self-cured composites. The authors provided strong evidence that the uncured acidic monomers present in the oxygen-inhibited layer interact with the basic initiators of the resin, consuming them and preventing them from generating free radicals that are required to properly polymerize the resin layer that is in contact with the adhesive. Reductions in bond strength with chemical-cured composite were in the order of 45 to 90%, which could easily explain the previously reported debonding of self-cured resin cores.

SINGLE-STEP ADHESIVES ARE PERMEABLE MEMBRANES

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ABSTRACT

Objectives: This in vitro study tested the null hypotheses that (1) prolonged contact of light-cured resin composite to cured single-step adhesives before light-activation does not result in compromised bond strengths to sound, hydrated dentin; and (2) the presence or absence of water on the substrate side of the bonded interface of single-step adhesives does not affect the results of delayed activation of a light-cured composite.

Materials and Methods: Bonding to dentin was performed on deep coronal dentin surfaces of extracted human third molars.

Experiment 1. Twenty-eight teeth were used in this part of the study. They were randomly divided into seven groups of four teeth each. All were bonded in their normal hydrated status. The adhesives tested were a three-step total-etch control and six simplified systems:

1. All-Bond 2 (BISCO Inc., Schaumburg, IL, USA)—control
2. One-Up Bond F (Tokuyama, Tokyo, Japan)
3. Etch & Prime 3.0 (Degussa, Hanau, Germany)
4. Xeno CF Bond (Dentsply Sankin, Tokyo, Japan)
5. AQ Bond (Sun Medical, Shiga, Japan; also marketed in North America as Touch & Bond by Parkell Inc, Farmingdale, NY, USA)
6. Reactmer Bond (Shofu, Kyoto, Japan)
7. Prompt L-Pop (3M ESPE, St. Paul, MN, USA)

Each adhesive group was further divided into two subgroups of two specimens each, based upon the contact time of the resin composite with the cured adhesive layer prior to light activation. In one subgroup the first layer of composite was light cured immediately. In the other subgroup, the first layer of composite was left in the dark for 20 minutes before being light cured.

Experiment 2. Three single-step "all in one" adhesives (Etch & Prime 3.0, Xeno CF Bond, and AQ Bond) were similarly bonded to completely dehydrated dentin using the same delayed light-activation protocol. Dehydrated dentin was obtained by passing the tooth crowns through a series of ascending ethanol concentrations up to 100%.

Experiment 3. A piece of processed composite was used as the bonding substrate for the same three single-step adhesives used in experiment 2. The composite was applied to the cured adhesives using the same immediate and delayed light-activation protocols.

After storage in water for 24 hours at 37°C, bonded specimens from experiments 1 and 2 were prepared for microtensile bond strength testing with a cross-sectional area of approximately 0.9×0.9 mm^2. In experiment 3, each slab obtained was hand trimmed to 0.9×0.9 mm^2. Specimens were tested in tension using 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 failures in either dentin or resin.

Results: When bonded to hydrated dentin, delayed light activation had no effect on the control three-step adhesive but significantly reduced the bond strengths of all simplified adhesives ($p < .05$). This adverse effect of delayed light activation was not observed for the three single-step adhesives that were bonded to either dehydrated dentin or processed composite. Morphologic manifestations of delayed light activation of composite in the hydrated dentin bonding substrate were exclusively located along the composite-adhesive interface and were present as large voids, resin globules, and honeycomb structures that formed partitions around a myriad of small blisters along the fractured interfaces.

Conclusion: As delayed light activation of resin composite adversely affected only the bond strengths of hydrated dentin bonded with single-step adhesives but not the control three-step adhesive (experiment 1), the authors rejected the first null hypothesis. The cured adhesive layer in single-step adhesives might act as a semipermeable membrane that allows water diffusion from the bonded hydrated dentin to the intermixed zone between the adhesive and the uncured composite. Osmotic blistering of water droplets along the surface of the cured adhesive layer and emulsion polymerization of immiscible resin components probably account for the compromised bond strength in single-step adhesives after delayed activation of light-cured composites.

COMMENTARY

This study is interesting in its approach to investigate the phenomenon of adhesive-composite incompatibility. The authors used several self-etch adhesives that are more acidic than total-etch, single-bottle adhesives. As a control, they used a three-step total-etch adhesive that includes a final layer of a nonacidic resin to be in contact with the composite. Based on the assumption that adverse interactions that occurred with self-cured composites could be enhanced because of the slow-setting reaction, the authors employed a light-cured composite but delayed its activation to permit reactions between its components and the acidic monomers of the adhesives. Additionally, they strategically used dehydrated dentin and processed composite to investigate the role of the water.

The major finding of this work was that adverse chemical interactions between acidic adhesives and resin composites are not the only factor that may compromise bonding. Simplified acidic adhesives function as permeable membranes that allow water from hydrated dentin to migrate across the adhesive layer and accumulate at the adhesive-composite interface. This water movement is driven by an osmotic gradient generated by the prolonged contact of the uncured resin with the adhesive. Penetration of water into the interface represents an additional factor (besides the interaction of the acidic monomers and tertiary amines) contributing to incompatibility of specific adhesives and self- and dual-cured composites.

ADHESIVE PERMEABILITY AFFECTS COUPLING OF RESIN CEMENTS THAT UTILISE SELF-ETCHING PRIMERS TO DENTINE

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ABSTRACT

Objective: This study examined the effect of adhesive permeability on the coupling of resin cements that employ self-etching primers for bonding to dentin. The null hypothesis tested was that the use of a more hydrophobic resin coating would have no effect on the

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