Minimally Invasive Crown Restoration Utilizing the Er:YAG Laser and CAD/CAM: The Melding of Technologies

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Editor’s note: In this clinical technique article, Dr. Mark Colonna describes using an Er:YAG laser and a Computer-Aided Design/Computer-Aided Manufacturing machine for a restoration. The reader is reminded to refer to Dr. Eugene Antenucci’s article, “Diode Lasers and Computer-Aided Design and Manufacturing (CAD/CAM) Dentistry: A Perfect Marriage of Two Advanced Technologies” in J Laser Dent 2009;17(2):100-103. That article discusses the fundamentals and workflow of CAD/CAM systems.

INTRODUCTION
Today’s technology allows us to deliver methods of patient care that seemed unfathomable not too many years ago. We used to perform multiple-appointment endodontics, multiple-appointment crown restorations utilizing a laboratory, and use valuable chair time to our disadvantage. Today, with proper magnification, illumination, Computer-Aided Design / Computer-Aided Manufacturing (CAD/CAM), and laser technologies, we can actually perform these procedures together in one appointment. This has not only enhanced the profitability of these procedures, but, more importantly, the quality, predictability, and the timeliness of the treatment outcome—all for the patient’s ultimate benefit.

The procedures described in this clinical case may have existed only in our mind’s eye years ago, but now are examples of today’s advanced technology. It is important to note that at no time was a rotary instrument used in this case, either high-speed or slow-speed. All procedures were performed using an Er:YAG laser almost exclusively, with the exception of the root canal hand files used to extirpate and enlarge the root canal space prior to obturation.

PATIENT HISTORY
The patient, a 58-year-old male, was visiting my city, and was experiencing a “toothache.” The radiographic examination of tooth #21 showed a small distoocclusal amalgam with recurrent decay underneath (Figure 1), leading to a diagnosis of irreversible pulpitis and a failing restoration.

The patient’s health history was unremarkable, and we proceeded to take preliminary correlation pictures with a CAD/CAM system (CEREC 3D, Sirona Dental Systems GmbH, Bensheim, Germany). A dental microscope (Global G6, Global Surgical™ Corporation, St. Louis, Mo.) was used with various magnifications to further examine the tooth, to assess what type of damage and wear the tooth had, and to help determine the type of crown design for the final restoration. The author emphasizes the need for proper magnification in practicing dentistry, especially to see what is happening when the laser is interacting with the oral tissues. Figure 2 is a “naked eye” view without magnification, and Figure 3 is the view at 4.5 power magnification.

After the initial imaging, a rubber dam was placed for complete isolation to perform the endodontic procedure. The clinician

Figure 1: Periapical radiograph of the lower left first bicuspid showing an amalgam restoration with a recurrent carious lesion and periapical pathology

Figure 2: The “naked eye” view (no magnification) shows very little detail

Figure 3: At 4.5 X or more magnification, the clinician has much better visualization to aid the diagnosis and treatment plan. Note wear facet on buccal area of the tooth
Colonna actually has two choices on how to proceed. One is to complete the crown preparation and, while the machine is milling the restoration, finish the endodontic treatment. The other alternative, described here, is more conventional in its order: complete the endodontics, place the buildup material, prepare the tooth, mill the crown, and place the final restoration.

**LASER-ASSISTED ENDODONTICS**

An Er:YAG laser (PowerLase® AT™, Lares Research, Chico, Calif.) was used with a “tipless” handpiece to gain access to the root canal chamber and expose the necrotic tissue (Figure 4). The parameters were 200 mJ, 15 Hz, and 50-µs pulse duration. The canal was shaped using hand instrumentation and then the laser was subsequently used for disinfection (Figure 5). The author, along with Dr. Enrico DiVito, has codeveloped a technique called Photon-Induced Photoacoustic Streaming (PIPS™) which uses a 300-micron tip with laser parameters of 20 mJ, 15 Hz, and 50-µs pulse duration. The root canal space was obturated according to the endodontic standard of care (Figure 6), and then a buildup was placed.

**RESTORATIVE PROCEDURE**

The occlusal surface was reduced with the tipless handpiece using 300 mJ, 15 Hz, and 100-us pulse duration, first to expose the peripheral rim of enamel (Figures 7-8).

The laser energy is easily controlled and directed with the aiming beam and by controls on the laser itself to set the amount of laser energy, air, and water necessary for the tooth preparation. The preparation dimensions for a proper CAD/CAM restoration should follow the manufacturer’s instructions.

By exposing the dentinoenamel junction (DEJ), one can direct laser energy down the axial walls, and create a very smooth and predictable crown preparation (Figure 9). This axial reduction is accomplished at 200 mJ, 30 Hz, and 100-µs pulse duration.

The available choices of pulse repetition rate (hertz) as well as different pulse duration settings can facilitate how smooth, or how coarse, and how quickly one can prepare a tooth for a porcelain restoration. The author has found that his laser can actually prepare a tooth as fast as, and in some cases faster than, a high-speed drill. In addition, he states that both chamfer or butt margins are also easily placed. The 900-micron diameter tipless handpiece is an ideal size for preparing a butt margin, and its spot size is shown in Figure 10. The author uses energy of 50-100 mJ at 30 Hz and 100-µs pulse duration to “rough-in” the margin with that handpiece and then changes to a tipped handpiece with an 800-micron diameter quartz tip (Figure 11), and utilizes...
100 mJ at 50 Hz with a 100-µs pulse duration to create a very smooth margin. This tip can be used in contact with the tooth as well, affording the operator some tactile sensation, as one would have using a high-speed rotary handpiece.

The Er:YAG laser can also be used for soft tissue management, and was used in this case along the distal of the preparation whose margin went just slightly below the tissue level. The gingiva was “troughed” to expose the margin (Figure 12) and to produce a bloodless field using a radial-firing 800-micron tip at 75 mJ, 50 Hz, and 600-µs pulse duration. The tip’s radial emission pattern allows the energy to disperse along the soft tissue which minimizes any concentrated ablation areas.

The final preparation is shown in Figures 13 and 14, entirely achieved using the Er:YAG laser. The CAD/CAM-captured images are shown in Figures 15 and 16.

After the CAD/CAM process was completed, the restoration was tried in, stained and glazed chairside, and bonded to the patient’s satisfaction (Figures 17 and 18).

CONCLUSION

With the above-described technologies, it is now a reality to be able to
perform endodontics and full prosthetic coverage without the need for rotary instrumentation in a single appointment. Except for endodontic files, the tooth in this case presentation never had a conventional instrument touch it during the entire treatment process. As few as 15 years ago, this seemed like a “myth” but today is a reality with the Er:YAG laser model now available. Patients appreciate the minimally invasive nature of how these procedures are performed, and that the conservation of their tooth structure is kept intact. We should challenge ourselves to continue to “think outside the box” when it comes to technology, and consider what we can do with it. As practitioners, we should want to have the best treatment modalities available for ourselves as well as those for whom we provide care. This kind of advancement in dentistry will only serve to make our patients more trusting and willing to avail themselves of appropriate treatment, with only secondary thoughts about the fee.

**AUTHOR BIOGRAPHY**

Dr. Mark Colonna is a 1983 graduate of Loyola University School of Dentistry. He has been in private practice since 1983, and has held positions as an assistant clinical professor of Radiology, and assistant clinical professor of Operative Dentistry at Loyola University School of Dentistry from 1983-1992. In 1992, he moved to Whitefish, Montana, and opened a new practice. He established the Montana Center for Laser Dentistry (MCLD) in Whitefish in January 2001. Dr. Colonna lectures and teaches nationally and internationally on laser dentistry, and has published articles in various well-known dental journals on this topic. He is a member of the American Dental Association, Montana Dental Association, Academy of General Dentistry, Academy of Laser Dentistry, a founding member of the World Clinical Laser Institute, and a lifetime member of The World Congress of Minimally Invasive Dentistry. He received the 2003-04 Clinician of the Year award from the World Congress of Minimally Invasive Dentistry. Dr. Colonna also received Diplomate Status in the World Congress of Minimally Invasive Dentistry and Mastership Status Certification in the use of the Er,Cr:YSGG dental laser from the World Clinical Laser Institute in January 2004. He is an adjunct associate clinical professor in the newly formed Department of Laser Dentistry at the Arizona School of Dentistry and Oral Health, the first dental school in the world to require laser certification prior to graduation by its dental students. Dr. Colonna can be contacted by e-mail at drmark@thelasergeeks.com.

**Disclosure:** Dr. Colonna performs advanced training for Lares Research and Fotona Laser systems.