ORIGINAL RESEARCH PAPER
VOLUME-6 | ISSUE-5 | MAY - 2017 | ISSN No 2277 - 8179 | IF : 4.176 | IC Value : 78.46
INTERNATIONAL JOURNAL OF SCIENTIFIC RESEARCH

LASERS IN PERIODONTICS

Dental Science

Dr. Nupur Sah — Reader and Guide, Department of Periodontics, Y.M.T Dental College and Hospital, Kharghar, Navi Mumbai-410210.

Dr. Kavita Pol Nalawade — Reader and Guide, Department of Periodontics, Y.M.T Dental College and Hospital, Kharghar, Navi Mumbai-410210.

Dr. Jyotsna Anjankar — PG student 3rd year, Department of Periodontics, Y.M.T Dental College and Hospital, Kharghar, Navi Mumbai-410210.

Dr. Sneha K. Rohra — PG student 1st year, Department of Periodontics, Y.M.T Dental College and Hospital, Kharghar, Navi Mumbai-410210.

ABSTRACT

Periodontal disease results from inflammation of the supporting structures of the teeth in response to chronic infections caused by various periodontopathic bacteria. The main goals of periodontal therapy are to eliminate bacterial deposits and niches by removing the supragingival and subgingival biofilms and to restore the biological compatibility of periodontally diseased root surfaces for subsequent attachment of periodontal tissues to the treated root surface. Although SRP produces significant clinical improvements in patients with chronic periodontitis (CP), the complete elimination of bacterial deposits can be difficult to accomplish. To overcome these limitations of conventional mechanical therapy, several adjunctive protocols have been developed. Among these, the use of lasers has been proposed for its bactericidal and detoxification effects and for its capacity to reach sites that conventional mechanical instrumentation cannot.

KEYWORDS:

periodontal disease, bacterial deposits, lasers

INTRODUCTION

The initial and most important stage of periodontal therapy is the nonsurgical mechanical debridement of periodontally diseased root surface. In the early and mid 1990s, scientific research had begun on root surface debridement and pocket curettage. Laser application also showed promising application in non – surgical pocket therapy. Currently, different equipments of laser radiation (Er:YAG, Er,Cr:YSGG, Nd:YAG, diode, CO_2) are available in periodontics, each one with particular features and diverse effects, making necessary the selection of the most suitable for each type of application.

DIFFERENT LASER SYSTEMS

Co_2 laser (Carbondioxide laser)

The CO_2 laser has a wavelength of 10,600 nm and is used as both a pulsed and a continuous wave laser. This laser is readily absorbed by water and therefore is very effective for the surgery of soft tissues, which have a high water content. The primary advantage of CO_2 laser surgery over the scalpel is the strong hemostatic and bactericidal effect. The CO_2 laser is absorbed at the tissue surface with very little scatter or penetration. CO_2 laser (10,600 nm) produces severe thermal damage, such as cracking, melting, and carbonization when applied to hard tissues, its use has been limited to soft tissue procedures. Ablation is mainly due to the action of heat generation, carbonization easily occurs on the irradiated surface but the heat produced does not scatter. Therefore, the CO_2 laser produces a relatively thin layer of thermally changed tissue (coagulation) around the ablated site[1]. Tissue penetration from this laser irradiation is approximately 0.5 mm deep, depending on power density.

Nd:YAG laser (Neodynium Yttrium Aluminium Garnet)

The Nd:YAG laser is a free-running pulsed wave laser with a wavelength of 1,064 nm. Unlike the CO_2 and Er:YAG lasers, the Nd:YAG laser has low absorption in water, and the energy scatters or penetrates into the biological tissues. In water, the Nd:YAG laser will theoretically penetrate to a depth of 60 mm before it is attenuated to 10% of its original strength.[2] Therefore at high energy level, it will penetrate into deeper tissues of the target site. In particular, when the irradiation is directed perpendicular to the target, this deep penetration may occasionally cause unexpected thermal damage in the tooth pulp[3], alveolar bone, and other surrounding tissues.

Due to the characteristics of penetration and thermogenesis, the Nd:YAG laser produces a relatively thick coagulation layer on the lased soft tissue surface, and thereby shows strong hemostasis.

Er:YAG LASER (Erbium Yttrium Aluminium Garnet)

The Er:YAG laser was introduced in 1974 as a solid-state laser that generates a light with a wavelength of 2,940 nm. Of all lasers emitting in the near- and mid-infrared spectral range, the absorption of the Er:YAG laser in water is the greatest because its 2,940 nm wavelength coincides with the large absorption band for water. The absorption coefficient of water of the Er:YAG laser is theoretically 10,000 and 15,000–20,000 times higher than that of the CO_2 and the Nd:YAG lasers, respectively. Also, as part of the apatite component, OH groups show a relatively high absorption at 2,940 nm, although the maximum absorption is around 2,800 nm. Since the Er:YAG laser is well absorbed by all biological tissues that contain water molecules, this laser is indicated not only for the treatment of soft tissues but also for ablation of hard tissues..

A mechanism of biological tissue ablation with the Er:YAG laser has been proposed, based on the optical properties of its emission wavelength and morphologic features of the surface ablated by Er:YAG laser. During Er:YAG laser irradiation, the laser energy is absorbed selectively by water molecules and hydrous organic components of biological tissues, causing evaporation of water and organic components and resulting in thermal effects due to the heat generated by this process ('photothermal evaporation'). Moreover, in hard tissue procedures, the water vapor production induces an increase of internal pressure within the tissue, resulting in explosive expansion called 'microexplosion'. These dynamic effects cause mechanical tissue collapse, resulting in a 'thermomechanical' or 'photomechanical' ablation[5]. This phenomenon has also been referred to as 'water mediated explosive ablation'

Diode lasers

The diode laser is a solid-state semiconductor laser that typically uses a combination of Gallium (Ga), Arsenide (Ar), and other elements such as Aluminum (Al) and Indium (In) to change electrical energy into light energy. The wavelength range is about 800–980 nm. The laser is emitted in continuous-wave and gated-pulsed modes, and is usually operated in a contact method using a flexible fiber optic delivery system. Laser light at 800–980 nm is poorly absorbed in water, but highly absorbed in hemoglobin and other pigments.[6]

The diode laser exhibits thermal effects using the 'hot-tip' effect caused by heat accumulation at the end of the fiber, and produces a relatively thick coagulation layer on the treated surface . The usage is quite similar to electrocauterization. Tissue penetration of a diode laser is less than that of the Nd:YAG laser, while the rate of heat generation is higher , resulting in deeper coagulation and more charring on the surface compared to the Nd:YAG laser. The width of the coagulation layer was reported to be in excess of 1.0 mm in an incision of bovine oral soft tissue in vitro.

The advantages of diode lasers are the smaller size of the units as well as the lower financial costs. Diode laser is an excellent soft tissue laser but does not interact with dental hard tissue. Many authors also concluded that irradiation with diode laser produced considerable bacterial elimination from periodontal pockets, especially in terms of A.actinomycetemcomitans.

Argon laser

The argon laser uses argon ion gas as an active medium and is fiber optically delivered in continuous wave and gated pulsed modes. This laser has two wavelengths, 488 nm (blue) and 514 nm (blue-green), in the spectrum of visible light. The argon laser is poorly absorbed in water and therefore does not interact with dental hard tissues. However, it is well absorbed in pigmented tissues, including hemoglobin and melanin, and in pigmented bacteria.

Excimer lasers

Excimer lasers are lasers that use a noble-gas halide, which is unstable, to generate radiation, usually in the ultraviolet region of the spectrum. Excimer laser wavelength depends on the chemical component serving as the medium of the laser. It has been suggested that tissue ablation occurs in the nonthermal process of photoablation, likely due to an instantaneous increase of the temperature or a straight combination of chemical elements.[9] However excimer laser cost and size still constitute an obstacle for clinical application of these lasers.

VARIOUS APPLICATIONS OF LASERS		
LASER TYPE	APPLICATION	
Excimer lasers	· Argon Fluoride · Xenon Chloride	· Hard tissue ablation · Dental calculus removal
Gas lasers	· Argon · Helium Neon · Carbon Dioxide	· Intraoral soft tissue surgery · Sulcular debridement (subgingival curettage in periodontitis and peri-implantitis) · Intraoral and implant soft tissue surgery · Removal of gingival melanin pigmentation · Treatment of dentin hypersensitivity,
Diode lasers	· Indium Gallium Arsenide Phosphorus · Galium Aluminum Arsenide and Galium Arsenide	· Calculus detection · Intraoral general and implant soft tissue surgery · Sulcular debridement (FDA approval-1998) · Treatment of dentin hypersensitivity · Removal of gingival melanin pigmentation
Solid state lasers	· Frequency-doubled Alexandrite · Neodymium:YAG (Nd:YAG)	· Selective ablation of dental plaque and calculus · Intraoral soft tissue surgery · Sulcular debridement · Treatment of dentin hypersensitivity. · Removal of gingival melanin pigmentation
	· Erbium group · Erbium:YAG (Er:YAG), Erbium:YSGG (Er:YSGG), Erbium,chromium: YSGG (Er,Cr:YSGG)	· Intraoral soft tissue surgery · Sulcular debridement · Treatment of dentin hypersensitivity Removal of gingival melanin pigmentation

CONCLUSION

Lasers have been promoted as an adjunct to, or substitute for, standard mechanical debridement of sub gingival root surfaces and periodontal pockets. The use of lasers has been proposed for its bactericidal and detoxification effects and for its capacity to reach sites that conventional mechanical instrumentation cannot.

Mahmoud et al.2014[9] conducted a study to assess Diode Laser (DL) therapeutic effects on chronic periodontitis and concluded that bleeding on probing, pocket depth and microbial count was less in study group compared to control group

Crispino et al. 2015[10] conducted a study to evaluate the effect of a 940-nm diode laser as an adjunct to SRP in patients affected by periodontitis. This study concluded that both procedures were effective in improving gingival index (GI), plaque index (PI) and probing depth (PD) but the use of diode laser was associated with more evident results.

The integration of dental lasers into the daily clinical practice of general dentist is being advocated as a “revenue booster”, offering patients a painless alternative to surgical treatment of periodontal disease. The use of lasers in dentistry has recently received much attention, in both clinical practice and research; their unique properties produce favourable clinical results in some cases and encourage patient's acceptance.

REFERENCES

1. Arashiro DS, Rapley JW, Cobb CM, Killoy WJ. Histologic evaluation of porcine skin incisions produced by CO2 laser, electrosurgery, and scalpel. Int J Periodontics Restorative Dent 1996: 16: 479–491.
2. AAP (The American Academy of Periodontology). The Research, Science and Therapy

Committee of the American Academy of Periodontology, Cohen RE, Ammons WF. Revised by Rossman JA. Lasers in periodontics (Academy report). J Periodontol 2002: 73: 1231–1239.
3. Tokita Y, Sunakawa M, Suda H. Pulsed Nd:YAG laser irradiation of the tooth pulp in the cat. I. Effect of spot lasing. Lasers Surg Med 2000: 26: 398–404.
4. Walsh JT Jr, Flotte TJ, Deutsch TF. Er:YAG laser ablation of tissue: effect of pulse duration and tissue type on thermal damage. Lasers Surg Med 1989: 9: 314–326.
5. Koort HJ, Frentzen M. Laser effects on dental hard tissue. In: Miserendino, LJ, Pick, RM, editors. Lasers in Dentistry. Chicago: Quintessence, 1995: 57–70.
6. ALD (The Academy of Laser Dentistry). Featured wavelength: diode – the diode laser in dentistry (Academy report) Wavelengths 2000: 8: 13.
7. White JM, Gekelman D, Shin K, Park J, Swenson T, Rouse B, Tran K, Bullard S, Scott-Beckles B, Oto MJSB, Yamamoto A. Laser interaction with dental soft tissues: What do we know from our years of applied scientific research? Proc SPIE 2002: 4610: 39–48.
8. Frentzen M, Koort HJ, Thiensiri I. Excimer lasers in dentistry: future possibilities with advanced technology. Quintessence Int 1992: 23: 117–133.
9. Mahmoud M M. Soliman, Sabra SM, Ammar SS Sorour A . A Study of the Diode Laser Phototherapy for Enhancing Healing and Reduction of Microbial Count in Periodontal Pockets within a Saudi Community. Journal of Dental and Medical Sciences. 2014;13(11):61-68.
10. Crispino A, Figliuzzi MM and Giudice RD. Effectiveness of a diode laser in addition to non-surgical periodontal therapy: study of intervention.Ann Stomatol.2015;6(1):15-20.