LASER ASSISTED PERI – IMPLANTITIS PROTOCOL (LAPIP) - A BOON IN THE MANAGEMENT OF PERI - IMPLANTITIS – A NARRATIVE REVIEW

1. Sakthivel Kannan

Postgraduate student, Department of Periodontics, Meenakshi Ammal Dental College and Hospital, Meenakshi Academy of Higher Education and Research (MAHER) (Deemed to be university), Chennai, Tamil Nadu, India.

2. Jaideep Mahendra (Corresponding Author)

Professor and Head, Department of Periodontics, Meenakshi Ammal Dental College and Hospital, Meenakshi Academy of Higher Education and Research (MAHER) (Deemed to be university), Chennai, Tamil Nadu, India.

3. Sathish Rajendran

Associate professor, Department of Periodontics, Meenakshi Ammal Dental College and Hospital, Meenakshi Academy of Higher Education and Research (MAHER) (Deemed to be university), Chennai, Tamil Nadu, India.

4. Annie Arockia Mary

Assistant professor, Department of Periodontics, Meenakshi Ammal Dental College and Hospital, Meenakshi Academy of Higher Education and Research (MAHER) (Deemed to be university), Chennai, Tamil Nadu, India.

ABSTRACT:

Lasers play a significant role in periodontics, with applications ranging from calculus removal to soft tissue excision, incision, and ablation. They are also employed for decontaminating root and implant surfaces, promoting biostimulation, reducing bacterial load, and performing osseous surgery. Their use offers a promising alternative by enabling the simultaneous removal of diseased tissues, targeting pathogenic microorganisms, and enhancing wound healing. This review explores the integration of lasers into dental practice and periodontics, highlighting their benefits, limitations, and potential risks in the management of peri - implantitis.

Keywords: Laser, periodontics, peri - implantitis, bacterial reduction, implant therapy.

INTRODUCTION:

Laser is a device that emits coherent electromagnetic radiation. With few exceptions, laser radiation is characterized by a well-defined wavelength and a minimal beam divergence. Laser irradiation produces significant hemostasis, bactericidal, detoxifying and ablation effects on tissue due to its photophysical properties. These results may be advantageous in the course of treating periodontal disease, particularly when it comes to the debridement of diseased tissues and fine cutting of soft tissue. As a result, laser in periodontal therapy may be used in place of or in addition to mechanical methods.[1] Periodontitis is the leading cause of tooth loss, with other factors including trauma, caries, and genetic or developmental anomalies. Over the past 30 years, the use of dental implants has increased significantly. While removable and fixed partial dentures were once common, implants are now the preferred option due to their high success rate and predictability.[2] Peri-implant disease includes peri-implant mucositis (reversible soft tissue inflammation) and peri-implantitis (irreversible tissue and bone loss). Peri-implantitis affects 5–8% of implants and is linked to anaerobic bacteria, poor force distribution, and failed osseointegration. Implant failure occurs with significant bone loss or mobility. Treatment challenges include limited drug efficacy, bacterial resistance, and mechanical damage from cleaning tools. Lasers offer a promising alternative due to their bactericidal, hemostatic, and selective cleaning properties.[3] The aim of this literature review is to summarize the use of hard and soft tissue lasers in the treatment of Peri - implantitis.

HISTORY OF LASERS:

The concept of lasers began in 1900 with Max Planck's quantum theory of light, which introduced the principles of stimulated and spontaneous absorption. These ideas evolved into the concept of stimulated emission. In 1917, Albert Einstein expanded on this by proposing photoelectric amplification through stimulated emission, laying the theoretical groundwork for both the laser and its forerunner, the maser.[4]

The acronym LASER ("Light Amplification by the Stimulated Emission of Radiation") was popularized in 1959 by Gordon Gould. Theodore Maiman constructed the first working laser using a helium-neon mixture. Key advancements followed:

- 1961: Nd:YAG laser (neodymium-doped yttrium-aluminum-garnet) emerged.
- 1962: Argon laser developed.
- 1963: Ruby laser used medically for retinal coagulation.
- 1964: CO_2 laser invented by Patel at Bell Labs.

  Today, diode lasers are widely applied in dentistry.

PROPERTIES OF LASER:

A laser emits monochromatic light—a single wavelength—by stimulating a synthetic active medium like gas, crystal, solid-state, or semiconductor. This stimulation produces energy-rich photons that can be used for incising, cutting, and ablation. The clinical applications of lasers depend on their wavelengths, as chromophores in oral and dental tissues absorb specific wavelengths, guiding their therapeutic use.[5]

Laser light is unique in that it is monochromatic (single wavelength), highly directional (focused in one direction), and coherent (its waves are in phase in space and time). These properties result in a beam that is far brighter and more intense than ordinary, incoherent light sources like sunlight or bulbs, which emit light in multiple directions and wavelengths.[6]

MECHANISM OF ACTION OF LASERS:

A laser produces monochromatic light (single wavelength) using three main components: an energy source, an active lasing medium, and an optical resonator formed by mirrors. Energy is introduced via pumping mechanisms (like flash lamps or electrical currents), causing spontaneous emission of photons. These photons undergo stimulated emission as they bounce within the resonator and exit through the output coupler. In dental lasers, the beam reaches tissue through fiberoptic cables, waveguides, or articulated arms. The wavelength and behavior of the laser are defined by the type of active medium used—gas, crystal, or semiconductor.[4]

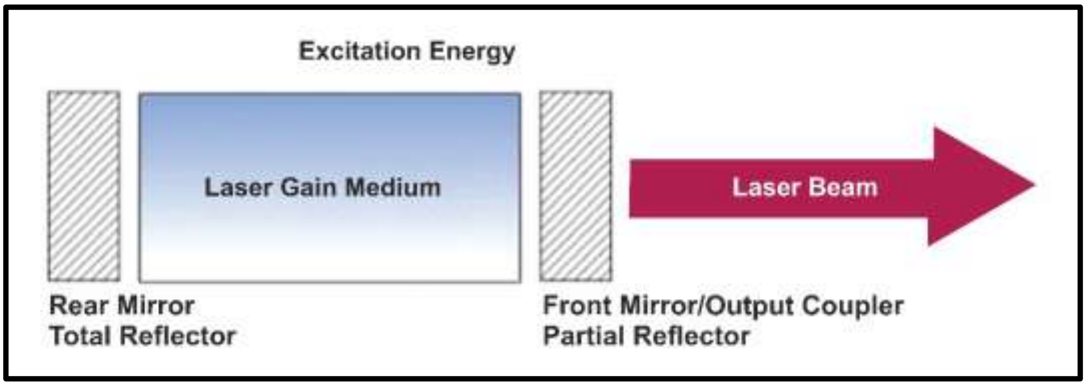

Figure: 1 Mechanism of action of laser.[4]
(Courtesy: Sanjeev Kumar Verma,2012

Laser amplification begins when energy is supplied to an active medium via a pumping mechanism (e.g. flash-lamp, electrical current), producing spontaneous photon emission within an optical resonator. These photons undergo stimulated emission as they bounce between reflective surfaces and exit through the output coupler.

Laser light interacts with tissues in four ways: Reflection, Transmission, Scattering, and Absorption. Upon absorption, laser energy raises tissue temperature, leading to:

- 60–100°C: Protein denaturation
- 100°C: Water vaporization (ablation)
- >200°C: Tissue burning (carbonization)

Different laser wavelengths have varying absorption in tissue components, making their clinical use highly procedure-specific.[4]

DENTAL IMPLANTS:

Dental implants are considered the gold standard for replacing missing teeth due to their stability, esthetics, and ease of maintenance. They are freestanding, making them ideal for both single and multiple tooth replacements, and can significantly enhance patients' quality of life and confidence. Implants are made from biocompatible materials like commercially pure titanium (CP-Ti grade 4) or titanium alloy (Ti-6Al-4V ELI), known for their corrosion resistance due to a protective TiO_2 oxide layer.

Their success hinges on osseointegration—a process first defined by Branemark—where the implant becomes firmly anchored to the jawbone. Key factors for successful osseointegration include:

- Surface properties of the implant
- Design features that ensure primary stability

Micromovements in unstable implants may hinder integration by causing fibrous tissue formation and bone resorption at the bone-implant interface.[7]

IMPLANT SURFACE CHARACTERISTICS:

Surface characteristics play a crucial role in bone-to-implant contact. Surface treatments enhance the active area and mechanical bonding with tissue, promoting faster and stronger osseointegration. A "moderately rough surface"—with height deviation values (Ra and Sa) between 1–2 µm—is considered optimal, enabling better stability during healing and allowing for earlier implant loading.[28] Implant surface modification techniques—such as machining, plasma spray coating, grit blasting, acid etching, SLA, anodizing, and biomimetic coatings—aim to enhance osseointegration by improving biological compatibility. Surface roughness, especially within the 1–100 µm range, has been shown to increase osteoblast activity compared to smooth surfaces. While rough surfaces generally promote better bone integration, the effectiveness of multiple surface treatments remains inconclusive due to varied research outcomes.[8]

TYPES OF DENTAL IMPLANTS:

There are four main **dental implant designs**: **subperiosteal**, **blade**, **ramus frame**, and the widely used **endosseous form**. Endosseous implants, often **screw-shaped**, are inserted into the **maxilla or mandible** to replace tooth roots. They're commonly made from **grade 4 commercially pure titanium** for its strength and corrosion resistance.

Key **macro-designs** of endosseous implants include:

1. **Screw threads**
2. **Solid body press-fit designs** (cylindrical or conical)
3. **Porous-coated designs**

These configurations influence **biomechanical stability** at the bone-implant interface. **Screw-type implants** are most popular due to their **high initial retention and success rates**. Critical **thread design parameters**—such as **pitch**, **height**, and **shape**—affect surface area and implant performance. A **smaller thread pitch** increases thread count for a given length, enhancing bone interaction.[9]

PERI – IMPLANTITIS:

Peri-implantitis is a disease affecting the tissue surrounding dental implants, marked by inflammation of the peri-implant mucosa and a gradual loss of supporting bone. Similar to how gingivitis can advance to periodontitis, peri-implantitis is believed to be preceded by peri-implant mucositis. However, the specific factors or conditions that trigger this progression remain unclear.[10]

RISK FACTORS FOR PERI – IMPLANTITIS:

SMOKING:

Studies show a strong link between smoking and chronic periodontitis, bone loss, and tooth loss. Initial research, like that of Lindquist et al. and Karoussis et al., indicated that smokers have a higher prevalence of peri-implantitis compared to non-smokers. However, more recent studies, including those by Aguirre-Zorzano et al., found no consistent increased risk for smokers after adjusting for confounding factors. This suggests that the apparent link between smoking and peri-implantitis may be influenced by other variables, rather than being a direct causal relationship.[10]

DIABETES:

Diabetes mellitus, a metabolic disorder affecting ~8% of adults globally, is recognized as a risk factor for periodontitis and peri-implantitis. Studies show that:

- Ferreira et al. reported peri-implantitis in 24% of diabetic individuals, versus 7% in non-diabetics.
- One 11-year study found a threefold higher risk of peri-implantitis in diabetic patients at implant placement—though without adjustment for confounding factors.
- Tawil et al. found no cases of peri-implantitis in patients with well-controlled diabetes (HbA1c ≤7%), while 6 cases occurred among those with HbA1c between 7–9%.

These findings suggest that poor glycemic control increases the risk of peri-implantitis, though confounding variables may influence outcomes.[10]

TREATMENT OF PERI – IMPLANTITIS:

Management of peri-implant infections involves both non-surgical (conservative) and surgical strategies. The choice of therapy depends on the extent of the condition: while peri-implant mucositis or milder forms of peri-implantitis may respond adequately to nonsurgical interventions alone, more advanced cases often require a sequential approach, beginning with nonsurgical therapy and progressing to surgical treatment if necessary.[11]

Peri-implantitis management may involve either nonsurgical (conservative) or surgical interventions. Surgical therapy can be performed through resective or regenerative techniques. Alongside pharmacological measures and conventional mechanical debridement methods—such as curettes, ultrasonic devices, and air-polishing systems—novel approaches including laser-assisted procedures and photodynamic therapy have recently been introduced as conservative treatment options.[11]

Manual debridement of implants can be performed using curettes made of materials such as Teflon, carbon, plastic, or titanium. Since conventional curettes may alter and roughen the implant surface, it is generally advised that the instrument tips be composed of materials softer than titanium. Both piezoelectric scalers and hand instruments have been shown to effectively reduce bleeding on probing, with studies reporting no significant differences between these methods in terms of improvements in bleeding scores, plaque index, or probing depth after a minimum follow-up of six months.[11]

A wide range of in vitro and in vivo studies have investigated the use of medicaments in managing mucositis and peri-implantitis. However, variations in study design make direct comparisons challenging. The therapeutic approaches generally fall into two categories:

- Antiseptic mouth rinses evaluated across different clinical parameters.
- Systemic and locally administered antibiotics assessed in relation to pocket depth and other variables.[11]

LASER THERAPY:

Lasers are increasingly being explored for peri-implant decontamination due to their ability to target small, inaccessible areas more effectively than mechanical methods. Their bactericidal, haemostatic, and selective calculus removal properties contribute to improved clinical outcomes. In vitro studies have confirmed that Er:YAG, CO_2, and diode lasers can significantly or completely eliminate bacteria on titanium surfaces, and microscopic analyses show that, when properly applied, these lasers do not damage the implant surface.[12] The LAPIP technique is a targeted, implant-specific adaptation of the LANAP protocol, both utilizing Nd:YAG laser ablation to remove inflamed sulcular tissue and decontaminate the implant surface. This is followed by non-surgical periodontal therapy. LAPIP promotes healing by forming a stable blood clot, which prevents epithelial down-growth and supports apico-coronal tissue regeneration around the implant.[13]

ADVANTAGES AND DISADVANTAGES OF LASER:

The advantages of laser includes greater homeostasis, bactericidal effect, minimal wound contraction in incision, ablation and reshaping oral soft tissues easily when compared to a scalpel. However a variety of disadvantages are observed including tissue destruction at bottom of the pocket, excessive ablation of root surface and gingival tissue, injury to hard and soft tissues. It is also necessary to follow precautions like use of glasses for protection, inadvertent irradiation, protect patients eyes, throat and oral tissue, reflection from shiny surfaces and adequate high speed vacuum to capture laser plume.[14]

LASER ASSSISTED PERI – IMPLANTITIS PROTOCOL:

LAPIP (Laser-Assisted Peri-Implantitis Procedure) is a minimally invasive laser-based treatment designed to manage peri-implantitis, an inflammatory condition around dental implants. Adapted from the LANAP protocol, LAPIP uses lasers to:

- Remove inflamed tissue and disrupt biofilms
- Decontaminate the implant surface
- Promote hemostasis and blood clot formation, sealing the area and supporting healing

LAPIP is notable for its:

- Up to 90% success rate in treating peri-implantitis
- Ability to preserve implant stability and integrity
- Stimulation of gum tissue and bone regeneration
- Reduced discomfort and recovery time compared to traditional surgery

By precisely targeting bacteria without cutting or suturing, LAPIP enhances long-term implant outcomes with minimal trauma to surrounding tissues.[15]

The LAPIP protocol is a minimally invasive laser treatment that effectively restores peri-implant tissues to health without damaging the implant. Using the PerioLase MVP-7 (Nd:YAG laser), it:

- Removes diseased tissue while preserving healthy structures
- Eliminates infection and maintains tissue height

- Promotes bone and tissue regeneration
- Requires no flap surgery, reducing pain and preserving future treatment options
- Forms a stable blood clot for healing and protects implant investment

Often completed in a single visit, LAPIP offers a low-risk, highly effective first-line therapy for managing peri-implantitis.[16]

LAPIP TREATMENT PROCEDURE:

- A periodontal probe detects excessive pocket depth.
- The PerioLase® MVP-7™ laser energy vaporizes bacteria, endotoxins, and unhealthy tissue selectively while also removing titanium corrosion debris from the soft tissue around the implant.
- Ultrasonic scaler tips are employed to clear debris from the implant.
- The bone is modified to allow the release of stem cells.
- After the cleaning of the pocket is complete, the PerioLase MVP-7 stimulates the growth of natural factors that aid in sealing the pocket, preventing any new bacteria from entering.
- The gums recover and return to a clean surface.
- Bite trauma is adjusted as necessary.
- Bone regeneration takes place around the implant.[16]

CONCLUSION:

Traditional non-surgical periodontal therapy, when combined with laser treatment, offers an effective approach for managing peri-implantitis. These methods can help resolve soft and hard tissue inflammation and support long-term implant health. Regardless of the technique, supportive periodontal care remains essential for treatment success. While laser therapy shows promise as an adjunct to mechanical debridement, there is still a need for standardized laser parameters to optimize treatment outcomes.[13,17]

BIBLIOGRAPHY:

1. Ishikawa I, Aoki A, Takasaki AA, Mizutani K, Sasaki KM, Izumi Y. Application of lasers in periodontics: true innovation or myth?. *Periodontol 2000* 2009;1:50(1).
2. Hong DG, Oh JH. Recent advances in dental implants. *Maxillofac Plast Reconstr Surg* 2017;39:1-0.
3. Prathapachandran J, Suresh N. Management of peri-implantitis. *J Dent Res* 2012;9(5):516.
4. Verma SK, Maheshwari S, Singh RK, Chaudhari PK. Laser in dentistry: An innovative tool in modern dental practice. *Natl J Maxillofac Surg* 2012;3(2):124-32.
5. Abu-Ta'a M, Karameh R. Laser and its application in periodontology: A review of literature. *J Stomatol* 2022;12(10):305-20.
6. Svelto O. Properties of laser beams. *In Principles of Lasers* 2009;21 (pp. 475-504). Boston, MA: Springer US.
7. Shemtov-Yona K, Rittel D. An overview of the mechanical integrity of dental implants. *Biomed Res Int* 2015;1:547384.
8. Hong DG, Oh JH. Recent advances in dental implants. *Maxillofac Plast Reconstr Surg* 2017;39:1-0.
9. Gaviria L, Salcido JP, Guda T, Ong JL. Current trends in dental implants. *J Korean Assoc Oral Maxillofac Surg* 2014;40(2):50.
10. Ramanauskaite A, Schwarz F. Current Concepts for the Treatment of Peri-implant Disease. *Int J Prosthodont* 2024;1:37(2).
11. Smeets R, Henningsen A, Jung O, Heiland M, Hammächer C, Stein JM. Definition, etiology, prevention and treatment of peri-implantitis–a review. Head & face medicine. 2014 Sep 3;10(1):34.
12. Ashnagar S, Nowzari H, Nokhbatolfoghahaei H, Zadeh BY, Chiniforush N, Zadeh NC. Laser treatment of peri-implantitis: a literature review. *J Lasers Med Sci* 2014;5(4):153.
13. Alshehri FA. The role of lasers in the treatment of peri-implant diseases: A review. *Saudi Dent J* 2016;28(3):103-8.
14. Aoki A, Sasaki KM, Watanabe H, Ishikawa I. Lasers in nonsurgical periodontal therapy. *Periodontol 2000* 2004;36(1):59-97.

15. Dörtbudak O, Haas R, Bernhart T, Mailath-Pokorny G. Lethal photosensitization for decontamination of implant surfaces in the treatment of peri-implantitis. *Clin Oral Implants Res* 2001;12(2):104-8.
16. De Angelis N, Felice P, Grusovin MG, Camurati A, Esposito M. The effectiveness of adjunctive light-activated disinfection (LAD) in the treatment of periimplantitis: 4-month results from a multicentre pragmatic randomised controlled trial. *Eur J Oral Implantol* 2012;1:5(4).
17. Roncati M, Lucchese A, Carinci F. Non-surgical treatment of peri-implantitis with the adjunctive use of an 810-nm diode laser. *J Indian Soc Periodontol* 2013;17(6):812-5.