single-step self-etch adhesive investigated—bonding to chemical-cured composites can be enhanced with the use of a chemical co-initiator. Adverse chemical interaction between the catalytic components of chemical-cured composite and the tested single-step self-etch adhesive was the major cause of reductions in bond strength, whereas adhesive permeability was a minor cause of bond strength reduction. Even so, a compromise in bond strength to chemical-cured composite would be expected when bonding is performed on vital hydrated dentin owing to the increased permeability of the cured adhesive layer. Increased permeability of these adhesives to water may also hasten the rate of water sorption, hydrolytic degradation of the hydrophilic resin components, thus compromising the longevity of bonds provided by these adhesives.

COMMENTARY

See commentary following next review.

FACTORS CONTRIBUTING TO THE INCOMPATIBILITY BETWEEN SIMPLIFIED-STEP ADHESIVES AND SELF-CURED OR DUAL-CURED COMPOSITES. PART II. SINGLE-BOTTLE, TOTAL-ETCH ADHESIVE

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ABSTRACT

Objective: This study tested the hypothesis that the coupling of a single-bottle adhesive (OptiBond Solo Plus, Kerr Corporation, Orange, CA, USA) to self- or dual-cured composites is compromised by adhesive permeability, even with the adjunctive use of chemical co-initiators.

Materials and Methods: Bonding was performed on the occlusal surfaces of deep coronal dentin from extracted, human third molars. The occlusal enamel of each tooth was removed using a slow-speed saw under water cooling. Dentin was polished with 180-grit silicon carbide paper to create clinically relevant, thick smear layers. The dentin substrates to be bonded were divided into two categories: hydrated (H) and dehydrated (DH) dentin. For hydrated dentin, the teeth were bonded in their normal hydrated status, as they were retrieved from the storage medium. For dehydrated dentin, the roots were sectioned parallel to the occlusal surfaces to expose and remove the contents of the pulp chamber. After preparation of the surface, these teeth were dehydrated through a series of ascending ethanol concentrations.

Two versions of chemical co-initiators (activators) were investigated: the proprietary resin-containing Opti-Bond Solo Plus Activator (A), and a resin-free solution of 2% benzene sulphinic acid sodium salt in ethanol (B). For microtensile bond testing, H or DH bonded human dentin was coupled to a dual-cured composite (Bis-Core, BISCO Inc., Schaumburg, IL, USA). Coupling of the composite to bonded dentin was performed under three different modes of activation:

1. Light-cured mode (L): Only the light-cured base syringe of the composite was used. The composite was hand mixed for 20 seconds under ambient light in the same manner as when both the base and catalyst components of the dual-cured composite were mixed. The composite was applied in five 1 mm increments, with each increment light activated for 40 seconds at an intensity of 500 $mWcm^{-2}$ immediately upon placement.
2. Delayed light activation (DL): The rationale for delayed light-activation was to simulate the slow rate of polymerization of a self-cured composite but to avoid the adverse chemical interaction between acidic resin monomers in the oxygen inhibition layer of the adhesive and the nucleophilic, basic tertiary amine accelerator in a self-cured composite. The first 1 mm increment of the hand-mixed composite from the base syringe was applied over the cured adhesive and left in

complete darkness for 20 minutes prior to light activation. After curing, the subsequent increments were applied and light activated immediately.

3. Self-cured mode (C): Composite from the base and catalyst syringes was hand mixed for 20 seconds in the manner described previously. The mixed composite was applied in bulk to the bonded adhesive surfaces and allowed to cure in complete darkness for 20 minutes before reexposure to ambient light.

Thirty-six teeth were used for evaluation of microtensile bond strength. They were divided into nine groups of four teeth each, with variations in the hydration status of the dentin, activation mode of the composite, and activator application. After storage in distilled water at 37°C for 24 hours, they were prepared for microtensile bond strength testing with a cross-sectional area of 0.8 mm^2 and stressed to failure in tension at a crosshead speed of 1 mm/min.

Results: Bond strength results indicated that only the experimental groups DL-D and C-B-D (were not significantly different from the control group L-H ($p > .05$). TEM revealed the presence of discrete silver-filled water blisters along the adhesive-composite interface in DL-H, C-A-H, C-B-H and within the composite in C-H. Adverse chemical interactions in the C-H and C-D groups resulted in deposition of silver along the adhesive-composite interface.

Conclusions: Coupling of composites after prolonged contact with hydrated dentin bonded with OptiBond Solo Plus is affected by the intrinsic permeability of the adhesive. The adjunctive use of the OptiBond Solo Plus Activator is only slightly effective in improving the coupling of this adhesive with self- or dual-cured composites. Although the use of resin-free benzene sulphinic acid sodium salt solution results in eliminating the adverse chemical interaction, the inherent permeability of the polymerized adhesive precludes optimal coupling of self- and dual-cured composites to hydrated dentin.

COMMENTARY

These two studies followed the rationale of the previous work of the same research group. The approach used allowed the authors to demonstrate that adverse chemical interactions and permeability of the adhesives are major factors that compromise the bonding between simplified, acidic adhesives and self- or dual-cured composites. The contribution of each factor to the overall damage to the interface is probably dependent on the type of the adhesive, its acidity, and the adjunctive use of co-initiators.

SUGGESTED READING

Cheong C, King NM, Pashley DH, Ferrari M, Toledano M, Tay FR. Incompatibility of self-etch adhesives with chemical/dual-cured composites: two-step vs one-step systems. Oper Dent 2003; 28:747–755.

Dong CCS, McComb D, Anderson JD, Tam LE. Effect of mode of polymerization of bonding agent on shear bond strength of autocured resin composite luting cements. J Can Dent Assoc 2003; 69:229–234.

Hofmann N, Papsthart G, Hugo B, Klaiber B. Comparison of photo-activation versus chemical or dual-curing of resin-based luting cements regarding flexural strength, modulus and surface hardness. J Oral Rehabil 2001; 28:1022–1028.

Holderegger C, Paul SJ, Luthy H, Scharer P. Bond strength of one-bottle dentin bonding agents on human dentin. Am J Dent 1997; 10:71–76.

Imai Y, Kadoma Y, Kojima K, Akimoto T, Ikakura K, Ohta T. Importance of polymerization initiator systems and interfacial initiation of polymerization in adhesive bonding of resin to dentin. J Dent Res 1991; 70:1088–1091.

Itthagarun A, Tay FR. Self-contamination of deep dentin by dentin fluid. Am J Dent 2000; 13:195–200.

Jayasooriya PR, Pereira PN, Nikaido T, Tagami J. Efficacy of a resin coating on bond strengths of resin cement to dentin. J Esthet Restor Dent 2003; 15:105–113.

Jayasooriya PR, Pereira PN, Nikaido T, Barrow MF, Tagami J. The effect of a "resin coating" on the interfacial adaptation of composite inlays. Oper Dent 2003; 28:28–35.

Perdigão J, Ramos JC, Lambrechts P. In vitro interfacial relationship between human dentin and one-bottle dental adhesives. Dent Mater 1997; 13:218–227.

Spencer P, Wang Y, Walker MP, Wielicka DM, Swafford JR. Interfacial chemistry of the dentin/adhesive bond. J Dent Res 2000; 79:1385–1391.

Suh BI, Feng L, Pashley DH, Tay FR. Factors contributing to the incompatibility between simplified-step adhesives and chemically-cured or dual-cured composites. Part III: effect of acidic resin monomers. J Adhes Dent 2003; 5:267–282.

Swift EJ Jr. Ask the experts: self-cured composites. J Esthet Dent 1999; 11:122.

Swift EJ, May KN, Wilder AD. Effect of polymerization mode on bond strengths of resin adhesive/cement systems. J Prosthodont 1998; 7:256–260.

Tay FR, King NM, Suh BI, Pashley DH. Effect of delayed activation of light-cured resin composites on bonding of all-in-one adhesives. J Adhes Dent 2001; 3:207–225.

Tay FR, Pashley DH. Have dentin adhesives become too hydrophilic? J Can Dent Assoc 2003; 69:726–731.

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