in the control group. Surfaces after etching with hydrofluoric acid or diamond abrasion showed similar distinct boundaries. The sharp edges, however, appeared to be blunted in the specimens that were sandblasted.

Bond strength tests identified sandblasting with alumina particles as the most effective surface treatment. Diamond-abraded specimens had higher bond strengths than those for the control group, but they were not significantly stronger than those for the hydrofluoric acid-etched group. Acid-etched samples had the weakest resin bond.

Conclusions: SEM examination of densely sintered aluminum oxide ceramic illustrated its inherent surface morphology and the influence of different surface treatment methods. Sandblasting revealed the most pronounced alterations, that is, blunting of the sharp edges typically appearing with the other surface treatment methods and the control group. Sandblasting produced the significantly highest resin bond strengths.

COMMENTARY

Densely sintered aluminum oxide ceramic is much stronger than glass-infiltrated alumina and does not contain any silica. The authors demonstrate that sandblasting alters the surface of densely sintered alumina more effectively for increased bond strengths than do conventional acid-etching and grinding. Multiple studies that included alternative testing methods and materials, simulated aging, and/or surface configurations confirmed these findings and made sandblasting the standard procedure for pretreating intaglio surfaces of bonded densely sintered alumina restorations.

SUGGESTED READING

Blatz MB, Sadan A, Arch G, Lang B. In-vitro evaluation of long-term bonding of Procera AllCeram alumina restorations with a modified resin luting agent. J Prosthet Dent 2003; 89:381–387.

Blixt M, Adamczak E, Linden L-A, Oden A, Arvidson K. Bonding to densely sintered alumina surfaces: effect of sandblasting and silica coating on shear bond strength of luting cements. Int J Prosthodont 2000; 13:221–226.

Friederich R, Kern M. Resin bond strength to densely sintered alumina ceramic. Int J Prosthodont 2002; 15:333–338.

LONG-TERM RESIN BOND STRENGTH TO ZIRCONIA CERAMIC

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Journal of Adhesive Dentistry 2000 (2:139–147)

ABSTRACT

Objective: This in vitro study evaluated the long-term bond strength of adhesive bonding systems to yttrium-oxide partially stabilized zirconia ceramic (YPSZ).

Materials and Methods: Industrially manufactured YPSZ disks were air abraded with 110 μ aluminum-oxide particles. Composite resin specimens were bonded to the pretreated ceramic surfaces with an alignment apparatus. Seven different surface treatment methods and bonding systems were included in this study (n = 16): Clearfil F2® (Kuraray Dental, Tokyo, Japan), Dyract Cem® (DeTrey/Dentsply, Konstanz, Germany), Kevloc® (Heraeus Kulzer, Wehrheim, Germany), Panavia® (Kuraray), Panavia 21® (Kuraray), Rocatec™ (3M ESPE, St. Paul, MN, USA), and Twinlook® (Heraeus Kulzer). Eight specimens per group were stored in distilled water at 37°C for either 3 days or 2 years and thermal cycled for 37,500 cycles between 5° and 55°C. Tensile bond strength was tested at a crosshead speed of 2 mm/min. The fractured interfaces were examined under a light microscope at ×30 magnification to determine failure modes.

Results: Conventional dimethacrylate composite resin had bond strengths that were initially low and, after the 2-year storage period, nonexistent. Specimens treated with Rocatec tribochemical coating had higher bond strengths after 3 days, which decreased by almost 50% during the storage

period. Treatment with Kevloc resulted in bond strengths that were initially higher than with Rocatec. However, all specimens in this group spontaneously debonded during long-term storage. Bond strengths with Dyract Cem were relatively high initially with a dramatic decline after long-term water storage. Panavia and Panavia 21 had the significantly highest bond-strength values after 3 days and after 2 years of storage/thermal cycling. Bond strengths decreased slightly over the 2-year period, but the decreases were not statistically significant. The differences between these two groups also were not statistically significant. After 2 years of storage and thermal cycling, all specimens bonded with Twinlook, Clearfil F2, Kevloc, and Dyract Cem showed adhesive failure. The failures in the Panavia and Panavia 21 groups were exclusively cohesive. Mixed failure was seen in the Rocatec group (80% adhesive).

Conclusions: Only the bonding systems containing an adhesive phosphate monomer (MDP) revealed strong and durable long-term resin-bond strengths to YPSZ ceramic. All other materials in this study failed to achieve acceptable bond strengths after long-term storage and thermocycling.

COMMENTARY

High fracture toughness and optical properties will possibly make zirconia a popular high-strength ceramic material that can serve as an alternative to the traditional porcelain fused to metal. This in vitro study evaluated long-term resin bonds to zirconium oxide ceramic and applied storage conditions of up to 2 years. The storage conditions and thermocycling regimen are rigorous but clearly demonstrate their significant impact. As with other oxide-based ceramic materials, conventional surface treatment methods, luting agents, and composite-resin cements cannot achieve long-term durable resin bonds to zirconium oxide ceramics. The influence of sandblasting on the fracture strength of high-strength ceramics is under discussion. In contrast to common beliefs, current research suggests that sandblasting may have a strengthening effect to some high-strength ceramic materials. The authors found that only sandblasting and resin cements containing special adhesive monomers provided predictable and long-term durable resin bonds.These findings raise serious concerns because some widely distributed clinical recommendations are exclusively based on short-term data.

SUGGESTED READING

Blatz MB, Sadan A, Martin J, Lang B. In-vitro Evaluation of Shear Bond Strengths of Resin to Densely Sintered High-Purity Zirconium-Oxide Ceramics After Long-Term Storage and Thermocycling. J Prosthet Dent 2004; 91:355–362.

Derand P, Derand T. Bond strength of luting cements to zirconium oxide ceramics. Int J Prosthodont 2000; 13:131–135.

Kern M, Wegner SM. Bonding to zirconia ceramic: adhesion methods and their durability. Dent Mater 1998; 14:64–71.

Kosmac T, Oblak C, Jevnikar P, Funduk N, Marion L. The effect of surface grinding and sandblasting on flexural strength and reliability of Y-TPZ zirconia ceramic. Dent Mater 1999; 15:426–433.

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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THE BOTTOM LINE: RESIN BOND TO DENTAL CERAMICS

Silica-based ceramics are preferred materials for conservative indirect restorations (eg, laminate veneers and ceramic inlays/onlays) requiring resin-bonding techniques for their final cementation. Even high-strength ceramic restorations benefit from adhesive cementation, especially when retention is compromised. The following conclusions can be drawn from the articles discussed:

- Acid-etching and silane application achieve strong and durable long-term resin bonds to silica-based ceramics through micromechanical interlocking and chemical bonds. Earlier studies emphasize the importance of surface microstructure, whereas more recent studies find silane application and therefore chemical interaction to be the main reason for reliable resin-ceramic bonds.
- The composition and physical properties of oxide-based high-strength ceramics make resin bonding more difficult and the adhesive interface more susceptible to failure. Conventional acid etching and dimethacrylate composite resin cements fail to provide long-term durable resin bonds. Preferred bonding methods are air abrasion with aluminum oxide particles and the use of composite resin luting agents containing special adhesive monomers.

SUMMARY

The current evidence favors the use of adhesive techniques to support ceramic restorations. The resin bond to silica-based ceramics is well documented and typically achieved through acid etching and silane application. The few in vitro studies on the resin bond to high-strength ceramic materials suggest that resin bonding to these materials is less predictable and requires substantially different bonding methods than does bonding to silica-based ceramics.

Talking with Patients

Periodontal Splinting

André V. Ritter, DDS, MS

WHAT IS IT?

Periodontal splinting is the immobilization of teeth that have become loose owing either to loss of bony support around the tooth or to trauma. Periodontal splinting can be achieved with a fixed partial denture, orthodontic wires or braces, or bonding with tooth-colored, resin filling materials, for example. Recently, strong and flexible resin-bonded reinforcing fibers have become available for periodontal splinting. Because of their ease of use, esthetics, and good results, resin-bonded fibers are currently the material of choice to use for most teeth in need of periodontal splinting. When these special fibers are used, the affected teeth must first be covered with a resin dental adhesive. Then the flexible fiber-like material is bonded to the teeth using a tooth-colored, resin filling material. The result is a strong, durable, and esthetic splint.

WHEN IS IT NEEDED?

Periodontal splinting is primarily recommended for teeth adversely affected by periodontal disease. In advanced stages of periodontal disease, the inflammation of the tooth ligament and the loss of bone around the tooth's root(s) can cause the tooth (or teeth) to become loose. Loose teeth are not only uncomfortable; the excessive mobility can make it difficult for the dentist to treat the periodontal