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Lasers in Periodontal Therapy

Mithlesh Bhagat[1], Roopali Tapashetti[2], Ghousia Fatima[3], Neha Bhutani[2]

[1]Post Graduate Student, [2]Reader, [3]HOD & Professor,
Department of Periodontics, Al Badar Rural Dental College and Hospital, Kalaburagi, Karnataka

Corresponding Author: Mithlesh Bhagat

ABSTRACT

Learning is a continuous process of acquiring knowledge through a systematic approach and awareness of the best technological advances in any field of specialty. Dentistry has entered the 1990s an era of high technology. We are fortunate to have at our disposal many technological innovations to enhance treatment, including intraoral video cameras, computer imaging, computer aided device (CAD), Computer aided machine (CAM) and air abrasive units. However no instrument is more representative of the term high-tech than the laser. "L.A.S.E.R" is an acronym for "Light Amplification by Stimulated Emission of Radiation"[1,2,3]. Lasers are intense sources of light or, more accurately non-ionizing electromagnetic radiation. Laser radiation has specific and predictable wavelengths, and at these wavelengths the radiation is more intense than can be generated by conventional light sources. Lasers offer little chance for mechanical trauma, they cause minimal scarring, and sutures are rarely needed[4, 5]. One of the greatest advantages of laser use in dentistry is a high rate of patient acceptance. Patients today are aware of lasers and their advantages. Dental lasers available today are small, light weight, highly portable and increasingly affordable. The future looks bright for lasers in dentistry. Investigating lasers to understand this type of light and its properties can help practitioners take advantage of this new technology. This Review on laser applications demonstrate the evolution of laser radiation within the Periodontics and provide practical information on the use of laser radiant energy in such areas as control of including periodontal surgery.[6,7]

Key Words: CO_2 Lasers, Er:YAG lasers, Frenectomy, Gingivectomy, gingivoplasty

INTRODUCTION

LASER, an acronym for Light Amplification by Stimulated Emission of Raditaion, was first developed by Theodore Maiman in Los Angeles , in 1960, based on theories derived by Einstein in the early 1900s,.The application of a laser to dental tissue was reported by Stern and Sognnaes and Goldman et al. in 1964, describing the effects of ruby laser on enamel and dentine with a disappointing result[2] .Although the discovery of lasers and research into their applicability for dental use began in the 1960s, it was not until 1985 that the first documented use of a laser in periodontal surgery was published. In 1985, Myers and Myers modified an ophthalmic Nd:YAG laser for dental use. It soon was noted by clinicians that this wavelength could be used for soft tissue surgery[3.]

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 CO2, Nd:YAG and diode lasers can be used in periodontics because of their excellent soft tissue ablation and hemostatic characteristic[6]. There are several advantages of using lasers in periodontal therapy. These advantages include hemostasis, less postoperative swelling, a reduction in bacterial population at the surgical site, less need for suturing, faster healing, and less postoperative pain[4]. Because of the photo-physical characteristics of lasers, laser irradiation exhibits strong ablation, hemostasis, detoxification and bactericidal effects on the human body. These effects could be beneficial during periodontal treatment, especially for the fine cutting of soft tissue as well as in the debridement of diseased tissues. Thus, in periodontal therapy, laser treatment may serve as an alternative or adjunctive therapy to mechanical approaches. Previously introduced laser systems showed strong thermal side effects, causing melting, cracking and carbonization of hard tissues, such as root and bone.

However, when the high power lasers are applied to the root surface or alveolar bone, carbonization and thermal damage have been reported. 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 [5]. The rapid advancement in laser technology have been introduced.

The recently developed Er:YAG and Er,Cr:YSGG lasers, however, can ablate both soft and hard tissues safely with water irrigation and are applicable to periodontal treatments such as scaling, debridement and bone surgery, and have minimal thermal effect. Thus, the erbium laser group has shown promise as a laser system for periodontal treatment approaches on hard tissues. Convissar R (2004) In their article explained when selecting a laser for a specific procedure, the dentist must consider the interaction between the wavelength, target tissue, and surrounding tissue. For many dental procedures, most soft tissue lasers produce excellent results. For these procedures, in which the selection of wavelength is a matter of personal preference, the selection of the correct operating parameters (joules, hertz, pulse duration) is crucial to the success of the procedure. For certain specific procedures, the choice of wavelength is crucial for the success of the procedure.[8]

A biologic rationale for the use of specific wavelengths for certain procedures has been outlined.

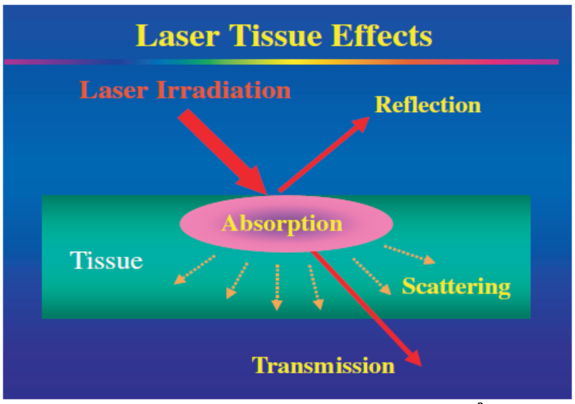

Fig.1: Effects of laser irradiation on tissue.[8]

When laser light impinges on tissue, it can reflect, scatter, be absorbed or transmitted to the surrounding tissue.

SOFT TISSUE APPLICATIONS

GINGIVAL SOFT TISSUE PROCEDURES

Gingivectomy, gingivoplasty and frenectomy are the most popular procedures carried out using lasers. Compared with the use of a conventional scalpel, lasers can cut, ablate and reshape the oral soft tissue more easily, with no or minimal bleeding and little pain as well as no or only a few sutures. Laser surgery occasionally requires no local anesthetic, or only a topical anesthetic. Use of electrosurgery also facilitates easy tissue incision accompanied with a strong hemostatic effect. Compared with electrosurgery, lasers have a higher comfort level in patients, resulting in less operative and postoperative pain and fewer complications.[9]

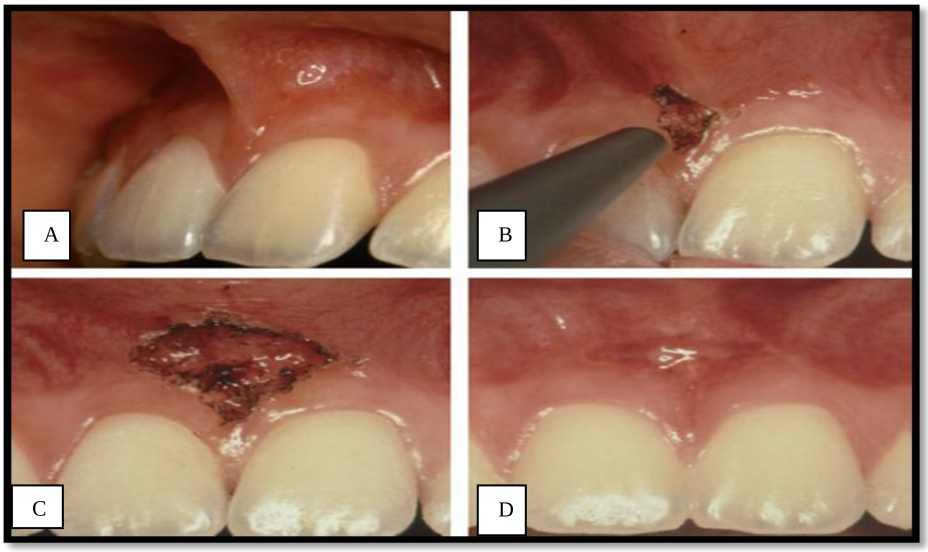

Fig.2: Frenectomy using a CO2 laser [9]

(A) Before treatment (B) The high attachment of frenum was easily ablated and resected with the continuousCO2 laser at 4 W under local anesthesia in noncontact mode. (C)The laser-treated surface shows moderate carbonization but lacks bleeding as a result of the strong hemostatic effect of the CO2 laser. (D) No suture surgery patient felt no postoperative pain and the wound healing was uneventful and favorable at 1 week.

ESTHETIC GINGIVAL PROCEDURES

Lasers can be applied in esthetic procedures such as recontouring or reshaping of gingiva and in crown lengthening. With the use of some lasers, the depth and amount of soft tissue ablation is more precisely and delicately controlled than with mechanical instruments. In particular, the Er:YAG laser is very safe and useful for esthetic periodontal soft tissue management because this laser is capable of precisely ablating soft tissues using various fine contact tips, and the wound healing is fast and favorable owing to the minimal thermal alteration of the treated surface. Depigmentation is another indication for laser use in esthetic treatments. The CO2, diode and Nd:YAG lasers can treat melanin pigmentation effectively. However, in areas of thin gingiva, these lasers have a risk of producing gingival ulceration and recession as a result of their relatively strong thermal and ⁄or deeply penetrating effects . In these situations, the Er:YAG laser is more useful and safe for melanin depigmentation.[9]

Fig.3: Removal of gingival melanin hyper pigmentation using an Er:YAGlaser.[9]

Uraz A. et al (2018) Thirty-six patients requiring labi al frenectomies , between 14 and 51 years old, were randomly assigned to either scalpel or diode laser treatments. The soft tissue measurements, including the keratinized gingiva width (KGW), attached gingiva width (AGW) and attached gingival thickness (AGT), were recorded before surgery, immediately after, one week later and one, three and six months after surgery .In Addition ,the functional complications and the morbidity(level of pain, swelling and redness)were evaluated during the first postoperative week using a visual analog scale (VAS). He concluded statistically significant gains in the KGW, AGW and AGT after surgery in both groups; however, there was no significant difference between the study groups .The VAS scores indicated that the patients treated with a diode laser had less discomfort and functional complications compare with scalpel surgery.[10]

Yung (2007) Describes the treatment of 60 patients with periodontitis using an Er:YAG laser with a long-term follow-up of an average of 2.4 years. It is an uncontrolled study of clinical cases whose goal was to assess the effectiveness of the use of the laser.They found that A total of 67 vital teeth were directly treated with a combination of 104 individual surgical procedures for this group of patients. The most common procedures were surgical curettage (n = 52), followed by gingivectomy (n = 47). The most common surgical site was the posterior maxilla (n = 29), followed by the posterior mandible (n = 24). The most common indication for laser periodontal surgery (24 out of 60 procedures) was moderate-to-severe acute periodontitis. There were only two cases in which conventional full periosteal flaps were raised; sutures were required for these two cases. Follow-up periods ranged from 6 to 54 months, with an average mean follow-up period of 2.4 years. The probing depths were normal, and there were signs of clinical attachment improvements. All of the treated teeth remained vital and functional during the follow-up period. The potential benefits of using an Er:YAG laser for periodontal surgery are quite evident. Based on the clinical observations collected, it is both safe and effective to use this laser wavelength in the manner described for periodontal surgery.[11]

Abdelfattah M (2018) Er:YAG lasers are solid-state lasers whose lasing medium is erbium-doped yttrium aluminum garnet (Er: Y3 Al5 O12). Er:YAG lasers typically emit light with a wavelength of 2940 nm, which is infrared light. Unlike Nd: YAG lasers, the output of an Er:YAG laser is strongly absorbed by water. Using Fotona’s Er:YAG laser using long pulse with setting parameters of 85 mJ, 1.25 W, and 15 Hz for 4 s The beam was defocused to produce a 3-mm diameter circle, thus reducing the beam penetration to 2–4 µ/pulse while increasing the treated surface. The laser beam was activated and used with “brush technique” as described by Tal et al., with continuous movement of the beam overlapping the laser spots by approximately 20%–30%. Postoperative follow-up was done after 24 h. There was no discomfort, teeth sensitivity, pain or bleeding, or any other complications. The patient experienced no interruption in performing daily activities. The patient was recalled after 1 week; healing was uneventful without any postoperative complications and required no supportive therapy. The gingival appeared pink, healthy, and firm, giving a normal appearance. The results were very pleasing and the gingival appearance completely transformed. Esthetics have gained a lot of importance in today’s dental practice.[12]

GINGIVECTOMY

A patient with gingival enlargement due to the use of calcium channel blockers having edematous finger-like projections of the interproximal papillae. This type of enlargement differentiates this tissue reaction from the bulkier and more fibrotic enlargements caused by phenytoin and cyclosporine. The patient was anesthetized with 2% lidocaine with 1:100,000 epinephrine. A periosteal elevator was placed between the tissue and the tooth to protect the hard tissue from the effects of the CO2 wavelength. Lasing was performed with a CO2 laser in a 7-W continuous wave mode. The slight amount of interproximal bleeding, which was due to the fact that the finger-like projections of the hyperplastic tissue contained capillaries that were larger than the diameter of the lasing beam. A biologic bandage (char layer) was placed over the surgical site, eliminating the need for a periodontal dressing. [13]

Fig. 4: A preoperative view of gingival enlargement caused by a calcium channel blocker.[13]

Fig.5: Immediate postoperative photo of the completed gingivectomy.[13]

Bradley D (2015) In their article described the state of periodontics is undergoing a paradigm shift, the advent of new laser technology provides periodontists and general practitioners with an instrument that allows minimally invasive, more comfortable treatment within the standard of care.The treatment capabilities involve the successful and effective treatment of traditional procedures, such as gingivectomies, frenectomies, soft tissue lesions; advanced procedures, such as functional or cosmetic crown lengthening; and site-specific therapies for residual periodontal conditions.[14]

Pohlhaus S (2018) Gingivectomy is the most common procedure performed with dental lasers. All laser wavelengths can be used to precisely incise gingiva for restorative, cosmetic, and periodontal indications. Rapid healing and reduced pain are commonly seen post operatively and patients rarely need periodontal packing or sutures. The thermal effects of diodes, Nd:YAG and CO_2 lasers must be understood to avoid collateral damage, but in properly trained hands these devices are quite effective. Erbiumed lasers pulsed technology, shallow penetration, and water absorption produce a minimal thermal effect and minor procedures can sometimes be achieved with no anesthetic at all. The nearly "cold cutting" effect of erbium tissue interaction creates a remarkable post-operative course.[15] Kohale BR (2018) the LLLT using 940-nm diode laser at an energy density of 4 J/cm as an adjunct to scalpel gingivectomy procedure can be used to reduce postoperative pain and discomfort and aid in better wound healing. There is a need to establish effective protocols of laser application, allowing this novel therapy to be used in periodontology and bring more comfort for the patients. Further studies should be conducted along with various other surgical procedures to evaluate the effect of adjunctive use of LLLT on wound healing and patients response.[16]

Akram et al (2017) deciding whether to do a conventional gingivectomy by scalpel or to use laser depends on many factors. First of all the surgery was easier and quicker in Laser than conventional gingivectomy. Bleeding was observed in the conventional gingivectomy while relatively bloodless in laser. Less anesthesia is needed in laser gingivectomy In Laser gingivectomy we found that the pain post-operatively was less compared to the pain in conventional gingivectomy this could be attributed to the heat generated by laser that inhibit the pain receptors and the coagulation which provided a dry and isolated environment and less infection to the wound.[17] L Campos et al (2018) High power lasers (HPL) have been used widely for conservative surgery and periodontal tissue management. The advantages of HPLs over conventional surgery for soft tissues as described in the literature include disinfection, hemostatic capacity that improves trans operatory visualization, and reduced procedure time and postoperative discomfort. Recurrent DIGO associated with different clinical conditions treated with HPL.[18]

GINGIVOPLASTY

Free gingival graft that is much thicker than the surrounding tissues. The area was anesthetized with 2% lidocaine with 1:100,000 epinephrine. A CO2 laser was set at 4 W in a continuous wave. The fibrotic tissue of the graft has been blended into the surrounding attached gingiva. The patient was given a prescription for chlorhexidine gluconate 0.12% and was dismissed with usual postoperative instructions .[13]

Fig.6: A preoperative view of a thick gingival graft requiring recontouring.[13]

Fig.7: Immediate postoperative view of a gingivoplasty completed with a CO2 laser.[13]

Fig. 8: The 3-week postoperative view shows the graft tissue blended into the adjacent attached gingival.[13]

Ishikawa I et al (2009) In their article discussed the application of lasers has been recognized as an adjunctive or alternative approach in periodontal and peri-implant therapy. Soft tissue surgery is one of the major indications of lasers. CO2, Nd:YAG, diode, Er:YAG and Er,Cr:YAG lasers are generally accepted as useful tools for these procedures. Laser treatments have been shown to be superior to conventional mechanical approaches with regards to easy ablation, decontamination and hemostasis, as well as less surgical and postoperative pain in soft tissue management. Laser or laser-assisted pocket therapy is expected to become a new technical modality in periodontics. The Er:YAG laser shows the most promise for root surface debridement, such as calculus removal and decontamination. Concerning the use of lasers for bone surgery, CO2 and Nd:YAG lasers are considered unsuitable because of carbonization and degeneration of hard tissue. Currently, the Er:YAG laser is safe and efficient for periodontal bone surgery when used concomitantly with water irrigation.[19]

Hegde et al (2014) the laser gingivoplasty procedure which helped enhance aesthetics. Gummy smile correction is done by gingivoplasty to increase the crown lengths for either aesthetic or functional purposes. The surgical procedure is aimed at re-establishing the biological width, apically, while exposing more tooth structure. During the early times, the conventional surgical techniques were the main treatment modalities for performing soft tissue surgeries .The clinical crown height and the gingival contour achieved with the laser therapy were highly remarkable.[20]

SOFT TISSUE CROWN LENGTHENING

Fig.9: Preoperative view of the surgical site.[21]

Soft tissue crown lengthening can be accomplished easily with a laser when two conditions exist. First, there must be no need to contour the underlying bone; second, there must be sufficient attached gingiva so that there will be an adequate zone of attached gingiva after the soft tissue has been ablated. The existing bridge was used as a temporary prosthesis; soft tissue crown lengthening is required. The patient was anesthetized with 2% lidocaine containing 1:100,000 epinephrine. During the surgical procedure, a periosteal elevator was inserted between the gingival tissues and the teeth so that the hard tissue would not be damaged inadvertently by the CO2 wavelength. The patient was dismissed with a prescription of chlorhexidine gluconate 0.12%, and the usual postoperative instructions were given, with normal tissue tone and contours restored.[21]

Fig.10: Immediate postoperative view.[21]

Fig. 11: One-month postoperative view.[21]

Arora S(2016) In Periodontal surgical procedures, Crown lengthening is performed for partial removal of supporting periodontal tissues to increase exposure of tooth structure. Numerous conditions are there in which crown lengthening is required such as unesthetic gingival heights, inadequate crown length, subgingival caries, crown fracture. Teeth having sulcus depth more than 4mm on facial surface, Gingivectomy can be performed to lengthen the crown. Laser light at 800 to 980 nm is poorly absorbed in water, but it is highly absorbed in other pigments. Because of its hot tip effect, it produces a thick coagulated layer. No deleterious effect on the root surface is reported by use of diode laser. Thus, it is considered that soft tissue laser surgery can be performed safely with regard to hard tissue. Kutsch V Lasers have become very useful clinical instruments in dental practice. The Er,Cr:YSGG laser is a versatile instrument for crown-lengthening procedures because it provides good hemostasis and recontouring of the gingival tissues and efficient recontouring of the osseous tissue as well. The procedure is less invasive than traditional surgical procedures and allows the entire crown lengthening and crown preparation to be performed in one appointment with predictable clinical results. Lasers are currently proving very effective in a broad range of restorative and esthetic procedures, including crown length.[22]

Fekrazad R (2018) Conducted a study in which closed flap crown lengthening performed with Er;Cr:YSGG No suture was needed Using Er;Cr:YSGG laser can be considered as valuable device for both soft and hard tissue surgery due to its advantages like producing less pain, reasonable bleeding, less post-operative complications and accelerated healing time compared to conventional method.[23] Prasad R et al (2018) conducted a study in which Crown lengthening procedure could be instituted with or without osseous recontouring. The patients presenting with short clinical crowns due to altered passive eruption requiring an increase in the length of the tooth structure are considered under the “esthetic crown lengthening”. Here, the crown lengthening procedure is confined to the anterior esthetic zone and helps in enhancing the esthetic appearance of an individual. Owing to the advantages such as minimal discomfort and quick hemostasis and placement of restoration immediately, lasers have an added advantage over the scalpel in functional crown lengthening procedures. Hence, our present clinical there is lesser pain associated with Laser and it can be a comfortable and effective alternative to traditional crown lengthening performed with the scalpel. In particular, the diode laser is safe and useful for esthetic periodontal soft-tissue management due to its limited depth of soft tissue penetration compared to other forms of Laser.[24]

CONCLUSION

The word laser conjures in the mind’s eye many aspects of what might be described as ‘modern’ life. The words ‘powerful’, ‘precise’ and ‘innovative’ complement our conception of the world in terms of technology, whereas patients often associate the words ‘magical’ and ‘lightening quick’ with the use of lasers in medical practice.[25]

The scientific basis and tissue effects of dental lasers have been discussed. It is most important for the dental practitioner to become familiar with those principles and then choose the proper laser(s) for the intended clinical application. Each wavelength and each device has specific advantages and disadvantages. The clinician who understands these principles can take full advantage of the features of lasers and can provide safe and effective treatment. The future of lasers in dentistry is promising, and new applications and procedures are being developed. The public is made aware of this by various media, and the word ‘‘laser’’ has power because patients want and trust the doctors who offer advanced technology.[26] Laser technology for caries detection, resin curing, cavity preparation and soft tissue surgery is at a high state of refinement, having had several decades of development up to the present time. This is not to say that further major improvements cannot occur. Indeed, as is in the case with laser abrasion, the fusion of concepts from differing technologies may open the door to novel techniques and treatments.

The pediatric dentist’s mission is simple: provide optimal preventive, interceptive, and restorative dental care in a stress-free environment. Lasers such as the argon, diode, Nd: YAG, CO2, and erbium have enabled dentists to reduce patient stress and fear during dental treatment. Lasers enable the dentist to provide children with minimally invasive dentistry for hard- and soft-tissue procedures with minimal discomfort, no pain during and after treatment, no injections, and little or no bleeding. Parents and children appreciate the elimination of needles, vibrations, and the smell of conventional dental care.[27]

In summary, the application of lasers has been recognized as an adjunctive or alternative approach in periodontal therapy. Soft tissue surgery is one of the major indications of lasers. CO2, Nd:YAG, diode, Er:YAG and Er,Cr:YAG lasers are generally accepted as useful tools for these procedures. Laser treatments have been shown to be superior to conventional mechanical approaches with regards to easy ablation, decontamination and hemostasis, as well as less surgical and postoperative pain in soft tissue management. Laser or laser-assisted pocket therapy is expected to become a new technical modality in periodontics. The Er:YAG laser shows the most promise for root surface debridement, such as calculus removal and decontamination. Currently, the Er:YAG laser is safe and efficient for periodontal bone surgery when used concomitantly with water irrigation. Application of lasers has also been considered in implant therapy. Based on previous reports, lasers, especially the Er: YAG laser, hold promise as an alternative treatment in the treatment of peri-implantitis. Application of photodynamic therapy in the treatment of periodontitis and peri-implantitis is a novel approach. The Er: YAG laser seems to provide the most suitable characteristics for various types of periodontal treatment [1].The treatment capabilities involve the successful and effective treatment of traditional procedures, such as gingivectomies, frenectomies, soft tissue lesions; advanced procedures, such as functional or cosmetic crown lengthening; and site-specific therapies for residual periodontal conditions.[28]

Basically, 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. Although the use of lasers for subgingival curettage and calculus removal in the treatment of periodontal pockets has been increasing among practitioners, the scientific studies indicating positive clinical results of lasers are still insufficient. Further basic and clinical studies, such as randomized controlled studies, are necessary to elucidate the actual effects and effectiveness of lasers in comparison with conventional treatment as well as negative side effects.

To use lasers safely in a clinic, the practitioner should have precise knowledge of the characteristics and effects of each laser system and their applications as well as a full understanding of the conventional treatment procedures, and finally should exercise appropriate caution during their use. A reliable procedure for laser application in nonsurgical periodontal therapy should be established by further studies, and clinicians should follow the results of scientific investigations to obtain successful outcomes. As understanding of the nature of laser light evolves, lasers will be used more effectively in the treatment of periodontal diseases. 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 nonsurgical periodontal therapy in the near future.

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