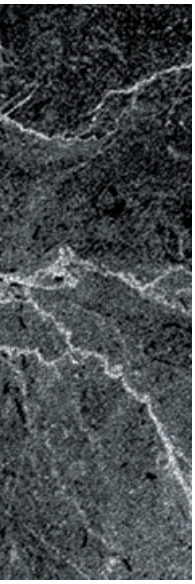

Critical Appraisal

EFFECTS OF BLEACHING ON TOOTH STRUCTURE AND RESTORATIONS, PART II: ENAMEL BONDING

Author and Associate Editor

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Tooth whitening has become a common treatment over the last 15 years, and much research has been reported on the effects of bleaching procedures on enamel, dentin, and restorative materials. We are presenting a series of Critical Appraisals covering recent research in this area. This installment focuses on resin bonding to enamel.

IMMEDIATE BONDING TO BLEACHED ENAMEL

A.K. Nour El-din, B.H. Miller, J.A. Griggs, C. Wakefield
Operative Dentistry 2006 (31:106–14)

ABSTRACT

Objective: This study evaluated the effects of acetone- and ethanol-based adhesives on immediate bonding to bleached enamel.

Materials and Methods: Seventy-two bovine incisors were assigned to three groups of 24 for treatment with deionized water only (control), 38% hydrogen peroxide (the in-office bleaching system Opalescence Xtra Boost, Ultradent Products, South Jordan, UT, USA), or 10% carbamide peroxide (the at-home product Opalescence, Ultradent). Each group was divided into two subgroups based on the type of adhesive used—either an ethanol-based product (Single Bond, 3M ESPE, St. Paul, MN, USA) or an acetone-based one (One-Step, Bisco, Schaumburg, IL, USA).

In the 10% carbamide peroxide group, Opalescence was applied to enamel for 6 hours daily for five consecutive days. In the 38% hydrogen peroxide group, the bleaching agent was applied in a single 30-minute session. Specimens were stored in deionized water when not being treated.

Bonding procedures were carried out immediately after bleaching, using these two total-etch adhesive systems according to their manufacturers' instructions. Shear bond strengths of the composite to enamel were measured using a mechanical testing device. Resin–enamel interfaces were evaluated using scanning electron microscopy (SEM), and failure modes were analyzed using an optical microscope at 20× magnification.

Results: Bond strengths in the untreated control group were nearly 18 MPa for each adhesive. These values declined to the 9-to-10-MPa range on enamel bleached with 10% carbamide peroxide, and to the 5-to-6-MPa range on enamel bleached with 38% hydrogen

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peroxide. Differences between the two adhesives were not statistically significant.

All failures were 100% adhesive in nature. Resin tags in the control group were long, thick, and dense. Fewer resin tags were present in the bleached enamel groups.

Conclusions: Bleaching causes significant reductions in the bond strength of resin to enamel (by up to 70% for the high-concentration hydrogen peroxide). These reductions are not reversed by the use of acetone- or ethanol-based adhesives immediately after bleaching.

COMMENTARY

Numerous studies have reported that bleaching reduces the bond strengths of resin-based materials to both dentin and enamel. This may be the result of residual oxygen in the teeth, which can inhibit polymerization of resins. Some earlier studies reported that solvents such as acetone and ethanol could reduce the adverse effects of bleaching on bonding. However, the present study does not confirm those earlier results. The acetone- and ethanol-based adhesives used here did not nearly return bond strengths to nearly the normal level. As other studies reviewed in this Critical Appraisal show, it appears that the safest approach for bonding to bleached enamel remains the simplest—waiting for some brief period of time before bonding.

SUGGESTED READING

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Barghi N, Godwin JM. Reducing the adverse effect of bleaching on composite-enamel bond. J Esthet Dent 1994;6:157–61.

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SHEAR BOND STRENGTH OF ENAMEL TREATED WITH SEVEN CARBAMIDE PEROXIDE BLEACHING AGENTS

R.T. Basting, J.A. Rodrigues, M.C. Serra, L.A. Pimenta

Journal of Esthetic and Restorative Dentistry 2004 (16:250–9)

ABSTRACT

Objective: The purpose of this study was to evaluate resin-enamel bond strengths after bleaching with different concentrations of carbamide peroxide and a 15-day postbleaching storage period in artificial saliva.

Materials and Methods: Enamel fragments measuring 4 mm × 4 mm × 3 mm were sectioned from extracted (and previously unerupted) human third molars. One hundred and twenty such specimens were mounted in PVC ring molds using a self-cure acrylic resin. Enamel was polished flat to 1,000 grit using aluminum oxide disks. A uniform 9-mm^2 area of enamel was created by covering the adjacent areas with nail varnish.

Specimens were assigned to eight groups for treatment with Nite White Excel 10, 16, and 22% (Discus Dental, Culver City, CA, USA), Opalescence 10%, Opalescence PF 20% (Ultradent Products), Rembrandt 15% (Den-Mat, Santa Maria, CA, USA), Nupro Gold 10% (Dentsply Professional, York, PA, USA), and a placebo containing glycerin and carbopol. Small flexible application trays were fabricated for each specimen. Treatment agents were applied for 8 hours per day for 42 days. After treatment, the specimens were rinsed and stored in artificial saliva. After the six-week bleaching regimen, the specimens were again stored in artificial saliva for an additional 15 days.

Composite was bonded to each specimen using the total-etch adhesive system Single Bond (3M ESPE), and a standard shear bond strength test was performed. Fractured surfaces were examined

using a stereomicroscope at 30× magnification.

Results: Mean shear bond strengths ranged from 15.8 MPa for the Nite White Excel 10% to 18.7 MPa for the Rembrandt 15%. The mean bond strength of the placebo control group was 18.4 MPa. None of the differences was statistically significant.

Conclusions: Bleaching with carbamide peroxide agents with concentrations ranging from 10 to 22% does not reduce the bond strength of resin to enamel after 15 days of storage in artificial saliva.

COMMENTARY

Numerous studies have demonstrated that bleaching reduces the adhesion of resin to both enamel and dentin. Although the mechanism for this reduction is not precisely understood, it might be related to residual oxygen in the tooth, which can prevent the adequate polymerization of resins at the bonding interface. Fortunately, exposure to saliva appears to reverse the adverse effects of bleaching on bonding. Ideally, bonding procedures should not be performed for at least 1 week after bleaching treatment, and some clinicians advise waiting even a bit longer (such as the 2 weeks in this study).

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EFFECT OF A WHITENING AGENT APPLICATION ON ENAMEL BOND STRENGTH OF SELF-ETCHING PRIMER SYSTEMS

M. Miyazaki, H. Sato, T. Sato, B.K. Moore, J.A. Platt

American Journal of Dentistry 2004 (17:151–5)

ABSTRACT

Objective: The aim of this study was to evaluate the bonding of self-etching primer adhesive systems to bleached enamel.

Materials and Methods: Three self-etching primer systems and a total-etch control (Single Bond, 3M ESPE) were used in this study. The self-etch systems were Imperva Fluoro Bond (Shofu, Kyoto, Japan), Mac Bond II (Tokuyama Dental, Tokyo, Japan), and Clearfil SE Bond (Kuraray Medical, Tokyo, Japan).

Labial enamel of 180 bovine incisors was ground to flat 240-grit surfaces. The teeth were mounted in self-cure acrylic resin, and the enamel was polished to 600 grit. An in-office whitening agent (Hi-Lite, Shofu) was applied three times, with each application lasting 3 minutes. Composite resin was applied either immediately after bleaching or after 24 hours of storage in distilled water. Unbleached enamel surfaces were used as a control for each adhesive system.

Shear bond strengths were determined using a universal testing machine. Fracture sites were examined using an optical microscope at 10× magnification. Conditioned and bonded enamel surfaces were examined using SEM.

Results: For the total-etch control Single Bond, the mean shear bond strength on unbleached enamel was 21.8 MPa. This declined to 15.3 MPa when bonding was done immediately after bleaching. However, storage in distilled water resulted in a mean of 19.6 MPa, which was not significantly different from the unbleached value.

For the three self-etch materials, bond strengths to unbleached enamel were 17.8 to 22.6 MPa. With immediate bonding, these fell to 3.0 to 7.9 MPa. After 24 hours

of water storage, the means had returned to their original range (17.1–21.0 MPa).

Adhesive failures at the resin–enamel interface were predominant in the immediate bonding specimens. SEM evaluation showed no obvious changes in the enamel surfaces, but that bleaching resulted in less resin tag penetration into the etched enamel.

Conclusions: Whitening procedures might adversely affect the bonding of self-etch adhesive systems when restorative procedures are done immediately after bleaching.

COMMENTARY

Unlike most of the studies reviewed, or offered as "suggested reading," in this Critical Appraisal, this study used an in-office, 35% hydrogen peroxide bleaching agent. However, results would probably be similar for the lower-concentration peroxide at-home agents.

Numerous studies about the bonding of resin to acid-etched bleached enamel have been reported. In contrast, almost nothing has been reported about the adhesion to bleached enamel using self-etch adhesive systems. The present study indicates that the problem of reduced bond strengths is not confined to total-etch systems, but is also an issue for self-etch systems. Some delay between bleaching and bonding is prudent, regardless of the bonding system being used.

SUGGESTED READING

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EFFECT OF AN ANTIOXIDIZING AGENT ON THE SHEAR BOND STRENGTH OF BRACKETS BONDED TO BLEACHED HUMAN ENAMEL

H. Bulut, M. Turkun, A.D. Kaya

American Journal of Orthodontics and Dentofacial Orthopedics 2006 (129:266–72)

ABSTRACT

Objective: The purpose of this study was to compare the effects of antioxidant treatment and delayed bonding on the shear bond strength of resin-bonded metal orthodontic brackets to enamel.

Materials and Methods: Eighty extracted human premolars were embedded in self-cure resin, with the crowns exposed. The specimens were randomly assigned to a control group and three experimental groups. The control group was immersed in artificial saliva. Teeth in the experimental groups were bleached with 10% carbamide peroxide gel (Rembrandt Xtra-Comfort, Den-Mat) for 8 hours a day for 1 week. While not being treated, they were stored in artificial saliva.

One of the experimental groups received no further treatment after bleaching. The second experimental group was treated with an antioxidant, 10% sodium ascorbate. The sodium ascorbate was applied as an irrigating solution for 10 minutes under continuous agitation. Specimens in the third experimental group were stored in artificial saliva for 1 week after bleaching.

Stainless-steel orthodontic brackets were bonded to all of the teeth using a self-cure composite resin cement (Concise, 3M Unitek, Monrovia, CA, USA). Prior to bracket bonding, the enamel was etched with liquid phosphoric acid, and a self-cure resin bonding agent was applied.

Specimens were thermocycled 200 times, and shear bond strengths were determined using a universal testing machine. Fracture analysis was done using a stereomicroscope at 16× magnification.

Results: The mean shear bond strength of the control group was

20.6 MPa. Bleaching significantly reduced the bond strength to 14.2 MPa. However, either sodium ascorbate treatment or 1-week delayed bonding returned bond strengths to normal levels (19.9 and 19.7 MPa, respectively). The greatest number of adhesive failures at the enamel–resin interface occurred in the group that was bleached and bonded without sodium ascorbate treatment or storage in artificial saliva after bleaching.

Conclusion: Bleaching immediately before bonding reduces the bond strength of resin to enamel, but treating the enamel with 10% sodium ascorbate or delaying the bonding procedure for 1 week returns bond strengths to their normal level.

COMMENTARY

Numerous studies have reported that bleaching teeth with peroxide agents significantly reduces the adhesion of resin to enamel. Fortunately, this reduction is transient, so there is a simple solution in most cases—that is, just wait a week or two after completion of bleaching before bonding resin to a tooth. In esthetic restorative cases, this is advisable for another reason. Tooth shades almost always regress slightly during the first few days after bleaching.

However, in some situations, such a delay might be impractical or inconvenient. Because of that, a treatment that would immediately reverse the adverse effects of bleaching is desirable. Some studies have reported that the use of an antioxidant such as sodium ascorbate can improve bonding to recently bleached enamel and dentin, and the present study supports these findings.

The cause of reduced adhesion after bleaching is not well understood but might be related to the presence of residual oxygen or oxygen free radicals in the tooth. The reversal of this effect by antioxidants, as shown in this study, supports the idea that residual oxygen indeed does play a role. To my knowledge, no commercial antioxidant product is being marketed for clinical use.

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Cacciafesta V, Sfondrini MF, Stifanelli P, et al. The effect of bleaching on shear bond strength of brackets bonded with a resin-modified glass ionomer. Am J Orthod Dentofacial Orthop 2006;130:83–7.

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Turkun M, Kaya AD. Effect of 10% sodium ascorbate on the shear bond strength of composite resin to bleached bovine enamel. J Oral Rehabil 2004;31:1184–91.

THE BOTTOM LINE

Bleaching reduces the bond strength of resin-based materials to enamel. This is true for both in-office and at-home bleaching, and for both total-etch and self-etch adhesive systems. The reason for the reduction in bond strength is not completely clear but is probably related to the presence of residual oxygen in the teeth.

At present, the best method for avoiding adhesion problems after bleaching is simply to wait a short time (e.g., 1–2 weeks) after bleaching to perform any adhesive dentistry. A waiting period provides the additional benefit of allowing the tooth shade to stabilize.

Some experimental treatments for reversing the adverse effect of bleaching on adhesion, most notably the use of antioxidants, have been reported in the literature. It remains to be seen whether these will find a place in clinical practice.

Editor's Note: We welcome readers' suggestions for topics and contributors to Critical Appraisal. Please address your suggestions to the section editor:

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