

Using the Erbium Laser to Remove Porcelain Veneers in 60 Seconds

Minimally Invasive, Efficient, and Safe

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Dr. van As will be speaking at the 29th Annual AACD Scientific Session in Seattle, Washington, on April 26, 2013. The title of his lecture is "*You Light up My Life: Lasers in Contemporary Esthetic and Implant Dentistry*." In this article, Dr. van As discusses how erbium lasers have the ability to quickly and safely remove all porcelain restorations.

Abstract

For more than 30 years, porcelain veneers have provided clinicians with a method for changing a patient's smile almost instantaneously. At times, however, veneers require replacement due to caries, fractures, or leakage or simply because the patient is unhappy with the esthetic outcome. Erbium hard tissue lasers can be used to efficiently, safely, and predictably remove all porcelain restorations while also keeping them in one piece. In doing so, this new tool for removing porcelain restorations provides clinicians with an alternative to high-speed handpieces while preventing further iatrogenic damage to underlying tooth structure.

Key Words: veneer, erbium laser, removal, esthetics, porcelain

Although erbium lasers have been shown to safely remove orthodontic brackets without damaging increases in pulpal temperature, research should continue...

Introduction

Porcelain laminate veneers, originally developed in the early 1980s, are very thin porcelain or all-ceramic facings used to improve anterior esthetics.¹⁻³ These porcelain facings can be used to enhance the appearance of peg-shaped lateral incisors, enamel hypoplasia, fluorosis, or tetracycline discoloration when they are placed on top of the underlying tooth.⁴

Originally, the preparations for the laminate restorations were considered to be minimally invasive and typically limited to enamel. As little as 0.5 mm of axial and incisal tooth reduction has been stated as being required to allow for adequate space to fabricate a stacked porcelain veneer.⁵⁻⁸ Longevity studies at 10 years have shown a remarkable success rate for porcelain veneer restorations, with failure rates that are often cited in single-digit percentages.⁹⁻¹² Beier,¹³ however, estimated a much higher failure rate of approximately 22% at 20 years following placement.

With the population living longer and many people proceeding with veneers at a younger age, there is a requirement for removal or replacement of these porcelain laminates for a variety of reasons, such as fracture, discoloration due to luting cement, marginal failure, or esthetic concerns from a patient's perspective (Table 1).

At present, the most common method for removing all-ceramic restorations is to use a high-speed handpiece with a diamond.¹⁴ Due to the nature of the tremendous color-matching abilities of both resin bonding cements and the veneers themselves with underlying tooth structure, removing veneers without damaging the underlying natural tooth can be both difficult and time consuming, even with magnification. Friedman¹⁵ has discussed how valuable enamel as a substrate is to the long-term success of porcelain veneers, and Ozurk¹⁶ has shown a drop in bond strength if veneer preparations are overly aggressive with large amounts of dentin exposure. Therefore, it can be assumed that alternative methods that could safely, predictably, and quickly debond porcelain restorations without the risk of developing further iatrogenic damage to underlying tooth structure would be met with enthusiasm by many dentists who currently face a difficult task when the need to replace existing all-porcelain restorations arises.

Table 1: Clinical Reasons for Porcelain Veneer or Crown Removal.

	Diagnosis of Problem	Benefit of Laser Removal of Restoration
1	Improper initial placement of new porcelain veneers or crowns.	May remove restoration without fracture and rebond it properly without redoing it.
2	Old fractured, chipped porcelain restorations.	May remove restoration without further iatrogenic damage to underlying tooth.
3	Caries around restorations.	May remove restoration without further iatrogenic damage to underlying tooth.
4	Irreversible pulpitis after bonding new porcelain restoration.	May remove restoration to save tooth structure or prevent fracture of it during endodontic access.
5	Patient unhappy with shade of new restorations.	May remove restoration and have lab repair shape instead of redo veneers.
6	Patient unhappy with shape of new restorations.	May remove restoration and have lab repair shape instead of redo veneers.
7	Patient decides that they do not like diastemas closed in minimal or no-prep veneer cases.	May remove restoration without further iatrogenic damage to underlying tooth (can be a reversible procedure now).

Literature Review

Since the early 1990s, lasers have been used experimentally to remove ceramic orthodontic brackets. Each of the four major dental laser wavelengths (diode, CO₂, Nd:YAG, and Er:YAG) have been utilized to try and help with debonding these brackets.¹⁷⁻²⁴ Oztoprak and colleagues²⁵ developed a new method to debond ceramic brackets using the Erbium YAG laser wavelength (2,940 nm). They found that short durations of three to nine seconds with moderately high energies of 4.2 W were effective and safe for this procedure. Enamel was not affected by the laser energy, and the pulpal temperature rise was measured to be below the 5.5°C threshold, at which point irreversible changes to the pulp can occur. Although erbium lasers have been shown to safely remove orthodontic brackets without damaging increases in pulpal temperature, research should continue, to ensure that the initial studies showing safety with laser removal of bonded veneers and crowns are also confirmed.

The erbium family of lasers exists between 2,780 nm (erbium, chromium:yttrium scandium-gallium-garnet [Er:CrYSGG]) and 2,940 nm (erbium:yttrium-aluminum-garnet [Er:YAG]). These wavelengths are well absorbed in water and hydroxyapatite (Fig 1), and their absorption in these tissue compounds makes it possible to ablate both soft tissue and hard tissue compounds, which both consist partially of water. Enamel has 6% water, bone has 22% water, and soft tissue is composed of approximately 80% water. The mechanism of action of ablation with erbium lasers, as proposed by Fried,²⁶ is that the erbium laser wavelengths are absorbed in water molecules and cause a rapid expansion of these molecules. The rapid expansion causes micro-explosions, and this, in turn, creates an ablation crater of 200 to 300µm in hard tissue (Fig 2).

Lasers, of course, have been utilized extensively in the provision of esthetic dentistry for soft and hard tissue crown lengthening associated with porcelain-bonded restorations.²⁷⁻³⁷ In addition, frenectomies, gingivectomies, and other soft tissue procedures can be completed in combination with esthetic dental procedures.

Morford Study

Within the past five years, research has begun to look at the use of erbium lasers as an alternative to traditional veneer removal techniques utilizing burs.³⁸⁻⁴¹ Morford and colleagues⁴² produced a study in 2011 that was "designed to systematically investigate the efficacy of an Er:YAG laser on veneer debonding, possibly without damage to the underlying tooth, and

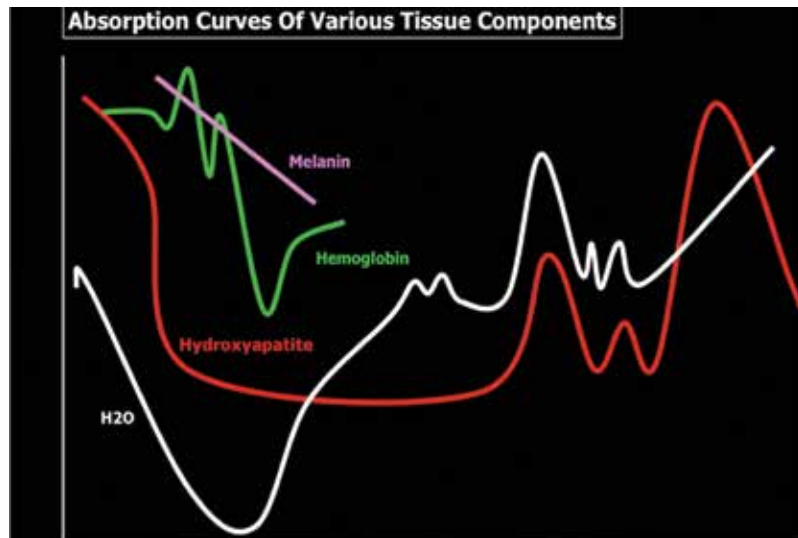


Figure 1: Absorption curve of various tissue components in the four major dental wavelengths. Erbium laser wavelengths are well absorbed in water and hydroxyapatite.

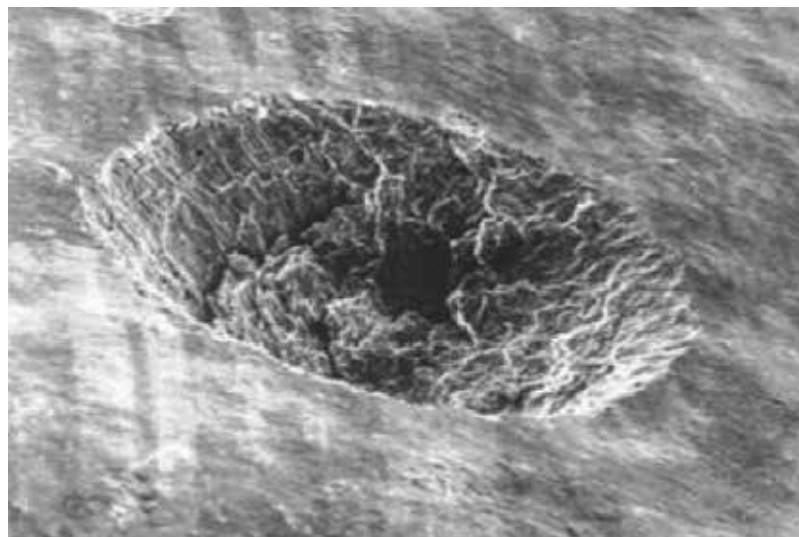


Figure 2: An approximately 200-300µm deep ablation crater made by multiple pulses from an erbium laser. (This image is the property of Peter Rechmann, DMD, PhD, Dr. med. dent., School of Dentistry, University of California San Francisco).

Table 2: Comparison of Techniques for Er:YAG Laser Veneer Removal.

Study	Wavelength	Energy used to debond veneers	Tip-to-veneer distance	Thickness of veneer	Seconds to debond veneers
Morford et al.	2940 nm	10Hz, 133mj 1.33 watts energy	3-6 mm away	0.76-1.18 mm	31-290 seconds
Oztoprak et al.	2940 nm	50Hz, 100mj 5 watts energy	2 mm away	0.07 mm	3-9 seconds

preservation of the veneer integrity.⁴² The researchers used an Er:YAG wavelength (2,940 nm) at a low repetition rate of 10 Hz and a low-energy setting of 133 millijoules (mj) (1.33 W) with a short pulse duration of 100 milliseconds on 24 porcelain (lithium disilicate and leucite-reinforced glass ceramic) veneers (13 e.max and 11 IPS Empress Esthetic [both Ivoclar Vivadent; Amherst, NY]). These veneers were bonded to preparations on freshly extracted incisors. They measured the energy and time necessary for debonding the veneers in seconds elapsed as well as the percentage of transmission of the erbium laser through the two different types of porcelain. The laser tip was held in a non-focused position that was 3 to 6 mm away from the veneer itself.

The results of their study found that the veneers transmitted between 11.5% to 43.7% of the incidental Er:YAG energy. Twice as much laser light was transmitted through e.max restorations versus IPS Empress Esthetic restorations at comparable thicknesses. All 24 veneers were completely removed with these low settings and the veneers “slid off” without mechanical dislodgment. The time for complete porcelain veneer removal with the laser was, on average, just under two minutes (113 ± 76 seconds). The author of this article contends that the longer times needed to remove the veneers are likely due to the very low energy settings used in this study. There were no signs of underlying tooth structure because the energies used for debonding were up to 20 times less than needed to ablate enamel and dentin.

The debonding mainly occurred at the cement/veneer interface, possibly by interacting with the hydroxyl molecule in the silane bond or by expanding the water molecules in the porcelain. None of the e.max lithium disilicate veneers fractured during debonding, whereas 36% of the Empress Esthetic veneers did fracture. The authors postulated that this was possibly due

to the known higher flexural strength of e.max restorations, which might more easily resist the pressure buildup between the tooth and the veneer during the explosive ablation of the cement. The higher flexural strength of e.max (lithium disilicate) veneers might explain why these veneers do not fracture during the removal process. Morford and colleagues⁴² concluded that other porcelain systems and other veneer cements, aside from RelyX (3M ESPE; St. Paul, MN) veneer cement, should also be tested in the future.

Oztoprak Study

In another recent study, Oztoprak and colleagues examined the effect of erbium lasers on debonding porcelain veneers.⁴³ The group had looked previously at using lasers to debond orthodontic brackets and used many of the materials and methods employed in their other studies for the removal of veneers. Table 2 shows that many differences exist between the studies of Morford et al.⁴² and Oztoprak et al. The latter group used much higher settings (50 Hz and 100 mj) directed closer to the veneers, which were thinner in dimensions. They also used mechanical dislodgment of the veneers after utilizing the laser for less than 10 seconds. Compared to the control group in their study, when using the laser at 5 W for nine seconds, the energy needed to pop the porcelain veneers off was only 12.8% versus the control group, which did not use a laser at all (27.5 ± 1.44 MPa for control group versus 3.54 ± 0.46 MPa for the laser group). The research paper explained the mechanism of action of debonding as a physical disruption of the composite luting agent; the authors found that failure occurred mainly within the luting agent, with no damage to the enamel itself during debonding. Table 2 compares the different studies, but both studies show that laser veneer removal is not only possible but also is probable in very short periods of time, with no risk to the enamel or pulp.

Clinical Cases Using Er:Yag Laser Removal of Veneers

The author has used the Er:YAG laser to successfully remove both single and multiple veneers as well as single and multiple all-ceramic e.max and IPS Empress Esthetic restorations. Zirconium restorations and more traditional restorations such as porcelain fused to metal (PFM) are not able to be removed with the laser. Only erbium wavelengths (Er,Cr:YSGG at 2,780 nm and Er:YAG lasers at 2,940 nm) will work to safely remove

Table 3: Settings for the Removal of Porcelain Veneers.

Porcelain Veneer Type	Removal Possible	Settings
Lumineers or minimal prep	Yes—cracking possible	4-5 watts, H ₂ O for 30 seconds facial and incisal
Pressed feldspathic	Yes—thicker veneers need mechanical removal after laser	4-6 watts, H ₂ O for 30-45 seconds facial and incisal
e.max	Yes—less likely to crack	5-6 watts, H ₂ O for 30-45 seconds





Table 4: Settings for the Removal of Porcelain Crowns.

Porcelain Crown Type	Removal Possible	Settings
All-porcelain, Empress, e.max	Yes—anterior easier than posterior	5-6 watts, H ₂ O, 30-45 seconds facial, lingual, incisal
Porcelain fused to metal	No	NA
Zirconia, Procera, LAVA	No	NA



the porcelain restorations. Other wavelengths, such as diode, CO₂, or Nd:YAG lasers, which are primarily soft tissue lasers, will not effectively or safely remove porcelain restorations. When using the erbium lasers, it is typical for veneer restorations to require less time and energy to remove than full-coverage all-porcelain restorations. The laser will not work on PFM, full metal, or any zirconia restorations that are cemented into place. In order for the laser to remove the porcelain veneers, etch and bonding of the restoration must be the cementation technique used. This allows the laser energy to interact with the resin bonding substrate so that the veneer or crown may be debonded. Traditional cementation of restorations with cements—such as regular or resin-modified glass ionomers, zinc phosphate, or temporary cements—will prevent laser removal of these restorations (Tables 3 & 4).

This article's author has used higher settings (6 W with water spray) and lower settings (1.5 W without

water) to successfully remove old restorations. Further research will be needed to see if one technique or another will provide for greater success in removing all porcelain restorations, but the following cases show how the laser might be used successfully and how it can be a "life saver" for many recently completed cases where the patient is in discomfort or unhappy with the final result.

If the restoration can be removed and reused and rebonded with minor alterations, it can be a huge time and cost saver for all parties involved.

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Figure 5: Preoperative view of e.max lithium disilicate veneers.



Figure 6: Incisal view of a slight interproximal fracture on the distal incisal embrasure of a lateral incisor.

Clinical Case 1: Er:Yag Removal of a Single E.Max Veneer

In this case, a 52-year-old male patient had fractured the distal incisal edge of an e.max porcelain lithium disilicate veneer on his maxillary right lateral incisor. The final restoration had been placed just three months earlier. Treatment options were discussed with the patient; the decision was made to remove and replace the veneer, as the patient was trapping food interproximally and he found the small chip was rough to his tongue and was shredding floss (**Figs 5 & 6**). The Hoya ConBio (Fremont, CA) Er:YAG laser (2,940 nm) wavelength was used at a setting of 10 Hz and 100 mj (compare with Morford et al., who used 10 Hz but 133 mj)⁴² with no water spray for 40 seconds on the facial surface and 10 seconds on the lingual surface. The veneer was removed with one downward pull using a crown and bridge remover. The veneer was intact (**Figs 7 & 8**); afterwards, diode laser troughing was used for tissue management and a final polyvinylsiloxane (PVS) impression was taken (**Figs 9 & 10**). The new porcelain veneer was bonded into place 10 days later. (**Fig 11**).

The role of the erbium laser in removing bonded porcelain restorations is promising, not only for the dentist but for the patient and laboratory as well.



Figure 7: Intaglio (lingual) view of a veneer removed with an Er:YAG laser. Note the intact nature of the veneer.



Figure 8: Facial view of the same veneer after removal using an erbium laser.



Figure 9: View after completion of diode laser troughing for tissue management.

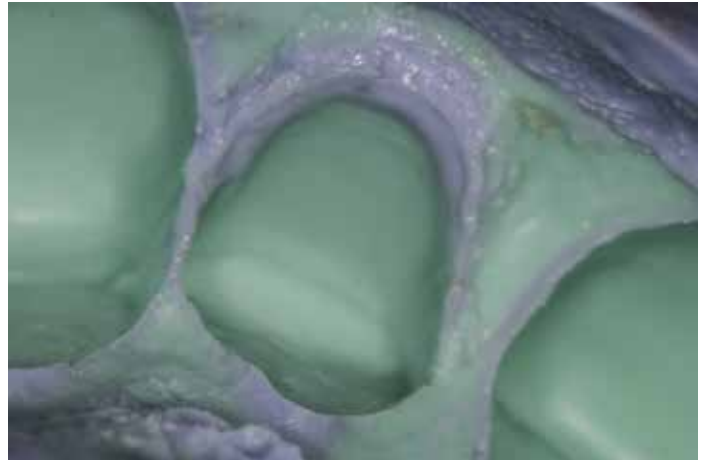


Figure 10: PVS impression of a veneer margin at high magnification.



Figure 11: Facial view of a completed veneer immediately postoperative.



Figure 12: Preoperative appearance of an old porcelain veneer on the right central incisor that is discolored and does not match the adjacent incisor.



Figure 13: Immediate appearance after the veneer was removed with an Er:YAG laser.



Figure 14: View of the lingual surface shows decay and old resin requiring full-coverage crown preparation instead of a veneer preparation.

Clinical Case 2: Er:Yag Removal of a Single E.Max Veneer

In this case, a 37-year old female patient wanted to have a discolored maxillary right central porcelain veneer replaced (**Fig 12**). Treatment options were discussed with the patient; the decision was made to remove and replace the veneer and try to create a better color match to the left central incisor. The Hoya Con-Bio Er:YAG laser (2,940 nm) wavelength was used at a setting of 30 Hz and 200 mj (compare with the 50 Hz and 100 mj used by Oztoprak et al.) accompanied by a fine water spray for 30 seconds on the facial surface and 10 seconds on the lingual surface. The veneer was removed after several downward pulls with a crown and bridge remover. The clinician should extend care when using mechanical means of removing restorations after the laser is used. Ideally, a small overhang in one area will help provide a "catch," whereby the clinician may remove the loosened restoration via a controlled, downward pull. The retained resin cement was visualized on the preparation (**Fig 13**). Due to the excessively aggressive previous preparation into dentin as well as the lingual decay (**Fig 14**), the decision to fabricate a full e.max lithium disilicate crown was made (**Fig 15**). The new porcelain restoration was bonded into place 10 days later (**Figs 16 & 17**).



Figure 15: Full-coverage preparation for a right central incisor with an e.max lithium disilicate crown.



Figure 16: Immediately postoperative appearance of a bonded e.max crown.



Figure 17: Immediately postoperative close-up view of a right central incisor crown.



Figure 18: Preoperative appearance of "short" porcelain veneer preparations with poor length-to-width ratios that make the teeth appear square.



Figure 19: View immediately following completion of a laser crown-lengthening procedure and removal of veneers on all four maxillary incisors.



Figure 20: Postoperative view of new e.max lithium disilicate crowns in place with an improved width-to-length ratio.

Clinical Case 3: Er:Yag Removal of Empress Porcelain Veneers

In this case, a 35-year-old female patient wanted to have short, leaking, and discolored veneers replaced on her maxillary anterior incisors (##7-10) (Fig 18). Treatment options were discussed with the patient. The decision was made to remove and replace only the maxillary central and lateral incisor veneers due to financial considerations; therefore, the buccal corridor (canines and premolars) were not treated. In addition to replacing the failing restorations, the patient wanted to make the teeth longer. A "laser smile lift" or closed flap crown lengthening was performed with an Er:YAG laser to make the teeth longer.

The Hoya ConBio Er:YAG laser (2,940 nm) wavelength was used at a setting of 30 Hz and 40 mj (1.2 W) with a fine water spray to recontour first the soft tissue and then to correct the resultant biologic width problems. The resultant crown preparations are shown in Figure 19. The veneers were removed with settings of 30 Hz and 175 mj (5.25 W) in 30 to 60 seconds.

The decision to fabricate full-porcelain IPS Empress Esthetic crowns was made. The new porcelain restorations were bonded into place later, and the immediate postoperative appearance can be seen in Figures 20 and 21.



Figure 21: Note the improved smile appearance after new restorations were placed compared to the preoperative view.



Figure 22: Preoperative view of the retracted smile prior to the "makeover."



Figure 23: The patient had irreversible pulpitis on the right maxillary lateral incisor and was unhappy with "spots" seen under final incisor e.max crowns.



Figure 24: View after root canal therapy and laser removal of the lithium disilicate crowns were completed; note the "brown spots" of uncured resin cement on incisor preparations.

Clinical Case 4: Er:Yag Removal of E.Max Lithium Disilicate Crowns

A 40-year-old female patient wanted to pursue a "smile makeover." Her extensively restored anterior maxillary dentition from her first premolar to first premolar had numerous failing and discolored composite restorations. The patient received eight lithium disilicate (e.max) crowns placed on ##5-8 (##14-11 international) and ##9-12 (##21-24 international). After the final restorations were bonded into place, the patient developed irreversible pulpitis on the maxillary right lateral incisor and endodontic therapy was required.

The lithium disilicate crown was removed with an Er:YAG laser used for two minutes (60 seconds on the facial and lingual surfaces, with settings of 30 Hz and 200 mj; 6 W with air/water- spray). The endodontic therapy was completed on the tooth. Subsequently, the remaining three incisor crowns were also removed using the Er:YAG laser with similar settings. The patient had noticed "brown spots" on the facials of these teeth, which turned out to be uncured resin cement showing through. The patient's restorations were replaced, and the new lithium disilicate crowns were bonded into place (Figs 22-26).



Figure 25: Four e.max crowns were removed via laser and sent back to the laboratory.



Figure 26: Final view of the patient's smile after placement of new e.max crowns fabricated at the laboratory.

Summary

Clinicians with access to erbium lasers in their practices have the ability to quickly and safely remove all porcelain restorations (glass ceramics, such as leucite-reinforced porcelain or lithium disilicate restorations) without fear of creating iatrogenic damage to underlying tooth structure. The role of the erbium laser in removing bonded porcelain restorations is promising, not only for the dentist but for the patient and laboratory as well. In some situations, restorations might be salvageable, even after bonding, if they require alterations in their position, shape, size, or color. Further research is required to determine whether lower settings without water (promoted by Morford et al.⁴²) or higher energies (used by Oztoprak et al.⁴³) will provide better results. However, there is no doubt that the use of erbium lasers for veneer removal is an exciting alternative to the traditional methods of using a high-speed handpiece.

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Procedure Videos

The digital edition of this issue of *jCD* will provide links to videos showing procedures for

- ▶ • removal of the left central incisor porcelain veneer
- ▶ • removal of the left lateral incisor porcelain veneer
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