

Critical Appraisal

RESIN BOND TO DENTAL CERAMICS, PART II: HIGH-STRENGTH CERAMICS

Authors

Markus B. Blatz, DMD, Dr Med Dent* Courtney Richter, BS[†] Avishai Sadan, DMD[‡] Gerard J. Chiche, DDS[§]

Associate Editor Edward J. Swift Jr, DMD, MS

The popularity of high-strength ceramic systems is increasing, and the range of their clinical indications is expanding constantly. Glass-infiltrated aluminum oxide ceramic (eg, InCeram[®] Alumina, Vita Zahnfabrik, Bad Säckingen, Germany), densely sintered aluminum oxide ceramic (eg, Procera[®] AllCeram, Nobel Biocare AB, Gothenburg, Sweden), and zirconium oxide ceramic (eg, Procera AllZirkon[®], Lava[®] 3M ESPE, St. Paul, MN, USA, Cercon[®], Dentsply Ceramco, Burlington, NJ, USA) are popular oxide-based high-strength ceramic materials that offer favorable esthetic characteristics, mechanical properties, and biocompatibility. Proper selection and application of luting agents for final cementation of all-ceramic restorations are keys for their clinical success. The few clinical trials on full-coverage, high-strength ceramic restorations report acceptable success rates with conventional luting agents. However, an article discussed in Part I of this Critical Appraisal reviewed available in vitro and in vivo studies on this topic and recommended adhesive cementation of ceramic and even high-strength ceramic restorations; are texture resistance because resin bonding is a technique-sensitive and time-consuming procedure. However, resin bonding has a number of advantages (eg, increased retention, improved marginal adaptation, and higher fracture resistance of the restored tooth and the restoration itself) and is required for some minimally invasive treatment options, such as resin-bonded fixed partial dentures and laminate veneers.

The resin bond to silica-based ceramics is well documented (as discussed in Part I of this Critical Appraisal) and yields predictable and long-term durable results through adequate surface preparation. Part II focuses on in vitro studies of the bonding interface of some popular high-strength ceramic materials. Comparative clinical trials are lacking, and the few available in vitro studies indicate that the composition and physical properties of oxide-based high-strength ceramics require surface preparation and bonding techniques that differ substantially from those used for silica-based ceramics.

> *Associate professor, Department of Prosthodontics, Louisiana State University School of Dentistry, New Orleans, LA, USA

[†]Dental student, Louisiana State University School of Dentistry, New Orleans, LA, USA [‡]Associate professor, Department of Prosthodontics, Louisiana State University School of Dentistry, New Orleans, LA, USA

[§]Professor and head, Department of Prosthodontics, Louisiana State University School of Dentistry, New Orleans, LA, USA

BONDING TO GLASS INFILTRATED ALUMINA CERAMIC: ADHESIVE METHODS AND THEIR DURABILITY

M. Kern, V.P. Thompson Journal of Prosthetic Dentistry 1995 (73:240-249)

ABSTRACT

Objective: This in vitro study investigated the resin bond to glass-infiltrated aluminum oxide ceramic and the effects of various bonding methods and simulated aging.

Materials and Methods: A total of 144 samples were fabricated from InCeram® (Vita Zahnfabrik, Bad Säckingen, Germany) glassinfiltrated alumina ceramic, sandblasted with 110 µm alumina (Al_2O_3) at 2.5 bars, and divided into six adhesive groups: (1) SANDbonding agent and dimethacrylate composite resin cement (Adhesive Bond/Twinlook®, Heraeus Kulzer, Wehrheim, Germany); (2) SILsilane coupling agent (ESPE-Sil[™], 3M ESPE, St. Paul, MN, USA) and dimethacrylate composite resin cement; (3) ROC-tribochemical silica coating (Rocatec[™], 3M ESPE), ESPE-Sil, and dimethacrylate composite resin cement; (4) SMDthermal silica coating (Silicoater® MD, Heraeus Kulzer), ESPE-Sil and dimethacrylate composite resin cement; (5) PEX-phosphatemonomer-modified composite resin cement (Panavia EX®, Kuraray Dental, Tokyo, Japan); (6) PNSexperimental phosphate-monomermodified composite resin cement (Panavia TPN-S[®], Kuraray).

Samples of Clearfil FII[®] (Kuraray) autocuring composite resin were

bonded to the ceramic disks with an alignment apparatus, and a weight of 750 g was added. Excess resin was removed with pellets, and an oxygen-blocking gel was applied. Dual-curing dimethacrylate resin (groups SIL, ROC, and SMD) was light cured for 30 seconds from both sides and then placed in a lightcuring unit for an additional 90 seconds.

These groups were each divided into three subgroups to evaluate the effects of storage time and thermocycling: (1) storage for 24 hours without thermocycling, (2) storage for 30 days and thermocycling for 7,500 cycles between 5° and 55°C, (3) storage for 150 days and thermocycling for 37,500 cycles between 5° and 55°C. The storage medium was an isotonic artificial saliva solution at 37°C.

Tensile bond strength was tested at a crosshead speed of 2 mm/min. A light microscope (×30 magnification) was used to determine the mode of fracture. Two specimens of each subgroup were randomly selected and examined with a scanning electron microscope (SEM).

Results: Specimens in group SAND had the weakest bond strength of all groups after 1 day, and bond strength significantly decreased after 30 days; spontaneous debonding occurred after 150 days of storage and thermal cycling. Bond strength of group SIL was greater than that of group SAND after 1 day, decreased by > 50% after 30 days, and was very low after simulated aging. Resin bonds achieved in the ROC group were significantly higher than in groups SAND and SIL and remained stable after simulated aging. Bond strength for group SMD was about the same as for the ROC group after 1 day, did not change significantly after 30 days, and then dropped dramatically after 150 days of storage and thermal cycling. Results in the PEX group were similar to those in groups ROC and SMD after 1 and 30 days, with only a slight decrease after 150 days. The PNS group had the highest bond strength after 1 day, but it decreased substantially after 150 days. There was no statistically significant difference between the two phosphate monomer-modified composite resins (groups PEX and PNS).

Failure modes for all samples in the SAND and SIL groups were adhesive, and they were cohesive for the ROC, PEX, and PNS groups. The failure mode was mixed for group SMD after 150 days.

Conclusions: Resin bonding to InCeram glass-infiltrated alumina ceramic requires different techniques than does bonding to silica-based ceramics to achieve predictable and durable long-term bonds. The only methods that provided longterm durable resin bonds were either tribochemical silica coating in combination with a conventional dimethacrylate composite resin or sandblasting and a composite resin containing an adhesive phosphate monomer.

COMMENTARY

This study is already considered a classic since it was one of the first to evaluate resin bond strengths to oxide-based high-strength ceramics and the effects of long-term water storage and thermocycling to demonstrate the susceptibility of the

bond between composite resin and high-strength ceramics to hydrolytic and thermal influences. The dramatic decrease of resin bond strengths to high-strength ceramics after simulated aging is in contrast to the resin bonds achieved to silica-based ceramics. The authors demonstrated that such aging parameters are indispensable tools to identify superior bonding methods and materials, especially for high-strength ceramic materials. Conventional dimethacrylate composite resin luting agents and silane couplers cannot provide long-term durable resin bonds to glass-infiltrated alumina. This study showed that some methods and materials that provide strong and

durable bond strengths to metal alloys (ie, tribochemical silica coating and a phosphate-modified resin cement) are highly effective for glass-infiltrated aluminum oxide ceramics.

SUGGESTED READING

- Blatz MB, Sadan A, Kern M. Resin-ceramic bonding—a review of the literature. J Prosthet Dent 2003; 89:268–274.
- Kern M, Thompson VP. Sandblasting and silica coating of glass-infiltrated alumina ceramic: volume loss, morphology, and changes in the surface composition. J Prosthet Dent 1994; 71:453–461.
- Ozcan M, Alkumru HN, Gemalmaz D. The effect of surface treatment on the shear bond strength of luting cement to a glassinfiltrated alumina ceramic. Int J Prostho dont 2001; 14:335–339.

SHEAR BOND STRENGTH OF A RESIN CEMENT TO DENSELY SINTERED HIGH-PURITY ALUMINA WITH VARIOUS SURFACE CONDITIONS

W. Awliya, A. Odén, P. Yaman, J.B. Dennison, M.E. Razzoog Acta Odontological Scandinavica 1998 (56:9-13)

ABSTRACT

Objective: This study evaluated the effect of different surface treatments on the surface morphology of densely sintered high-purity alumina and the influence of these treatments on the shear bond strength of a resin cement to this core material.

Materials and Methods: Forty cylindric samples were fabricated from densely sintered high-purity aluminum-oxide ceramic (Procera[®], Nobel Biocare AB, Gothenburg, Sweden) and divided into four groups of different surface treatments: (1) etching with hydrofluoric acid (9.6%) for 2 minutes followed by rinsing with air/water spray for 30 seconds; (2) sandblasting with a microetcher for 15 seconds using 50 μ m alumina particles; (3) roughening with a diamond bur and etching with 37% phosphoric acid for 2 minutes followed by rinsing for 30 seconds with an air/water spray; (4) no treatment (control). The surfaces of all specimens were examined with an SEM to determine surface morphology.

Four additional groups of specimens (n = 10) were prepared as described

above and bonded with a dual-cure resin cement (EnForce®, Dentsply Caulk, Milford, DE, USA). The bonding areas were isolated and coated with EnForce silane coupling agent and EnForce bonding agent. After bonding, all specimens were stored at 100% humidity at room temperature for 1 week before shear bond strength was tested in an Instron® (Instron Corp, Canton, MA, USA) testing machine.

Results: The SEM micrographs of the densely sintered high-purity alumina surfaces revealed a relatively rough and distinct microstructure Copyright of Journal of Esthetic & Restorative Dentistry is the property of B.C. Decker Inc. and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.