

## A Randomized Clinical Trial of In-Office Dental Bleaching with or without Light Activation

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### Abstract

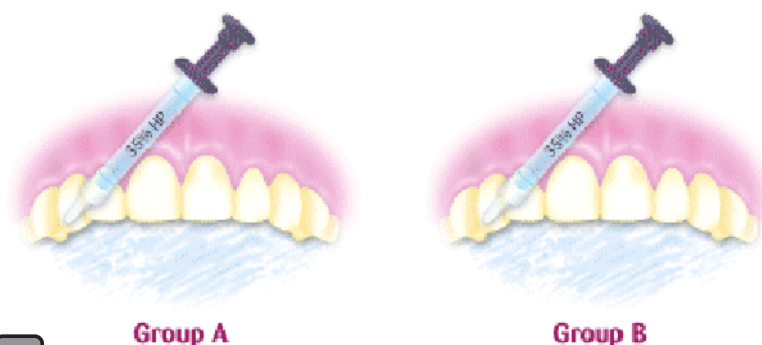
**Aim:** The study aimed to evaluate the effect of four in-office dental bleaching methods on shade change, color stability, patient satisfaction and postoperative sensitivity.

### Methods and Materials:

Forty patients were randomly divided into four groups (n=10) according to the method of in-office bleaching used: Group A—35% hydrogen peroxide (HP); Group B—35% HP plus BriteSmile and a blue curing light; Group C—35% HP plus QuickSmile and an LED curing light; Group D—35% HP and a Zoom2 metal halide curing light. For all groups, there was only one session of bleaching with three 20-minute applications of bleaching gel. The shade was evaluated before bleaching, immediately after, and one month after treatment using a VITA Classical Shade Guide.

**Results:** Immediately after bleaching there was a significant difference in color change between the four groups, with Group B having the best results. At one month there was no difference between the four groups. Immediate postoperative sensitivity was the least in Group A and the highest for Group B. Patients in Group B were the most satisfied with the outcome of the bleaching procedure.

**Conclusions:** In general, the use of different lights for activation of an in-office bleaching agent did not affect the long-term results. Tooth sensitivity was mild and transient in the study. Patients were satisfied with in-office bleaching.



**Clinical Significance:** Using light activation with in-office bleaching seems to increase the efficacy of treatment only for a short period of time.

**Keywords:** Randomized clinical trial, in-office bleaching, light activation, sensitivity, and satisfaction.

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### Introduction

Public demand for tooth whitening, also referred to as dental bleaching, has increased in recent years.<sup>1</sup> Compared to other restorative treatment modalities, bleaching is a conservative and easy-to-perform procedure.<sup>2</sup> In general, three fundamental vital tooth bleaching approaches exist:<sup>3</sup>



1. An at-home, but dentist-supervised application of a bleaching gel-filled night guard system.
2. An in-office or power bleaching application by a dental professional.
3. Over-the-counter bleaching products used by patients at home without the supervision of a dental professional.

In-office bleaching is an appropriate treatment modality especially in severe discoloration cases, in the presence of a lack of patient compliance, or if a rapid result is desired.<sup>4</sup> Compared to home bleaching, in-office bleaching offers the advantages of control by the clinician, prevention of ingestion of the peroxide material, and a reduction of the total treatment time.<sup>5</sup> In-office bleaching therapies can be performed by using either chemically or photo-activated bleaching regimens. Photo-activated treatment involves the application of a high concentration of hydrogen peroxide agent (30–38%) in the dental office by a dental professional, which is then activated using a plasma-arc, light-emitting diode (LED), metal halide, argon laser, or xenon halogen light source.<sup>1</sup> The theory behind using light is its ability to heat the hydrogen peroxide to accelerate the breakdown of the peroxide to lighten the teeth more rapidly.<sup>6</sup>

Using a light source can result in an increase in the intrapulpal temperature.<sup>7</sup> In addition, current studies have produced equivocal results with some touting the benefits,<sup>8–10</sup> while others conclude there is no benefit to using light or heat during bleaching.<sup>2,11,12</sup> Therefore, the aim of this study was to investigate the additional efficacy of light-activated tooth whitening systems versus their non-light-activated controls in terms of tooth color change, color stability, dental sensitivity, and patient satisfaction..

## Methods and Materials

### Inclusion and Exclusion Criteria

Forty patients between 18 and 40 years (mean 27.8 years) were selected for this study. Among them there were 12 (30%) males and 28 (70%) females. All maxillary anterior teeth of the participants had to be vital, free of caries and restorations, with a color shade of A3 or darker to be included in the study. Participants had good oral hygiene and were free from periodontal diseases and were nonsmokers. Participants were also free of any tooth sensitivity, tetracycline staining, and dental fluorosis and had not undergone any previous tooth-whitening procedures. Pregnant or lactating females and patients with any gross oral pathology or on any medications were excluded from the study.

### Study Design

Subjects were selected from regularly scheduled patients who had been appointed for in-office bleaching of their teeth. After the dental examination, they were informed about the procedure, including advantages and disadvantages of in-office bleaching compared to other bleaching methods. The subjects gave their informed consent before the onset of the study. All subjects received a professional dental prophylaxis prior to the start of the study and then were randomly assigned into one of four groups (n=10) as shown in Table 1.

The study was double blind with neither the patient nor the evaluator knowing group assignments of the participants. The bleaching treatment was carried out by one practitioner. As shown in Table 1, a 35% hydrogen peroxide (HP) bleaching material was used (Opalescence extra®, Ultradent Inc., South Jordan, UT, USA)

**Table 1. Group Divisions, Bleaching Materials, and Equipment Used for Activation.**

Group	Number	Bleaching Material	Equipment	Type of Light
A	10	35% HP	None	None
B	10	35% HP	BriteSmile®	Blue light
C	10	35% HP	QuickSmile®	LED light
D	10	35% HP	Zoom2	Metal halide light

**Table 2. Ranking of Shade Tabs.**

Rank	Shade	Rank	Shade
1	B1	9	A3
2	A1	10	D3
3	B2	11	B3
4	D2	12	A3.5
5	A2	13	B4
6	C1	14	C3
7	C2	15	A4
8	D4	16	C4

in all groups. In Group A, the bleaching material was used alone with no light activation. In Group B, the bleaching agent was activated with a BriteSmile® blue halogen light (BriteSmile 2000®, BriteSmile Inc., Walnut Creek, CA, USA). In Group C, the bleaching material was activated using a QuickSmile® Bleaching Lamp, which uses a light-emitting diode (LED) light (QuickSmile, Melbourne, Victoria, Australia). In Group D, the bleaching material was activated using a Zoom2® metal halide light (Discus Dental Europe BV, Ettlingen, Germany).

All procedures were the same for all four groups except for using different activation methods of the bleaching agent. Before the application of the bleaching agent on the teeth, the gingival tissues were isolated using a light-cured resin (OpalDam®, Ultradent Inc., South Jordan, UT, USA). A 1-mm-thick layer of the bleaching agent was applied to the labial surface of the six anterior teeth (canine to canine) and the manufacturer's instructions for handling were followed. For Group A, no light activation was performed. For Groups B, C, and D, different light sources were used for 20 minutes per cycle and the cycle was repeated

three times during the same visit for a total of 60 minutes of application time.

In all of the groups, extreme care was taken so that no bleaching material came in contact with the gingiva. During the study, subjects were instructed to use a soft toothbrush twice a day with their regular toothpaste and to use a dental floss once a day. Also, patients were instructed to avoid drinking beverages like coffee and tea that could stain the teeth.

### Shade Evaluation

Shade selection was recorded before, immediately after, and at one month after the bleaching treatment using VITA Classic Shade Guide® (Vita®, Zahnfabrik, Bad Sackingen, Germany). Shade tabs were arranged and ranked in value order as shown in Table 2.<sup>13-16</sup>

All of the shade recordings were taken independently in the same dental office with a blue background and under the same lighting conditions by two trained dental assistants who were blind to the group assignments. The measurement area for shade matching was

the middle one-third of the facial surface of the central incisors according to American Dental Association guidelines. A pilot study of five patients (not included in the study) was carried out to train the two evaluators until an agreement on shade was at least 85 percent ( $\kappa$  statistics).

### Tooth Sensitivity and Patient Satisfaction Evaluation

Tooth sensitivity was evaluated immediately after the bleaching procedure and after one month. Sensitivity was evaluated by blowing air from the air-water syringe of the dental unit over the labial surfaces of the upper anterior teeth for five seconds. The degree of sensitivity was recorded according to the following criteria:

- 0 – no sensitivity
- 1 – slight sensitivity
- 2 – moderate sensitivity
- 3 – severe sensitivity

Patient satisfaction also was evaluated after one month from completion of the treatment using the following scale:<sup>17</sup>

- 0 – no sensitivity
- 1 – satisfied
- 2 – highly satisfied

### Statistical Analysis

The statistical program SPSS™ version 15 (SPSS, Inc., Chicago, IL, USA) was used to analyze the results. The means and standard deviations of the shades at baseline, immediately after, and at one month were calculated. The means and standard deviations of the relapse in shade change also were calculated. One-way ANOVA and Duncan's multiple range tests were used to compare the groups at a significance level of  $\alpha < 0.05$ .

## Results

There were no statistically significant differences between the four groups in the mean baseline shade, age, or gender of the participants ( $p > 0.05$ ) (Table 3).

Immediately after treatment there was a statistically significant difference in the mean dental shade ( $p = 0.012$ ) between the groups. Group B (BriteSmile blue halogen light) showed the lowest mean of dental shade, i.e., the most white, and it was not statistically different than Group D (Zoom2 metal halide light) ( $p > 0.05$ ). There was no statistically significant difference between Groups A, C, and D ( $p > 0.05$ ). Figures 1 and 2 (before and after) are examples of patients from Group B.

The mean values of shades at one month after bleaching are also presented in Table 3. There were no statistically significant differences in dental shades between the groups ( $p > 0.05$ ).

As shown in Table 3, the mean values of relapse in dental shade at one month after bleaching is statistically different between the groups ( $p = 0.002$ ). Group A showed the least amount of relapse and there was no statistically significant difference between the other three groups.

About 70% of the patients in the study had tooth sensitivity immediately after treatment. There was a statistically significant difference between the four groups in the mean value of dental sensitivity immediately after treatment ( $p = 0.002$ ), with Group A reporting the least sensitivity (Table 4). There was a statistically significant difference in the mean value of patient satisfaction ( $p = 0.015$ ), with Group B being the most satisfied with the outcome of

**Table 3. Means and Standard Deviations of Dental Shades for the Various Bleaching Treatments at Baseline, Immediately after, at One Month, and the Relapse.**

Group	Baseline	After	At One Month	Relapse
A	11.4 ± 1.4 a	4.4 ± 1.8 a	5.2 ± 1.9 a	0.8 ± 0.8 a
B	11.6 ± 1.9 a	2.0 ± 1.9 b	4.5 ± 2.1 a	2.5 ± 0.8 b
C	11.1 ± 1.9 a	4.3 ± 2.0 a	6.4 ± 2.0 a	2.1 ± 0.9 b
D	11.2 ± 1.8 a	3.0 ± 1.3 ab	5.2 ± 1.8 a	2.2 ± 1.3 b
<b>Note:</b> Means for groups in homogeneous subsets are displayed.				



**Figure 1.** Group B patient. **A.** Prior to bleaching. **B.** One month after bleaching.



**Figure 2.** A second Group B patient. **A.** Prior to bleaching. **B.** One month after bleaching.

**Table 4. Means and Standard Deviations of Dental Sensitivity Immediately after Bleaching and Patient Satisfaction at One Month.**

Group	Sensitivity	Satisfaction
A	0.30 ± 0.5 a	1.50 ± 0.5 a
B	0.80 ± 0.4 b	2.00 ± 0.0 b
C	1.00 ± 0.0 b	1.20 ± 0.8 a
D	0.80 ± 0.4 b	1.40 ± 0.5 a
<b>Note:</b> Means for groups in homogeneous subsets are displayed.		

the bleaching procedure. There was no dental sensitivity in any of the groups at one month ( $p > 0.05$ ).

## Discussion

In this clinical study, an in-office vital tooth bleaching using 35% hydrogen peroxide was performed. This treatment has become very popular in the last few years because it is a simple procedure to perform and patients undergoing this procedure can see an immediate effect.<sup>18</sup> *In vivo* studies on this kind of treatment

reported no alteration in the dental structure as saliva prevents the demineralization of bleached dental enamel.<sup>19–23</sup>

To limit the confounding variables, only one bleaching agent was used in all of the groups tested. This facilitated a comparison of the effect the different light sources had on color change.

The two main side effects for this treatment modality are gingival irritation and tooth sensitivity.<sup>24</sup> Gingival irritation is usually due to the irritation from the high concentration of the bleaching agent if it comes in contact with the



gingival tissues. Gingival irritation did not occur in the present study because care was taken to apply a protective resin over the gingiva. Tooth sensitivity was reported to affect two-thirds of individuals sometime during the period of active bleaching.<sup>2,13,25</sup> This sensitivity typically is mild in severity, is transient in nature, and often resolves after active treatment.<sup>26</sup> In the present study, about 70% of the patients had tooth sensitivity immediately after bleaching. The sensitivity was mild and tolerable in all of the participants and disappeared within one month following treatment in all of the groups. Chemical bleaching alone caused less sensitivity than for the other three groups where light was used to enhance bleaching. This might be explained by the fact that light sources used for bleaching elevated the pulp temperature and therefore resulted in more tooth sensitivity.<sup>7</sup>

In this study, the evaluation of the bleaching treatment was done specifically on six maxillary anterior teeth (canine to canine). The number of applications and the duration of each application were standardized to facilitate a comparison between the test groups and to compare the results with similar studies.<sup>17,22,27</sup>

The VITA Classic Shade Guide<sup>®</sup> was used for the visual evaluation in this study because determination of the shade of a patient's teeth by comparing the color of their teeth with a commercially available dental shade guide is the most frequently applied method in clinical practice.<sup>28,29</sup> Besides being simple and a quick procedure, this method has been used successfully in similar studies.<sup>9,16,20,30</sup> Factors that can affect accuracy of this method include operator experience, gender, and color impairment of the observer,<sup>31-33</sup> in addition to the lighting used in the room in the dental office where the shade is taken.<sup>34</sup> In this study, the



shade selection process was performed by two experienced, qualified female dental assistants without any visual impairment using the same artificial light in the same room for all participants.

The theory behind using an activation light with in-office bleaching is that the light will speed the breakdown of the hydrogen peroxide and thus lighten the teeth more rapidly.<sup>12,16</sup> The assumed benefit is that the procedure is less time-consuming while producing faster results. Current studies have produced equivocal results with some touting the benefits,<sup>12,35</sup> while others concluded that there is no benefit to light activation.<sup>2,36,37</sup>

Evaluation of the shade changes immediately after the bleaching treatment showed the use of the halogen blue light (Group B) resulted in lighter teeth than for the other three groups. On the other hand, there were no statistically significant differences observed between the four groups at one month after treatment. There was a relapse in the shade lightening produced after bleaching in all of the groups, but it was less in Group A, in which no light was used. In agreement with other studies, the degree of the relapse corresponded with the degree of shade change initially, i.e., the more the initial shade lightening, the more the relapse occurred at one month.<sup>3</sup> On the contrary, another study found the shade change to be stable up to six months.<sup>2</sup> This might be due to the fact that they did two sessions of bleaching, each with three applications, while in the present study there was only one bleaching session used. Furthermore, their initial shade evaluation was one week after the treatment and the first evaluation in the present study was done immediately after the treatment. The post-treatment evaluation at one month was done to give more time for the relapse to take place and to avoid the inconvenience of having the participants return within such a short time period.

The results of patient satisfaction were comparable to other studies.<sup>2</sup> Group B, in which the BriteSmile<sup>®</sup> halogen blue light was used, was most satisfied with the treatment, which was expected since this group had the lightest shade after bleaching. This is interesting since there were no differences in shade change at one month; it strongly suggests participants were not aware of the relapse in shade that had taken place since the initial treatment. It also might

suggest that the initial result of treatment is very important on patients' perception of the treatment.

Although tooth sensitivity was least among Group A (chemical bleaching), this did not lead to greater patient satisfaction. This indicates that the degree of color change is the most important for the patients and they can tolerate, or accept, a level of mild sensitivity in order to achieve this goal.

This study was carried out under limited conditions, using specific materials within a short time. Therefore, the results are not transferable to different materials and conditions. Further studies are needed using a wider range of materials for a longer period of time in order to reach such a global conclusion on this topic.

## Conclusions

With the limits of this study, the following conclusions can be reached:

1. One session with three applications of 35% hydrogen peroxide was effective for the whitening of vital teeth.
2. The use of light-activation sources (other than BriteSmile® halogen blue light) did not affect the initial outcome of in-office vital tooth bleaching when used in conjunction with 35% hydrogen peroxide.
3. At one month, the use of light-activation sources failed to improve the results over using 35% hydrogen peroxide alone.
4. Patients' satisfaction with the treatment is directly related to the degree of whitening of the teeth.

## Clinical Significance

Using light activation with in-office bleaching seems to increase the efficacy of treatment only for short period of time.

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