Comparison of Efficacy of an In-Office Whitening System Used with and without a Whitening Priming Agent

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ABSTRACT

Purpose: The purpose of this study was to compare the whitening efficacy of an in-office whitening system with and without the whitening primer application and evaluate tooth and soft tissue sensitivity.

Materials and Methods: This was a randomized, split-mouth design, single-blinded, clinical study. Twenty-five patients received a whitening priming agent (Power Swabs, Power Swabs Corporation, Beaverton, OR, USA) on right or left maxillary incisors prior to in-office tooth whitening with Opalescence Boost (38% hydrogen peroxide; Ultradent Products, Inc., South Jordan, UT, USA). Color was evaluated with the Bleachedguide 3D Master (Vita Zahnfabrik, Bad Sackingen, Germany) and Vita Easyshade spectrophotometer (Vident, Brea, CA, USA), after 30 minutes, 1 day, and 15 days postwhitening. After each tooth color measurement, the subjects were asked to rate their tooth and soft tissue sensitivity experience using a visual analog scale (1–10 categories). Results were analyzed by two-way repeated measurements analysis of variance/Tukey's ($p < 0.05$); Mann–Whitney rank sum test and Kruskal–Wallis.

Results: The teeth that were treated with the primer prior to tooth whitening did not show significant difference in ΔL^*, Δa^*, Δb^*, ΔE^* and delta shade guide from the teeth that were not treated with the primer, at the three time points evaluated (baseline versus 30 minutes after in-office treatment, baseline versus 1 day, and baseline versus 15 days). None of the subjects experienced soft tissue sensitivity, and those who experienced tooth sensitivity said it was not noticeable after 15 days postwhitening.

CLINICAL SIGNIFICANCE

The primer neither enhanced the whitening effect nor decreased tooth sensitivity when used before vital bleaching with Opalescence Boost (Ultradent Products, Inc., South Jordan, UT, USA). None of the subjects experienced soft tissue sensitivity, and some experienced transient tooth sensitivity.

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INTRODUCTION

Cosmetic dentistry has become a significant part of restorative dental practice. The appearance and color of teeth are very important to many patients seeking dental treatment. Vital tooth whitening can be performed with a high rate of success as a more conservative measure than restorative treatment, such as porcelain veneers, crowns, or resin composite.[1] Tooth whitening options have expanded, and patients have the choice of undergoing vital tooth whitening procedures either in the dental office or at home.[2]

The in-office systems typically use a high concentration of hydrogen peroxide (15–38% [HP]). The HP needs to be in contact with the outer enamel surface for a period of time in order to develop its whitening potential. The tooth whitening mechanism is not fully understood. It is believed that the HP breaks down into oxygen and water, which then penetrate the tooth and liberate the pigment molecules.[3] The dentist is in complete control of the process throughout the treatment, providing the option of termination at any time. Usually the color change results can be observed after a single visit. As light-activation devices, such as plasma arc, light-emitting diodes, and xenon-halogen lamps, have been introduced for curing dental composites, manufacturers have also introduced "bleaching" lights for the stated purpose of accelerating the whitening process. The benefit of using a light for in-office tooth whitening is controversial—one study reported positive results[4] whereas others reported the opposite.[5,6]

Despite the advantage of the in-office method to achieve tooth whitening quickly, tooth sensitivity is usually reported. Some studies have reported that tooth sensitivity may occur during the whitening procedure and usually stops when treatment is suspended.[7,8] In order to overcome this shortcoming, some manufacturers have incorporated amorphous calcium phosphate, fluoride, or potassium nitrate in the whitening gel formulas. More recently, a whitening priming agent was introduced on the market. The manufacturer claims that the primer is an oral surfactant and helps to remove teeth stains by a "cleaning" action and thereby it may help to whiten teeth via an alternative mechanism. Moreover, the primer contains ingredients that are claimed to help rehydrate enamel to reduce sensitivity caused by enamel dehydration. To the best of the authors' knowledge, no previous studies have evaluated the efficacy of this primer on enhancing tooth whitening and decreasing tooth sensitivity.

The purposes of this study were to: (1) visually and spectrophotometrically compare the whitening efficacy of an in-office whitening system when used with and without the whitening primer application, and (2) evaluate tooth and soft tissue sensitivities.

The null hypothesis tested was that there would be no difference in whitening effect on the anterior maxillary teeth and tooth and soft tissue sensitivities when the primer was applied prior to the tooth whitening gel.

MATERIALS AND METHODS

This was a randomized, single-blinded, clinical study. One clinician performed the whitening, and a different clinician evaluated the tooth color change. The half-mouth study design was used in previous studies.[2,8–10] Twenty-five patients were selected for this study according to the inclusion and exclusion criteria (Table 1). During the screening appointment, the subjects signed the Institutional Review Board authorization and consent form. Loe and Silness gingival index of the upper anterior teeth was utilized to ensure that subjects did not have moderate-to-severe periodontal tissue inflammation. One impression of the maxillary arch was made and a stone model was produced to fabricate two whitening trays, one for the tooth whitening and the other

TABLE 1. INCLUSION AND EXCLUSION CRITERIA FOR ACCEPTANCE AS SUBJECTS.

Inclusion criteria	Exclusion criteria
– Be at least 18 years old – Willing to sign a consent form – Willing to return for postwhitening evaluation – Presence of all six maxillary teeth equal or darker than 1M2 Vita Bleached guide in the value order – Have no maxillary anterior teeth with more than 1/6 of the facial surface covered with a restoration.	– History of any medical disease that may interfere with the study or require special consideration – Presence of gross pathology – Use of tobacco products during previous 30 days – Current or previous use of whitening agent – Loe and Silness gingival score greater than 1.0 – Pregnant or lactating women – Tetracycline-stained teeth

one modified to make a positioning jig to ensure placement of the tip of the spectrophotometer in the same position at every color measurement. An impression of the tip of the probe of the spectrophotometer was made and a cast was fabricated. The spectrophotometer probe cast was used as a stamp guide to mark the whitening jig. The facial middle third of the maxillary teeth was marked with the spectrophotometer tip cast using an ink pad. The facial marks were cut leaving an opening for placement of the spectrophotometer probe.

Prior to color measurement, the custom jig was positioned in the patient's mouth, and the spectrophotometer probe was positioned into the jig opening. At the same appointment, the subjects received a dental prophylaxis to remove any extrinsic stains. The subjects also received a nonwhitening toothpaste (Crest cavity protection, Procter & Gamble, Cincinnati, OH, USA) and soft bristled manual toothbrush (Oral B, Iowa City, IA, USA) and were asked to brush at least twice a day in order to maintain a standardized home care regimen.

At the baseline appointment, tooth color was evaluated visually using the Bleachedguide 3D Master (BSG—Vita Zahnfabrik, Bad Sackingen, Germany) by one independent experienced evaluator; and instrumentally using an intraoral spectrophotometer (Vita Easyshade, Vident, Brea, CA, USA). The BSG presents 15 shade tabs, 0M1 being the lightest and 5M3 the darkest, and it is arranged in the value order. The evaluator was calibrated by using two BSG and matching pairs. The shade tab designation was covered with a white tape so the evaluator could not see the shade tabs marks. The spectrophotometer measures the color of the teeth based on the Commission Internationale de l'Eclairage color notation system,[11] in which L^* denotes lightness (achromatic), whereas a^* and b^* denote green-red and blue-yellow coordinates, respectively. ΔE^* is the total color difference or the distance between two colors and was calculated using the formula: $\Delta E^*_{ab} = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$.[11]

The lip and cheek retractor was placed in the patient's mouth, the cheek and lips were covered with gauze, and a light-cure resin, OpalDam (Ultradent Products, Inc., South Jordan, UT, USA), was applied on the soft tissue of the maxillary anterior teeth to isolate and protect them. Then, the priming agent (Power Swabs, Power Swabs Corporation, Beaverton, OR, USA; lot # PSP1014) was randomly, by flip of coin, applied to the right (teeth #6–8) or left (teeth #9–11) maxillary anterior teeth on the same subject prior to the application of the whitening gel. The primer was scrubbed on the facial surface of either right (teeth #6–8) or left (teeth #9–11) teeth for 30 seconds each, in

accordance with manufacturer's instructions. The contralateral teeth did not receive a pre-treatment. Both right and left maxillary anterior teeth were treated with Opalescence Boost (Ultradent Products, Inc.; lot # B43NM). According to the manufacturer, similar to the previous Opalescence Xtra boost (Ultradent Products, Inc.), the whitening gel is chemically activated, and no light activation is necessary. The update to the product is the inclusion of potassium nitrate and fluoride as well as a new activation system. The 38% HP gel was applied according to the manufacturer's instructions, by allowing the gel to remain on the teeth for a total of 15 minutes. The gel was then rinsed off using an air-water syringe directed from the gingiva to the incisal of the tooth to ensure that it did not contact the gingival tissues during rinsing. Then the teeth were dried. The primer application and tooth whitening application were repeated three more times, providing a total of 60 minutes of tooth whitening.

The color measurements were taken instrumentally and visually at 30 minutes and at 1 day, and then at 15 days after the whitening procedure to evaluate any color relapse. Shade matching with the BSG was performed under a color-corrected light (Rite.light, Addent, Danbury, CT, USA), having a correlated color temperature of 5,500°K that simulates light from the northern sky, according to the manufacturer. After each tooth color measurement at each office visit, the subjects were asked to rate their tooth and soft tissue sensitivity experience using a visual analog scale in 1 of 10 categories, with 10 being the worst. If they experienced tooth sensitivity, they were asked which side and to point out which tooth or teeth they were, and the information was recorded. If the subjects experienced severe tooth sensitivity (analog scale above 6), they received desensitizing gel (Ultra EZ, Ultradent Products, Inc.). At the last appointment, if the subject desired, he/she was given an upper whitening tray and whitening gel, Opalescence 10% carbamide peroxide (Ultradent Products, Inc.), to continue whitening the upper teeth. An impression of the lower teeth was taken in order to make a lower tray to whiten the lower teeth at home until the desired color was reached.

The results were analyzed with computer software (Sigmastat 3.1, Systat software, Chicago, IL, USA). The mean value and standard deviation of the maxillary incisors, right side and left side, were calculated for each patient, at each time point. A *t*-test ($p < 0.05$) was used to compare the color of right-side and left-side teeth at baseline. The ΔL^*, Δa^*, Δb^*, and ΔE^* results were analyzed by two-way repeated measurements analysis of variance (ANOVA)/Tukey's test ($p < 0.05$); the shade guide rank results were analyzed by Mann–Whitney rank sum test to compare both treatments ($p < 0.05$) and by Kruskal–Wallis one-way ANOVA on ranks/Tukey's test to compare the three times within treatments ($p < 0.05$). Both parametric and nonparametric tests evaluated two factors: treatment (tooth whitening with or without primer application) and time (30 minutes, 1 day, and 15 days after whitening).

The tooth and gingival sensitivity scores were compared using Kruskal–Wallis one-way ANOVA on ranks/Tukey's test ($p < 0.05$) at the different time points.

RESULTS

Twenty-five subjects enrolled and 24 completed the study. One participant did not present for the last tooth color evaluation. Thirteen subjects were males and 11 were females, with an age range from 23 to 52 years.

Tooth Color Change

The baseline data are given in Table 2. The data for ΔL^*, Δa^*, Δb^* are given in Table 3, and ΔE^* and Δshade guide is given in Table 4 and graphically presented in Figures 1 and 2, respectively.

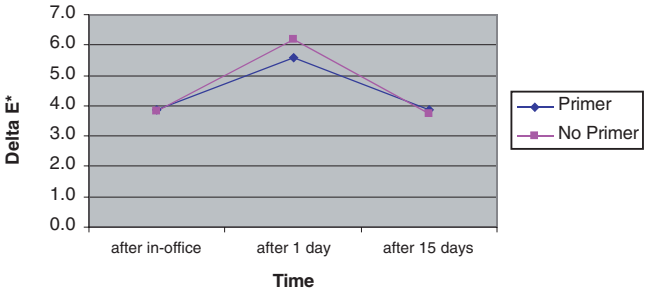

Figure 1. Mean change in ΔE.*

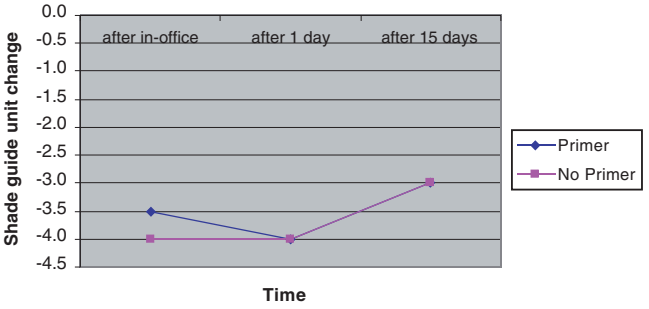

Figure 2. Mean change in shade guide.

TABLE 2. MEAN BASELINE COLOR AND STANDARD DEVIATION (SD).

Treatment	*L**	*a**	*b**	BSG
Primer	78.1	–0.1	24.0	8 (2.5M2)
SD Primer	5.15	1.6	6.15	2.2
No Primer	78.0	0.0	23.6	8 (2.5M2)
SD No Primer	5.16	2.15	6.04	2.1

According to the *t*-test, at baseline, the right and left teeth did not show significantly different *L**, *a**, *b**, and shade guide values (Table 2).

The teeth that were treated with the primer prior to tooth whitening did not show a significant difference in Δ*L**, Δ*a**, Δ*b**, Δ*E**, and delta shade guide from the teeth that were not treated with the primer at any of the three time points evaluated (baseline versus 30 minutes after in-office treatment, baseline versus 1 day, and baseline versus 15 days).

There was a significant increase in Δ*L** values between baseline and 30 minutes and 30 minutes and 1 day. There was no significant change in lightness after 1 day postwhitening.

There was an overall increase in tooth color change (Δ*E**), tooth whitening (delta shade guide), and decrease in red (Δ*a**) from baseline to 30 minutes after whitening. There was no significant difference for Δ*a**, Δ*E**, and delta shade guide values at 1 day and 15 days after tooth whitening. Overall, there was an even greater change for Δ*a**, Δ*E** after 1 day, showing a relapse from the 1 day color measurement to 15 days. The postwhitening result at 15 days was similar to that at 30 minutes.

There was significant difference for Δ*b** values at each evaluation time. When compared with baseline, after 30 minutes the tooth color did not show significant change. After 1 day, there was a significant decrease in Δ*b** (yellow) and a relapse after 15 days. Despite the large Δ*b** relapse from 1 day to 15 days, the Δ*b** value was still significantly different from the color measurement at 30 minutes (i.e., it was less yellow when compared with baseline).

Sensitivity

None of the subjects experienced soft tissue sensitivity at any evaluation time. At baseline, none of the subjects reported tooth sensitivity. After thirty minutes after tooth whitening, eight subjects experienced tooth sensitivity in the group that received primer, and twelve subjects in the group that did not receive primer. Within 1 day after tooth whitening, four subjects

TABLE 3. MEAN COLOR CHANGE AND STANDARD DEVIATION (SD).

Treatment	Delta *L**			Delta *a**			Delta *b**		
	after in-office	after 1 day	after 15 days	after in-office	after 1 day	after 15 days	after in-office	after 1 day	after 15 days
Primer	1.48^{A}	2.7^{B}	2.77^{B}	-0.4^{A}	-1.21^{B}	-0.66^{A}	-0.22^{A}	-4.33^{B}	-1.08^{C}
SD Primer	3.16	2.03	2.44	1.46	1.03	0.81	2.5	2.12	2.11
No Primer	1.35^{A}	2.6^{B}	2.45^{B}	-0.45^{A}	-1.26^{B}	-0.67^{A}	-0.21^{A}	-4.4^{B}	-0.72^{C}
SD No Primer	3.32	2.25	2.37	1.75	1.01	0.77	2.6	2.76	2.3

The uppercase superscripts refer to the rows (treatment within time). Values with the same superscript are not significantly different.

TABLE 4. MEAN COLOR CHANGE AND STANDARD DEVIATION (SD).

Treatment	Delta *E**			Delta BSG		
	after in-office	after 1 day	after 15 days	after in-office	after 1 day	after 15 days
Primer	3.9^{A}	5.58^{B}	3.9^{A}	-3.78^{A}	-4.5^{B}	-3.4^{A}
SD Primer	2.37	2.55	1.72	1.5	1.7	1.4
No Primer	3.83^{A}	6.16^{B}	3.71^{A}	-3.5^{A}	-4.4^{B}	-3.32^{A}
SD No Primer	2.82	2.74	2.16	1.5	1.6	1.7

The uppercase superscripts refer to the rows (treatment within time). Values with the same superscript are not significantly different.

experienced tooth sensitivity in the group that received primer, whereas seven experienced the same in the group that did not receive primer. No sensitivity was reported after 15 days postwhitening. Though there was a trend for less tooth sensitivity with the primer at the early time periods, there was no significant difference between the teeth that received primer and the ones that did not at any time point.

DISCUSSION

There was no significant difference in tooth color and soft tissue and tooth sensitivities when the teeth were treated with or without the primer, so the null hypothesis could not be rejected.

The tooth whitening was apparent after the in-office treatment and remained elevated at the end of the study. Fifteen days postwhitening, the teeth that were treated with or without the primer had become lighter, less red, less yellow, and showed significant overall tooth whitening when compared with baseline. Previous studies evaluated the same in-office whitening system, Opal Xtra Boost (Ultradent Products, Inc.) and found it to be similarly efficacious for whitening teeth.[7–9]

It is believed that it takes 30 minutes for the teeth to rehydrate after rubber dam isolation,[12] and this provided the rationale in this study for waiting 30 minutes after whitening for the first evaluation, as the subjects' mouths were open for over an hour and partially isolated, therefore promoting tooth dehydration. Because other in-office whitening studies have evaluated tooth color change immediately after in-office treatment,[9,13] 15 minutes after,[10] 24 hours after,[8] and 1 week after,[7] we also decided to evaluate tooth color 1 day after the whitening procedure to completely avoid any dehydration effects. Interestingly, in this current study, the teeth appeared whiter up to 1 day after the procedure was performed. Thus, either the whitening was still progressing or the teeth had not completely rehydrated after 30 minutes. Furthermore, the overall

color change was not different 30 minutes after the in-office procedure and 15 days post-whitening. Future studies should evaluate the appropriate amount of time that a tooth takes to rehydrate in order to not erroneously include the dehydration in the color change.

The subjects did not experience soft tissue sensitivity either during or after the whitening procedure. This is probably because the gingiva was well isolated and therefore well protected from the whitening gel. One study[9] reported that soft tissue irritation was generally mild and resolved while the participants were still undergoing whitening treatment, or within 1 to 3 days after discontinuation of use. Another study[7] reported that some participants experienced slight gingival irritation and it took only 2 days to return to the pretreatment level. Auschill and colleagues documented initial gingival irritation, and the symptom was mild, transient, and reversible.[8]

Similar to our study, previous studies have reported slight and transient thermal tooth sensitivity after in-office whitening treatment.[7–9] In the present study, subjects who experienced tooth sensitivity rated it as mild (1–4 on the analog scale) to moderate (5 on the analog scale). There was only one subject who experienced severe sensitivity (9 on the analog scale). This subject received a whitening tray with Ultra EZ (Ultradent Products, Inc.) and the sensitivity decreased to a moderate level (4–5 on the analog scale) within 20 minutes, and after 1 hour the sensitivity had decreased to mild (2 on the analog scale). This patient did not report any sensitivity 1 day after whitening. Thirty minutes after the whitening treatment was completed, seven of the eight subjects that experienced teeth sensitivity on the primer side experienced mild sensitivity and one experienced severe sensitivity; and out of the 12 subjects that experienced sensitivity in the nonprimer side, nine experienced mild sensitivity, two experienced moderate sensitivity, and one experienced severe sensitivity. The one subject who had severe tooth sensitivity experienced it on teeth in which the primer was applied as well as the teeth in which the primer was not applied. The seven subjects in the primer side that experienced mild tooth sensitivity were the same ones that experienced tooth sensitivity on the nonprimer side. None of the subjects experienced sensitivity after 15 days.

Recently, a new VITA Bleachedguide 3D Master (BSG, Vita Zahnfabrik) was launched on the market. This shade guide was designed primarily for visual evaluation of tooth whitening efficacy. The main difference between this shade guide and others is the inclusion of lighter shade tabs and a more subtle color gradation.[14] This current study is one of the few conducted with the BSG, as previous studies have used the Vita Classical shade guide or Trubyte Bioform to evaluate tooth color change. It is possible to compare the BSG findings with these other two shade guides from previous studies by multiplying the values obtained in this study by approximately 2.0.[14]

One of the limitations of this study was that the postwhitening evaluation was done after a short period of time, only 15 days. Another limitation was that only one whitening system was used; perhaps different whitening products in conjunction with the primer could have shown more beneficial results. Future studies should evaluate the tooth color change for months instead of weeks and use different whitening agents.

CONCLUSION

Within the limitations of this study, it was concluded that the whitening priming agent neither enhances the whitening effect nor decreases teeth sensitivity. None of the subjects experienced soft tissue sensitivity, and those who experienced tooth sensitivity noted that it was

transient and not noticeable after 15 days postwhitening.

DISCLOSURE

This study was supported by Ultradent Products, Inc. The shade guide was donated by Vita Zahnfabrik. The authors do not have any financial interest in the companies whose materials are included in this article.

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