Critical Appraisal

INTRAORAL REPAIR OF FRACTURED CERAMIC RESTORATIONS

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Much of dentistry performed today has an esthetic focus, and subsequently more teeth are being restored with porcelain in the attempt to provide the most natural esthetics possible. Unfortunately, along with an increase in the use of dental porcelains comes an increase in risk for fractures, which at times can require an urgent and expedient solution. This Critical Appraisal reviews four studies to determine which method(s) of repair might yield the most predictable results.

EFFECT OF SURFACE TOPOGRAPHY ON THE BOND STRENGTH OF A COMPOSITE TO THREE DIFFERENT TYPES OF CERAMIC

W.-S. Oh, C. Shen

Journal of Prosthetic Dentistry 2003 (90:241–6)

ABSTRACT

Objective: To determine whether or not mechanical and/or chemical roughening of ceramic surfaces will result in higher tensile bond strengths.

Materials and Methods: Ceramic blocks were fabricated from three different materials—a feldspathic veneering porcelain (Eris, Ivoclar Vivadent, Schaan, Liechtenstein), a leucite-reinforced pressable porcelain (IPS Empress, Ivoclar Vivadent), and an experimental lithium disilicate core ceramic (Ivoclar Vivadent). Four different surface treatments consisting of polishing, airborne-particle abrasion, acid-etching, and a combination of abrasion and etching were investigated. Prior to any surface treatment, all ceramic blocks were polished with silicon carbide abrasive paper under running water. The polished group received no further treatment and served as the control group. Etching was performed with 5% hydrofluoric (HF) acid gel for 2 minutes. Airborne-particle abrasion for the abraded groups was performed using 50-µm Al_2O_3 at a pressure of 35 psi. After the surface roughening procedures, the ceramic surfaces were thoroughly cleaned via a pressure-vaporized steam cleaner. Silane treatment was excluded to minimize the number of variables. An adhesive resin (Heliobond, Ivoclar Vivadent) was applied, lightly thinned

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with compressed air, and light-activated. Composite resin (Tetric-Ceram, Ivoclar Vivadent) was applied and light-cured in 1.5-mm increments. The blocks were sectioned to yield 20 specimens for each group. The specimens were then subjected to a tensile force via an Instron machine, and the tensile bond strengths (MPa) were calculated.

Results: Adhesion at the ceramic/resin interface failed during sectioning for all the specimens of the control group. For each material, tensile bond strengths were significantly higher when the ceramics were abraded followed by etching than with either etching or abrasion alone. For the combined surface treatment, the feldspathic porcelain had significantly lower mean repair strength (9.3 MPa) than the leucite-reinforced porcelain (13.5 MPa), which was significantly lower than that of the lithium disilicate-reinforced porcelain (23.1 MPa). Evaluation of the failure mode by Scanning Electron Microscopy (SEM) demonstrated mixed failures predominant for all three.

Conclusions: The highest tensile bond strength of the resin repair to each ceramic was obtained by the combination of airborne-particle abrasion surface treatment with Al_2O_3, followed by etching with HF acid. Higher repair strengths were observed for pressable ceramics than for fired porcelain.

COMMENTARY

This study was well designed in that the authors tested three commonly used classes of ceramic and three common methods of increasing the ceramic surface area to improve bond strength. The results were consistent with previous studies that have found the best combination of surface treatment to be airborne-particle abrasion followed by HF etching.

The authors mention the omission of a silane as one limitation of this study. Application of a silane coupling agent to an abraded or etched ceramic surface provides covalent and hydrogen bonding, and numerous studies have discussed its importance for an adequate resin bond to silica-based ceramics.

In addition, this study did not consider the effect of aging on the bond strength of the resin-ceramic interface. Some of the more common methods to simulate clinical aging are long-term water storage and thermocycling. Most studies that use these methods of aging reveal fairly substantial differences between early and late bond strengths. Thus, early bond strengths, as are often reported by manufacturers, should be viewed with caution as they may not necessarily predict long-term success.

It should be noted that this study only evaluated resin repair strengths to ceramic surfaces. However, intraoral fractures often involve metal substrates or tooth structure in varying degrees. The surface treatments used in this study have been shown in other studies to be, at best, minimally effective in the treatment of metal exposure. Thus, the clinician must use other options to adequately prepare ceramic fractures that expose significant metal or tooth structure.

REPAIR STRENGTH OF ETCHED VERSUS SILICA-COATED METAL-CERAMIC AND ALL-CERAMIC RESTORATIONS

R. Frankenberger, N. Krämer, J. Sindel
Operative Dentistry 2000 (25:209–15)

ABSTRACT

Objective: The purpose of this in vitro study was to examine the shear bond strengths (SBS) of resin composite repairs to substrates simulating porcelain-fused-to-metal restorations, porcelain-fused-to-metal restorations with metal exposed, machined feldspathic

porcelain restorations, and pressed all-ceramic restorations.

Materials and Methods: To simulate fractured crowns, four substrate groups were fabricated with the following: a machinable feldspathic porcelain (Vita Mark II [VM], Vident, Brea, CA, USA), a leucite-reinforced pressable ceramic (IPS Empress [EM], Ivoclar Vivadent), a feldspathic porcelain for veneering of noble metal ceramic alloys, (Vita VMK 68 N [VMK], Vident), and the same porcelain applied such that half of the surface to be repaired was exposed metal (VMK50).

All specimens were finished with water-cooled 54–76 µm diamond burs before treatment with either silica coating (CoJet-Sand, 3M ESPE, St. Paul, MN, USA) or HF acid (control group). The control group was acid-etched with 5% HF for 60 seconds followed by silanation with ESPE-Sil (3M ESPE) and left undisturbed for 5 minutes. Next, the bonding agent was applied, air-thinned, and light-activated.

In the metal-exposed group, only the ceramic portion was treated with HF acid while the metal part was covered with opaquer. For the silica-coated groups, the specimens were air-abraded with 30 µm CoJet-Sand at 30 psi for 15 seconds. Following application of CoJet-Sand, the silane coupling agent was applied and left undisturbed for 5 minutes. The bonding agent was applied, air-thinned, and light polymerized for 20 seconds. In the metal-exposed group, following application of the silica coating, the metal surface was also silanated followed by application of an opaquer (which also served as the bonding resin).

Resin composite cylinders were bonded to the treated surfaces. All specimens were stored in distilled water for 24 hours at 37°C. The specimens were subsequently thermally cycled for 24 hours (1,150 cycles) alternating between 5°C and 55°C with a dwell time of 30 seconds at each temperature. Shear loads were applied to each specimen using a Zwick (Ulm, Germany) universal testing machine. The fracture modes were examined by SEM and divided into adhesive or cohesive fractures.

Results: Pretreatment of the Empress, VMK, and VMK50 specimens with silica coating (CoJet-Sand) resulted in significantly higher SBS than with the etching technique. The bond strengths in the VM specimens were slightly higher using acid-etching, but the difference was not statistically significant. In the all-ceramic groups, the mode of failure was cohesive, whereas in the metal-ceramic groups, the failure was cohesive within the ceramic portion and adhesive between the metal and opaquer for the exposed metal portions.

Conclusions: Silica coating with CoJet-Sand represents an acceptable alternative for surface conditioning of fractured porcelain compared with other methods such as airborne particle abrasion with aluminum oxide or acid etching with HF acid. The advantage of silica coating is that multiple exposed surfaces (porcelain and metal) can be treated in one step.

COMMENTARY

This study was well designed as it tested the bond strength of composite repairs to multiple substrates including veneering porcelain, metal, and ceramic substrates that are becoming more popular today. The results of the CoJet-Sand treatment appear to be very promising. Out of the four groups tested, three substrates showed an increase in bond strength when compared with acid-etching.

In previous studies, adequate surface preparation of a combination of various substrates has been difficult when using only one protocol. For example, conventional sandblasting can provide less than favorable repair bond strengths to veneering ceramic.

In the current study, acid-etching provided an acceptable bonding resin to ceramic but not to exposed metal. Additionally, this study provided good in vitro evidence that silica-impregnated aluminum oxide will yield clinically acceptable repair bond strengths to multiple substrates.

SHEAR BOND STRENGTHS OF 2 INTRAORAL PORCELAIN REPAIR SYSTEMS TO PORCELAIN OR METAL SUBSTRATES

D.R. Haselton, A.M. Diaz-Arnold, J.T. Dunne
Journal of Prosthetic Dentistry 2001 (86:526–31)

ABSTRACT

Objective: To evaluate the shear bond strength of two porcelain repair systems to three different substrates.

Materials and Methods: Resin composite cylinders were bonded to three different substrates using two porcelain repair systems, the CoJet system and Ivoclar Vivadent's Ceramic Repair system. Twenty specimens were fabricated from feldspathic porcelain, 20 from a high-noble ceramic alloy and feldspathic porcelain, and 20 from a high-noble ceramic alloy. Surfaces were polished by wet sanding with 600-grit silicon carbide abrasive followed by a 20-second surface treatment with 50 µm aluminum oxide at 60 psi. The specimens were ultrasonically cleaned in double distilled water and stored in distilled water for 48 hours.

The various substrates were treated either with CoJet or the Ceramic Repair system. For CoJet, the bonding procedure included the airborne-particle abrasion step, silanation, application of opaquer (in the metal groups), and a bonding agent. The Ceramic Repair system included aluminum oxide airborne-particle abrasion and etching. Resin composite cylinders (Tetric Ceram, Ivoclar Vivadent) were bonded to each specimen. For the specimens that included both porcelain and metal, the alloy portion of the substrate comprised approximately 25% of the bonded area.

The specimens were stored in 37°C distilled water for 24 hours followed by thermocycling, alternating between 5°C and 55°C for 300 cycles with a 30-second dwell time. Following thermocycling, the specimens were stored for an additional 8 days in 37°C distilled water prior to being subjected to the shear load. SBS were determined using a universal testing machine. Each specimen was examined under a light microscope at 10× power, and the failure recorded as adhesive, cohesive, or a combination.

Results: The CoJet system had higher bond strengths than the Ceramic Repair system for all the substrate groups. For both systems, the failures were cohesive for the porcelain substrate, a combination for the porcelain-metal substrate, and adhesive for the metal substrate.

Conclusions: Both repair systems had SBS in the 14.3 to 25.0 MPa range, which is comparable to the range of 16 to 20 MPa commonly reported for acid-etched enamel. Both systems exhibited reasonable bond strengths to all three substrates; however, the CoJet system achieved significantly higher bond strengths to the porcelain-alloy and alloy substrates.

COMMENTARY

CoJet-Sand is applied to the fractured substrate by means of air-abrasion, thereby embedding silica particles into the surface, which subsequently interact with the silane agent to yield a strong resin bond. The results of this study showed resin to ceramic repair strengths (with use of the CoJet system) that rival that of acid-etched enamel.

Research on porcelain repair has been measured by multiple methods, including shear, tensile, three-point loading, and fatigue loading. The authors chose shear load testing for their protocol because of the fact that multiple substrates were used and that anterior teeth/restorations are primarily subjected to shear stresses.

The use of 300 thermal cycles would probably be considered a minimum standard; however, realistically 1,000 or more cycles may more adequately represent intraoral conditions. As a general rule, bond strengths typically decrease with an increase in the number of thermal cycles. Additionally, most studies use distilled water as the medium for such testing, but it has been argued that perhaps artificial saliva would be a more relevant medium. When dealing with ceramic fractures, multiple substrates are often present and must be conditioned properly to yield the most predictable repair.

Previously, results of resin repairs have often been mixed depending upon whether the fracture was limited only to the porcelain, extended to involve some metal, or resulted in a large amount of metal exposure. The use of the CoJet system demonstrated a clinically acceptable result to all substrates tested. With the increasing use of crowns with nonmetal substrates, a similar study would warrant utilizing several of the more current substrates such as alumina or zirconia.

CLINICAL STUDY ON THE REASONS FOR AND LOCATION OF FAILURES OF METAL-CERAMIC RESTORATIONS AND SURVIVAL OF REPAIRS

M. Ozcan
International Journal of Prosthodontics 2002 (15:299–302)

ABSTRACT

Objective: The purpose of this clinical study was to determine the reasons for, and the locations of, failures of ceramo-metal restorations and to evaluate the success of restorations repaired using an intraoral silica-coating system.

Materials and Methods: This clinical study evaluated 153 patients with a total of 289 fractured restorations, 255 of which were Fixed Partial Denture (FPD) units and the remainder single crowns. All intraoral repairs were performed by the same clinical operator. The observation period ranged from 2 months to 40 months.

The materials used for the repair procedures included ESPE-Sil (3M ESPE) as the silane coupling agent, three types of resin opaquers; and three composite resins. Under rubber dam isolation, the metal-ceramic fractured sites were air-abraded using 30 µm silica-impregnated aluminum oxide particles (CoJet-Sand, 3M ESPE) at a distance of 10 mm for 13 seconds at 2.3-bar pressure utilizing an intraoral sandblasting device (Danville Engineering, Danville, CA, USA). All ceramic surfaces were subsequently treated with silane and allowed to air dry for 5 minutes. Opaquer was applied to exposed metal and light activated. Repair composite was applied using an incremental build-up technique. Finishing and polishing techniques were carried out with 15–40 µm diamond burs, carbide burs, extra-fine diamond burs, or stones followed by use of diamond paste or gel. Failure criteria of the repairs were categorized as chipping, partial failure (adhesive or cohesive), or total failure.

Results: The author classified the original failures as follows: 66%

from normal chewing, 10% from accidents, 6% from surgical procedures (e.g., intubation), and the remaining 18% from iatrogenic factors (e.g., endodontic procedures).

Of the 289 repaired restorations, 22 (8%) failed and required a second repair, and six of the restorations required repair a third time. Of these 22 failures, 19 were FPD facings, and three were single crowns. In six of these cases, rubber dam isolation was not possible; and in eight of the cases, failure was because of a traumatic incident. The remaining eight failures occurred under normal function. Most of these first repair attempt failures occurred from week 1 to 3 months. The overall cumulative survival rate was 89% up to 3 years.

Conclusions: The ultimate success rate for intraoral repairs to porcelain is multi-factorial. Understanding the reasons for original failure are important, as are factors to improve the odds for success of the repair. The extent of the repair, occlusal forces exerted upon it, and the patient's oral habits, oral hygiene, and esthetic demands are some of the factors that might contribute to the survival of the repair. The use of a rubber dam is essential in providing adequate isolation for the adhesive steps, and the occlusion must be adjusted meticulously. It should be noted as well that care must be exercised in determining which restorations would be candidates for intraoral repair and which situations would be better served by replacement of the restoration. The clinician must keep in mind that the restoration for which a repair is being considered must fulfill the fundamental requirements for an otherwise clinically acceptable restoration.

COMMENTARY

As we have all heard, the final success lies in the clinical test. The author adequately makes this point as well, stating that "once a material has passed various preclinical levels of physical and biologic tests, the ultimate test remains—a clinical evaluation." For dental techniques and materials, the ultimate laboratory is the intraoral cavity. It is there that we can observe the effects of the complexities of the oral environment (acidity, bacteria, temperature fluctuations, mechanical loading, etc.). In vitro studies cannot fully evaluate all the intraoral variables that exist, which ultimately affect the success of our clinical procedures. Very few in vivo studies exist to document the clinical performance of intraoral repair technique for fractured ceramo-metal or all-ceramic restorations, hence the choice of this article as part of the review.

The protocol was well standardized and an adequate follow-up evaluation period was used. The application of a resin adhesive to the pretreated, fractured porcelain interface was not mentioned in this paper. However, it was noted that a thin layer of opaque resin was applied to exposed metal surfaces. Most manufacturers recommend application of an adhesive following silanation, even though the use of silane, in and of itself, improves the wettability of the ceramic surface.

As mentioned in the conclusions, many intraoral variables contribute to restoration longevity but cannot be adequately simulated in the laboratory setting. Understanding the cause for the original failure and attempting to modify the patient's habits that might have contributed to the original porcelain fracture is paramount to the success or failure of the repair. Obviously, there are times when failure is related to laboratory error. One would also suspect a higher risk for fractures in FPDs compared with single crowns, due partly to the span of the framework and increased likelihood for flexure, particularly in longer edentulous spans. Lastly, as pointed out in the conclusions, close attention must be paid to the role of occlusion in restoration longevity.

SUGGESTED READING

Blatz MB, Sadan AS, Kern M. Resin-ceramic bonding: a review of the literature. J Prosthet Dent 2003;89:268–74.

Ozcan M. Review: Evaluation of alternative intra-oral repair techniques for fractured ceramic-fused-to-metal restorations. J Oral Rehabil 2003; 30:194–203.

Suh B. Porcelain bonding. Dental Research & Applications 2007;1:42–5.

Alex G. Preparing porcelain surfaces for optimal bonding. Compend Contin Educ Dent 2008;29:324–35.

THE BOTTOM LINE

In the practice of dentistry, it is inevitable that restorations will eventually fail and need either repair or replacement. As stated by Dr. Mutlu Ozcan, "just as what nature creates has a certain lifespan, artificial materials last in the mouth only for a certain period of time." Given the brittle nature of ceramic materials, the increasing use of ceramic restorations, and an increasing life expectancy of our patients, it is likely we will frequently face a greater need for intraoral repairs to fractured restorations.

Ceramic failures have been reported as the second most likely cause (after dental caries) for the replacement of a restoration. Failure from porcelain fracture has been reported ranging from 2.3% to 8%. Although it is likely occlusal prematurities and trauma are the most common reasons for porcelain fracture, inadequate preparation reduction, technical errors (e.g., inappropriate coping design, microporosity, mismatch of the coefficients of thermal expansion between the veneering porcelain and substrate, contamination), and fatigue are additional factors that may contribute to ceramic failures. Although fractures of the ceramic material itself do not necessarily mean failure of the restoration, they do pose an esthetic and functional dilemma for the patient and the dentist. Replacement of the failed restoration may not necessarily be the most practical solution because of the added cost and chair time required of the patient.

Repair alternatives can be classified into two categories: the direct method and the indirect method. Numerous articles have been published describing the indirect technique whereby the remainder of the restoration is prepared, and a laboratory fabricated restoration is cemented or bonded over the remaining substrate. This technique is more appropriate for larger fractured surfaces, in areas of heavy functional loading, or where supreme esthetics are paramount. However, it does require a second appointment, involves an increased cost to the patient, and may not be feasible in cases with minimal coping thickness.

A chairside repair, when possible and appropriate, offers several advantages over replacement of the restoration. These advantages include the ability to obtain immediate results, reduced chair time, lower cost, and ease of application. The disadvantages include lower strength (especially in load bearing areas), higher risk for wear, and potentially decreased esthetic qualities compared with porcelain.

For a repaired restoration to meet the functional and esthetic demands placed upon it, a strong and durable bond between the crown and repairing resin must be achieved. A strong resin bond relies on micromechanical interlocking and chemical bonding to the ceramic and substrate surfaces, which requires roughening and cleaning for adequate surface activation. Traditionally, attempts at surface pretreatment have included methods to promote mechanical adhesion such as airborne-particle abrasion with aluminum oxide, roughening with a diamond rotary cutting instrument, and etching with HF acid or acidulated phosphate fluoride. Additionally, for exposures involving larger areas of metal exposure, some have advocated placing mechanical retention in the metal framework itself. However, this protocol might affect the strength of the coping or framework.

HF etching can achieve the proper surface roughness for fractures involving porcelain only, as the glassy matrix is selectively removed and crystalline structures are exposed. HF solutions between 4% and 9.5% applied for 2 to 5 minutes appear to be most successful. The dentist is usually not aware of the type of veneering or substrate porcelain used and subsequently the appropriate concentration and duration of application for the acidic conditioner that is best suited for that particular ceramic. It has been postulated that acid concentrations and etching times should be adjusted with specific ceramics to optimize bond strength. For instance, with the leucite-reinforced IPS Empress system, 9% HF acid applied for only 60 seconds was the most successful at providing a proper etch. If the ceramic type is unknown, use of 4% HF for 5 minutes or 9.5% HF for 90 seconds to 2 minutes has been shown to be reliable. It would be advisable to use lower concentrations of HF acid when application of a rubber dam is not possible. Alumina content of the ceramic material plays a significant role on the effect by HF. While alumina increases the inherent strength of the ceramic, it is highly resistant to chemical etching.

Sole airborne-particle abrasion has been shown in several studies to provide insufficient bond strengths, and surface pre-treatment using diamond instrumentation has been shown to produce chipping or create micro-cracks in the porcelain. The study by Oh and Shen reviewed in this *Critical Appraisal* and other studies have shown that predictable repair to ceramic or metal substrates can be accomplished by a combination of aluminum oxide air abrasion and HF etching. Surface treatment with aluminum oxide microscopically cleans and roughens the metal surface allowing efficient wetting by the resin adhesive. Some studies have shown an increase in adhesion to exposed metal following abrasion with aluminum oxide and subsequent application of a metal primer.

In numerous studies, it has been shown that the repair of fractures involving both porcelain and metal or tooth substrate is more problematic because of the different characteristics of each particular material. However, in the majority of studies within the past several years, the most predictable bond strength to varying substrates has been shown following surface treatment with CoJet-Sand. Air-abrasion using the CoJet system entails a tribochemical coating in which silica acid-modified aluminum oxide particles are embedded within the material surface. The surface roughening resulting from this air-abrasion treatment provides a larger surface area for increased wettability, and simultaneously a micro retentive structure for the micromechanical luting of the bonding material. Chemical bonding is achieved by application of a silane.

Silanes are bifunctional molecules that bond silicone dioxide with hydroxyl groups on the ceramic surface and are a major factor for a sufficient resin bond to silica-based ceramics. They also have a functional group that copolymerizes with the organic matrix of the resin. Additionally, silanation increases the wettability of the ceramic surface and has been shown to improve the bonding of composite resin to porcelain by up to 25%. However, it is important to note that silanes may have different chemical structures, and as a result, it would be prudent to stay within one bonding system and not interchange components that may not be compatible. It is recommended to follow the manufacturer's directions as to the number of coats of silane recommended and the duration of application. More coats are not necessarily better, as there is a point of diminishing return, and may lead to a thick and intrinsically weak layer that could be prone to cohesive failure. As a general rule, one to two coats is sufficient for most systems.

Several studies have reported that warm-air drying of the silane might improve the bond strength of composite to ceramic. Warm-air drying appears to help facilitate the evaporation of solvents present in the silane agent, enabling a more complete coupling. Although these studies were in general agreement for most effective temperature, 38°C (100°F), there was no discussion of a recommended duration for warm-air drying on the silane intraorally. In a separate article, the author, Dr. Gary Alex (see Suggested Reading), recommended a warm-air drying time of 60 seconds, which would seem clinically sound so as not to overheat the tooth resulting in possible negative pulpal or adjacent soft tissue sequelae.

In the papers reviewed, very little mention was made of the composites selected for intraoral repairs. The strength of the repair has been shown to be more of a factor of the surface pretreatment protocol and extent of the fracture. However, it has also been shown that the bond strength of the composite resin to porcelain is also affected by the bonding agent and composite used. For example, hybrid composites generally provide higher bond strengths than microfilled composite resins. Therefore, it would seem prudent to limit the use of microfilled resins to areas of low stress and where a patient's esthetic demand is high. Otherwise, in most cases, repair with a more highly filled composite resin may yield better predictability.

None of the papers discussed potential negative effects arising from early, aggressive finishing procedures. It has been shown in numerous bonding studies that early bond strengths are less than those recorded at 24 hours and are subject to the effects of finishing and polishing. It would be beneficial to attempt to contour the composite resin repair as ideally as possible prior to light-activation to minimize the need for substantial finishing. If extensive finishing is necessary, it would be advisable to perform only the bare minimum of contouring and finishing needed to accommodate for occlusion and basic esthetics. More precise finishing and polishing would be best postponed for a minimum of 24 hours to allow for full maturation of the adhesive bond.

In summary, it has been shown, both in vitro and clinically, that effective surface preparation for intraoral repair of fractured porcelain with composite resin can be predictably achieved with the CoJet-Sand system. The advantage of this system is that multiple substrates can be adequately conditioned with one technique. Additionally, the intraoral use of potentially harmful acids (HF) can be avoided along with the dilemma of what concentration of HF acid to use and the duration. When possible, it is recommended to isolate the working field by use of a rubber dam to protect adjacent teeth and tissue and to provide for an uncontaminated, dry environment for adhesive bonding. Although various protocols have been used in the literature, the suggested method would be to use the CoJet system at 30–40 psi with an application of 10–15 seconds to the exposed, fractured surfaces (may need to add or decrease time slightly based on size of defect). Metal alloy surfaces are sufficiently coated when they have turned a uniform dark color. Fresh, chemically reactive silane (one to two coats) should be applied and allowed to dry for a minimum of 30 seconds to 1 minute in room temperature air or by use of gentle warm-air drying (for 60 seconds). If metal is exposed, an opaquer should be applied. Otherwise, the adhesive system of choice should be applied and light polymerized (according to manufacturer's directions) followed by application of the reparative composite resin in incremental layers to minimize stress to the adhesive interface as well as to reduce the amount of post-polymerization finishing needed. Following this proposed repair protocol when appropriate, it is often feasible to extend the life of the affected restoration. As discussed earlier, repair longevity is dependent upon multiple variables, many of which are out of the clinician's control. Therefore, it would be advisable to attempt to identify and control the circumstances that lead to the original failure.

Editor's Note: We welcome readers' suggestions for topics and contributors to Critical Appraisal. Please address your suggestions to the section editor:

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