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JOURNAL OF LASER-ASSISTED DENTISTRY

MIST vs. YSGG

A Landmark 6-Month Comparative, Randomized, Blinded, Multi-Center, Clinically Controlled Study

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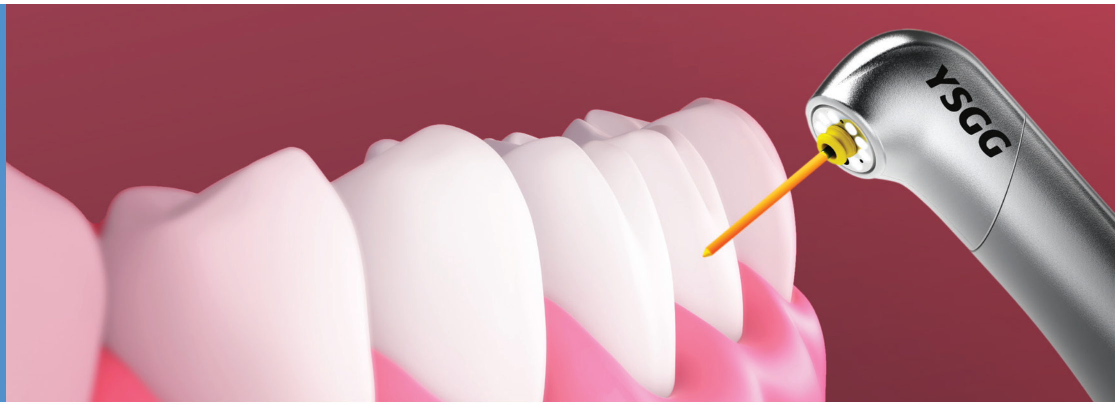
INSIDE ISSUE 4 2021



2021
A YEAR OF RENEWAL

2020 was a year of hardships, reflections and isolation. Most of us were shaken by the new reality and did our best to survive and adapt and come out stronger than ever. From my own experiences, what I missed the most is the social aspect of our profession, such as the conventions and symposiums where I reconnected with friends and colleagues from all over the world and then travelling near and far to share my knowledge with the newcomers into the field of laser dentistry. Zoom meetings and online webinars don't even begin to replace the lively dinners and exchange of ideas among friends after a day of in-person hands-on learning.

Let 2021 be a year of renewal of everything good that was forgotten and a year for new beginnings and new enthusiasm for learning and sharing what we know for the benefit of the profession, our patients and ourselves.

WCLI (World Clinical Laser Institute) has changed my career path and offered me so much more than what my conventional training has allowed me to achieve. For the last 15 years I chose to focus my practice on incorporating lasers into every procedure which I offer to my patients, from 100% laser procedures, like frenectomies, to incorporating a laser step into otherwise conventional treatment like endodontic therapy to achieve better patient-related outcomes (PRO's). I encourage all of you who chose to invest into laser technology in recent years to pursue additional training, meet like-minded people on your way to Fellowship or Mastership within the WCLI family.

As a new editor, it is my great honor to present you with an annual edition of the latest news and developments in the field of laser dentistry to share some of the important research recently published, and to introduce you to the WCLI Masters who deserve our recognition and respect for their commitment to never-ending learning. I invite you to participate in upcoming WCLI symposiums and in-person meetings as the world re-opens to post-pandemic travel. I welcome your comments and feedback and ideas on what you would like to see in the 2022 issue of JLAD.

Marina Polonsky, DDS, MSc.
EDITOR

DR. MARINA POLONSKY
EDITOR

Dr. Polonsky holds a Mastership with WCLI, Master of Science in Lasers in Dentistry degree from RWTH University in Aachen, Germany. She is a recipient of Advanced Proficiency and Mastership Certificate with ALD (Academy of Laser Dentistry) and is a recognized member of the ALD Speaker Bureau. She is a founder of the Canadian Dental Laser Institute (CDLI), ALD affiliated international study club.

JOURNAL OF LASER-ASSISTED DENTISTRY
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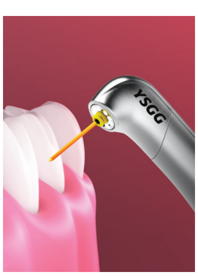


COVER IMAGE
A new landmark study by The McGuire Group has shown that use of an Er,Cr:YSGG laser is a useful treatment modality for intrabony defects with statistically similar outcomes as MIST.

MIST VS. YSGG

A Landmark 6-Month Comparative, Randomized, Blinded, Multi-Center, Clinically Controlled Study

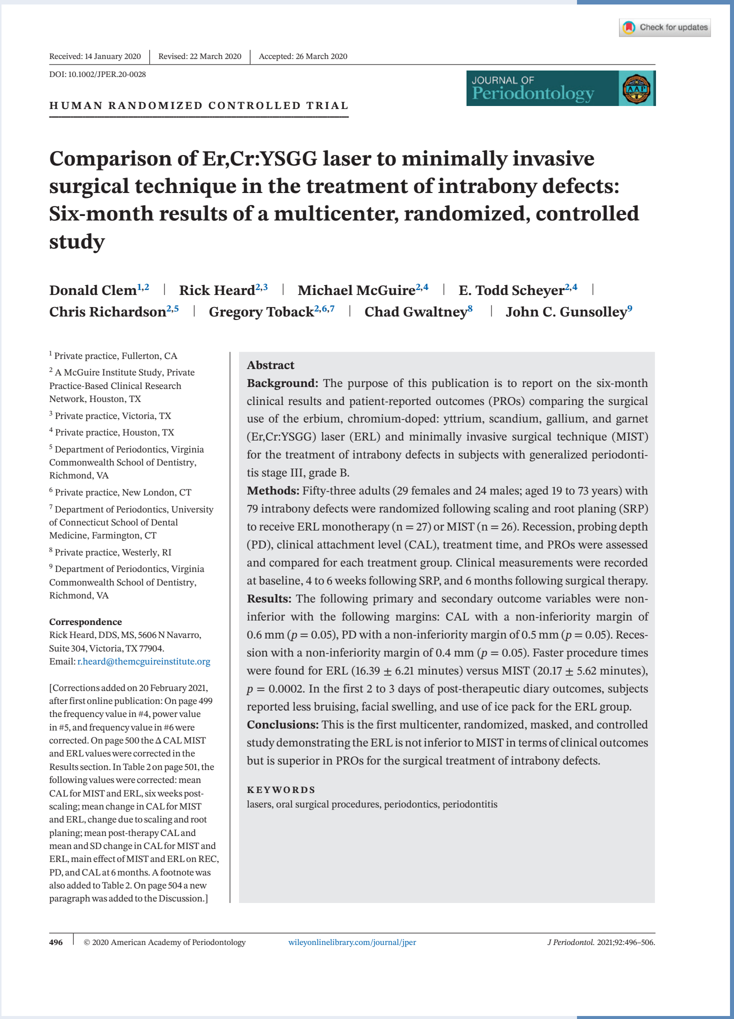
1. MATERIALS AND METHODS

The design of this study was a randomized, prospective, multicenter, single-masked, clinical controlled trial of 15 months duration. Inclusion criteria for the study were (1) Adults, 18-75 years of age (2) Diagnosis of Generalized Stage III Grade B Periodontitis, (3) Probing depths of 6mm or more for non-adjacent qualifying teeth and radiographic evidence of an intrabony defect (4) 6 weeks following SRP, qualifying teeth must exhibit probing depths of 6mm or more (5) Informed consent (6) adherence to study protocols, OHI, and follow up visits. Exclusion criteria were (1) inability to visualize CEJ or landmark for reproducibly accurate probing (2) acute periodontal abscess (3) Mobility >1 (4) 3rd molars or RCT teeth (5) systemic disease that may compromise wound healing (6) traumatic occlusion (7) use of Bisphosphonates (8) Heavy use of nicotine products (9) Pregnant subjects (10) Use of antibiotics or steroids during the trial or within 30 days of SRP (11) Agents shown to cause gingival overgrowth (12) Any oral health intervention within 90 days of trial commencement. All examiners were calibrated for measuring probing depth (PD), clinical attachment level (CAL), recession (REC), bleeding on probing (BOP), and modified gingival index (MGI).

Full mouth assessments were taken at baseline and 4 to 6 weeks after SRP. Following therapy, at 90-day intervals up to and including 6 months, clinical measures were recorded for study teeth and immediately adjacent teeth. Subjects selected at random were treated with an erbium, chromium:yttrium-scandium-gallium-garnet (Er,Cr:YSGG) laser, or ERL for short, versus a minimally invasive surgical technique (MIST). Following each surgical procedure, antibiotics, use of chlorohexidine-dabbed swabs, and ibuprofen or acetaminophen for post-operative discomfort were prescribed. Periodontal maintenance, oral hygiene instruction (OHI), and patient reported outcomes (PROs) were completed every 90 days following therapy. All subjects completed a PROs assessment before and after surgical procedures were completed with the criteria of anxiety, pain, and satisfaction reported on a scale of 0-10.

2. RESULTS

Fifty-three adult subjects (29 females and 24 males; aged 19 to 73 years) with 79 intrabony defects were randomized and received MIST or ERL therapies. Shorter procedure times were found for ERL versus MIST. No statistical differences were found between the two treatment groups for REC, PD reduction, or CAL gain. The PROs from the laser group versus MIST demonstrated statistically significant differences, with the laser group reporting less bleeding, swelling, bruising, and the use of ice following treatment. Low-levels of post-operative pain was observed in both groups.



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JOURNAL OF Periodontology

HUMAN RANDOMIZED CONTROLLED TRIAL

Comparison of Er,Cr:YSGG laser to minimally invasive surgical technique in the treatment of intrabony defects: Six-month results of a multicenter, randomized, controlled study

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[Corrections added on 20 February 2021, after first online publication: On page 499 the frequency value in #4, power value in #5, and frequency value in #6 were corrected. On page 500 the Δ CAL MIST and ERL values were corrected in the Results section. In Table 2 on page 501, the following values were corrected: mean CAL for MIST and ERL, six weeks post-scaling; mean change in CAL for MIST and ERL, change due to scaling and root planing; mean post-therapy CAL and mean and SD change in CAL for MIST and ERL, main effect of MIST and ERL on REC, PD, and CAL at 6 months. A footnote was also added to Table 2. On page 504 a new paragraph was added to the Discussion.]

Abstract

Background: The purpose of this publication is to report on the six-month clinical results and patient-reported outcomes (PROs) comparing the surgical use of the erbium, chromium-doped: yttrium, scandium, gallium, and garnet (Er,Cr:YSGG) laser (ERL) and minimally invasive surgical technique (MIST) for the treatment of intrabony defects in subjects with generalized periodontitis stage III, grade B.

Methods: Fifty-three adults (29 females and 24 males; aged 19 to 73 years) with 79 intrabony defects were randomized following scaling and root planing (SRP) to receive ERL monotherapy (n = 27) or MIST (n = 26). Recession, probing depth (PD), clinical attachment level (CAL), treatment time, and PROs were assessed and compared for each treatment group. Clinical measurements were recorded at baseline, 4 to 6 weeks following SRP, and 6 months following surgical therapy.

Results: The following primary and secondary outcome variables were non-inferior with the following margins: CAL with a non-inferiority margin of 0.6 mm ($p = 0.05$), PD with a non-inferiority margin of 0.5 mm ($p = 0.05$). Recession with a non-inferiority margin of 0.4 mm ($p = 0.05$). Faster procedure times were found for ERL (16.39 ± 6.21 minutes) versus MIST (20.17 ± 5.62 minutes), $p = 0.0002$. In the first 2 to 3 days of post-therapeutic diary outcomes, subjects reported less bruising, facial swelling, and use of ice pack for the ERL group.

Conclusions: This is the first multicenter, randomized, masked, and controlled study demonstrating the ERL is not inferior to MIST in terms of clinical outcomes but is superior in PROs for the surgical treatment of intrabony defects.

KEYWORDS
lasers, oral surgical procedures, periodontics, periodontitis

496 | © 2020 American Academy of Periodontology wileyonlinelibrary.com/journal/jper *J Periodontol.* 2021;92:496–506.

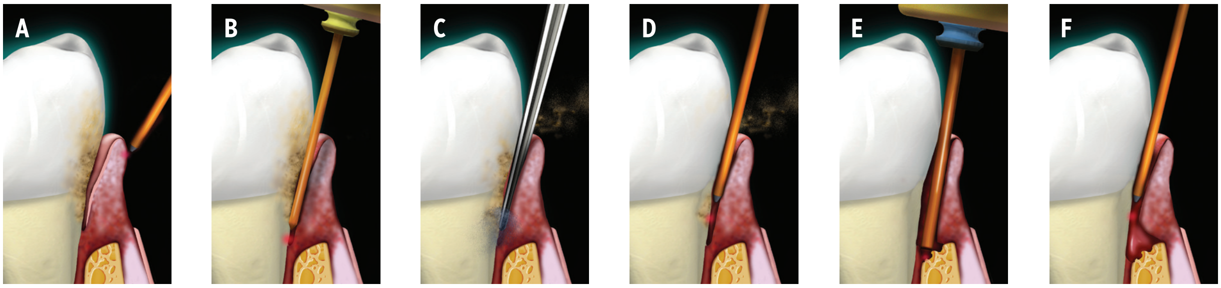


FIGURE 1 A) Removal of the outer pocket gingival epithelium from the free gingival margin down to a millimeter coronal to the MGJ. B) De-epithelialization and reflection of pocket epithelium down to the bone level. C) SRP without laser. D) Root and defect debridement using the laser. E) Bone decortication. F) Final sulcular debridement by removing residual debris and inducing blood coagulation.

TABLE 4 Post-therapy daily diary reported percentage of swelling, bruising, and ice pack use by treatment group

Measure		Facial swelling 0 to 10			Bruising 0 to 10			Ice pack Y/N
Time	Group	% >0	Mean	SD	% >0	Mean	SD	% - Y
Day 1	MIST	81%*	2.35*	2.53*	15%*	0.19*	0.49	62%*
	ERL	46%*	0.78*	1.01*	0%*	0.00*	0.00	17%*
Day 2	MIST	62%*	1.77*	2.64*	19%*	0.19*	0.40	30%
	ERL	15%*	0.3*	0.72*	0%*	0.00*	0.00	22%
Day 3	MIST	42%*	1.04*	1.66*	12%	0.12	0.33	13%
	ERL	4%*	0.15*	0.77*	4%	0.04	0.19	4%
Day 4	MIST	19%	0.46	1.1	8%	0.19	0.69	12%
	ERL	4%	0.07	0.38	4%	0.04	0.19	4%
Day 5	MIST	15%	0.31	0.79	12%	0.19	0.63	4%
	ERL	4%	0.04	0.19	0%	0.00	0.00	4%
Day 6	MIST	15%	0.23	0.59	4%	0.04	0.20	4%
	ERL	4%	0.04	0.19	0%	0.00	0.00	0%
Day 7	MIST	4%	0.04	0.2	0%	0.00	0.00	4%
	ERL	0%	0	0	0%	0.00	0.00	4%

* = (Individual statistical differences ($p = 0.05$) repeated measures analysis of variances. Individual time points tested with Tukey's test at $p = 0.05$).
Key: Y/N, Yes/No; MIST, minimally invasive surgical technique; ERL, Er,Cr:YSGG laser.

3. OVERALL SUMMARY

As the first multicenter, randomized, single-masked, controlled clinical trial study, the investigators of this study found the use of an ERL for the surgical treatment of intrabony defects is not inferior to MIST. Comparable outcomes were achieved in both groups with the laser group exhibiting less postoperative side effects as compared to the MIST group. In a separate study, radiographic assessments will be assessed to compare the use of an ERL for intrabony defects versus MIST.

4. CLINICAL SIGNIFICANCE AND IMPACT

Postoperative healing, patient reported satisfaction, and clinically significant outcomes in periodontal surgery are paramount in the treatment of periodontal defects. Of note, this study has shown that use of an Er,Cr:YSGG laser is a useful treatment modality for intrabony defects with statistically similar outcomes as MIST for postoperative measures in PD, BOP, REC, and CAL. In addition, reduced chair time is a contributing factor to the surgical technique one chooses to use, and as such, this study concludes that laser therapy may be an effective technique, if not, an adjunct to conventional periodontal surgical methods. The investigators of this study proport that future studies will be required before validating the use of laser therapy as an alternative to a "gold standard". ■

A comparison of Er,Cr:YSGG laser to minimally invasive surgical technique in the treatment of intrabony defects: six-month results of a multicenter, randomized, controlled study. Donald Clem, Rick Heard, Michael McGuire , E. Todd Scheyer, Chris Richardson, Gregory Toback, Chad Gwaltney, John C. Gunsolley, Journal of Periodontology, 10.1002/JPER.20-0028, (2020)
https://doi.org/10.1002/JPER.20-0028

A CLINICAL LOOK

Easier, Predictable Harvesting of Connective Tissue of Excellent Quality and Quantity

Laser De-epithelialization of Autogenous Gingival Graft for Root Coverage and Soft Tissue Augmentation Procedures

Ching-Yi Lin, DDS, DMSc/Myron Nevins, DDS/David M. Kim, DDS, DMSc

The International Journal of Periodontics & Restorative Dentistry, Volume 38 , Issue 3, May/June 2018, Pages 405–411

METHODS AND MATERIALS

The present study uses three case reports to outline the use of an erbium, chromium:yttrium-scandium-gallium-garnet (Er,Cr:YSGG) laser to de-epithelialize autogenous gingival grafts (AGG) used for root coverage, dental implant fenestration coverage, and ridge augmentation procedures.

Case 1 - root coverage: A 19 year-old male with Miller Class I recessions from the mandibular right central incisor to right first premolar was treated. Tunneling technique was used and the donor tissue was harvested from the palate after being de-epithelialized 3 times with an Er,Cr:YSGG laser (dimensions of donor tissue outlined first with a 15c blade). The graft was sutured to the recipient bed and the flap was sling sutured. The donor site was covered with cyanoacrylate and periodontal dressing.

Case 2 - dental implant fenestration coverage: A 56 year-old female presented with soft tissue fenestration on the buccal aspect of an implant at the site of the maxillary right central incisor + crown fracture of the maxillary right central incisor. Tunneling technique was used from maxillary right canine to right central incisor. Same protocol as case 1 was used for dimensional marking and harvesting of donor tissue, transfer of donor tissue to prepared recipient bed, and suturing technique. Same palatal coverage technique as case 1 was employed.

Case 3 - ridge augmentation: A 29 year-old woman presented with vertical alveolar ridge deficiency from maxillary right lateral incisor to left incisor. Envelope technique was used for preparation of the recipient bed with split-thickness flap elevation from maxillary canine to canine. Same protocol as case 1 was used for marking and harvesting of donor tissue. Donor tissue was transferred to crestal side of recipient bed from maxillary lateral incisor to incisor. Same palatal coverage technique as case 1 was employed. Two implants were placed following an adequate post-operative period and a second mucogingival graft was used to provide keratinized tissue.

RESULTS

All 3 cases exhibited root and/or implant coverage following the use of an Er,Cr:YSGG laser to de-epithelialize the autogenous gingival grafts. No adverse outcomes nor patient reported morbidities were obtained following the post-operative period.

OVERALL SUMMARY

The Zucchelli technique for de-epithelializing a free gingival graft is a useful way to obtain autogenous gingival grafts for treatments such as root coverage, implant fenestration coverage, and ridge augmentation. This study uses an Er,Cr:YSGG laser to remove the epithelial layer of the donor tissue in question versus a 15c blade traditionally used in the Zucchelli technique. In a histologic examination by Harris 2003, AGGs harvested with the Zucchelli technique revealed 80% of the grafts contained some level of epithelium; clinically successful outcomes were still obtained in the Harris study. In the present study, histologic examination resulted in complete removal of epithelium using an Er,Cr:YSGG laser.

CLINICAL SIGNIFICANCE AND IMPACT

One of the advantages of using an Er,Cr:YSGG laser in AGG procedures is that de-epithelization is performed intraorally before the donor tissue is harvested. This allows for a uniform, controlled approach to removing the epithelial layer from the donor tissue. Reduced chair time is also observed using this technique. Although further research is needed to compare patient comfort level following traditional AGG harvesting techniques and the one employed in this study, use of an Er,Cr:YSGG laser may be a useful and effective treatment modality in autogenous gingival graft procedures. ■

A CLINICAL LOOK

Safe and Effective Removal of Biofilm from Titanium Surfaces with the Er,Cr:YSGG Laser

Erbium, Chromium:Yttrium-Scandium-Gallium-Garnet Effectively Ablates Single-Species Biofilms from Titanium Disks without Detectable Damage

Jason M. Strever, Jaebum Lee, William Ealick, Mark Peacock, Daniel Shelby, Cristiano Susin, Donald Mettenberg, Ahmed El-Awady, Frederick Rueggeberg, Christopher W. Cutler

The Journal of Periodontology, May 2017

MATERIALS AND METHODS

Single-species biofilms consisting of Porphyromonas gingivalis (Pg) strain 381 were grown on titanium disks, including: 1) sandblasted, large-grit, acid-etched (SLA); 2) calcium phosphate nano-coated (CaP); 3) anodized; or 4) machined surfaces. Power settings from 0 to 1.5 W using an erbium, chromium:yttrium-scandium-gallium-garnet (Er,Cr:YSGG) laser equipped with radial firing tip were used. Biofilm formation/removal was quantified using confocal and scanning electron microscopy. Surface changes in temperature, microroughness, and water contact angle were analyzed.

RESULTS

Confocal imaging of the discs for residual Pg before and after treatment were analyzed. Percentages of biofilm remaining at 0 W, based on surface, was 0.09% – 0.11%, 0.9% – 0.9%, 13.6% – 5.5%, and 8.9% – 8.0% for machined, anodized, CaP, and SLA surfaces, respectively. An inverse relationship was found between a higher power setting and residual Pg. To remove greater than or equal to 95% of single-species biofilm from all surfaces, smooth or rough, a setting of 1.0 to 1.5W was used. Under SEM, images revealed that most, but not all, Pg microbes were ablated from the surface when a power setting between 0.5 and 1.5 W was used. No visible or reproducible changes to the physical properties of all treated surfaces were found up to a setting of 1.5W. An increase of 20 degrees Celsius was observed when no irrigation was used during laser treatment followed by a reduction in temperature to baseline after 50 seconds of constant irrigation.

OVERALL SUMMARY

This study used an Er,Cr:YSGG laser to ablate the surface of titanium discs inoculated with Pg and the intent of replicating its use for titanium dental implants in the treatment of peri-implantitis. The purpose of this study was to establish an in vitro single-species biofilm model on implant surfaces and determine power settings of the Er,Cr:YSGG laser that removes biofilm without altering the physical properties of the ablated surfaces. In this study, the Er,Cr:YSGG laser with radial firing tip and water spray was able to effectively remove greater than or equal to 95% of biofilm on all tested titanium surfaces, using clinically relevant power settings, without causing measurable physical changes to surfaces.

CLINICAL SIGNIFICANCE AND IMPACT

The biofilm of dental implants in vivo contains plasma/salivary binding proteins and a host of numerous other bacterial pathogens, including Pg. This biofilm poses a challenge to successfully remove and render clinically significant outcomes in peri-implant disease; further research is needed to obtain a biofilm model that appreciates the diverse composition of biofilm in vivo. Although the surfaces treated in this study were limited to cultures of Pg on titanium surfaces, this study demonstrates promising results in the removal of Pg cultures on all titanium surfaces tested, with a power setting between 0.5 and 1.5 W, and without damaging or altering the physical properties of each surface ablated with an Er,Cr:YSGG laser and water spray. ■

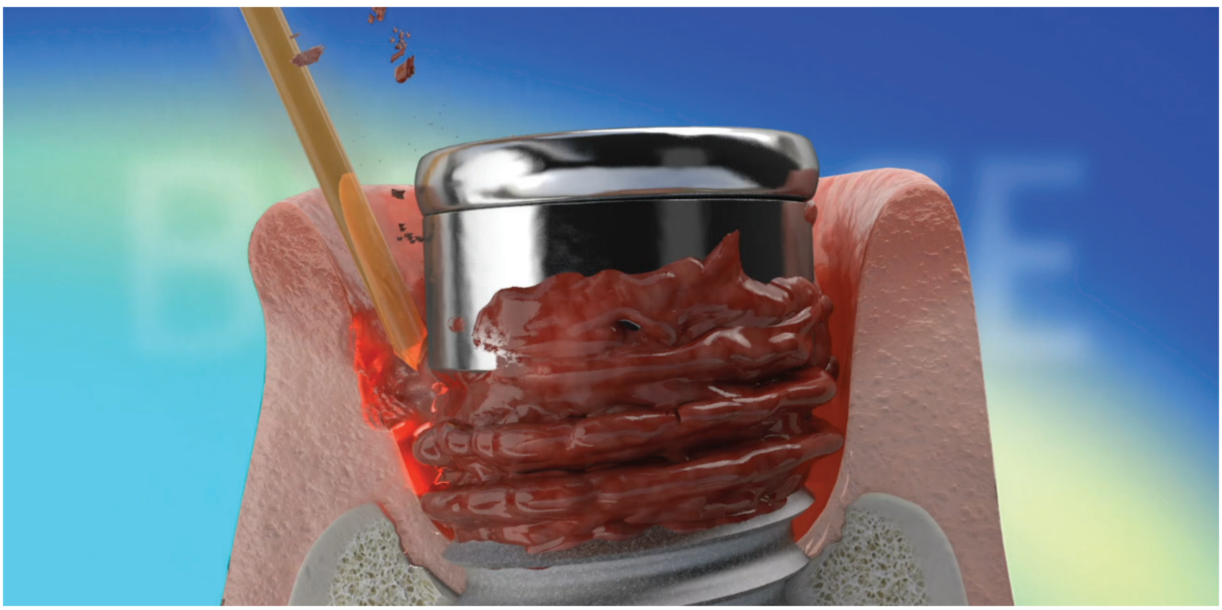
A CLINICAL LOOK

Re-Establish Bone to Implant Contact

Human Histologic Evaluations of the Use of Er,Cr:YSGG Laser to Decontaminate an Infected Dental Implant Surface in Preparation for Implant Reosseointegration

Myron Nevins, Stefano Parma Benfenati, Primo Galletti, Andrei Zuchi, Cosmin Sava, Catalin Sava, Mihaela Trifan, Andriano Piattelli, Giovanna Iezzi, Chia-Yu Chen, David M Kim, Isabella Rocchietta

International Journal of Periodontics and Restorative Dentistry, November/December 2020, Volume 40, Issue 6;   DOI: 10.11607/prd.5139



METHODS AND MATERIALS

This prospective proof-of-principle human histologic study investigated the use of erbium, chromium:yttrium-scandium-gallium-garnet (Er,Cr:YSGG) laser to decontaminate the surfaces of dental implants that had lost bone-to-implant contact (BIC). Three patients with the following inclusion criteria were enrolled: 1) 20-70 years of age with at least one failing implant 2) informed consent, participation in the study, and return for follow-up visits 3) non-significant medical history and medications (American Society of Anesthesiologists classifications ASA 1 and ASA2) 4) non-smoking 5) not pregnant.

Oral-hygiene was assessed pre and post surgically. Implant crowns were removed, sulcular incisions were made, and exposure of the contaminated implants were completed. Granulation tissue was removed and a Er,Cr:YSGG laser was used to debride all implant surfaces. Following laser treatment, surrounding bone was decorticated, and the treated exposed implant surfaces were grafted freeze-dried bone allograft (FDBA) hydrated with recombinant human platelet-derived growth factor-BB (GEM21S, Lynch Biologics). Grafted sites were contained with a collagen barrier membrane (OSSIX Plus, Datum Dental). The flaps were approximated with primary, tension-free closure using resorbable and non-resorbable sutures. Post-operative instructions were given, including the use of a chlorohexidine mouth rinse bid for 4 weeks, 500mg amoxicillin q8 tid for 7 days, and ibuprofen 600mg q6 prn pain. Follow-up visits administered at 1, 2, 4, 8, and 12 weeks + every 4 weeks until biopsy.

En bloc biopsies were performed and biopsy sites reconstructed with regenerative procedures for future placement of implants and further prosthetic reconstruction. The en bloc biopsies were fixed, prepared, dehydrated, and later infiltrated with a graded series of alcohols and resin. The blocks were then polymerized and sliced longitudinally bucco-lingually and mesiodistally.

Sections were stained and analyzed under bright-field and polarized light microscopy.

RESULTS

Case I) Implant from mandibular left first molar site with circumferential bone loss at 6 months→ Radiographic and clinical bone gain was observed

Case II) Maxillary left second premolar site with buccal bone loss at 6 months→ Radiographic and clinical bone gain was observed

Case III) Mandibular left second premolar and a first molar site with bone loss extending to middle third of implant surface→ clinical and radiographic bone gain more notable for premolar implant biopsy while the molar implant had little to no bone gain (molar implant experienced pre-mature implant exposure prior to 6 month re-entry for biopsy).

OVERALL SUMMARY

One of the main difficulties encountered with treating peri-implantitis is fully decontaminating the titanium implant surface. Both the first and second cases discussed presented with loss of bone-to-implant contact (BIC) with subsequent gain of BIC following degranulation, decontamination using Er,Cr:YSGG laser treatment, osseous grafting, containment with a collagen membrane, and primary + tension-free closure of the surgical site. Case III presented with unfavorable soft-tissue conditions which may have contributed to premature exposure of the implant surface at the molar site, however, during post-operative examination, neither bleeding on probing nor suppuration were noted.

CLINICAL SIGNIFICANCE AND IMPACT

Despite the small sample size of this study, the Er,CR:YSGG laser is a viable instrument in the dental armamentarium when treating peri-implantitis. In treating patients with failing implants, our goal is to arrest the disease process of bone loss around dental implants and further promote regeneration of BIC. Threaded implants with a treated/rough surface present a challenge to contaminate with alternative methods. Using the clinical protocols outlined in this study, strict patient adherence to oral hygiene instruction, and regular follow-up visits, the Er,CR:YSGG laser may render promising results in the treatment of peri-implantitis. ■

A NOVEL APPROACH TO VENEER REMOVAL

A Clinical Case Report Using Er,Cr:YSGG Laser

By Dr. Amir Azzat

Oral Health Journal, 2018 Special Edition

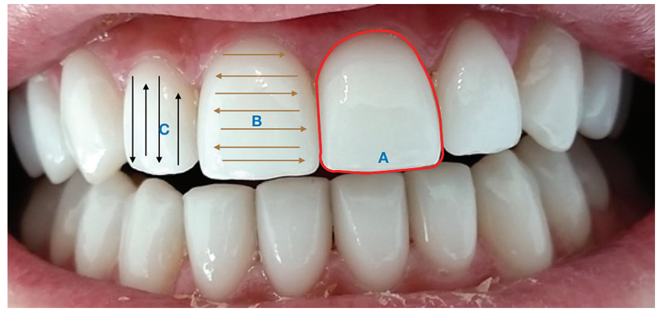
INTRODUCTION

In the last decade, as a result of patients' desires to get the HOLLYWOOD SMILE, full-ceramic restorations have become more popular due to their superior aesthetic appearance and are frequently used in the restorative and prosthetic fields. The development of new materials and improvements in manufacturing technologies have led clinicians to utilize ceramic restorations in more and more cases. Ceramic crowns and veneers aid clinicians in achieving patient satisfaction, because of their excellent optical characteristics and biocompatibility. However, these kinds of restorations are usually adhesively cemented, which makes their removal for the purposes of remake, a challenging and time-consuming process.[1]

Generally, the removal process is performed by cutting or grinding off the restoration using rotary burrs instead of using potentially painful and damaging mechanical crown-bridge removers. The risk of harming the underlying tooth structure due to the lack of color contrast between tooth, adhesive resin interface and the restoration, makes the remake of ceramic restorations a delicate and time-consuming process. In cases of replacement due to fractures, secondary caries, or gingival recession, the integrity of the veneer following its removal is not important. However, when the removal of the ceramic restoration is required shortly after its insertion because of misalignment during cementation, poor color selection of the luting cement or unexpected inflammatorypulpal responses, keeping the integrity of the restoration becomes critical. Avoiding the cost involved and the time required for re-manufacturing of the crown or veneer is beneficial for both the clinician and the patient. With the conventional removal techniques, it is almost impossible to remove the adhesively luted ceramic restoration in one piece.

To overcome these conventional limitations, the use of laser technology was recently introduced as a more comfortable and conservative technique for veneer removal.[1] Laser debonding technique was first described for the removal of ceramic orthodontic brackets, and has been experimentally

FIG 1



A You go with the laser tip on all the margins of the veneer
B You go on the veneer from the buccal surface horizontally
C You go on the veneer from the buccal surface vertically

FIG 2

used since early 1990s.[2] Tocchio et al[3] reported that de-bonding of ceramic brackets happens because of the degradation of adhesive resin, and that laser energy degrades the resin by three different mechanisms: thermal softening, thermal ablation, and photo-ablation. Thermal softening occurs when the laser energy heats up the bracket and resin until the resin becomes soft enough to remove the bracket, but this relatively slow method can lead to a large increase in both bracket and tooth temperature. Thermal ablation is the rapid vaporization of adhesive resin caused by the laser energy that heats up the resin instantly. The last mechanism of photo-ablation occurs when very powerful laser energy interacts with the adhesive resin to raise the energy levels of the bonds between resin atoms above their dissociation levels, resulting in decomposition of the material.[3] The latter two are considered to be the more favorable mechanisms because they proceed so rapidly, the temperature of the resin and tooth and tooth surface remain within the physiologic range

Rechman P. et al[4] showed that transmission of Er:YAG Laser wavelength in Emax CAD was 60.4%±4.2% at 1 mm veneer thickness and 20.5% ± 1.8% at 2.5 mm thickness. Empress Esthetics ranged from 48.6% ±1.7% to 20.5% ±1.8%, and Emax ZirCAD showed a range from 9.9%±0.9% to 4.9%±0.6%.4 This study also showed that resin bonding cements, such as Variolink Veneer, Variolink II, Multilink and SpeedCem, have high content of H2O/OH-, which matches with Er:YAG and Er,Cr:YSGG peak absorption in H2O/OH-. The ablation threshold for these cements was tested and determined to be 126-700mJ/pulse depending on the thickness of the veneer and the type of cement.

CASE REPORT

A 34-year-old female patient presented to our clinic complaining of recently cemented veneers on the upper six anterior teeth done in another clinic. The patient's chief complaint was the misalignment of the two central veneers and the shape of the canines bilaterally because they were longer than the other veneers (**Fig. 1**). The patient was concerned with the time needed for the re-fabrication of the new restorations and the likelihood of fracturing the existing veneers while attempting to remove them, because she had an important social event. The process of veneer removal while preserving the restoration and the underlying tooth structure using the erbium laser technology was explained to the patient, informed consent was acquired. Provided everything went according to plan, the existing veneers would be re-cemented with improved alignment and better aesthetic result.

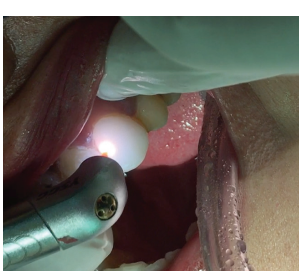


FIG 3

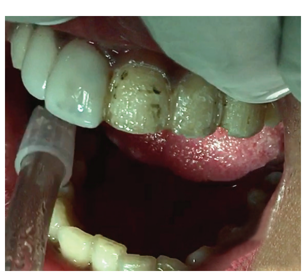


FIG 4

FIG 5

FIG 6

PROCEDURE

The removal of the existing veneers is to be performed using Er,Cr:YSGG laser without preliminary administration of local anesthesia. The injection is to be provided in case of sensitivity, if requested by the patient. Laser Parameters: 4.5 W average power, 30Hz, 150mJ/ pulse, 60µs pulse duration (H-mode), 80%W/60%A, MZ8 tip.

1. Remove each veneer separately by outlining the margins first in NON-CONTACT mode, followed by sweeping NON-CONTACT motion close to the veneer surface from cervical to incisal edge vertically and mesial to distal line angle horizontally (Fig. 2).
2. Keep repeating the procedure until the strokes under the veneer sound and feel differently (as if there is an air bubble or it is no longer a solid unit).
3. Push the veneer gently using an excavator, but do not use force to avoid breakage. Alternate between laser ablation and gentle pressure on the veneer until it is removed.
4. Repeat steps one to three for the remaining veneers (**Figs. 3-6**).
5. Removal of the remaining resin cement from the tooth surface using finishing tapered stone (infiltration anesthesia was administrated for this part).
6. Surface treatment of the inner surface of the veneer using silane application.
7. Re-cementation of veneers was done using Resin Cement (G-Cem from GC) Capsules.
8. New impressions for the canine veneers to be changed, then cementation of the temporary veneers, so the patient could attend her social event without any noticeable change in her appearance.
9. Next appointment: the removal of the temporary veneers using the same procedure with the Er,Cr:YSGG laser, followed by cementation of the new veneers.

DISCUSSION

The laser de-bonding procedure for all-ceramic restorationshas been shown to be easy and safe, in comparison to the conventional techniques. The ceramic materials and hard tissues were evaluated under light microscope after the de-bonding and it was concluded that the bond between the ceramic restoration and the tooth is disrupted mainly at the ceramic/cement interface, leaving the majority of the inner surface of ceramic veneer free of resin cement. Moreover, no ablation craters or even slight marks of ablation were found on the tooth surface. It was also reported that laser de-bonding does not change the chemical surface composition of dental ceramics.[4-8] The clinical protocol described in this case report confirms the findings described in the literature. During the de-bonding process of all ceramic restorations, erbium laser energy is transmitted through the ceramic and is absorbed in the resin cement. The mechanism of veneer removal using Erbium lasers is mainly based on thermal ablation and photo-ablation of the composite resin cement.[7] Theoretically, in photon-induced thermo-mechanical ablation process, the water in the media or within the material absorbs the energy, vaporizes and rapidly expands, causing subsurface pressure within the enclosed environment of the irradiated material.[9,10] This explains how the process of veneer removal in this case worked without affecting the underlying tooth structure.

CONCLUSION

We can safely conclude that Erbium laser energy is transmitted through the all-ceramic materials and the amount of transmitted energy depends on the ceramic thickness and the composition. The bonding cement absorbs the energy transmitted through the veneer resulting in the selective ablation of the cement and loosening of the restoration within seconds. This novel technique offers a significant advantage to the clinician in cases where preservation of the existing veneer is preferred. There is also a valuable savings of chair time necessary for the removal and remake of the old ceramic restorations. The use of old veneers as temporary restorations during the interim waiting period may be an interesting option to consider in the interest of saving clinician's chair time and additional expense for the patient. ■

REFERENCES:

1. Morford, C.K., Buu, N.C., Rechmann, B.M., Finzen, F.C., Sharma, A.B., and Rechmann, P. (2011). Er:YAG laser debonding of porcelain veneers. Lasers. Surg. Med. 43, 965– 974.
2. Azzeh, E., and Feldon, P.J. (2003). Laser debonding of ceramic brackets: a comprehensive review. Am. J. Orthod. Dentofacial. Orthop. 123, 79–83.
3. Tocchio, R.M., Williams, P.T., Mayer, F.J., and Standing K.G. (1993). Laser debonding of ceramic orthodontic brackets. Am. J. Orthod. Dentofacial. Orthop. 103, 155–162.
4. Rechmann P, Buu NC, Rechmann BM, Le CQ, Finzen FC, Featherstone JD.(2014) Laser all-ceramic crown removal-a laboratory proof-of-principle study-phase 1 material characteristics. Lasers Surg Med. 46(8):628-35.
5. Sari T, Tuncel I, Usumez A, Gutknecht N. Transmission of Er: YAG laser through different dental ceramics. Photomed Laser Surg 2014;32:37–41
6. Rechmann P, Buu NCH, Rechmann BMT, Finzen FC. Laser all-ceramic crown removal-a laboratory proof-of-principle study-Phase 2 crown debonding time. Lasers Surg Med 2014;46:636–643.
7. Morford CK, Buu NC, Rechmann BM, Finzen FC, Sharma AB, Rechmann P Er:. YAG laser debonding of porcelain veneers. Lasers Surg Med 2011;43:965–974.
8. Pich O, Franzen R, Gutknecht N, Wolfart S. Laser treatment of dental ceramic/cement layers: Transmitted energy, temperature effects and surface characterization. Lasers Med Sci 2015;30:591–597.
9. Mundethu AR, Gutknecht N, Franzen R. Rapid debonding of polycrystalline ceramic orthodontic brackets with an Er: YAG laser: An in vitro study. Lasers Med Sci 2014;29: 1551–1556.
10. Apel C, Franzen R, Meister J, Sarrafzadegan H, Thelen S, Gutknecht N. Influence of the pulse duration of an Er:YAG laser system on the ablation

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A CLINICAL LOOK

Reducing Aerosols — The Role of YSGG Lasers in the Prevention of the Spread of Airborne Disease

Aerosols Generation using Er,Cr:YSGG Laser Compared to Rotary Instruments in Conservative Dentistry: A Preliminary Study

Haitham Abdelkarim-Elafifi, Cristina Arnabat-Artés, Isabel Parada-Avendaño, Marina Polonsky, Josep Arnabat-Domínguez

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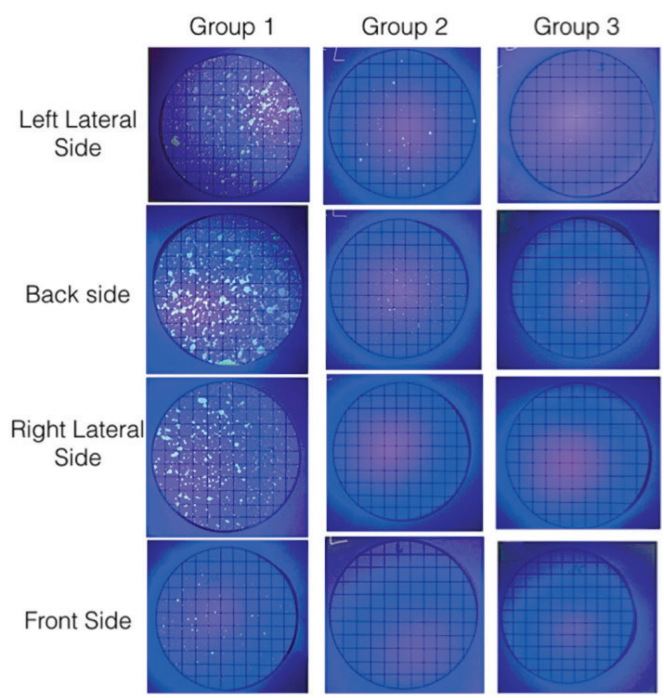
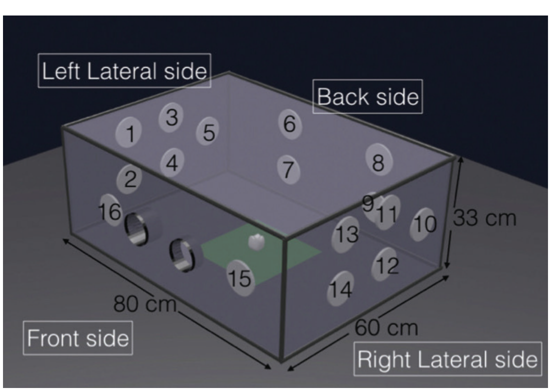
BACKGROUND

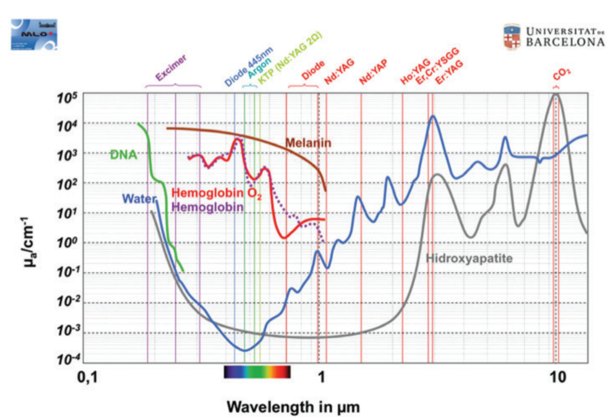
In restorative dentistry, the use of high-speed air turbine, which generates aerosols, can be associated with the transmission of airborne diseases. New laser technologies could be useful in reducing the amount of aerosols, but there is a lack of scientific research on this topic.

MATERIAL AND METHODS

This is a descriptive study to analyze the amount of aerosols produced after class I cavity preparation using high-speed air turbine (group 1) and Er,Cr:YSGG laser with two different parameters (groups 2 and 3). Fluorescein dye was incorporated into the coolant reservoir in order to visualize the production of aerosols during each procedure. Tooth preparation was performed in a typodont with human lower molar tooth under rubber dam isolation. The procedure was carried out in a transparent plastic box to avoid aerosols dispersion. Sixteen grade I cellulose filter discs were distributed along the surfaces of the box. The area contaminated with aerosols in the filters was measured using ultraviolet illumination.







	LASER GROUP 2	LASER GROUP 3
TIP	MGG6 (600 µm sapphire)	MGG6 (600 µm sapphire)
POWER	3,75 W	2,75 W
REPETITION RATE	15 Hz	50 Hz
MODE	H	H
WATER %	80	40
AIR %	60	60
ENERGY PER PULSE	250 mJ	55 mJ

RESULTS

In group 1, the contaminated surface area covered with fluorescein dye reached 77.3% (1349 cm^2) of the total; in group 2 (laser with 80% water) we observed 7.3% (128 cm^2) and in group 3 (laser with 40% water) it was 3.8% (68 cm^2). The reduction in water parameter from 80% to 40% coincided with 48% reduction of the contaminated area on the filter discs. Focusing on the surfaces of the box, we noted that the mean contamination on the left side was more than on the right side in all three experimental groups. In group 1 using air turbine, we measured a mean of 102.6[±7.5 SD]cm^2 on the left side, compared to 70.6[±32.3 SD]cm^2 on the right side. In laser groups 2 and 3, a mean of 12.8[±14.9 SD]cm^2 and 6.8 [±5.7SD]cm^2, respectively, was described on the left surface versus 0 cm^2 of surface contamination on the right surface.

FILTERS	GROUP 1 (HIGH-SPEED TURBINE)	GROUP 2 (LASER 80% WATER)	GROUP 3 (LASER 40% WATER)
1	89	0	0
2	100	22	4
3	109	1	12
4	109	38	15
5	106	3	3
6	97	7	9
7	109	52	22
8	88	1	2
9	108	2	1
10	86	0	0
11	90	0	0
12	108	0	0
13	17	0	0
14	52	0	0
15	16	0	0
16	65	2	0

CONCLUSIONS

The contaminated area during the procedure of class I cavity preparation, is reduced by 70% using Er,Cr:YSGG laser compared to high-speed turbine. A slightly higher contamination was observed between laser groups with 80% versus 40% water. The use of Er,Cr:YSGG laser in restorative dentistry can be a valid treatment alternative to reduce aerosols production compared to conventional high-speed rotary instruments. Key words:Er,Cr:YSGG laser, Aerosols, SARS-CoV-2, Rotary instruments, conservative dentistry. ■

DISCLOSURES

The devices employed in this study (Waterlase Express Er,Cr:YSGG laser, High-speed air turbine, transparent plastic box) were kindly provided by Clínica Dental Arnabat-Artes (Barcelona Spain). Outside the submitted work, the authors would like to disclose the following relations: Dr. Haitham Abdelkarim-Elafifi reports no conflicts of interest. Dr. Cristina Arnabat-Artés reports no conflicts of interest. Dr. Isabel Parada-Avendaño, reports no conflicts of interest. Dr. Marina Polonsky reports no conflicts of interest. Dr. Josep Arnabat-Dominguez reports no conflicts of interest.

A CLINICAL LOOK

A Comparison of Laser Settings

An In-vitro Analysis for Using an Er,Cr:YSGG Laser for Class II Cavity Preparation while Modulating Multiple Parameters

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International Journal of Dentistry and Oral Medicine 2021, 1, 1-8.

ABSTRACT

The purpose of this study was to test various laser parameters while creating Class II cavity preparations and comparing treatment time and intrapulpal temperature to highspeed rotary hand piece. Class II cavity preparations were made in 70 extracted maxillary human premolars. Ten preparations were created using a high-speed hand piece and diamond bur, with copious water spray. Each preparation included a proximal box which was 3 mm mesiodistally by 4 mm buccolingually, and 4 mm deep. Six Laser Groups of ten teeth each were completed with an Er,Cr:YSGG laser to a size equal to the control.

Treatment time and intrapulpal temperature were recorded and compared. Teeth in the Control Group took an average of 33.4 seconds ± 3.0 seconds to complete. Pulpal temperature in the Control was raised in ten out of ten samples, an average of 3.00°C ± 2.49°C, with the highest rise (outlier) being 9.6°C above baseline. Laser test groups demonstrated an average increase of 0.37°C ± 0.36°C. Additionally, the average preparation time of 36.7 ± 3.3 seconds was 3.3 seconds longer and just under 10% slower than the Control. This study presented three sets of laser parameters using an Er,Cr:YSGG laser to prepare Class II cavities. Based on the results of this study, maintaining the energy per pulse and increasing the number of pulses per second is the most favorable adjustment, as treatment time is reduced, while maintaining a modest increase in pulpal temperature. Results improve further as the volume of water in the spray increases up to a setting of 100%.

INTRODUCTION

Since the development of erbium dental lasers, clinicians and researchers have pursued methods to improve the efficiency, comfort, and speed of laser cavity preparation to be comparable to high-speed rotary hand piece. To this end, device improvements have included increased peak power, innovative terminal fiber design and the development of non-traditional lenses, tips and waveguides. With these improvements in mind, laser cavity preparation has become a viable treatment option. The next logical steps should involve maximizing function andconfirming safe use. The purpose of this research was to compare various laser parameters to a high-speed rotary hand piece with a diamond bur while preparing Class II cavity preparations in human maxillary premolars. All adjustments were completed while monitoring intrapulpal temperature so asnot to exceed a net rise of more than 5.5°C as described by Zach and Cohen.[1]

Erbium lasers ablate tooth enamel using a combination of photothermal, photomechanical and photo-acoustic phenomena.[2] Dental enamel is comprised by as much as 96% of hydroxyapatite, a crystalline form of calcium phosphate. Water and organic material make up the remainder.[3] Erbium lasers have the ability to ablate enamel because of the high absorption coefficient by both water and to a lesser degree, hydroxyapatite. When an erbium laser irradiates enamel, the energy is absorbed initially by the water molecules suspended within the enamel matrix. As water absorbs laser energy the temperature rapidly increases, causing a sudden significant increase in volume. This expansion by micro-explosions causes enamel cracking. Tooth ablation is complete when the photo acoustic and photomechanical effects from the erbium laser cause the weakened portions of enamel to be expelled from the tooth surface, leaving in its place an ablation crater.[2,4-6] Most of the irradiated energy is consumed during the ablation process, leaving only small amounts of energy in the tooth structure, therefore minimizing thermal effects.[7]

The benefits of using a strong aerosolized water spray during tooth ablation has been established; the rationale being that the water spray keeps target tissues cooler and subsequently, the patient more comfortable. However, it has also been shown that water plays a significant role in the ablation of tooth structure, in fact, initiating the ablative process.[8] Without water spray the heat generated by erbium lasers may cause melting, cracking and other thermal effects.[9] The addition of an aerosolized water spray, along with ultra short, microsecond pulses minimizes increase in pulpal temperature during cavity preparation.[10,11]

The presence of additional water could theoretically slow tooth ablation because of the higher absorption coefficient, since water absorbs much of the laser energy, interfering with target tissue ablation. Then again, some studies suggest that parameters which is included in this study.[12-15] The null hypothesis is that there will be no difference in the results observed when comparing data such as treatment time and intrapulpal temperature rise while preparing Class II cavity preparations using either high-speed handpiece or erbium laser.

MATERIAL AND METHODS

70 extracted human maxillary premolars were obtained from a tissue bank and used for this study. Each tooth was prepared by amputating the root(s), leaving 5 mm of root intact from the cement enamel junction. A 0.060 inch (1.524 mm) diameter cylindrical post prep bur (Para Post X, Size 6, Coltene/Whale dent, Cuyuhoga Falls, OH, USA) was then used with a low-speed rotary hand piece to enlarge a single root canal into the pulp chamber of every tooth, allowing adequate space for the thermocouple probe to passively extend to the roof of the pulp chamber. All specimens were stored in distilled water containing 0.4% thymol until ready for use.

Each pulp chamber was filled with a conductive silicone paste (Omega herm 201, Omega Engineering, Inc., Stamford, Connecticut, USA). A 1.5 mm diameter Type-J sheathed and grounded thermocouple (IC-SS-116-G-6, Omega Engineering Inc, Stamford, Connecticut, USA) was placed into each tooth and sealed with clear rope wax. A latex dental dam was then placed around the tooth to prevent water spray from reaching the tooth root or thermocouple probe directly. An additional latex dental dam was used to cover and protect the base of the probe, once again, to prevent temperature alterations. All study components were held steady using a series of lab clamps on a ring stand. A curing light (DemiUltra, Kerr Co., Orange, California, USA) was used to confirm the accuracy and sensitivity of the thermocouple setup. The curing light test was confirmed, as temperature increased 2°C after 30 seconds of light activation at an irradiance of 1135 mW/cm^2.

The first ten Class II cavity preparations were created using a new diamond bur for every specimen (331D FG Pear Diamond, Peter Brasseler Holdings, LLC, Savannah, GA USA) in a high-speed rotary hand piece using copious water spray, by a single operator (KLO). Each preparation included a proximal box which was 3 mm mesiodistally x 4 mm buccolingually, with a depth at least into dentin (4 mm deep). A 5 mm occlusal extension was also prepared with the overall cavity dimensions made slightly larger, but based upon traditional amalgam preparation principles for standardization. 16 After establishing the control using the high-speed rotary hand piece, six Laser Groups were completed by creating ten Class II cavity preparations in each group (total n = 70) by another experienced operator (CW). All laser preparations were completed to a size equal to the control. The same thermocouple setup was utilized and data was collected for temperature changes and total time for each laser cavity preparation.

An Er,Cr:YSGG dental laser (Waterlase iPlus, BIOLASE, Inc., Foothill Ranch, CA, USA) was fitted with a hand piece and MZ-6 laser fiber (600µm diameter cylindrical fiber, 6 mm in length). The same operator prepared a Class II cavity preparation into ten premolars. The parameters for Group 2 were 250 mJ/pulse, 15 Hz, 50% water, 100% air, 140 msec pulse, 3.75 Watts. Although air and water ranges are normally closer in value, it was decided that values of 50% and 100% would be utilized for air and water spray in order to more clearly demonstrate changes in temperature. Additionally, Olivi et al. have suggested that more water flow will clear the ablation zone of debris and provide a more uniform prismatic tooth structure.[17] This result was observed following cavity preparation.

Five additional Groups were completed with ten Class II cavity preparations in each group. The same setup was utilized and the same data was collected for temperature fluctuation and total time for each cavity preparation. Before initiating each preparation, the thermocouple was inserted into the pulp chamber and thermal data was collected for 30 seconds, to establish a baseline. A single operator (LL) kept time from the start of each preparation until the end, and a second operator (JR) managed the thermocouple setup and data collection. Group 3 was similar to Group 2 with the

Table 1

GROUP	1 = CONTROL	2	3	4	5	6	7
AVG PREP TIME (sec)	33.4	52.2	59.2	36.7	38	37.8	44
HIGHEST TEMP (°C)	2.959	0.02	0.059	0.4535	0.322	1.009	0.381
LOWEST TEMP (°C)	N/A	-1.114	-1.592	-0.563	-0.825	-0.549	-0.883

1. Control: High speed handpiece
2. 250mJ/pulse, 15Hz, 50% Water, 100% Air
3. 250mJ/pulse, 15Hz, 100% Water, 50%Air
4. 250mJ/pulse, 25Hz, 50% Water, 100% Air
5. 250mJ/pulse, 25Hz, 100% Water, 50% Air

exception of the ratio of air and water: 250 mJ/pulse, 15 Hz, 100% water, 50% air, 140 msec pulse, 3.75 Watts. The main difference in Group 4 was the increase in the pulses per second: 250 mJ/pulse, 25 Hz, 50% water, 100% air, 140 msec pulse, 6.25 Watts. Similar to the difference between Groups 2 and 3, the parameters in Group 5 were identical to Group 4 except for the air and water: were 250 mJ/pulse, 25 Hz, 100% water, 50% air, 140 msec pulse, 6.25 Watts. Groups 6 and 7 increased the energy per pulse as comparison, to demonstrate the differences caused by changing this parameter. Group 6: 400 mJ/pulse, 15 Hz, 50% water, 100% air, 140 msec pulse, 6.00 Watts. Group 7: 400 mJ/pulse, 15 Hz, 100% water, 50% air, 140 msec pulse, 6.00 Watts. The energy/pulse and repetition rate in Groups 6 and 7 are the most common as reported by the laser manufacturer.

RESULTS

In Group 1 (Control), ten samples were prepared using a high-speed rotary handpiece with new diamond burs, with copious water spray. Preparations in this group took an average of 33.4 seconds ± 3.0 seconds to complete. Intrapulpal temperature in this Group was raised in ten out of ten samples, an average of 3.00°C ± 2.49°C, the highest temperature rise (outlier) being 9.6°C; significantly above the target of 5.5°C. All test samples in Groups 2 through 7 were prepared with water spray.

Laser parameters for Group 2 were 250 mJ/pulse and 15 Hz (3.75 W), at 50% water and 100% air. With slight adjustments to the air and water settings, these laser parameters are identical to the presets on the laser device. At these settings, a Class II cavity preparation made in human premolar teeth took an average of 52.2 ± 2.8 seconds to prepare ($p<0.0001$), and resulted in a decrease in intrapulpal temperature of -1.11°C ± 0.93°C. When all parameters remained constant except for the percentage of air (100% down to 50%) and water (50% up to 100%) in the water spray (Group 2), preparation time increased to 59.2 ± 4.5 seconds ($p<0.0001$), however, the intrapulpal temperature decreased further, to -1.59°C ± 0.77°C. In Group 4, the energy per pulse was kept constant at 250 mJ/pulse, but the number of pulses per second increased from 15 Hz to 25 Hz (6.25 W). As might be expected, this resulted in an overall increase in intrapulpal temperature at 50% water and 100% air. It should be noted that this increase in temperature could be offset by increasing the amount of water in the spray from 50% to 100% (Group 5). At a maximum increase of 0.45°C ± 0.61°C ($p<0.0001$), these parameters could be deemed safe to the pulp, and the average preparation time of 36.7 ± 3.3 seconds (Not Significant), creating a maximum increase in temperature of and maximum decrease of -0.56°C ± 0.34°C. Group 5, prepared with more water, took slightly longer at 38.0 ± 3.1 seconds (Not Significant) was 3.3 seconds longer and just under 10% slower than the Control.

As comparison, the last two groups used higher pulse energy, consistent with more commonly used laser settings. In Group 6, the laser was set at 400 mJ/pulse at 15 Hz (6.0 W) at 50% water and 100% air. The highest temperature rise at these settings was 1.01°C ± 1.33°C ($p=0.001$). When the water spray was increased from 50% to 100% and air was decreased to 50% (Group 7), intrapulpal temperature increased a more manageable 0.38°C ± 0.45°C ($p<0.0001$). Total cavity preparation time was 44.0 ± 4.0 seconds.

DISCUSSION

As the dental laser industry moves forward, several areas of dentistry have been positively affected. Soft tissue surgery, endodontics, periodontics and oral implantology have all seen consistent developments with adjunctive laser therapies. An area of dentistry which has not seen as rapid an acceptance is in basic cavity preparation using lasers. Although studies exist regarding laser cavity preparation, the number of scientific papers presenting safe and effective ablation parameters is relatively limited in comparison. The primary reasons for the increased use of erbium laser cavity preparation are the growing base of studies demonstrating the comfort (less noise and vibration) and effectiveness, along with requiring potentially less local anesthetic, and decreasing damage to the dental pulp.[18-26] In fact, Hadley et al and others have found no significant difference between high-speed rotary hand piece and erbium laser for both cavity preparation and caries removal.[27-30] Every trial in the high-speed hand piece Control Group demonstrated a sudden, rapid increase in pulpa temperature during preparation. In addition, in none of the Control Group trials did the pulpal temperature drop below the baseline marked at the beginning of each trial. Conversely, in every trial in the erbium laser preparation groups, there was a point when the pulpal temperature dropped below the baseline. In some of the laser trials where the irradiance was higher, the pulpal temperature did rise, however, this increase in pulpal temperature in all six laser groups was significantly less than the Control. (Groups 2, 3, 4, 5, 7 $p<0.0001$, and Group 6 $p<0.001$).

It may be interesting to note that previous studies of dental hard tissue preparation using erbium lasers have resulted in two distinct outcomes. While most researchers have reported open dentinal tubules and an absence of smear layer, resulting in an increase in bond strength, others have found a fusion of collagen fibers, which resulted in a reduction in interfibrillar spaces and lower bond strength.[31-36] Indeed, common ground has not yet been achieved. An increase in dentinal permeability and elimination of smear layer and smear plugs is generally considered positive in light of the finding that as much as 86% of dentinal permeability resistance is caused by smear debris due to its low surface energy.[37-41] Maintaining a constant energy per pulse at 250 mJ/pulse, but increasing the number of pulses per second from 15 Hz to 25 Hz (Group 4), resulted in an overall increase in intrapulpal temperature at 50% water and 100% air. This thermal increase could be offset by increasing the amount of water in the spray to 100% as noted in Group 4. At a maximum increase of 0.45°C ± 0.61°C, none of these parameters was found to be detrimental to the pulpal vitality, and the average preparation time of 36.7 ± 3.3 seconds took just 3.3 seconds longer than the hand piece control preparation.

Despite the potential for a cleaner and more porous cavity preparation surface, consensus would indicate that etching with phosphoric acid continues to be necessary following either rotary hand piece or laser preparation, and results in a measurable increase in tensile strength.[40,42] Cavities prepared with an erbium laser have been shown to have higher micro hardness values than those prepared with high-speed handpiece.[43-45] It is thought that the measurable improvements are related more to morphologic changes than surface topography. The resultant change in calcium/phosphorus ratio results in caries resistance.[46,47] The purpose of this paper was to compare three of the most common settings for dentin and enamel ablation using an Er,Cr:YSGG laser, while simultaneously demonstrating the profound effect of modulating the volume of water in the aerosolized spray. While some studies have reported significantly longer preparation times during laser irradiation as compared to high-speed rotary hand piece,[48] the current study suggests that erbium laser cavity preparations of the same size, shape and depth can be completed in 44.6 seconds across all samples compared to 33.4 ± 3.0 seconds with a high-speed rotary hand piece. These results are consistent with research completed by Den Beston et al.[49] There also seems to be an advantage to using an erbium laser with respect to pulpal health. While the average of all laser test groups increased pulpal temperature by 0.74°C ± 1.0°C, the high-speed rotary hand piece group increased pulpal temperature by 3.00°C ± 2.49°C. In addition, all laser test groups produced a decrease in pulpal temperature at some point during cavity preparation benefit, improving the thermal safety of cavity preparation.

CONCLUSION

One of the topics most often debated regarding hard tissue laser ablation is whether the energy per pulse or the number of pulses per second is more important in regards to the speed, efficiency and safety. The average power may be determined by multiplying these two variables (mJ/pulse x pulses/second). The same average power may be achieved with a higher energy per pulse and fewer pulses per second, or by reducing the energy per pulse and increasing the number of pulses per second proportionately. This study presented three sets of laser parameters using an Er,Cr:YSGG laser while cutting Class II cavity preparations, modulating the energy per pulse, the number of pulses per second and the amount of water in the spray. Based on the results of this study, it would appear that maintaining the energy per pulse and increasing the number of pulses per second is most favorable, as preparation speed improves significantly while maintaining a modest increase in pulpal temperature. Results improve further as the volume of water in the spray increases up to 100%.

Within the limitations of this study (in vitro, single laser wavelength, settings tested and only maxillary premolars), it can be concluded that using an Er,Cr:YSGG dental laser is a thermally safe and time efficient method to prepare cavity preparations in human premolars. At the highest pulse energy tested (400 mJ), preparation time averaged 37.8 ± 4.2 seconds, and caused a maximum increase in intrapulpal temperature of 1.01°C ± 1.33°C. The null hypothesis has been disproved, as lower pulse energies resulted in slightly longer preparation times, and as much as - 1.6°C ± 0.8°C decrease in pulpal temperature. Increasing the water spray resulted in decreasing pulpal temperature by 50% across all samples, while increasing preparation time by approximately 11%. Increasing water spray significantly during cavity preparation is a practice that should be employed often. It is reasonable to expect that in-vitro thermal increases would be minimized in-vivo because the presence of pulp tissue would likely buffer any thermal changes. ■

DISCLOSURES

Dr. Christopher J. Walinski is a consultant for BIOLASE, Inc., the manufacturer of the laser device used in this study. No compensation or support of any kind was received from the manufacturer.

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REFERENCES

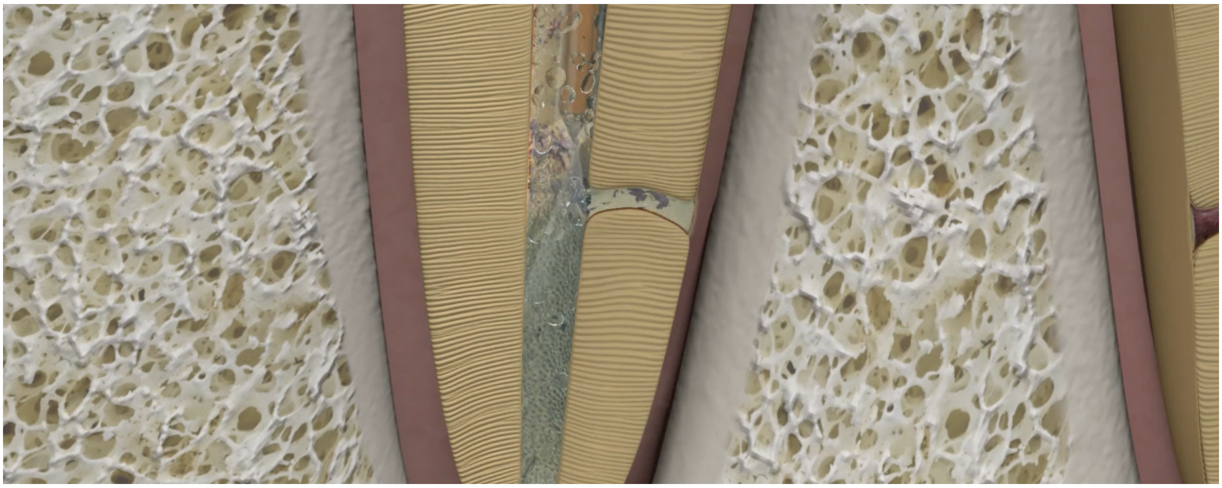
1. Zach L.; Cohen G. Pulp response to externally applied heat. Oral Surg Oral med Oral Pathol. 1965, 19, 515-530.
2. Fried D.; Zuerlein MJ.; Featherstone DB.; Seka W.; Duhn C.; McCormack SM. IR laser ablation of dental enamel: Mechanistic dependence on the primary absorber. Appl Surf Sci. 1998, 127-129, 852-6.
3. Nanci A.; & Ten C. A. R.; Ten Cate's oral histology: Development, structure, and function. St. Louis, Mo: Mosby. 2003, 70-94.
4. Ceballos L.; Osorio P.; Toledano M.; Marshall GW. Microleakage of composite restorations after acid of Er:YAG laser cavity treatments. Dent Mater. 2001, 17, 340-346.
5. Tocchio RM.; Williams PT.; Mayer F J.; Standing KG. Laser debonding of ceramic orthodontic brackets. Am J Orthod Dentofacial Orthop. 1993, 103, 155-162.
6. Li ZZ.; Code JE.; Van de Merwe WP. Er:YAG laser ablation of enamel and dentin of human teeth: determination of ablation rates at various fluences and pulse repetition rates. Lasers Surg Med. 1992, 12, 625- 630.
7. Raucci-Neto W.; dos Santos CR.; de Lima F A.; Pecora JD.; Bachmann L.; Palma-Dibb RG. Thermal effects and morphological aspects of varying Er:YAG laser energy ondemineralized dentin removal: an in vitro study. Lasers Med Sci. 2015, 30(4), 1231-1236.
8. Hossain M.; Nakamura Y.; Yamada Y.; Kimura Y.; Matsumoto N.; Matsumoto K. Effects of Er,Cr:YSGG laser irradiation in human enamel and dentin: ablation and morphological studies. J Clin Laser Med Surg. 1999, 17(4), 155-159.
9. Keller U.; Hibst R. Er:YAG laser effects on soft and hard dental tissues. In: Miserandino LJ, Pick RM (eds). Lasers in dentistry. Quintessence, 161-172.
10. Firoozmand L.; Faria R.; Araujo MA.; di Nicolo R.; Huthala MF. Temperature rise in cavities prepared by high and low torque handpieces and Er:YAG laser. Br Dent J. 2008, 205(1), 1, 28-29.
11. Shigetani Y.; Suzuki H.; Ohshima H.; Yoshiba K.; Yoshiba N.; Okiji T. Odontoblast response to cavity preparation with Er:YAG laser in rat molars: an immunohistochemical study. Odontology. 2013, 101(2), 186-192.
12. Fried D.; Ragadio J.; Champion A. Residual heat deposition in dental enamel during IR laser ablation at 2.79, 2.94, 9.6 and 10.6 um. Lasers Surg Med. 2001, 29, 221-219.
13. Kim ME.; Jeoung D J.; Kim KS. Effects of water flow on dental hard tissue ablation using Er:YAG laser. J Clin Laser Med Surg. 2003, 31, 139-144.
14. Colucci V.; do Amaral FL.; Pecora J D.; Palma-Dibb RG.; Corona AS. Water flow on erbium:yttriumaluminum-garnet laser irradiation: effects on dental tissues. Lasers Med Sci. 2009, 24, 811-818.
15. Colucci V.; do Amaral FL.; Palma-Dibb RG.; Pecora JD.; Corona AS. Effects of water flow on ablation rate and morphological changes in human enamel and dentin after Er:YAG laser irradiation. Am J Dent. 2012, 25, 332-336.
16. Black GV, Manual of Operative Dentistry, 1896.
17. Olivi G.; Angiero F.; Benedicenti S.; Iaria G.; Signore A.; Kaitsas V. Use of the erbium, chromium:yttriumscandium- gallium-garnet laser on human enamel tissues. Influence of the air-water spray on the laser-tissue interaction: scanning electron microscope evaluations. Lasers Med Sci. 2010 25(6), 793-797.
18. Hossain M.; Nakamura Y.; Yamada Y.; Kimura Y.; Nakamura G.; Matsumoto K. Ablation depths and morphological changes in human enamel and dentin after Er:YAG laser irradiation with the without water mist. J Clin Laser Med Surg. 1999, 17, 105-109.
19. Trajtenberg CP.; Pereira P N R.; Powers JM. Resin bond strength and micromorphology of human teeth prepared with an erbium:YAG laser. Am J Dent. 2004, 17, 331-336.
20. Aranha ACC.; Turbino ML.; Powel GL. Assessing microleakage of class V resin composite restorations after Er:YAG and bur preparation. Lasers Surg Med. 2005, 37, 172-177.
21. Hibst R.; Keller U. Experimental studies of the application of the Er:YAG laser on dental hard substances: I. Measurement of the ablation rate. Lasers Surg Med. 1989, 9, 338-344.
22. Burkes EJ Jr.; Hoke J.; Gomes E.; Wolbarsht M. Wet versus dry enamel ablation by Er:YAG laser. J Prosthet Dent. 1992, 67, 847-851.
23. Keller U.; Hibst R.; Geurtsen W.; Schilke R.; Heidemann D.; Klaiber B. Er:YAG laser application in caries therapy. Evaluation of patient perception and acceptance. J Dent 1998, 26, 649-656.
24. Pelagalli J.; Gimbel C.; Hansen R.; Sweett A.; Winn D. Investigation study of the use of Er:YAG laser versus dental drill for caries removal and cavity preparation – phase I. J Clin Laser Med Surg. 1997, 15, 109-115.
25. Burkes EJ.; Hoke J.; Gomes E.; Wolbarsht M. Wet versusdry enamel ablation by Er:YAG laser. J Prosthet Dent. 1992, 67, 847-851.
26. Dommisch H.; Peus K.; Kneist S.; Krause F.; Braun A.; Hedderich J.; Jepsen S.; Eberhard J. Fluorescencecon-trolled Er:YAG laser for caries removal in permanent teeth: a randomized clinical trial. Eur J Oral Sci. 2008, 116(2), 170-176.
27. Hadley J.; Young DA.; Eversole L R.; Gornbein JA. A laser-powered hydrokinetic system for caries removal and cavity preparation. J Am Dent Assoc. 2000, 131, 777-785.
28. Moosavi H.; Ghorbanzadeh S.; Ahrari F. Structural and morphological changes in human dentin after ablative and subablative Er:YAG laser irradiation. J Lasers Med Sci. 2016, 7(2), 86-91.
29. Muhammed G.; Dayem R. Evaluation of the microleakage of different class V cavities prepared by using Er:YAG laser, ultrasonic device, and conventional rotary instruments with two dentin bonding systems (an in vitro study). Lasers Med Sci. 2015, 30(3), 969-75.
30. Navarro RS.; Gouw-Soares S.; Cassoni A.; Haypek P.; Zezell DM.; Eduardo CdP, The influence of erbium:yttrium-aluminum-garnet laser ablation with variable pulse width on morphology and microleakage of composite restorations. Lasers Med Sci. 2010, 25(6), 881- 889.
31. Matsumoto K.; Hossain M.; Hossain MM.; Kawano H.; Kimura Y. Clinical assessment of Er,Cr:YSGG laser application for cavity preparation. J Clin Laser Med Surg. 2002, 20, 17-21.
32. Harashima T.; Kinoshita J.; Kimura Y.; Brugnera A.; Zanin F.; Pecora JD.; Matsumoto K. Morphological comparative study on ablation of dental hard tissues at cavity preparation by Er:YAG and Er,Cr:YSGG lasers. Photomed Laser Surg. 2005, 23, 52-55.
33. Bertrand M F.; Semez G.; Leforestier E.; Muller-Bolla M.; Nammour S.; Rocca JP. Er:YAG laser cavity preparation and composite resin bonding with a singlecomponent adhesive system: relationship between shear bond strength and microleakage. Lasers Surg Med. 2006, 28, 615-623.
34. Dunn WJ.; Davis JT.; Bush AC. Shear bond strength and SEM evaluation of composite bonded to Er:YAG laserprepared dentin and enamel. Dent Mater. 2005, 21, 616- 24.
35. Ceballo L.; Toledano M.; Osorio R.; Tay FR.; Marshall GW. Bonding to Er:YAG laser-treated dentin. J Dent Res. 2002, 81, 119-122.
36. Delfino CS.; Souza-Zaroni W C.; Corona SAM.; Palma- Dibb RG. Microtensile bond strength of composite resin to human enamel prepared using erbium: yttrium aluminum garnet laser. J Biomed Mater Res A. 2007, 80(2), 475-479.
37. Tao L.; Pashley DL.; Boyd L. Effect of different types of smear layers on dentin and enamel bond shear strengths. Dent Mater. 1988, 4, 208-216.
38. Oliveira SS.; Pugach MK.; Hilton JF.; Watanabe LG.; Marshall SJ.; Marshall GW Jr. The influence of the dentin smear layer on adhesion: a self-etching primer vs. a totaletch system. Dent Mater. 2003, 19, 758-767.
39. Convissar RA. The biologic rationale for the use of lasers in dentistry. Dent Clin North Am. 2004, 48, 771-794.
40. Shahabi S.; Chiniforush N.; Bahramian H.; Monzavi A.; Baghalian A.; Kharazifard MJ. The effect of erbium family laser on tensile bond strength of composite to dentin in comparison with conventional method. Lasers Med Sci. 2013, 28(1), 139-142.
41. Adu-Arko A Y.; Sidhu SK.; McCabe J F.; Pashley DH. Effect of an Er,Cr:YSGG laser on water perfusion in human dentine. Eur J Oral Sci. 2010, 118(5), 483-488.
42. DeMunck J.; Van Meerbeek B.; Yudhira R.; Lambrecths P.; Vanherle G. Micro-tensile bond strength of two adhesives to erbium:YAG lased vs. bur-cut enamel and dentin. Eur J Oral Sci. 2002, 110, 322-329.
43. Jorge ACT.; Cassoni A.; de Freitas PM.; Reis AF.; Junior AB.; Rodrigues JA. Influence of cavity preparation with Er,Cr:YSGG laser and restorative Materials on in situ secondary caries development. Photomed Laser Surg. 2015, 33(2), 98-103.
44. Colucci V.; de Souza-GabrielA E.; Scatolin RS.; Serra MC.; Corona SAM. Effect of Er:YAG laser on enamel demineralization around restorations. Lasers Med Sci. 2015, 30(4), 1175-1181.
45. Cecchini RCM.; Zezell DM.; de Oliveira E.; de Freitas PM.; Eduardo CdP. Effect of Er:YAG laser on enamel acid resistance: morphological and atomic spectrometry analysis. Lasers Surg Med. 2005, 37(5), 366-372.
46. Karaman E.; Yazici AR.; Baseren M.; Gorucu J. Comparison of acid versus laser etching on the clinical performance of a fissure sealant: 24-month results. Oper Dent. 2013, 38(2), 151-158.
47. Shahabi S.; Zendedel S. Atomic analysis and hardness measurement of the cavity prepared by laser. Lasers MedSci. 2010, 25(3), 379-383.
48. Jacobsen T.; Norlund A.; Englund GS.; Tranaeus S. Application of laser technology for removal of caries: A systematic review of controlled clinical trials. Acta Odontol Scand. 2011, 69(2), 65-74.
49. Den Besten PK.; White JM.; Pelino JEP.; Furnish G.; Silveira A.; Parkins FM. The safety and effectiveness of an Er:YAG laser for caries removal and cavity preparation in children. Med Laser Appl. 2001, 16, 215-222.

A REPORT OF TWO CLINICAL CASES

Managing Refractory Endodontic Disease With Radial Apical Cleansing

By Dr. Justin Kolnick

Oral Health Journal, 2018 Special Edition



INTRODUCTION

One of the defining attributes of an astute endodontist is the ability to successfully treat refractory endodontic disease. Refractory disease is defined as disease that is recalcitrant, unresponsive, stubborn, unmanageable or resistant to treatment or cure. While the pathogenesis of refractory endodontic disease is not clearly comprehended, it is highly likely that microbiological and host immune influences play an important role. Unsuccessful endodontic outcomes are often attributed to persistent infection perpetuated by entombed bacteria or by reinfection of a previously disinfected root canal system, commonly via coronal leakage or tooth fracture. Extra-radicular causes are less common and include periapical actinomycosis, cholesterol crystals, foreign body reactions, unresolved cystic lesions and extra-radicular biofilm and usually require surgical intervention or extraction of the tooth.

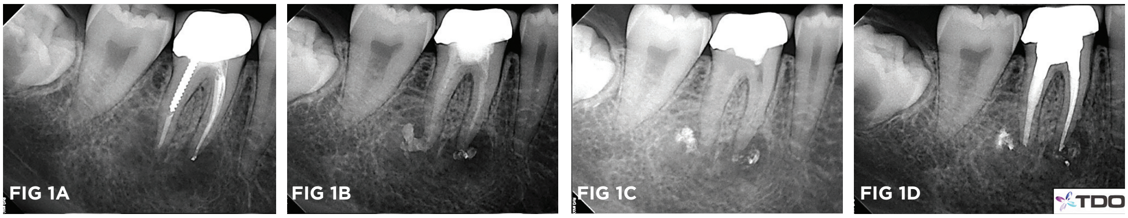
REFRACTORY ENDODONTIC DISEASE

Below is an example of such a clinical case (**Fig. 1**). It was posted online by an endodontist and is presented with his authorization. It involves retreatment of a lower right first molar tooth with a diagnosis of symptomatic apical periodontitis. Periodontal probing measurements were normal with no evidence of a tooth fracture. A CBCT was taken but it was not posted. The treatment followed a standard endodontic protocol with long-term application of calcium hydroxide that was reapplied twice over a period of seven months. As the patient's symptoms improved somewhat, the canals were obturated and the tooth restored. A week later the tooth was extracted due to persistence of symptoms!

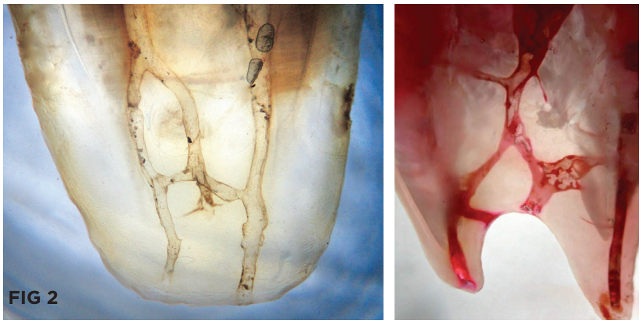
Although the etiology of the failed treatment and inability to resolve symptoms was never ascertained, a strong possibility is that the protocol used was ineffective in reducing sufficiently the bioburden within the tooth. Lower molars are known to have a complicated root canal system, especially in the mesial root (**Fig. 2**) and current instrumentation and irrigation techniques fall short of adequately addressing this anatomy.

CASE REPORT #1

The patient was a 58-year-old male dentist with a historyof thyroid cancer. He had been diagnosed with recurrent endodontic disease in his lower right second molar. Retreatment was initiated by his endodontist. He presented in my office complaining of pain to percussion in the tooth. He had seen



Pre-op Calcium Hydroxide Dressings Post-Op



Typical complex root canal system found in the mesial roots of lower molars

his endodontist multiple times over a period of several months with no improvement in his symptoms. Occlusion was light on the tooth. Periodontal probing depths were normal and trans-illumination showed no signs of a tooth fracture. A diagnosis of symptomatic apical periodontitis was made. The CBCT scan (**Fig. 3**) showed no evidence of untreated root canal anatomy or root fracture.

Under local anesthesia, the tooth (**Fig. 4**) was treated with the Radial Apical Cleansing (RAC) protocol and re-medicated with calcium hydroxide paste. A prescription for Amoxicillin 500mg TID for seven days was prescribed. At the second visit three weeks later, the tooth was asymptomatic and was obturated with a bioceramic sealer and single cone gutta percha technique (EndoSequence® BC Sealer and Points™, Brasseler, USA). At his one and a half year follow up, the tooth was functional and asymptomatic with normal probing and radiographic evidence of complete healing. The tooth had not yet been permanently restored.

CASE REPORT #2

A 77-year-old female patient presented with pain and swelling associated with her lower left first molar tooth. She had previously been treated by two endodontists who were unable to relieve her symptoms (**Fig. 5**). Examination revealed swelling in the adjacent buccal fold and the tooth was percussion sensitive. Periodontal probing was normal except for a narrow 7 mm pocket on the buccal aspect of the mesial root. Trans-illumination showed no signs of a cracked tooth. Radiographic examination showed a J-shaped radiolucency on the mesial root and a smaller apical radiolucency on the distal root. The CBCT scan (**Fig. 6**) confirmed the extent of the findings as well as evidence of loss of buccal plate on the distal root. A diagnosis was made of symptomatic apical periodontitis with a buccal draining sinus along the periodontal ligament space.

Under local anesthesia, the tooth was treated with the Radial Apical Cleansing (RAC) protocol and re-medicated with calcium hydroxide paste (**Fig. 7**). The patient was prescribed Amoxicillin 500 mg TID for seven days. At the second visit, three weeks later, the tooth was asymptomatic and was obturated with a bioceramic sealer and single-cone gutta percha technique (Endo-Sequence® BC Sealer and Points™, Brasseler, USA).

At recall, nine months later, probing depths were normal and the tooth was functional and asymptomatic with evidence of osseous healing.

RADIAL APICAL CLEANSING (RAC)

RAC is a treatment protocol that consistently achieves superior cleaning and disinfection of complicated root canal systems, utilizing a chemo-mechanical protocol assisted by the application of radially firing laser energy.

RAC MAIN ELEMENTS

Instrumentation:

1. Glide path is established with .06 and .08 hand files and rotary NiTi path files.
2. Deep apical shaping with heat-treated NiTi files, always preserving root structure, especially in the coronal third and peri-cervical zone.

Irrigation:

1. Effective apical negative pressure irrigation with Endo-VacTM system (Kavokerr) using 6% sodium hypochlorite solution.

2. Sonic activation of irrigant.

Cleansing:

1. Laser Activated Irrigation (LAI) with Er,Cr:YSGG laser (Waterlase iPlus, Biolase, Irvine, CA) using RFT2 and RFT3 laser tips with settings 1.25 Watts, H mode, 20 Hz (PPS), 30% air, 10% water, 62.5 mJ/ pulse.

Disinfection:

1. Laser disinfection with Er,Cr:YSGG laser (Waterlase iPlus, Biolase, Irvine, CA) using RFT2 and RFT3 laser tips with settings of 1.00 Watt, H mode, 20 Hz (PPS), 10% air, 0% water, 50 mJ/pulse.
2. Deep dentin disinfection with 940 nm diode laser (Epic X, BIOLASE, Irvine, CA), with an uninitiated laser tip, using settings of 1 Watt, continuous wave, in a wet canal. This is an off-label use of the diode in the USA as no FDA clearance has been issued for this application.

Ideally, for both cleansing and disinfection, the laser tip is placed 1 mm short of working length and activated on withdrawal of the tip, in a circular motion, at a rate of 1-2 mm per second. This process is repeated four times in each canal. Placement of the laser tip is influenced by root canal anatomy, diameter and flare of the prepared canal and presence or absence of canal patency; it will remain effective even at distances of 5 mm or more from the apical foramen.

ERBIUM LASERS IN ENDODONTICS

Erbium lasers have emerged as the most promising laser-wavelength in endodontics. They are both hard and soft tissue capable and have the most FDA clearances for a multitude of dental procedures. Their primary chromophore is water and to a lesser degree, hydroxyapatite. Photo-thermal interactions prevail in soft tissue and photo-disruptive in hard tissue procedures. When proper parameters are followed, thermal relaxation is excellent with minimal collateral thermal damage in surrounding tissues.

ACTION IN ROOT CANAL SYSTEMS

When activated in the presence of water, instantaneous vaporization occurs, creating a vapor bubble at the end of the radially-firing laser tip (Fig. 8). The rapidly expanding and imploding bubbles create a cavitation effect with high

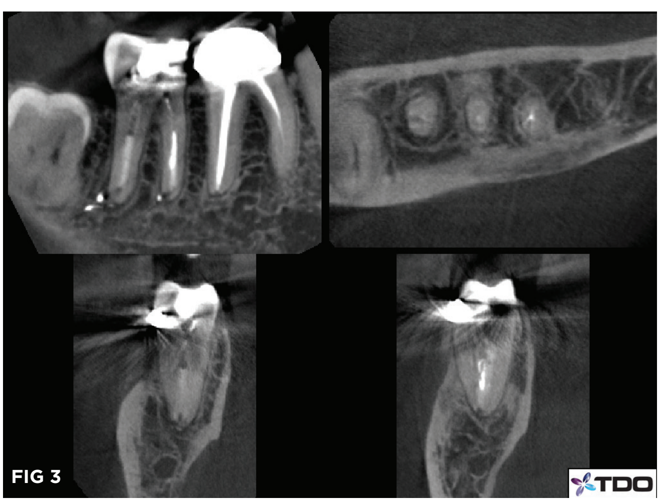


FIG 3

CBCT slices.

FIG 4

Pre-op — Post-op — 1.5-year recall

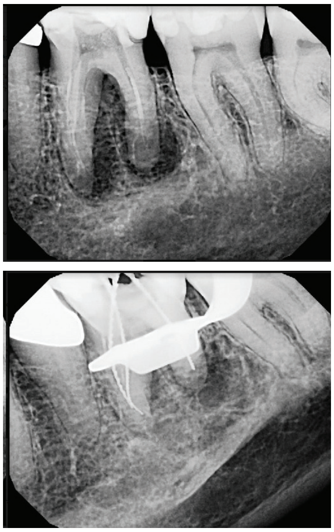


FIG 5

Images from previous endodontist.

FIG 6

CBCT slices showing a J-shaped finding on the mesial root and a smaller apical finding on the distal root.

FIG 7

Pre-op; Interim $Ca(OH)^2$ dressing; Post-op and nine-month recall radiographs.

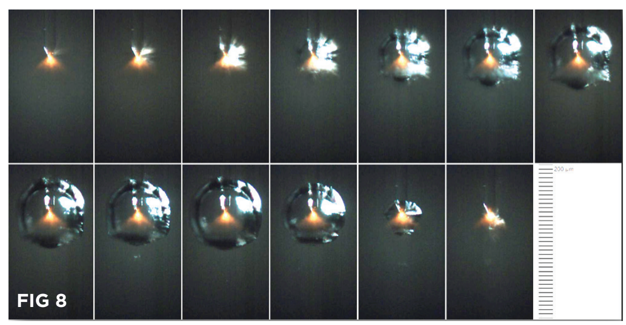


FIG 8

Vapor bubble expansion and implosion at laser tip following a single pulse of laser energy (Courtesy Alina Sivriver).

velocity water jets forming shear stress along the canal wall. Secondary cavitation effects from canal irregularities also contribute to the cleaning and sterilization potential of the treatment.

At liquid-solid boundaries (canal walls) microscopic bubbles are generated by the shear forces from the passing acoustic wave resulting in a micro-streaming and micro-cavitation effect that can permeate canal ramifications and dentinal tubules (**Fig. 9**). Expansion and collapse of intra-tubular water is possible at a depth of 1,000 microns or more, capable of producing acoustic effects strong enough to disrupt biofilm and kill bacteria.18

DISCUSSION

Endodontic disease is essentially a biofilm-mediated disease and the success of endodontic therapy depends to a large extent on the ability to remove biofilm and to kill biofilm bacteria.

To achieve this end, endodontic therapy has relied on a chemo-mechanical debridement of the root canal system. Due to the complexity of root canal anatomy, about 30-45% of the root canal system remains untouched by mechanical instrumentation[1] and overinstrumentation will further weaken the tooth and may influence apical crack initiation.[2] As a result, more reliance has been placed on the efficacy of disinfecting agents for the killing of biofilm bacteria as opposed to planktonic bacteria. Biofilm bacteria can be up to 1,000 times more resistant to antibacterial agents than their planktonic counterparts.[3]

Previous studies have shown that instrumentation and antibacterial irrigation with NaOCl eliminated bacteria in

50–75% of the infected root canals at the endof the first treatment session, whereas the remaining root canals contained recoverable bacteria.[4,5] In their study, Nair et al. showed that 88% of root canal–treated mandibular molars showed residual infection of mesial roots after instrumentation, irrigation with NaOCl, and obturation in a one-visit treatment.[6] For antimicrobial agents to be effective, they need to reach the canal terminus, carry undissolved particles away, create a current and continuously replenish themselves. Chow illustrated that there is little flushing effect beyond the tip of a side-vented needle.[7] In addition, the dissolving action of sodium hypochlorite on intracanal tissue releases bubbles that can coalesce to form apical vapor lock that promotes poor apical cleaning by preventing irrigants from reaching the canal terminus. Apical negative pressure irrigation has been shown to be extremely effective in overcoming these obstacles[8] but is becoming increasingly more difficult to use with the smaller canal shapes being advocated with minimally invasive endodontic principles.

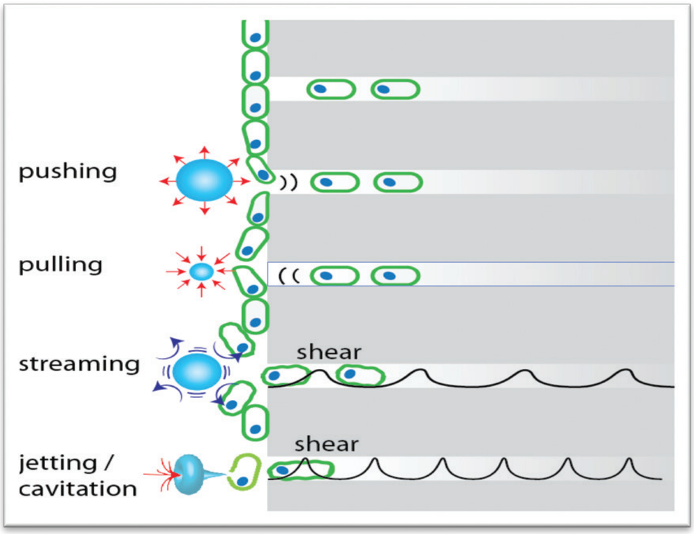


FIG 9

Micro-streaming and micro-cavitation effect at liquid/solid boundaries (Courtesy Alina Sivriver).

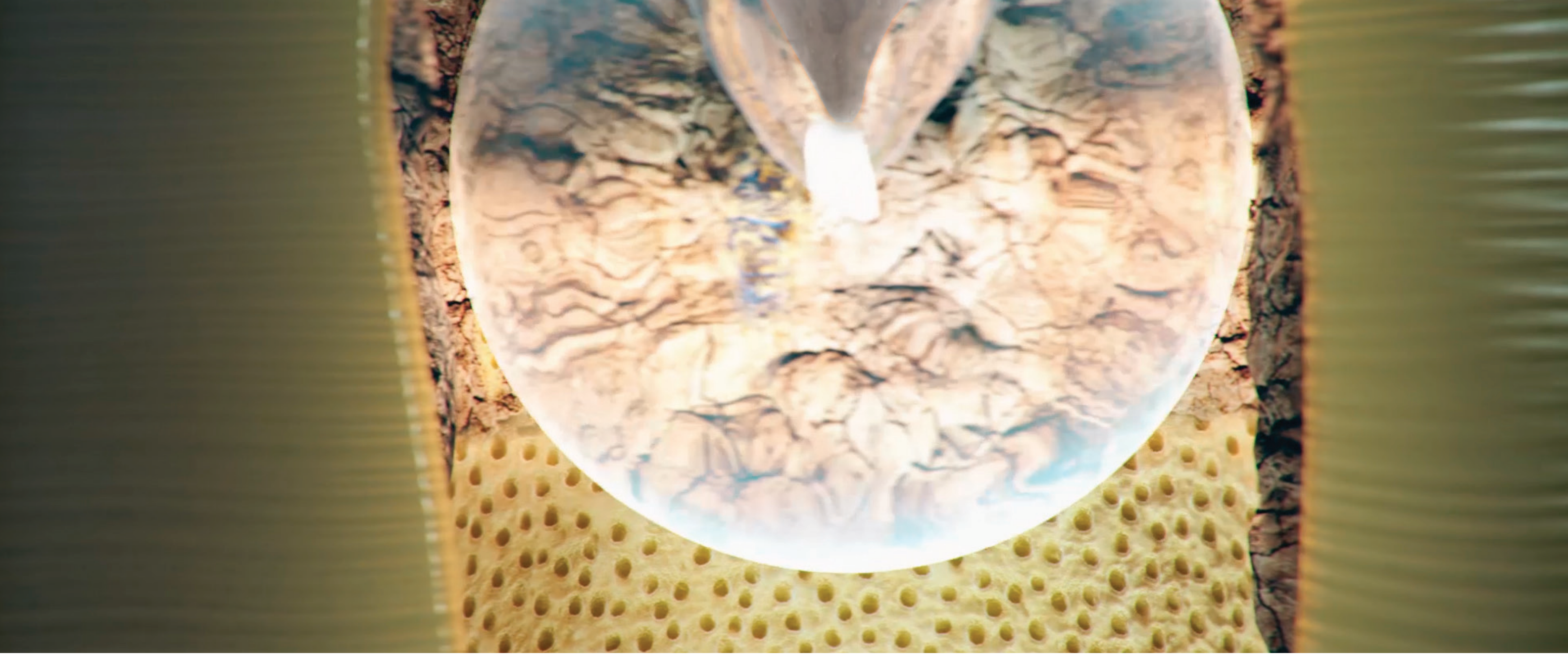
Laser Activated Irrigation (LAI) generates stress waves strong enough to disrupt biofilm, thereby releasing bacteria into their planktonic state.[9,10] This may occur either due to cohesive failure, disrupting superficial layers, or adhesive failure, completely removing the biofilm. This makes the bacteria more susceptible to the biocides (intra-canal irrigants and medicaments) used for canal disinfection. There is also a reported direct effect on the bacteria themselves, increasing bacterial permeability by creating temporary pores in their membranes and damaging cell surfaces.[11,12] If the shear forces generated are insufficient to break down the cohesive bonds of the viscoelastic biofilm matrix, the biofilm will simply deform and return to its original state.[9] Insufficient forces may be generated with the use of sonic or ultrasonic agitation or if the laser tip placement is too distant from the biofilm. LAI has also been shown to effectively remove smear layer[13] and dentinal plugs,[14] thereby playing an important role in maintaining and re-establishing canal patency. Removal of apical vapor lock is another advantage of LAI and occurs by disruption of the surface tension at the solution-air interface.[15,16]

Laser disinfection is an important element of RAC and occurs with the application of the Er,Cr:YSGG laser in the dry mode. The laser energy seeks out the water in infected tissue, the highly hydrated biofilm matrix as well as the bacteria themselves, resulting in ablation of the targeted tissues and microorganisms. The end result is an effective disinfection to a depth of 200 microns into dentin.[17,18] Deeper dentin disinfection has been reported with the diode laser[19,20] and the dual laser approach has been showing promise in vitro.[21,22] The primary chromophore for the diode laser wavelength is pigment (melanin and hemoglobin) and to a lesser degree, water. This results in greater light penetration through dentin with little interaction with it, making it possible to seek out and destroy microorganisms deeper in the dentinal tubules.

CONCLUSION

The challenge presented by refractory endodontic disease can be summed up by Ricucci[23]: "*(We need) to develop strategies, instruments or substances that can reach those areas distant from the main root canal to achieve sufficient reduction in the infectious bioburden to permit predictable periradicular healing*".

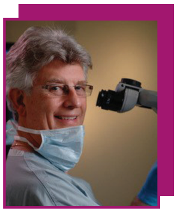
A treatment protocol, Radial Apical Cleansing, (RAC) is presented for non-surgical management of refractory endodontic disease. The protocol relies primarily on a synergistic effect between Er,Cr:YSGG laser irradiation and subsequent apical negative pressure irrigation with 6% sodium hypochlorite, that promotes disruption and destruction of biofilm bacteria within complex root canal systems and dentinal tubules. While several studies have focused on identifying root canal microflora in recalcitrant cases in an attempt to explain the pathogenesis of refractory disease, it is the contention of this author that RAC is a valuable tool capable of successfully treating the infectious bioburden, irrespective of the makeup of the biofilm itself. In the two case reports presented, the only significant deviation from standard endodontic protocols was the introduction of laser-assisted, endodontic cleaning and disinfection. ■



REFERENCES:

1. Peters OA, Schönenberger K, Laib A. Effects of four Ni-Ti preparation techniques on root canal geometry assessed by micro computed tomography. Int Endod J. 2001;34:221–30.
2. Çapar İD, Uysal B, Ok E, Arslan H. Effect of the Size of the Apical Enlargement with Rotary Instruments, Single-cone Filling, Post Space Preparation with Drills, Fiber Post Removal, and Root Canal Filling Removal on Apical Crack Initiation and Propagation. J Endod. 2015 Feb;41(2):253-6.
3. Ceri H, Olson ME, Stremick C, Read RR, Morck D, Buret A. The Calgary Biofilm Device: New technology for rapid determination of antibiotic susceptibilities of bacterial biofilms. J Clin Microbiol. 1999;37:1771–6.
4. Byström A, Sundqvist G. Bacteriologic evaluation of the effect of 0.5 percent sodium hypochlorite in endodontic therapy. Oral Surg Oral Med Oral Pathol. 1983;55:307–12.
5. Peters LB, van Winkelhoff AJ, Buijs JF, Wesselink PR. Effects of instrumentation, irrigation and dressing with calcium hydroxide on infection in pulpless teeth with periapical bone lesions. Int Endod J. 2002;35:13–21.
6. Nair PN, Henry S, Cano V, Vera J. Microbial status of apical root canal system of human mandibular first molars with primary apical periodontitis after "one-visit endodontic treatment." Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2005;99:231–52.
7. Chow TW. Mechanical effectiveness of root canal irrigation. J Endod. 1983 Nov;9(11):475-9.
8. Nielsen BA, Baumgartner JC. Comparison of the EndoVac System to Needle Irrigation of Root Canals. J Endod 2007;33:611-5.
9. Y. Krespi, et al. Laser Disruption of Biofilm. Laryngoscope 2008;118:1168-1173.
10. Gnanadhas, D. P. et al. Successful treatment of biofilm infections using shock waves combined with antibiotic therapy. Sci. Rep. 2015; 5,17440; doi: 10.1038/srep17440
11. Arnabat J, Escribano C, Fenosa A, Vinuesa T, Gay-Escoda C, Berini L, Viñas M. Bactericidal activity of erbium, chromium:yttrium-scandium-gallium-garnet laser in root canals. Lasers Med Sci. 2010 Nov;25(6):805-10.
12. Lopez-Jimenez L, Arnabat J, Vinas M, Vinuesa T. Atomic force microscopy visualization of injuries in Enterococcus faecalis surface caused by Er,Cr:YSGG and diode lasers. Med Oral Patol Oral Cir Bucal. 2014;Doi:10.4317/medoral.19991
13. De Moor RJ, Blanken J, Meire M, Verdaasdonk R. Laser induced explosive vapor and cavitation resulting in effective irrigation of the root canal. Part 2: evaluation of the efficacy. Lasers Surg Med. 2009 Sep;41(7):520-3.
14. De Moor RJ, Meire M, Goharkhay K, Moritz A, Vanobbergen J. Efficacy of ultrasonic versus laser-activated irrigation to remove artificially placed dentin debris plugs. J Endod. 2010 Sep;36(9):1580-3.
15. Peeters HH, De Moor RJ, Suharto D. Visualization of removal of trapped air from the apical region in simulated root canals by laser-activated irrigation using an Er,Cr:YSGG laser. Lasers Med Sci. 2015 Aug;30(6):1683-8.
16. Peeters HH, Gutknecht N. Efficacy of laser-driven irrigation versus ultrasonic in removing an airlock from the apical third of a narrow root canal. Aust Endod J. 2014 Aug;40(2):47-53.
17. Gordon W, Atabakhsh VA, Meza F, Doms A, Nissan R, Rizoiu I, Stevens RH. The antimicrobial efficacy of the erbium, chromium:yttrium-scandium-gallium-garnet laser with radial emitting tips on root canal dentin walls infected with Enterococcus faecalis. J Am Dent Assoc. 2007 Jul;138(7):992- 1002.
18. Schoop U, Barylyak A, Goharkhay K, Beer F, Wernisch J, Georgopoulos A, Sperr W, Moritz A. The impact of an erbium, chromium:yttrium-scandium-gallium-garnet laser with radialfiring tips on endodontic treatment. Lasers Med Sci 2009 Jan;24(1):59-65.
19. Beer et al. Comparison of two diode lasers on bactericidity in root canals-an in vitro study. Lasers in Med Sci. 2012;27;361-4.
20. Hedge MN, Bhat R, Shetty P. Efficiency of a semiconductor diode laser in disinfection of the root canal system in endodontics: An in vitro study.J Int Clin Dent Res Organ 2015;7:35-8.
21. Gutknecht N, Al-Karadaghi TS, Al-Maliky MA, Conrads G, Franzen R. The bactericidal effect of 2780 and 940 nm laser irradiation on Enterococcus faecalis in bovine root dentin slices of different thicknesses. Photomed Laser Surg. 2016 Nov;34(1);11-6.
22. Al-Karadaghi TS, Gutknecht N, Jawad HA, Vanweersch L, Franzen R. Evaluation of temperature elevation during root canal treatment with dual wavelength laser: 2780 nm Er,Cr:YSGG and 940 nm diode. Photomed Laser Surg. 2015 Sep;33(9):460-6.
23. Ricucci D, Loghin S, Siqueira JF Jr. Exuberant biofilm infection in a lateral canal as the cause of short-term endodontic treatment failure: report of a case. J. Endod. 2013;39(5):712-8.

ABOUT THE AUTHOR



Justin Kolnick, DDS is not only an accomplished endodontist, but is also a world authority on laser-assisted endodontics and frequent lecturer at international endodontic conferences across the globe. Dr. Kolnick attended dental school at the University of the Witwatersrand in Johannesburg, South Africa. In 1982, he graduated from the postdoctoral endodontic program at Columbia University in the City of New York. Dr. Kolnick has been committed to endodontic education, first as an Associate Clinical Professor in Endodontics at Columbia University and then as an Attending at Westchester Medical Center and an Associate Clinical Professor in Endodontics at New York Medical College. Although he no longer holds these positions, he continues to lecture extensively on a local, national and international level and has published several articles on endodontics.

PHOTOBIOMODULATION

940NM Diode Laser in Orthodontic Tooth Movement

By Drs. Samual Ibarra and Marina Polonsky

INTRODUCTION

Photo-Bio-Modulation (**PBM**), also known as Low Level Light/ Laser Therapy (**LLLT**) was first discovered by Prof. Endre Mester in 1967 in Budapest, Hungary. In his famous experiment on the shaved backs of mice, he irradiated the animals with the recently discovered low power ruby laser beam to find out if this new 'light' might cause cancer. To his surprise, the group treated with laser did not develop cancer, but instead, had faster hair growth - this phenomenon was called Bio-Stimulation.[1]

In 2012, the North American Association of Light Therapy (NAALT) reached a consensus on the proper terminology to describe the effects of any light source, including laser, on the living tissues, and called it **PBM** because there is both up-regulation of some processes and down-regulation of others inside the cellular micro-environment.[2]

Electro-Magnetic Spectrum is comprised of many different wavelengths, some of which are used in medicine and dentistry, but the optical window of opportunity for PBM is limited to Visible Red (VR) and Near-Infra-Red (NIR) radiation (600 – 1400 nm) due to the minimal water absorption and, hence, deeper penetration into living tissues to exert its biologic effects.[3]

The biochemical pathways of laser radiation within living cells leading to PBM can be explained by the absorption of VR/NIR photons within mitochondria, T. Karu.[4] Mitochondria are responsible for cellular energy production (ATP) from oxygen and pyruvate. In hypoxic, injured or otherwise stressed tissues, Cytochrome C Oxydase (CCO), the fourth enzyme in the electron transport chain, located inside the mitochondria, has mitochondrial nitric oxide (mtNO) bound to its oxygen binding sites which causes reduced ATP production and increased oxidative stress. When CCO absorbs VR/NIR radiation, mtNO is released from O_2 binding sites, ATP production is re-established and oxidative stress is reduced. Release of ROS (reactive oxygen species) affects cytosol, cell membrane and nucleus leading to up-regulation in gene transcription, which in turn increases protein synthesis, cell proliferation and migration, reduces inflammation and cell death (apoptosis).[5]

FIGURE 1. Before Treatment

ORTHODONTIC TOOTH MOVEMENT ACCELERATION

The discomfort associated with orthodontic treatment in adults is primarily due arch-wire adjustments every month and is experienced by 91% of patients.[6] Furthermore, a demand to reduce active treatment time and aesthetic devices has led to the development of accelerated orthodontic movement techniques such as self-ligating brackets, aligners and alveolar corticotomies (AC).

FIGURE 2. November 2016

Randomized clinical trials (RCT's) suggest that AC's decrease bone density which appears to accelerate orthodontic tooth movement during the first 3-4 months resulting in faster outcomes, regardless of the type of device used (conventional, self-ligating brackets or aligners). But the need for surgery, incremental cost and possible need to repeat the AC, makes the significance of this technique questionable.[7]

In addition to mechanical and surgical means to reach faster treatment outcomes, there are pharmacological methods like the injection of prostaglandins into the alveolar ridge, and physiotherapies with micro-vibrational frequencies which improve cellular response to force applications. However, the conclusions reached in these clinical studies are still debatable. Laser therapy, on the other hands, seems to increase RANK-RANKL, biomarkers of bone turnover, promoting the differentiation of osteoclast and potentially increasing the rate of orthodontic tooth movement through biological and cellular effects.[8]

The purpose of this article is to report a clinical case where the application of new PBM protocol using 940nm diode laser was successful in accelerating orthodontic tooth movement with self-ligating brackets.

CLINICAL & RADIOGRAPHIC CHARACTERISTICS

A healthy 15-year-old male patient in permanent dentition presented with main concern for faster completion of orthodontic treatment due to family's planned move to another country in 10 months. Bilateral 5mm dental Class II malocclusion, skeletal Class II malocclusion with mandibular retrusion, inferior and superior moderate crowding, increased vertical and horizontal overbite, increased Curve of Spee, bilaterally constricted maxilla (**Fig. 1**)

ORTHODONTIC PROTOCOL

Initial orthodontic treatment plan consisted of bilateral maxillary first bicuspid extraction after levelling-aligning phase, anterior retraction with maximum anchorage and Class II elastic, 24 month expected treatment time. Four months into treatment, the patient had 0.016 Cu-Ni-Ti arch-wires in both jaws, the mother announced their intention to move to another country and asked to speed up the case as much as possible. PBM was proposed as a means to accelerate orthodontic tooth movement (**Fig. 2**)

LASER PBM PROTOCOL

A 940nm diode laser (BIOLASE) was used with buccal/vestibular and lingual/palatal protocols as follows:

- Palatal/Lingual application - surgical handpiece (0.1 cm^2), 0.1 W, CW, 20s/root divided in 3 points cervical, middle and apical (6.7s each point). The energy was delivered in direct contact with soft tissue, point technique without movement of the handpiece. (**Fig. 3**)
- Buccal/Vestibular application - whitening handpiece (2.8 cm^2), 0.6 W, CW, 20s every 3 teeth. (**Fig. 4**) The energy was delivered in direct contact with soft tissue wherever the curvature of the arch permitted it, point technique without movement of the handpiece, starting in attached and finishing in loose gingiva.

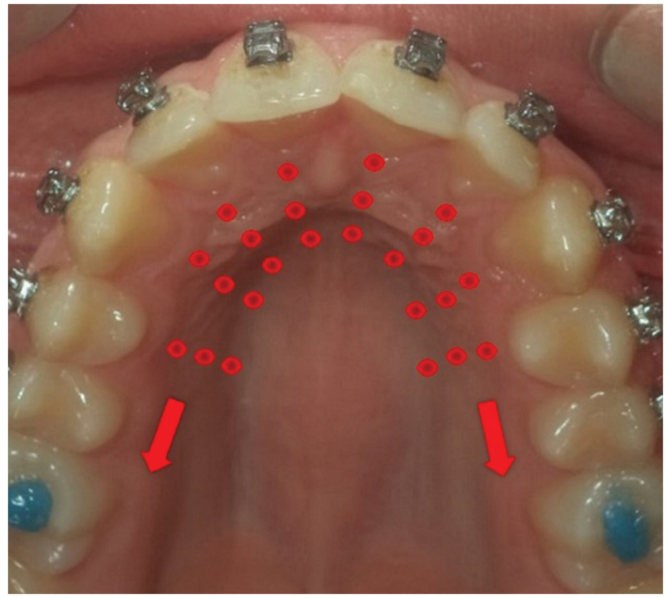


FIGURE 3. Laser Surgical Hanpiece Application

A total of 128 J per session with an average fluence (energy density) of 5.4 J/cm^2 per tooth was applied. PBM therapy was delivered weekly the first month (November 2016) and every 15 days for remaining 5 months (December 2016 to April 2017). A total of 14 laser applications in 6 months were administered.

FIGURE 4. Laser Whitening Handpiece Application

RESULTS

After 5 months of PBM therapy with 940nm diode laser delivering 4-6.6 J/cm^2 dose of radiant energy we can report the following:

- The molar and canine Class II malocclusion was corrected to Class I, without the need for bicuspid extractions or distallizing devices, as originally planned.
- Deep bite correction from 5.66mm to 4mm.
- Overjet correction from 6mm to 4mm.
- Upper incisors were retroclined.
- Lower incisors were proclined.
- Correction of lip incompetence.
- Increase in facial height.
- Adequate smile projection.

DISCUSSION

The first RCT evaluating the effect of LLLT on orthodontic tooth movement goes back to 2004, when Cruz et. al. treated 11 orthodontic patients undergoing first bicuspid extractions and space closure by canine retraction. 780nm diode laser irradiation was applied for 10 seconds at 20 mW, 5 J/cm^2, on the fourth day of each month, in a split mouth study design. The study reported significantly accelerated retraction of canines on the laser treated side compared to the control.[9]

In 2008, Youssef et. al. achieved similar outcome using 809nm diode laser at 100 mW of power with the tip of the handpiece held in contact at three points along the root: cervical, middle, apical; buccal and lingual sides. LLLT was applied on 0-, 3-, 7-, and 14-day intervals after each orthodontic adjustment. They also recorded the patient-reported pain intensity was lower in the lased group than in the control group throughout the retraction period.[10]

In 2013, Long et. al. published the first meta-analysis on the effectiveness of LLLT in accelerating orthodontic tooth movement concluding that low-level laser irradiations using 780 nm wavelength, the fluence of 5 J/cm^2 and/or the output power of 20 mW could accelerate orthodontic tooth movement within two and three months. However, the level of evidence was weak suggesting that at least two months is necessary to determine the effect of the laser therapy.[11]

FIGURE 5. February 2017 – March 2017

The first RCT evaluating the effect of 940nm diode laser on pain perception and accelerated orthodontic tooth movement was published in 2016. It concluded that a single dose could be sufficient to reduce the postoperative pain associated with the placement of elastomeric separators.[12] At 3-week intervals, 940 nm laser irradiation in CW mode, energy density 7.5 J/cm^2 /point, 0.04 cm^2 optical fiber tip diameter, applied at 5 points buccally and palatally around the canine roots on the experimental side can accelerate orthodontic tooth movement and reduce the pain, when compared to the control.[13]

The laser protocol described in this case report differs from others as follows:

1. Full mouth buccal and lingual application using two different settings with the whitening and surgical handpieces in contact mode along the radicular surface of the teeth to deliver an average of 5.4 J/cm^2.
2. PBM frequency was weekly during the first month and bi-weekly for the remainder of the treatment, bracket removal and retention.

This protocol is better suited to the clinical logistics of running a dental/orthodontic practice where the appointments may be scheduled for 5 to 10 minutes, and the patients does not need to be present more than twice a month during the entire treatment.

CONCLUSIONS

PBM therapy using 940nm diode laser for stimulation of orthodontic tooth movement has been demonstrated in this clinical case report. According to the experience of the orthodontist responsible for the treatment, the correction of Class II malocclusion greater than 4 mm with extraction of first premolars takes at least 18 months and, in more complex cases requiring distallization, up to 30 months. In this case, adjunctive PBM therapy not only resulted in 45 % faster completion of orthodontic treatment but also enabled the patient to retain his bicuspids.

The PBM protocol proposed here is in accordance with published studies using 780nm, 808nm and 810nm laser wavelengths for the acceleration of orthodontic tooth movement with 30-60% reduction in treatment time.[14] ■

The devices included in this article are not cleared by the FDA for the indications featured. The manufacturer, BIOLASE, does neither approve or condone of the methods used in this article and assumes no responsibility for complications or contra-indications in the illustrated use.

FIGURE 6. Final Results

ABOUT THE AUTHORS

DR. SAMUEL IBARRA received his general dentist degree from the Faculty of Dentistry at the University of Panama, orthodontist specialty from the Pontificia Universidad Javeriana de Bogotá and Mastership in Laser Dentistry from RWTH University in Aachen, Germany.

He is a Member of the Panamanian Society of Orthodontics, Colombian Society of Orthodontics and a founder of SOLALO (Sociedad Latino-Americana de Laser Odontológico).

Dr. Ibarra speaks internationally about the protocol he developed for the accelerated tooth movement with 940nm BIOLASE diode laser and is currently in the process of completing his Master of Periodontics diploma from the Faculty of Dentistry, University of Panama and the Master of Laser in Dentistry diploma from the University of Barcelona.

DR. MARINA POLONSKY graduated from the University of Toronto, Canada in 1999, with the Dean's Gold Medal of Achievement and maintains a private general practice in Ottawa, Canada, with focus on multi-disciplinary treatment utilizing lasers of different wavelengths.

Dr. Polonsky holds a Mastership with WCLI (World Clinical Laser Institute), Master of Science in Lasers in Dentistry degree from RWTH University in Aachen, Germany. She is a recipient of Mastership Certificate with ALD (Academy of Laser Dentistry) and is a recognized member of the ALD Speaker Bureau. Dr. Polonsky is a founder of the Canadian Dental Laser Institute (CDLI), ALD affiliated international study club in Canada.

Dr. Polonsky is a key opinion leader (KOL) and a Clinical Mentor for BIOLASE Technologies Inc., the author of multiple scientific papers, reviews and case reports on the uses of lasers in dentistry, she is the Chief Editor for JLAD (Journal of Laser-Assisted Dentistry) and a peer-reviewer for LIDS (Lasers in Dental Science) by Springer. In 2017, Dr. Polonsky joined Canada's Oral Health Journal Executive as the Chief Editor of Laser Dentistry and General Dentistry issues.

REFERENCES:

1. Mester E, Szende B, Gärtner P. Die Wirkung der Lasstrahlen auf den Haarwuchs der Maus [The effect of laser beams on the growth of hair in mice]. Radiobiol Radiother (Berl). 1968;9(5):621-6. German. PMID: 5732466.
2. https://www.naalt.org/
3. Ying-Ying Huang, Aaron C.-H. Chen, James D. Carroll, Michael R. Hamblin. Biphasic dose response in low level light therapy. Dose-Response, 7:358–383, 2009
4. Tiina I. Karu, "Cellular mechanisms of low-power laser therapy," Proc. SPIE 5149, Laser Applications in Medicine, Biology, and Environmental Science, (22 September 2003); https://doi.org/10.1117/12.518686
5. James D. Carroll. Introduction to Low-Level Laser/Light Therapy (LLLT) for Dentists. J Laser Dent. 2013;21(1):10-20.
6. Lew K. K. (1993). Attitudes and perceptions of adults towards orthodontic treatment in an Asian community. Community dentistry and oral epidemiology, 21(1), 31–35. https://doi.org/10.1111/j.1600-0528.1993.tb00715.x
7. Copy Dab S, Chen K, Flores-Mir C. Short- and long-term potential effects of accelerated osteogenic orthodontic treatment: A systematic review and meta-analysis. Orthod Craniofac Res. 2019 May;22(2):61-68. Epub 2019 Mar 18. PMID: 30884158. https://doi.org/10.1111/ocr.12272.
8. Miles P. Accelerated orthodontic treatment - what is the evidence? Aust Dent J. 2017 Mar;62 Suppl 1:63-70. PMID: 28297096. https://doi.org/10.1111/adj.12477.
9. Cruz, D. R., Kohara, E. K., Ribeiro, M. S., & Wetter, N. U. (2004). Effects of low-intensity laser therapy on the orthodontic movement velocity of human teeth: a preliminary study. Lasers in surgery and medicine, 35(2), 117–120. https://doi.org/10.1002/lsm.20076
10. Youssef, M., Ashkar, S., Hamade, E., Gutknecht, N., Lampert, F., & Mir, M. (2008). The effect of low-level laser therapy during orthodontic movement: a preliminary study. Lasers in medical science, 23(1), 27–33. https://doi.org/10.1007/s10103-007-0449-7
11. Long, H., Zhou, Y., Xue, J., Liao, L., Ye, N., Jian, F., Wang, Y., & Lai, W. (2015). The effectiveness of low-level laser therapy in accelerating orthodontic tooth movement: a meta-analysis. Lasers in medical science, 30(3), 1161–1170. https://doi.org/10.1007/s10103-013-1507-y
12. Qamruddin, I., Alam, M. K., Fida, M., & Khan, A. G. (2016). Effect of a single dose of low-level laser therapy on spontaneous and chewing pain caused by elastomeric separators. American journal of orthodontics and dentofacial orthopedics: official publication of the American Association of Orthodontists, its constituent societies, and the American Board of Orthodontics, 149(1), 62–66. https://doi.org/10.1016/j.ajodo.2015.06.024
13. Qamruddin, I., Alam, M. K., Mahroof, V., Fida, M., Khamis, M. F., & Husein, A. (2017). Effects of low-level laser irradiation on the rate of orthodontic tooth movement and associated pain with self-ligating brackets. American journal of orthodontics and dentofacial orthopedics: official publication of the American Association of Orthodontists, its constituent societies, and the American Board of Orthodontics, 152(5), 622–630. https://doi.org/10.1016/j.ajodo.2017.03.023
14. Imani, M. M., Golshah, A., Safari-Faramani, R., & Sadeghi, M. (2018). Effect of Low-level Laser Therapy on Orthodontic Movement of Human Canine: a Systematic Review and Meta-analysis of Randomized Clinical Trials. Acta Informatica Medica(AIM): Journal of the Society for Medical Informatics of Bosnia & Herzegovina : casopis Drustva za medicinsku informatiku BiH, 26(2), 139–143. https://doi.org/10.5455/aim.2018.26.139-143i

PHOTOBIOMODULATION

A Practical Approach to Optimal Clinical Care

By Dr. Mark Cronshaw, BSc, BDS, LDSRCS (Eng), MSc

Photobiomodulation Therapy (PBMT)

is the application of photonic energy to selectively influence cellular activity. Downstream this can result in local, regional and systemic changes in tissue and organ behavior. PBMT has far reaching effects on sub-cellular systems that range from a protective influence increasing cellular resistance to stress to an increase in cell numbers via mitosis, enhancements to the volume of production of matrix materials including bone and collagen as well as the selective promotion of anti-inflammatory pathways. In addition, there is angiogenesis and vasodilatation resulting in an increased availability of an oxygenated blood supply to the tissues, plus an improvement in lymphatic drainage. The overall clinical results include the mitigation of pain and inflammation, an improved quality of repair to optimize the potential for regeneration as well as the capacity to reduce complications in medically compromised patients.[1-2]

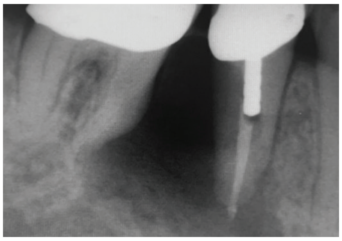


FIGURE 1. Pre-op: cracked root LR5 & extensive apical pathology

For example, following multiple systematic reviews and meta-analyses PBMT is accepted to the highest level of grade one evidence based clinical acceptance for the prevention and management of oral mucositis following head and neck radiotherapy and chemotherapy for oral cancer. Also, the same beneficial effects are seen to mitigate the distressing oro-pharyngeal complications frequently associated with the treatment of various forms of leukaemia.[3] This may seem far removed from every day clinical dental practice, however the underlying pathways that produce these highly useful outcomes are in essence the same as we may seek to use in dealing with many common dental issues. PBMT can be used as a primary management tool and as an adjunctive measure to treat aphthous ulceration, traumatic wounds, angular cheilitis, burns, oral viral eruptions including herpes labialis and other superficial conditions associated with ulceration and impaired healing such as erosive lichen planus.[4]

FIGURE 2. Waterlase iPlus laser-assisted atraumatic extraction

In fact, the list of clinical conditions that have published evidence based research on PBMT is very long as clinicians seek to incorporate the potential benefits of this non-invasive non-toxic treatment modality. In oral surgery for instance, PBMT has been found in a number of double-blind randomized controlled trials to be comparable to prednisolone in efficacy to reducing post-operative angular swelling following third molar extractions.[5-6] As a matter of course in my daily clinical practice, I use it to reduce the peak intensity and duration of acute inflammation following many surgical procedures, including apicectomy as well as an adjunctive measure to my alveolar socket osseous regenerative procedures where I use it in combination with PRF (platelet rich fibrin) and grafting materials (see Case Report, **Fig. 1-6**).

In sum, the use of PBMT in my opinion is an invaluable aid to very many common daily procedures which deserves to be integrated into every dental office as a gold standard and hallmark of best 21st Century clinical practice.

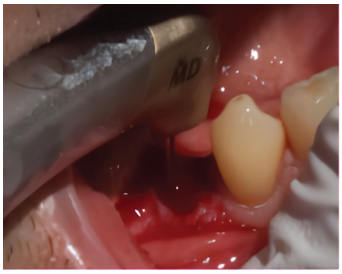


FIGURE 3. Laser-assisteed removal of granulation tissue

It is important to have an understanding of what we mean by dose and how it relates to the challenge of delivering a meaningful dose to sub-surface targets, for example such as

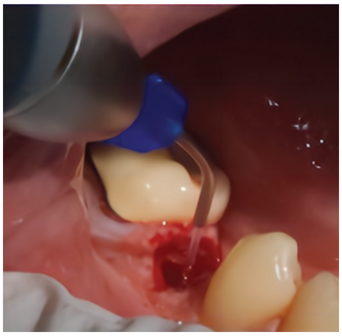


FIGURE 4. PBMT delivered with a non-initiated 300 micron tip

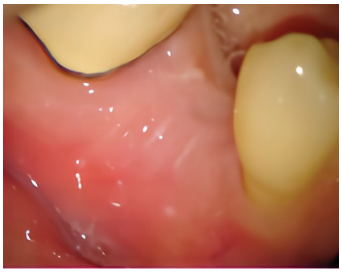


FIGURE 5. Post-op at one month

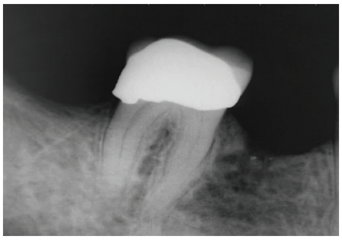


FIGURE 6. 12 months post-op

FIGURE 7. The choice of PBMT applicator

a muscle which may be involved in myalgia associated with TMD. By dose we mean the amount of photonic energy we must deliver to the target tissue. As the target tissue may be either large or small, we usually express the total delivered dose at target tissue level as Joules (energy) per centimeter squared area (J/cm^2).

The rate at which we deliver the dose is determined by the power output setting of the device and we generally recommend to deliver the energy in a slow and gentle manner. Using the BIOLASE Epic 940 nm diode laser I use an average power per unit area of no more than 0.5 Watts/cm2 which is the upper limit I recommend to employ in order to avoid over heating the tissues. Next, before setting the power output of your Epic 940 nm laser you need to decide which peripheral applicator you're going to use (**Fig. 7**). There are three choices: you can opt to use the surgical handpiece with or without a non-initiated tip, the contour (whitening) handpiece or the deep tissue handpiece, which is an optional extra that I recommend you choose to use for some clinical conditions with the Epic.

The rationale for deciding which of these tools you will use depends on the size of area you need to treat as well as the depth of the target tissues along with simple ergonomics, if it's an intra oral target. For a smaller target particularly inside the oral cavity the surgical hand piece is easy to use. You don't have to put a tip on the end, although it can be useful if one requires a light guide to areas which otherwise would be hard to illuminate, say the base of a recent extraction socket.

As mentioned earlier, when thinking about dose we are looking at the size of the area to treat and it is important to be able to approximate the area you are actually exposing to the radiation. As the 940 nm wavelength is outside of the visible spectrum, I find it useful to turn up the aiming beam to full in the settings panel and then you can see the red wavelength as an indicator of the spot size at the surface of the target. To get the dosimetry correct I suggest you use a spot size diameter of around about 1cm. By setting the power output of the device to 0.5 Watts in continuous wave (CW) mode you are then able to deliver approximately 0.5 Joules/cm^2 in one second (**Fig. 8**).

If it's a larger target such as, for example, the lateral pterygoid muscle in TMD management, I recommend you use a larger applicator handpiece. It saves a lot of valuable clinic time plus my most recent research shows that use of a larger area of exposure is associated with a substantial increase in clinical success particularly in sub surface targets.7 The surface area of the contour (bleaching) handpiece is 2.8cm^2 (**Fig. 9**) and if this is held in contact with the tissues you can work more or less three times faster than you could with a 1 cm^2 spot size surgical handpiece, plus there is a greatly increased likelihood of a successful outcome. For cross infection purposes I suggest you cover the contour handpiece with a bag or a bit of cling wrap. It is not recommended to process the contour handpiece through the autoclave or use plasticizing powerful surface disinfectants as that can damage the device. When not in use, store it in its case and handle it with care as this is a useful device for sextant intra-oral applications and offers the best approach to treating subsurface pathologies if you don't have access to the deep tissue handpiece. If you opt to use the contour handpiece in contact, set the power output on the Epic to 1.4 Watts CW. This equates to the same average power exposure of 0.5Watts/cm2 as before except it is over a larger area of 2.8 cm^2 and as with the surgical handpiece in one second you will be able to deliver 0.5Joules/cm^2.

As for the deep tissue hand piece (**Fig. 10**), this is a highly useful tool for deep tissue work, and I recommend you acquire this attachment as it will rapidly prove really useful for extra-oral work. This tool has a spacer which you can adjust and I recommend you set the spacer at the final notch which is the 30mm mark. This gives you a working area of tissue exposure with the spacer in contact with the tissues of 7.1cm^2. With conditions such as TMD, there can be large areas of muscles to treat along with the lateral pterygoid, trigger points on the

FIGURE 8. PBMT delivered with a non-initiated 300 micron tip

FIGURE 9. The contoured Whitening Handpiece

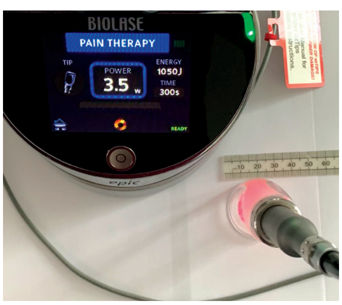


FIGURE 10. The Deep Tissue Handpiece

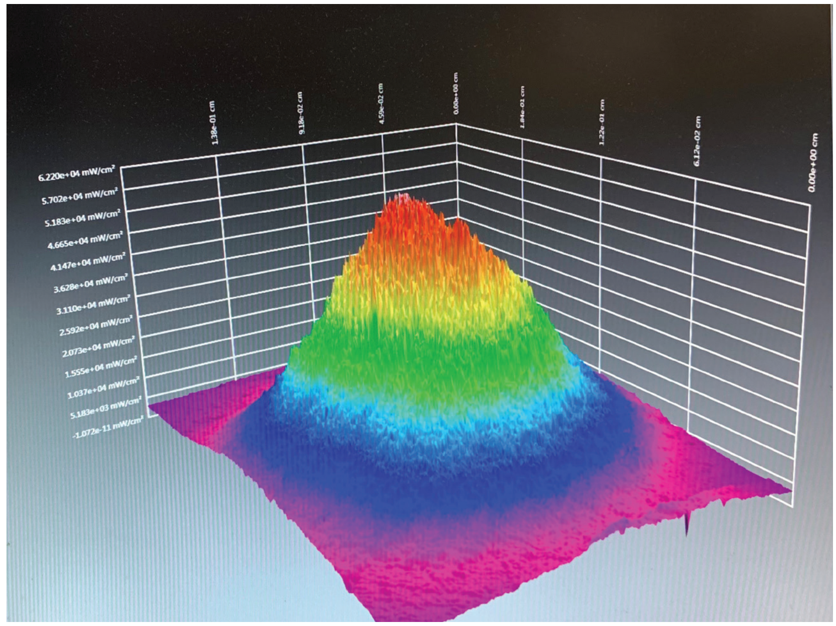


FIGURE 11. 3D profilometer Image of Gaussian beam

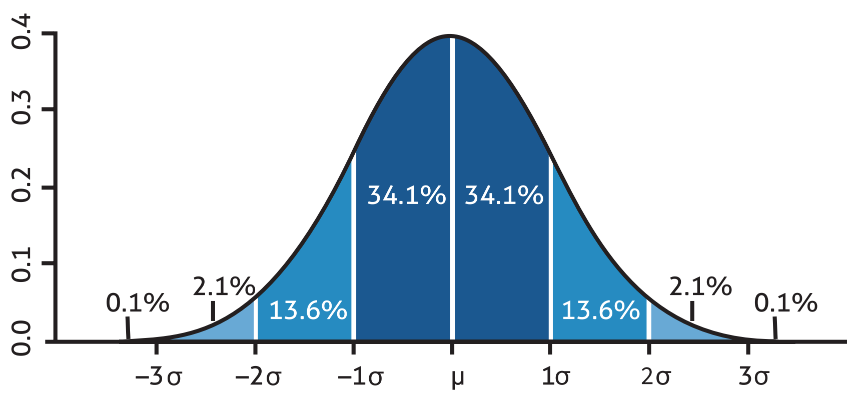


FIGURE 12. The spatial energy distribution of the Gaussian beam

trapezius, the junction of the sternocleidomastoid, the nuchal crest and, on occasion, if there is some trismus, other areas such as the temporalis or the masseter. Similarly, with extensive swelling associated with trauma or post-surgery this is the optimal tool of choice for any larger treatment targets as you can work around 3 times faster than the contour hand piece and 7 times faster than the surgical hand piece. If you decide to use the deep tissue handpiece in contact mode, set the output power to 3.5 Watts. Given the larger surface area of exposure this equates to a unit dose of around 0.5W/cm^2 over the 7.1cm^2 area and you will be delivering 0.5 Joules/second.

Having decided based on the target size, target depth and ergonomics which applicator device to use, the next decision is the treatment objective. Are you seeking to enhance healing and repair or are you seeking to relieve pain and inflammation? The evidence base clearly shows that there are two distinct tissue level dose windows for PBMT. The lower zone of 2-8 Joules/cm2 is good for photobiostimulation resulting in increased cellular volumes and an enhanced quality of repair. A higher zone of 10-20 Joules/cm2 is recommended for pain and inflammation relief.[8]

As you are delivering a uniform rate of energy for each centimeter exposed, you can then calculate how many seconds it will take. So, to deliver 5 joules/cm^2 with any surface applications this will take 10 seconds (0.5 Joules/s x10). To deliver a recommended dose for pain control of 15 Joules/cm^2 for the surface target, this will take 30 seconds (0.5 Joules/s x30).

However, there are other considerations to take into account before you start treatment. First of all, there is the depth of the target: is it superficial or is it sub surface? The dosimetry is the level of energy required at the target level. In comparison to some other diode laser wavelengths, the Epic 940 nm diode laser is not highly absorbed by the overlying tissues and the predominant effect is that the energy is widely scattered within the target. This results in energy losses such that you are left with only 5-10% of the energy delivered at the surface at 1 centimeter depth. In order to achieve a unit dose of 5 Joules/cm^2 at 1 centimeter depth, you have to supply a minimum of 10x the dose at the surface (50 Joules/cm^2). And to reach 15 Joules/cm^2 you have to deliver 150 Joules/cm^2 to the surface.

An important limitation to the treatment methodology is that when you are delivering higher doses to the surface, you can start to heat up the superficial tissues overlying your target. This is especially true with the larger handpiece attachments where due to the greater area of exposure and target depth of penetration, the overall power output must be higher. The energy distribution across the beam is not uniform, Gaussian beam profile is such that the middle third of the beam is 2-4 times higher energy than the perimeter (**Fig.11-12**). In order to overcome this difficulty and to deliver a more uniform dose without overheating tissues in the centre of the beam, it is advisable to adopt a slow sweeping motion.

Finally, there is the issue of deciding the length of duration of the treatment which varies depending on the size of the lesion as well as the extent of any regional involvement. For convenience, the approximate treatment size can be viewed as a multiple of the optical footprint. For example, if the sweeping motion covers surface area equal to 3 times the area of the contour handpiece ($3x2.8cm^2$), then the treatment time must be 3 times longer.

In conclusion, what are the safety aspects? Aside from the obvious need for the correct optical protective eyewear, the use of PBMT is a safe and gentle treatment modality. Patients may comment that it feels warm, however, this should not be anything other than a pleasant mildly warm and tingling sensation. For patients with heavy skin pigmentation, it can be more difficult to deliver the required dose to the target depth due to more superficial heat build-up. In this type of patient, it is recommended to extend the target areas to allow short breaks in order to permit time for the tissues at the surface to cool or apply a cold pack or simply air cool the exposed area. Your patients will definitely let you know if it is getting excessively warm and the settings presented here are very safe. The only contra-indication for PBMT is treatment around a suspect malignancy as its application in oncology deserves some added training and precautions in line with the current recommendations of the joint task force of the MASCC/ISOO.[3]

Once you truly understand the principles of PBMT, preferably with some structured clinical guidance and hands-on instruction, this is a really useful management tool which takes minutes to provide and can even be delegated to a suitably trained auxiliary. By minimizing post-operative pain and inflammation plus by optimizing the biological capacity of the tissues to repair, heal and regenerate, PBMT is a powerful tool that will distinguish you and your team from the competition and win you many friends among your patients. ■

ABOUT THE AUTHOR

Dr Mark Cronshaw is a general dental surgeon based in the South of England. He is a highly experienced BIOLASE approved laser instructor and has lectured Worldwide on oral laser applications. As a professor he taught oral lasers at the prestigious Genoa University Advanced Master's Degree and he is currently highly active in doctoral research into photobiomodulation therapies with academic affiliations to the University of Birmingham, UK and De Montfort University, Leicester. Over the past couple of years, along with his colleague and DELTA co-Director, Professor Steven Parker, hundreds of colleagues were trained to very good effect. For further information you can find details on DELTA training programs plus a supporting manual available at www.dentallaseracademy.co.uk.

The devices included in this article are not cleared by the FDA for the indications featured. The manufacturer, BIOLASE, does neither approve or condone of the methods used in this article and assumes no responsibility for complications or contra-indications in the illustrated use.

REFERENCES

1. Romagnoli, E.; Cafaro, A. Ch. 7: PBM. Theoretical and Applied Concepts of Adjunctive use of LLLT/PBM within Clinical Dentistry. In Lasers in Dentistry- Current Concepts; Coluzzi, D., Parker, S., Eds.; Pub. SpringerNature: Cham, Switzerland, 2017; pp. 125–157, ISBN: 978-3-319-51943-2, doi:10.1007/978-3-319-51944-9.
2. Hamblin, M.; Ferraresi, C.; Huang, Y.; Freitas, L.; Carroll, J. Low-Level Light Therapy: Photobiomodulation. TutorialTexts in Optical Engineering; SPIE Press: Bellingham, WA, USA, 2018; Volume TT115. ISBN 9781510614161.
3. Zadik, Y.; Arany, P.R.; Fregnani, E.R.; Bossi, P.; Antunes, H.S.; Bensadoun, R.-J.; Gueiros, L.A.; Majorana, A.; Nair, R.G.; Ranna, V.; et al. Systematic review of photobiomodulation for the management of oral mucositis in cancer patients and clinical practice guidelines. Support. Care Cancer 2019, 27, 3969–3983, doi:10.1007/s00520-01904890-2.
4. Merigo, E.; Rocca, J.-P.; Pinheiro, A.L.; Fornaini, C. Photobiomodulation Therapy in Oral Medicine: A Guide for the Practitioner with Focus on New Possible Protocols. Photobiomodulation, Photomedicine, Laser Surg. 2019, 37, 669–680, doi:10.1089/photob.2019.4624.
5. Aras MH, Güngörmüş M. The effect of low-level laser therapy on trismus and facial swelling following surgical extraction of a lower third molar. Photomedicine and laser surgery. 2009 Feb 1;27(1):21-4.
6. Kazancioglu HO, Ezirganli S, Demirtas N. Comparison of the influence of ozone and laser therapies on pain, swelling, and trismus following impacted third-molar surgery. Lasers in medical science. 2014 Jul;29(4):1313-9.
7. Cronshaw M, Parker S, Anagnostaki E, Mylona V, Lynch E, Grootveld M. Photobiomodulation Dose Parameters in Dentistry: A Systematic Review and Meta-Analysis. Dentistry Journal. 2020 Dec;8(4):114.
8. Cronshaw M, Parker S, Arany P. Feeling the heat: evolutionary and microbial basis for the analgesic mechanisms of photobiomodulation therapy. Photobiomodulation, photomedicine, and laser surgery. 2019 Sep 1;37(9):517-26
9. Cronshaw M, Parker S, Anagnostaki E, Lynch E. Systematic review of orthodontic treatment management with photobiomodulation therapy. Photobiomodulation, Photomedicine, and Laser Surgery. 2019 Dec 1;37(12):862-8.
10. Parker S, Cronshaw M, Anagnostaki E, Bordin-Aykroyd SR, Lynch E. Systematic Review of Delivery Parameters Used in Dental Photobiomodulation Therapy. Photobiomodulation, Photomedicine, and Laser Surgery. 2019 Dec 1;37(12):784-97.
11. Cronshaw, M.; Parker, S.; Anagnostaki, E.; Mylona, V.; Lynch, E; and Grootveld, M.; Photobiomodulation and oral mucositis: a systematic review Dent. J. 2020,8,87-114 doi: 10.1002/JPER.20-0028
12. Parker S, Anagnostaki E, Mylona V, Cronshaw M, Lynch E, Grootveld M. Systematic Review of Post-Surgical Laser-Assisted Oral Soft Tissue Outcomes Using Surgical Wavelengths Outside the 650–1350 nm Optical Window. Photobiomodulation, Photomedicine, and Laser Surgery. 2020 Oct 1;38(10):591-606.
13. Melnik I, Steiner R, Kienle A, Light penetration in human skin: in-vivo measurements using isotropic detector," Proc. SPIE 1881, Optical Methods for Tumor Treatment and Detection: Mechanisms and Techniques in Photodynamic Therapy II, (18 June 1993); doi:10.1117/12.146313

THE BENEFITS OF LASERS IN PRACTICE

Michaela ONeill discusses her introduction to lasers in dental practice and the benefits they can provide for hygienists in particular

By Michaela O'Neill, Dental Hygienist

Dentistry, May 2021; https://dentistry.co.uk/2021/05/02/lasers-vision-benefits/

INTRODUCTION

When I was first asked what I thought of lasers, I wasn't falling over myself to be first in the queue to use them. I am not an early adopter: I like confirmation that something works before I invest time in it. But in these days of evidence-based clinical decisions, I also realise that if we all waited for the unequivocal evidence to try something new, we would never move on in our treatment modalities.

So, I decided to be open to the use of lasers in my clinic. Fortunately, I was asked to attend a training seminar. I spent a day with leading laser user and periodontal specialist, Rana Al Falaki.

Rana has been a UK specialist in periodontics for more than 10 years. She is the owner and principal dentist at Al-Fa Perio Clinic. She was the first UK periodontist to use lasers in her daily practice and is an international speaker and BIOLASE laser-approved trainer. Rana lectures both in the UK and internationally on the subject, pioneering its use in this field.

She has published articles and presented research on the use of Er,Cr:YSGG laser, in both periodontology and peri-implantitis. So, when Rana invited me to her practice for the training seminar, I knew I was in good hands.

CHANGE OF HEART

The visit was a turning point for me. Until then, I was on the fence as to whether using a laser in my practice would have any benefit. This day really changed my mind. I assisted Rana that day (and for that I am still apologising!). As her patients attended, I went over the notes with Rana. The patients' periodontal diagnoses and their contraindications were discussed. Discussion of how treatment had progressed for that patient then followed.

Areas of potential problems were highlighted and after a new pocket and bleeding chart, the results checked. The pocket reductions were very high compared to what I would expect without surgery. The bleeding was overall well reduced generally. The treatment comprised of LA, USS and some hand instrumentation. The majority of the appointment was spent using the Er,Cr: YSGG laser to debride the pocket and remove granulation tissue from the pocket.

You could visibly see the gingiva look healthier by the end of the appointment.

One patient attended for the second half of her mouth to be treated. She was hesitant to undergo treatment that day. She complained of pain on the side that had been previously debrided and had limited opening as a result of this pain.

On examination a large ulcer was apparent.

Rana decided to use photobiomodulation therapy. This is also known as LLLT. Using the diode laser, she let the laser pulse in the affected area for a few minutes. Surprisingly (for me, as I think Rana expected this outcome), the patient sat through another hour of treatment with her mouth open and commented that the previous discomfort felt much better.

After this day I agreed to try a laser out.

LASER LOVE

I have since been using my diode to reduce bacterial load post NSPD and I love it for peri-implantitis. I feel I am giving an added boost to my Airflow or Perioflow treatments. Especially if there are areas of bleeding.

The tips are so thin and slightly flexible so they can step over the threads of the implant (Figures 1A and 1B).

It is still early days in my usage of lasers and I am in the process of assessing the outcomes. In general though, my diode laser unit, handpiece and tips are certainly easy to use and that was my main concern.

I have been amazed at the ease and effectiveness of lasers in my implant hygiene procedures and would encourage hygienists and therapists to at least investigate the use of lasers as part of their own professional development. ■

FIGURE 1A.

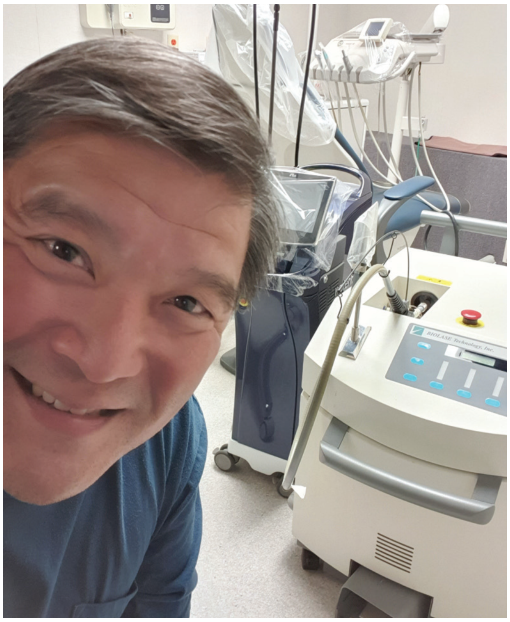
FIGURE 1B.

MEET THE MASTERS

Stanley Yasuhiro

My name is Stan Yasuhiro, a 1983 graduate of Marquette University School of Dentistry. Back in the 90's, I was looking for the magic bullet. I was looking at CO_2, Argon, Nd:YAG lasers to see if I could apply it in my dental armamentarium. But each one had very specific uses, and mainly in the medical arena. Then, along came the beer cooler looking metallic box with wheels in 1999 that touted lasers for teeth and painless dentistry. This was what I was looking for.

At the 2000 ADA Annual Session, I wanted to look at the new "Millenium" from BIOLASE of San Clemente, CA. I couldn't miss it as it had a huge "Painless Dentistry" sign hanging over their booth. I talked to the sale reps about buying one, and when they found out that I was from Guam, they balked and called their GM, Keith Bateman. After some discussion, I was told they would not sell a unit to Guam unless I became a BIOLASE trained Er,Cr:YSGG service technician. This was perceived as either a deterrent, or a challenge. So, I agreed to become a laser tech, or as they are now called "Field Service Engineer". This is when I met Pedro Pantoja, Doc Nguyen and Peter Pham. I look up to these people as they are still with the company and helped me out with my laser journey. Other people that were there to offer guidance during my quest for the magic bullet were Jenine McQuaid and Kirk Striler. I still have my Millenium, or as the old timers named it affectionately "Zamboni".



So as the saying goes "been there and done that" pretty much sums up my Er,Cr:YSGG experience in the last 21 years. In 2002, I was asked to present a lecture and introduce the Biolase Millennium at a Hawaii Dental Association meeting organized by my dental idols in Hawaii, George Wessberg DDS and Bill Sheerer DDS, at the Queens Hospital lecture hall. There were no "Er,Cr:YSGG laser lectures" during those days. Then, around 2004, I heard a dentist named Chris Walinski was running a group of laser dentists called WCLI. As years passed, more studies were being done on lasers and some of my thoughts on the use and effectiveness on lasers were being supported. On painless dentistry, I found about two thirds of the patients were ok without anesthesia and the remaining third had some sensations ranging from "felt cold" to "ouch". Marina Polonsky's study on tooth pain with the laser pretty much corroborated with my experience. I listened, watched, modified, developed and tried techniques that are being used today. Receiving

Mastership at WCLI in 2018 was nice as it shows the level of knowledge on lasers and recognizes you as an expert in the field. But, in my office, laser dentistry is still about developing and modifying techniques, and undergoing evaluation on effectiveness using new information introduced to dentistry with ongoing research.

Laser is not my only dental hobby, many other dental disciplines are of interest as well. Full mouth rehab with RPDs or C&B, along with implants, perio surgeries (Modified Widman fan), endo, third molars, TMD and, of course, Cosmetics are all "fun". However, I will find a laser use whenever and wherever I can.

I really like sports. I played, coached, and supported as an enthused parent in baseball, softball, football (American) and motocross. In 2012 and 2013, I became the FIM Asia Veteran Champion racing in various countries in Asia. Now, I don't race as much, but stayed in motorcycling as Deputy President of FIM Asia, President of Guam Motorcycle and ATV Corporation and in the process of re-certifying as FIM Asia Stewards in Environment and Sustainability, Circuit Racing and Motocross. Also, Guam is a great place to fish if you are into pelagics.

Yes, the Er,Cr:YSGG laser is not the golden bullet or the magic wand, but I cannot provide the optimal treatment and service without it. It has become required equipment in our office. And it really helps to have a laser cheerleader, Steve Jang, jumping up and down to keep the excitement level goin g. Looking back 21 years and to the future, the age of laser dentistry has just begun!

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