Rate of Color Changes with External Tooth Bleaching *in Vitro*

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ABSTRACT

An understanding of the type, location and kinetics of oxidation which occurs with vital tooth bleaching may prove valuable in development of future safe and effective formulations. Objectives: In this study, extracted human teeth were bleached *in vitro* in a kinetic study involving topical hydrogen peroxide treatments. CIELAB color changes were thus determined, and a kinetic profile for topical bleaching with strip forms was developed. **Methods:** Extracted human premolars were measured initially for tooth color (Fuji X1000 – calibrated CIELAB measures) and teeth were subsequently subjected to bleaching with whitening strips (Crest Whitestrips Supreme containing 14% hydrogen peroxide) in a cycling protocol. Cycling including topical bleach exposure alternating with storage in pooled human and/or artificial saliva. Plots of color change with time of bleaching and % color change were determined for six groups of ten teeth. **Results:** Bleaching kinetics followed a 3 parameter exponential response $MB = MB_o + a(1-e^{-bx})$ where x is treatment time in hours and MB is the % of maximum bleaching ($r^2 = 0.959$). **Conclusion:** Kinetic response of tooth bleaching (for strip forms) follows an exponential model for whitening strips. With respect to period of bleaching, 50% tooth bleaching occurs in less than 10% topical exposure time needed to maximum tooth response. Clinically effective consumer noticeable tooth bleaching produces color response in teeth far below maximum changes possible in the tissues, further supporting the reported safety of these procedures.

INTRODUCTION

Tooth whitening is popular with the general public with numerous oral hygiene techniques directed toward stain removal and modulation of intrinsic tooth color. Oxidative directed tooth whitening with peroxide is arguably the most effective route to tooth whitening. Peroxide tooth whiteners are today provided by various regimens: office administered systems, office prescribed and fabricated systems, office prescribed strips generic trays and over the counter paints, strips and trays. Despite considerable research there remains considerable interest in enhancing bleach efficiencies. Of particular focus is the development of understanding of where and how much oxidation constitutes clinically effective bleaching. In our laboratories we have developed advanced techniques for assessing internal changes occurring in teeth bleached in vitro including color, chemical and spectrophotometric and spectral variations.

PURPOSE

In our previous studies of bleaching mechanisms, results were partially limited due to the extensive amount of bleaching used; far beyond clinical bleach activities. The purpose of this study was to examine the color change in smaller increments of bleach time relative to the amount of color change from a bleach maximum at which no further color change was observed. In this study, extracted human teeth with were bleached in vitro in a kinetic study involving topical hydrogen peroxide treatments. CIELAB color changes were thus determined and a kinetic profile for topical bleaching with strip forms was developed.

MATERIALS AND METHODS

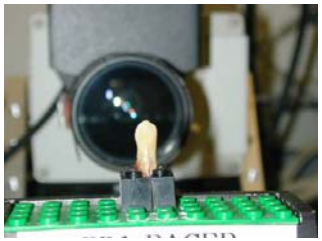
60 Premolars were mounted in acrylic blocks and hydrated for 3 days in saliva with twice daily fluoride dentifrice treatments. External color readings were taken under standard reading conditions and specimens divided into groups of 10, balanced by baseline b* color.

One group of 10 teeth were treated at 37C with Crest Whitestrips Supreme for 30 min, 4 times per day with saliva soaks in between. Strips were placed on anterior side of tooth only. Daily bleaching was continued until b* color change from baseline was not increasing. This avg. delta b* at 66 hrs of -8.35 was set as 100% maximum bleaching.

The remaining groups of teeth were bleached as above but in smaller time increments until the average delta b* was equal to approximately 10%, 15%, 25% and 50% of delta b* maximum.

Color readings were taken daily or as needed to ensure bleaching effect (delta b*) was kept within desired range. Final b* readings were taken to calculate kinetic response.

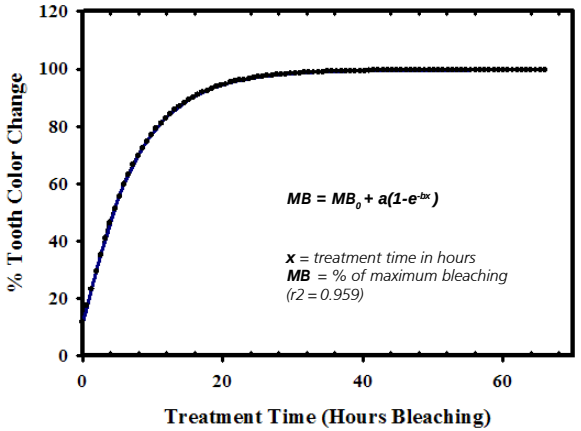
Premolar mounted on plastic block to allow precise positioning for repeat imaging



Tooth specimen placed on plastic platform for precision in repositioning for camera.

RESULTS

	Control		Group 1		Group 2		Group 3		Group 4		Group 5	
AVG	b*	delta b*	b*	delta b*	b*	delta b*	b*	delta b*	b*	delta b*	b*	delta b*
	15.5482	n/a	14.9793	-0.7589	14.66508	-1.12489	14.32399	-2.2452	12.04166	-4.03688	7.91168	-8.34971
Total Bleach Time	no treat		15 min		22 min		40 min		4.5 hrs		66 hrs	
% b* change	0.00%		9.09%		13.47%		26.89%		48.35%		100.0%	



CONCLUSION

Kinetic response of tooth bleaching (for strip forms) follows an exponential model for whitening strips. With respect to period of bleaching, 50% tooth bleaching occurs in less than 10% topical exposure time needed to maximum tooth response. Clinically effective consumer noticeable tooth bleaching produces color response in teeth far below maximum changes possible in the tissues, further supporting the reported safety of these procedures.