

PERIODONTICS

Laser-Assisted Periodontal Regeneration With the LANAP Protocol

INTRODUCTION

In this article, we present a single case report involving a lower right molar that includes a clinical and serial radiographic laser-assisted regeneration (LANAP protocol) result over a 13-year time frame.

Key Points Regarding the LANAP Protocol

In the LANAP protocol, no exogenous materials, such as growth factors, bone grafting, and biologics, are used. The true periodontal regeneration achieved in the LANAP protocol is accomplished by using the patient's own blood proteins that contain stem cells, native growth factors, and blood constituents. The blood is thermally affected in the LANAP protocol in such a manner that the regenerative factors are trapped within a red thrombus that is formed using scientifically determined algorithms of optimal laser operating parameters.

In the LANAP protocol, there is a lack of any wide surgical access outside of the bony housing, a lack of deep dissection into the vestibule or across the palate, and a lack of extensive vertical releasing incisions. The LANAP protocol uses a minimally invasive periodontal flap to enable access under the periosteum and directly to bone for an ostectomy and/or osteotomy. The soft tissues are thereby easily approximated and stabilized without the need to suture with tension to adapt the margins of the flaps together.



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Background

Periodontitis is an infectious disease that progressively destroys the alveolar bone, periodontal ligament (PDL), and root cementum that attach the teeth to the bone. Destruction of this attachment apparatus results in the loss of teeth. The ultimate aim of periodontal regeneration techniques is to induce or guide healing to regenerate the morphology back to its original configuration. In order to evaluate a regeneration technique experimentally, a notch is made on the root surface at the bottom of a periodontal pocket to provide a histological landmark for the apical extent of the destruction.¹

Periodontal regeneration on a previously diseased tooth root surface is a unique, challenging, and elusive healing event to obtain in humans.^{FN-1} True periodontal regeneration requires the 3 original components of the periodontal apparatus to arise anew and eventually form into new cementum, a new periodontal ligament, and new alveolar bone.^{FN-2}

Kao et al² is the most recent in a long series of literature and systematic reviews of published methods to achieve periodontal regeneration.³⁻¹² Current approaches include demineralized freeze-dried bone allografts (DFDBAs), guided tissue regeneration (GTR), bone fill with enamel matrix derivatives (EMDs), recombinant human platelet-derived growth factor BB (rhPDGF-BB), and open flap debridement (OFD). Kao et al² have

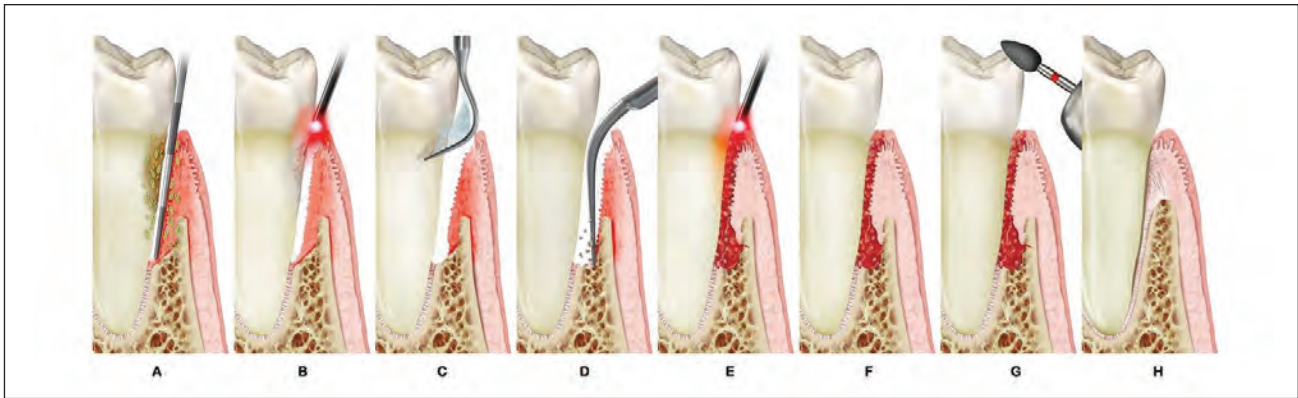


Figure 1. The LANAP protocol: The step-by-step surgical technique is outlined here. **(a)** Periodontal probing indicates excessive pocket depth. **(b)** Laser Troughing: Free-running^{FN-1} pulsed Nd:YAG laser irradiation is done at short pulse duration or longer, as warranted. Troughing provides visualization of, and access to, the root surface by removing necrotic debris, releasing tension of circumferential periodontal fibers, and controlling hemorrhages. 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 diseased, infected, inflamed, ulcerated pocket epithelium, preserving connective fibrous tissues and rete ridges.^{21,22} **(c)** A piezo-electric scaler with specialized tips is used to remove root surface accretions. **(d)** Bone modification by osteoplasty and/or ostectomy is performed, and angiogenesis is promoted. **(e)** A second pass with the laser at 150 to 650 μ sec pulse duration finishes debriding the pocket; provides hemostasis; and creates a “soft clot,” or red thrombus, resulting in a “closed” biologic thermogenic wound (fibrin clot) from the deep bony defect to the gingival collar. **(f)** The tissue is adapted against the root surface to create a thin-film clot and stabilize the fibronectin. **(g)** Occlusal trauma is eliminated with a high-speed handpiece, and mobile teeth are splinted. **(h)** True periodontal regeneration occurs.

included a new category of regenerative approaches termed laser-assisted regeneration (LAR), which is identified specifically as the Millennium Dental Technologies LANAP protocol using the PerioLase pulsed Nd:YAG Dental Laser System.^{FN-3} Based on the review of 2 peer-reviewed studies of human histology following LANAP treatment,^{13,14} Kao et al² conclude, “Using the Nd:YAG laser with this [LANAP] procedure, periodontal regeneration is achievable on a previously diseased root surface.”

Data from the first human histology study post-LANAP protocol by Yukna, Carr, and Evans¹³ in 2007 was submitted to the FDA in 2003. Healing at 3 months clearly showed new attachment and evidence of regeneration. Subsequently, the FDA granted marketing clearance (510(k) No. K030290) on July 26, 2004, for the claim “Laser assisted new attachment procedure (cementum-mediated periodontal ligament new-attachment to the root surface in the absence of long junctional epithelium).” The second, more recent study by Nevins et al¹⁴ looked at healing 9 months following LANAP treatment. They concluded, “This report provides evidence that LANAP therapy can induce periodontal regeneration.”¹⁴ This data from the human histology study by Nevins et al¹⁴ was submitted to the FDA, which granted marketing clearance (510(k) No. K151763) on March 15, 2016, specifically for the PerioLase pulsed Nd:YAG Dental Laser System for the clinical outcome claim:

Periodontal regeneration—true regeneration of the attachment apparatus (new cementum, new periodontal ligament, and new alveolar bone) on a previously diseased root surface when used specifically in the LANAP protocol.

In 4 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.¹⁵⁻¹⁸ It was argued by some skeptics that while those clinical examples are individually impressive, they are isolated and atypical examples of success and not likely to be repeatable. However, in a recent *Dentistry Today* CE article,¹⁹ we reviewed 2 human histology investigations by 2 different groups of investigators (Yukna, Carr, and Evans¹³ and Nevins et al¹⁴). This review combines the histologic findings from those investigations and offers an explanation as to why the case studies had successful outcomes. In this article, we present a single case report to add to the accumulating body of evidence that shows stability over a span of 13 years.

The LANAP protocol is a laser-based periodontal regenerative procedure invented by the lead author and developed specifically for the treatment of moderate-to-advanced periodontitis. It was patterned, conceptually, after the excisional new attachment procedure (ENAP)²⁰ to separate the epithelium from the underlying connective tissue dermis and to selectively vaporize and disrupt diseased, infected, inflamed, and necrotic tissue from the connective tissue.^{21,22} Lasers are not used as replacements for the scalpel. Scalpels cannot approach the kind of differential selectivity needed to separate thin, discrete tissue types.

The LANAP protocol, which retains the original 26 sequential steps, was initially referred to as Laser-ENAP,^{15,16} then laser periodontal therapy (LPT) due to FDA insistence over possible confusion with scalpel ENAP. The human histology study performed by Yukna, Evans, et al¹³ in 2003 was the basis for the novel FDA 510(k) clearance for the laser-assisted new attachment procedure in 2004.

The LANAP protocol is, by definition, a one-time full-mouth treatment protocol as a complete replacement alternative to osseous resective periodontal surgery and/or scaling and root planing. The LANAP protocol is completed in a one-half mouth treatment of

TABLE 1. LIGHT DOSE PER QUADRANT/TOOTH

Quadrant/Tooth	Total Joules	Total 6 Point Periodontal Probe Depth	Average Joules per Tooth (Total J/6)	Light Dose
Upper right	2,543 J	257 mm	423.8 J	9.89 J/mm PD
Lower right	1,861 J	242 mm	310.2 J	7.69 J/mm PD
Tooth No. 30	553.7 J	72 mm	553.7 J	7.69 J/mm PD

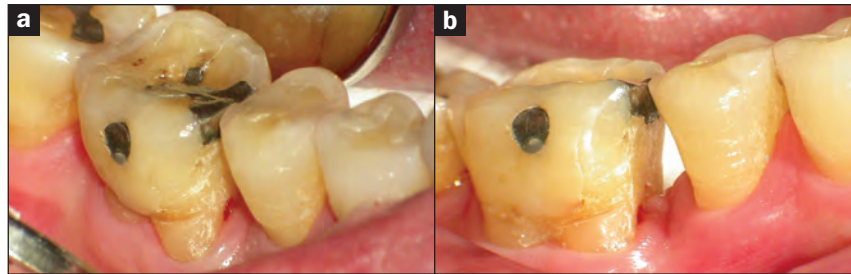


Figure 5. Lower right molar No. 31, 6-year clinical postoperative image. Note the intentional and complete removal of the distal amalgam and the majority of the central occlusal amalgam as part of the LANAP protocol in 2006. Proximal teeth “guard” the molar from occlusal trauma. Bleeding on probing was noted on the mesial, and inflammation was treated with scaling and root planing and laser pocket disinfection.

built-in power meter.^{FN-6} (Please note: Exceeding an average power of 4.0 W is not recommended for anyone except the most experienced or expertly trained laser user.^{FN-7})

Another advantage of this laser system is the display of total energy delivered to the oral tissues during the procedure. This value is essential in determining the *light dose* (joules per millimeter pocket depth [J/mm PD]).^{FN-8} The light dose is calculated by dividing the total energy delivered by the sum of the depths of all pockets to safely dose the tissue with the appropriate range of light energy, which will safely range between 12 to 17 J/mm PD (Figure 1).

The bactericidal effects of the FR pulsed Nd:YAG laser,²⁴⁻²⁷ plus the intraoperative use of topical antibiotics, are designed for the reduction of microbiotic pathogens (antiseptis) within the periodontal pockets and bony defects and the surrounding tissues. The red thrombus is stabilized, and occlusal trauma is eliminated to promote true periodontal regeneration. Oral hygiene is stressed, and continued periodontal maintenance is scheduled.

The desired result is to achieve true periodontal regeneration (ie, new bone, PDL, and cementum) to the root surface, thereby decreasing pocket depth by 50% in more than 90% of patient pockets through regeneration, not amputation.

CASE REPORT

Patient: A 59-year-old male (Figures 2 to 5).

February 21, 2006: Consult.

Chief Concern: To avoid conventional surgery for the treatment of his bleeding gums.

Medical: The patient reported no health conditions or medica-

tions. He developed brain cancer in 2009 and Parkinson’s disease in 2012.

Consultation and Exam: The patient had heard of LANAP treatment from a television report. A periodontal risk assessment and prognosis form were completed with the patient. Informed consent was given after reviewing the alternatives, risks, and benefits with the patient, including no treatment. He declined alternative treatment options.

The LANAP protocol was reviewed with the patient, as well as the full-mouth treatment sequence of 2 visits, each one treating one-half of the mouth, plus a post-op assessment. The patient was informed that the LANAP protocol requires “spot grinding” of the teeth and any crowns and, separately, that laser treatment is not a “magic wand.” Laser safety was reviewed with the patient.

Patient risk assessment/patient report:

- Hygiene appointment 3 years prior
- No history of periodontal surgery
- Diagnosis of periodontal disease
- Recommendation for conventional scalpel and suture surgery
- Gingival tissues bleed “badly”

Clinical findings:

- Soft tissues were red and inflamed
- A presence of generalized calculus
- Gingival recession and mucogingival defects
- Light probing revealed generalized 6-mm-plus probe depths and bleeding on probing
- A Class IV vertically compressible mobility of tooth No. 30

Diagnosis: Generalized, severe, chronic, adult periodontitis; Case Type IV.

Prognosis: Guarded.

March 13, 2006: The right upper/lower quadrants were treated.

March 20, 2006: The left upper/lower quadrants were treated.

Bone Density

Clinical comparison of the LANAP Protocol pretreatment with post-radiographs indicates the formation of new bone. We have not completed the analysis that will indicate the frequency of this occurrence, but we can suggest that it is frequent among LANAP protocol patients. In a previous study, we presented 40 patient outcomes where sampled sites indicate that 100% of the cases demonstrated increased bone density by an average of 38%.²⁸ Crestal/horizontal height had clearly increased, but the quality and density of the bone was especially noteworthy. Also evident was new cortical crestal bone and lamina dura and a defined PDL space.

Light Dosimetry

Critical to patient safety and treatment efficacy is the ability to record and document the Joules per millimeter pocket depth (J/mm PD) of the quadrants of teeth and/or of a specific tooth. This allows the clinician to maintain the proper exposure of infrared thermal laser energy to oral tissues and eliminate adverse treatment outcomes of teeth, soft tissue, and bone.

This patient received only one full-mouth treatment of the LANAP protocol in 2006 and received no repeat treatments with the LANAP protocol.

As discussed previously in the Materials and Methods section, light dose (Joules per millimeter pocket depth) was calculated for this patient. In the 2 quadrants reported in this article, there were 6 teeth per quadrant. Their values are shown in Table 1.

CLOSING COMMENTS

The results reported here in no way suggest that other non-laser methodologies for treating periodontal bony defects (eg, guided bone regeneration) do not also lead to periodontal regeneration (eg, Straumann Emdogain). However, the LANAP protocol is a full-mouth protocol vs a site-specific regenerative treatment.

The results of real-world case results, confirmed by the research gold standard of human histology, confirm that using an FR pulsed Nd:YAG laser with optimized operating parameters, together with appropriately applied treatment algorithms, provides an additional benefit of true periodontal regeneration and reduced pocket depths over what conventional scaling and root planing, or osseous surgery alone, can achieve.^{FN-9} Furthermore, the LANAP protocol is another approach to minimally invasive surgical therapies, a *minimally invasive surgical approach* that may offer advantages in the regeneration of defects, and may be appropriate for multiple defects as a first line of management.² ♦

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Footnotes

1. "Currently, osseous grafting and guided tissue regeneration (GTR) are the 2 techniques with the most histologic documentation of periodontal regeneration. Other regenerative therapies have also provided a promising potential for significantly improving clinical parameters and demonstrating substantial "fill" of treated defects. However, only limited histologic evidence of true regeneration has been demonstrated with the majority of these therapies."¹
2. "Regeneration refers to the reproduction or reconstitution of a lost or injured part, in contrast to repair, which describes healing of a wound by tissue that does not fully restore the architecture or the function of the original part. Periodontal regeneration is defined histologically as regeneration of the tooth's supporting tissues, including alveolar bone, periodontal ligament, and cementum over a previously diseased root surface. New attachment is defined as the union of connective tissue or epithelium with a root surface that has been deprived of its original attachment apparatus. This new attachment may be epithelial adhesion and/or connective tissue adaptation or attachment and may include new cementum. It is to be distinguished from reattachment, which describes the reunion of epithelial and connective tissue with a root surface. *Bone fill is defined as the clinical restoration of bone tissue in a treated periodontal defect. Bone fill does not address the presence or absence of histologic evidence of new connective tissue attachment or the formation of new periodontal ligament.*"¹
3. "...this technique is intriguing in that it is another approach to minimally invasive surgical therapies as reviewed by Cortellini.²⁹ A minimally invasive surgical approach may offer advantages in regeneration of defects in the aesthetic zone in which minimal soft tissue change is required. Additionally, because of the minimally invasive nature and expendable surgical materials required, this approach may be appropriate for multiple defects as a first line of management."²
4. *Free Running (FR)* is the measure of the time duration of a single pulse in 10⁹ seconds, or millionths of a second or microseconds (µsec). This allows for high peak powers in the order of 1,000 to 3,000 W per pulse and pulse intervals that are 500 or more times longer than the pulse "on" time.
5. *Pulse Duration* can be measured several ways, depending on whether the pulse is digital or analog. Digital pulse durations are qualitatively and quantitatively different from analog pulse durations. An analog pulse has a Gaussian profile (ie, a sine wave), whereas the digital pulse is square. Digital pulse durations are more accurately measured than analog ones since the shape of the area measured is a discrete area vs 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.
6. *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 power meter (PM10-19AW [Coherent, Inc]) was used in the case study presented.
7. *Caution*: Laser dosimetry described in this paper is *not* recommended unless the practitioner is well-trained and experienced. Exceeding the laser parameters or overtreating the large defects described for these cases may lead to prolonged healing, tissue and tooth loss, and other complications.
8. *Light dose* (Joules per millimeter pocket depth) is similar to drug dose (milligrams per kilogram of 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.
9. *Other Nd:YAG laser devices*: One cannot extrapolate to other laser devices or other treatment protocols that have not defined their protocols, operating parameters, treatment algorithms, or healing events absent human histology.

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