The Saudi Journal for Dental Research (2014) 5, 29–33

King Saud University

The Saudi Journal for Dental Research

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ORIGINAL ARTICLE

Influence of bleaching and antioxidant agent on microtensile bond strength of resin based composite to enamel

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Received 17 February 2013; accepted 2 June 2013
Available online 25 June 2013

KEYWORDS

Carbamide peroxide;
Bleached enamel;
Sodium ascorbate;
Micro tensile bond strength;
Resin composite

Abstract The purpose of this investigation was to determine the effect of bleaching agent (10% carbamide peroxide) and antioxidant (10% sodium ascorbate) on the microtensile bond strength (μTBS) of resin based composite to enamel. Sixteen extracted human molar teeth were divided into three bleaching groups of 10% carbamide peroxide and an unbleached control group. The specimens in group 1 were bonded immediately after bleaching; group 2 were treated with antioxidant; group 3 were immersed for 3 h in distilled water, whereas the unbleached specimens in group 4 had no treatment (control) before bonding. The enamel was etched using 36% phosphoric acid, and was bonded to light polymerized resin composite. The tooth and resin composite assembly was sectioned to produce specimen of 1.0 mm^2 cross-section. Specimens were subjected to microtensile testing and fractographic analysis using scanning electron microscopy. The data was analyzed using one-way analysis of variance and Tukey–Kramer multiple comparisons test ($P = 0.05$). The specimen bonded immediately after bleaching revealed significantly lower μTBS (22.33 ± 8.46) compared to those of the control group (30.77 ± 8.01). The bleached specimen treated with antioxidant had μTBS (31.27 ± 6.92) similar to the control group. The majority of failures were

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Peer review under responsibility of King Saud University.

ELSEVIER Production and hosting by Elsevier

http://dx.doi.org/10.1016/j.ksujds.2013.06.001

at the adhesive interface, however the control group had greater cohesive failures. μTBS reduced significantly when resin based composite was bonded to prebleached enamel with carbamide peroxide ($P < 0.001$). Furthermore, application of antioxidant to bleached enamel restored the μTBS to levels similar to unbleached enamel ($P < 0.001$).

1. Introduction

Vital tooth bleaching is a safe and well accepted procedure for the treatment of surface and intrinsic staining of teeth.[1] The first report of home whitening system was made by Haywood and Heymann,[2] utilizing carbamide peroxide as a patient-applied, home bleaching agent. Consequently, various whitening systems have been developed using peroxide compounds of various concentrations to bleach enamel.[3,4]

Carbamide peroxide dissociates into hydrogen peroxide and urea. Hydrogen peroxide which diffuses through enamel due to its low molecular weight, further degrades into water and oxygen free radicals, interacting with colored organic molecules and stains. The free radicals oxidize these pigmented macromolecules into smaller and lighter molecules. The whitening effect is due to production of these shorter wavelength compounds which are colorless or lighter in shade.[5] The increase in bleaching procedures led us to question the consequences of such procedures on the tooth structure, dental materials and resultant adhesive bond strength to bleached tooth structures. Low molecular weight carbamide peroxide retains in the bleached enamel[6] and the residual oxygen free radicals result in the incomplete polymerization of the adhesive.[7] Compromised bond strength between resin-based materials to bleached tooth structures has been documented in many studies.[8–12] Few strategies for eliminating the compromised tooth- resin bond strength reported are, removal of superficial layer of enamel,[13] treating the enamel with alcohol,[14] use of adhesive containing organic solvents[15] and delaying the bonding procedures. However there is no consensus among studies regarding the waiting period that is required before resin-enamel bond strengths return to values for unbleached enamel. The waiting period has been reported to vary from 24 h to four weeks.[11,16–18]

The oxidizing ability of bleaching agents is thought to compromise the tooth–resin bond, also hydroxyl radicals in the apatite lattice are reportedly replaced by peroxide ions[19,20] rendering the surface unfavourable for bonding. Therefore the process may be reversed and bond strength restored by the application of a biocompatible anti-oxidant such as sodium ascorbate (SA). Lai et al.[8] reported that 10% sodium ascorbate when applied for 3 h to enamel after bleaching with CP increased the bond strength of resin based composite to enamel, reversing the effect of bleaching.

Microtensile bond strength testing using non-trimming method has been accepted as the gold standard for investigating integrity of an adhesive tooth-resin bond.[21] Investigators in previous reports have ground or sandblasted the surface enamel to create a more even or flat bonding surface, however this results in issues of depth of enamel reduction, differences in surface and subsurface enamel and dentine encroachment. To date there are limited microtensile bond strength studies using non-trimmed specimens of composite bonded to bleached unground enamel surface. Therefore, the purpose of this investigation was to determine the effect of bleaching agent (10% carbamide peroxide) and antioxidant (10% sodium ascorbate) using a non-trimming specimen technique on the microtensile bond strength (μTBS) of resin based composite to unground enamel surface.

2. Materials and methods

Sixteen non carious freshly extracted third molar teeth were cleaned of debris using pumice and rubber cup and stored in 0.2% thymol solution. The most flat surface of each molar was identified and the opposing parallel tooth surface was secured to a flat surface using composite resin which was light cured. Teeth were transferred to a silicone mold ($20 \times 20\ mm^2$) with the cured composite sitting flat at the bottom of the mold. Teeth were then partially embedded in self cure acrylic resin exposing only the flat enamel surface for bonding, following which they were stored in distilled water for 24 h before the assigned treatments were performed. Teeth were randomly divided into four groups, of which groups 1 to 3 were bleached using a 1 mm layer of 10% carbamide peroxide (CP) gel with potassium nitrate and fluoride (Optident) for 8 h at 100% relative humidity. Post-bleaching, the teeth were thoroughly rinsed with distilled water for 10 s. In group 1 (CP), prebleached teeth were immersed in distilled water for 10 min before bonding RBC to enamel. Prebleached teeth in group 2 (CP + SA) were immersed in 10% sodium ascorbate (SA) (anti-oxidant) (Sigma Aldrich) for 3 h, thoroughly rinsed with distilled water for 20 s and immersed in distilled water for 10 min (to dissolve sodium ascorbate crystals) before bonding to resin. Group 3 (CP + H_2O) comprised of bleached teeth which were immersed in distilled water (H_2O) for 3 h. Four teeth were left untreated to use as a control (Group 4). Subsequently resin based composite (RBC) was bonded to all the teeth in the study.

Bonding process involved enamel surface etching with 36% phosphoric acid (De Trey Conditioner 36, Dentsply) for 15 s and then rinsing with tap water for 20 s. The enamel surface was blot dried with an absorbent paper and a total-etch adhesive (Prime & Bond NT, Dentsply) was applied as a single layer, air dried lightly and light cured for 10 s. A cubic build-up of RBC (Filtek Supreme, 3 M ESPE) was bonded on the enamel surface in approximately 2 mm horizontal increments. Each increment was light cured for 20 s. The bonded teeth were stored in distilled water at room temperature for 24 h before sectioning into bar specimens.

The teeth were partially embedded in a self cure acrylic resin using a square silicone mold. The smoothed acrylic resin and tooth-composite assembly was mounted on the isomet sectioning machine (Isomet 1000). A slow speed diamond wheel saw was used to section at a constant speed of 400 rpm at 200 g force. A total of 32 specimen sticks of $1\ mm^2$ cross sec-