Laser Removal of All-Ceramic Restorations: Solving a Difficult Clinical Challenge

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INTRODUCTION
I am a laser dentist who purchased my first pulsed dental laser in 1999. I immediately began successfully implementing and developing uses for dental laser technology in my general dental practice.

Dental lasers work utilizing a beam of light. This beam is amplified light energy. Energy, produced in the resonator and directed through mirrors and a fiber-optic system, moves to the tip of the laser handpiece precisely to the site of interaction at the speed of light. Different dental lasers are operated at specific wavelengths of light. This gives me different effects on gingiva and other soft oral tissues, bone, teeth, and certain restorative materials.

In my hands, lasers are as safe as any other dental instrument. The precise control of the laser allows microdentistry, addressing diseased tissue and leaving as much healthy tissue as possible. Laser use allows for comparable end results to more traditional and conventional therapies. Successful results in dentistry are possible using different methods. Laser periodontal therapy and laser cavity preparation are 2 of those. In addition, there is a recently introduced laser technique that has no conventional counterpart. In my office, I utilize a hard-tissue laser to remove bonded veneers and all other bonded/cemented ceramic crowns, including the widely used CAD/CAM zirconia and pressed or CAD/CAM lithium disilicate restorations.

Patients Using the Internet Are More Aware of New Technologies
Before presenting a series of mini case reports using this high-tech procedure, I would like to share an insightful experience that happened recently involving a patient who arrived after lunch one afternoon. My schedule had this note written in it: “New patient with painful crown made outside the United States; wants it removed and replaced.”

We first reviewed the patient’s medical history and found him to be a healthy 40-year-old. He was then greeted by my chairsie dental assistant and ushered into one of our treatment rooms. When I walked in, he was busy showing my assistant a PowerPoint presentation on his laptop that he had prepared the night before coming into his appointment! There were photos of an upper left second molar (tooth No. 15) that included a before photo of the tooth and a postoperative photo of a restoration that he referred to as a “monolithic zirconia crown.” He even knew the brand of zirconia that had been used. He stated that the crown was permanently cemented 2 months previously, and then he said, “All hell broke loose! The crown had been made with a poor design; it was too big, too low, and had a poor bite surface, so I couldn’t chew on my left side without pain and aching, and my tooth became cold sensitive.” His dentist had told him that it would need to be cut off, and this patient believed that this procedure might cause even more damage to the underlying tooth, possibly resulting in the need for a root canal.
Figure 1. Preoperative view of tooth No. 15 for the patient from Tokyo.

Figure 2. Tooth No. 15 immediately after removal of monolithic zirconia crown.

Figures 3a and 3b. Occlusal and internal views of the crown after removal.

Figure 4. The completed restorations on teeth Nos. 14 and 15.

The patient lives in Tokyo and had flown 12 hours overnight, and then drove 2 hours to my office to have me use my laser to remove his crown, which had been placed by a dentist in Japan! It turns out that our patient had done a search on the Internet, and had read my article on laser crown removal (*Dentistry Today*, June 2013), and learned the location of our office.

Examination and radiographs showed a solid zirconia crown in traumatic occlusion, interproximal inflammation caused by retained excess cement, and caries on the distal of the adjacent molar. The treatment plan was to restore the first molar, then remove the previously placed all-zirconia crown with an erbium laser from the second molar, and to remove the cement and treat the inflamed tissue with an Nd:YAG laser; and finally to adjust and recement the zirconia crown.

However, the patient wanted the crown to be replaced with a gold restoration, so our treatment plan was adjusted to prepare tooth No. 15 for a full-coverage gold crown. With this agreed upon plan, his existing zirconia crown would be used as a temporary after any necessary modifications and occlusal adjustments were made.
At this appointment, the monolithic zirconia crown on tooth No. 15 popped off in less than 2 minutes using the erbium laser, and the tooth was then prepared for a full cast gold crown and tooth No. 14 was restored. Next, an Nd:YAG laser was used to trough and create hemostasis, and an impression was taken and sent to our lab team with all the necessary materials and instructions. The existing crown was then adjusted and cemented temporarily. The permanent, full-gold restoration was inserted one week later.

I had a lot of pressure on me to remove that Japanese crown. I did not know the type of cement that was used, the thickness of the ceramic, what the existing buildup consisted of, or the condition of the underlying tooth structure. I followed my usual protocol and the crown removal was successful (Figures 1 to 4). A 2-day follow-up phone call found the patient doing well.

The Internet gives dental patients information that previously was only available to the dental community. Who would have thought that patients would be reading scientific articles and case reports online, exploring treatments that they think are best for them, then be walking into your office and telling you what they would like you to do? They have already been to your website, checked reviews by other patients, and have seen what treatment options you offer. They know a lot about you before you even meet. Be forewarned, moving into the future, many patients will have the need for removal of resin-cemented ceramic crowns, and they are searching the Internet for an alternative way to have this procedure done without damaging the underlying tooth structure or causing damage to the nerve system.

All-ceramic crowns are numbering more than 80% of new insertions. More than 5 million monolithic zirconia restorations are now in patients’ mouths. How are we going to treat postoperative clinical failures related to fracture or other reasons (such as endodontic treatment, recurrent caries, functional and aesthetic changes, etc) as was the case described above with a monolithic zirconia crown that required removal? Many clinicians have experienced the time and expense needed to remove stronger and stronger all-ceramic materials with a high-speed handpiece and multiple diamond burs. There is a definite need to find an alternative to remove not only bilayered restorations but also, and especially, monolithic zirconia crowns.

For the past 6 years, I have used an erbium laser to remove porcelain veneers bonded with light-cured resin cements. No anesthetic is required for the removal procedure, unless other clinical work to be done during the appointment requires its use. The Fotona PowerLase AT Er:YAG (2,940 nm) (Lares Research) has been used utilizing a cylindrical quartz tip (8.0 mm length and 1.0 mm end diameter) in contact in the R14 handpiece; or, using the noncontact R02 handpiece that has a 7.0 mm focal distance. The narrowest pulse width was used (50 µsec). Settings varied from 135 to 275 mJ at 8 or 15 Hz. A 2-to-1 water-to-air mix was utilized. The complete external aspect of the veneer is traced at the focal distance while firing the laser and, within a minute, the veneer or remaining fragments of a previously fractured veneer will “pop off.” The resin cement remains bonded to the tooth. The technique is very predictable. Veneers were never thought to be removable.

How about ceramic crowns with thickness of more than 1.5 mm? The resin cement-restoration interface is too strong for easy conventional crown or bridge removal, when and if needed. My crown removal technique works on bilayered zirconia (porcelain layered over zirconia), monolithic (solid) zirconia (such as BruxZir [Gliderwell Laboratories]), pressed leucite-reinforced (such as IPS Empress [Ivoclar Vivadent]), and pressed or CAD/CAM lithium disilicate (such as IPS e.max [Ivoclar Vivadent]) restorations. For crowns, I use the R14 handpiece with a quartz tip at 15 Hz and 2.0 to 3.0W 50 µsec. These crowns can be
removed en masse and used as a temporarily cemented provisional while a new one is designed and fabricated by the dental laboratory team.

Let’s now look at a few more cases that demonstrate the use of this application of laser technology.

**CASE 1**

**Diagnosis and Treatment Planning**

A 40-year-old male patient presented from another dental practice in Virginia with 20 resin-bonded pressed lithium disilicate (IPS e.max) crowns and veneers on the maxillary and mandibular anterior teeth. The restoration on tooth No. 25 was recently remade and temporarily cemented using a conventional cement. Pain existed to biting on tooth No. 26 with the clinical examination showing occlusal trauma, excess residual cement, and gingival inflammation involving both teeth (Figure 5).

With the patient’s agreement, treatment would consist of removing the crowns with an erbium laser. The rest of the treatment would be to adjust the occlusion on the restorations, desensitization of the teeth, troughing, decontamination, and biostimulation of the surrounding gingival tissues, and then the recementation of the crowns.

The crowns were removed using the Fotona AT PowerLase Er:YAG R14 handpiece, 8 mm/1.0 m cylindrical quartz tip.

**Laser Parameters:**

- Wavelength = 2,940 nm
- Beam Delivery Type = 7-mirror articulated arm
- Peak Power = 3.0 W
- Pulse Energy = 200 mJ per pulse
- Repetition Rate = 15 Hz
- Pulse Width = Super Short Pulse (SSP) 50 µsec
- Water 6/Air 2 spray with a vacuum tip to remove water from the patient’s mouth.

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**Figure 5.** Preoperative photo of the previously cemented lithium disilicate crowns.

**Figure 6.** Teeth Nos. 25 and 26, after laser removal. Note the resin cement remaining on the prepared tooth No. 26.
Figure 7. The IPS e.max (Ivoclar Vivadent) crown (No. 26) immediately after removal with the laser.

Figures 8a and 8b. Recemented crowns on teeth Nos. 25 and 26.

Only the erbium laser was used with the tip in contact with outer surfaces of the crowns, with a pulse repetition rate at a frequency of 15 pulses per second; starting on the facial at the gingival margin surface; slowly painting back and forth over all surfaces; then to lingual surface, back and forth bottom to top. A small fracture line resulted on the lingual aspect of margin No. 26. Next, the crowns were popped off using a scaler inserted at the gingival facial margin (Figures 6 and 7).

A free-running Nd:YAG (PerioLase MVP 7 [Millennium Dental Technologies]) was used for soft-tissue therapy with 4.0 W 20 Hz 150 μsec 360 μ contact fiber to trough the gingival tissues and create hemostasis. All cement was removed using a 12-fluted carbide finishing bur (No. 7664 [DENTSPLY Midwest]). The fracture line on the lingual of No. 26 was removed, and solid ceramic was left, utilizing air abrasion.

The crowns were adjusted and polished to proper form and function. The internal surfaces were air abraded with 50-μm aluminum oxide, and a bond enhancer (RelyX Ceramic Primer [3M ESPE]) was applied and thoroughly dried with oil- and water-free air. Finally, the teeth were treated with a desensitizer (GLUMA [Heraeus Kulzer]), and then the restorations were delivered using a dual-cured resin cement (RelyX Unicem 2, A2 [3M ESPE]).

After the completion of the outlined treatment, teeth Nos. 25 and 26 were asymptomatic (Figure 8).

CASE 2
Diagnosis and Treatment Planning
A 49-year-old male presented with pain to biting and thermal changes in the lower left quadrant. A monolithic zirconia crown had been placed 14 months previously on tooth No. 18 and the pulp was now diagnosed as necrotic. Root canal therapy (RCT) on tooth No. 18 was the indicated treatment (Figures 9.
and 10).

The treatment plan was to remove the crown, do RCT, and then to recement the crown, all in the same day.

**CASE 2**

**Figure 9.** Preoperative photo of tooth No. 18.

**Figure 10.** Radiograph of tooth No. 18.

**Figure 11.** Immediately after lasering the crown off.

**Figures 12a and 12b.** Views of crown after removal.

**Figure 13.** Post-RCT radiograph No. 18.

**Figure 14.** Recemented crown, No. 18.

**Treatment Protocol**

Local anesthetic (one carpule of 2% Carbocaine [1/20,000 Levonordefrin]) was delivered (needed for the RCT, not for the crown removal). With all required laser safety and regulatory compliances observed, the BruxZir crown was removed using the Fotona PowerLase AT laser system with a 90° optical handpiece model R14-C, and utilizing an 8.0 mm/1.0 m cylindrical quartz tip.

**Laser Parameters:**
Wavelength = 2,940 nm free running pulsed Er:YAG laser
Peak Power = 2.0 W
Pulse Energy = 135 mJ per pulse
Repetition Rate = 15 Hz
Pulse Width = SSP 50 µsec
Water 4/Air 2 spray

Only the erbium laser was used with the tip in near contact with outer surfaces of the monolithic zirconia crown. Focal distance from the fiber tip was at 0.7 mm; using the shortest pulse width (50 µsec) to increase the photo acoustic response; slow movement of tip to increase the power density; pulse repetition rate was set at a frequency of 15 pulses per second; starting on the occlusal surface, slowly painting back and forth over all surfaces; then to the buccal surface, moving back and forth, top to bottom; then to the lingual, starting at occlusal. The crown was popped off with a scaler. In less than 2 minutes, the crown had been removed (Figures 11 and 12). There was no cement left in the crown; however, cement remained bonded to the prepared tooth and to the composite resin core material.

RCT was done, and then the resin cement that remained on the tooth surfaces after laser removal was cleaned off and the endodontic access opening was sealed (bonded) using composite resin. Next, the internal surfaces of the zirconia crown were sandblasted; the crown was tried-in, adjusted, and polished. (Note: It is easier to polish zirconia in the lab than in the mouth.) Finally, the crown was inserted with a self-etching and self-adhesive resin cement (RelyX Unicem 2 [A2]) (Figures 13 and 14).

CASE 3
Diagnosis and Treatment Planning
A 68-year-old female patient presented with bilayered zirconia crowns (Lava [3M ESPE]) on her maxillary central incisors (teeth Nos. 8 and 9). She had experienced sensitivity and tissue redness since their insertion. The crowns had been resin-cemented using RelyX Unicem 2 (Figure 15).

Treatment would consist of removing the crowns with an erbium laser, crown lengthening procedures to regain biologic width and create better marginal access, and then the existing crowns were to be recemented. After healing, the teeth would be re-prepared and new crowns made.

Figure 15. Preoperative photo of teeth Nos. 8 and 9.
Figure 16. Immediately after laser removal of the crowns.

Treatment Protocol
The Lava crowns were removed using the Fotona PowerLase AT laser system with an optical handpiece model R14, 8 mm/1.0 mm cylindrical quartz tip.

Laser Parameters:
- Wavelength = 2,940 nm
- Peak Power = 3.0 W
- Pulse Energy = 200 mJ per pulse
- Repetition Rate = 15 Hz
- Pulse Width = SSP 50 µsec
- Water 4/Air 2 spray.

The Fotona PowerLase AT Er:YAG laser was used with quartz tip in contact with the ceramic, with slow movement of the tip to increase power density; pulse repetition rate was set at a frequency of 15 pulses per second; starting on the facial surface, slowly painting back and forth over all surfaces; then to lingual, starting at the incisal aspect, brushing across the lingual surfaces side to side, moving toward gingival. The crowns popped off easily with a scaler (Figure 16).

The central incisors were temporized using the existing crowns, and the patient returned at a later date (after gingival healing) for final impressions.

**CLOSING COMMENTS**

An erbium laser can be used to remove feldspathic porcelain and all other high-strength, all-ceramic crowns. This can be accomplished without damaging the restorations, underlying bonded composite buildups, abutments, or the tooth structure. This technique is specific for the erbium wavelength, not diode, Nd:YAG or CO₂ lasers; and, of course, no laser can be used to remove metal or PFM restorations.

Tens of millions of all-ceramic restorations have been placed in our patients’ mouths; a safe guess would be that more than 5% will likely fail during the next 5 years, requiring removal. The good news is that we now have a laser technique that can be used in those infrequent, but certain to be increasing and very challenging, clinical circumstances.

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*Disclosure: Dr. Cranska has no financial interest in any laser company; however, he is compensated as a clinical consultant for presenting, lecturing, and training as requested by Institute for Advanced Laser Dentistry and Millennium Dental Technologies.*