

# Dental Lasers: Possibilities and Benefits

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It is surprising to realize that laser use in dentistry dates back to Dr. Leon Goldman's initial experiments on dental caries in 1964.<sup>1,2</sup> For when the topic comes up in conversation among dentists today, the response is typically, "They are still too new," or "I'm going to wait."

During the past 40 years, dental lasers have slowly been making headway into the arsenals of dental offices. As we look back over laser dentistry's storied past, we see almost as many "learning experiences" as successes in treating dental hard and soft tissues.

Absorption of laser energy is what effectuates the desired result of tissue ablation or removal by thermal or photoacoustic means. Most early experiments using lasers on soft tissue were successful to a degree. Hard tissue, however, offered completely different results. In many cases, dental lasers caused pulpal necrosis and enamel cracking due to heat generated during treatment.<sup>3-12</sup> The wavelengths tested had a high affinity for pigmented tissues, and since the only pigmented tissue in a normal tooth is the dental pulp, it stands to reason that pulpal tissues absorbed the heat and became necrotic as a result.

During the 1990s, dental applications for the erbium family of lasers were developed.<sup>13</sup> The wavelengths from erbium lasers have a high affinity for water and hydroxyapatite but are not absorbed especially well by pigmented tissues, thus providing the solution to the hard-tissue dilemma. Rather than absorption into the dental pulp that was seen with other wavelengths, erbium laser energy was absorbed primarily by enamel, dentin, and water.

Today, we are very fortunate to be able to add not only soft-tissue lasers to our armamentaria, but hard-tissue wavelengths as well. The benefits of using a laser versus conventional modalities are numerous and varied and depend on whether the target tissue is hard or soft.

Most of us are aware of the norm when discussing hard-tissue responses, so this article will only cover the differences using a hard-

tissue laser rather than a high-speed rotary handpiece or air abrasion unit.

Hard-tissue lasers only occasionally require a local anesthetic. Because of the laser's ability to seal nerve endings and the natural pain-blocking effect of the laser energy itself, many laser preparations are done without having to anesthetize the patient.

Although the actual physiology for "laser-assisted anesthesia" remains unclear, current theories suggest a disruption in the sodium-potassium pump on a cellular level. This disruption inhibits transmission to pain receptors. The effect lasts for approximately 5 to 10 minutes, which is sufficient to complete the restoration. It is important to note that anesthesia is not used, but the perception of pain is completely blocked, similar to when a transcutaneous electrical nerve stimulator (TENS) is used.

The ability to work in more than one quadrant during the same visit is another benefit of laser use. Rather than reschedule a patient for more than one bilateral mandibular restoration, the dentist can complete this procedure at the same sitting. This is better for the patient and also offers cost savings to the dental practitioner by eliminating extra setup and breakdown of the treatment room.

Rizoiu has shown that when an Er,Cr:YSGG (Erbium, Chromium: Yttrium, Scandium, Gallium, Garnet) laser is used on hard tissue, pulpal temperatures can actually decrease by as much as 2°C. In comparison, rotary high-speed preparation using water spray can cause a 3° to 4°C rise in pulpal temperatures.<sup>14</sup>

Another benefit to lasers is the elimination of the smear layer during preparation. The presence of a smear layer is detrimental to the life of a bonded restoration. Removing this layer of debris reduces postoperative sensitivity. In addition, wide-open dentinal tubules create a stronger bond to restorative materials.

Among all the benefits of using lasers, one drawback to using a hard-tissue laser is that it is ineffective when attempting to remove metallic restorations. The laser's light



**Figure 1. Preoperative photo showing fractured composite from the distal of tooth 13 and failing restorations and recurrent caries throughout tooth 14.**



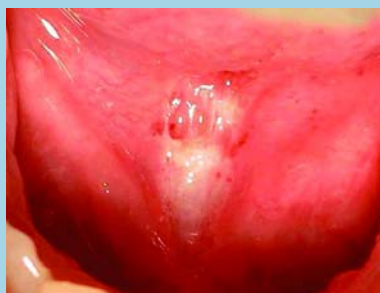
**Figure 2. Periapical radiograph confirming initial diagnosis.**



**Figure 3. High-speed handpiece preparations using only laser-assisted anesthesia. The laser was used to bevel, disinfect, etch, and remove the smear layer before bonding.**



**Figure 4. Preoperative photo of ankyloglossia. Note that the tissue connects the tip of the tongue almost to the free gingival margin of teeth 24 and 25.**



**Figure 5. Laser surgical site during treatment. Note the absence of tissue charring and minimal bleeding.**



**Figure 6. Five days postoperative.**

energy would reflect back to the source. Not to mention, laser energy should never purposely be directed at an alloy. Fortunately, over the last year, techniques have evolved that allow laser users to treat a tooth with laser energy at the buccal and lingual/palatal CEJ for 30 seconds each and then remove the alloy using a high-speed handpiece. The entire preparation is treated with the laser one last time to etch and disinfect the surface and remove the smear layer in preparation for restoration.

Unlike air abrasion units, a hard-tissue laser can be set up for a Class II cavity preparation. Because the sapphire tip is end-cutting only, there is very little chance of damage to the adjacent tooth. Also, slot and tunnel preps are more the norm than the exception. The second difference to air abrasion technology is the laser's ability to remove soft or rubbery caries during excavation. This significant benefit was never within the abilities of air abrasion.

When comparing the use of lasers for soft-tissue procedures,

there are just as many benefits. Lasers have the ability to seal blood vessels, providing a nearly bloodless surgical field. Also, postoperative swelling is greatly reduced because of the laser's ability to seal lymph vessels. In many cases, similar to hard-tissue procedures, the laser's sealing of nerve endings and its anesthetic properties allow for painless surgical procedures without the use of local anesthetics. However, the use of local anesthetic may be necessary depending on the type of laser used. An Er,Cr:YSGG laser rarely requires the use of a local anesthetic whereas a diode, Nd:YAG, or carbon dioxide laser almost always requires the use of anesthesia. The difference lies in the mechanism of tissue ablation. A diode laser's tissue vaporization generates a significant amount of heat in comparison with a more gentle mechanism of the Er,Cr:YSGG (i.e., where the free-running pulse and long thermal relaxation time minimize the thermal tissue effects). Both examples demonstrated in this case presentation were completed with an Er,Cr:YSGG laser—a small sampling of the possibilities that exist with the technology available today.

The hard-tissue case depicts many benefits to using a laser in daily practice. Local anesthetic would normally be indicated considering the depth of the carious lesions in teeth 13 and 14 (see Figures 1 and 2). However, laser-assisted anesthesia allowed for completed preparations using high- and low-speed dental handpieces. In addition, the laser was then used to finish the preparations by removing the smear layer created by the burs, disinfect the surface (especially helpful in the case of carious exposures), bevel the margins, and etch the surface in preparation for a bonded restorative material (see Figure 3).

For this case, a 6 mm – 600 µm sapphire tip was used. The laser was operated between 1.25 W and 3.00 W at 20 Hz, with 150 µsec free-running pulse for 120 seconds for anesthesia and 60 seconds for finishing.

The example cited used a combination of laser and high-speed rotary preparations. If an alloy is not being removed, as in the case of a virgin carious tooth or when removing a previously placed composite, the entire preparation and restoration can be comfortably completed with only an erbium laser. In fact, the Er,Cr:YSGG laser has been approved by the FDA to complete all classes of preparations. If necessary, finishing and polishing can be accomplished with rotary instrumentation.

The soft-tissue case illustrated in Figure 4 (lingual frenulectomy on a 10-year-old female) is an example of how the Er,Cr:YSGG laser has a reduced traumatic effect on the target tissue with faster and improved postoperative healing (see Figures 5 and 6). This case was completed using 4 percent topical lidocaine cream placed over the tissue for one minute. The anterior portion of the tongue was grasped with a 2 x 2 cotton-filled gauze, and the excess tissue was removed using a 6 mm – 600 µm sapphire tip. A high-speed suction was used to remove the laser plume, any odor, and the water spray. The settings were 2.00 W with 20 percent air and 20 percent water for 30 seconds under the tongue. This process was repeated on the lingual surface of the mandible, between teeth 24 and 25, near the genial tubercle. In both surgical sites, the excess tissue was grasped and completely removed using the same laser settings. The entire procedure, excluding topical anesthetic and photography, lasted one minute.

The laser used in both of these cases was a 2780 nm Er,Cr:YSGG (Waterlase™) laser manufactured by BioLase Technology, Inc., of San Clemente, California.

## Conclusion

Dental lasers have advanced to the point that they can be used quite predictably on both hard and soft tissue, including bone. The problems and drawbacks that once were common with laser use are now just a memory and part of dental laser history. The benefits of adding a

laser, especially an erbium hard- and soft-tissue laser, to a general dental practice far outweigh any of the tired arguments against it.

This presentation has focused on the clinical benefits of owning an “all-tissue laser.” However, the positive financial impact on a dental practice can be as dramatic as the clinical results and should be examined as well. ●

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