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ORIGINAL RESEARCH

Spectrophotometric Comparison of Effectiveness of Two In-office Bleaching Agents with/without Light Activation: A Clinical Study

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ABSTRACT

Aim: The aim of the study is to evaluate the effectiveness of two different in-office bleaching agents, Zoom2 (Z) and Boost (B), regarding color stability 1-week, 2-week, 1-month and 2-month periods after treatment.

Materials and methods: A total of 60 patients each of whom had anterior teeth of shade A3 or darker were randomly selected from the pool of patients attending the Dental Hospital at the University of Dammam. For the Z group (n = 30), a light activation unit was used to activate the bleaching agent. While for group B (n = 30), the whitening gel was used without light activation. The shades measurements were taken using spectrophotometer before the treatment, after 1-week, 2-week, 1-month, and 2-month periods.

Results: Analysis of variance repeated-measures (ANOVA) test was applied to compare the mean effect of color change between the materials on various follow-up measurements. Wilcoxon signed rank test was applied to compare the mean effect of color change within the material on various follow-ups. A p-value ≤ 0.05 was considered statistically significant. At the termination of the study, the statistical analysis of the data indicated that both products efficiently lightened the color of the teeth but Z group is more efficient than B group in different follow-up intervals.

Conclusion: Both tested whitening systems demonstrated efficient tooth whitening. Z system is more efficient and stable than B system at 2 months' interval.

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Clinical significance: Zoom2 bleaching system is more efficient and stable than Boost bleaching system after 2 months' follow-up.

Keywords: Bleaching systems, Clinical study, Spectrophotometer.

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Conflict of interest: None

INTRODUCTION

It is amazing the great influence a conservative and simple esthetic dental procedure, such as tooth bleaching has on patient self-esteem.

Tooth discoloration can be classified as intrinsic, extrinsic, or a combination of both. Extrinsic discoloration is associated with chromogens from diet and environmental progressions, including tea, red wine, and smoking.[1,2] Intrinsic discoloration, however, is a result of structural or compositional changes of hard tissues, as tetracycline staining or fluorosis.[3] Also discolorations may be due to physiological changes, such as disease or aging where a reduction in pulp size with increased secondary dentin formation occurs.[4]

Most of the bleaching agents deliver their benefits either by increasing the efficiency of surface cleaning or by reducing the intrinsic and extrinsic stain by neutralizing the color with agents like hydrogen peroxide or carbamide peroxide.[5]

Generally, in-office bleaching is done with high concentrations of hydrogen peroxide (25–35%), with or without light activation source, a rubber dam, or specially

designed light curing isolating resin dams used to protect the gingiva.[6]

The theoretical advantage is the ability of the light source to heat the hydrogen peroxide, accelerating the rate of released free radicals with high kinetic energy to improve its effect on the stain molecules.[7-9] Despite the fact that many curing lights have been introduced to accelerate the bleaching process, the action of light in accelerating or enhancing bleaching is still under investigation.[10]

Indeed, only a few researchers have attempted to evaluate the bleaching efficiency *in vivo*. Most of these clinical studies investigated the efficacy of tooth bleaching using dental shade guides. However, it is a simple method to use, it is not very reliable, and is highly subjective.[11] Variables, such as evaluator's experience, eye fatigue, ambient light conditions, and the background against which a tooth is compared may lead to inconsistencies.[12,13] To overcome these problems, computerized assessment of tooth shade has been recommended. This study was conducted to collect clinical data following the American Dental Association's recommendation using recently introduced color measuring device to validate the claim that the chemical activated bleaching agent managed to reduce postoperative sensitivity with no difference in the final bleaching results or color longevity.

The aim of the study is to assess clinically the effectiveness of two different in-office bleaching agents Zoom2 (ultraviolet light-activation technique, Discus Dental, Culver City, California, USA) and Boost (non-light-activated chemical technique, Ultradent Products Inc., Salt Lake, Utah, USA) regarding tooth whitening and color stability 1 week, 2 weeks, and 1 month and 2 months after treatment using Crystal Eye spectrophotometer (Olympus America Inc., USA) to digitally analyze color changes.

MATERIALS AND METHODS

Sixty patients (20–40 years) each of whom had anterior teeth of shade A3 or darker were randomly selected from the pool of patients attending the Dental Hospital at the University of Dammam. All patients signed a consent form; the form and the study protocol were approved by the Ethics Committee of the University of Dammam under the number IRB-2017-02-088.

Inclusion and Exclusion Criteria

All participants had all anterior natural teeth present (centrals, laterals, and canines); caries-free, no extensive restorations, no hypersensitivity and periodontal disease; no previous tooth-whitening treatment; nonsmoking; and compliance with requirements to avoid use of staining food and beverages during treatment period. Participants received a professional prophylaxis 2 weeks before beginning the treatment and received verbal and written oral hygiene instructions to brush their teeth with nonwhitening toothpaste at least twice a day, as well as to floss at least once a day.

Study Design

Subjects were randomly assigned to one of the two treatment groups (n = 30); Z group and B group (Flow Chart 1). The allocation sequence of patients was concealed from the operator in sequentially numbered, opaque, sealed, and stapled envelopes. All participants were treated by one operator according to the manufacturer's instructions. During the treatment procedure, the gingival tissue should be isolated using the light-cured resin dam provided by the manufacturer with each bleaching kit.

Subjects were treated with three applications of their assigned product, following the manufacturer's instruction for the product. For Zoom2, the whitening gel was painted on teeth; an ultraviolet light activation unit (ZOOM Light,

Flow Chart 1: Clinical trial process

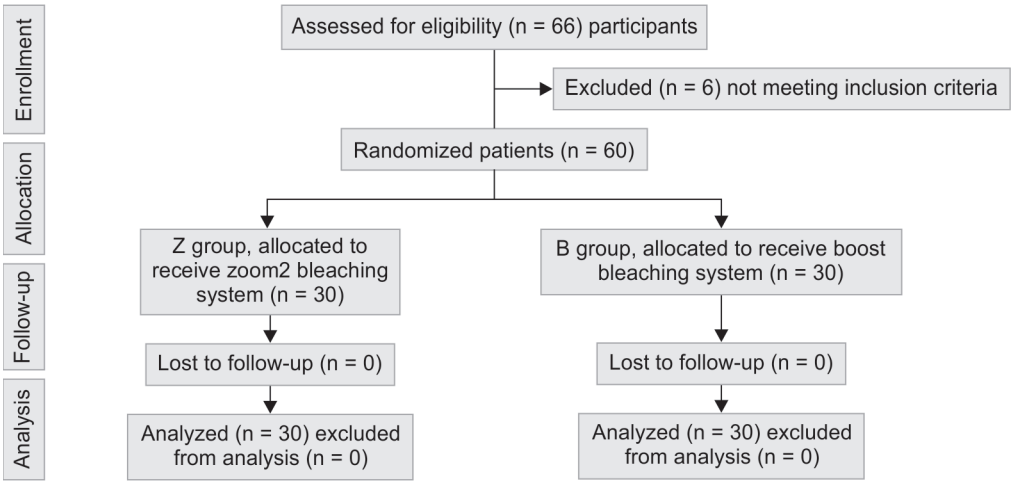


Table 1: Comparison of mean effect of color change between and within the two materials

	Material		*Between materials*
Follow-up	*Zoom (Z)*	*Boost (B)*	*Sig (Z vs B)*
Baseline (E0)	4.0312843 ± 2.29107776	4.7608890 ± 2.20197319	0.214
1 week (E7)	5.6325757 ± 2.33964282	5.7761297 ± 3.20698758	0.844
2 weeks (E14)	5.6906450 ± 4.20794290	4.7604417 ± 4.23180446	0.397
4 weeks (E30)	5.2544013 ± 3.03831738	4.8523833 ± 4.96882239	0.707
8 weeks (E60)	5.1474817 ± 2.95582627	4.8885967 ± 6.12231740	0.836
Within materials			
E0 *vs* E14 =	p < 0.001*	p = 0.237	
E0 *vs* E30 =	p = 0.035*	p = 0.465	
E0 *vs* E60 =	p = 0.049*	p = 0.926	
E7 *vs* E14 =	p = 0.060	p = 0.309	
E7 *vs* E30 =	p = 0.766	p = 0.106	
E7 *vs* E60 =	p = 0.829	p = 0.221	
E14 *vs* E30 =	p = 0.959	p = 0.185	
E14 *vs* E60 =	p = 0.770	p = 0.910	
E30 *vs* E60 =	p = 0.949	p = 0.615	

*Statistically significant difference of means at ≤0.05.

Discus Dental, Culver City, California, USA) was applied for the full cycle of 15 minutes for each treatment session.

The Boost (B) whitening gel was painted on teeth and left undisturbed for 20 minutes for each treatment session.

Shade Evaluation

The shades measurements were performed by an independent examiner using the Crystal Eye spectrophotometer at the beginning before treatment, after 1-week, 2-week, and 1-month and 2-month periods. The Crystal Eye spectrophotometer provides a uniform shade measurement environment by sealing the intraoral selected area from other light sources. Crystal Eye utilizes light-emitting diode as an illumination source with 45/0° geometry. The spectrophotometer was calibrated prior to each color measurement, pictured image was then transmitted via cable to a computer with a Crystal Eye application which aided with color analysis.

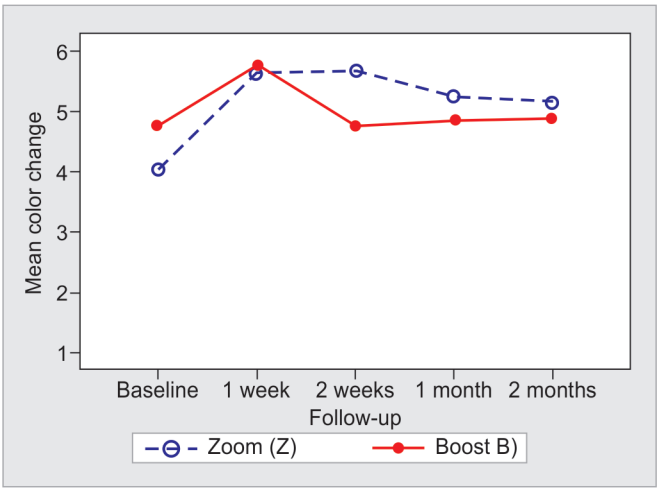
Color change was measured by measuring the color difference (ΔE) as follows:

$$\Delta E_X = [(L_0 - L_X) + (a_0 - a_X) + (b_0 - b_X)]^{\frac{1}{2}}$$

where L_0, a_0, and b_0 are the color dimensions at baseline and L_X, a_x, and b_x are the color dimensions at X-time interval (X = 1 week, 2 weeks, 1 month, and 2 months). L* represents the lightness where L = 0 = black, L = 100 = diffused white. a* negative value indicates green where positive value indicates magenta. b* negative value indicates blue where positive value indicates yellow.

Statistical Analysis

Statistical analysis was done by using software Statistical Package for the Social Sciences version 20.0 (IBM Product, USA).



Graph 1: Comparison of mean color change according to different follow-up intervals

RESULTS

The results of color change (ΔE) are presented in terms of mean ± standard deviation. The statistical analysis of the color change for the two evaluated bleaching systems is presented in Table 1 and Graph 1. Analysis of variance test (repeated-measures ANOVA) was applied to compare the mean effect of color change between the materials on various follow-up measurements. Wilcoxon signed rank test was applied to compare the mean effect of color change within the material on various follow-up findings as paired datasets with high standard deviation assuming non-Gaussian distribution. A p-value ≤ 0.05 was considered statistically significant.

Data showed no significant difference of color measurement means between the materials Z *vs* B on various follow-up measurement periods. There was statistically significant effect on color change in material Z at 2 weeks,

one 1 month, and 2 months after the treatment compared with baseline. Although there is detectable color change after Boost treatment, there is no significant effect of color change for material B on various follow-ups as compared with the baseline measurement.

DISCUSSION

Many studies used shade guides to measure teeth color. However, the shade guide has many limitations, such as evaluator variations and it only measures the overall color value of the subjects. It was reported that intraevaluator agreement can be as low as 60%.[14] To overcome this, the instrumental evaluation has been favored over the visual evaluation because it makes the process more practical and statistically more reliable. The instrumental evaluation consisted of a spectrophotometer, colorimeter, and image analysis techniques using software programs.[15] For objective measures of changes in the color, a spectrophotometer was used in this study.

The major change in color after bleaching was recorded in the first 2 weeks and then it became more stable. The same finding was reported and explained by another study; the color stability evaluation after 1 week recall period may not be enough to complete oxygen release which alters the optical properties of tooth structure.[16]

A scale for ΔE evaluation was used that considers a nonvisible difference when ΔE is less than or equal to 1 unit, and a visual perceptible difference to the experienced examiner when ΔE is between 1 and 2 units, and a clinical acceptable difference when ΔE is 3.3 units.[17,18] In this study, the change in ΔE was >1 and more in the 1st and 2nd week follow-up visit for both groups. Therefore, it is far more than the value mentioned and it can be accepted that the use of Zoom2 and Boost whitening gel should have visual perceptible difference to the experienced examiner.

On the contrary, the change in color ΔE > 1 at 2-, 4-, and 8-week follow-up visit was not a clinically perceptible difference for Boost bleaching system. The color reversal after bleaching in B group occurred more rapidly compared with Z group.

Some studies have shown that the benefit of using the light in bleaching is limited, while other studies have shown the effectiveness of using light.[19-21] In this study, Zoom2 bleaching system(light-activated bleaching technique) is more efficient than Boost (B) bleaching system(nonlight-activated bleaching technique). This finding may have been due to irradiation of the ferrous gluconate containing bleaching gel in the Zoom gel which enhances the photo-Fenton process. This reaction provides numerous numbers of free radicals via a remarkable regeneration reaction as shown:

$$Fe^{3+} + UV\ light + OH^{-} \leftrightarrow Fe^{2+} + OH$$

CONCLUSION

Within the limitations of the current study, the following conclusions can be drawn:

- Both tested whitening systems (Boost and Zoom2) demonstrated detectable color changes.
- Zoom2 bleaching system (light-activated bleaching technique) is more efficient and stable than Boost (B) whitening gel (nonlight-activated bleaching technique).

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