontal regeneration" (LAR).[37]

A histological analysis of teeth that have undergone laser-assisted regeneration (LAR) treatment was done by Yukna et al. They demonstrated that following a 12-week follow-up, it was possible to create new attachment and regenerate cementum and the periodontal ligament.[33]

A clinical and microbiological investigation was conducted by Nammour et al utilising a 980 nm diode laser and 3% hydrogen peroxide. The CAL significantly improved, and the depth of the pocket decreased.[38] Laser assisted periodontal regeneration has a lot of potential as it involves usable surgical resources and minimally invasive character.

XII. PERI-IMPLANTITIS

1. **Nonsurgical Treatment Outcomes for Peri-Implantitis:** When compared to mechanical debridement, using a laser to decontaminate implants has been found to improve the nonsurgical results. In order to treat periimplantis, Chambrone et al. used antimicrobial photodynamic therapy (aPDT). Results from aPDT were equivalent to those from nonsurgical therapy.[39]

2. **Surgical Treatment Outcomes for Peri-Implantitis:** Laser therapy for peri-implantis is effective. An Er: YaG laser was used in a study by Clem D and Gunsolley JC for implant surface and defect debridement.After receiving treatment for a year, radiographic defect filling was visible and probing depths of 6 mm decreased to 3.5 mm[40]

XIII. CONCLUSION

Lasers have the power to boost cellular activity, reduce inflammation, and speed up the healing of wounds. For the elimination of biofilm and removal of calculus, lasers present an effective and dependable alternative to conventional treatment procedures. Laser surgery is associated with less pain than conventional therapy. Clinical attachment level and probing depth improvements from laser therapy are comparable to or slightly superior to those from traditional therapy. As lasers tend to have a variety of tissue reactions, newer modalities of delivery and use of lasers is the need of the hour.

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