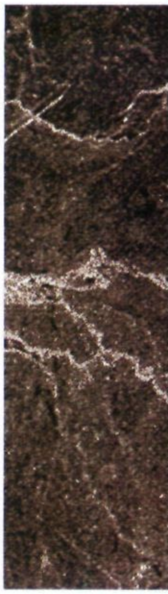

Critical Appraisal

ADHESIVE-COMPOSITE INCOMPATIBILITY, PART II

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Apart from some questions related to the repairability of resin composite restorations, dentists have always assumed that methacrylate-based resins are compatible with each other. For example, there is no clinically relevant problem in using a microfilled composite to laminate a Class IV restoration made with a hybrid composite, even if they are not of the same brand or manufacturer. In the context of adhesive systems, we have always believed that resin composites, regardless of their type or composition, bond well to all types of bonding agents. However, unexpected debonding of self-cured, core buildup composites that had been bonded with single-bottle adhesive systems was reported about 5 years ago. Subsequent studies demonstrated that there were, indeed, compatibility problems between simplified adhesive systems and self- or dual-cured resin composites. Apparently, when such combinations are used, reduced bond strengths and subsequent failures at the resin-adhesive interface can occur because of adverse reactions between the acidic resin monomers, an integral part of the simplified adhesive systems, and the chemicals involved in the polymerization mechanism of the self- or dual-cured composites, particularly the basic tertiary amines.

At least one research group has expanded the information on this issue by further investigating the mechanisms involved in this phenomenon. This group demonstrated that not only adverse chemical reactions but also the permeability of such simplified systems contribute to the compromised bonding. This issue has profound clinical implications in view of the wide use of self- and dual-cured composites as core buildup materials and in the bonding of indirect restorations and endodontic posts. Some of the most representative studies of this group are described in this Critical Appraisal.

FACTORS CONTRIBUTING TO THE INCOMPATIBILITY BETWEEN SIMPLIFIED-STEP ADHESIVES AND CHEMICAL-CURED OR DUAL-CURED COMPOSITES. PART I. SINGLE-STEP SELF-ETCH ADHESIVE

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ABSTRACT

Objective: The aim of this in vitro study was to determine whether an adverse chemical interaction and adhesive permeability are both responsible for the incompatibility between a single-step self-etch adhesive and chemical-cured or dual-cured composites. The null

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**Department of Operative Dentistry, Endodontics and Dental Materials, Bauru School of Dentistry, University of São Paulo, Bauru, SP, Brazil* hypothesis tested was that the bond strength and interfacial ultrastructure would remain the same when dual-cured or chemical-cured composites were applied to dentin bonded with a single-step self-etch adhesive, irrespective of the hydration status of the bonded dentin or the adjunctive use of a chemical co-initiator.

Materials and Methods: Bonding was performed on deep coronal dentin of human third molars. The substrates to be bonded were divided into two categories—hydrated (H) and dehydrated dentin (DH). For H the teeth were bonded in their normal hydrated status. For DH the roots were sectioned parallel to the occlusal bonding surfaces to expose and remove the contents of the pulp chamber. These teeth were dehydrated through a series of ascending ethanol concentrations (70%, 80%, 95%, three changes in 100%) for 2 hours each. Finally, they were left to completely dehydrate in absolute ethanol for an additional 48 hours.

A single-step self-etch adhesive, Xeno CF Bond (Dentsply Sankin, Tokyo, Japan) was employed in this study. The adhesive was applied to dentin for 20 seconds, slightly air dried to evaporate the solvent, and light cured for 10 seconds. A dual-cured hybrid resin composite, Bis-Core (BISCO Inc., Schaumburg, IL, USA), was applied to the treated dentin surfaces under three different modes of activation:

1. Light-cured mode (L): composite from the base syringe only
2. Delayed light-activation (DL): the base syringe composite left on top of the cured adhesive in the dark for 20 minutes before light activation
3. Chemical-cured mode (C): composite from the base and catalyst syringes mixed but kept in complete darkness for 20 minutes before reexposure to ambient light

In some groups BondLink (B) (Den-Mat Corporation, Santa Maria, CA, USA), a chemical co-initiator, was applied to the cured adhesive before coupling with the composite in chemical-cured mode. The various combinations of dentin hydration condition, light-curing mode, and use of the co-initiator resulted in seven treatment groups, including the control (hydrated dentin, light-cure mode, and no co-initiator).

After storage in water for 24 hours at 37°C, specimens were prepared for microtensile bond strength testing with a cross-sectional area of approximately 0.8 mm^2 and the use of a universal testing machine (Model 4440, Instron Corporation, Canton, MA, USA) at a crosshead speed of 1 mm/min. Failure modes were recorded as adhesive, mixed, or cohesive in either dentin or resin.

The data were analyzed using the Kruskal-Wallis one-way analysis of variance on ranks followed by Dunn's multiple comparison tests. Statistical significance was set in advance at $\alpha = .05$.

For TEM the dual-cured composite in the seven groups was replaced with a light-cured microfilled composite (Metafil CX, Sun Medical Co., Ltd., Shiga, Japan) and an experimental chemical-cured microfilled composite of the same composition. Specimens were immersed in ammoniacal silver nitrate for 24 hours. After reduction of the diamine silver ions to silver, undemineralized and unstained sections were examined for nanoleakage within the resin-dentin interfaces of the seven groups.

Results: For the light-cured modes, bond strengths fell substantially in DL-H but not in DL-DH. For the chemical-cured modes, bond strengths were lowest in C-H and only increased slightly in C-DH. The use of a chemical co-initiator with the adhesive further improved the bond strength in C-B-H. Only C-B-DH was not significantly different from the control light-cured mode L-H. Two abnormal modes of silver deposition were observed in resin-dentin interfaces. A continuous layer of silver was observed when the chemical-cured composite was applied to the cured adhesive in the absence of the chemical co-initiator (C-H and C-DH). Silver-impregnated water blisters were identified when the chemical-cured composite was coupled to bonded hydrated dentin (C-H and C-B-H). Similar water blisters were seen in DL-H, in which adverse chemical interaction should not occur.

Conclusions: The results of this study showed that—at least for the 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 OptiBond 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

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