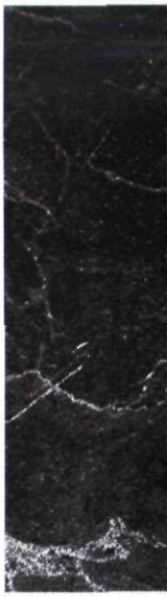

Critical Appraisal

RESIN BOND TO DENTAL CERAMICS, PART I: REVIEW AND SILICA-BASED CERAMICS

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Silica-based ceramics (eg, feldspathic, glass, and leucite-reinforced feldspathic ceramics) are preferred materials for conservative, highly esthetic indirect restorations such as laminate veneers, ceramic inlays and onlays, and full-coverage crowns because of their optical properties, biocompatibility, and longevity. Adhesive cementation of ceramics to the supporting tooth using resin cements has been identified as the main determinant for the excellent clinical success of bonded silica-based ceramic restorations. The first article discussed in this Critical Appraisal reviews the current evidence for the need of adhesive technologies to support ceramics. Even though review articles typically are not addressed in this section, its thoroughness and clear conclusions make this article an important contribution to the field of esthetic and restorative dentistry.

Controlled clinical trials are ideal to evaluate the success of certain materials or therapeutic interventions. However, laboratory studies are necessary to compare large varieties of materials and influencing parameters and to identify superior materials and bonding techniques prior to their clinical application. Numerous in vitro studies have evaluated the ceramic–composite resin interface. The in vitro studies reviewed in this section indicate that acid-etching and silane application are ideal methods to achieve strong and durable resin bonds to silica-based ceramics. The selected articles indicate interesting trends in testing methods and interpretation of results. Earlier studies favor shear bond strength testing methods and emphasize the importance of surface microstructure and mechanical interlocking. However, some recent studies prefer modified tensile bond strength methods, and find silane application, and therefore chemical interaction, to be the main contributor to reliable resin-ceramic bonds. Unfortunately, direct comparisons between different studies are difficult owing to the variations in methods and materials and the lack of standard protocols.

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EFFECTS OF TREATMENT AND STORAGE CONDITIONS ON CERAMIC/COMPOSITE BOND STRENGTH

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ABSTRACT

Objective: This in vitro study investigated the effects of ceramic material composition, ceramic-surface roughening methods, silane coupling agents, heat treatments, storage conditions, and their combinations on composite-ceramic bond strength.

Materials and Methods: Five hundred forty small and large cylindric specimens were fabricated with the silica-based ceramic materials Dicor® (Dentsply, Dreieich, Germany), Mirage® (Mirage, Kansas City, KS, USA), and Vitabloc® (Vita Zahnfabrik, Bad Säckingen, Germany). The ceramic surfaces were roughened by grinding with 600-grit SiC paper, sandblasting with Al_2O_3 particles, or acid etching. The type of acid etchant depended on the ceramic material and its manufacturer's recommendations: Dicor was etched with 10% ammonium bifluoride gel, and Mirage and Vitabloc with 10% hydrofluoric acid gel.

The specimens were cleaned, dried, and coated with one of three silane solutions: (1) 2.5 vol% methacryloxypropyltrimethoxysilane (MPS) and 2.5 vol% acetic acid with 95 vol% ethanol; (2) 2.5 vol% MPS, 0.5 vol% *N,N*-dimethyl-paratoluidine, and 2.5 vol% acetic acid mixed with 94.5 vol% ethanol; and (3) 2.5 vol% vinyltrichlorosilane (VTC) and 2.5 vol% acetic acid mixed with 95 vol% ethanol. The silane-treated specimens were either stored at room temperature for 60 seconds or heat treated with a hot air stream for 60 seconds at 100°C ± 5°C before cooling to room temperature. The heat-treated surfaces were thinly coated with a visible light-cured dimethacrylate (BIS-GMA) resin.

The small ceramic specimens were bonded to the larger cylinders using a dual-polymerizing resin composite (Dual Cement®, Vivadent, Schaan, Liechtenstein). All bonded specimens were stored dry at room temperature for 24 hours, and half the specimens from each treatment group were subjected to shear testing. The other half were stored in tap water for 12 months at 37°C before bond strength was evaluated.

Results: The etched sample groups had the highest bond strength, which was stronger than that of either the sandblasted or ground specimen groups. Ground specimens had the weakest bond strength. The etched specimens were more similar in strength than the ground specimens for both silane treatment and storage condition variables. Heat treatment had significant effects on most groups except for those with ground specimens. The strength of the samples treated with MPS doubled after heat treatment, but there was no effect on the other silane-treatment groups. VTC ethanol solution revealed the highest bond strength of the three silane solutions investigated. Ceramic materials could not be ranked in any order without defining the influence of the other variables. Water storage had differing effects, depending on the combination of materials and conditions used.

Conclusions: Bond strength of the ceramic-composite interface is mostly determined by the surface roughening method. Acid etching provides the highest bond strength, regardless of the ceramic composition, silane material, heat treatment, or storage condition.

COMMENTARY

Resin-ceramic bonding relies on chemical covalent bonds and micromechanical interlocking to the ceramic surface, which requires adequate surface roughening. This study investigated common surface treatment modalities (grinding, airborne particle abrasion, and acid etching) and clearly indicates that surface treatment has a significant influence on the resin-ceramic bond. Acid etching of silica-based ceramics with solutions of hydrofluoric acid or ammonium bifluoride provided

bond strengths that were significantly higher than those with grinding and sandblasting. Gel-type acid etchants are simple to use without the risk of damaging delicate marginal areas of silica-based ceramic restorations. The authors suggest etching and silanating the ceramic surface after try-in procedures to avoid contamination. Various ceramic-silane combinations revealed differences in their susceptibility to hydrolytic degradation. These findings emphasize the need for proper material selection and combination to obtain long-term durable resin bonds. The large number of variables and influential parameters applied in this study limits detailed rankings of specific materials and methods.

SUGGESTED READING

Chen JH, Matsumura H, Atsuta M. Effect of etchant, etching period, and silane priming on bond strength to porcelain of composite resin. Oper Dent 1998; 23:250–257.

Kato H, Matsumura H, Atsuta M. Effect of etching and sandblasting on bond strength to sintered porcelain of unfilled resin. J Oral Rehabil 2000; 27:103–110.

Lacy AM, Laluz J, Watanabe LC, Dellinges M. Effect of porcelain surface treatment on the bond to composite. J Prosthet Dent 1988; 60:288–291.

SHEAR BOND STRENGTH TO FELDSPATHIC PORCELAIN OF TWO LUTING CEMENTS IN COMBINATION WITH THREE SURFACE TREATMENTS

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ABSTRACT

Objective: This in vitro study evaluated bond strength and durability of various ceramic bonding systems bonded to feldspathic porcelain.

Materials and Methods: Eighty pairs of feldspathic porcelain disks (VMK 68®, Vita Zahnfabrik, Bad Säckingen, Germany) were used as substrate material. They were wet ground with SiC paper, air abraded for 10 seconds with 50 μm aluminum oxide particles, and etched for 5 seconds with 40% phosphoric acid gel. Clapearl Bonding Agent®, Clearfil Porcelain Bond®, and Panavia Ceramic Primer® (all Kuraray Co. Ltd., Tokyo, Japan) were applied to the prepared surfaces. The remaining 20 pairs of specimens were used as controls, receiving no primer treatment. Half the specimens in each group were luted with the autopolymerizing resin cement Panavia 21® (Kuraray) and the other half with the dual-polymerizing resin cement Clapearl DC® (Kuraray). Five specimens per group were stored in water for 24 hours, and the other five specimens were subject to thermocycling for 20,000 cycles before shear bond strength testing.

Results: Before thermocycling, bond strengths of all cement systems using Clapearl DC luting agent were comparable, whereas bond strengths of the groups using Panavia 21 revealed significant differences. After thermocycling, Clapearl DC cement exhibited a greater bond strength than did Panavia 21 when the primer was the same. Bond strength with Clapearl DC was not affected by the priming agent used. The bond strengths were extremely low in both control groups. Failure modes were significantly affected by the combination of priming agent, luting cements, and thermocycling.

Conclusion: The results of this study suggest that bond strength of ceramic bonding systems is poor in the absence of a priming agent. The dual-polymerizing resin cement Clapearl DC was significantly stronger and more durable than was Panavia 21, regardless of the primer used, before and after thermocycling. Thermocycling had mixed effects on the priming/luting agents used.

COMMENTARY

This study indicates the necessity for silane coupling and bonding agents to provide strong and durable bonds of composite resin cements to pretreated feldspathic ceramic surfaces.