Lasers in Periodontics: A Review

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Abstract
The advent of newer modalities of treatment herald a change in periodontics. One such modality, lasers, have been widely researched. Their characteristics, advantages and the current status of usage has been reviewed in the current article. While evidence suggests that lasers are a useful adjunct in initial periodontal therapy, laser surgery and more recently their utility in salvaging implants opens up a wide range of applications. More research with better designs are a necessity before lasers can become a mandatory part of the dental armamentarium.

Key words: Lasers, periodontics, implant.

Introduction

The pathogenesis of periodontal disease has undergone a sea of change over the last few decades as have modalities of its treatment.[1] Since the discovery of LASER (Light Amplification by Stimulated Emission of Radiation) by Maiman[2] in 1960, and its subsequent initial application in dentistry (1964)[3], there is still controversy among clinicians regarding the application of dental lasers to the treatment of periodontal diseases. With recent advances and development of wide range of laser wavelengths, different instrument designs and different delivery systems, the purpose of this review is to analyze the peer-reviewed research literature to determine the state of the science regarding the utility and safety in periodontal therapy. [4]

Presently various laser systems have been used in dentistry. Among them carbon dioxide (CO_2), Neodymium-doped: Yttrium-Aluminium-Garnet (Nd:YAG), semiconductor diode lasers are used for soft tissue treatment. Recently Erbium doped:Yttrium-Aluminum-Garnet (Er:YAG) laser has been used for calculus removal, and decontamination of the diseased root surface in periodontal non-surgical , surgical and implant therapy.[4] The properties and applications of some lasers have been summarized in Table 1.

Application of lasers in periodontal treatment

Lasers can be used for initial periodontal therapy and surgical procedures**.** This usage becomes more complicated because the periodontium consists of both hard and soft tissues. Among the many lasers available, high power lasers such as CO_2, Nd:YAG and diode lasers can be used in periodontics because of their excellent soft tissue ablation and hemostatic characteristics. However, when they are applied to the root surface or alveolar bone, carbonization and thermal damage have been reported.[5] Therefore the use of these lasers is limited to gingivectomy, gingivoplasty, frenectomy, depithelilization of reflected periodontal flaps, removal of granulation tissue, second stage exposure of dental implants, coagulation of free gingival graft donor sites and gingival depigmentation.[6]

Initial periodontal thearpy

Scaling and root planing

Initial periodontal therapy, now includes nonsurgical debridement of tooth surface, host modulators, reduction in sulcular bacteria and localized antimicrobials in and around the periodontium. In this context, soft tissue lasers are a good choice for bacterial reduction and coagulation.[7] Since these lasers, such as argon, diode and Nd:YAG, are well absorbed by both melanin and hemoglobin as well as other chromophores , they are an excellent choice to use in periodontally involved sulcus that has dark inflamed tissue and pigmented bacteria.[8] The Erbium family of lasers demonstrated significant bactericidal activity on both *Porphyromonas gingivalis and Actinobacillus actionomycetemcomitans,* considered to be the primary components of periodontal infection.[9] Gingival inflammation and the levels of *P. gingivalis* and *Prevotella intermedia* continued to be subdued, as compared to scaling root planning group at 3 months.[10] Lasers also have the potential to reach sites that conventional mechanical instrumentation cannot.[11] While reduction in the interleukin (IL) 1beta[12] and pocket depth[13] have been noted with laser therapy, it is essential to note that most studies summarize the use of lasers as an adjunct and not as a substitute to scaling and root planing in periodontal therapy. When used clinically, the calibration of the laser fiber is done after debridement of the tooth surface. By placing it 1 mm short of the treatment depth, damage to the attachment is avoided. Bacterial reduction is deemed complete when fresh bleeding occurs from the inflamed epithelial lining of the pocket. This is followed by shift to the coagulation mode till bleeding stops .[8]

Sulcular debridement (curettage)

Proponents of laser curettage point to the ability of these lasers to kill microorganisms. A critical review of the best available evidence strongly indicates that there is no added benefit to the patient when this procedure is performed after traditional mechanical scaling and root planing.[14] With no demonstrable benefit and a significant risk of collateral damage to the periodontium, laser curettage appears to be neither scientifically nor ethically justified.[15]

LANAP (Laser Assisted New Attachment Procedure)

The term non-surgical when referring to a procedure based

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Lasers		Wavelength	Colour	Applications
Excimer Lasers	Argon fluoride (ArF) Xenon Chloride (XeCl)	193nm 308nm	Ultravoilet Ultravoilet	Hard tissue ablation, dental calculus removal
Gas Lasers	Argon (Ar) Helium Neon (HeNe) CarbonDioxide (CO2)	488nm 514nm 637nm 10,600nm	Blue Blue-Green Red Infrared	Intraoral soft tissue surgery, sulcular debridement, analgesia, Treatment of dentin hypersensitivity, analgesia Intraoral and implant soft tissue surgery, gingival depigmentation
Diaode Lasers	Indium Gallium Arsenide Phosphorus (InGaAsP) Gallium Aluminium Arsenide (GaAlAs) Gallium Arsenide (GaAs) Indium Gallium Arsenide (InGaAs)	488nm 655nm 670-830nm 840nm	Red Red-Infrared Infrared Infrared	Caries and calculus detection Intraoral soft tissue surgery, sulcular debridement, treatment of dentin hypersensitivity, gingival depigmentation
Solid State Lasers	Frequency- doubled Alexandride Potassium Titanyl Phosphate (KTP) Neodymium:YAG (Nd:YAG) Holmium:YAG(Ho:YAG) Erbium,Chromium:YSGG (Er,Cr:YSGG) Erbium:YSGG(Er:YSGG) Erbium:YAG(Er:YAG	337nm 532nm 1,064nm 2,100nm 2,780nm 2,790nm 2,940nm	Ultravoilet Green Infrared Infrared Infrared Infrared Infrared	Selective ablation of dental plaque and calculus. In intraoral soft tissue surgery, sulcular debridement, analgesia,treatment of dentin hypersentivity, gingival depigmentation. In intraoral general and implant soft tissue surgery, sulcular debridement, scaling of root surfaces, osseous surgery, treatment of dentin hypersensitivity analgesia,aphthous ulcer treatment.

Table 1: Characteristics of lasers and its periodontal applications

on the concept of subgingival curettage is debatable. Initial reports suggest that LANAP can be associated with cementum mediated new connective tissue attachment and apparent periodontal regeneration of diseased root surfaces in humans.[16] However, translation of these results into clinical practice requires long-term well designed clinical trials with larger sample size.

Surgical procedures

The purported advantages of laser versus scalpel surgery have been enumerated by numerous authors and include increased coagulation that yields a dry surgical field and better visualization, the ability to negotiate curvatures and folds within tissue contours, tissue surface sterilization and therefore, reduction in bacteraemia, decreased swelling, edema and scarring, decreased operative and post operative pain, faster healing response and increased patient acceptance.[17,18]

Lasers are effectively used to perform gingivectomies and gingivoplasties. CO_2 laser uses only light impinging on the tissue with surgical time reduced to one-fourth of the conventional method.[19] While this denies the operator any tactile feedback, Nd:YAG laser maintains contact with tissue.[20] Potential for damage to underlying bone remains a concern, particularly when used on thin soft tissues.[21] These properties come handy in mucogingival procedures like frenotomy and frenectomy which can be performed in less than 3 to 4 minutes with CO_2 laser and with added advantages of bloodless, painless and suture less procedure.[19]

Excessive gingival pigmentation is a major esthetic concern for many people. Gingival depigmentation has been carried out using non-surgical and surgical procedures. Recently, laser ablation has been recognized as a most effective, pleasant and reliable technique.[22] Er:YAG laser in defocused mode with brush technique [23] or contact mode mostly requiring only topical anaesthesia was followed by uneventful healing with no recurrences at 3 and 6 months check up respectively.[24]

Laser and implants

The long term success of an implant is highly dependent on its maintenance. One of the main reasons for the failure of an implant is peri-implantitis. Peri-implant infection results in inflammation of the surrounding soft tissues and can induce a breakdown of the implant supporting alveolar bone. Gingival enlargement is relatively common around implants when they are loaded with removable prostheses.[25,26] Mechanical instruments such as metal curettes and ultrasonic scalers are prohibited for decontamination of titanium implant surfaces as they easily damage them.[27] Lasers can be used for the hyperplasia removal as well as in the treatment of peri-implantitis, when inflamed tissues can be irradiated. Er:YAG laser has been shown to be useful in the maintenance of an implant, taking advantage of its bactericidal or decontamination effect whereas CO_2 laser is not useful for the modification of implant surface.[28] Er:YAG and Er,Cr:YSGG (Erbium Chromium doped Yttrium Scandium Gallium Garnet) lasers are useful because their wavelengths have a high reflection potential and thus hardly any absorption takes place in metallic surfaces. Implants when irradiated with low energy densities and studied under electron microscope demonstrated that the Er:YAG laser has a high bactericidal potential on common implants with no excessive heat generation on the implant surfaces.[29,30] Debridement of implant abutment surface by Er:YAG laser reported effective removal of plaque and calculus without producing damage to the implant surface.[31]

Current status of lasers in periodontics: applications, newer trends and safety concerns

Lasers have the potential advantages of bactericidal effect, detoxification effect and removal of epithelial lining and granulation tissue. They are capable of effectively removing not only dental plaque but also calculus from the root surface with extremely low mechanical stress and no formation of a smear layer on the treated root surface.[11] Thus, its use in combination with conventional mechanical treatment as an adjunct has the potential to improve the condition of periodontal pockets more than mechanical therapy alone.

Some features of laser use are attractive with regard to patient appeal. For example, postoperative healing after soft-tissue surgery with the CO_2 laser typically involves much less morbidity than that after traditional scalpel surgery.[19] It is interesting that some early evidence suggests that Er:YAG laser energy can produce superior attachment levels after root debridement compared with mechanical root planning.[12] Such novel techniques, while requiring further development and testing, hold exciting potential.

What is perhaps the most important recent development in laser dentistry is the advent of the Er,Cr:YSGG laser, which is used with a water spray (Hydrophotonics effect). This laser is capable of multiple applications because its interaction with tissue is strongly influenced by variations in the air-to water ratio of the spray. It can be used on soft tissue, enamel, dentin and bone, and its shallow interaction minimizes the risk of collateral damage. Also, the ability to be used for multiple applications improves the economic feasibility of this laser. Another significant benefit of this laser is that it does not necessitate the use of local anesthetic in many operative procedures. Recent innovations to improve patient appeal and the multiple-use capability while achieving equivalent results make a strong argument in favor of the Er,Cr:YSGG laser.[32,33]

Unfortunately, much of the studies done on laser suffer from poor study design, lack of long term clinical trails with insufficient evidence to suggest that any specific wavelength of laser is superior to the traditional modalities of therapy. Most of the laser usage is currently fuelled by increased patient demand for use of 'Sophisticated' technology, giving a boost to marketability of lasers in dentistry. For some dentists, such public perception could create pressure to rush towards implementing laser technology.

Despite numerous advantages, the use of laser also has disadvantages that requires precautions to be taken during clinical application apart from sophisticated equipment, cost and size of the laser device. Safe operation of laser is important both for the patient and the doctor. The operator, staff and the patient has to wear safety goggles. Use of an appropriate evacuation system to draw off and filter the plume is essential. Extreme caution should be exercised when operating laser in the vicinity of explosive gases. Finally, the dental laser user should have good understanding of in laser wave length, characteristics, tissue interaction and laser device specification to provide a platform for achieving the best results.

Future developments

There is a great potential for laser systems to be developed further to include additional futures and functions. The Alexandrite (Chromium doped:Beryllium-Aluminum-Oxide chrysoberyl) laser for clinical use is widely accepted due to its excellent ability to remove dental calculus in a selective mode without ablating the underlying enamel or cementum from the tooth surface.[34,35]

Conclusion

Laser treatment is expected to serve as an adjunct to conventional mechanical periodontal treatment. The decision to use a laser should be based on the proven benefits of hemostasis, a dry field, reduced surgical time and the general experience of less postoperative swelling. Further research on the potential use of laser energy in periodontal therapy is indicated, and scientific literature should be followed for future developments. This is an exciting field with many promising possibilities to be investigated and represents an area that may ultimately prove to be rich with utility in the context of periodontics.

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