“Current Advances in the Use of Lasers in Periodontal Therapy: A LANAP Case Series

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Summary: The focus of periodontal surgical procedures has shifted over the last three decades from a philosophy based on resection (“subtractive”) to one of regeneration of lost tissues (“additive”). This shift has had particular significance in cases of advanced Periodontitis. When a patient presents with severe loss of attachment, regeneration cannot take place until the etiologic factors have been effectively managed or reversed, and the disease progression arrested.

Traditional surgical techniques have been successful in facilitating access, and addressing the goal of “pocket elimination.” However, such surgical methods often result in unpleasant side effects, which can be painful and disfiguring.

Clinicians have come to accept that prior tissue destruction as often irreversible. Additionally, the theory behind conventional pocket elimination was to produce an environment that promoted ongoing disease control by facilitating personal oral hygiene. At its best, traditional pocket surgery often falls short of achieving these goals and objectives.

Additionally, conventional resective surgical techniques do not adequately address esthetic concerns, whereas surgical techniques, which are directed toward regeneration, have as their ideal outcome, the preservation and/or restoration of lost periodontal tissues.

Conclusions: The results of recent research on the PerioLase MVP-7 laser, a Free-Running, Pulsed Nd: YAG Laser suggests that this laser provides a viable alternative to traditional periodontal surgery. Properly applied the laser has been shown to produce less bleeding, swelling and discomfort. The PerioLase MVP-7 appears to address the cause of periodontal disease rather than the effects, by specifically targeting identifiable periodontal pathogens. Regeneration of periodontal tissues is the gold standard by which dentists measure treatment effectiveness. Evidence has emerged that the PerioLase MVP-7 provides an enhanced method for achieving this elusive goal, while eliminating many of the negative sequelae, which have been historically associated with conventional pocket elimination surgery.

KEY WORDS

BACKGROUND
Donna E. Shallala, Secretary of Health and Human Services, in Oral Health in America: A Report of the Surgeon General (Executive Summary), 2000 states the following:

• A major theme of this report is that oral health means much more than healthy teeth.
• A second theme is that oral health is integral to general health.
Most adults show signs of periodontal or gingival diseases. Severe periodontal disease (measured as 6 millimeters of periodontal attachment loss) affects about 14 percent of adults aged 45 to 54.

- Twenty-three percent of 65 to 74 year olds have severe periodontal disease
- About 30 percent of adults 65 years and older are edentulous.

Conflicting data from various epidemiological studies suggests that while extremely difficult to quantify, it is widely accepted that, 70-80% of Americans have some form of periodontal disease, and as much as 50% of these may be characterized as moderate to severe.

Anecdotal data suggests that less than 4% of patients with periodontal disease are receiving treatment in the US. Allowing for the possibility that these numbers may be understated, there seems to be no disagreement that periodontal disease represents a world-wide health hazard, and the most significant cause of tooth loss.

From the foregoing, it may be inferred that individuals with periodontal disease are not seeking or receiving adequate periodontal care. What are the factors that contribute to the low incidence of periodontal therapy being sought or rendered? These statistics are especially troubling, in spite of recently emerging data suggesting that periodontal disease has been associated with a plethora of life threatening systemic health conditions?

The answer may be attributed to the general perception that periodontal treatment, especially surgical, is invasive, often with unpredictable and undesirable outcomes as well as onerous, long-term side effects. In addition, surgical intervention is thought to be time consuming, costly and painful.

Progressive increase in pocket depth has been directly correlated with loss of periodontal attachment. It is noteworthy that the focus of corrective periodontal surgery has shifted over time from an emphasis on resection to achieve pocket elimination, to more current thinking based on regeneration of lost tissues.

This change in focus has particular significance in patients exhibiting advanced Periodontitis. As a resident in Periodontology in the 70’s, my mentor, Dr. D. Walter Cohen prophesized, and I paraphrase: “In the future, the management of periodontal disease will focus on plastic and reconstructive procedures “additive,” rather than resective “take away” procedures.”

Historically, the procedure of choice for pocket elimination was the Gingivectomy. Pierre Fauchard first described this surgical approach in the 18th century. Various modifications were promoted throughout the early 20th Century. However, the efficacy of the Gingivectomy procedure came to be questioned. The limitations included an inability to address bony deformities and undesirable post-operative sequelae.

These negative outcomes included denuded, sensitive and caries prone teeth. Results included exposed root surfaces, large spaces between teeth and partial or total loss of attached gingiva. For all of these reasons the Gingivectomy procedure was found to be deficient.

In 1949, Saul Schluger provided a treatise on “osseous resection,” which described enhanced methods for accessing the alveolar bone, enabling alteration of bony irregularities and defects long associated with advanced periodontal disease.
In 1954 Nabers\textsuperscript{5} recommended an alternative approach to alleviate the perceived disadvantages of the available pocket elimination procedures. He promulgated elevation of a full thickness mucoperiosteal flap and relocating of the attached gingiva. Naber’s approach enhanced access, preserved keratinized masticatory mucosa, and addressed pockets extending into the alveolar mucosa.

Notwithstanding their success in pocket elimination these methods were still associated with undesirable post treatment sequelae, such as “long teeth,” interproximal spacing, and marked changes in phonetics and esthetics.

For these and other reasons, patients were extremely reluctant to accept traditional periodontal flap surgery. On the other hand, the non-surgical alternative of traditional scaling, root planning did little to eliminate pathologic pockets, much less repair or regenerate lost tissues.

Historically, the “Gold Standard” of periodontal therapy has been “Regeneration,” loosely defined as the natural renewal of lost tissue or a component part. The specific requirements for regeneration or new attachment include: “New Bone, New Periodontal Ligament, and New Cementum.”

True regeneration must further demonstrate attachment of connective tissue (Sharpey's) fibers, originating from the principle fibers of the periodontal ligament, extending from the walls of the alveolus and inserting in the cementum of the tooth root.

Since traditional resective procedures, did not predictably produce the classic elements of regeneration, other methods were introduced with varying, but often unpredictable outcomes. These have included bone grafting procedures, utilizing autogenous bone, allografts, xenografts, alloplasts, and synthetic materials.

Several researchers reported Guided Tissue Regeneration\textsuperscript{6, 7} in the early 80’s. This modality relied upon the use of “barrier membranes” in conjunction with flap surgery. The objective of the barrier was to create space and retard apical down-growth of the gingival epithelium. It was theorized that the exclusion of these tissues would permit the more slowly growing bone and the requisite reattachment of the periodontal ligament fibers to occur.

Modifications of the classical GTR procedure included use of various barriers. The earliest membranes were non-resorbable, typically expanded polytetrafluorethylene (ePTFE). This approach, however, mandated a subsequent surgery to remove the membrane.

The requirement of a second surgical procedure imposed yet another obstacle preventing patients from choosing the GTR technique. This, in turn, led to the development of other resorbable collagen and synthetic membranes.

Recent enhancements to the regenerative procedures have included the use of biologic mediators and tissue engineering. These surgical enhancements are said to stimulate more rapid healing and jump starting the process of regeneration.

Such biological products may be obtained directly from human subjects, animals or synthetically created in the laboratory. Two examples of these include enamel matrix proteins\textsuperscript{8} obtained from developing teeth as well as Platelet Rich Plasma, derived from processing human blood.

The concept underlying the use of these and other similar products is their ability to stimulate the release growth factors, an example of which is platelet-derived growth factor (PDGF). Recently,
rhPDGF-BB (Recombinant Human Growth Factor-BB) has become available as a commercial product for clinical use in periodontics. It is marketed as Growth-Factor Enhanced Matrix\textsuperscript{9}

In the ongoing search for predictable regeneration, material has been developed, which contains recombinant human bone morphogenetic protein (rhBMP-2)\textsuperscript{10}, a genetically engineered version of a naturally occurring protein, capable of initiating bone growth. The discovery and development of the concept and the potential uses of BMP in medicine, originated with the research of Marshall Urist almost fifty years ago\textsuperscript{11,12}

The search for “The Holy Grail” of periodontal regeneration continues. Notwithstanding all of advances referenced above, predictable regeneration of periodontal tissues continues to be an enigma within a conundrum. Puzzling, contradictory and controversial because of an incomplete understanding of its mechanism, it remains a lightening rod of ongoing controversy.

For more than a generation, dentists have employed lasers for a variety of applications in clinical dental practice. More than ten years ago Drs. Robert Gregg and Delwin McCarthy published on the use of a specific free-running (FR) pulsed Nd: YAG laser for the treatment of periodontal disease. First conceived and developed in the 1990’s, they later proposed its use, for achieving bone regeneration\textsuperscript{13,14}

They developed a specific protocol (LANAP), with research-proven operating parameters. (Laser Assisted New Attachment Procedure), received FDA clearance in 2004.\textsuperscript{15} Millennium Dental Technologies, Inc., developed the PerioLase MVP-7 laser, (Nd: YAG), which operates at a wavelength of 1064 nm to deliver the LANAP therapeutic procedure.

The formal definition developed for LANAP is “Cementum mediated New Attachment to the root surface in the absence of a Long Junctional Epithelium.”

Specific aspects of the LANAP Protocol\textsuperscript{16} are as follows:

- A thin 0.3 – 0.4 laser fiber permits easy access deep into the periodontal pocket without the need to surgically elevate a flap.
- Selective photothermolysis is generated to remove diseased, infected, and inflamed pocket epithelium, while preserving healthy adjacent connective tissue
- Precise tissue ablation and antiseptic hemostasis by varying the laser’s energy density, pulse duration and repetition.
- Destruction of periodontal pathogens - (Operating at a wavelength of 1060nm, laser light energy is attracted to pigmented tissues and colored bacteria)
- Changing the settings of the laser completes the debridement process and achieves hemostasis with a fibrin clot.
- Closure is achieved without sutures or surgical glue, relying on the fibrin clot and tissue compression.
- Management of occlusal pathology is accomplished with occlusal adjustment and splinting of teeth with greater than Class II mobility.

The potential for regeneration is facilitated by:
• Delivering intense, precise and selective energy to the effected area (periodontal pocket), without damage to adjacent tissues
• Being bactericidal to pigmented periodontal pathogens
• Sealing the pocket orifice with a “thermal fibrin clot”
• Creating a physical barrier (like a barrier membrane), preventing downgrowth of epithelium
• Promoting healing from the bottom up, rather than the top down; by stimulating the release of pluripotential cells from the periodontal ligament and alveolar bone

Despite the initial controversy surrounding aspects of LANAP, the procedure represents a precise treatment protocol; combining the best aspects of laser mediated surgery with the well established principles of traditional periodontal therapy. The goals are the same; however the application of methods for achieving these objectives is markedly different. In all cases, consistent with the LANAP Protocol, aggressive debridement of all pockets/defects is accomplished with high power, piezo scalers.

On the other hand, notwithstanding that the goals parallel each other, there are many substantial benefits attributed to LANAP therapy, when compared to conventional periodontal surgery. The benefits have been described as follows:
• Less invasive and less traumatic
• Minimal postoperative discomfort
• Minimal recession and thermal sensitivity
• Quicker healing
• Equally successful results treating dental implants and natural teeth.

In one of the largest human histology studies, Yukna et al\textsuperscript{17, 18} were the first to publish and prove incontrovertibly, the positive results of LANAP therapy when compared with conventional periodontal treatment. The study was university based, longitudinal, controlled, prospective and blinded. The results showed unequivocally, that 100% of the teeth treated with the LANAP procedure formed new attachment as opposed to 0% of the control teeth.

More recently, in 2012, Marc L. Nevins, DMD, MMSc, and co-workers reported another, landmark human block study, demonstrating highly successful outcomes of patients treated with the LANAP Protocol in cases of extreme Periodontitis.\textsuperscript{19}

What follows are examples of various clinical cases illustrating favorable results utilizing LANAP. In all cases, in accordance with the LANAP Protocol, mobility and other manifestations of occlusal pathology were assessed. The occlusion was carefully addressed and managed, utilizing a combination of procedures.
CLINICAL SCENARIOS

Case #1
This is the case of a middle aged woman who presented to a private practice (Dr. Murray Rabalais, Houma, Louisiana) with a 9mm pocket, exhibiting a marked osseous defect on the mesial of tooth #22 (Figure 1). Significant bleeding on probing was noted, with a mild diastema between tooth #22 and 23. Medical history was unremarkable and non-contributory.

The benefits, risks, alternative treatments and possible consequences of non-treatment were discussed with the patient and it was decided to provide the LANAP Protocol.

Sequential standard radiographs during the post-operative period illustrated evidence of progressive repair and suggest ongoing regeneration (Figure 2). Probings were within normal limits, without observable pathology, and the diastema had spontaneously closed. Clinical photographs were not available.

Case #2
A 34 year old male presented to a private practice (Dr. Murray Rabalais, Houma, Louisiana) with a vertical osseous defect on the distal of tooth #18 (Figure 3). The defect measured 8mm on the disto-facial and 5mm on the disto-lingual. The location of the defect, in the absence of other significant periodontal disease suggested that the pathology might have developed subsequent to prior extraction of tooth #17.

There was marked bleeding on probing suggesting the presence of pathologic tissue, most likely of bacterial origin, secondary to the development of the defect. Medical history was unremarkable and non-contributory.

The benefits, risks, alternative treatments and possible consequences of non-treatment were discussed with the patient and it was decided to provide the LANAP Protocol.

Probings were within normal limits and there was complete absence of bleeding on probing (Figure 4). Clinical photographs were not available.

Case #3
A 30 year old male presented to a private practice (Dr. Braden Seamons, Honolulu, Hawaii) with an implant replacing tooth #9 which had been placed several years previously (Figure 5). Pathologic loss of crestal bone was noted, with probing pocket depths of 6mm on the mesial and 5mm on the distal. Accurate measurements may have been greater; however, the width of the probe precluded reaching the base of the defects. Medical history was unremarkable and non-contributory.

The benefits, risks, alternative treatments and possible consequences of non-treatment were discussed with the patient and it was decided to provide the LANAP Protocol.

Probings were within normal limits with no evidence of ongoing periodontal pathology (Figure 6). Clinical photographs were not available.
**Case #4**

A 56 year old male presented with to a private practice (ISB, Philadelphia, Pennsylvania) severe, progressive periodontal disease (Figure 7). Medical history revealed Type II Diabetes, and a variety of cardiovascular problems, including the presence of a pacemaker. Significantly, he was taking Coumadin. His medical history and drug regimen were clearly contributory to the observed symptoms of generalized severe, progressive periodontal disease.

The patient expressed a significant desire to save his teeth. Several previous periodontal consultations only offered scaling and root planing, in conjunction with conventional flap surgery. He declined this treatment approach, expressing a previous history of similar treatment.

The benefits, risks, alternative treatments and possible consequences of non-treatment were discussed with the patient and it was decided to provide the LANAP Protocol (Figure 8).

Figures 9 and 10 illustrate healing at one and three weeks, respectively. Gentle manual brushing only is permitted at 7-10 days, to preserve the integrity of the fibrin clot. Plaque control is supplemented by twice-daily Chlorhexidine rinse.

At one month the patient reported a marked reduction in blood glucose levels.

**Case #5**

A 13 year old male presented to a private practice (Dr. Matthew Heaton, Knoxville, Tennessee) with persistent soreness in his maxillary right molar, of 6-8 month’s duration. Clinical findings revealed advanced attachment loss, with 12-15mm pocketing (Figure 11), bleeding, suppuration and a Grade 2 trifurcation involvement (Figure 12). The tooth was clinically vital, which precluded a diagnosis of Endo-Perio Lesion.

The benefits, risks, alternative treatments and possible consequences of non-treatment were discussed with the patient and it was decided to provide the LANAP Protocol.

Radiographs were taken as 4 and 11 months (Figures 13 and 14). Attachment levels at 11 months recorded a 7-11mm gain of attachment, with closure of the mesial furcation defect and radiographic evidence of bone regeneration. Clinical photographs were not available.

**Case #6**

A 46 year old male presented to a private practice (Dr. Braden Seamos, Honolulu, Hawaii) for periodontal treatment, with a defect on the mesial aspect of tooth # 9 (Figure 15). Clinical findings revealed a 9mm pocket of which 5 mm was sub-crestal. There was distinct bleeding on probing and clinical observations included edema and alterations in gingival architecture.

The benefits, risks, alternative treatments and possible consequences of non-treatment were discussed with the patient and it was decided to provide the LANAP Protocol.

Seven months post-treatment, a marked resolution of the osseous defect was observed (Figure 16). Clinical photographs were not available.

**CONCLUSIONS**

With the advent of the PerioLase MVP-7, which has been specifically designed to address the treatment of periodontal pockets and the loss of attachment apparatus, the historically elusive goal
of regeneration of cementum, periodontal ligament and supporting bone, has become a predictable reality. Historically, most of our surgical procedures focused on treating the effects of periodontal disease.

Techniques have evolved, which have the potential to achieve more predictable outcomes by focusing on simultaneously reversing, the causes and the effects of periodontal disease. With successful application of these principles, one can anticipate producing greater longevity and ease of maintenance of the results. This, in turn, has the potential to produce enhanced clinical outcomes and better patient acceptance. LANAP is a well-defined treatment protocol, with human histologic validation, and evidence of initial and long-term success. Continued research and careful observation will be necessary to sustain the clinical findings.

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9. GEM 21S®, Growth-factor Enhanced Matrix, (Osteohealth)

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**Figure 1**
Case 1. Pre-operative, standard clinical periapical radiograph. (radiograph courtesy of Dr. Murray Rabalais).

**Figure 2**
Case 1. Post-operative, standard radiograph at 10 months. (radiograph courtesy of Dr. Murray Rabalais).

**Figure 3**
Case 2. Pre-operative, standard, periapical radiograph. (radiograph courtesy of Dr. Murray Rabalais).

**Figure 4**
Case 2. Post-operative, standard radiograph at 15 months. (radiograph courtesy of Dr. Murray Rabalais).

**Figure 5**
Case 3. Pre-operative, standard periapical radiograph. (radiograph courtesy of Dr. Braden Seamons).

**Figure 6**
Case 3. Post-operative standard periapical radiograph at 3 months. (radiograph courtesy of Dr. Braden Seamons).

**Figure 7**
Case 4. Pre-operative clinical appearance.

**Figure 8**
Case 4. Tissues immediately post-operatively. Note the marked absence of bleeding. Early, generalized thermal fibrin clotting is exhibited at the gingival margins.

**Figure 9**
Case 4. Substantial healing and alteration of the gingival tissues at one week, in spite of the presence of interproximal plaque deposition.

**Figure 10**
Case 4. Three week healing. Note ongoing positive changes in gingival color and architecture, with minimal shrinkage and root exposure.

**Figure 11**
Case 5. Digital charting illustrating 12-15 mm pocket depth. (image courtesy of Dr. Matthew Heaton).
Figure 12 –
Case 5. Initial standard periapical radiograph at presentation, showing severe loss of attachment and invasion of the trifurcation. (radiograph courtesy of Dr. Matthew Heaton).

Figure 13 –
Case 5. Standard radiograph at 4 months. (radiograph courtesy of Dr. Matthew Heaton).

Figure 14 –
Case 5. Standard radiograph at 11 months. (radiograph courtesy of Dr. Matthew Heaton).

Figure 15 –
Case 6. Initial standard periapical radiograph illustrating the osseous defect. (radiograph courtesy of Dr. Braden Seamons).

Figure 16 –
Case 6. 7 month post-treatment standard radiograph exhibiting marked resolution of the osseous defect. (radiograph courtesy of Dr. Braden Seamons).

Focused Clinical Question/s