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The LANAP Procedure–An Update.

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Abstract:
This review aims to provide a comprehensive understanding of the LANAP-laser assisted new attachment procedure, its various other dimensions and the recent advances following the procedure. The numerous literature sources available regarding the LANAP procedure and its applications in Periodontology are reviewed and analyzed systematically to ensure a detailed description on the topic in this section.

Keywords*: LANAP, new attachment, Nd:YAG lasers, periodontal therapy, periodontal regeneration*

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I. Introduction

The aim of periodontal therapy is to restore the diseased or lost tissues back to their normal structure and function. As the periodontium involves all the supporting structures of the teeth, any infection or trauma will automatically affect the deeper supporting apparatus such as the periodontal ligament and the alveolar bone leading to tooth loss and function. The main objective of any periodontal therapy is to arrest or eliminate the actively spreading infection at the most effective rate as early as possible. Periodontists and clinicians across the globe are in search of treatment modalities which are effective and less time consuming in daily dental practice.

Development of less invasive but effective procedures have become the need of the hour for patients and practitioners.[1] Many a times, conventional surgical procedures are not perceived by patients due to the subjective and objective apprehensions of pain, swelling, root exposure and postoperative discomfort.[2] Regeneration in a true sense refers to the formation of new bone, cementum, and periodontal ligament. It was observed that laser-assisted new attachment procedure (LANAP) would initiate regeneration of the affected periodontal tissues and a new connective tissue attachment mediated by cementum is formed as a result.[2-4]

Dentists have been widely using the free-running (FR) pulsed Nd:YAG lasers for more than 20 years, but only recently has this laser became popular combined with a specific, successful protocol and research-proven operating parameters to achieve FDA clearance and it has a track record of success in university-based clinical studies for its efficacy at "cementum-mediated new PDL attachment to the tooth root surface in the absence of long junctional epithelium.[5, 6] The protocol showed consistent probing depth reductions, histological and clinical new attachment, and radiographic bone fill for periodontally involved teeth.[7-9]

II. History of LANAP

Dr. Robert H. Gregg II and Dr. Delwin K. McCarthy, together with more than 1,000 dentists and specialists who have learnt the procedure from the Institute for Advanced Laser Dentistry (IALD), pioneered the use of the FR pulsed Nd:YAG laser for the treatment of periodontal diseases since 1990s. They were astonished by their ability to regenerate bone (routine 50 percent defect fill) and stimulate new attachment for their patients with severe periodontal diseases. They continued to refine the procedure after patenting it so they could share it with peers and envision a goal for the new gold standard for the treatment of periodontal diseases across the world.[9,12]

III. The LANAP procedure

LANAP is defined as "cementum-mediated new attachment to the root surfaces in the absence of a long junctional epithelium.[10] It is a minimally invasive, well-defined procedure, that involves the surgical removal of the sulcular epithelium, modification & osteoplasty of bone and perforation of the PDL using piezoelectric bone cutting tips, and wound closure via a thermogenic stable fibrin clot.[11] Pocket reduction, new tissue attachment and lack of tissue recession are achieved with LANAP.

The LANAP protocol is utilized for patients with a probing pocket depth of ≥ 4mm. There is no initial periodontal therapy that is started prior to LANAP procedure. The effectiveness of the procedure lies in the

systematic way it is performed. Usually the procedure is performed in one or two non adjacent quadrants. An Nd:YAG laser that operates at a wavelength of 1,064 nm is used in LANAP. The protocol is elaborated below:-

Step 1: Local anesthesia is administered to the sites of involved teeth, followed by bone sounding around each tooth to determine areas of osseous defects that is difficult to view radiographically.

Step 2: A thin 0.3 to 0.4 laser fibre permits easy access into deep periodontal pockets and hence, no need to surgically elevate a flap. The thin optic fibre is placed parallel to the root surface. The first pass with the laser, is called Laser Troughing, which is accomplished with the short duration pulse i.e., 3W 150µs pulse duration and 20Hz. This step leads to the removal of diseased sulcular epithelium, selectively effects bacteria associated with periodontal disease, the presence of calculus and thermo labile toxins.

Selective photothermolysis removes diseased, infected and inflamed pocket epithelium preserving healthy adjacent connective tissues, separating the tissue layers at the level of the rete pegs. The bacteria that are associated with periodontal diseases are pigmented and are found in the sulcus. Laser at wavelength of 1,064 nm is attracted to pigmented tissues and colored bacteria thereby killing periodontal pathogens. The shorter 1,064 nm wavelength is selected due to its affinity for melanin or dark pigmentation, unlike the longer wavelengths that are highly absorbed in water and would have a shallow depth of penetration.[12]

Step 3: In this step**,** Piezo-scalers are used to remove calculus present on the root surfaces. The interaction of laser energy with the calculus makes removal of calculus easier. The initial formation of a mini-flap by laser assists in the removal of calculus due to increased visibility and access to the calculus.

Step 4: Next, the laser parameters are varied i.e., 4W 635-µs pulse duration and 20 Hz, to enhance the ability to form a fibrin clot in order to close the mini-flap and to disinfect the site. The fibrin clot is stable for approximately 14 days. The fibrin clot keeps the sulcus sealed against the bacterial infiltration and prevents the growth of epithelium apically into the sulcus. Therefore, flap closure is achieved without any sutures or surgical glue. Other laser wavelengths not only lack the ability to form this stable fibrin clot, but also require repeated interventions to prevent epithelium growth down into the sulcus. Through the use of specific fiber sizes, energy, repetition rates, pulse durations and standardization of the energy at the fiber tip, this protocol can be performed in a predictable and reproducible manner.

Step 5: The fibrin clot is compressed to enhance the healing process. Healing of laser wounds occur by secondary intention. Closer approximation accelerates the healing.

Step 6: Refining the occlusion is the last step of LANAP protocol. Occlusion has been considered as a greater cofactor in the progression of periodontal disease. In order to minimize this role, occlusal adjustments are made.

Patients are seen at a one-week post operatively for re-evaluation and then at 30 days post op to have supragingival prophylaxis. The patients are then followed for nine to twelve months with routine supragingival scaling and occlusal refinements. No subgingival restoration or periodontal probing is done during this time period. Only during the final post-operative visit periodontal probing is done.

IV. Advantages of LANAP procedure

- Less invasive
- Less traumatic
- Closure is achieved without sutures
- Minimal postoperative discomfort like pain, bleeding, swelling
- The recession associated with traditional surgery is not present.
- Faster healing is achieved.
- Equally successful results obtained in treating dental implants and natural teeth.
- LANAP results in sealing of the pocket orifice with a thermal fibrin clot which acts as a physical barrier preventing the apical growth of epithelium and promotes healing from bottom up rather than the top down by stimulating the release of pluripotent cells from the PDL and alveolar bone.
- Creation of a healthier condition for the body to regenerate and heal itself.
- Safe treatment for patients with conditions like haemophilia, HIV and diabetes, or on medications such as cyclosporine. [2, 11, 12,13,14,15]

V. Disadvantages of LANAP

- The hazards associated with LANAP treatment are similar to any hazards allied with laser use in dentistry, like, ensuring the dentist is trained to use the technology for the specific procedure according to health and safety guidelines; the equipment is preserved and is in proper working condition, and that the laser is not used for procedures that require other treatment options.[15]
- The treatment can be expensive.

- If the laser is not used with caution or improperly angled for debridement, it can cause serious alveolar tissue damage. There is some evidence that the use of lasers in periodontal pockets may damage root surfaces, adversely affect adjacent alveolar bone or may cause undesirable pulpal changes.[16,17,18,19]

VI. The controversies

The pros and cons of this technique is still on debate. The American Academy of Periodontology 1999 stated with respect to this technique, "The Academy is not aware of any randomized blinded controlled longitudinal clinical trials, cohort or longitudinal studies, or case-controlled studies indicating that 'laser excisional new attachment procedure (or Laser ENAP)' or 'laser curettage' offers any advantageous clinical results that are not achieved by traditional periodontal therapy. Moreover, the data published suggests that use of lasers for ENAP procedures and/or gingival curettage could render root surfaces and adjacent alveolar bone incompatible with normal cell attachment and healing."[12]

On the contrary, human histologic studies by Yukna et al in 2007 proved the positive clinical outcomes of LANAP treatment when compared to conventional periodontal treatment. In this study, 100% of teeth treated with LANAP procedure formed a new attachment as opposed to 0% of the control teeth.[20] Another study by, Nevins et al in 2012 reported highly successful clinical outcomes in patients treated with LANAP procedure in cases of extreme periodontitis.[2]

More longitudinal studies are required in this aspect to prove it to be the best treatment option for daily practice so as to completely resolve the controversies.

VII. Discussion

The discussions and reviews on LANAP procedure and its outcome seem to be incessant. The comparison of LANAP protocol with the conventional procedures; its effects on human periodontal tissues and use of LANAP in diabetes patients will be discussed one by one below.

- ***LANAP and ENAP***: The ENAP- Excisional new attachment procedure was initially described in 1976 as "a definitive sub gingival curettage performed with a knife."[21] Similar to subgingival curettage, the ENAP results in "a long, thin epithelial attachment and a minimal amount of connective tissue attachment."[22] The only published human clinical study comparing the clinical outcomes of gingival curettage to that of ENAP procedure and found no significant differences in probing pocket depth reductions or clinical attachment level gain.[23]

  - Elimination of pocket epithelium by gingival curettage, ENAP or other internal bevel incision designs appears to be clinically not feasible for long-term therapeutic goals.
  - A study conducted by Gudakuwala et al (2018) compared and evaluated the clinical efficacy of diode laser as an adjunct to SRP versus the ENAP procedure in the treatment of chronic periodontitis. A total of 10 patients with generalized moderate chronic periodontitis were included in the study. Results revealed that for all clinical parameters, both the groups reported statistically significant differences compared to baseline values ($P < 0.0001$). Both treatments were effective in improving the gingival index, probing depth, and bleeding on probing.[24]
  - Another study conducted by Sameera et al (2018) compared the clinical efficacy of LANAP versus ENAP and also assessed the blood flow in both the procedures using ultrasound Doppler flowmetry. This study was a split-mouth double-blinded controlled clinical trial carried out in 15 subjects with chronic periodontitis. Results showed a statistically significant reduction in all the clinical parameters when compared baseline to subsequent follow-ups. The authors observed a greater reduction in all the parameters in the LANAP group compared to that of ENAP group. The rate of revascularization was found to be higher in the ENAP group than that of LANAP group.[25]

- ***LANAP and diabetes***: A study conducted by Long demonstrated that the patient's HbA1c levels and periodontal health exhibited marked improvements after treatment using LANAP procedure.[26] Long 's study is also supported by studies from Aemaimanan et al who reported a significant prevalence of red complex bacteria in the subgingival biofilm of patients with poor glycemic control. These pathogens are associated with periodontitis and found significantly higher in diabetic patients when compared to control groups with good glycemic control.[27] Another study by De Andrade et al noted that Nd:YAG laser combined with conventional periodontal treatment significantly reduced bacterial populations in class II furcations.[28]

- ***Periodontal healing after* LANAP**: The periodontal tissue healing after the LANAP procedure is found to be secondary intention. A stable fibrin clot is formed with the second pass of the laser, thereby creating a barrier to prevent the epithelial down growth (i.e., no long junctional epithelium formation) and ingress of bacteria and deposits. The epidermal cells from both the margins of the wound proliferate and migrate into the wound space to form epithelial spurs and a complete re-epithelialization takes place. The granulation

tissue elements from the PDL gives rise to the formation of a new cementum and connective tissue attachment. The formation of this new cementum is believed to occur in not less than 3 weeks.

- Accounting for the biostimulant effect of the laser, the therapy with laser induces the acceleration of mitotic processes within the irradiated tissues, without causing structural or functional alterations of tissues.[30-33] According to the studies by Benedicenti, the laser stimulates mitochondrial activity, with a production of intracellular ATPs greater than 22% in irradiated cells compared to that not exposed to radiant energy, resulting in halving of cell duplication.[34] In a different study by Conlan it was found that there is an increase of about 50% of the proliferation and differentiation of fibroblasts and collagen synthesis within the periodontal ligament.[35] This process, according to Choi begins to occur between the next 24 and 48 hours of laser therapy, and intensifies after 72 hours,[36] all these reactions accelerates the healing process and leads to gain in clinical attachment level. Considering the tolerance and compliance of the patients, the laser therapy of periodontal pockets does not involve any discomfort or intra operative pain or requires local anaesthesia.[32]
- Studies by Yukna et al (2007)[20] reported human histologic wound healing following LANAP procedure. In this study there was 100% new cementum formation and the frequency of connective tissue attachment is also found to be 100% as compared to 77% and 68% observed in the Bowers et al study.
- In another study by Katuri et al (2015)[4] reported that Nd:YAG laser with a wavelength of 1060 nm was used to evaluate the clinical benefits of LANAP procedure as an adjunct to conventional periodontal therapy for achieving new attachment indicates that non-surgical periodontal therapy using hand instruments or in combination with LANAP procedure showed significant improvements in clinical parameters (BOP, PD, and CAL) for both moderate and deep pockets at 6 weeks and 24 weeks post treatment. Similar results were projected in earlier case reports and case series, showing significant improvements in gingival inflammation during the observation period from baseline to 6 weeks and 24 weeks.
- Nevins et al (2014) evaluated periodontal regeneration after LANAP procedure in humans and stated that there was a significant degree of periodontal regeneration with formation of new cementum, periodontal ligament and alveolar bone.[2] In a prospective study by Nevins et al., the efficacy of LANAP therapy in eight patients for a period of 9 months were evaluated and concluded that majority of treated sites showed improvements in all clinical parameters.

❖ ***LANAP and LAPIP***: Millennium technologies came up with a modification of LANAP for implants known as LAPIP protocol for implants.[1]

- The LAPIP Protocol- McCarthy brought forth the concept of LAPIP, "Laser- Assisted Peri-Implantitis Procedure" as a modification of LANAP which could be used in the treatment of diseased implants. Laser, removes inflamed pocket tissue, disrupt biofilms, and decontaminates the implant surfaces. Decrease in inflammation and a laser-induced hemostasis decontaminates the tissue creating a durable blood clot to close the system.
- LAPIP transforms diseased structures to healthy states, promotes bone and tissue regeneration, and another feature is that the procedure is performed on implants without damaging it. Since no flap is reflected, it leaves chances for other therapies in the future. The LAPIP protocol recommends the PerioLase MVP-7, a Nd:YAG "free-running" pulsed laser, to treat periimplantitis.[37]
- Suzuki, in 2015 compendium mentioned a few studies in relation to implant complications, a laboratory study by Harris and Yessik which found an effect of pulsed Nd:YAG laser in removing pigmented bacteria exclusively while sparing the adjacent tissues.[38]
- Another study in 1992 by Cobb et al, found 3 bacterial groups (Aggregatibacter actinomycetecomitans, Porphyromonas gingivalis, and Prevotella intermedia) to be low in periodontal pockets after laser treatment in comparison to non-treated sites.[39] Twenty-two years later, McCawley observed the benefits Nd:YAG laser on putative bacterial agents in the pockets of 20 human patients. Pathogens were estimated to be below culture detection limits.[16]
- Giannelli et al conducted a study on the effects of Nd:YAG laser- an In vitro study. He concluded that the use of Nd:YAG laser can be a solution to treat periimplantitis.[40]

VIII. Recent advances

The recent advances in the field of laser assisted procedures are emerging day by day and various studies have come up with excellent clinical results of LANAP and its use in Periodontology.

- Laser-assisted bacteria reduction in periodontal tissues- Nd:YAG laser has shown bacetericidal effects in studies in vivo. The application of laser into the deeper periodontal tissues has an effect on the pathogenic microflora in the tissues.[41]

- Laser-assisted scaling and root planning- The removal of subgingival deposits using laser has been studied and is found to be an effective and simplest way of performing SRP.[41]

Various studies outline the use of lasers for varied periodontal treatment strategies. A recent case report showed that use of Nd:YAG laser (1064nm) improved radiographic bone levels, clinical parameters in a patient with severe attachment and alveolar bone loss and received orthodontic treatment 13 months after the procedure and hence avoiding the risk and morbidity of conventional periodontal surgery.[42]

IX. Conclusion

The LANAP protocol is believed to be emerging as a treatment modality in periodontal practice because of its efficacy to promote a true periodontal regeneration. LANAP not only regenerates diseased tissues, but also promotes antisepsis and increased tissue integrity. The modifications of LANAP for implants i.e., LAPIP has tremendously shown results towards treatment of pockets around implants. Although the effects of laser on root surfaces and alveolar bone should be studied further in order to understand any adverse events; these advancements in the use of Nd:YAG laser promises to effectively treat periodontal pockets for long term. Of course, the need for professional trainings before attempting the procedure is a must to minimize risks. Most importantly, the LANAP is so far one of the minimally invasive procedures with utmost patient acceptance. Hence, better grounds pertaining to this particular research should be established in the future.

References

[1]. Jha A, Gupta V, Adinarayan R. LANAP, periodontics and beyond: A review. Journal of lasers in medical sciences. 2018; 9(2):76-79.
[2]. Nevins M, Kim SW, Camelo M, Martin IS, Kim D, Nevins M. A prospective 9-month human clinical evaluation of laser-assisted new attachment procedure (LANAP) therapy. Int J Periodont Rest.2014; 34(1):21- 27.
[3]. Brown IS. Current advances in the use of lasers in periodontal therapy: a laser-assisted new attachment procedure case series. Clin Adv Periodontics. 2013; 3(2):96- 104.
[4]. Katuri KK, Bollepalli AC, Sunkireddy HKR, Chilakalapudi HCB, Kurapati S, Vinnakota NR. Clinical effectiveness of laser assisted new attachment procedure as an adjunct to nonsurgical periodontal treatment: a randomized clinical study. J Int Oral Health. 2015; 7(11):57-62.
[5]. Myers TD, Myers WD, Stone RM. First soft tissue study utilizing a pulsed Nd:YAG dental laser. Northwest Dent. 1989;68:14–17.
[6]. White JM, Goodis HE, Rose CL. Use of the pulsed Nd:YAG laser for intraoral soft tissue surgery. Lasers Surg Med. 1991;11: 455–461.
[7]. Gregg RH II, McCarthy D. Laser periodontal therapy: case reports. Dent Today.2001; 20:74–81.
[8]. Gregg RH II, McCarthy D. Laser periodontal therapy for bone regeneration. Dent Today. 2002; 21:54–59.
[9]. Gregg II AH. Introduction to the LANAP protocol for the treatment of periodontitis. Laser. 2012; 3:6-9.
[10]. US Food and Drug Administration. 510(k)s Final decisions rendered for July 2004 (PerioLase MVP-7, 510(k) number K030290).
[11]. David M. Harris, Dawn M. Nicholson, Delwin Mc Carthy, Raymond A. Yukna, Mark A. Reynolds, Henry Greenwell, James Finley, Thomas K. McCawley, Pinelopi Xenoudi, Robert H Gregg II. Change in clinical indices following laser or scalpel treatment for periodontitis: A split-mouth, randomized, multicenter trial. Proc. of SPIE.2014;8929: 89290G-89291G.
[12]. Vishnu V, Ajithkumar KC, Beevi NR, Janam P. Laser assisted new attachment procedure/lanap: A review. JSPIK.2015; 8(3):109-112.
[13]. Institute for advanced laser dentistry, University of Colorado School of Dental Medicine Denver: lectures and didactic manuals, evolutions.1-5.
[14]. Harris DM, Gregg RH, McCarthy DK, Colby LE, Tilt LV. Laser assisted new attachment procedure in private practice. General Dentistry.2004;52(5):396-403.
[15]. Shafei RM, Jefri AA, Alhindi MA. Laser-Assisted New Attachment Procedure–LANAP. The Egyptian Journal of Hospital Medicine. 2017;69(1):1641-1645.
[16]. Cobb CM, Mc Cawley TK, Kiloy WJ. A preliminary study on the effects of the Nd:YAG laser on root surfaces and subgingival microflora in vivo. J Periodontol 1992;63: 701-707.
[17]. Tewfik HM, Garnick JJ, Schuster GS, Sharawy MM. Structural and functional changes of cementum surface following exposure to a modified Nd:YAG laser. J Periodontol. 1994;65: 297-300.
[18]. Krause LS, Cobb CM, Rapley JW, Killoy WJ, Spencer P. Laser irradiation of bone. An in vitro study concerning the effects of the CO2 laser on oral mucosa and subjacent bone. J Periodontol.1997;68: 872-880.
[19]. 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.
[20]. Yukna RA, Carr RL, Evans GH. Histologic evaluation of an Nd:YAG laser-assisted new attachment procedure in humans. Int J Periodontics Restorative Dent. 2007; 27:577-587.
[21]. Yukna RA, Bowers GM, Lawrence JJ, Fedi PF, Jr. A clinical study of healing in humans following the excisional new attachment procedure. J Periodontol.1976; 47:696-700.
[22]. Yukna RA. A clinical and histologic study of healing following the excisional new attachment procedure in Rhesus monkeys. J Periodontal.1976; 47:701-709.
[23]. Borghetti A, Ranchain D. ENAP ou curetage aveugle? Etude biométrique.J Parodontol. 1984; 4:189-195.
[24]. Gudakuwala A, Ansari W, Badaam H, Hegde R, Muglikar S, Sheikh S. Excisional New Attachment Procedure Versus Laser-assisted New Attachment Procedure-A Split Mouth Study. International Journal of Preventive and Clinical Dental Research.2018;5(2):6-10.
[25]. Sameera S, Kumar PA, Nagasri M, Indeevar P, Raviraj K. ENAP vs LANAP: assessment of revascularization using ultrasound Doppler flowmetry—a split-mouth randomized controlled clinical trial. Lasers in medical science. 2018;33(6):1181-1188.
[26]. Long CA. New attachment procedure: using the pulsed Nd:YAG laser. Dent Today. 2008;27(2):166-171.
[27]. Aemaimanan P, Amimanan P, Taweechaisupapong S. Quantification of key periodontal pathogens in insulin-dependent type 2 diabetic and non-diabetic patients with generalized chronic periodontitis. Anaerobe. 2013;22: 64- 68.

[28]. de Andrade AK, Feist IS, Pannuti CM, Cai S, Zezell DM, De Micheli G. Nd:YAG laser clinical assisted in class II furcation treatment. Lasers Med Sci.2008; 23(4):341-347.
[29]. Gregg II RH. The LANAP protocol: laser-assisted new attachment procedure. Int J Periodont Rest.2007;577:87.
[30]. Saglam M, Kantarci A, Dundar N, Hakki SS. Clinical and biochemical effects of diode laser as an adjunct to nonsurgical treatment of chronic periodontitis: A randomized, controlled clinical trial. Lasers Med Sci.2014;29: 37-46.
[31]. Ejiri K, Aoki A, Yamaguchi Y, Ohshima M, Izumi Y. High frequency low-level diode laser irradiation promotes proliferation and migration of primary cultured human gingival epithelial cells. Lasers Med Sci.2014;29: 1339-1347.
[32]. Passanezi E, Diamante CA, de Rezende ML, Greghi SL. Lasers in periodontal therapy. Periodontol 2000.2015;67: 268-291.
[33]. Fujimura T, Mitani A, Fukuda M, Mogi M, Osawa K, Takahashi S, *et al.* Irradiation with a low-level diode laser induces the developmental endothelial locus-1 gene and reduces proinflammatory cytokines in epithelial cells. Lasers Med Sci. 2014;29:987-994.
[34]. Benedicenti S, Pepe IM, Angiero F, Benedicenti A. Intracellular ATP level increases in lymphocytes irradiated with infrared laser light of wavelength 904 nm. Photomed Laser Surg.2008;26:451-453.
[35]. Conlan MJ, Rapley JW, Cobb CM. Bio stimulation of wound healing by low-energy laser irradiation. A review. J Clin Periodontol.1996;23:492-496.
[36]. Choi EJ, Yim JY, Koo KT, Seol YJ, Lee YM, Ku Y, et al. Biological effects of a semiconductor diode laser on human periodontal ligament fibroblasts. J Periodontal Implant Sci.2010;40:105-110.
[37]. Zeza B, Pilloni A. Peri-implant mucositis treatments in humans: a systematic review. Ann Stomatol (Roma).2012;3(3-4):83-89.
[38]. Harris DM, Yessik M. Therapeutic ratio quantifies laser antisepsis: ablation of Porphyromonas gingivalis with dental lasers. Lasers Surg Med. 2004; 35(3):206-213.
[39]. McCawley TK, McCawley MN, Rams TE. LANAP immediate effects in vivo on human chronic periodontitis microbiota. J Dent Res. 2014; 93(Special A):428-429.
[40]. Giannelli M, Bani D, Tani A, et al. In vitro evaluation of the effects of low-intensity Nd:YAG laser irradiation on the inflammatory reaction elicited by bacterial lipopolysaccharide adherent to titanium dental implants. J Periodontol. 2009; 80(6):977-984.
[41]. Romanos GE. Lasers in Periodontology. Advanced Laser Surgery in Dentistry. 2021:139-184.
[42]. Johnson TM, Bice RW, Gilbert WA. Orthodontic Treatment of Periodontally Compromised Teeth After Laser Periodontal Therapy: A Case Report. Photobiomodulation, Photomedicine, and Laser Surgery. 2021.

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