

PERIODONTICS

Eight-Year Retrospective Review of Laser Periodontal Therapy in Private Practice

By Robert H. Gregg II, DDS; Delwin K. McCarthy, DDS

In four previously published articles in *Dentistry Today*, the authors presented 10 radiographic case study examples of bone and periodontal ligament (PDL) regeneration around severely compromised periodontally involved teeth.¹⁻⁴ It has been argued by some skeptics of our work that while those clinical examples are individually impressive, they are isolated and atypical examples of success, and not likely to be repeatable.

In this article we present the results of an 8-year retrospective review of 22 patients randomly selected from over 800 patients in our private practice patient database of patients treated with a patented laser-based periodontal treatment protocol. The results of this retrospective study treating moderate to severe periodontal cases using laser periodontal therapy (LPT) for consistent bone regeneration are not random, occasional happenstance, but routine and reproducible.

BACKGROUND

LPT is a laser-based procedure developed specifically for the treatment of moderate to advanced periodontitis. It was patterned conceptually after the Excisional New Attachment Procedure (ENAP)⁵ to selectively dissect epithelium, as well as diseased and necrotic tissue, from the connec-

tive tissue predominately composed of collagen.⁶ Lasers are not used as replacements for the scalpel. Scalpels cannot approach the kind of differential selectivity needed to separate thin discrete tissue types.

Originally referred to as Laser-ENAP,^{1,2} LPT has evolved to provide a minimally invasive and stand-alone alternative to osseous flap surgeries for infectious or inflammatory periodontal disease. Other advantages of LPT include improved hemostasis intraoperatively and improved patient comfort and acceptance. The procedure combines the best aspects of laser soft tissue surgery with well-established principles of periodontal disease management.

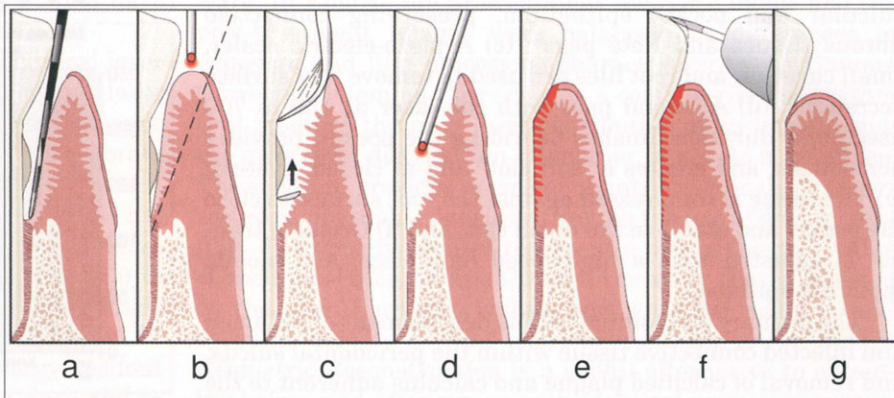


Figure 1. Step-by-step surgical technique for LPT.

MATERIALS AND METHODS

Twenty-two patients were randomly selected from a sample of over 800 patients treated. Pocket depths were recorded before treatment and within 24 months after treatment by different examiners (New Attachment Methodology). Before and after radiographs were digitized and analyzed with Digital Subtraction Radiography (DSR) using Emago, and evaluated by an independent reviewer for hard tissue density changes (Note 1).

A Free-Running (FR) pulsed Nd:YAG PerioLase prototype laser was used for these patients (Note 2). A benefit of this laser is the availability of five pulse durations (Note 3). Troughing around the tooth was typically done with a "short pulse" having duration of 100 to 150 μ sec. Pulse energy was set to 160 to 200 mJ, and repetition rate was 20 Hz, giving an average power of 3.4 to 4 W. The parameters for the coagulating or "long pulse" used to finish the procedure were 500 to 700 μ sec duration, 215 mJ, 20 Hz, giving an average power of 4.3 W, as confirmed using a power meter (Note 4). (Please note: 4.3 W average power is NOT recommended for anyone except the most experienced or expertly trained laser user [Note 5]).

Another advantage of this laser system is the readout of total energy delivered during the procedure. This value is essential in determining the light dose (Note 6). To compute light dose the total energy delivered is divided by the sum of the depths of all pockets, which was typically 15 to 17 Joules per mm pocket depth.

The indications for LPT are the same as for standard therapies and include: probing depths ≥ 4 mm; hemorrhage following probing; infection in the surrounding gingival tissue (erythema and edema); visible tooth mobility; radiographic evidence of bone loss; and positive lab tests for periodontal pathogens. Patients who decline to cooperate seem to be the only contraindication to performing LPT.

The step-by-step surgical technique is outlined in Figure 1: (a) Periodontal probing indicates excessive pocket depth; (b) Laser troughing: FR (Note 1) pulsed Nd:YAG laser irradiation, at 100 to 150 μ sec pulse duration. Beginning at the gingival crest (not into the sulcus at first). Troughing provides visualization of and access to the root surface by removing necrotic debris, releasing tension, and controlling bleeding. It further defines tissue margins preceding ultrasonic and mechanical instrumentation, preserves the integrity of the mucosa, and aids maintenance of the gingival crest. This technique provides the selective removal of sulcular and pocket epithelium, preserving connective fibrous tissues and Reté pegs⁶; (c) A piezo-electric scaler, small curettes, and root files are used to remove root surface accretions; (d) A second pass with the laser at 150 to 700 μ sec pulse duration finishes debriding the pocket, provides hemostasis, and creates a "soft clot" and a "closed" system; (e) The tissue is compressed against the root surface to close the pocket and stabilize the fibrin clot; and (f) Occlusal trauma is adjusted with a high-speed handpiece, and mobile teeth are splinted.

The primary endpoint of LPT is debridement of inflamed and infected connective tissue within the periodontal sulcus, and removal of calcified plaque and calculus adherent to the root surface. In addition, the bacteriocidal effects of the FR

pulsed Nd:YAG laser⁷⁻¹⁰ plus intraoperative use of topical antibiotics are designed for the reduction of microbiotic pathogens (antiseptics) within the periodontal sulcus and surrounding tissues. The wound is stabilized and occlusal trauma minimized to promote healing. Oral hygiene is stressed and continued periodontal maintenance is scheduled.

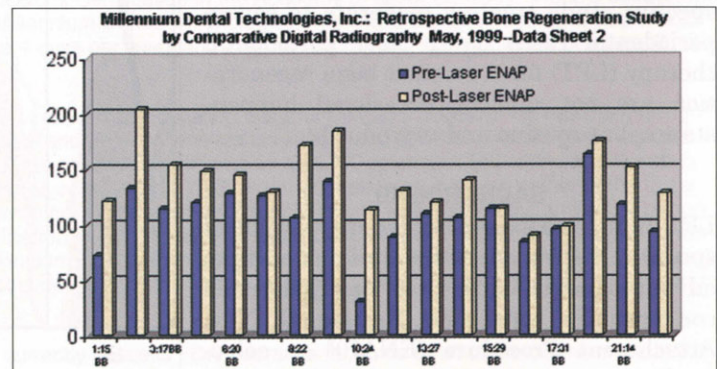
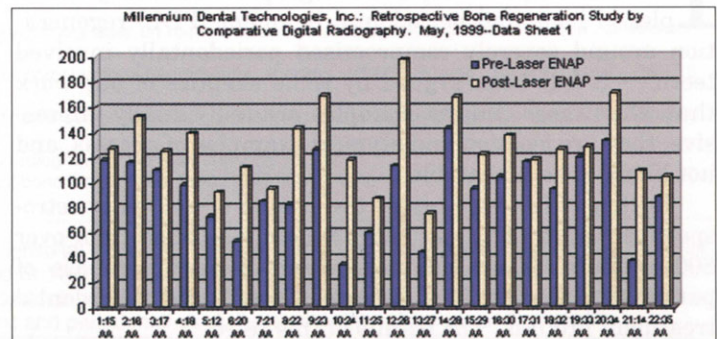
The desired result (g) is achieving new attachment (ie, new bone, PDL, cementum) to the root surface thereby decreasing pocket depth.

RESULTS

While the individual data points were highly variable, one finding was hard to ignore. In every patient and in every pocket site evaluated, bone had regenerated. In some cases the bone regenerated was only a slight improvement, and in other cases the bone regeneration was dramatic. Pre-laser ENAP and post-laser ENAP data sheets of 40 sites are presented as representative samples, and indicate graphically the range of results. In 100% of the bone density profiles using comparative radiography (Emago), the bone regenerated and bone density increased, however slight it may have been (Figures 2 and 3).

Calculating all the data points of probe depth reduction resulted in a mean pocket depth reduction of 2.49 mm (40% pocket depth reduction), with no observed recession. Mean bone density profiles were also measured using Emago. Again, the results were encouraging: bone density around all teeth increased an average of 38%. Some teeth increased less, some increased considerably more (Figure 4).

A representative radiograph shows the "average" findings (Figure 5). Crestal/horizontal height has clearly increased, but the quality and density of the bone is what stands out. Also evident is new cortical crestal bone, lamina dura, and a defined PDL space.



Figures 2 and 3. Bone density profiles using comparative radiography.

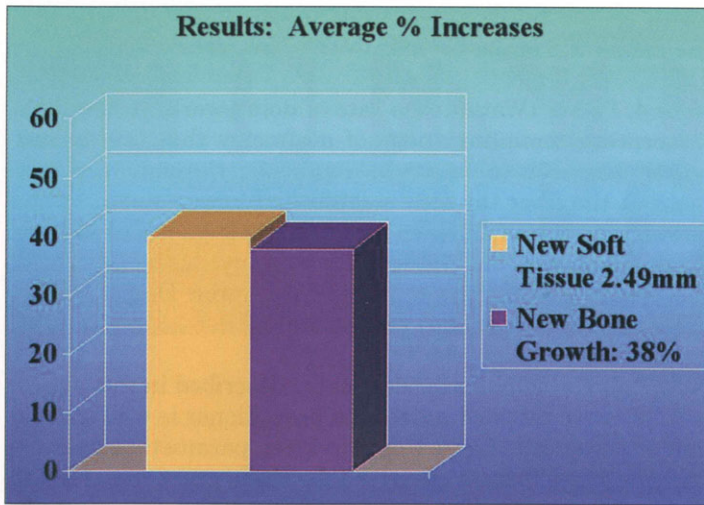


Figure 4. Comparison of bone density profiles.

DISCUSSION

The changes we have observed in bone density are an improvement to those reported by Dubrez et al (1990).¹¹ They wrote, "The superficial bone density was, on the average, 13% higher at 6 months and 16% higher at 1 year, as compared to that measured immediately after treatment. The improved bone density observed at 1 year could be predicted from the decrease in pocket depths measured clinically at 2 and 6 months and, with a high degree of statistical significance, from the gain of attachment measured at 6 months."

Comparison of our preliminary radiographic findings with this study are useful because their quantitative radiographic analyses are identical in concept to the density profiles generated by Emago. While the comparative digital radiography in the 40 sampled sites indicate that 100% demonstrated increased bone density by an average of 38%, or twice as high as the 10 cases reported in the Dubrez study, and all pockets reduced an average of 2.49 mm or 40%, our clinical experience indicates a larger sample size of patients and probing sites will find that some pockets and some bone around a few teeth do not improve regardless of what methods are employed.

More detailed, quantitative comparative analyses of the efficacy of LPT with a larger sample size are in preparation. These results, however, can be compared with published data for a better understanding of how these patients have fared relative to alternative treatments.

In over 25 combined years of research and clinical laser experience we have had the opportunity to use most laser wavelengths, device configurations, and delivery systems. We have applied our experience and research to calibrate the laser parameters and modified our protocol as we went along. When we evolved from using the dLase 300 to the Multi-Variable Pulse PerioLase II (Millennium Dental Technologies), the availability of longer pulse durations (100 to 650 μ sec) dramatically improved intraoperative hemostasis and shortened the overall time in the chair by 50%, from 90 minutes per quadrant to 45 minutes. The energy readout (fluence) has allowed us to keep track of light dose and to

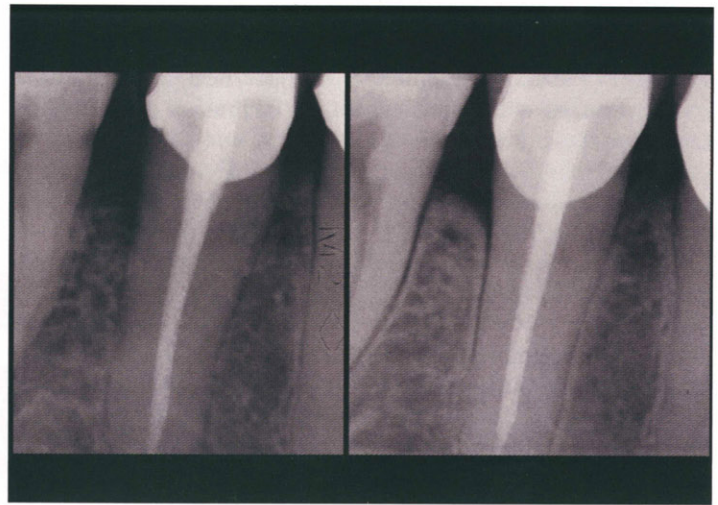


Figure 5. Before and after radiographs depicting qualitative increase in bone density.

compare dosimetry with clinical outcomes. From this we have developed procedural-based dosimetries. We have also added modifications to the overall treatment program. Over the years LPT has evolved to the proper application of laser technology plus a medically sound approach to wound management, together with real-world clinical efficiencies in implementation and applicability.

CONCLUSION

The results we report here in no way suggest that other methodologies for treating periodontal disease do not also lead to the increase in bone density around teeth. However, the results of this study strongly indicate that using a FR Nd:YAG pulsed laser in the sulcus provides an additional benefit for increasing bone density and reducing pocket depths over what conventional scaling and root planing can achieve.♦

Acknowledgment

We thank David M. Harris, PhD, of Bio-Medical Consultants, Inc, in Castro Valley, Calif, for data processing and graphic presentations.

Notes

Note 1. Analog X-ray films were digitized and analyzed with Emago (Advanced Medical Devices) and Photoshop software. In Emago, the pretreatment reference image and the post-treatment images were balanced for differences in exposure and film processing characteristics with Gamma Correction. Gamma Correction is a computerized algorithm that modifies the gray level distribution of an image using the gray level distribution of another image as a reference. The software provides means of quantitative analysis of corrected radiographic densities through the use of density profiles. The density profiles represent a plot of the gray value of each pixel along a line through the x-ray that is selected by the user. Each gray value represents the relative radiographic density at that point in arbitrary units. Emago Geometric Reconstruction is a useful alternative to obtaining before and after x-rays with identical projection geometry.

try. In Subtraction Radiography this is provided by consistently using individual bite blocks or other aiming techniques.¹¹⁻¹³ Emago Geometric Reconstruction produces a pair of images with identical image formation geometry by mapping the information contained in one image onto the projection plane of a reference image. After projection corrections and density analysis the two images were combined to produce one side-by-side image that was filtered in Photoshop (contrast and sharpness) to enhance visualization of bony features.

Note 2. Free Running (FR) is the measure of the time duration of a single pulse in the 10⁻⁶ sec or millionths of a second or microseconds (µsec). This allows for high peak powers in the order of 1,000 to 2,000 W per pulse, and pulse intervals are 500 times longer than the pulse “on” time.

Note 3. Pulse Duration can be measured several ways depending on whether the pulse is digital or analog. Digital pulse durations are qualitatively and quantitatively different than analog pulse durations. An analog pulse has a Gaussian profile (ie, a sine wave), where the digital pulse is square. Digital pulse durations are more accurately measured than analog because the shape of the area measured is a discrete area versus an alternating wave front. The convention used here is known as Full Width/Half Max. That is the pulse time (duration) in microseconds measured the full

width on the “x” axis (width) of an oscilloscope at one-half the maximum of the “y” axis.

Note 4. Power (Watts): The rate of doing work. It is critical to accurate communications of dosimetry that therapeutic power delivered to tissue be confirmed through measurement at the fiber tip with a calibrated power meter, as the power can vary as much as 30% or more from the power settings displayed on the console of any laser device. A PowerMax PM600 power meter (Moletron Detector) was used in both case studies presented.

Note 5. CAUTION. Laser dosimetry described in this article is NOT recommended unless the practitioner is well trained and experienced. Exceeding the laser parameters or overtreating large defects described for these cases may lead to prolonged healing, tissue and tooth loss, and other complications.

Note 6. Light dose (Joules per mm pocket depth) is similar to drug dose (mg per kg body weight) in that light dose defines the concentration of laser energy at the treatment site, in a similar manner as drug dose defines the concentration of a drug in the tissues. Light dose is a very useful parameter inasmuch as certain clinical outcomes of laser surgery (eg, adverse effects) are dose dependent.

References

1. Gregg RH, McCarthy DK. Laser ENAP for periodontal bone regeneration. *Dent Today*. 1998;17:88-91.
2. Gregg RH, McCarthy DK. Laser ENAP for periodontal ligament (PDL) regeneration. *Dent Today*. 1998; 17:86-89.
3. Gregg RH, McCarthy DK. Laser periodontal therapy: case reports. *Dent Today*. 2001;20(10):74-81.
4. Gregg RH, McCarthy DK. Laser periodontal therapy for bone regeneration. *Dent Today*. 2002;21(5):54-59.
5. Yukna RA, Bowers GM, Lawrence JJ, et al. A clinical study of healing in humans following the excisional new attachment procedure. *J Periodontol*. 1976;47:696-700.
6. Gold SI, Vilardi MA. Pulsed laser beam effects on gingiva. *J Clin Periodontol*. 1994;21:391-396.
7. Moritz A, Schoop U, Goharkhay K, et al. The bactericidal effect of Nd:YAG, Ho:YAG and Er:YAG laser irradiation in the root canal: an in vitro comparison. *J Clin Laser Med Surg*. 1999;17:161-164.
8. Whitters CJ, MacFarlane TW, McKenzie D, Strang R., Moseley H. (1994). The bactericidal activity of pulsed-Nd:YAG laser radiation in vitro. *Lasers Med Sci*. 1994;9:297-303.
9. Cobb CM, McCawley TK, and Killoy WJ. A preliminary study on the effects of the nd:yag laser on root surfaces and subgingival microflora in vivo. *J Periodontol*. 1992;8:701-707.
10. Neil ME and Mellonig JT. Clinical efficacy of the Nd:YAG laser for combination periodontitis therapy. *Pract Proced Aesthet Dent*. 1997;9 (Supplement):1-5.
11. Dubrez B, Graf JM, Vuagnat P, Cimasoni G. Increase of interproximal bone density after subgingival instrumentation: a quantitative radiographic study. *J Periodontol*. 1990;61:725-731.
12. Grondahl HG, Grondahl K, Webber RW. A digital subtraction technique for dental radiography. *Oral Surg*. 1983;55:96-102.
13. Grondahl HG, Grondahl K. Subtraction radiography of the diagnosis of periodontal bone lesions. *Oral Surg*. 1983;55:203-218.

Dr. Gregg is a past faculty member at UCLA School of Dentistry, Section of Hospital Dentistry. He has been using lasers clinically since August, 1990, including CO₂, Pulsed Nd:YAG, surgical and photopolymerization Argon, and Er:YAG. He has given lectures nationally and internationally on the subject of clinical laser applications, and has conducted seminars for UCLA Department of Continuing Education. In addition to authoring several peer-reviewed articles on the clinical applications of pulsed Nd:YAG for endodontic and periodontal uses, he is an author of the Laser Curriculum Guidelines, versions 1 & 2. Dr. Gregg has obtained his Mastership and Educator's Certification in the Academy of Laser Dentistry. He is a codeveloper of the FDA-cleared PerioLase pulsed Nd:YAG laser, and is a founder of Millennium Dental Technologies, Inc. He is a codeveloper and patent holder of the Laser ENAP periodontal technique. He maintains a private practice 4 days per week and may be reached at (562) 860-6587 or rgregg@millenniumdental.com/.

Dr. McCarthy is a past faculty member at UCLA School of Dentistry, Section of Advanced Education General Dentistry (AEGD). He has been using lasers clinically since November, 1989, including CO₂, Pulsed Nd:YAG, surgical and photopolymerization Argon, and Er:YAG. He has given lectures nationally and internationally on the subject of clinical laser applications, and has conducted seminars for UCLA Department of Continuing Education. In addition to authoring several peer-reviewed articles on the clinical applications of pulsed Nd:YAG for periodontal uses, he is an author of the Laser Curriculum Guidelines, versions 1 & 2. Dr. McCarthy served as an executive officer in the International Academy of Laser Dentistry, and wrote its constitution and by-laws. He has obtained his Mastership and Educator's Certification in the Academy of Laser Dentistry. Dr. McCarthy is a codeveloper of the FDA-cleared PerioLase pulsed Nd:YAG laser, and is a founder of Millennium Dental Technologies, Inc. He is a codeveloper and patent holder of the Laser ENAP periodontal technique. He divides his time between practicing dentistry and teaching laser periodontal therapy. He may be reached at (562) 860-2908 or dmccarthy@millenniumdental.com/.

Millennium Dental Technologies, Inc., distributor of the PerioLase, does not currently possess FDA clearance for some or all of the claims made in these articles.

Disclosure: Drs. Gregg and McCarthy developed the FDA-cleared PerioLase pulsed Nd:YAG laser, and are founders of Millennium Dental Technologies, Inc. They developed and hold the patent for the Laser ENAP periodontal technique.