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Research Article

APPLICATIONS OF LASERS IN PERIODONTAL THERAPY

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A R T I C L E I N F O

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A B S T R A C T

There are many advances in dentistry, one of the most important and commonly utilized technologies in dentistry is the Laser. With recent advances and developments in laser technology, a wide range of laser wavelengths and different delivery systems, have been utilized for a variety of dental therapies including periodontal, restorative and surgical treatments. Different types of lasers are available for clinical and specific use for soft and hard tissues and are activated at different power setting modes, and pulse modes.This review paper aims to briefly review the use of lasers in periodontics.

INTRODUCTION

Dentistry has seen tremendous advances in the past decade for the advantage of both the clinician and the patient and lasers are one among them. The use of laser has increased tremendously in the last couple of decades since its introduction in 1960s. Lasers were made available in the field of clinical dentistry with the hope of overcoming some of the short comings posed by conventional methods in the treatment of dental procedures. Different types of lasers are available for clinical and specific use for soft and hard tissues and are activated at different power setting modes, and pulse modes [1].

Initially introduced as a substitute to the traditional halogen curing light, the laser because of its advantages in many applications, has now become one of the treatment modality for both periodontal and restorative care. Lasers are indicated as an extensive variability various procedures [1].

The most common laser used in dentistry are Carbon dioxide (CO2), Neodymium-doped: Yttrium-Garnet (Nd: YAG), Semiconductor diode lasers for soft tissue treatment and Erbium doped: Yttrium- Aluminium- Garnet (Er: YAG) laser has been used for removal of calculus and decontamination of the diseased root surfaces in periodontal non – surgical therapy, surgical therapy and implant therapy [1].

Applications of Lasers in Periodontal Treatment

Lasers are being used in periodontal treatment over the past 10 years for the following procedures:

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Lasers are primarily used as an alternative for phase I periodontal therapy and surgical procedures. The laser eliminates the diseased granulation tissue and associated bacterial load when applied in deep periodontal pockets with associated bony defects; it also promotes "osteoclast and osteoblast activity", resulting in bone regrowth. The most commonly used lasers in periodontics are CO2, Nd: YAG and diode lasers because of their excellent ablation and hemostatic characteristics.

Laser in Diagnosis

A useful tool in diagnosis, monitoring, prognosis and management of periodontal patients is Doppler flowmetry, which allows access of not only gingival blood flow but also of pulpal microcirculation. Early detection of gingival micro vessel dysfunction helps to diagnose and prevent the progression of initial periodontal pathology. Doppler flow meter helps to realize the ultimate target of predictive, preventive and personalized periodontology tailored with respect to the particular patient [2, 3].

Laser in Non-Surgical Periodontal Therapy

Many studies revealed the surface modification of cementum and dentin by the use of variety of laser wave lengths primarily CO2, Nd: YAG, Er: YAG, and to a lesser extent by the diode laser. The ideal selection of required wavelength is a major conceptual consideration in laser-induced root surface modification which will effectively remove calculus while suppressing both thermal damage to the pulp tissue and undesired removal of sound root structure. These goals are achieved by the selection of the wavelength which is characterized by minimal penetration depth in the mineralized tissue.

For bacterial reduction and coagulation, soft tissue lasers are a good choice. Greater reduction of interleukins and pocket depth was resulted with laser as a treatment modality. The Erbium group of lasers has shown significant bactericidal effects against Porphyromonas gingivalis and Actinobacillus actinomycetemcomitans [4].

With the availability of specific laser hand-piece tips, the access to calculus deposits are enhanced with the use of mid-infrared erbium wavelengths. The supra- and sub-gingival calculus is susceptible to de-fragmentation through photo-mechanical ablation with the erbium group dueto the higher water content and the poor calcification of deposits. This enables deposits to be removed using laser energy levels less than those required for ablation of dental hard tissues. In addition to the treatment of periodontal diseases, Erbium YAG and erbium YSGG lasers can be used to carry out bone remodeling.With the availability of Er:YAG and Er,Cr:YSGG, together with innovative near-UV wavelengths such as frequency- doubled alexandrite (FDA, 377 nm), has given scope for the safe use of calculus removal [5].

Lasers in Surgical Periodontal Therapy

Minor Surgical Procedures

Minor Surgical Procedures such as Gingivectomy, Gingivoplasty, free gingival graft procedures, crown lengthening, operculectomy and many more procedures can be effectively performed by application of Laser [6]. An effective, pleasant, and a reliable technique recognized for gingival de-pigmentation is by using laser ablation technique.
The availably and extensive use of the Erbium laser in crown lengthening procedures in the anterior region has given a new dimension in the area of smile design in terms of aesthetic dentistry.

Gingivectomy Procedures by Laser

The most frequent soft tissue procedures completed by lasers according to White and Swift are gingivectomies and Gingivoplasty [7].

Technique: When considering the use of diode laser for gingivectomies, several factors must be taken into consideration. When considering the clinical technique for doing a Gingivectomy, there are two possible sequences. The removal of tissue in an external bevel is done in situations where the tissue is thin and the amount of tissue is small and in situations where topical anesthetic and not injections is preferred (exposure of partially erupted teeth requiring placement of orthodontic brackets). The properly initiated tip is angled at an external bevel of 45 degrees and at energy settings of 0.6-1.2 watts. Small brush like strokes back and forth and gradual progression deeper along the same initial laser incision will remove the tissue. Tissue tags can be removed with a wet cotton pellet or hydrogen peroxide.

Clinical Procedure for Gingivectomy of small Amount of Tissue

The following steps are to be followed for Gingivectomy of small amount of tissue.

1. Properly strips, cleave and initiate the diode fiber.
2. Position tip at 45 degree angle to long axis of tissue. (External bevel).
3. Use 0.6 - 1.2 watts Continuous wave (Less energy without anesthetic).
4. Gentle back and forth brush strokes gradually going deeper in planes.
5. Hydrogen Peroxide or wet cotton pellet to remove tissue tags.

Clinical Procedure for Gingivectomy of Moderate Amounts of Tissue

The following steps are to be followed for gingivectomy of moderate amount of tissue.

1. Properly strip, cleave and initiate the diode fiber.
2. Position tip at 90 degree angle to long axis of tissue. (External bevel) and outline the area to be cut at low power (i.e., 0.5 watts).
3. Use 1.5- 2.5 watts Continuous wave (with anesthetic) on wet tissue.
4. Penetrate to contact in one “puncture” vertically at start of incision.
5. Penetrate to contact in one “puncture” vertically at end of incision.
6. Penetrate to contact in one “puncture” vertically at middle of incision.
7. Continue to “split” the dots half way until there is a continuous line of dots.
8. Apply tension or traction to tissue and remove with a curette, spoon or the laser.
9. Hydrogen Peroxide or wet cotton pellet to remove tissue tags.

Frenectomy by Laser

Lasers can be of tremendous benefit to dentistry in the release, reduction or removal of aberrant frenum in either dental arch. A frenum is a fold of mucous membrane attaching the cheeks and lips to the mandibular and maxillary mucosa and limiting the motions of the lips, cheeks and tongue.

The advantages of a laser Frenectomy as compared to traditional techniques are:[8]

1. Reduced bleeding throughout surgery with minimum operating time and better postoperative hemostasis.
2. Elimination of the need for sutures.
3. The lack of requirement for anesthetics.
4. Enhanced postoperative comfort and healing.

For the release, reduction or removal of aberrant frenum, diode lasers have several advantages when compared to monopolar electro surgery units. The diodes cause less lateral thermal damage, which results in faster healing with less postoperative pain.

Clinical Procedure for Frenectomy

1. Properly strip, cleave and initiate well the disposable fiber tip.
2. Place topical (small) or a few drops of anesthetic (large) on either side of the frenum attachment.
3. Use 0.8 - 1.4 watts Continuous wave (Less energy without anesthetic).
4. Start ablation at the attachment and pull the lip outwards releasing attachment, resulting in a “diamond” shaped wound.
5. Continue until all vertical fibers are removed and you are at the periosteum.

6. If necessary "score" the periosteum horizontally with a scalpel blade or periosteal elevator.
7. Hydrogen Peroxide or wet cotton pellet to remove tissue tags.

Upon completion of the Frenectomy which takes 2-5 minutes depending on the type of anesthetic used (topical vs injection), the following postoperative instructions can be given and the patient reappointed at 7-10 days to evaluate healing of the area.

Crown Lengthening Procedure by Laser

Gherlone *et al* found lasers to yield less recession than using either a double retraction cord or electro surgery technique for tissue management [9]. Their conclusion was that the laser was "less traumatic to the periodontal tissues" when compared to the traditional techniques of using either retraction cords or an electro surgery.

Technique

When considering the use of diode laser for tissue management in the anterior esthetic zone where thin tissue genotypes exist, care with diode troughing must be taken.Goharkhay *et al* concluded that the diode laser has a "significant cutting ability and the acceptable damage zone" and due to its "excellent coagulation ability" it is a useful alternative in soft tissue surgery of the oral cavity [10].Adequate magnification (4.0 X Loupes) and judicious use of power (0.6-0.9w CW) are vital to success in laser troughing. Another option to low settings is to use a pulsed mode of laser energy on the diode. (Comfort Mode on AMD Lasers Picasso Lite). Pulsing the laser means chopping up the continuous beam of light, and gives time between pulses to help cool the tissue down. Prior to beginning with preparation of the teeth, the diode laser can be used to provide idealized soft tissue contours.

Minimal alterations in tissueheight and/or tissue symmetry can be accomplished with the diode as long as these alterations do not infringe upon the biologic width of the sulcus. These subtle alterations to the soft tissue improve the final result and be completed on the same day as final impressions for the restorations are completed. Subsequently, the initial crown or veneer preparations are completed and the properly stripped, cleaved and initiated quartz fiber tip (or single use initiated disposable tip) is extended just into the gingival sulcus (0.5 - 1.0 mm).

Clinical Procedure for Laser Troughing

1. Slight alterations of gingival height or symmetry with diode.
2. Initial gross reduction and margin placed equi-gingival with magnification.
3. Diode laser troughing : suggested settings 0.6-0.9 w CW (less on facial).
4. Final margin placements subgingivally as needed for esthetics.
5. Hydrogen Peroxide or wet cotton pellet to remove tissue tags.
6. Lateral distention of tissue if needed (Expasyl, Traxodent).
7. Rinse thoroughly and take PVS impression
8. Provisional fabrication - Make sure no overhangs on facial.

Depigmentation of Gingiva

Gingival melanin pigmentation is one of the factors which determine the smile of an individual. The demand gets fulfilled not only by having healthy set of dentition but also esthetically improved gingival component. The factors which determine the color of the gingiva depends on the "ethnicity and varying degree of melanin deposition". Gingival and cutaneous melanin pigmentation is a common aesthetic problem.

Based on the available literature gingival melanin pigmentation can vary depending on whether it is physiological or pathological. Its esthetic importance depends on the skin complexion of the patient and is one of the most important factors for determining the treatment for gingival melanin pigmentation. This problem is intensified in patients with a gummy smile or excessive gingival display. The gumminess in cases of "skeletal class II malocclusion", "bimaxillary protrusion" and fairer individuals makes the smile unpleasant. Various techniques of depigmentation have been explained in the literature to treat this entity.

It is necessary to select an appropriate technique for treating unaesthetic gingival melanin pigmentation of patients and the treatment should cause minimal discomfort and should be effective for a longer period of time. Treatment of gingival melanin pigmentation can be done using scalpel, chemical agents, abrasion, grafts, electro surgery, cryosurgery or lasers. Recent reports on treatment of gingival melanin pigmentation using cryosurgery and lasers show results in terms of ease of use, acceptance and patient comfort to be far superior to other techniques [11]

Due to its superficial absorption, the Er: YAG laser is extremely harmless in the treatment of gingival de-pigmentation. With longer Er: YAG pulses de-epithelialization of the basal layer with pigmentation is accomplished. It is observed that the tissue heals faster if a less quantity of water spray is used but there can be mild bleeding during the operation [12].

Use of Laser in major Surgical Procedures

There are countless benefits of the combined use of laser-assisted and conventional methods for the effective elimination of infected soft and hard tissue during both surgical and non-surgical therapy. For removing bacteria [14] endotoxins [15] and lipopolysaccharide on the hard root surface, and the elimination of granulomatous tissue on the soft gingival side the Er: YAG laser with an appropriate fiber tip is used [13]. To decontaminate the pocket as well as to de-epithelize, the Nd: YAG laser is an indispensable tool [16].

The paramount solution for decontamination and smear layer removal of laser-assisted treatment provides successful clinical and microbial outcomes as they eliminate the cause of the periodontal problem and provide a better surface for fibroblast attachment [17]. Both wavelengths help to advance the treatment outcomes [18] and patient comfort [19]. The Twin Light combination of Er: YAG and Nd: YAG laser assisted, minimally invasive periodontal treatment is able to replace classical invasive surgery or ease the procedure with increased access, selective removal of tissues and biomodulation during the surgical approach. Many perio-surgical procedures can be performed by lasers in an elegant way [20]. Very clean cuts of gingival tissue with a desired coagulation depth can be accomplished with a VSP (Variable Square Pulse Technology)

Er: YAG laser without detrimental thermal effects. The surgery can also be combined with the Twin Light Nd: YAG step, if robust hemostasis is required.

Procedure

Easy access into the periodontal pocket has been provided with the development of the quartz optic fiber delivery system associated with the diode and Nd:YAG group of lasers, with diameters of 200-320µm.

The pocket architecture, especially the depth is re-assessed following the removal of all hard and soft deposits through scaling and/or root-planning. The laser probe or fiber is measured to a distance of one to two millimeters short of the pocket depth and is inserted at an angle to maintain contact with the soft tissue wall at all times [21].

Using laser power values sufficient to ablate the epithelial lining (approximately 0.8 W CW diode, 100 mJ/20 pps, 2.0 W Nd:YAG and Er:YAG/YSGG, 1.0 W CW CO2), the laser probe is used in a light contact, sweeping mode to cover the entire soft tissue lining. Ablation should commence near the base of the pocket and proceed upwards, by slowly removing the probe. Due to disruption of the fragile inflamed pocket epithelium, some bleeding of the pocket site will occur. Re-treatment of each pocket site should be done for 20-30 seconds with approximate weekly intervals for a maximum of four-week period. Gentle pocket probing and measurement to establish benefits of treatment should be resisted during this period.

Osseous Resection by Laser

Many full-thickness mucoperiosteal flap procedures include osseous resection. The Erbium family of lasers(Er:YAG and Er:Cr:YSGG) are the only wavelengths cleared by the FDA for osseous surgery. Er:YAG and Er:Cr:YSGG are the only wavelengths that have the ability to ablate osseous tissue safely[22].

The Er:YAG wavelength produces an excellent cut and charring was not seen as long as the surface remained moist during ablation and the appropriate settings were used. Romano investigated the Er:YAG laser and its ability to cut bone and found that the depth of ablation was linearly related to the number of pulses and that moisture of the surgical site with water spray prevented char formation. In addition, Romano calculated that repetition rates above 20 Hz would not significantly increase the risk of more collateral thermal damage [23].

Sasaki *et al* looked at the nature of tissue after irradiation with the Er:YAG wavelength compared with the CO2 laser and bur drilling. Using scanning electron microscopy and transmission electron microscopy, they demonstrated that laser irradiation of bone resulted in a changed layer of 30µm thickness, which consisted of two distinct sub-layers: a superficial, greatly altered layer and a deeper, less affected layer. They found that the major changes on bone consisted of micro cracking, disorganization, slight re-crystallization of the original apatite, and slight reduction of the surround organic matrix [24].
The results produced by laser were deemed to be comparable to conventional surgical bone wound healing. The investigators concluded that the ‘‘wound cavities were smooth, clean and straight’’ and ‘‘at 24 hours, the wound sites for both bur and HKS (hydrokinetic system) showed a clean cut margin with a thin zone of basophilic characteristic of a thermal coagulative effect. This zone measured 40–60 µm. In the future the laser is likely to become much more commonly used in osseous surgery. The laser can be used routinely for the ablation of bone and for the removal of root tips, osseous recontouring, apical surgery exposure of bony impacted teeth, and other procedures [25].

Recent Advances

A revolutionary dental device known as Waterlase system uses laser energized water to cut or ablate the soft and hard tissue. To destroy the bacteria, photodynamic disinfection system known as Periowave is used which utilizes nontoxic dye (photosensitizer) in combination with low intensity lasers enabling singlet oxygen molecules [26].

Laser-assisted oral Implantology

There are several clinical indications for laser surgery in modern implant dentistry [27]. For every step of the implant procedure different laser wavelengths are included. Before starting implant surgery the soft tissues that will surround the implant should be prepared. Several laserwavelengths can be used for this step, but Er:YAG lasers cause less pain as they do not heat the tissue surface as do diode, Nd:YAG or CO2 lasers, and the healing is faster [28]. The next important step in implant procedures where Er:YAG lasers have a crucial role is the removal of granulation tissues and disinfection of the surgical area after extractions. Because of the strong absorption of the Er:YAG laser beam in water, only soft tissue is removed if the parameters are adjusted correctly (energy density and pulse duration). The Nd:YAG laser is used for deep disinfection and a biomodulation effect after the removal of granulation tissues and superficial disinfection helps in healing, leading to less edema and pain[29].

Ablating the bone with Er:YAG[30] laser in order to have the desired coronal bone thickness, such as by removing a knife-edge thin portion to shape a plateau, or an osteotomy for sinus lift, or obtaining a bone block, or bone splitting is advantageous. For new implantologists, marking the location of the first drilling site with an Er:YAG laser is easier, because the laser beam cannot slip and cause iatrogenic damage like an implant drill. In special indications relating to the implant bed preparation, such as when the bone is very thin and soft the Er:YAG laser is used. It is beneficial to prepare the implant bed with a laser to disinfect the site, remove the smear layer, activate osteoblastic activity and achieve more bone- to-implant contact during the early healing [31].

Uncovering the implant with the Er:YAG laser leads to fast healing, thus facilitating rapid prosthetic rehabilitation, and is patient-friendly [32]. The combination of longer and shorter Er:YAG pulses for this procedure ensures that the impressions can be taken without a delay. The most efficient usage of the Twin Light treatment concept in implantology is in the case of peri-implantitis. With Er:YAG, used safely with water irrigation [33], it is possible to clean the granulation tissues both on the bone surface and implant surface while decontaminating [34]. The Nd:YAG laser adds the effect of deep disinfection and biomodulation. As there is there is no mechanical or chemical trauma while removing the granulation tissue around the implant, similar to the cleaning of the surgical area after extractions, it is possible to leave the highly fragile surrounding bone intact, because [34].

CONCLUSION

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 for lasers. Lasers generally accepted as useful tools for these procedures are CO2, Nd:YAG, diode, Er:YAG and Er, Cr:YAG. In consideration to easy ablation, decontamination and hemostasis, as well as less surgical and postoperative pain in soft tissue management, laser treatments have been shown to be superior to conventional mechanical approaches.

In periodontics laser or laser-assisted pocket therapy is expected to become a new technical modality. The Er:YAG laser shows the most promise for root surface debridement, such as calculus removal and decontamination. Because of carbonization and degeneration of hard tissue, CO2 and Nd:YAG lasers are considered unsuitable for the use of lasers in bone surgery. The Er:YAG laser seems to provide the most suitable characteristics for various types of periodontal treatment. Patients need to be motivated in order to have a successful periodontal treatment. To maintain a good and stable periodontal condition it is not the technology but themotivation and psychology that matters when it comes to practice of oral hygiene before, during and after the periodontal treatment.

References

1. Yukna RA, Scott JB, Aichelmann-Reidy ME, LeBlanc DM, Mayer ET. Clinical evaluation of the speed and effectiveness of sub gingival calculus removal on single rooted teeth with diamond-coated ultrasonic tips. *J Periodontal* 1997;68:436-42.
2. Cohen RE, Ammons WF: Lasers in periodontics. Report of Research, Science and Therapy Committee, American Academy of Periodontology (revised by LA Rossman), *J Periodontol* 73:1231,2002.
3. Orekhova LY, Barmasheva AA. Doppler flowmetry as a tool of predictive, preventive and personalized dentistry. *EPMA J* 2013;4:21.
4. Chen RE, Ammons WF. Lasers in periodontics academy report. *J Periodontol* 2002:73:1231-9.
5. Coluzzi D J. Lasers in Dentistry: From Fundamentals to Clinical Procedures. *Dent Clin N Am* 2004; 48:771–794.
6. Moritz A, Schoop U, Goharkhay K, Schaver P, Doertbudak O, Wernisch J, *et al*. Treatment of periodontal pockets with a diode laser. *Lasers Surg Med* 1998;22:302-11.
7. White JM, Swift EJ. Lasers for Use in Dentistry. *Journal of Esthetic and Restorative Dentistry*.Vol 17, Issue 1, page 60, January 2005.
8. L. Kotlow. Lasers and Pediatric Dental Care. General Dentistry. Nov-Dec. 2008: Vol 56 (7): 618-627.)
9. Gherlone EF, Maiorana C, Grassi RF, Ciacaglini R, Cattoni F. The use of 980- nm Diode and 1064-nm Nd:YAG Laser for Gingival Retraction in Fixed Prostheses. *J Oral Laser Appllications*.2004; 4:183-190.
10. Goharkhay K, Mortiz A, Wilder-Smith P, Schoop U, Kluger W, Jakolitsch S, Sperr W, Effects on oral soft tissue produced by a diode laser in vitro, *Lasers Surg Med,* 1999; 25(5): 401-6.
11. Dukic W, Bago I, Aurer A. Clinical Effectiveness of Diode Laser Therapy as an Adjunct to Non-Surgical Periodontal Treatment: A Randomized Clinical Study. *J Periodontol* 2012; 83:1256-1263.
12. Hegde R, Padhye A, Sumanth S, Jain AS, Thukral N. Comparison of Surgical Stripping, Er:YAG Laser and CO(2) Laser Techniques for Gingival Depigmentation: A Clinical & Histological Study. *J Periodontol*.2012 Sep 24.
13. Aoki A, Miura M, Akiyama F, Nakagawa N, Tanaka J, Oda S, Watanabe H, Ishikawa I. In vitro evaluation of Er:YAG laser scaling of subgingival calculus in comparison with ultrasonic scaling. *J Periodontal Res* 2000: 35: 266-277.
14. Folwaczny M, Mehl A, Aggstaller H, Hickel R. Antimicrobial effects of 2.94 micron Er:YAG laser radiation on root surfaces: an in vitro study. *J ClinPeriodontol* 2002: 29: 73-78.
15. Folwaczny, M., Aggstaller, H., Mehl, A., &Hickel, R (2003). Removal of bacterial endotoxin from root surface with Er:YAG laser *American journal of dentistry*, 16(1), 3-5.
16. Schultz RJ, Harvey GP, Fernandez-Beros ME, Krishnamurthy S, Rodriguez JE, Cabello F (1986) Bactericidal effects of the Neodymium:YAG laser: in vitro study. *Lasers in Surgery and Medicine* 6(5):445-8.
17. Bolortuya, G., Ebihara, A., Ichinose, S., Watanabe, S., Anjo, T., Kokuzawa, C., Saegusa, H., *et al* (2012). Effects of dentin surface modifications treated with Er:YAG and Nd:YAG laser irradiation on fibroblast cell adhesion Photomedicine and Laser Surgery, 30(2), 63-70.
18. Schwarz, F., Sculean, A., Georg, T., & Reich, E (2001). Periodontal treatment with an Er:YAG laser compared to scaling and root planing. *A controlled clinical study Journal of Periodontolog*y, 72(3), 361-7.
19. Braun, A., Jepsen, S., Deimling, D., &Ratka-Krüger, P (2010). Subjective intensity of pain during supportive periodontal treatment using a sonic scaler or an Er:YAG laser *Journal of Clinical Periodontology*, 37(4), 340-5.
20. Ishikawa I, Aoki A, Takasaki AA. Potential applications of Erbium:YAG laser in periodontics. *J Periodontal Res.* 2004 Aug;39(4):275-85.
21. Galli C, Macaluso GM, EridaElezi. The Effects of Er:YAG Laser Treatment on Titanium Surface Profile and Osteoblastic Cell Activity: An In Vitro Study. *J Periodontol* 2011; 82:1169-1177.
22. Parker S. Surgical lasers and hard dental tissue. *British Dental Journal* 2007; 202:445-454.
23. Hegde R, Padhye A, Shivaswamy S. Comparison of Surgical Stripping, Er: YAG Laser and CO2 Laser Techniques for Gingival Depigmentation: A Clinical & Histological Study. *J Periodontol* 2012; 83:456-465.
24. Dukic W, Bago I, Aurer A. Clinical Effectiveness of Diode Laser Therapy as an Adjunct to Non-Surgical Periodontal Treatment: A Randomized Clinical Study. *J Periodontol* 2012; 83:1256-1263.
25. Raghavendra M, Koregol A and Bhola S. Photodynamic therapy: a targeted therapy in periodontics. *Australian Dental Journal* 2009; 54:102-109.
26. Walsh LJ. The current status of laser applications in dentistry. *Aust Dent J* 2003; 48:146-55.

27. Romanos GE, Gutknecht N, Dieter S, Schwarz F, Crespi R, Sculean A. Laser wavelengths and oral implantology. *Lasers Med Sci*. 2009 Nov;24(6):961-70.
28. Maden I, Kazak Z. Lasers in oral implantology, International Magazine of Laser Dentistry, Vol. 4, Issue 2/2012: 34-36.
29. Ishikawa I, Aoki A, Takasaki AA. Potential applications of Erbium:YAG laser in periodontics. *J Periodontal Res*. 2004Aug;39(4):275-85.
30. Pourzarandian A, Watanabe H, Aoki A, Ichinose S, Sasaki KM, Nitta H, Ishikawa I. Histological and TEM examination of early stages of bone healing after Er:YAG laser irradiation. *Photomed Laser Surg*. 2004 Aug;22(4):342-50.
31. Kesler G, Romanos G, KorenR.Use of Er:YAG laser to improve osseointegration of titanium alloy implants--a comparison of bone healing. *Int J Oral Maxillofac Implants.* 2006 May-Jun;21(3):375-9.
32. Arnabat-Domínguez J, España-Tost AJ, Berini-Aytés L, GayEscodaC.Erbium:YAG laser application in the second phase of implant surgery: a pilot study in 20 patients. *Int J Oral Maxillofac Implants*. 2003 Jan-Feb;18(1):104-12.
33. Leja C, Geminiani A, Caton J, Romanos GE. Thermodynamic effects of laser irradiation of implants placed in bone: an in vitrostudy. *Lasers Med Sci*. 2012 Oct 10. [Epub ahead of print]
34. Kim JH, Herr Y, Chung JH, Shin SI, Kwon YH. The effect of erbium-doped: yttrium, aluminium and garnet laser irradiation on the surface microstructure and roughness of double acid-etched implants. *J Periodontal Implant Sci.* 2011 Oct;41(5):234-41.

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