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Multi-Center Retrospective Report of Periodontal Tissue Regeneration Following Twinlight® Periodontal Treatment

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ABSTRACT

Among the different types of lasers which have been considered for periodontal therapy, the highly absorbed Er:YAG laser wavelength and the deeply penetrating Nd:YAG laser wavelength merit the most attention, due to the extensive published research and reported positive results involving these two laser wavelengths.

Looking at the reported positive effects of both therapies, the next natural step in the development of minimally invasive, efficient, and safe treatments has been to introduce a combined "TwinLight" Er:YAG and Nd:YAG laser periodontal treatment.

In this paper, four private dental practices conducted a retrospective case series analysis of the available before and after radiographic images of their patients who received the TwinLight® periodontal treatments, as collected during the past approximately 6 years. The analyzed images provide evidence of periodontal tissue regeneration following the combined TwinLight® treatment, in agreement with the tissue regeneration observed in published studies where only a single laser therapy, either Er:YAG or Nd:YAG, was performed.

Further research is needed to quantify the contribution of each of the laser therapies, and of the expected synergistic effect of the combined therapy to the observed regeneration of periodontal tissues following the TwinLight procedure.

Key words: Laser periodontics, periodontitis, tissue regeneration, bone regeneration, Er:YAG, Nd:YAG, TwinLight, WPT, LightWalker.

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I. INTRODUCTION

Periodontitis is a chronic inflammatory disease characterized by a progressive destruction of the supporting tissues of the tooth. This results in pathological lesions and may eventually lead to the loss of the tooth [1]. Periodontitis is also associated with age-related chronic inflammatory diseases, affects general health and may increase the risk of stroke [2].

The primary goal of non-surgical periodontal treatment is to eliminate bacterial infection and slow down or preferably stop the progression of the inflammatory process.

The first step in the eradication of bacterial infection and the reduction of inflammation of supporting tissues consists of mechanical debridement, i.e. scaling and root planing (SRP). Unfortunately, the mechanical treatment has been found lacking and does not result in complete healing, especially in severe periodontitis patients. This is because mechanical treatment does not remove all the perio-pathogens. Therefore, after mechanical removal of bacterial deposits from the root surface, local or systemic antibiotics and antiseptics are often implemented as adjunctive measures in the treatment of periodontal infections [6-9]. However, antibiotic resistance and the side effects of systemic antibiotics limit the rationale for their use in chronic periodontitis patients [10-12].

For the above reasons (and also because of their better access to deep pockets, furcations, and grooves) dental lasers have been considered for irradiation of periodontal pockets as an efficient alternative to non-surgical treatment. Consequently, various studies have demonstrated the benefits of laser therapy, including bio-modulatory, anti-infective, and ablation effects [16, 17].

Several types [13-15] of surgical lasers have been identified as promising new technical modalities for decontamination of periodontal pockets and root surfaces, either due to their effective ablation or because of their strong bactericidal and detoxication effects. Among the different types of lasers, the highly ablative Er:YAG laser and the deeply penetrating Nd:YAG laser appear to be the most suitable for performing periodontal treatments.

The Nd:YAG laser has been shown to decontaminate periodontal pockets and vaporize the pocket-lining epithelium without causing necrosis or carbonization of the underlying connective tissue [18]. It has also been shown that Nd:YAG can eradicate periodontopathogens trapped within gingival epithelial cells. Clinical studies show that adding an Nd:YAG laser treatment to scaling and root planing can significantly reduce the gingival index and probing pocket depth, and significantly improve the clinical attachment level compared to SRP alone [20, 21, 22].

Similarly, in comparison to conventional methods, Er:YAG laser removes deposits and biofilm more thoroughly and creates a more biocompatible surface for reattachment than SRP [23, 24].

Consequently, lasers today are used in the clinical nonsurgical treatment of periodontal disease, either as an adjunct or as an alternative to conventional mechanical instruments. There are at least two nonsurgical laser periodontal procedures which have been extensively researched and have as a result gained relatively broad clinical acceptance.

The first technique involves sulcular debridement with Nd:YAG laser, which helps achieve new connective tissue attachment and regeneration of the root surface [18]. The second technique involves the use of Er:YAG laser, both as an alternative and an adjunct to mechanical therapy for subgingival calculus removal in nonsurgical pocket therapy SRP [47]. Surgical debridement with an Er:YAG laser not only facilitates the debridement procedure in flap surgery but also may be advantageous for tissue repair and regeneration.

Based on the published favorable clinical outcomes of each of the laser treatments, i.e., Er:YAG and Nd:YAG, a combined dual-wavelength procedure called TwinLight® (also known as WPT™) has been introduced, which utilizes the complementary beneficial effects of both laser wavelengths to further improve the clinical outcome of laser-assisted non-surgical periodontal treatments [40-46].

Periodontal tissue regeneration, which is considered to be the ultimate form of periodontal healing, has been demonstrated to be promoted individually with either Nd:YAG laser or Er:YAG laser being used as an adjunct to mechanical therapy [48, 49]. It is therefore to be expected that the TwinLight procedure with the best of both periodontal laser treatment effects should result in at least as much, if not significantly greater promotion of periodontal tissue regeneration.

The aim of this four-center retrospective study was to provide clinical evidence of periodontal tissue regeneration when following the TwinLight® procedure, by conducting a retrospective case series analysis of available before and after radiographic images of patients receiving TwinLight® periodontal treatment, as collected during the past approximately 6 years.

II. MATERIALS AND METHODS

Patients were given the TwinLight® dual Nd:YAG/Er:YAG laser periodontal treatment using a LightWalker/Powerlase laser (manufactured by Fotona d.o.o., Ljubljana, Slovenia).

The TwinLight® procedure consists of the following three steps:

a) 1st step: de-epithelialization and decontamination

Perform Nd:YAG laser sulcular debridement. Initiate Nd:YAG laser treatment of the inner pocket wall to remove the pocket epithelium around the entire tooth (2 - 4 Watts to the tissue, MSP or SP mode, 10 - 20 Hz). Nd:YAG handpiece strokes from side to side. Denature the inner pocket epithelium to the depth of the probe readings. Remove the denatured tissue as it collects on the fiber ending.

b) 2nd step: calculus removal (debriding refinishing)

i) Perform Er:YAG laser root debridement (removal of the subgingival calculi) with a 600 μm VARIAN tip, up to 100 mJ (experts alternatively up to 200 mJ), 10-20 Hz, MSP pulse duration (experts alternatively SSP or QSP mode). Handpiece strokes are up and down. ii) Perform mechanical scaling and root planing with a piezoelectric or ultrasonic scaler. iii) remove biofilm with Er:YAG laser using a 400-600 μm XPulse or VARIAN fiber tip, 20-50 mJ, 20-40 Hz, MSP pulse duration (experts alternatively SSP mode). Handpiece surface movement.

c) 3rd step: clot formation.

Lase the pocket contents of the teeth (3 - 4 Watts to the tissue, VLP mode, 20 Hz) to help coagulate any blood present and to form a pocket seal. Activate the Nd:YAG laser on the out-stroke only. Approximate the wound edges. Compress the tissue with wet gauze against the tooth from both a facial and lingual direction. Eliminate all occlusal interference. Prescribe medications for home use.

The following private dental practices were involved in the retrospective collection and analysis of before and after radiographic images of their patients receiving the TwinLight periodontal treatments, as collected during the period of approximately the past 6 years:

a) Dalessandro Implants and Periodontics, 2500 West Higgins Rd, Suite 665, Hoffman Estates, IL 60169, USA
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III. RESULTS

The figures below show the case series' radiograph images demonstrating periodontal tissue regeneration following TwinLight® Nd:YAG/Er:YAG treatment. Periodontal tissue regeneration was confirmed also by soft tissue probings.

Fig. 1: Bone regeneration observed on radiographic images of patient #1 before (left image) and 6 months following TwinLight® treatment (right image). Source: Dalessandro Implants and Periodontics.

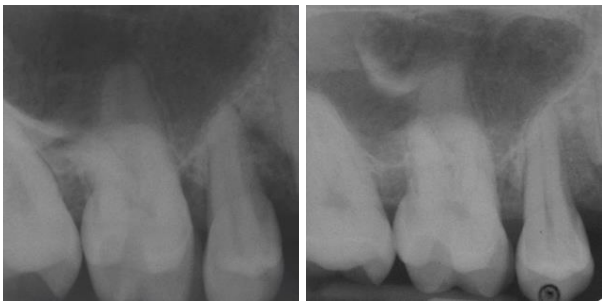

Fig. 2: Bone regeneration observed on radiographic images of patient #2 before (left image) and 6 months following TwinLight® treatment (right image). Source: Dalessandro Implants and Periodontics.

Fig. 3: Bone regeneration observed on radiographic images of patient #3 before (left image) and 9 months following TwinLight® treatment (right image). Source: Dalessandro Implants and Periodontics.

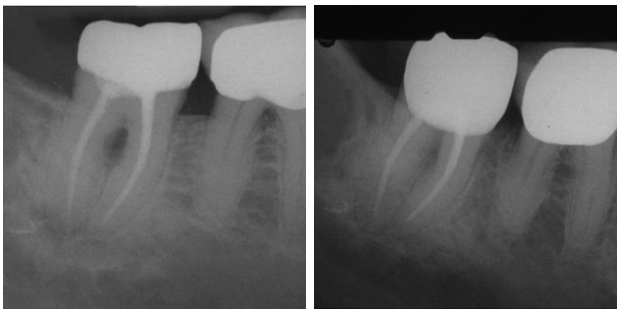

Fig. 4: Bone regeneration observed on radiographic images of patient #4 before (left image) and 9 months following TwinLight® treatment (right image). Source: Dalessandro Implants and Periodontics.

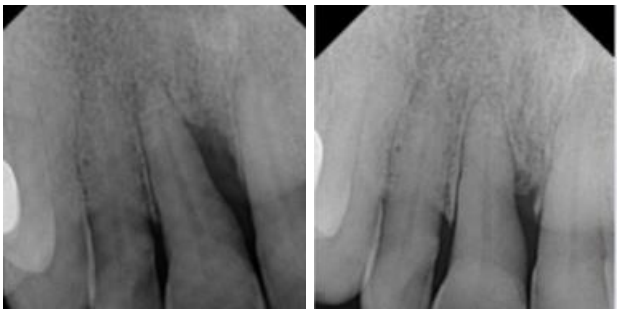

Fig. 5: Bone regeneration observed on radiographic images of patient #5 before (left image) and 12 months following TwinLight® treatment (right image). Source: Dalessandro Implants and Periodontics.

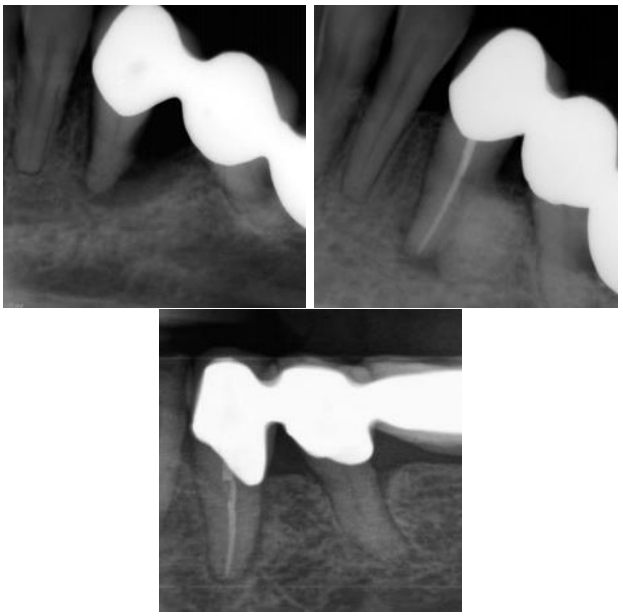

Fig. 6: Bone regeneration observed on radiographic images of patient # 6 before (top left, #22), 22 months post (top right) and 6 years post TwinLight® treatment (bottom). Source: Boynton Laser Dental Center.

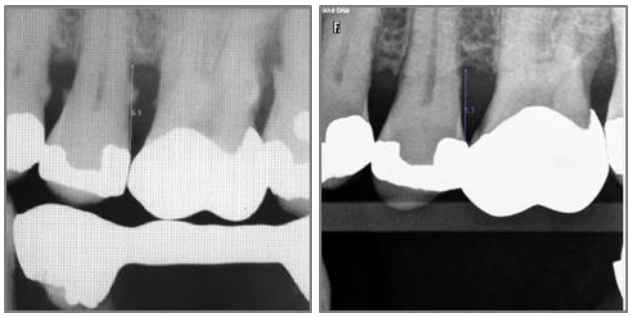

Fig. 7: Bone regeneration observed on radiographic images of patient #7 before (left image) and 4 years following TwinLight® treatment (right image). Source: Baltimore Center for Laser Dentistry.

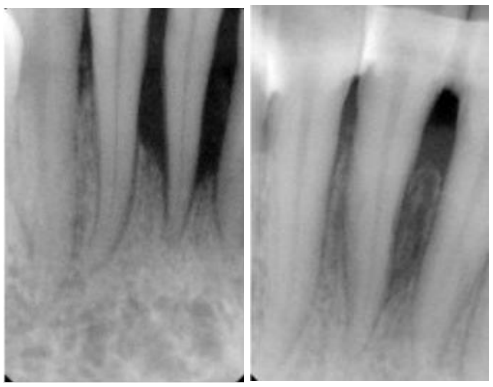

Fig. 8: Bone regeneration observed on radiographic images of patient #8 before (left image) and following TwinLight® treatment (right image). Source: Baltimore Center for Laser Dentistry.

Fig. 9: Bone regeneration observed on radiographic images of patient #9; before (top, first periapical #12 mesial), 3 months post (middle, bitewing x-ray) and 18 months post TwinLight® treatment (bottom, bitewing x-ray). Source: Source: Boynton Laser Dental Center.

Fig. 10: Bone regeneration observed on radiographic images of patient #10: before (top, #18), 3 years after (middle) and 6 years after TwinLight® treatment (bottom). Source: Source: Boynton Laser Dental Center.

IV. DISCUSSION

Several decades since the introduction of lasers into treatment protocols, there is now sufficient evidence that laser technology constitutes a beneficial adjunct or alternative periodontal therapy, with the potential to promote regeneration of periodontal tissues.

Due to the complementary effects of the near-infrared (Nd:YAG: 1064 nm) and medium-infrared (Er:YAG: 2940 nm) laser wavelengths, the TwinLight® dual-wavelength procedure synergistically combines the individual effects of both wavelengths for a better resolution or control of some aspect of the periodontal disease, such as bacterial load, inflamed tissue or tartar, and thus promises to result in a more effective adjunct to conventional periodontal therapy (SRP).

V. CONCLUSIONS

Data presented in this study reveals the ability of the combined TwinLight® Nd:YAG and Er:YAG laser treatment of chronic periodontitis to promote bone regeneration. This evidence is in addition to the previously published evidence of probing depth reduction and clinical attachment level gain in medium deep periodontal pockets. In conjunction with the published microbiological results, the non-surgical TwinLight periodontal treatment with Nd:YAG and Er:YAG laser thus promises to become a preferred alternative treatment for moderate-to-severe chronic periodontitis.

Further long-term, randomized, controlled clinical trials are needed to quantify the contribution of each of the TwinLight® laser wavelengths and of their combined, potentially synergistic effect on the clinically observed regeneration of periodontal tissues.

REFERENCES

1. American Academy of Periodontology Task Force Report on the Update to the 1999 Classification of Periodontal Diseases and Conditions (2015). J Periodontol 86 (7):835-838. doi:10.1902/jop.2015.157001
2. Slowik J, Wnuk MA, Grzech K, Golenia A, Turaj W, Ferens A, Jurczak A, Chomyszyn-Gajewska M, Loster B, Slowik A (2010) Periodontitis affects neurological deficit in acute stroke. J Neurol Sci 297 (1-2):82-84. doi:10.1016/j.jns.2010.07.012
3. Darveau RP, Tanner A, Page RC (1997) The microbial challenge in periodontitis. Periodontol 2000 14:12-32
4. Herrera D, Sanz M, Jepsen S, Needleman I, Roldan S (2002) A systematic review on the effect of systemic antimicrobials as an adjunct to scaling and root planing in periodontitis patients. J Clin Periodontol 29 Suppl 3:136-159; discussion 160-132
5. Patel PV, Patel A, Kumar S, Holmes JC (2012) Effect of subgingival application of topical ozonated olive oil in the treatment of chronic periodontitis: a randomized, controlled, double blind, clinical and microbiological study. Minerva Stomatol 61 (9):381-398
6. Jhinger N, Kapoor D, Jain R (2015) Comparison of Periochip (chlorhexidine gluconate 2.5 mg) and Arestin (Minocycline hydrochloride 1 mg) in the management of chronic periodontitis. Indian J Dent 6 (1):20-26. doi:10.4103/0975-962X.151697
7. Laugisch O, Ramseier CA, Salvi GE, Hagi TT, Burgin W, Eick S, Sculean A (2016) Effects of two different post-surgical protocols including either 0.05 % chlorhexidine herbal extract or 0.1 % chlorhexidine on postsurgical plaque control, early wound healing and patient acceptance following standard periodontal surgery and implant placement. Clin Oral Investig 20 (8):2175-2183. doi:10.1007/s00784-016-1713-7
8. Salvi GE, Mombelli A, Mayfield L, Rutar A, Suvan J, Garrett S, Lang NP (2002) Local antimicrobial therapy after initial periodontal treatment. J Clin Periodontol 29 (6):540-550
9. Zandbergen D, Slot DE, Niederman R, Van der Weijden FA (2016) The concomitant administration of systemic amoxicillin and metronidazole compared to scaling and root planing alone in treating periodontitis: =a systematic review=. BMC Oral Health 16:27. doi:10.1186/s12903-015-0123-6
10. Jepsen K, Jepsen S (2016) Antibiotics/antimicrobials: systemic and local administration in the therapy of mild to moderately advanced periodontitis. Periodontol 2000 71 (1):82-112. doi:10.1111/prd.12121
11. Tamura A, Ara T, Imamura Y, Fujii T, Wang PL (2008) The effects of antibiotics on in vitro biofilm model of periodontal disease. Eur J Med Res 13 (9):439-445
12. Walters J, Lai PC (2015) Should Antibiotics Be Prescribed to Treat Chronic Periodontitis? Dent Clin North Am 59 (4):919-933. doi:10.1016/j.cden.2015.06.011
13. Aoki A, Mizutani K, Schwarz F, Sculean A, Yukna RA, Takasaki AA, Romanos GE, Taniguchi Y, Sasaki
14. KM, Zeredo JL, Koshy G, Coluzzi DJ, White JM, Abiko Y, Ishikawa I, Izumi Y (2015) Periodontal and periimplant wound healing following laser therapy. Periodontol 2000 68 (1):217-269. doi:10.1111/prd.12080
15. Karlsson MR, Diogo Lofgren CI, Jansson HM (2008) The effect of laser therapy as an adjunct to nonsurgicalperiodontal treatment in subjects with chronic periodontitis: a systematic review. J Periodontol 79 (11):2021-2028. doi:10.1902/jop.2008.080197
16. Schwarz F, Aoki A, Becker J, Sculean A (2008) Laser application in non-surgical periodontal therapy: a systematic review. J Clin Periodontol 35 (8 Suppl):29-44. doi:10.1111/j.1600-051X.2008.01259.x
17. Cheng Y, Chen JW, Ge MK, Zhou ZY, Yin X, Zou SJ (2016) Efficacy of adjunctive laser in non-surgical periodontal treatment: a systematic review and meta-analysis. Lasers Med Sci 31 (1):151-163. doi:10.1007/s10103-015-1795-5
18. Ishikawa I, Aoki A, Takasaki AA, Mizutani K, Sasaki KM, Izumi Y (2009) Application of lasers in periodontics: true innovation or myth? Periodontol 2000 50:90-126. doi:10.1111/j.1600-0757.2008.00283.x
19. Yukna RA, Carr RL, Evans GH (2007) Histologic evaluation of an Nd:YAG laser-assisted new attachment procedure in humans. Int J Periodontics Restorative Dent 27 (6):577-587
20. Giannelli M, Bani D, Viti C, Tani A, Lorenzini L, Zecchi-Orlandini S, Formigli L (2012) Comparativeevaluation of the effects of different photoablative laser irradiation protocols on the gingiva of periodontopathicpatients. Photomed Laser Surg 30 (4):222-230. doi:10.1089/pho.2011.3172
21. Nevins M, Kim SW, Camelo M, Martin IS, Kim D, Nevins M (2014) A prospective 9-month human clinicalevaluation of Laser-Assisted New Attachment Procedure (LANAP) therapy. Int J Periodontics Restorative Dent 34 (1):21-27. doi:10.11607/prd.1848
22. Gomez C, Dominguez A, Garcia-Kass AI, Garcia-Nunez JA (2011) Adjunctive Nd:YAG laser application in chronic periodontitis: clinical, immunological, and microbiological aspects. Lasers Med Sci 26 (4):453-463.doi:10.1007/s10103-010-0795-8
23. Gutknecht N, Van Betteray C, Ozturan S, Vanweersch L, Franzen R (2015) Laser supported reduction ofspecific microorganisms in the periodontal pocket with the aid of an Er,Cr:YSGG laser: a pilot study. ScientificWorldJournal 2015:450258. doi:10.1155/2015/450258

24. Schwarz F, Sculean A, Berakdar M, Szathmari L, Georg T, Becker J (2003) In vivo and in vitro effects of an Er:YAG laser, a GaAlAs diode laser, and scaling and root planin periodontally diseased root surfaces: acomparative histologic study. Lasers Surg Med 32 (5):359-366. doi:10.1002/lsm.10179
25. Sgolastra F, Petrucci A, Gatto R, Monaco A (2012) Efficacy of Er:YAG laser in the treatment of chronic periodontitis: systematic review and meta-analysis. Lasers Med Sci 27 (3):661-673. doi:10.1007/s10103-011-0928-8
26. Almehdi A, Aoki A, Ichinose S, Taniguchi Y, Sasaki KM, Ejiri K, Sawabe M, Chui C, Katagiri S, Izumi Y(2013) Histological and SEM analysis of root cementum following irradiation with Er:YAG and CO2 lasers. Lasers Med Sci 28 (1):203-213. doi:10.1007/s10103-012-1110-7
27. Ogita M, Tsuchida S, Aoki A, Satoh M, Kado S, Sawabe M, Nanbara H, Kobayashi H, Takeuchi Y,Mizutani K, Sasaki Y, Nomura F, Izumi Y (2015) Increased cell proliferation and differential protein expression induced by low-level Er:YAG laser irradiation in human gingival fibroblasts: proteomic analysis. Lasers Med Sci 30 (7):1855-1866. doi:10.1007/s10103-014-1691-4
28. T, Vohra F, Kellesarian SV, Javed F (2017) Efficacy of scaling and root planing with and without adjunct Nd:YAG laser therapy on clinical periodontal parameters and gingival crevicular fluid interleukin 1-beta and tumor necrosis factor-alpha levels among patients with periodontal disease: A prospectiverandomized split-mouth clinical study. J Photochem Photobiol B 169:70-74.doi:10.1016/j.jphotobiol.2017.03.001
29. Eltas A, Orbak R (2012) Effect of 1,064-nm Nd:YAG laser therapy on GCF IL-1beta and MMP-8 levels in patients with chronic periodontitis. Lasers Med Sci 27 (3):543-550. doi:10.1007/s10103-011-0939-5
30. Negi S, Krishnamurthy M, Ganji KK, Pendor S (2015) Modulatory effects by neodymium-doped yttriumaluminum garnet laser on fibroblast attachment to single rooted tooth surfaces following ultrasonic scaling and root planing: An in vitro study. J Indian Soc Periodontol 19 (1):25-31. doi:10.4103/0972-124X.145819
31. Harris DM, Reinisch L (2016) Selective photoantisepsis. Lasers Surg Med 48 (8):763-773.doi:10.1002/lsm.22568
32. Sculean A, Schwarz F, Berakdar M, Romanos GE, Arweiler NB, Becker J (2004) Periodontal treatment with an Er:YAG laser compared to ultrasonic instrumentation: a pilot study. J Periodontol 75 (7):966-973.doi:10.1902/jop.2004.75.7.966
33. Lopes BM, Theodoro LH, Melo RF, Thompson GM, Marcantonio RA (2010) Clinical and microbiologicfollow-up evaluations after non-surgical periodontal treatment with erbium:YAG laser and scaling and root planing. J Periodontol 81 (5):682-691. doi:10.1902/jop.2010.090300
34. Crespi R, Cappare P, Toscanelli I, Gherlone E, Romanos GE (2007) Effects of Er:YAG laser compared to ultrasonic scaler in periodontal treatment: a 2-year follow-up split-mouth clinical study. J Periodontol 78(7):1195-1200. doi:10.1902/jop.2007.060460
35. Yan M, Liu M, Wang M, Yin F, Xia H (2015) The effects of Er:YAG on the treatment of peri-implantitis: ameta-analysis of randomized controlled trials. Lasers Med Sci 30 (7):1843-1853. doi:10.1007/s10103-014-1692-3
36. Eick S, Meier I, Spoerle F, Bender P, Aoki A, Izumi Y, Salvi GE, Sculean A (2017) In Vitro-Activity of Er:YAG Laser in Comparison with other Treatment Modalities on Biofilm Ablation from Implant and Tooth Surfaces. PLoS One 12 (1):e0171086. doi:10.1371/journal.pone.0171086
37. Akiyama F, Aoki A, Miura-Uchiyama M, Sasaki KM, Ichinose S, Umeda M, Ishikawa I, Izumi Y (2011) Invitro studies of the ablation mechanism of periodontopathic bacteria and decontamination effect on periodontallydiseased root surfaces by erbium:yttrium-aluminum-garnet laser. Lasers Med Sci 26 (2):193-204.doi:10.1007/s10103-010-0763-3
38. Kranendonk A, van der Reijden W, van Winkelhoff A, van der Weijden G (2010) The bactericidal effect of aGenius Nd:YAG laser. Int J Dent Hyg 8 (1):63-67. doi:10.1111/j.1601-5037.2009.00375.x
39. Yaneva B, Firkova E, Karaslavova E, Romanos GE (2014) Bactericidal effects of using a fiber-less Er:YAGlaser system for treatment of moderate chronic periodontitis: preliminary results. Quintessence Int 45 (6):489-497. doi:10.3290/j.qi.a31803
40. Saglam M, Koseoglu S, Tasdemir I, Erbak Yilmaz H, Savran L, Sutcu R (2017) Combined application of Er:YAG and Nd:YAG lasers in treatment of chronic periodontitis. A split-mouth, single-blind, randomizedcontrolled trial. J Periodontal Res. doi:10.1111/jre.12454
41. Grzech-Lesniak K; Laser Assisted reduction of specific organisms in the periodontal pockets using Er:YAG, Nd:YAG and Diode laser: a randomized controlled clinical study, World Federation of Laser Dentistry, Nagoya (2016): 46.
42. Grzech-Lesniak K; A randomized controlled clinical study evaluating the combination of Nd:YAG laser and Er:YAG laser in nonsurgical periodontal therapy, World Federation of Laser Dentistry, Nagoya (2016): 82.
43. Grzech-Lesniak K, Sculean A, Gaspirc B. Laser Reduction of Specific Microorganisms in the Periodontal Pocket Using Er:YAG and Nd:YAG laser: A Randomized Controlled Clinical Study, submitted for publication in Lasers in Medical Science.
44. Simunovic K, Laser-assisted dentistry in the daily office routine: A "multi-wave" concept, Laser – International Magazine in Laser Dentistry; 3 (4/2011):16-21.
45. Olivi G, Lasers in periodontal therapy: the Twinlight approach, Laser – International Magazine in Laser Dentistry; 3 (2013):30-3
46. Shiffman HS, Er:YAG and Nd:YAG dual wavelength optimized periodontal therapy; Dental Tribune U.S. Edition; June 2013: A7-A8
47. Gaspirc B, Skaleric U, Clinical Evaluation of Periodontal Surgical Treatment With an Er:YAG Laser: 5-Year Results, J Perdontol, October 2007 78(10): 1864-1871
48. Bozic Z, Alveolar Bone Regeneration Using Nd:YAG Laser, J Laser and Heath Academy- J LA&HA 2017 (1): 1-6
49. Korosec B, et al, Research Study: Periodontal Tissue Regeneration Following Er:YAG and Nd:YAG Laser Treatments, J Laser and Health Academy- J LA&HA 2017 (1): onlineFirst.