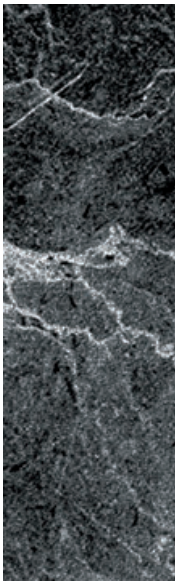

Critical Appraisal

EFFECTS OF BLEACHING ON TOOTH STRUCTURE AND RESTORATIONS, PART III: EFFECTS ON DENTIN

Author and Associate Editor

Edward J. Swift Jr., DMD, MS

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 describes studies regarding the effects on dentin properties and resin bonding to dentin.

FLEXURAL STRENGTH AND MODULUS PROPERTIES OF CARBAMIDE PEROXIDE-TREATED BOVINE DENTIN

L.E. Tam, R. Abdool, W. El-Badrawy

Journal of Esthetic and Restorative Dentistry 2005 (17:359–67)

ABSTRACT

Objective: The purpose of this study was to evaluate the effects of direct and indirect carbamide peroxide bleaching on the flexural strength and modulus of dentin.

Materials and Methods: Rectangular bar specimens of dentin ($20 \times 2 \times 2$ mm) were machined from bovine incisors using a low-speed saw. Opalescence (10% carbamide peroxide; Ultradent Products, South Jordan, UT, USA) was used for all of the bleaching treatments in the study. Four bleach immersion protocols were used. During each treatment, the specimens were completely surrounded by the bleaching gel at 37°C and at least 80% humidity for 6 hours. The bleaching gel was applied directly, or indirectly (i.e., through enamel), to the dentin. Specimens were treated with Opalescence except for a control group that was treated only with distilled water.

After 2 weeks of treatment, some of the direct-application specimens were stored for two more weeks in artificial saliva. Some of the specimens also received a daily 30-minute topical fluoride treatment (1.1% NaF), and others did not. The flexural strength and elastic modulus of each specimen were determined using a universal testing machine (Instron Corporation, Canton, MA, USA) at 24 hours after bleaching or after the final postbleaching treatment.

Results: When the carbamide peroxide bleach was applied directly to dentin, the modulus was lower than when the specimens were kept in distilled water, but the flexural strength was unchanged. When the carbamide peroxide was applied indirectly (i.e., through enamel), the flexural strength and modulus of the experimental and control groups were similar.

© 2008, COPYRIGHT THE AUTHOR
JOURNAL COMPILATION © 2008, BLACKWELL PUBLISHING
DOI 10.1111/j.1708-8240.2008.00166.x

In specimens stored in artificial saliva without topical fluoride treatments, the flexural strength and modulus of the bleached dentin were similar to those of the control. However, in specimens stored in artificial saliva and receiving topical fluoride treatments, the flexural strength and modulus of the bleached dentin were significantly lower than those of the control.

Conclusions: A 2-week bleaching treatment using 10% carbamide peroxide does not significantly affect the flexural strength and modulus of dentin when the bleaching agent is applied to the enamel of intact teeth. However, the effects of direct application of the bleaching agent (e.g., to exposed root surfaces) should be evaluated further.

COMMENTARY

This in vitro study reports that a popular carbamide peroxide bleaching gel did not adversely affect the mechanical properties of dentin when it was applied in the usual manner (i.e., to the enamel covering the dentin). In contrast, when the bleaching gel was applied directly to dentin, the flexural strength and modulus of dentin were reduced. Clinically, exposure to natural saliva might reverse these effects. So the question becomes—is this a clinical problem? We really do not have an answer to that question, but it is conceivable that bleaching treatment might adversely affect the mechanical properties of dentin in clinical situations such as root exposure. However, any such adverse effects have not been reported in the literature to date.

SUGGESTED READING

Chng HK, Ramli HN, Yap AUJ, Lim CT. Effect of hydrogen peroxide on intertubular dentine. J Dent 2005;33:363–9.

Hairul Nizam BR, Lim CT, Chng HK, Yap AUJ. Nanoindentation study of human premolars subjected to bleaching agent. J Biomech 2005;38:2204–11.

THE EFFECT OF 10% CARBAMIDE PEROXIDE, CARBOPOL, AND/OR GLYCERIN ON ENAMEL AND DENTIN MICROHARDNESS

R.L. Basting, A.L. Rodrigues, M.C. Serra

Operative Dentistry 2005 (30:608–16)

ABSTRACT

Objective: The aim of this study was to evaluate the effects of 10% carbamide peroxide, carbopol, glycerin, and combinations of these compounds on the microhardness of sound and demineralized enamel and dentin.

Materials and Methods: This study involved eight different treatments: the commercial product Opalescence 10%; 10% carbamide peroxide; carbopol; glycerin; 10% carbamide peroxide + carbopol; 10% carbamide peroxide + glycerin; carbopol + glycerin; and 10% carbamide peroxide + carbopol + glycerin. Treatments were applied for 8 hours daily in individual custom trays for 6 weeks. The effects of each treatment were measured at baseline, 8 hours, and weekly intervals during treatment, and at 1 and 2 weeks after treatment. The specimens treated were 80 slabs each of normal and demineralized enamel and dentin. The demineralized specimens were prepared by a dynamic model of demineralization and remineralization that has been reported in the literature. Specimens were stored in artificial saliva when not being treated. Knoop hardness values were determined using a microhardness tester.

© 2008, COPYRIGHT THE AUTHOR
JOURNAL COMPILATION © 2008, BLACKWELL PUBLISHING

Results: With the various treatment groups and measurement times, this study generated a very large amount of data. For sound enamel, microhardness decreased during treatment with each agent or combination of agents. Hardness of the demineralized enamel actually increased during treatment (probably as the result of storage in artificial saliva). The hardness of sound dentin decreased with all of the treatments, although the effect was more pronounced in some groups than in others. Hardness of the demineralized dentin also decreased during treatment but increased during the post-treatment phase.

Conclusions: Carbamide peroxide, carbopol, glycerin, and combinations of these agents decreased the hardness of sound enamel, sound dentin, and demineralized dentin.

COMMENTARY

Several studies have reported that at-home bleaching agents reduce the hardness of dentin and enamel, at least in the laboratory. To my knowledge, the present study is the first to isolate the effects of the various ingredients found in most at-home bleaching gels. Both the active ingredient, 10% carbamide peroxide, and a polymeric thickening agent, carbopol, reduced hardness. To a lesser extent, so did glycerin, which is used as the carrier in many bleaching gels. Although these specific results are somewhat interesting, they may have little direct clinical relevance.

Another recent study demonstrated substantial reductions in enamel hardness in vitro, but absolutely no change in situ. A similar effect might be expected for dentin. It is very likely that the remineralizing effects of saliva effectively counteract any demineralizing effects of the bleaching agent. Of course, in patients with limited salivary function, bleaching should be used with more caution than in "normal" patients.

SUGGESTED READING

Arcari GM, Baratieri LN, Maia HP, De Freitas SF. Influence of duration of treatment using a 10% carbamide peroxide gel on dentin surface microhardness: an in situ study. Quintessence Int 2005;36:15–24.

Attin T, Vollmer D, Wiegand A, et al. Subsurface microhardness of enamel and dentin after different external bleaching procedures. Am J Dent 2005;18:8–12.

de Freitas SF, Turssi CP, Hara AT, Serra MC. Dentin microhardness during and after whitening treatments. Am J Dent 2004;17:342–6.

de Freitas SF, Turssi CP, Hara AT, Serra MC. Monitoring of demineralized dentin microhardness throughout and after bleaching. Am J Dent 2004;17:342–6.

IN SITU EFFECT OF 10% CARBAMIDE PEROXIDE ON RESIN-DENTIN BOND STRENGTHS: A NOVEL PILOT STUDY

L.C. Miguel, L.N. Baratieri, S. Monteiro, A.V. Ritter

Journal of Esthetic and Restorative Dentistry 2004 (16:235–42)

ABSTRACT

Objective: The purpose of this study was to evaluate the effects of an at-home bleaching treatment on resin adhesion to dentin.

Materials and Methods: A single, 21-year-old male patient participated in the study. His third molars were extracted, and flat, 3-mm-thick dentin disks were sectioned from each and polished to 600-grit. A custom intraoral acrylic appliance (similar to a Hawley retainer) was fabricated on a stone cast of his maxillary arch. Two pairs of dentin disks were mounted

on the palatal side of the appliance. One pair was fixed in the appliance, and the other pair was removable. A modified bleaching tray also was fabricated to fit the patient's maxillary arch, including the appliance.

The patient wore the removable appliance for 24 hours a day for 3 weeks, removing it only for meals or oral hygiene procedures. During bleaching treatments—which consisted of daily 2-hour applications of 10% carbamide peroxide gel (Nite White Excel 2Z, Discus Dental, Culver City, CA, USA)—he removed one pair of dentin disks and stored them in artificial saliva. Thus, one pair of dentin disks was subjected to the bleaching treatment and the other was not.

At the completion of the 3-week treatment phase, a composite resin material was bonded to each dentin disk using the total-etch adhesive Single Bond (3M ESPE, St. Paul, MN, USA). The bonded specimens were sectioned into small "sticks" for microtensile bond strength testing, which was accomplished using a universal testing machine (Instron Corporation).

Results: The mean microtensile bond strength to untreated dentin was 39.2 MPa. The mean bond strength to bleached dentin was significantly less at 29.9 MPa.

Conclusions: The results of this in situ pilot study suggest that bleaching with carbamide peroxide can reduce the bond strength of resin to dentin.

COMMENTARY

This is certainly not the only study to report that bleaching adversely affects the bond of resin to dentin, but it is a unique one because of its novel in situ experimental design. Because this study was performed in a clinical setting, it provides the needed confirmation that the results reported in laboratory studies are probably accurate. In other words, we *do* need to be concerned about bonding to dentin that has been bleached recently. Fortunately, many studies have shown that adhesion to tooth structure returns to normal in the early weeks after cessation of bleaching.

The obvious limitations of this study are that it tested a single bleaching agent and a single adhesive in a single patient. Results might differ if any of these elements of the experimental design were changed. Nevertheless, this is a very interesting study that provides clinical evidence of the difficulty in bonding to recently bleached dentin.

SUGGESTED READING

Far C, Ruse ND. Effect of bleaching on fracture toughness of composite-dentin bonds. J Adhes Dent 2003;5:175–82.

Kaya AD, Turkun M. Reversal of dentin bonding to bleached teeth. Oper Dent 2003;28:825–9.

INFLUENCE OF WHITENING ON THE DEGREE OF CONVERSION OF DENTAL ADHESIVES ON DENTIN

M. Cadenaro, L. Breschi, F. Antoniolli, A. Mazzoni, R. Di Lenarda
European Journal of Oral Sciences 2006 (114:257–62)

ABSTRACT

Objective: The purpose of this study was to evaluate the degree of conversion (i.e., extent of polymerization) of four representative resin adhesives applied to dentin immediately after whitening and after 24 hours or 14 days of storage in a humid environment.

© 2008, COPYRIGHT THE AUTHOR
JOURNAL COMPILATION © 2008, BLACKWELL PUBLISHING

Materials and Methods: Two dentin disks, 0.8-mm thick, were sectioned from 80 extracted human molars parallel to the occlusal surface. Enamel and peripheral dentin were removed from each using abrasive paper to produce specimens that were 0.5 mm in diameter. These dentin disks were polished to 600-grit to produce a standardized smear layer.

Specimens were randomly assigned to four treatment groups. In three of the groups, specimens were bleached using a 38% hydrogen peroxide gel (Opalescence Xtra Boost, Ultradent Products) for three 10-minute applications. Adhesive systems were applied immediately after whitening or at 24 hours or 14 days. For the delayed bonding, specimens were stored in 100% humidity at 37°C. The control group was not treated with the bleaching agent prior to adhesive application.

The adhesives tested were a three-step total-etch system (Scotchbond Multi-Purpose, 3M ESPE), a "one-bottle" total-etch system (One-Step, Bisco, Schaumburg, IL, USA), a self-etching primer system (Clearfil Protect Bond, Kuraray Medical, Tokyo, Japan), and an "all-in-one" self-etch material (Xeno III, Dentsply DeTrey, Konstanz, Germany). All light-curing was done using a halogen source at 600 mW/cm^2 for 20, 40, or 60 seconds. The degree of conversion was determined using an analytical technique called differential scanning calorimetry.

Results: Immediately after bleaching, the extent of polymerization was significantly reduced, compared with the controls for all four adhesives. Results were mixed in the 24-hour specimens, but the extent of polymerization returned to control values for all adhesives in the 14-day group. The extent of polymerization consistently increased with increasing curing times.

Conclusions: Bleaching reduces the polymerization of resin-based adhesives, but delaying the bonding procedure reverses this adverse effect. Extending the curing exposure time might also help improve polymerization.

COMMENTARY

Numerous studies have reported that bleaching reduces the bond strength of resin-based materials to enamel and dentin. Although the mechanism of this reduction is not quite clear, speculation centers on the possibility of residual oxygen interfering with the polymerization of monomers at the interface.

The present study found that the degree of conversion, or extent of polymerization, was significantly reduced for four different adhesives when they were applied to dentin immediately after a bleaching procedure. Delaying the bonding procedure for 24 hours was sufficient to return conversion to normal levels for multistep adhesives but not for the simplified ones. A 2-week delay returned the extent of polymerization to normal levels for all of the adhesives. These findings provide further evidence that residual oxygen is the culprit for the reduction in bond strength caused by bleaching.

This study also reports that extending the curing time of an adhesive improves its degree of conversion, which is not surprising. This was an effective method for improving polymerization, even with the specimens bonded immediately after bleaching. However, it is unclear whether extended curing times would prove adequate to provide thorough polymerization and good bond strengths clinically. At present, the best advice for bonding to bleached teeth is this: delay the bonding procedure for a week or two after bleaching is finished.

SUGGESTED READING

Spyrides GM, Perdigão J, Pagani C, et al. Effect of whitening agents on dentin bonding. J Esthet Dent 2000;12:264–70.

Kum KY, Lim KR, Lee CY, et al. Effects of removing residual peroxide and other oxygen radicals on the shear bond strength and failure modes at resin-tooth interface after tooth bleaching. Am J Dent 2004;17:267–70.

INFLUENCE OF BLEACHING AGENTS AND DESENSITIZING VARNISHES ON THE WATER CONTENT OF DENTIN

H. Betke, E. Kahler, A. Reitz, G. Hartmann, A. Lennon, T. Attin
Operative Dentistry 2006 (31:536–42)

ABSTRACT

Objective: The purpose of this study was to determine whether bleaching agents cause dehydration in dentin, and whether protective varnishes can prevent any such water loss during bleaching.

Materials and Methods: Disk-shaped specimens, 5 mm in diameter and 1-mm thick, were sectioned from the roots of bovine incisors. These were stored at room temperature and 70% humidity for 2 weeks before the experiment and under the same conditions when not being treated during the experiment. Two groups of specimens ($N = 5$) were untreated and served as controls. One group was kept in the humid conditions, and the other was dehydrated for 8 hours in a sterilizing oven.

Three groups of specimens were treated with protective varnishes (Bifluorid, Voco, Cuxhaven, Germany; Seal & Protect, Dentsply DeTrey; and Vivasens, Ivoclar Vivadent, Schaan, Liechtenstein). These specimens were then bleached with an experimental material containing 20% carbamide peroxide and 72% glycerin. Additional specimens were not coated with any type of varnish, but were bleached using either this experimental material, a commercial 16% carbamide peroxide gel, or a paint-on material. Bleaching was performed for 7 days, using 2-hour applications of the 16 and 20% gels, and 20-minute applications of the paint-on. The water composition of all specimens was determined using an analytical technique called Karl–Fischer titration.

Results: The hydrated control group had a water content of 15.2%, and the dehydrated control group had a water content of only 3.3%. Application of the various bleaching agents to uncoated dentin resulted in a significant reduction of water content. However, two of the protective agents prevented loss of water from the dentin when they were applied prior to bleaching.

Conclusions: Glycerin-based bleaching agents can significantly dehydrate dentin, but the application of certain coatings before bleaching can reduce this dehydration.

COMMENTARY

The primary side effect of bleaching is transient tooth sensitivity. The cause of this sensitivity is not known with any certainty, but speculation centers on, possibly, dehydration by the bleaching agents. Glycerin is used as a vehicle for the active ingredients in many bleaching products and can absorb water. As this study demonstrates, bleaching agents that contain glycerin can cause dehydration of dentin. It is quite possible that this dehydration could lead to tooth sensitivity.

Clinical studies have not demonstrated a clear link between exposed dentin and sensitivity with bleaching. Therefore, the application of protective agents to exposed dentin prior to bleaching may or may not be beneficial. The real importance of the present study is its confirmation of the suspected dehydration by glycerin-based bleaching agents.

SUGGESTED READING

Leonard RH, Haywood VB, Phillips C. Risk factors for developing tooth sensitivity and gingival irritation associated with nightguard vital bleaching. Quintessence Int 1997;28:527–34.

Jorgensen MG, Carroll WB. Incidence of tooth sensitivity after home whitening treatment. J Am Dent Assoc 2002;125:1219–26.

© 2008, COPYRIGHT THE AUTHOR
JOURNAL COMPILATION © 2008, BLACKWELL PUBLISHING

THE BOTTOM LINE

Peroxide tooth bleaching apparently demineralizes dentin to some extent, reducing its hardness, flexural strength, and elastic modulus. Furthermore, bleaching reduces adhesion of resin-based materials to dentin. Studies suggest that these adverse effects are most pronounced when the bleaching agent is applied directly to dentin. However, because peroxide freely passes through enamel, it cannot be assumed that "indirect" contact of the bleaching agent would not have similar effects.

Fortunately, as has been demonstrated with enamel, any adverse effects are probably eliminated or reduced by the action of saliva in most patients. Certainly, no problems related to dentin demineralization have been reported in clinical trials. Nevertheless, bleaching agents should probably be used more cautiously in patients with xerostomia or other issues with salivary flow.

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

Critical Appraisal—Dr. Edward J. Swift Jr.
Department of Operative Dentistry
University of North Carolina
CB#7450, Brauer Hall
Chapel Hill, NC 27599-7450
Telephone: 919-966-2773; Fax: 919-966-5660
E-mail: Ed_Swift@dentistry.unc.edu

Copyright of Journal of Esthetic & Restorative Dentistry is the property of Blackwell Publishing Limited and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.

Copyright of Journal of Esthetic & Restorative Dentistry is the property of Blackwell Publishing Limited and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.

Copyright of Journal of Esthetic & Restorative Dentistry is the property of Blackwell Publishing Limited and its content may not be copied or emailed to multiple sites or posted to a listserv without the copyright holder's express written permission. However, users may print, download, or email articles for individual use.