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Laser – As an Alternative or Adjunctive Treatment in Periodontics - A Review Article

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Abstract: ***The use of lasers for treatment has become a common phenomenon in the medical field. Currently, numerous laser systems are available for dental use. Among the many lasers available, high power lasers such as Carbon Dioxide Laser (CO2), Neodymium-Doped Yttrium Aluminium Garnet (Nd:YAG) and Diode lasers can be used in periodontics. The use of these lasers is limited to gingivectomy, frenectomy and similar soft tissue procedures including the removal of melanin pigmentation of gingiva. Recently, Erbium: Yttrium Aluminium Garnet (Er: YAG) and Erbium, Chromium doped Yttrium Scandium Gallium Garnet (Er, Cr: YSGG) lasers are used for scaling, root debridement, cutting, shaving, contouring and resection of oral osseous tissues.***

1. Introduction

The word "laser" is an acronym for "Light Amplification by Stimulated Emission of Radiation (LASER)." When directed at tissues, different interactions result. The absorption, reflection, transmission, and scattering of the laser light vary depending on wavelength of the laser and the characteristics of the tissue. [1]

Laser light is unique in that it is monochromatic (light of one specific wavelength), directional (low divergence), and coherent (all waves are in a certain phase relationship to each other). These highly directional and monochromatic laser lights can be delivered onto target tissue as a continuous wave, gated-pulse mode, or free running pulse mode. [2]

Lasers have various periodontal applications including calculus removal; soft tissue excision, incision and ablation; decontamination of root and implant surfaces; biostimulation; bacteria reduction; and last but not least bone removal (osseous surgery). The lasers that can be used in periodontics are divided either as soft tissue lasers or soft and hard tissue lasers. Neodymium-doped: Yttrium-Aluminium-Garnet (Nd:YAG), carbon dioxide (CO2) and semiconductor diode lasers can be categorized as the soft tissue group while erbium family lasers are capable of performance in both hard and soft tissues. Since the periodontium consists of both hard and soft tissues, the erbium group lasers seem more beneficial for periodontal applications. [3]

2. Laser as an Alternative or Adjunctive in Treating Periodontal Diseases

1) Removal of Subgingival Calculus:

Subgingival calculus presents a challenge to a Periodontist during its removal. Though mechanical scaling and root planing along with curettage helps to achieve considerable removal, lasers aid in complete treatment. [4]

Of the wide range of lasers the Er: YAG laser is capable of easily removing subgingival calculus without a major thermal change of root surface. Erbium family lasers including Er: YAG and Erbium- Chromium doped: Yttrium-Selenium-Gallium-Garnet (Er, Cr: YSGG) have shown very promising results for scaling, since they are capable to ablate both hard and soft tissues. (Er, Cr: YSGG) has an intense bactericidal effect on the putative periodontal pathogens, such as P. gingivalis and A.actinomycetemcomitans. [5]

Patients are also more comfortable with intermittent laser activation sound rather than high-pitch sound of ultrasonic devices. Pain is lesser in laser application and the need for anesthesia is reduced in sub- gingival scaling. [6]

2) Periodontal Pocket treatment (Nonsurgical)

Unlike mechanical tools for curettage in treating periodontal pockets, the Nd: YAG laser is effective in complete removal of pocket-ling epithelium in periodontal pockets, thus aiding in new attachment without causing necrosis or carbonization of underlying connective tissue. Lasers are also effective in debriding and decontaminating areas of limited accessibility such as deep intrabony defects and furcations areas. Photodynamic therapy is another important application of a low power laser that enables the laser to indirectly decontaminate the periodontal pocket by activation of a photo- sensitizer agent, thus potentiating the bactericidal effect of the laser. Soft tissue thermolysis and bacterial decontamination can be done by a variety of lasers such as argon (488 nm, 514 nm), [7] diode laser (800-830 nm, 980 nm) [8] and Nd: YAG [9] (1064 nm), but these lasers are unsuitable for calculus removal because of low surface thermal absorption.

3) Conventional Root Debridement

In periodontal pockets along with accumulated plaque and calculus, the cementum of exposed root surfaces is infiltration with bacterial endotoxins. These periodontal pockets are usually treated by mechanical scaling and root planing using manual or power-driven instruments. However inaccessible areas such as furcations and grooves limit complete removal of bacterial deposits and their toxins from the root surface which usually is achieved by the use of lasers. All lasers have thermal effects. Many period onto pathogens are susceptible to this thermal range as research has shown that they are deactivated in 50 c°. Laser mediated coagulation and inflamed tissue removal takes place in 60 c°. [10]

4) Periodontal surgeries:
Lasers are beneficial in reducing traditional surgical problems such as bleeding, reduced vision, pain, scarring, suturing, bacteremia, long healing period and wound contraction. They will also result in higher patient acceptance, since no or little anesthesia is required. However, potential bone damage has been always a concern in periodontal surgery using lasers. CO2, diode, and Nd: YAG is traditionally known as soft tissue laser and Er: YAG lasers can be applied to both hard and soft tissues. [11]

5) Treatment of Dentine Hypersensitivity with Lasers:
Dentine hypersensitivity is characterized by short, sharp, excruciating pain arising from exposed dentine in response to various stimuli. The lasers used for the treatment of dentine hypersensitivity are Nd: YAG and CO lasers. The mechanism of laser effects on dentine hypersensitivity is thought to be the laser induced occlusion or narrowing of dentinal tubules, as well as direct nerve analgesia, via pulpal nerve system. [12]

6) Laser Deepithelization For Enhanced GTR:
Historically, many techniques have been tried to retard epithelial down growth for successful treatment of periodontal defects to obtain new attachment. The CO laser creates a unique wound in the gingival tissue which causes a delay in reepithlization because of factors such as reduced inflammatory response and less wound contraction. It is not a burn, rather an instantaneous vaporization of the intercellular fluid and a resulted disintegration of the cell structure. [13]

7) Depigmentation With Laser:
Gingival and cutaneous melanin pigmentation varies widely among individuals with unacceptable aesthetic problem. Various methods like cryotherapy, gingivectomy and argon laser irradiation are considered suitable for the removal of pigmentation from the gingiva. In addition several lasers are used for ablation of cutaneous pigmented lesions and oral lesions, among them are ruby, dyed pulsed, Nd: YAG, CO and eximer laser. [14]

8) Soft Tissue Applications:
Lasers have long been used for soft tissue ablation which includes gingivectomy, frenectomy, removal of muco-cutaneous lesions (both benign and malignant) and gingival sculpting techniques associated with implant therapy and mucocutaneous surgery. With the use of some lasers, in particular, the Er: YAG lasers, the depth and amount of soft tissue ablation is more precisely and delicately controlled than with mechanical instruments making them more useful for esthetic periodontal soft tissue management such as recontouring and reshaping of gingiva and in crown lengthening. [15]

9) Laser Bleaching
The bleaching process is usually achieved using the 488- nm argon laser with the most efficient energy source to excite the hydrogen peroxide molecule. Argon lasers emit fairly short wavelengths (488 nm) with higher-energy photons; conversely, other heating instruments emit short wavelengths as well as longer invisible infrared thermal wavelengths (750 nm to 1 mm) with lower-energy photons and predictable high thermal character. This high thermal energy can create unfavorable pulpal responses. The argon laser rapidly excites the already unstable and reactive hydrogen peroxide molecule; the energy then is absorbed into all intramolecular and intermolecular bonds. The hydrogen peroxide molecule falls apart into different, extremely reactive ionic fragments that swiftly combine with the chromophilic structure of the organic molecules, altering them and producing simpler chemical chains. The result is a visually whitened tooth surface. [16]

10) Implant Dentistry
The most common application of lasers in the implant dentistry is soft tissue removal during second stage implant exposure. Lasers offer instant coagulation of the small blood vessels providing a clear field, and the patient benefits from less pain and swelling. Also lasers aid in treatment of peri-implantitis which includes thorough debridement of implant surface without damaging either the bone or implant. The CO2, diode, and Er: YAG lasers appear to be safe for treating peri-implant diseases, however Nd: YAG lasers are contraindicated as they change implant surface. [17]

Advantages of using lasers in the periodontal therapy include: [18]
1) Less pain
2) Less need for anesthetics (an advantage for medically compromised patients)
3) No risk of bacteremia
4) Excellent wound healing; no scar tissue formation
5) Bleeding control (dependent on the wavelength and power settings);
6) Usually no need for sutures
7) Use of fewer instruments and materials and no need for autoclaving (economic advantages)
8) Ability to remove both hard and soft tissues
9) Lasers can be used in combination with scalpels.

Disadvantages of using lasers in periodontal therapy include: [18]
1) Relatively high cost of the devices
2) A need for additional education (especially in basic physics)
3) Every wavelength has different properties
4) The need for implementation of safety measures (i.e. goggle use, etc.).

3. Conclusion

In summary, laser treatment is expected to serve as an alternative or adjunctive to conventional mechanical periodontal treatment.

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