Lasers for Phase One Periodontal Therapy

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Learning Objectives:

After reading this article, the reader should:

1. have a basic knowledge of the fundamentals of laser-tissue interaction;
2. become familiar with the variety of wavelengths of dental lasers that can be safely and effectively used for initial periodontal therapy;
3. identify the treatment protocol and how a dental laser is used as part of the armamentarium; and
4. understand that certain dental lasers can help to treat periodontal disease, as demonstrated by clinical case examples.

Introduction

Understanding the pathogenesis of periodontal disease and development of treatment methods continue to evolve.(1) The current model for periodontal disease includes microbial components, host-inflammatory responses, and host risk factors that contribute to the advancement of this disease.(2,3) The pathogenic bacterial plaque in the susceptible host triggers an immune response that results in inflammation and changes in the metabolism of the connective tissue and bone.(4,5,6)

Phase one periodontal therapy is the initial treatment of periodontal disease. Following a thorough examination and accurate diagnosis, the protocol usually includes scaling, antimicrobial regimens, home care instructions, and evaluation for possible subsequent surgical procedures. The ‘gold standard’ for successful treatment is defined as a maintenance of or a gain in the clinical attachment level. (7)

Over the last 10 years, certain dental lasers have been included in the above regimen, starting with the pulsed Nd:YAG laser, which the United States Food and Drug Administration granted an indication for use for sulcular debridement. (8) Moreover, research and clinical case studies indicate that lasers, adjunctively used with scaling, can improve the effectiveness of this phase one care.

The dental hygienist generally is the provider of this initial non-surgical periodontal therapy. As an aside, each practitioner must be familiar with the licensing stipulations of the Dental Practice Act where he or she practices before using the laser instrumentation.

Laser basics

Lasers produce light energy that can be absorbed by a target tissue. The absorption process produces a thermal reaction in that tissue. Depending on the instrument’s parameters and the optical properties of the tissue, the temperature will rise and various effects will occur. The results can be useful in the treatment of periodontal disease. In general, most non-sporulating bacteria, including anaerobes, are readily activated at temperatures of 50 degrees C. (9) The inflammatory soft tissue present in periodontal disease can be removed with a temperature of 60 degrees C; moreover, hemostasis can also be achieved within the same heat parameters. Laser excisional or incisional surgery is accomplished at 100 degrees C, where vaporization of intra- and extra cellular water causes ablation, or removal of biological tissue.(10) This is the temperature at which calculus could be removed from the root surface.

There are many different types of lasers and each produces a specific color or wavelength of light; however, the light from nearly all of the available dental lasers is invisible to the human eye. Each wavelength has a somewhat unique effect on dental structures, due to the specific absorption of that laser energy in the tissue. Some lasers are only absorbed by blood and tissue pigments, while others are only absorbed by water as well as “hard” tissue, like enamel, dentin, bone, and calculus. (11)

More specifically, the wavelengths can be categorized into three groups:

1) Erbium lasers (Er,Cr:YSGG and Er:YAG) can be used for calculus removal as well as for soft tissue debridement, because of the their excellent absorption in apatite crystals and water.
2) Carbon Dioxide lasers also easily interact with free water molecules in soft tissue as well as vaporizing the intracellular water of pathogens.
3) Diode and Nd:YAG wavelengths would target inflammatory tissue and pigmented pathogens.

Clearly, all of these lasers can disinfect and detoxify periodontal tissues. These lasers can successfully and safely be used on a wide range of the population such as children and pregnant women unlike some prescribed and/or sulcularly delivered drugs. (12) Unlike those medications, the patient will not experience allergic reactions, bacterial resistance, or untoward side effects when the laser is used.

There are significant differences in the depth of penetration of dental laser wavelengths: The Erbium wavelengths are absorbed on the surface of the tissue with a depth as little as 5 microns and Carbon Dioxide’s radiation will travel about 0.5 millimeters; whereas the diode and Nd:YAG can penetrate up to a few millimeters.

Current technology allows light energy to emanate from the distal end of the tip of the laser's delivery system. Thus there is only an end cutting action, which is significantly different than most conventional dental instruments. The diode and Nd:YAG lasers use a small diameter (300 micron) flexible glass fiber for laser transmission; however, Erbium and Carbon Dioxide lasers utilize either rigid quartz or sapphire tips or metal cannulas.

Initial Periodontal therapy applications of various laser wavelengths

Erbium The Erbium lasers are effective in removing calculus, as well as producing pocket depth reduction. Several references indicate safe and effective root substance removal comparable with conventional instrumentation;(13, 14, 15) moreover, there were no negative thermal effects on the pulpal tissue.(16) Furthermore, these lasers are highly bactericidal against *P. gingivalis* and *A. Actinomycetemcomitans*,(17) as well as effective in removing lipopolysaccharides and other root surface endotoxins. (18, 19) Clinical studies show pocket depth reduction with similar or better improvement of periodontal health parameters compared to conventional scaling. (20)

These lasers have some drawbacks:

-The rigid tips can be difficult to manipulate all around the root surfaces during scaling.

-The laser energy is not totally selective at removing the root surface accretions. The lased cementum does exhibit micro-irregularities after laser calculus removal. However, studies show that better conditions for fibroblast attachment are produced on this cementum. (21, 22)

-hemostasis can be challenging, because the wavelength is not absorbed in blood products, is not deeply penetrating, and has extremely short pulse duration which minimizes heat accumulation necessary for coagulation.

Carbon Dioxide This wavelength is a very effective in removing soft tissue, and is used for removal of diseased and inflamed tissue, with good hemostasis and bacterial reduction. However, only one clinical study has been published to show that this laser can decrease probing depth, and thus it is not yet widely used for initial periodontal therapy.(23) Two studies do suggest an advantage of using this instrument to decontaminate and condition the root surfaces for better fibroblast attachment after conventional scaling. (24,25)

Carbon Dioxide's chief disadvantage is that the current emission mode's irradiation produces severe thermal damage and carbonization to the root surface. New modalities are under development to address this problem.

Diode and Nd:YAG These lasers are only used for treatment of the diseased periodontal soft tissue, allowing significant bacterial reduction and removal of the inflammatory products while creating excellent hemostasis. As mentioned above, these instruments employ a flexible fiber optic delivery system that allows the clinician easy and safe access around the periodontal pocket. The wavelengths are transmitted through water and are very poorly absorbed in apatite crystals, making them an excellent choice to use in a periodontally involved sulcus that has dark inflamed tissue and pigmented bacteria.

Various studies, some over 15 years old, highlight the success of treatment of periodontal disease where these lasers were used following traditional scaling procedures.

(26, 27, 28) Clinical health indices were significantly improved and subgingival microflora populations, such as *P. gingivalis* and *P. intermedia*, were greatly reduced when compared to conventional instrumentation alone. (23, 29, 30, 31, 32) In a recent small sample size abstract, adjunctive use of the Nd:YAG laser resulted in histological evidence of new cementum and a new connective tissue attachment. (33)

These lasers are contraindicated for calculus removal not only because of their ineffective absorption but also because of the possibility of heat build-up due to the interaction with darkly colored deposits. Older papers demonstrated tremendous root surface damage with these wavelengths, but new studies showed virtually no negative effect when the proper parameters were used. (34, 35, 36)

Treatment planning and protocol

After the diagnosis is completed, the treatment planning consists of dividing the mouth into manageable treatment areas according to the severity of the disease, and each treatment area corresponds to the number of disease sites that can be treated in each therapeutic appointment. The recorded six-point probed chart becomes the roadmap for the planned initial periodontal therapy. Of course, the pocket anatomy must be visualized along with amounts of debris and inflammation present in determining the time needed to adequately treat the site.

The appointment protocol follows a simple formula, suggested for a one-hour appointment time. (37) The tooth and root surface (the hard side of the pocket) are debrided first, followed by laser bacterial reduction and coagulation of the soft side (epithelial tissue) of the sulcus. It is important to note that the laser parameters are adjusted to much lower settings than would be used for conventional surgery, remembering that the tissue temperature only needs to be elevated to 60 degrees C. Therapy should always begin in the area with the deepest pocket depths and progress to the more shallow ones. On subsequent appointments, the clinician should plan to re-lase the previously treated sites with a bacterial reduction setting which reduces the bacterial load and enhances the healing process.

The first one hour period consists of the following steps:

- Anesthesia as needed (topical or injected)
- Calculus removal employing an Erbium laser and/or an ultrasonic scaler with antimicrobial irrigant
- Detailed hand instrumentation to finish the hard deposit elimination
- Laser bacterial reduction of soft tissue
- Laser coagulation of the treatment sites
- Ultrasonic antimicrobial irrigation
- Post-op instruction/home care instruction

For patients requiring multiple visits, the laser is used with a bacterial reduction setting on previously treated sites with the fiber calibrated to account for healing that has taken place since the previous appointment.

Soft tissue laser treatment

Calculus removal is very straightforward whether a laser, ultrasonic, or a hand scaler is used. Following scaling, the author recommends a diode or Nd:YAG laser be used for the soft tissue phase of treatment, and those wavelengths' fibers must be calibrated prior to performing bacterial reduction. After tooth debridement, each pocket is probed to recheck the architecture and reconfirm the depth. The probe is then placed next to the laser fiber assembly and the fiber length is adjusted in length. (**figure 1**). The calibration depth is 1mm shorter than the pocket. This measurement is important because the laser energy will penetrate through the tissue and the adjustment will minimize any interaction with the epithelial attachment.

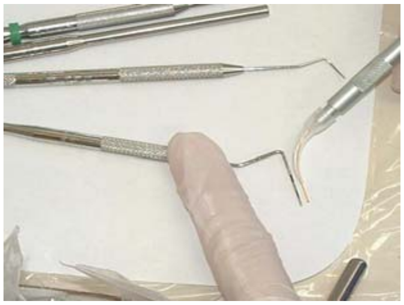
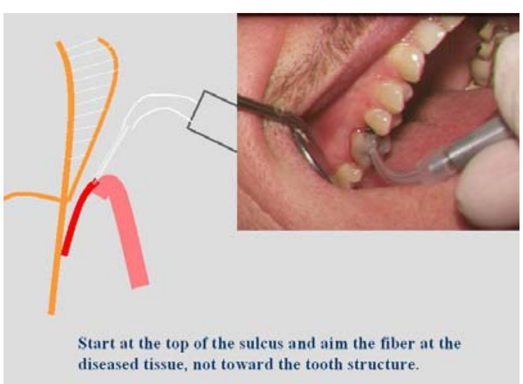


Figure 1, calibration of laser fiber 1mm less than pocket depth

At subsequent therapy appointments the fiber calibration is 2 mm less than the initial pocket depth to take into account the healing that takes place from the apical end of the pocket after initial therapy. **(**38)

Laser Fiber Placement and Therapy

The laser fiber's design allows energy emission at the tip, thus making the fiber "end cutting," and the clinician must maintain contact with the inflamed epithelial lining of the pocket. The fiber is placed on the tissue at the top of the sulcus which directs the laser energy away from the tooth structure. (figures 2,3)



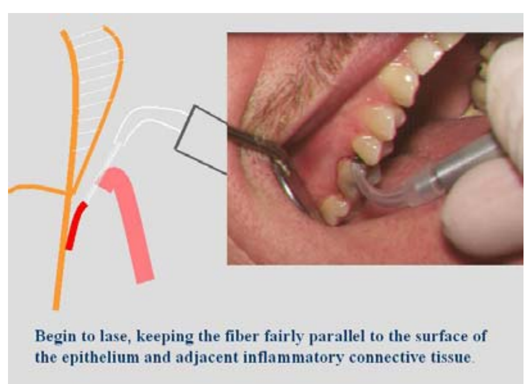


Figure 2 The laser is placed at the top of the sulcus in contact with the soft tissue

Figure 3 The laser is activated and the fiber is oriented parallel to the long axis of the tooth.

The fiber is moved both horizontally and vertically, and contact is maintained with the soft tissue down to the calibrated depth. (figures 4,5)

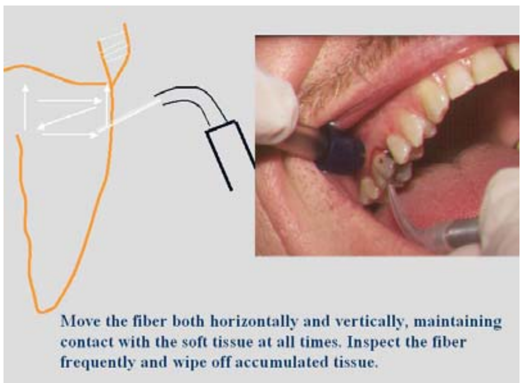


Figure 4 The laser is moved horizontally and vertically along the soft tissue.

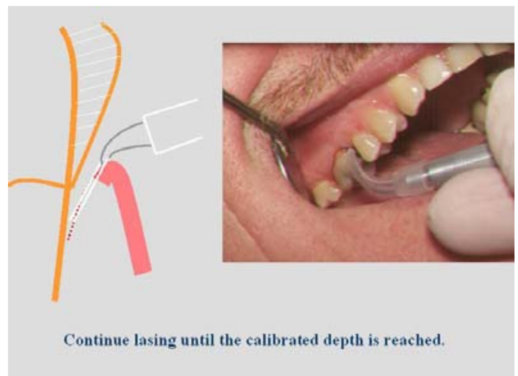


Figure 5 The calibration depth is reached.

The distal end of the fiber must be inspected frequently and any accumulated tissue and debris must be wiped off to avoid the laser's energy from heating up the darkly colored material. (figure 6) Bacterial reduction is finished when signs of fresh bleeding occur. (figure 7) The clinician would then proceed with the adjacent tooth, continuing the above steps.

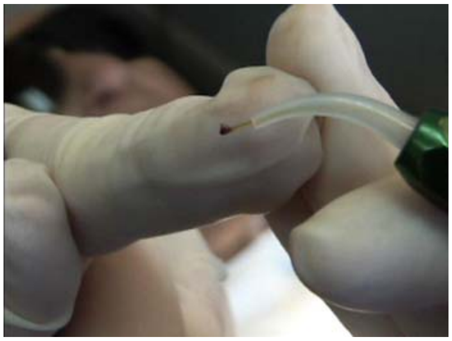


Figure 6 accumulated debris must be wiped off.

Figure 7 Bacterial reduction is completed when fresh bleeding occurs

When this first laser step has been completed on all of the teeth scheduled to be treated on that appointment, the laser energy is then changed to a coagulation setting and the fiber is held in contact with the tissue with the same motion from the top of the sulcus to the bottom until the bleeding stops. Laser therapy is now complete at the site.

Post Operative Instructions

It is important that the patient perform adequate oral hygiene following laser treatment. In addition to soft brushing and careful flossing, additional aides might be suggested. The lased site is not particularly fragile, but spicy or grainy foods that would irritate healing tissue should be avoided. Generally mild analgesics should easily manage any discomfort. Rinses and irrigation can begin immediately, but light swishing is recommended for the first few days.

Re-evaluation and continuing care

As usual in periodontal treatment, post-operative probing depths will assess the healing response. However, since newly re-attaching tissue is fragile and easily disrupted with a probe, a light touch is essential for several months; definitive six-point probing should be resumed at six months following laser treatment. An assessment of the tissue tone, bleeding on light probing, and gingival index signs can help the clinician determine if any areas need re-treatment. Assuming that calculus removal is adequate, the laser can be used with the bacterial reduction followed by the coagulation parameter.

The author recommends a one year continuing care regimen, with three month evaluations. This time line allows for healing of the treated sites and re-treatment of deeper pockets. Adjunctive therapies, such as locally delivered subgingival antibiotics can be used for further pocket depth reduction, and the laser could be used to first disinfect and prepare the site for the medication. At one year a decision can be made to refer the patient for surgical periodontal therapy.

Clinical cases

In the following clinical case figures, scaling was already accomplished. The lasers are shown performing bacterial reduction, inflammatory tissue debridement, and hemostasis. Figure 8 shows a patient with severe gingivitis of long duration. Twelve months later, the tissue remains healthy. (figure 9)

Figure 8 Acute generalized gingivitis

Figure 9 One year post therapy showing periodontal health.

Moderate periodontitis is shown in figure 10. The position of the laser fiber as it enters the pocket is shown in figure 11, and figure 12 shows a one year post-operative result.

Figure 10 Moderate periodontitis

Figure 11 laser activated in pocket. Note parallel orientation of fiber.

Figure 12 One year post operative showing periodontal health.

Figure 13 demonstrates a case of severe periodontitis, and figure 14 shows a 5 year follow-up. This is true re-attachment, not gingival recession.

Figure 13 Severe periodontitis

Figure 14 Five year post treatment showing re-attachment and periodontal health.

The patient in figure 15 presented at a continuing care appointment with severe gingivitis only around one tooth. Clearly, this is not due to calculus; rather the microflora is causing the inflammation. Figure 16 shows the laser treatment, and six months later, the tissue is healthy. (figure 17)

Figure 15 shallow pocket with acute gingivitis.

Figure 16 laser in use.

Figure 17 The sulcus is healthy 6 month post treatment

Conclusion

The literature is replete with studies and articles describing the use of lasers for periodontal therapy. There is also controversy surrounding some of those articles as well as an ongoing discussion of the safety and efficacy of this application of laser energy in the context of evidence based practices. However this article was intended to present evidence to suggest that lasers used adjunctively with scaling provide additional benefits to patients with periodontal disease. The clinician is advised to gain competence with laser instruments by completing training offered by the manufacturers. The Academy of Laser Dentistry (39) is an additional source for numerous educational and hands-on courses.

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