Effects of Whitening Peroxide Gels on Exposed Surface Dentin *In Vitro*

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ABSTRACT

A common side effect of vital tooth bleaching involves transient dentinal hypersensitivity, the mechanism of which is not understood. This study examined the effects of bleaching gels on dentin. Root dentin blocks were prepared from extracted human canines and premolars - with surfaces tested including patent tubules (smear layers opened with 0.5 M EDTA etching) and intact smear layers. Pre hardness evaluations (Buehler, 500 gm.) were made on (7 each) root surfaces which were placed into treatment groups: Saliva Only Control (WHSCTR), 5.3 % H_2O_2 Gel - 14 hours treatment (5.3PER), 6.5 % H_2O_2 Gel - 70 hr. (6.5 PER), Placebo to 5.3 % Gel - 14 hr. (5.3PL), Placebo to 6.5 % Gel - 70 hr. (6.5PL), Opalescence® 10 % Carbamide Peroxide (CP) Gel - 70 hr. (OP10) and Opalescence® 20 % CP Gel - 70 hr. (OP20). The 5.3 and 6.5 % H_2O_2 gels (and placebos) were prepared in Crest Whitestrips™ gel base. Specimens were exposed to a cycling regimen of 14 hour bleaching (0.5 gm. gel/spec. 1x/day) with human saliva/buffer immersion in between (and 48 hr. saliva post trmt.). Post bleaching specimens were re-examined for surface hardness and morphology (SEM). Pre:Post hardness values (only Students t $p< 0.05$ sig shown - all others nsd) measured: Smear covered: 5.3PL 51±3: 53±4; 6.5PL 56±4: 52±4; WHSCTR 55±6: 56±7; 5.3PER 54±5: 55±6; OP10 50±7: 53±6; 6.5PER 55±9: 56±9; OP20 55±5: 52±6: Open tubule: 5.3PL 49±6: 49±5; 6.5PL 52±5: 49±4; WHSCTR 50±4: 54 ±4; 5.3PER 54±7: 53±7; OP10 50±6: 51±5; 6.5PER 51±6: 54±6; OP20 49±4: 42±4 sig. SEM revealed no ultrastructure changes. Most importantly, closed tubules remained essentially intact. **These results establish that bleaching gels do not etch or soften dentin, nor do they apparently produce patent tubuli in smear covered dentinal surfaces. This research suggests that transient hypersensitivity from vital tooth bleaching is not related to surface effects on dentin.**

INTRODUCTION/PURPOSE

While vital tooth bleaching is directed toward cosmetic color modification of enamel surfaces, the topical action of bleaches may not be restricted to dental enamel. Exposed root surfaces may also be subject to the actions of bleaches. In fact, this might be expected in routine bleaching of adults given the prevalence of brushing induced gingival recession in the United States. The effect of topical bleaching systems on exposed dentin surfaces has not been extensively studied. A more complete understanding of the mechanism of tooth bleaching associated with non-etching oxidizing agents is necessary to establish the benefits and limitations of consumer-safe whitening procedures. Studies of effects on coincidentally exposed dentinal surfaces could provide insight into possible contributions of surface reactivity to transient dentinal hypersensitivity associated with bleaching procedures. This study examined the effects of hydrogen peroxide bleaching on dentin surfaces *in vitro*.

MATERIALS AND METHODS

General Study Design: The effects of bleaching gels on exposed dentin surfaces were examined by evaluating bleaching effects on dentin surface hardness and ultrastructure as assessed by Scanning Electron Microscopy. Because dentin surfaces exposed to the intraoral environment can present as both smear covered or with exposed dentinal tubuli, experiments separately examined topical bleach effects on these surfaces.

The approach to testing included the selection of treatment groups which would bracket the clinical range of expected peroxide exposure with respect to most dentist applied and OTC gel systems. Treatments thus included bleach compositions providing from 3.3 - 6.7 % hydrogen peroxide with applications for periods ranging from 14-70 hours tooth exposure. Control treatments included placebo gels and a negative control.

Human premolars and canines were selected from batches of extracted teeth collected for our laboratory by local dentists and periodontal surgeons in the course of their clinical practices within the Cincinnati area. Teeth were stored in dilute thymol solutions under refrigeration. Rectangular sections of caries free root dentin approximately 3-4 mm in diameter were prepared under a water cooled saw and mounted in methacrylate polymer (Durabase). Root blocks were ground with pumice and serially polished to a mirror finish with aluminum oxide polishing series to 0.3mm finish. Open tubule specimens were prepared post polishing by immersion in 0.5 M EDTA for 1-3 minutes. Dentin specimens were pre-measured for tooth color (Fuji digital Camera) (to confirm whitening took place in the study) on L*a*b* scale with internal standards serving as controls. Specimens were pre-evaluated for surface microhardness using a Buehler hardness tester (Vickers 500 gr.)

The bleaching protocol was designed to simulate treatment of teeth under cycling conditions of bleach and saliva exposure which are encountered under in situ conditions. This cycling was viewed as preferable, considering the likely temporal local dehydration effects of bleaching gels on hard tissues. However, 14 hour bleaching times (overnight) were used (rather than ° hour twice per day) to keep the study logistics more manageable. Dentin specimens were aggregated into groups of 7 specimens per treatment group. No special efforts at pre-treatment randomization were carried out. Cycling treatments were carried out with specimens in individual cells of a 12 well polystyrene cell culture plate. Cell culture plates were pre-tested for bleach compatibility.

The cycling regimen was initiated by immersing specimens into 2 ml of wax stimulated whole human saliva (WHS). To establish an initial salivary conditioning film, specimens were individually exposed to WHS for 2 hours at 37°C - 2 ml per specimen. Following this, specimens were placed in 0.5 grams of test gel (bulk gel) face down in a clean cell culture cluster for 14 hours overnight at 37°C. Following treatment exposures, specimens were washed with tap water and a wet tooth brush and reimmersed into WHS at 37°C throughout the day, after which a further, as appropriate, bleaching was carried out. This bleaching/saliva cycling was carried out for the entire duration of treatments. Following the specified time period of bleaching, specimens were post soaked for 48-72 hours in WHS (changed 2x per day) to re-establish specimen hydration equilibria - particularly vital for dentin specimens.

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Post Treatment Measures: Color and surface microhardness of enamel specimens were measured as described above. Following surface measures specimens were separated into different post treatment analysis groups as follows.

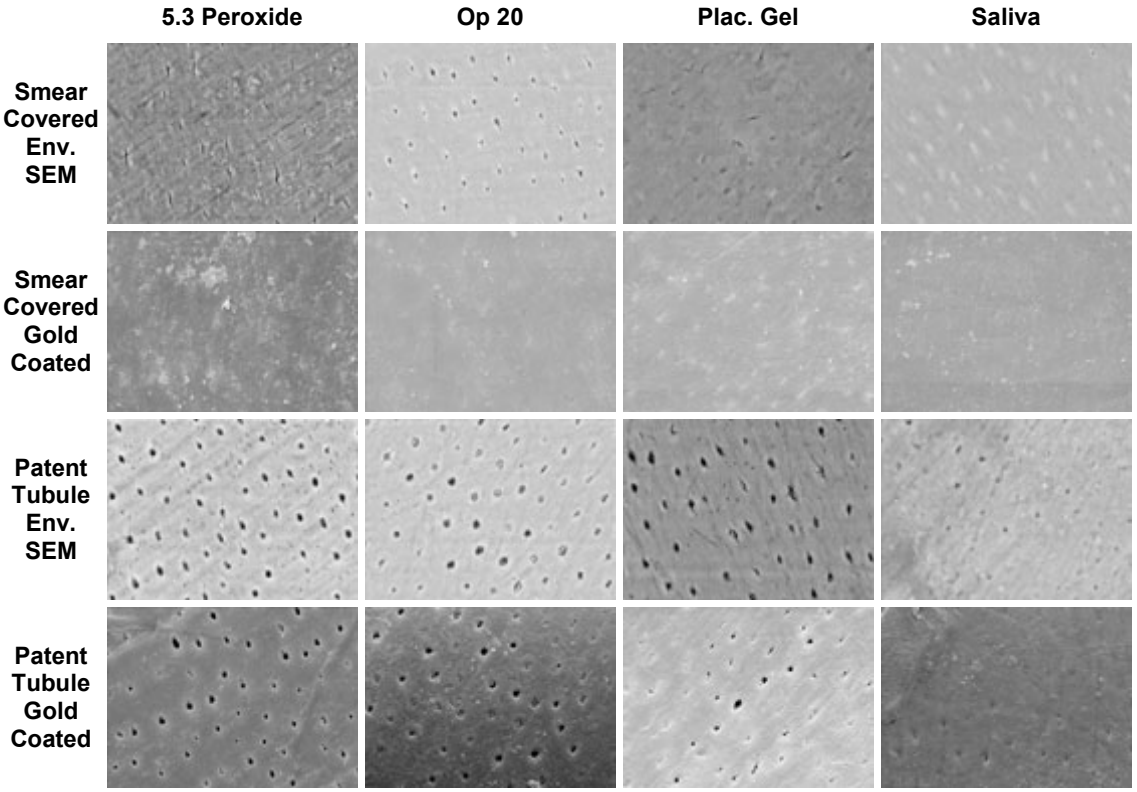
Specimens to undergo SEM evaluations were fixed with osmium tetraoxide and then serially dehydrated in an acetone/Peldri II and finally critical point dried in pure Peldri II. Specimens were examined for surface morphology changes by Scanning Electron Microscopy according to American Dental Association guidelines at 2,500X magnification. SEM's were collected on a Joel SEM/EDAX under both high vacuum (gold sputtered coating) and variable pressure (non-coated) mode.

Bleaching Treatments: Treatment groups included three control groups and four active bleaching groups respectively as follows:

- 5.3 % H_2O_2 Gel 14 hours treating {5.3PER}
- Placebo gel to 5.3 % H_2O_2 - 14 hours treating {5.3PL}
- 6.5 % H_2O_2 Gel - 70 hours treating {6.5PER}
- Placebo gel to 6.5 % H_2O_2 - 70 hours treating {6.5PL}
- 10 % Carbamide Peroxide (20 % water added) Opalescence Gel - 70 hours treating {OP10}
- 20 % Carbamide Peroxide (20 % water added) Opalescence Gel - 70 hours treating {OP20}
- Whole Human Saliva Only Control {WHSCTR}
- Non-treated control {NT} (for SME only)

RESULTS

Scanning Electron Microscopy - Bleach and Control Groups X 2,500



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RESULTS (cont.)

Effects of Treatments on Smear Layer Covered Dentin

Treatment	VHN Initial	Students t $p < 0.05$	VHN Final
5.3PL	51 ± 3	ns	53 ± 4
6.5PL	56 ± 4	ns	52 ± 4
WHSCTR	55 ± 6	ns	56 ± 7
5.3PER	54 ± 5	ns	55 ± 6
OP10	50 ± 7	ns	53 ± 6
6.5PER	55 ± 9	ns	56 ± 9
OP20	55 ± 5	ns	52 ± 6

Effects of Treatments on Etched Dentin

Treatment	VHN Initial	Students t $p < 0.05$	VHN Final
5.3PL	49 ± 6	ns	49 ± 5
6.5PL	52 ± 5	ns	49 ± 4
WHSCTR	50 ± 4	ns	54 ± 4
5.3PER	54 ± 7	ns	53 ± 7
OP10	50 ± 6	ns	51 ± 5
6.5PER	51 ± 6	ns	54 ± 6
OP20	49 ± 4	sig.	42 ± 4

CONCLUSION

-Bleaching treatments did not affect microhardness of smear covered or etched (patent tubule) dentin

-Bleaching did not open smear covered tubules - this suggests that bleach effects on transient hypersensitivity are not derived from surface effects on dentin tubuli

-Bleached specimens maintained patent tubuli better than saliva and placebo controls - possibly due to oxidation of organic intratubular deposits or surface cleaning

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