Reversal of Compromised Bonding after Bleaching

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Bleaching with peroxide agents compromises the adhesion of resin-based materials to enamel and dentin. The problem is likely caused by delayed release of oxygen from the teeth that inhibits resin polymerization at the interface. The typical method for avoiding problems with bonding to bleached teeth is simply to delay the bonding procedure for a week or two after bleaching. However, there is evidence that bonding can be done immediately if bleaching is followed by the application of an antioxidant. This Critical Appraisal reviews some of the published reports on the reversal of compromised bonding after bleaching via the use of antioxidants such as sodium ascorbate.

Reversal of Compromised Bonding in Bleached Enamel

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Journal of Dental Research 2002 (81:477–81)

ABSTRACT

Objective: This study evaluated the microtensile bond strength and nanoleakage of two resin-based adhesives to bleached enamel and to enamel that was bleached and then treated with an antioxidant (reducing) agent.

Materials and Methods: Composite was bonded to the enamel of extracted human third molars using either Single Bond (3M ESPE, St. Paul, MN, USA), an ethanol-based adhesive, or Prime & Bond NT (Dentsply DeTrey, Konstanz, Germany), an acetone-based adhesive. Surfaces to be bonded were airborne particle-abraded using 50-µm aluminum oxide. In the control groups, teeth were placed in distilled water for 8 hours and were etched with 32% phosphoric acid for 15 seconds. Teeth in a second group were bleached for 8 hours using a 10% carbamide peroxide gel and were placed in distilled water for 10 minutes before etching. In the final group, the teeth were bleached in the same manner, placed in distilled water for 10 minutes, and immersed in 10% sodium ascorbate (Sigma Chemical, St. Louis, MO, USA) for 3 hours before etching. The bonded specimens were sectioned for microtensile bond strength testing, which was accomplished using a Bencor Multi-T device (Danville Engineering, San Ramon, CA, USA) fitted to a universal testing machine (Instron, Canton, MA, USA). Additional specimens were subjected to a silver staining technique to evaluate nanoleakage using transmission electron microscopy (TEM).

Results: Bleaching with 10% carbamide peroxide significantly reduced the enamel bond strength of Prime & Bond NT (from 33.1 to 23.7 MPa) and Single Bond (from 32.0 to 24.0 MPa). However, treatment with sodium ascorbate returned enamel bond strengths to control levels—36.2 MPa for Prime & Bond NT and 33.5 MPa for Single Bond. The resin-enamel interface of the bleached teeth had more extensive nanoleakage, as represented by isolated silver grains and bubble-like silver deposits.

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Conclusions: Bleaching reduces enamel bond strengths, probably by delayed release of oxygen, but this reduction can be reversed by treatment with sodium ascorbate, an antioxidant or reducing agent.

COMMENTARY

Resins do not polymerize well in the presence of oxygen, which is why the surface of a freshly placed pit and fissure sealant feels sticky. The presence of oxygen in recently bleached teeth seems to prevent complete polymerization of resins at enamel and dentin surfaces, and therefore results in lower-than-normal bond strengths. This was one of the first studies to discover that a reducing agent such as sodium ascorbate can reverse compromised bonding to tooth structure by reversing the oxidizing effects of the bleaching agent.

The sodium ascorbate regimen used in this study was lengthy—3 hours, or approximately one-third of the bleach application time. That might not be practical clinically (more on it in the following review), but this study provided important proof of concept.

The Effect of Hydrogel and Solution of Sodium Ascorbate on Bond Strength in Bleached Enamel

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Operative Dentistry 2006 (31:496–9)

ABSTRACT

Objective: This study compared the effects of two different sodium ascorbate hydrogel concentrations and a sodium ascorbate solution on shear bond strengths of resin to enamel after bleaching.

Materials and Methods: Roots were removed from 60 extracted human third molars and the crowns were embedded in acrylic resin with the buccal surfaces exposed. The enamel was airborne particle-abraded using 50-μm aluminum oxide and a 10% carbamide peroxide bleaching gel was applied for 8 hours.

A 10% aqueous solution of sodium ascorbate was prepared, as were two sodium ascorbate hydrogels at 10% and 20% concentrations. Carbopol 934 resin (Noveon, Brussels, Belgium) was used as the thickening agent for the hydrogels and their pH was adjusted to 7 by addition of triethanolamine. Specimens were either immersed in the solution, or had the gels applied, for 3 hours at 100% humidity. (This time was based on the study by Lai et al., which—as described above—reported a reversal of compromised bonding using a sodium ascorbate application time of about one-third the bleaching time.) The control group was not treated with sodium ascorbate. After rinsing, the enamel was etched with phosphoric acid. Composite was applied to the enamel in molds following application of Single Bond adhesive. Shear bond strengths were determined using a universal testing machine.

Results: The mean shear bond strength of the control group was 23.4 MPa. Mean bond strengths in the groups treated with sodium ascorbate ranged from 29.3 MPa to 30.7 MPa. All of these were significantly greater than the control group mean and were not significantly different from each other.

Conclusions: Two forms of sodium ascorbate—solution and hydrogel—significantly increase the bond strength of resin to bleached enamel.

COMMENTARY

The methodology of this study was very similar to the one reviewed earlier. Although their methods for measuring bond strengths were different, they used the same concentration and application time of carbamide peroxide, and the same application time for sodium ascorbate. However, the present study evaluated whether sodium ascorbate was as effective in hydrogel

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form as in liquid form. The results showed that this was indeed the case and that the concentration of the sodium ascorbate was not critical, as both 10% and 20% gels were equally effective. The potential benefit of a gel-like antioxidant is that it could be easily applied in a patient's bleaching tray. Of course, a shorter application time would be desirable. Applying the antioxidant for 3 hours for every 8 hours of bleaching would render the technique nearly useless. The same result could be accomplished simply by doing nothing for a week or two! As we shall see, some later research has focused on shorter application times.

Can the Hydrogel Form of Sodium Ascorbate Be Used to Reverse Compromised Bond Strength after Bleaching?

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Journal of Adhesive Dentistry 2009 (11:35–40)

ABSTRACT

Objective: The purpose of this study was to evaluate the effects of different concentrations of sodium ascorbate hydrogel on bond strengths of composite to bleached enamel.

Materials and Methods: Sixty 4 × 5 mm slabs of enamel were sectioned from bovine teeth and were assigned randomly to six groups. The two control groups received no treatment or bleaching only without antioxidant treatment. In the other groups, bleaching was followed by a 10% sodium ascorbate solution or 2.5, 5, or 10% sodium ascorbate hydrogels. As in the study reviewed above, Carbopol was used as the thickening agent. Gel pH was adjusted to 7.4 via addition of sodium hydroxide.

Bleaching was accomplished by application of 10% carbamide peroxide gel (Opalescence, Ultradent Products, South Jordan, UT, USA) for 8 hours per day for 7 days. While not being bleached, the specimens were stored in artificial saliva. The sodium ascorbate solution was applied by dripping 1 mL of the solution every minute for 10 minutes. The gel versions were applied for 2 hours, a time that was determined in a pilot study.

After bleaching, antioxidant treatment, and rinsing, enamel surfaces were treated using Clearfil SE Bond (Kuraray, Osaka, Japan) self-etch primer and bonding agent. Composite was applied and cured in Teflon molds. After thermocycling, bond strengths were determined using a universal testing machine. Failure analysis was done with optical microscopy at 50 × magnification.

Results: The mean shear bond strength of the unbleached control group was 24.8 MPa. In the group that was bleached without subsequent application of sodium ascorbate, the mean bond strength was 17.9 MPa. In the sodium ascorbate solution group, the mean was 27.1 MPa. For the lower hydrogel concentrations, the mean bond strength was only about 21 MPa—but it was 33.3 MPa for the 10% sodium ascorbate group.

Conclusions: A 10% sodium ascorbate gel can reverse compromised bonding as effectively as a 10% solution and would be a good clinical alternative. Smaller gel concentrations are not as effective.

COMMENTARY

This study supports earlier research showing that a 10% sodium ascorbate gel can reverse the effects of bleaching on bonding. Unlike most of the other studies on this topic, the present study evaluated a self-etch adhesive system. However, its most interesting finding was that a relatively brief (2-hour) application of the 10% gel completely reversed the adverse effects of an entire simulated week of bleaching with 10% carbamide peroxide.

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Assessing the Use of 35 Percent Sodium Ascorbate for Removal of Residual Hydrogen Peroxide after In-Office Tooth Bleaching

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Journal of the American Dental Association 2011 (142:836–41)

ABSTRACT

Objective: This study was designed to quantify the amount of hydrogen peroxide remaining in dentin after in-office bleaching and to evaluate the effectiveness of a high concentration of sodium ascorbate for removing peroxide from the dentin.

Materials and Methods: Small (4 × 4 × 2 mm) dentin blocks were sectioned from the crowns of extracted human third molars and were assigned to eight groups. As controls, one group of specimens was left untreated and another was bleached with 35% hydrogen peroxide but not treated with sodium ascorbate. In all of the experimental groups, the dentin was bleached using 35% hydrogen peroxide. Subsequently, 35% sodium ascorbate was applied using several different regimens, ranging from a single 60-minute application to two 1-minute applications.

The bleaching procedure involved three separate 15-minute applications of a commercial 35% hydrogen peroxide gel. The antioxidant treatment was delivered by immersing each specimen in a microtube filled with a 35% sodium ascorbate solution (Sigma-Aldrich, St. Louis, MO, USA) for the designated time. The amount of hydrogen peroxide remaining in each specimen was determined by a chemical assay method.

Results: No peroxide was detected in the group that was not bleached. The highest amounts of residual peroxide were found in the bleach-only group, immediately and 24 hours after bleaching. Detectable peroxide remained for four days. Immediately after bleaching and sodium ascorbate treatment in the experimental groups, very small amounts of peroxide were detected in specimens that were treated with 60- and 10-minute applications of the antioxidant. In contrast, when the sodium ascorbate was applied 2–3 times for just 1, 5, or 10 minutes, no peroxide was detected.

Conclusions: Two 1-minute applications of 35% sodium ascorbate achieved the same result as that observed five days after bleaching with 35% hydrogen peroxide without antioxidant treatment—i.e., complete removal of peroxide from dentin.

COMMENTARY

In an earlier study, the same authors discovered that the concentration of sodium ascorbate required to counteract the effects of bleaching on bonding should be equal to the peroxide concentration used for bleaching. For that reason, and because the study involved 35% hydrogen peroxide, they used a higher concentration of sodium ascorbate (35%) than that used in most other studies (10%). It should be noted that the peroxide-sodium ascorbate concentration equivalence has not been proven anyway. For example, 10% carbamide peroxide is equivalent to only about 3.5% hydrogen peroxide, so a 10% sodium ascorbate gel represents a triple concentration ratio of antioxidant to peroxide.

The most important finding of this study is obvious—very short applications of 35% sodium ascorbate completely eliminated peroxide from bleached dentin immediately after bleaching. In other words, using this method, a clinician could begin a bonding procedure shortly after bleaching if desired. Of course, it is worth noting that another reason to delay bonding after bleaching is to allow for the early relapse of the bleaching effect. This obviously could be an important consideration for shade selection in esthetic procedures.

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SUGGESTED READING

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THE BOTTOM LINE

- Tooth-whitening procedures using peroxide-based products either with lower at-home concentrations or higher in-office concentrations reduce the adhesion of resin restorative materials to enamel and dentin. This phenomenon likely results from the teeth acting as reservoirs of oxygen that inhibit complete resin polymerization. The most common method to avoid problems with compromised bonding after bleaching is simply to delay bonding by 1–2 weeks.
- Antioxidants, notably sodium ascorbate, counteract this effect and can return bond strengths to normal levels.
- Sodium ascorbate is effective in both liquid and gel forms.
- A sodium ascorbate concentration of at least 10% is probably required to counteract the adverse effects of bleaching on bonding, and higher concentrations are likely to do so more rapidly.
- Sodium ascorbate gel applied using the patient's custom bleaching tray would be an effective method for returning adhesion to normal levels. However, to the author's knowledge, no such product is commercially available.

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