CASE STUDY

THE EFFECTS OF DESENSITIZING AGENTS IN VITRO

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Over the last 25 years, the techniques and materials used to place indirect restorations have evolved

to provide more stable, durable and long-lasting bonds. Among the first available are still in use today, including total-etch techniques and materials. These are known to effectively remove the smear layer and re-open dentin tubules with a 30 percent to 40 percent phosphoric acid etchant.[1] Total-etch techniques have also proven useful in facilitating bonds to un-cut enamel in minimal-to-no-preparation, all-ceramic restorative cases.[2] Additionally, these materials and techniques provide dentists the ability to etch sclerotic dentin.[1]

Because of this, well-proven total-etch techniques and materials have remained among the most effective in indirect restorative cases.[3] However, a recent shift away from total-etch techniques and materials is occurring.[1]

Because of the technique sensitivity of total-etch systems, many dentists have sought products and techniques requiring fewer steps and simpler placement to reduce clinical challenges and the likelihood of operator error. Typically requiring separate application of the etchant and primer, total-etch techniques demand extra steps and the time required for the bonding process is increased.[1] Further, because the phosphoric acid in the etchant is relatively strong, careful observation of acid exposure times to different substrates is required to prevent over-etching.[1] Finally, one of the most significant consequences has remained postoperative sensitivity.[1,4]

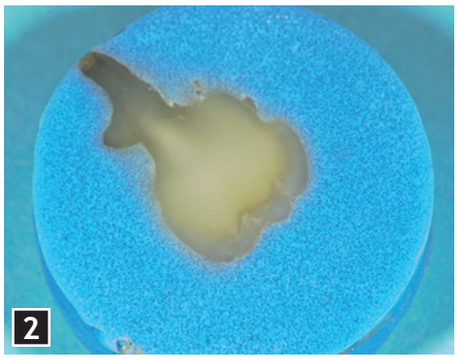
Postoperative sensitivity, or dentin hypersensitivity, does not result from defects within the tooth or other pathological causes, but is related to the loss of the protective enamel layer through dysfunction, parafunctional habits, disease, or mechanical and chemical preparation.[4,5] Triggering pain, the exposed dentin becomes sensitive to a variety of chemical, thermal, tactile and osmotic stimuli.[4,5] The phosphoric acid used in total-etch techniques has been shown to cause hypersensitivity when the dentin is not sealed prior to etching or bonding, often requiring removal and replacement of indirect restorations.[4,5]

To address these concerns, newer generations of materials and techniques have attempted to reduce incidences of postoperative and technique sensitivity.[4] Promising greater ease-of-use, self-etch or all-in-one materials combine the acid, primer and adhesive in one bottle.[1,4] Although they have gained popularity, there is reason for skepticism regarding the efficacy, viability and longevity of the bonds they create.[4,6] Coinciding with their use, increased rates of fracture, de-bonding, marginal leakage and postoperative sensitivity led to questions about the ability of self-etch and all-in-one materials to properly etch tooth substrates (Fig. 1).[6] Therefore, it has been suggested that total-etch techniques and materials be used for indirect restorations, rather than self-etch and all-in-one adhesive materials.[6]

Fig. 1: Clinical example of leakage at an enamel margin where a self-etch system was used with no enamel etching

Through a greater understanding of the chemical and mechanical aspects of bonding, techniques have improved and material sciences evolved. By sealing, disinfecting and desensitizing the dentin, these newer-generation materials reduce or completely eliminate the risk of postoperative sensitivity.[7] Although desensitizing agents have demonstrated a long history of success, key opinion leaders and researchers have struggled to qualify when these materials should be placed. Consequently, confusion has arisen over which techniques offer the greatest benefit and whether sealing should be delayed or completed immediately with these agents.

Gluma (Heraeus) has been specially formulated to penetrate exposed dentin tubules up to 200×, while reducing the permeability of the dentin by sealing the peripherals of the tubules.[8] By preventing the flow of fluid during osmotic changes, postoperative pain is significantly reduced, and the material also acts as a microbial barrier by forming a hermetic



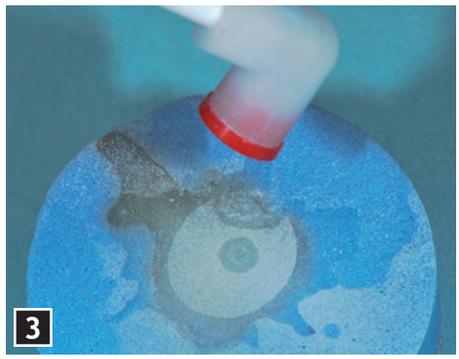


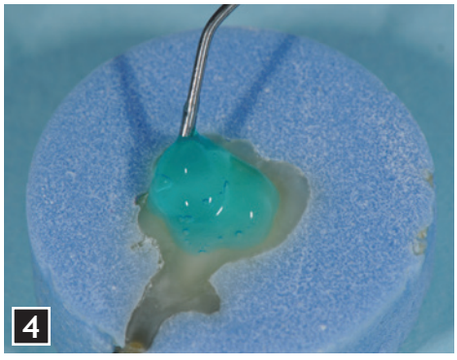
Fig. 2: Specimen of freshly extracted tooth with dentin exposed, ready for bonding

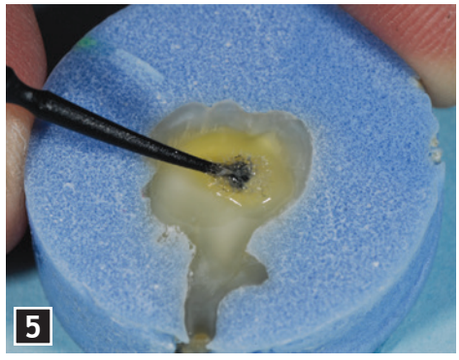
Fig. 3: Tooth specimens sprayed with CEREC Opti-Spray

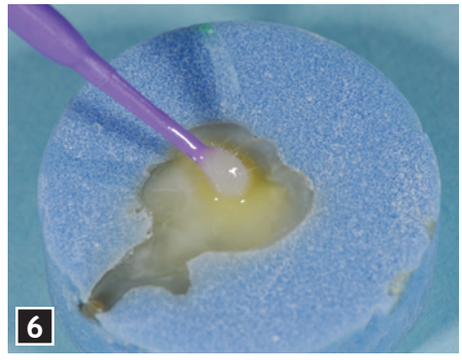
Fig. 4: Specimen with 32% H_2PO_4 Uni-tech (Bisco) applied to exposed dentin

Fig. 5: Applying dentin primer

Fig. 6: Applying filled adhesive







seal that inhibits bacterial growth.[9] Additionally, Gluma does not affect bond strength and can be used safely in conjunction with adhesive bonding agents and resin cements.[8]

Here, we discuss using Gluma as a desensitizer in the adhesive process, and test its effect on dentin bond strengths in conjunction with the CEREC chair-side technique in vitro.

IN VIVO CLINICAL OBSERVATIONS IN THE UCLA CENTER FOR ESTHETIC DENTISTRY

To observe the effects of a desensitizing agent (5 percent Glutaraldehyde and 35 percent HEMA; Gluma and Gluma Power Gel desensitizer, Heraeus) on the adhesive process, following clinical observations were undertaken in 2010.

Total-etch and self-etch techniques were compared to determine which offered the greatest benefit and the least clinical challenges. Standard total-etch and self-etch techniques were accomplished by graduate students. Patients reported at least some postoperative sensitivity in approximately 20 percent of the cases using total-etch without a desensitizer and less than 5 percent postoperative sensitivity using self-etch. Marginal micro-leakage and staining was evident at enamel margins over time with the self-etch but not the total-etch. In another patient group, a 5 percent Glutaraldehyde and 35 percent HEMA desensitizer was added to the total-etch technique. Patient-reported postoperative sensitivity decreased drastically to less than 5 percent, consistent with the self-etch technique. Due to etching of the enamel, there has been no observable marginal leakage in this patient population.

IN VITRO BOND STRENGTH TESTING METHODS

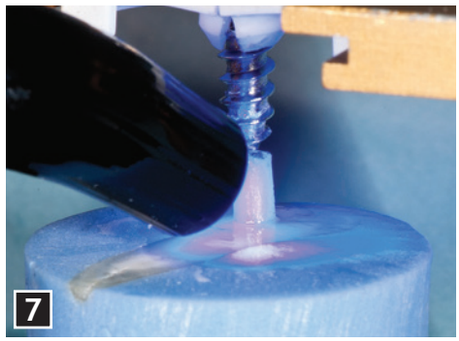
To test the effects of a desensitizing agent (5 percent Glutaraldehyde and 35 percent HEMA; Gluma and Gluma PowerGel desensitizer; Heraeus) on the adhesive effect of bond strength to dentin, 40 extracted teeth were mounted and the axial dentin was exposed just below the dento-enamel junction (DEJ) (Fig. 2). The 40 teeth were randomly assigned to four groups. The process used in Groups 1, 2 and 3 has been referred to as the delayed dentin sealing technique (DDS), which performs dentin sealing at the time of cementation of the final prosthesis. The specimens in groups 1, 2 and 3 were sprayed with CEREC Opti-Spray (Fig. 3) on the exposed dentin and then stored in water at 37 degrees Celsius for one hour. After one hour, the specimens from all three groups were treated by three different methods, and IPS Empress (Ivoclar Vivadent) ceramic rods were adhesively bonded to the dentin.

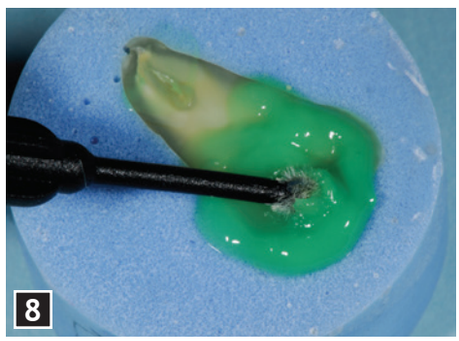
In Group 1, the dentin surface was rinsed thoroughly with water and then dried for two seconds, a 32 percent phosphoric acid was applied for 30 seconds (Fig. 4), and a fourth-generation bonding agent (All-Bond 3, Bisco) was applied by first placing two coats of the All-Bond 3 primer for 15 seconds (Fig. 5), drying for 10 seconds in air, and then applying the All-Bond 3 filled adhesive (Fig. 6) that was then thinned in air. A dual-cure cement (Duo-Link) was then applied to a ceramic rod, placed on the dentin and photopolymerized for one minute (Fig. 7, next page). In Group 2, the exact same steps were followed, except sandblasting was added after the initial rinsing but prior to the acid etch. The dentin surface was sandblasted at 20 psi with 50-micron aluminous oxide for 10 seconds. In Group 3, all steps were

Fig. 7: IPS Empress ceramic rod bonded to dentin using a dual-cure cement

Fig. 8: Applying Gluma Gel to dentin after etching, but before primer application

Fig. 9: Specimen set in Ultradent jig and in Instron ready for shear testing



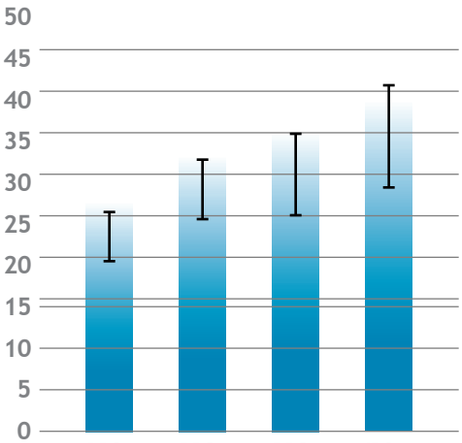


followed as in Group 2 (i. e., sandblasting), and Gluma Gel was placed on the exposed dentin directly after the acid etching (Fig. 8), but before applying the dentin primer and allowed to dwell for 30 seconds. The gel was rinsed for 10 seconds and then dried for two seconds. The primer was then applied as in the other groups, and ceramic rods were bonded as before. In all three groups, glycerin was applied at the margin area and specimens were post-cured for 40 seconds.

Specimens in Group 4 were bonded using what has been termed the immediate dentin sealing technique (IDS), which performs dentin sealing at the time of preparation and prior to impressioning procedures. For Group 4, the dentin was sealed prior to spraying the CEREC contrast powder. For this group, the dentin was first sandblasted as in Groups 2 and 3, the dentin was etched for 30 seconds and Gluma Gel applied for 30 seconds as in Group 3. All-Bond primer and then adhesive were applied to the exposed dentin and cured. The specimens were then post-cured for 40 seconds after glycerin addition. The specimens were then rinsed and dried. CEREC Opti-Spray was then applied. The specimens were then stored for one hour in water at 37 degrees Celsius. The specimens were then rinsed and lightly sandblasted with 20 psi and 50-micron aluminous oxide for three seconds to remove the residual CEREC powder. Only filled adhesive was applied to the dentin, and ceramic rods were cemented using Duo-Link. Specimens in all four groups were tested in shear 10 minutes after bonding the ceramic rods using the Ultradent shear method (Fig. 9).

RESULTS

The results of the testing as outlined prior can be seen in the table below:



	DDS No SB	DDS Sandblast	DDS Gluma Gel SB	IDS Gluma I Hour
Mean	27.44	33.13	35.36	39.86
S.D.	2.83	3.81	4.96	6.05

ANALYSIS OF RESULTS

It was noted there was a general increase in bond strength with lightly sandblasting the dentin prior to adhesive techniques in all groups. Many factors contribute to this, but overall cleaner dentin —free of powder and with other surface contaminants removed — is the most likely reason for bond improvement. There also was an increase in bond strength in both groups using Gluma Gel over the non-Gluma Gel groups. There was an increase in bond strength with the IDS Gluma Gel technique versus the DDS Gluma Gel technique, but the increase was only slight.

In other IDS versus DDS studies conducted by Magne, there was a much more significant difference between IDS and DDS groups.[10] Differentiating these studies was use of normal impression material over a two-week storage period. For the DDS groups in these studies, the dentin was probably altered and contaminated in a much more significant way that contributed to the larger bond strength differences. In the current study there was only storage for one hour, while no conventional impression materials or temporary cement were used, so little or no alteration to dentin occurred. This may be the ultimate benefit of the CEREC same-day technique (i. e., a DDS technique can be used, which is much simpler).

Therefore, based on the aforementioned observations, the following technique for adhesively bonding indirect CAD/CAM restorations has been suggested to eliminate postoperative sensitivity and increase bond strength.

UCLA CEREC ADHESIVE TECHNIQUE

After fabrication of the CEREC restoration using the standard chair-side CEREC technique, contaminants were removed from the preparation through light sandblasting with 50-micron aluminum oxide at 20 psi. Although pumice solutions may be used, sandblasting cleans more effectively and enhances the bond strength. However, careful consideration is necessary when sandblasting, since pressure above 20 psi may damage prior restorations and cause gingival bleeding.

Immediately following sandblasting, the enamel and dentin were both etched with 32 percent phosphoric acid for 30 seconds to standardize. The large bolus of etch is removed by suction, and the preparation is rinsed for 10 seconds and then dried for two seconds. A 2 percent chlorhexidene solution is applied and left to dwell for 10 seconds, after which the excess is removed with suction. Recent research has shown that rinsing with chlorhexidine may further increase final bond strengths and aid Gluma when re-wetting the dentin.

Using a delayed sealing technique and a nylon brush, Gluma was then burnished on the preparation for 20 to 30 seconds. If using Gluma PowerGel, it is necessary to leave the gel on the dentin for 45 seconds, since it takes a bit longer to soak into the dentin. Excess was removed using suction, rather than air-drying, since Gluma may burn soft tissues, specifically the mucosa. When using the gel, it is necessary to rinse slightly for five seconds to remove the gel residue. Although the burns are often minor and will heal quickly and fully, they can be painful. Immediately following removal of excess, compressed nitrogen was used for two seconds to remove excess water that remained on the dentin from the Gluma.

A fourth-generation dentin bonding agent (All-Bond 3) is then applied to the Gluma-treated preparation. First, the dentin primer All-Bond 3 is applied and burnished into the dentin for 10 seconds. Then, compressed nitrogen is used to evaporate the ethanol solvent for 10 seconds. The surface should still be shiny; if it isn't, the All-Bond 3 should be re-applied. This is not cured. Then, a filled adhesive is applied and nitrogen thinned, but again not cured. To seat the restoration, a highly filled, dual-cured resin cement is used, since it offers a more stable bond on dentin.

The restoration is then seated on the preparation and firm pressure applied. Prior to initial light-curing, excess was removed from the margins and interproximal areas. After initial curing, remaining excess cement was removed and the restoration underwent final curing. Occlusion was then adjusted as necessary, and the restoration was finished and polished.

In cases where the CEREC technique is used but there will be extended time between preparation and cementation (e. g., temporaries will be fabricated and several days or longer will pass before cementation), the IDA technique will be performed as described in Group 4 from the in vitro study.

CONCLUSION

When placing indirect restorations, the authors believe that total-etch techniques and materials should be chosen over self-etching for a variety of reasons.[7] Although the literature has demonstrated that self-etch materials offer sound dentin bonding in the short term, research on their efficacy in the long term remains inconclusive.[6] Further, it is known that self-etching materials lack the ability to bond to enamel long term.[6] While initial bond strength appears promising, marginal leakage frequently leads to restorative failure.[6]

Currently, the trend in adhesive dentistry has shifted toward the use of self-etch and all-in-one materials and techniques for simpler placement of indirect restorations. However, the inherent risks must be considered. Providing greater strength, durability, stability and longevity on both enamel and dentin, total-etch techniques remain among the most proven.[7] Although these materials are more technique-sensitive, the time and additional steps are nominal when compared to restorative failure and replacement.[6] Combined with the proper techniques and materials, desensitizing materials such as Gluma offer the greatest benefit to both dentist and patient.[7]

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