

LASERS AND THEIR CLINICAL APPLICATIONS IN PERIODONTICS: A REVIEW

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Abstract: This article reviews the application of lasers in field of periodontics. Various types of lasers along with their mechanism of action and their role in dental field are discussed in this article. A brief explanation of the classification is mentioned.

Keywords: Lasers, Periodontics.

1. INTRODUCTION

LASER, an acronym for Light Amplification by Stimulated Emission of Radiation, was first developed by Maiman (1), a scientist with the Hughes Aircraft Corporation, using ruby crystal that emits a coherent radiant light when stimulated by energy based on theory originally postulated by Albert Einstein. Goldman (2), a dermatologist experimenting laser for tattoo removal, showed painless surface crazing of enamel after focusing two pulses of redlight beam from ruby crystal. Following experiments by Stern and Sognnaes (3), pendulum shifted from ruby laser to CO₂ and Nd:YAG lasers for better interactions with dental hard tissues. 1970s and 1980s sought use of lasers for soft-tissue surgical procedures, and Lenz et al (4) were among the pioneers to report oral surgical application of CO₂ laser, togetherwith Frame, Pecaro, and Pick who used the same for oral soft-tissue lesions and periodontal procedures. Myers and Myers described the use of modified ophthalmic Nd:YAG laser for removal of dental caries and received The US FDA gave permission for selling of Nd:YAG laser device in 1989 (5). After Myers's suggested use in soft tissue surgery, Nd:YAG laser was eventually used in periodontal procedures (6), and since then lasers have been used largely by researchers and clinical periodontal parctioners.

2. CLASSIFICATION OF LASERS

Lasers can be classified according its spectrum of light, material used, and hardness etc. Lasers are also classified as soft lasers and hard lasers. Soft lasers are of cold (athermic) energy emitted as wavelengths; those are thought to stimulate cellular activity. These soft lasers generally utilize diodes and the manufacturers claim that these lasers can aid healing of the tissue, reduces inflammation, edema, and pain. Clinical application includes healing of localized osteitis, healing of aphthous ulcers, reduction of pain, and treatment of gingivitis. The current soft lasers in clinical use are the:

- Helium-neon (He-N) at 632.8 nm (red, visible).
- Gallium- arsenide (Ga-As) at 830 nm (infra-red, invisible).

Hard lasers (surgical) can cut both soft and hard tissues. Newer variety can transmit their energy via a flexible fiber optic cable. Presently more common type clinically used, under this category of the medical lasers are:

- Argon lasers (Ar) at 488 to 514 nm

- Carbon-dioxide lasers (CO₂) at 10.6 micro-meter
- Neodymium-doped yttrium aluminum garnet (Nd:YAG) at 1.064 micrometer.
- Holmiumyttrium-aluminum-garnet (Ho:YAG) at 2.1 micro-meter.
- Erbium,chromiumyttrium-selenium-gallium-garnet (Er,Cr:YSGG) at 2.78 micro-meter.
- Neodymiumyttrium-aluminum-perovskite (Nd:YAP) at 1,340 nm.

3. CLINICAL APPLICATIONS

Initial Periodontal Therapy

Soft tissue lasers are used as an adjunct or an alternate in periodontal therapy to reduce the soft tissue inflammation (7). It reduces the bacterial populationsphotothermally and in addition eliminates the antimicrobial's problems like resistance, allergy and side effects, thus can be used even in children and pregnant women (8). For bacterial reduction and coagulation, soft tissue lasers as argon (488 nm, 514 nm), diode laser (800-830 nm, 980 nm) and Nd:YAG (1064 nm) are a good choice for periodontally diseased dark inflamed tissues and pigmented bacteria. Laser energy is delivered with a thin, flexible fiber optic system and are well absorbed by melanin and hemoglobin and other chromophores but transmitted through water and poorly absorbed in hydroxyapatite (9). Although well absorbed by hydroxyapatite and water, Er,Cr:YSGG (2790 nm), may also be applicable for soft tissue therapy when used carefully by keeping the fiber in contact with target tissue and in vitro study had shown significant bactericidal effect on *P. gingivalis* and *A. actinomycetemcomitans* (10). Laser pocket thermolysis uses the argon laser in conjunction with scaling and root planing for reducing the pathogens within the pocket. Unlike CO₂ and Nd:YAG laser, Er:YAG (11) and Er,Cr:YSGG lasers are capable of providing selective subgingival calculus removal to a level equivalent to that provided by scaling and root planing. Er:YAG had been shown to remove subgingival calculus without a thermal change of the root surface (8) similar to ultrasonic scaler with cementum ablation of 15-30 μ m. Rechmann (12) suggested selective removal of supragingival and subgingival calculus and dental plaque without ablating underlying cementum or enamel with frequency doubled Alexandrite laser (337 nm).

Soft Tissue Surgical Applications

With the beneficial properties over conventional scalpel that includes

- relative ease of ablation of soft tissue,
- hemostasis,
- instant sterilization, reduced bacterimia,
- little wound contraction,
- reduced edema,
- minimal scarring,
- reduced mechanical trauma,
- less operative and post-operative pain,
- faster healing, increased patient acceptance,
- no or few sutures, and
- requiring no or topical anaesthesia.

Lasers viz CO₂, Nd:YAG, diode, Er:YAG and Er,Cr:YSGG are being widely used as a tool for gingival soft tissue procedures such as gingivectomy, frenectomy, gingivoplasty, epulis or benign tumors removal (13), gingival depigmentation, second stage exposure of dental implants, irradiation of aphthous ulcers, coagulation of free gingival graft donor sites (14), and soft tissue crown lengthening.

Root surface modifications

Root surface modification using CO₂, Nd:YAG, Er:YAG and diode laser had been studied with conflicting results and

shown to be related to the energy density and selection wavelength of laser.

Osseous surgery

Since laser-biologic tissue interactions are photothermal (14), hence, inspite of having added advantages of surgical precision, reduced collateral damage of soft tissue, reduced noise and eliminating vibrations with conventional instruments (13), effect of most dental lasers on bone is determinental for osseous surgery with the exeption of Er:YAG and Er,Cr:YAG (14). Recent clinical applicatons for Er:YAG laser in bone surgery have been reported, however, lower cutting efficiency as compared to conventional instruments and lack of depth control are its limitations (13).

Implant therapy

Various lasers have been used in second stage implant therapy for uncovering the submerged implant, with advantages of improved hemostasis, fine cutting surface, less postoperative discomfort, and favourable healing (13).

Because of difficult and time consuming mechanical debridement, emergence of bacterial resistance to antibiotics, lasers are now being proposed for treating peri-implantitis. Nd:YAG laser is contraindicated because of morphological changes it produces on implant surface (15). Er:YAG laser at appropriate settings possess the best property for degranulation and implant surface decontamination, without causing titanium surface changes and like CO₂ laser it does not influence the attachment rate of osteoblasts (16).

Wound Healing

Improved blood flow

- Laser therapy significantly increases the formation of new capillaries (tiny blood vessels) within damaged tissues.

Reduced formation of scar tissue

- Laser therapy reduces the formation of scar tissue (fibrous tissue) following tissue damage related to cuts, burns, and surgery.
- Laser therapy is able to reduce this formation by speeding up the healing process, improving the blood flow to the injured area, and more effectively carrying away waste products.
- Faster healing always leads to less scar tissue formation.(17)

Advantages of Laser

- Relatively bloodless surgical and post-surgical course
- The ability to coagulate, vaporize, or cut tissue
- Sterilization of wound tissue
- Minimal swelling and scarring
- No requirement of sutures
- Little mechanical trauma
- Reduced surgical time
- Decreased post-surgical pain
- High patient acceptance(18)

Recent Advances

- Waterlase system is a revolutionary dental device that uses laser energized water to cut or ablate soft and hard tissue.
- Periowave™, a photodynamic disinfection system, utilizes nontoxic dye (photosensitizer) in combination with low-intensity lasers enabling singlet oxygen molecules to destroy bacteria (Thomas, 2006).(19)

4. CONCLUSION

Lasers have the potential advantages of bactericidal effect, detoxification effect, and removal of the epithelium lining and granulation tissue, which are desirable properties for the treatment of periodontal pockets. Thus, laser systems, applying the ablation effect of light energy which is completely different from conventional mechanical debridement, may emerge as a new technical modality for periodontal therapy in the near future.(18)

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