Surgical Periodontal Therapy using as a Different Scalpel

Dr. Kamal Garg, [1] Dr. Rajni Aggarwal, [2] Dr. Puneet Kalra, [3] Dr. Amit Khunger [4]

1. **Dr. Kamal Garg**
   Professor and Head, Department of periodontology and Oral Implantology, Surendera Dental College and Research Institute. Sri Ganganagar. Rajasthan
2. **Dr. Rajni Aggarwal**
   Reader, Department of periodontology and Oral Implantology, Surendera Dental College and Research Institute. Sri Ganganagar. Rajasthan
3. **Dr. Puneet Kalra**
   Post-Graduate Student. Department of periodontology and Oral Implantology, Surendera Dental College and Research Institute. Sri Ganganagar. Rajasthan
4. **Dr. Amit Khunger**
   Senior Lecturer. Department of periodontology and Oral Implantology, Surendera Dental College and Research Institute. Sri Ganganagar. Rajasthan

Abstract Surgeries are considered as traumatic procedures in dental field. Fear of bleeding, delayed healing, post–operative trauma or complications are the major factors which the most challenging questions are asked by patients before periodontal surgeries. To overcome these, LASERS were introduced and very much appreciated both by the patients and dental professionals. LASERS have overcome complications of many dental surgical procedures. In this review article, all these factors are explained along with other author studies.

Keywords - LASERS, Frenectomy, Gingivectomy, Depigmentation, Periodontal Flap, LANAP, Dental implants.

INTRODUCTION

Surgical techniques such as subgingival curettage, gingivectomy, and flap surgeries have been studied in the attempt of reducing probing pocket depth (PD) and gaining clinical attachment level (CAL). Other treatment options aiming to regenerate tissues include guided tissue regeneration (GTR), or the application of growth factors, which have demonstrated varying degrees of success and predictability. Regardless of the treatment modality, surgical periodontal therapy is often associated with pain and discomfort.[1]

In the last decade or so, the use of LASER (Light amplification by stimulated emission of radiation) has occupied part of the dialogue within periodontology due to several proposed advantages. Several researches have shown that use of lasers for surgical or non surgical periodontal therapy have resulted in decrease in pain and enhanced the wound healing and thus enhance patient comfort.

Stated best by Apfelberg in 1987, lasers are a "new and different scalpel," (optical knife, light scalpel). When used correctly in proven applications, lasers offer an acceptable and impressive alternative within the field of periodontics and other dental field. Therefore, LASERS in periodontal therapy can be used for various surgeries like, frenectomy, gingivectomy, depigmentation, flap surgeries, second stage implant surgery.

Lasers in Frenectomy Procedure

Laser-assisted frenectomy is much more comfortable for the patient because it is painless, does not require suture and immediate haemostasis can be achieved. Frenectomy can be done using CO2 laser with 4 to 5 W and in slightly defocused mode. While in case of diode laser 0.8 W in continuous wave mode in contact mode is used. Argon laser can be used for frenectomy procedure at 1.0 to 2.25 W in continuous wave delivery; water spray may be used .[1]

In maxillary and mandibular frenectomy, the frenum is simply vaporised with the laser. In lingual frenectomy, the tip of the tongue is grasped, tension is placed, and from the greatest concavity of the frenum moving posteriorly, the frenum is simply vaporized until the desired effect is achieved. Few more studies which supports the use of LASER as a surgical blade in frenectomy. Haytac MC et al.2006[2] compared the degree of postoperative pain, such as discomfort and functional complications (eating and speech), experienced by patients after two frenectomy operation techniques. Forty patients requiring frenectomy were randomly assigned to have treatment either with a conventional technique or with a carbon dioxide (CO2) laser. The results indicated patients treated with the CO2 laser had less postoperative pain and fewer functional complications (speaking and chewing) and required fewer analgesics compared to patients treated with the conventional technique. Olivi G et al. 2010[3] evaluated the efficacy of an Er, Cr: YSGG laser in removing the labial frenum in an adolescent and pre-pubescent population. Using an Er, Cr: YSGG laser at a power setting of 1.5 W or less and 20–30 pulses per second, a total of 156 frenectomies were performed on 143 children. Patient acceptance was very high, and no postoperative adverse events were reported. Aldelaimi TN et al. 2014[4] conducted laser-assisted frenectomy on twenty five patients using 980nm diode laser. The postoperative advantages, i.e., lack of swelling, bleeding, pain or, scar tissue formation, the good wound healing and overall satisfaction were observed in the clinical application of laser-assisted frenectomy.

Lasers in Gingivectomy Procedure

Gingivectomy is performed using diode laser at 1W in continuous wave mode in contact method. CO2 laser can also be used at 4 to 10W depending on the thickness of the gingival and the beam is used in both the focused and defocused mode. Argon laser can also be used for gingivectomy procedure using 300µm fibre in contact mode at 1.0 to 1.8 W in continuous wave with water spray.[1] Other studies which also suggest that use of LASER is safe and reliable**.** Pick et al. 1985[5] used CO2 laser for the removal of phenytoin hyperplasia in twelve patients. The results showed lack of haemorrhage, sterilization of the surgical area, prompt healing, minimal post operative discomfort, and minimal time spent to perform the procedure. Shankar et al. 2012[6] performed gingivectomy using diode laser in three patients undergoing orthodontic treatment. The authors concluded that diode lasers showed no post- operative pain , swelling, excellent haemostasis and patient acceptance. Funde S et al. 2015[7] Compared Laser, Electrocautery and Scalpel in the Treatment of Drug-Induced Gingival Overgrowth in a forty six old male patient. The result showed that healing with scalpel was best among all three with minimal inflammation. Healing with electrocautery was worst among all with uneven healing and incomplete surface epithelization. Healing with laser was better than electrocautery.

Lasers in De-Pigmentation Procedure

Various treatment options are in practice for depigmentation which includes scalpel technique, free gingival graft surgery, use of chemicals (90% phenol and 95% alcohol), bur abrasion, electrocautery, cryosurgery and lasers. Among these techniques laser offers a promising therapeutic option since it is simple, painless and predictable. It has many advantages over conventional treatment. Diode laser can be used at 1.5 to 2 W in continuous wave mode in contact method. CO2 laser can be used in superpulsed wave (10 watts, 0.8 mm spot size, 20 Hz, 10 milliseconds) or at 2 to 4 W continuous pulsed wave mode.[1]

Er: YAG laser (Versa wave) can also be used in depigmentation procedure. The laser beam set up at 1000 mj, 45 Hz per second in defocused mode to produce a 3 mm diameter circle, thus reducing the beam penetration while increasing the treated surface. After every 2 minutes the gingiva is wiped off by wet sterile gauze soaked with 1% normal saline, then depigmentation continued until no pigment remained. Er: YAG can also be used at settings of 250 mJ, 15 Hz, with water and air in defocused mode. There are many other studies which also suggest the LASERS are safe. Astawasuwan et al .2000[8] presented the use of Nd:YAG laser for gingival depigmentation in three cases .Nd:YAG laser was set at 6watt

,60millijoules/pulse and 100 pulse /second in contact mode. The results showed that ablation of gingival hyperpigmentation was accomplished without any bleeding complication or post-operative pain. Azzeh M 2007[9] treated gingival hyperpigmentation by Erbium-Doped: Yttrium Aluminum Garnet Laser for esthetic purposes. In six patients laser ablation was performed by an erbium-doped: yttrium, aluminum, and garnet (Er: YAG) laser (settings: 250 mJ, 15 Hz, with water and air and using the defocused mode) without using topical or local anesthesia. The results showed that, no patient discomfort, pain, or bleeding complications were found Ablated wounds healed almost completely within 4 days. No recurrence of gingival hyperpigmentation was found during the follow-up periods.The authors concluded that depigmentation of melanin hyperpigmented gingiva by the Er: YAG laser is a reliable and satisfactory procedure Singh et al.2012[10] did comparative evaluation of gingival depigmentation by diode laser and cryosurgery using tetrafluoroethane.20 patients were divided into two groups ,group A (diode laser) and group B (tetrafluoroethane). The laser beam was set at 0.70 W powers, 200 J energy, in continuous mode. The authors concluded that the depigmentation achieved using both the techniques were found equivalent and satisfactory. Grover HS et al.2014[11] evaluated patient response and recurrence of pigmentation following gingival depigmentation carried out with a surgical blade and diode laser. A split mouth approach was used for 20patients wherein one side received laser and the other side scalpel surgery. The results of this study indicated that both scalpel and laser were efficient for gingival depigmentation. Butchibabu K et al.2015[12] did comparative evaluation of the gingival depigmentation by using a surgical blade and a diode laser. Four systemically healthy patients were treated with different gingival depigmentation techniques. Diode laser and surgical blade was used for the depigmentation in either of the arches. The results showed that diode laser were esthetically pleasing with great patient comfort, less bleeding and no pain as compared to surgical blade.

Lasers used in Flap Procedures

In periodontal surgery, tissue healing may be accompanied by apical migration of epithelial cells, thus preventing the regeneration and restoration of periodontal attachment lost to disease.'-[6] New connective tissue attachment and cementum regeneration can be achieved by cells originating from the periodontal ligament. Many attempts to prevent apical migration of epithelial cells include: subgingival curettage, cryotherapy, chemical substance application (e.g., phenol camphor, and antiformin[13]), free palatal grafts, and different types of incision, biological barrier membranes and carbon dioxide laser.

Lasers block the epithelial downgrowth by forming the necrotic layer on the wound area that gives time for cells of the periodontal ligament to repopulate the root surface and form a new attachment.

Carbondioxide laser has the potential to de-epithelialize tissue. Biologic tissue, regardless of pigmentation or vascularity, absorbs CO2 laser energy because the target of interaction is water. This feature virtually assures no heat conduction to deeper soft tissue layers. Recent research suggests that gingiva can be totally de-epithelialized using CO2 laser while leaving the connective tissue basically undisturbed in monkeys and in humans. CO2 laser treatment of flaps at the time of surgery delayed epithelial downgrowth along the root surface for up to 14 days longer than conventional techniques. Therefore CO2 laser can be used at 8W in pulsed and focused mode for de-epithelialization. Similarly diode a soft tissue laser can be used for de-epithelialization at 2 to 4 W continuous wave in contact mode.[1] Rossmann et al.1992[14] conducted a study to examine whether controlled de-epithelialization with CO2 laser would retard the apical migration of the epithelium and thereby increase the amount of connective tissue attachments. Elastics were placed on the maxillary premolars and incisors of 7 cynomolgous monkeys to create periodontal defects. On experimental side the oral epithelium was removed by CO^2 laser irradiation. The results showed less epithelium and more connective tissue on the experimental side. Therefore carbondioxide lasers may be useful to retard epithelium and enhance new connective tissue attachment. Centty et al.1997[15] compared conventional periodontal surgery combined with carbondioxide laser and conventional periodontal surgery alone with respect to epithelial elimination and degree of necrosis of mucoperiosteal flaps. Five patients with at least two comparable bilateral periodontal defects needing pocket elimination surgery participated in this study. The test site received a sulcular incision and carbondioxide laser de-epithelialization of the outer and inner aspect of the flap. The control group received reverse bevel incision only. The results showed significant differences between the carbondioxide laser and reverse bevel incision with respect to sulcular and gingival(external) flap surface epithelial elimination and tissue necrosis. The carbondioxide laser eliminated sulcular and gingival (external) epithelium without disturbing underlying connective tissue. Rossmann and Israel .2000[16] conducted animal and human studies on laser de-epithelialization for enhanced guided tissue regeneration and concluded that the histologic results of using membranes and the laser procedure enhanced the wound healing and regeneration of new bone compared with defects using the membrane alone.

LANAP (Laser Assisted New Attachment Procedure)

The LANAP (laser-assisted new attachment procedure) is a protocol that deals with inflammation, the infectious process, occlusion, tooth mobility, and an osseous component. It is a surgical laser procedure designed for the treatment of periodontitis through regeneration rather than resection. Regeneration is a rather complex event and, as seen with guided tissue regeneration or scaling and root planning alone, can be very unpredictable, whereas LANAP is predictable.

The concept of LANAP was born in 1989 with Drs. Robert Gregg and Del McCarthy. They were involved in the early use of Nd: YAG lasers in dentistry. LANAP utilizes a free-running (10- 6 seconds) pulsed Nd: YAG laser in place of a scalpel. Originally referred to as Laser-ENAP, LANAP has evolved to provide a minimally invasive alternative to flap surgeries.[17]

The potential for regeneration by LANAP procedure is facilitated by[17]

1) Delivering intense, precise, and selective energy to the affected area (periodontal pocket), without damage to adjacent tissues.
2) Being bactericidal to pigmented periodontal pathogens.
3) Sealing the pocket orifice with a “thermal fibrin clot”
4) Creating a physical barrier (such as a barrier membrane), preventing down growth of epithelium.
5) Promoting healing from the bottom up rather than the top down by stimulating the release of pluripotential cells from the PDL and alveolar bone.

The hallmark of LANAP is pocket reduction, new tissue attachment and a lack of tissue recession

Yukna R et al. 2007[18] presented histologic results in human following a laser assisted new attachement procedure (LANAP) for the treatment of periodontal pocket. Six pairs of single rooted teeth with moderate to advanced chronic peridontitis associated with subgingival deposits were treated. One of each pair of teeth received treatment of the inner pocket wall with free running pulsed Nd: YAG laser to remove the pocket epithelium and test pocket was lased second time to seal the pocket .The results concluded that LANAP treated teeth showed greater reduction in pocket depth and gain in clinical attachment level than the control teeth. All LANAP treated specimens showed new cementum and new connective tissue attachment. Pope J et al. 2014[19] reported a novel approach to the treatment of severe chronic periodontitis using a carbon dioxide (CO_2) laser in combination with scaling and root planning (SRP). This study presents the findings of 17 patients that were compared in a split-mouth design and followed for 3 months. The authors concluded that sites treated with the CO_2 laser tended to show a greater decrease in probing depths, greater amounts of recession, and greater gains in clinical attachment levels, but the results were not statistically significantly better than SRP alone.

Lasers in Implant Surgery

One of the most interesting uses of lasers in implant dentistry is when lasers are used for uncovering in second stage implant surgery providing less postoperative pain, less bleeding, and faster healing. The fundamental key to success in implant placement is the apposition of normal healing bone onto the implant surface. The preparation of the osteotomy site demands a technique whereby the local temperature does not exceed 47^{o}C.Since laser use results in the conversion of incident electromagnetic energy into heat energy, this heat energy should not damage the implant surface.

Research into the use of this laser as an adjunctive to implantology, drew conclusions that the penetrating and high peak heat energy effects produced during soft tissue and peri-implant treatment, caused damage to both the implant surface and the surrounding bone. This led to a general deprecation of laser use in connection with implants, which remained for several years. With the further development of other laser wavelengths, investigations were carried out to establish whether these new lasers would cause damage. The general parameters would include the emission mode of the laser, the nature of the target tissue and type of laser-tissue interaction. Other investigation centred on the material used in implant manufacture, its reflectivity, whether the titanium was coated and generally, the conductive effects of heat through the implant into surrounding bone.

Titanium as a metal exhibits reflectivity to incident light energy. With regard to the wavelengths of current lasers, the reflectivity is lowest in the range 780-900nm,rising as the wavelength increases towards 10,600nm.This would suggest that shorter wavelengths are most damaging, as the low reflectivity would allow greater heat effects to build up, and is keeping with studies carried out with the Nd:YAG laser. However, there is evidence to suggest that the diode wavelength group, delivered in low power continuous wave (1-2 Watts average power) cause minimal damage to the implant or surrounding bone. While Nd: YAG, Er, Cr: YSGG and Er: YAG results in high peak values and heat production (> several hundred ^{o}C) .[2]It should be noted that despite concerns about overheating and surface changes during laser usage, the experience of the past few years seems to support the idea that the risks can be minimized with proper technique and control of laser parameters.

Soft Tissue Management associated with Implants

Following the placement of an implant and its integration into the osseous substrate, the current method of treatment is to surgically uncover the implant, wait for the tissues to heal, and then proceed with impressions and the fabrication of the restoration. The reason for this delay is to facilitate the impression-taking process. The use of laser can greatly expedite this procedure because the implant can be uncovered and the impressions can be obtained at the same appointment. This is possible because the laser allows for a bloodless field. Based on laser tissue interaction characteristics, all laser wavelengths are suitable, provided care is exercised to avoid contact with the implant body. The ablation of soft tissue lead to precise and predictable healing and often this procedure can be carried out using topical anaesthesia. Suggested energy levels of one to two watt (Continuous wave diode), 150 mJ/ 15pps (Nd: YAG), 200-250 mJ/10 pp(erbium group) and one to two watts (CO2), appear to be appropriate in removing gingival tissue overlying the implant cove screw.[2]

Different lasers which can be use in second stage implant surgery are diode, Nd: YAG and Erbium family. But various studies conclude that diode lasers are more beneficial and cause less damage to the implant surface. Kreisler et al. 2002[20] compared the effects of various laser wavelengths on titanium implants and concluded that NdYAG and HoYAG lasers are contraindicated on osseointegrated implant surface irrespective of power output, the Er: YAG and CO2 output powers must be limited to avoid implant damaging while (Gallium-AluminumArsenide (GaAlAs)) are safely used as no structural damage to the implant surface was occurred after laser irradiation.

The diode wavelength is poorly absorbed by titanium and the implant body temperature did not elevate significantly during laser exposure. The ability of the diode laser not to effect neither polished titaniumn was confirmed by Stubinger et al.2010[21.] He also showed that the, diode lasers seem to be the only laser systems offering surface preservation and safely used with Zirconia implants.

Diode Lasers

Diode laser of 970 nm wavelength in a power of 3 W can be used effectively at second stage surgery instead of scalpel; the laser cuts precisely without infiltrative anesthesia and excellent homeostasis will be resulted and seems to minimize post operative pain. The gingival contours remain stable after laser implant recovery procedure. The great decontamination capability of diode laser permits to work in an almost sterile operative field (a 98%

reduction of pathogenic bacteria), with clear advantages for rapid the wound healing and decreasing possibilities for post-operative infections. When there is no harm for the soft tissue, there is no retraction of the tissue, so the impressions can be taken as soon as possible without delay. Kholey EL. 2013 [22] conducted a study to assess if dental implant uncovering is possible with a diode laser without anaesthesia, compare its performance with traditional cold scalpel surgery. For the study group, second-stage implant surgery was done with a 970 nm diode laser. For the control group, the implants were exposed with a surgical blade. The use of the diode laser obviated the need for local anaesthesia; there was a significant difference between the two groups regarding the need for anaesthesia. Raghavan R et al. 2014[23] presented a clinical report comparing efficacy of laser and electrocautery in second stage implant surgery and concluded that both lasers and electrosurgery units work well for simple cutting of oral soft tissues as opposed to the use of scalpel.

Management of Peri-implantitis with Lasers

Among the various procedures to manage peri implantitis, the use of lasers have evolved as a new technique. Laser can be used for decontamination of different implant surfaces which also depends on power intensities. It has been reported that, bacteria kill-rates of up to 99.4% have been attained through the use of lasers. The semiconductor 809-nm, the CO2 and Er: YAG lasers are recommended, since it appears that they do not exert a negative impact on the implant surface while Nd: YAG laser is not suitable for implant therapy, since it easily ablates the titanium irrespective of output energy. Schwarz et al.2003[24] observed that the Er:YAG laser at 100 mJ/pulse (energy out put of 85 mJ/pulse, calculated energy density 10.3 J/cm2 per pulse) and 10 Hz under water irrigation does not damage titanium surfaces and does not affect the attachment of osteoblast- like cells. Schwarz F et al .2004[25] showed that nonsurgical treatment of peri-implantitis with an Er: YAG laser at 100 mJ/pulse and 10 Hz (energy density 12.7 J/cm2 per pulse) under water spray led to a statistically significant reduction in pocket depth and gain in clinical attachment level. Schwarz et al .2006[26] conducted a study to assess clinical and histo-pathological healing pattern of peri-implantitis lesions following non-surgical treatment with an Er: YAG laser (ERL).The study concluded that a single course of non-surgical treatment of peri-implantitis using Er: YAG may not be sufficient for the maintenance of failing implants.

Volkan et al. 2015[27] did a radiographic and microbiologic split-mouth clinical trial, to evaluate the efficacy of a diode laser as an adjunct to conventional scaling in the nonsurgical treatment of peri-implantitis. In addition to conventional scaling and debridement (control group), crevicular sulci and the corresponding surfaces of 24 random implants were laced by a diode laser running at 1.0 W power at the pulsed mode. The authors concluded that adjunct use of diode laser did not yield any additional positive influence on the peri-implant healing compared with conventional scaling alone. Papadopoulos et al. 2015[28] compared the effectiveness of open flap debridement used alone, with an approach employing the additional use of a diode laser for the treatment of peri-implantitis. Nineteen patients were divided into two groups and treated for peri-implantitis. The test group was irradiated with diode laser. The authors concluded that surgical treatment of peri-implantitis by access flaps leads to improvement of all clinical parameters studied while the additional use of diode laser does not seem to have an extra beneficiary effect.

SUMMARY

With the beneficial properties over conventional scalpel that includes relative ease of ablation of soft tissue, hemostasis ,instant sterilization, reduced bacteraemia, little wound contraction ,reduced edema, minimal scarring, reduced mechanical trauma, less operative and post-operative pain, faster healing, increased patient acceptance, no sutures and requiring no or topical anaesthesia, soft tissue lasers(CO2,Nd:YAG ,diode ,Er:YAG and Er:YSGG) are being widely used as a tool for gingival soft tissue procedures.[22]

Performance of lasers differs depending on their penetration depth and hence may possibly damage the underlying tissues by thermal effects. In CO2, Er: YAG and Er, Cr: YSGG laser, laser light is absorbed in superficial layers and hence is advantageous, with rapid and simple vaporization of soft tissues. However, deeply penetrating Nd: YAG and diode lasers having greater thermal effects, leave a thicker coagulation area on treated surface and hence used similar to electrosurgical procedures. Epithelial exclusion using CO2 laser had been suggested to retard its downward growth, and studies have shown effective removal of epithelium from gingival tissues without damaging the underlying connective tissues.[22]

REFERENCES

1. Miserendino L, Pick RM Lasers in Dentistry. Quintessence publishing. Chicago1995.
2. Haytac MC and Ozcelik O. Evaluation of Patient Perceptions After Frenectomy Operations: A Comparison of Carbon Dioxide Laser andScalpel Techniques.J Periodontol .2006;77:1815-1819.
3. Olivi G , Chaumanet G n Genovese MD, Beneduce C, Andreana S. Er,Cr:YSGG laser labial frenectomy: A clinical retrospective evaluation of 156 consecutive cases. Academy of General Dentistry .2010;126-133.
4. Aldelaimi1 TN and Mahmood AS. Laser-Assisted Frenectomy Using 980nm Diode Laser. J Dent Oral Disord Ther .2014;2(4): 1-6
5. Pick RM, Bernard C. Pecaro , Silberman CJ. The Laser Gingivectomy The Use of the CO2 Laser for the Removal of Phenytoin Hyperplasia. J. Periodontol.1985;56(8):492-496.
6. Shankar BS, Ramadevi T, Neetha M S, Reddy P S K, Saritha G, Reddy J M. Chronic Inflammatory Gingival Overgrowths: Laser Gingivectomy & Gingivoplasty. J Int Oral Health 2013; 5(1):83-87.
7. Funde S ,Dixit M B , Pimpale SK. Comparison between Laser, Electrocautery and Scalpel in the Treatment of Drug-Induced Gingival Overgrowth: A Case Report. IJSS .2015; 1(10):27-30.
8. Astawasuwan P,Greenthong K,Nimmanon V. Treatment of Gingival Hyperpigmentation for Esthetic Pupose by Nd:YAG Laser:Report of 4 cases.J Periodontol.2000;71:315-321.
9. Azzeh MM.Treatment of Gingival Hyperpigmentation by Erbium-Doped:Yttrium, Aluminum, and Garnet Laser for Esthetic Purposes. J Periodontol.2007;78(1):177-184.
10. Singh V, Bhat SG, Kumar S and Bhat M. Comparative Evaluation of Gingival Depigmentation by Diode Laser and Cryosurgery Using Tetrafluoroethane: 18-Month Follow-Up. Clin Adv Periodontics .2012; 2:129-134.
11. Grover HS, Dadlani H, Bhardwaj A, Yadav A, Lal S. Evaluation of patient response and recurrence of pigmentation following gingival depigmentation using laser and scalpel technique: A clinical study. J Indian Soc Periodontol .2014;18:586-92.
12. Butchibabu K, Koppolu P, Tupili MK, Hussain W, Bolla VL, Patakota KR. Comparative evaluation of gingival depigmentation using a surgical blade and a diode laser. J Dent Lasers 2014;8:202-5.
13. Mainman TH. Stimulated optical radiation in ruby nature 1960;187:493-494.
14. Rossman J,McQuade M,Turunen D.Retardation of epithelial migration in monkeys using a carbondioxide laser.J Periodontal .1992;63:902.
15. Cenntty IG,Blank LW,Levy BA, Romberg E and Barnes D. Carbondioxide Laser for De-epithelialization of Periodontal Flaps. J Periodontal.1997;68:763-769.
16. Rossmann JA and Israel M.Laser de-epithelialization for enhanced guided tissue regeneration.A Paradigm shift.Dent Clin North Am.2000;44(4):793-809.
17. Khadtare Y, Chaudhari A, Waghmare P, Prashant S. The LANAP Protocol (laser- assisted new attachment procedure) A Minimally Invasive Bladeless Procedure. J Periodontol Med Clin Pract .2014;1: 264-271.
18. Yukna R, Carr R and Evans G. Histologic Evaluation of an Nd:YAG laser Assisted New Attachment Procedure in Humans.The International Journal of Periodontics and Restorative Dentistry.2007;27(6):577-587.
19. Pope J, Rossmann JA, Kerns D, Beach MM and Cipher D.Use of a Carbon Dioxide Laser as an Adjunct to Scaling and Root Planing for Clinical New Attachment: A Case Series. Clin Adv Periodontics .2014;4:209-215.
20. M. Kreisler, H. Gotz and H. Duschner. Effect of Nd:YAG, Ho: YAG, Er:YAG,CO2, and GaAIAs laser irradiation on surface properties of endosseous dental implants, Int J Oral Maxillofac Implants.2002; 17 : 202-211.
21. Stubinger S, Etter C , Miskiewicz M , Homann F, Saldamli B, Wieland M and Sader R. Surface alterations of polished and sandblasted and acid-etched titanium implants after Er:YAG, carbon dioxide, and diode laser irradiation. Int J Oral Maxillofac Implants2010;25(1) :104-111.
22. Kholey EL.Efficacy and safety of a diode laser in second-stage implant surgery: A comparative study.Int J Oral Maxillofac Surg. 2013;43(5):633-638.

23. Raghavan R , Shajahan PA , Koruthu A , Sukumar B , Nair A , Divakar KP . Second stage surgery: a clinical report comparing efficacy of laser and electrocautery. International Journal of Dental Research. 2014 ;2 (1) :26-28.
24. Schwarz F, Rothamel D, Sculean A, Georg T, Scerbaum W, Becker J. Effects of an Er:YAG laser and the Vector ultrasonic system on the biocompatibility of titanium implants in cultures of human osteoblast-like cells. Clin Oral Implants Res. 2003; 14: 784–792.
25. Schwarz F, Sculean A, Rothamel D, Schwenzer K, Georg T, Becker J. Clinical evaluation of an Er:YAG laser fornonsurgical periodontal therapy surgical treatment of peri-implantitis. A pilot study. Clin Oral Implants Res 2004; 15.701-711.
26. Schwarz F ,Bieling K , Nuesry E , , Sculean A and Becker J. Clinical and histological healing pattern of peri-implantitis lesions following non-surgical treatment with an Er:YAG laser. Lasers Surg Med.2006;38(7):663-671.
27. Arısan Volkan, Karabuda Zihni Cüneyt, Arıcı Selahattin Volkan, Topçuoğlu Nursen, and Külekçi Güven. Photomed Laser Surg. 2015;33(11): 547-554.
28. Papadopoulos A, Vouros I, Menexes, Konstantinidis A. The utilization of a diode laser in the surgical treatment of peri-implantitis. A randomized clinical trial. Clin Oral Investig.2015;19(8):1851-1860.