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Color change of vital teeth exposed to bleaching performed with and without supplementary light

Joe C. Ontiveros *, *Rade D. Paravina*

Department of Restorative Dentistry and Biomaterials, The University of Texas Dental Branch at Houston, TX, USA

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ABSTRACT

Objectives: The aim of this clinical study was to evaluate tooth color change after exposure to 25% hydrogen peroxide in-office tooth whitening system, with and without supplementary light exposure.

Methods: Twenty subjects were treated with two separate 45-min exposures of bleach, with and without light using an opposing-arch design. Visual and instrumental color measurements were obtained from eighty teeth before bleaching and seven days after treatment using two different shade guides, Vitapan Classical (VC), Vita Bleachedguide 3D-Master (BG) and an intraoral spectrophotometer. Data were analyzed using ANOVA, paired *t*-test, and Wilcoxon signed rank tests at the 0.05 level of significance.

Results: Instrumental method revealed significant difference in color between treatment with light ($\Delta E^*_{ab} = 6.0$) and without light ($\Delta E^*_{ab} = 4.7$) after seven days ($p < 0.05$). No differences were visually detected between treatment with light and without light using the VC ($p = 0.56$). However, a significant difference was recorded using the BG ($p < 0.01$). Instrumental measurements of color change were in better accordance with visual findings using the BG guide ($R^2 = 0.60$) rather than the VC ($R^2 = 0.20$).

Conclusions: Within the limitations of this study, the treatment with supplementary light showed significantly greater bleaching-dependent changes in color compared to treatment without light when assessed using instrumental methods. The same was determined for the visual method with Vita Bleachedguide 3D-Master. No significant difference in color change with respect to light exposure was detected for the Vitapan Classical.

1. Introduction

In the context of presenting a technique for bleaching discolored teeth, the 19th century dental researcher, E.P. Wright stated, ''there is no higher glory for one who professes the healing art [of dentistry] than that of preserving the natural tissues''.[1] Aside from the obvious desire to improve the appearance of teeth, the conservative nature of in-office bleaching remains one of the primary reasons why in-office bleaching appeals to both patient and dentist alike. Hydrogen peroxide (H_2O_2) has been used to treat discolored teeth as early as 1884.[2] Throughout the 1960s and 1970s, techniques were introduced using direct or indirect heat in attempts to accelerate the oxidation process.[3–6] The direct application of heat soon fell out of favor, because of evidence suggesting that it may cause cervical resorption. Techniques using chemicals alone, such as sodium perborate and, or superoxyl followed, with some success on lightening of non-vital teeth. While these techniques are helpful for treatment of single, non-vital teeth, accelerated techniques for simultaneous lightening

* *Corresponding author at*: Department of Restorative Dentistry and Biomaterials, The University of Texas Dental Branch at Houston, 6516 M.D. Anderson Boulevard, #493, Houston, TX 77030, USA. Tel.: +1 713 500 4482; fax: +1 713 500 4108.
E-mail address: joe.c.ontiveros@uth.tmc.edu (J.C. Ontiveros).
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multiple vital teeth were still lacking. Improvement in bleaching products in the mid 1990s, such as light-and-chemical application, and delivery systems such as light-cured barrier materials, increased usage of in-office bleaching for multiple vital teeth.[7] Combined with the introduction of at-home bleaching trays, bleaching emerged as among the most sought after procedures in dentistry.[8]

The mechanism of bleaching by hydrogen peroxide is not fully known. The most accepted theory is that peroxide diffuses into and through enamel to reach dentin where it reacts with the organic chromophores responsible for the major color factors of teeth.[9] While it is generally accepted that the decomposition of hydrogen peroxide is influenced by *direct* heat and peroxide concentration, the influence of *indirect* heat and/or light on the decomposition rate of hydrogen peroxide and its mechanisms is not well established in the dental literature.

Many clinicians currently employ light/indirect radiation to hasten and enhance in-office vital bleaching. However, clinical studies investigating use of supplementary light on the effectiveness of vital bleaching have been equivocal. This lack of agreement may result from the variability associated with methods used to analyze bleaching efficacy, leaving the validity of using supplementary light application during vital tooth bleaching in question.

A common technique for measuring color change during the bleaching process utilizes a subjective, visual evaluation method based on variety types of shade guides. The Vitapan Classical (VC, Vita Zahnfabrik, Bad Säckingen, Germany) is one of the most commonly used shade guides for this purpose. This system was developed in 1956, and since that time, researchers have pointed out its inherent flaws: lack of uniformity and limited color space coverage of natural teeth.[10–16] A newer type of shade guide, Vita Bleachedguide 3D-Master (BG, Vita Zahnfabrik, Bad Säckingen, Germany) displays a greater emphasis on the extra light area of the tooth color space and is designed primarily for use with bleached teeth. When compared to the VC guide, the BG has a wider color range (almost doubled), more uniform color distribution, and a visually perceived light-to-dark value order that precisely matches the manufacturers' suggested tab arrangement. All these properties are designed to increase the reliability and validity of visual color comparisons in clinical practice, with an emphasis on monitoring tooth whitening.[17,18]

Color differences can also be measured using non-subjective, instrumental methods. The CIE[a] $L^*a^*b^*$ color difference (ΔE^*_{ab}) represents the sum of differences in L^* (lightness), a^* (green–red), and b^* (blue–yellow) coordinates, or the sum of differences in L^* (lightness), C^*_{ab} (chroma) and h° (hue). By calculating the before and after bleaching difference in absolute values of each color coordinate, the direction of the color change can be quantified. For example, a positive difference in lightness (ΔL^*) and negative corresponding difference in chroma (ΔC^*_{ab}) would mean that the teeth became lighter and less chromatic after bleaching.

[a] Commission Internationale de l'Eclairage, International Commission on Illumination.

The American Dental Association (ADA) Acceptance Program Guidelines recommends a visual method for establishing bleaching efficacy using a 16-step VC "value-ordered" shade guide for all three bleaching regimens (in-office, dentist-dispensed at-home bleaching, and over the counter—OTC).[19–21] For professional in-office tooth bleaching products, these guidelines call for documentation of color changes $\geq$5 color change units (ccu) to indicate efficacious bleaching treatment; where 1 ccu = 1 shade guide unit (sgu) = $1\Delta E^*_{ab}$.[19]

The purpose of this study was to visually and instrumentally evaluate the in vivo color changes of a 25% H_2O_2 in-office tooth bleaching system, with- and without the use of a supplementary chairside bleaching light. Because of the paucity of literature indicating effectiveness of enhancement of the bleaching process using light application, the research hypothesis was that chairside bleaching with light will exhibit equal bleaching efficacy compared to the same treatment without light, verified using either visual or instrumental methods.

2. Materials and methods

2.1. Patient inclusion and exclusion criteria

A total of 20 patients were enrolled for an in-office clinical tooth whitening study using an opposing-arch design, and a total of 80 teeth were analyzed (one canine and central incisor for both arches). For inclusion, each patient was required to have no caries on teeth to be bleached, similar pre-test color of maxillary and mandibular anterior teeth, eighteen years or more. The study exclusion criteria encompassed patients whose teeth had been previously bleached or where a shade lighter than A2, reported tooth sensitivity, teeth with notable intrinsic staining (tetracycline, fluorosis), existing dental restorations in teeth to be bleached, currently undergoing treatment for caries, gingivitis or periodontitis, current use of Chlorhexidine or Listerine mouth rinses, or who demonstrated any medical or dental condition (gingival inflammation) considered by investigators to place the patient at increased health risk or to impact patient's ability to participate in study. After discussing the trial, patients were required to sign an informed consent form adhering to the ethical principle stated by the World Medical Association's Declaration of Helsinki[22] in addition to agreeing to return for scheduled visits and follow up examinations. Enrolled patients were further instructed to avoid any non-study dentifrices or tooth whitening products for the duration of the study.

2.2. Study design

Study subjects were treated with two separate 45-min exposures of 25% hydrogen peroxide (H_2O_2) gel (Zoom2 kit, Discus Dental, Culver City, CA, USA). At the first appointment, the order of arch (maxillary or mandibular) and treatment type (light or no light) was randomized by flip of a coin for each patient's initial bleaching and the opposite treatment was chosen for the second appointment. Protective lip cream was applied and the six anterior teeth to be treated were isolated

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with a light-cured resin barrier for gingival protection (both cream and barrier were included in Zoom2 kit). Teeth to be bleached were pre-treated with an aqueous alkaline solution (Zoom2 starter swab) from the kit. The pre-treatment solution and the bleaching gel were applied and repeated for three individual 15-min cycles for a total exposure time of 45 min. Between treatment applications, the components were removed by suction. Filtered glasses were worn by each subject when the chairside whitening lamp (ZoomAP, Discus Dental) was applied. This light was a sodium-free, 25 W, short-arc halide lamp, emitting between 350 and 600 nm. Each patient was asked to report their extent of sensitivity experienced on a scale of 0–10 (none to worst) during bleaching and after bleaching (a mean score from the end of application until the next appointment). Gingival health for all patients was monitored, but was not analyzed for the purpose of this study. The evaluators were blind to the assigned intervention and the instrument measured color objectively regardless of the treatment.

2.3. *Visual color matching*

Visual color matching was performed before bleaching and seven days after bleaching. Visual color matching scores were given by three trained and calibrated evaluators using two different shade guides: Vitapan Classical (VC) and Vita Bleachedguide 3D-Master (BG) arranged by value order (Table 1). Color matching was performed under a color corrected light (Rite·lite, AdDent, Inc., Danbury, CT), having a correlated color temperature (CCT) of 5500 K and color rendering index (CRI) $>$ 92, circumferential 45/0 optical geometry, and illuminance of ~1000 lx at the distance of 5 cm. The shade matching distance was 25 cm. Both value scale VC, and BG shade guides were used to determine the best match on one canine and central incisor for both arches. Shade matching results were recorded and bleaching-dependent color change in shade guide units (sgu, difference in the absolute numbers of shade guide ''steps'' in visual evaluation) were calculated and compared in order to establish a VC/BG sgu ratio.

2.4. *Instrumental method for color measurement*

Instrumental color monitoring was performed before bleaching and seven days after bleaching using a contact-type intraoral spectrophotometer (Vita Easyshade, Vita Zahnfabrik, Bad Säckingen, Germany) with a 5 mm diameter probe excluding the specular mode. The Easyshade had a spectral range 400–700 nm (with a wavelength resolution of 25 nm), and was calibrated according to manufacturer's instruction. A custom positioning jig was made for each subject's arch to provide accurate repositioning and measurement on the middle third of labial tooth surface. The jig was fabricated by attaching a 5 mm diameter acrylic rod to the area to be measured, using light-cured flowable resin. For canines, the base of rod was slightly curved for better adaptation to the convex surface area. Clear silicone registration material (ClearBite, Discus Dental) was injected around the cylinder and along the incisal surface of the teeth to capture the subject's bite. Upon setting, the rod was simultaneously dislodged from the tooth with light finger pressure while the jig was removed from the mouth. Once removed from the mouth, the rod was pushed out from the set material leaving a tunnel for placement of the spectrophotometer probe. Prior to color measurement, the jig was positioned in the patient's mouth, and the spectrophotometer probe was inserted into the jig opening until contacting the tooth. In this manner, probe angulation was controlled thus helping to improve the repeatability of measurements (Fig. 1). The jig enabled a short-term repeatability of $\Delta E^*_{ab} < 0.7$. Color differences were calculated using the following equation[23]:

$$\Delta E^* = [(\Delta L*)^2 + (\Delta a*)^2 + (\Delta b*)^2]^{1/2}.$$

2.5. *Statistical analysis*

Descriptive statistics were obtained, and data were compared using *t*-test and Wilcoxon Signed Ranks Tests at the 0.05 level of significance. Multiple linear regression was used to analyze the influence of changes in lightness, chroma, and hue on color change.

3. Results

Mean (s.d.) sgu color changes for VC with and without light were not statistically significant ($p = 0.56$, Table 2). Corresponding BG color changes were significantly different ($p < 0.01$). Differences in sgu between two shade guides were significant ($p < 0.001$) irrespective of bleaching light exposure.

Table 1 – Tab arrangement and numeric order for Vitapan Classical (''Value'' scale), and Vita Bleachedguide 3D-Master.

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

Vita Bleachedguide 3D-Master														
Lightest ←														→ Darkest
0M1	0.5M1	1M1	1M1.5	1M2	1.5M2	2M2	2.5M2	3M2	3.5M2	4M2	4.5M2	5M2	5M2.5	5M3
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

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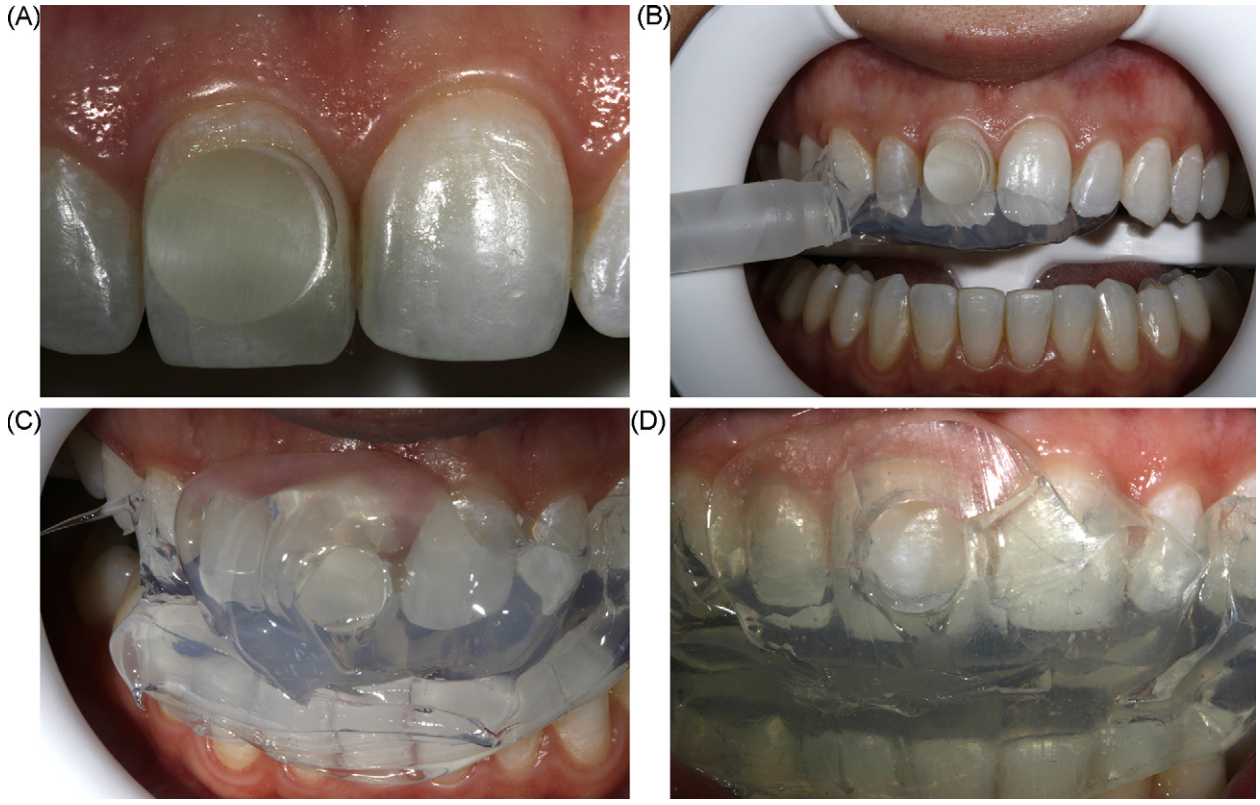

Fig. 1 – Fabrication of a custom positioning jig: (A) Acrylic rod attached to the tooth; (B) Initial injection of clear silicone registration material; (C) Clear silicone registration material set; and (D) Custom made jig with the acrylic rod removed for probe placement.

Mean color difference values (ΔE^*_{ab}) and differences in color coordinate values (ΔL^*, Δa^*, Δb^*, ΔC^*_{ab}, and Δh°) with and without light are listed in Table 3. Color changes with and without light were significantly different ($p < 0.05$). Instrumental measurements of color change (ΔE^*_{ab}) were in better accordance with visual findings (sgu) using the BG guide ($R^2 = 0.60$) rather than the VC ($R^2 = 0.20$). Overall bleaching efficacy was highly varied among patients, both visually (VC: 0–12 sgu with light and 1–10 sgu without light; and BG: 1–6 sgu with light and 0–5 sgu without light), and instrumentally (ΔE^*_{ab} : 1.2−12.1 with light and 1.1–10.5 without light.

Significant interactions existed between ΔE^*_{ab} and ΔL^* ($p < 0.001$), and between ΔE^*_{ab} and ΔC^*_{ab} ($p < 0.001$), while no significant interaction existed between ΔE^*_{ab} and Δh°. Based on standardized coefficients, which allow for relative comparison of the extent of influences of different independent variables on the dependent variable, the effect of change in chroma was nearly three times more influential (0.78) than that of lightness (0.28) (standardized coefficients in Table 4). The predictive multiple logistic regression correlation between overall color change and the individual color parameters derived based on the recorded results was as follows: $\Delta E^*_{ab} = 0.51 \times \Delta L* + (-0.98 \times \Delta C^*_{ab}) + 0.02 \times \Delta h^\circ$. Multiple linear regression showed that bleaching-dependent color differences can be very well estimated based on changes in lightness, chroma, and hue ($R^2 = 0.95$).

Patient tooth sensitivity was higher immediately after bleaching (with the typical peak within 24 h after bleaching) as compared to 1-week time period after bleaching and the difference was not statistically significant ($p > 0.05$). Higher sensitivity was recorded for bleaching with light (2.8 ± 3.0) as compared to bleaching without light (1.4 ± 1.6) ($p < 0.05$).

Table 2 – Means (s.d.) for visually assessed whitening-dependent changes in color, recorded in with- and without light procedures and expressed in shade guide units (sgu).

Light		sgu
With	Vital Classical	6.1 (3.1)
	Bleachedguide	3.8 (1.4)*
Without	Vital Classical	4.5 (3.0)
	Bleachedguide	2.8 (1.5)*

* $p < 0.01$.

4. Discussion

4.1. *Opposing-arch design and timing of color measurements*

An opposing-arch design was chosen over a split-arch method, as a means to eliminate the potential influence of radiation on the no light segment. The opposing-arch design

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Table 3 – Means (s.d.) for bleaching-dependent changes in color (ΔE^*_{ab}), and changes in lightness (ΔL^*), chroma (ΔC^*_{ab}), and hue (Δh°), recorded in with- and without light procedures.

Light	$(\Delta E^*_{ab})^*$	ΔL^*	Δa^*	Δb^*	(ΔC^*_{ab})	Δh°
With	6.0 (2.6)	2.3 (2.6)	−0.9 (0.9)	−4.6 (2.7)	−4.4 (2.8)	3.2 (2.6)
Without	4.7 (2.2)	1.8 (2.3)	−0.9 (0.9)	−3.3 (2.4)	−3.3 (2.4)	2.9 (3.0)

* $p < 0.05$.

Table 4 – Multiple regression coefficients for color parameters (ΔL^*, ΔC^*_{ab}, and Δh°), dependent variable being ΔE^*_{ab}, irrespective of bleaching light exposure.

Variable	Non-standardized coefficients		Standardized coefficients	*T*	Significance
	B	Std. error	Beta		
ΔL^*	0.51	0.06	0.28	8.71	<0.001
ΔC^*_{ab}	−0.98	0.07	−0.78	13.66	<0.001
Δh°	0.02	0.08	0.01	0.25	0.800

also allows the patient to discern the location of sensitivity more easily compared to a split-arch design. Balancing the groups with an equal number of maxillary and mandibular teeth allowed for control of any color change influenced by tooth size. The effect of immediate dehydration that accompanies tooth isolation during a long session of chairside bleaching, and potential effect of exposure to the supplementary light, must be taken into account when considering the timing of post-treatment shade evaluation. The purpose of waiting seven days before the final shade comparisons and instrumental measurements was to avoid these influences.

4.2. *Shade guides used*

In order to facilitate comparison of test results among other studies, the Vitapan Classical (VC) shade guide, arranged by ''value-order,'' was included. However, because of the prior noted problems associated with this shade guide, the Vita Bleachedguide 3D-Master (BG) system was also included. The evaluators agreed that it was easier to discern shade and reach a consensus using the BG system compared to the VC.

4.3. *Repositioning of the probe for repeatability*

A novel method for obtaining color measurements with an intraoral contact spectrophotometer and custom apparatus was introduced in this study. Repositioning of the color measuring instrument is an important variable that must be controlled in bleaching studies. Not only the repeatability of measuring area should be ensured, but also a fixed perpendicular position (angulation) of the instrument probe. A pilot investigation with the instrument used in the current study showed that slight changes in probe angulation would lead to a high degree of variation in the data, while a fixed position resulted in a higher repeatability. An in vitro study out of Ohio State University showed the precision of the Vita Easyshade to be better that a laboratory spectrophotometer when various color measuring instruments were compared.[24] The apparatus developed in this research is preferred over the thin, vacuum-form stent with an open hole commonly used in other studies for the purpose of repositioning. Unlike the common stent type, the apparatus used in this study provides for vertical supporting walls to control angulation and prevent related edge loss.

4.4. *ADA recommendations and visual judgments of color differences*

The VC shade guide changes and ΔE^*_{ab} values corresponded to the ADA recommended efficacy level for professional in-office tooth bleaching products of at least 5 ccu.[19] Longevity of changes after 3 and 6 months was not evaluated in this study. The nature of changes also corresponded to the ADA guidelines and literature: teeth became lighter (increase in ΔL^*) and less chromatic (decrease in ΔC^*_{ab}) after bleaching.[19–21,25] In addition, mean change in shade guide units for the VC system were the same as the instrumental findings, which supports the ADA recommendation that $1\,\text{ccu} = 1\Delta E^*_{ab} = 1\,\text{sgu}$.[19–21] The ΔE^*_{ab} values recorded for both with- and without light exceeded the 50:50% acceptability thresholds reported in other studies ($\Delta E^*_{ab} = 2.7$[26] and $\Delta E^*_{ab} = 3.3$[27]). This indicates very obvious changes in color after bleaching as compared to baseline, pre-treatment condition. On the other hand, the mean difference in bleaching efficacy of $\Delta E^*_{ab} = 1.3$ (6.0 with light minus 4.7 without light) was slightly above the perceptibility threshold of $\Delta E^*_{ab} = 1$ obtained under controlled conditions with trained evaluators[28] and well below the perceptibility threshold of $\Delta E^*_{ab} = 2.6$ recorded in less controlled clinical setting and using evaluators that were not specifically trained for color matching.[29] This study was performed by trained evaluators and under controlled clinical conditions, but a distinction should be made between the statistical significance and clinical perceptibility. Further studies are needed to determine whether the effect of light would be perceivable for non-trained evaluators in the routine clinical practice, the influence of the peroxide dose on color change, and sensitivity with- and without the light.

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4.5. VC–BG conversion and result validity

Color changes noted using the BG shade guide exhibited smaller variation compared to those using the VC system, and were in better agreement with the instrumental findings. It is likely that the inconsistent color distribution of the VC influenced the accuracy of findings in this study and could have also influenced previously reported work. The sgu conversion factor for BG–VC comparisons was 1 BG sgu = 1.6 VC sgu, which closely corresponds to the conversion factor reported in an in vitro study (1 BG sgu = 1.9 VC sgu).[17] Instrumental color change as measured showed that application of supplemental light exposure during the chairside bleaching treatment significantly influenced the results. Therefore the research hypothesis was rejected for both instrumental findings and visual evaluation using BG. The instrumental measurements are more sensitive, as they provide objective color parameter values. The visual method relies on visual perception in determining the best before- and after matches. However, one should be aware that the best visual matches are rarely exact matches.

4.6. Comparison with other studies

Although it is more appropriate to report polar coordinates (C^*_{ab} and h°) than rectangular coordinates (a^* and b^*) in studies on color in dentistry, changes in a^* and b^* values were included in Table 3 for easier comparison with former bleaching studies. However, indicative comparisons between $L^*C^*h^\circ$ and $L^*a^*b^*$ findings can be easily made: C^*_{ab} values of human teeth are almost identical to b^* values, and the decrease in a^* coordinate values corresponds to the increase in h° values.

There are many factors that can attribute to findings contrary to those reported in the current study. Commercial bleaching lights emit a wide variety of irradiant energy to teeth, which partially originates from the variability of the light-to-tooth distances.[30] A few studies concluded that application of light during the bleaching process did not have any effect on bleaching efficacy.[31–33] Papathanasiou et al. used a dental polymerizing unit as a supplementary source of light for determining the efficacy of 35% H_2O_2 with- and without light exposure.[31] Some elements related to shade matching method and testing parameters, such as correlated color temperature (CCT) and color rendering index (CRI) of the intraoral illuminating light source used, its optical geometry, and shade matching distance were not reported. They were unable to detect a difference between groups using a visual color matching method (with Vitapan Classical). An additional study found no difference in bleaching efficacy between a chemical-activated and photo-activated system (Opalescence Boost and Brite Smile), respectively.[32] However, since two different agents and concentrations of product were used, it is difficult to conclude about the effects of the supplementary light in that study. Differences in bleaching agent, methods and instruments used for assessment of color changes, and characteristics of the bleaching lights (irradiance and spectral distribution) all add to the confusion associated with this topic.

4.7. "Bleaching" or "desaturation": the influence of chroma

The standardized coefficients for ΔL^*, ΔC^*_{ab}, and Δh° enabled an objective comparison of the influence of each color parameter on total color difference. Based on the ratio derived from the standardized coefficients reported in Table 4, ΔE^*_{ab} values were influenced by changes in chroma nearly three times more than by changes in lightness, while hue changes had almost no influence on color change. These findings are in accordance with the literature.[25] Thus the recorded change in color appearance during bleaching treatment would more accurately be described as *desaturation* than *bleaching/whitening*. This finding suggests that a "chroma scale" of dental shade guides would be more appropriate than a "value scale" for monitoring bleaching results. Furthermore, this result also underscores the importance of using a progressive and uniform increase in chroma/yellowness, from the lightest to the darkest tab, which is probably one of the most pronounced advantages of BG shade guide as compared to VC.[17,18]

4.8. Additional considerations

The mechanistic details accounting for the recorded differences between the light and no light group are related not only to photolysis of hydrogen peroxide but also to the photolysis of the chromophoric organic matter found in dentin. Photolysis of hydrogen peroxide has been shown to be independent of temperature.[33,34] However, in 1957 it was reported in the *Transactions of the Faraday Society* that photolysis of hydrogen peroxide can occur by light of wavelengths of 365 nm or less,[35] which is within the range of the light used in the current study. Tavares et al. reported using short-arc gas plasma light in combination with a 15% H_2O_2.[36] They reported significantly lighter teeth when using the light/bleach combination compared to bleach alone. Their protocol included the use of sun-block to protect the lips from UV radiation. It has been shown that chromophoric dissolved organic matter (CDOM) present in natural waters can undergo photolysis by exposure to UV radiation leading to the formation of hydrogen peroxide.[37] It is plausible that endogenous dentinal water exposed to UV radiation can lead to the formation of additional hydrogen peroxide and thus potentiate the bleaching effect. While photolysis of hydrogen peroxide and chromophoric organic matter within the dentinal matrix may play an important role in the mechanisms responsible for the current results, further investigation is required on this topic to expound the many possible reasons why supplemental light increases the bleaching results of hydrogen peroxide.

5. Conclusions

Within the limitations of this study, the treatment with supplementary light showed significantly greater bleaching-dependent changes in color compared to treatment without light when assessed using instrumental methods. The

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same was determined for the visual method with Vita Bleachedguide 3D-Master. No significant difference in color change with respect to light exposure was detected for the Vitapan Classical. Future research might reveal weather recorded differences can be perceivable by untrained evaluators in a typical clinical setting with uncontrolled lighting conditions.

Acknowledgement

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Conflict of interest

Vita Bleachedguide 3D-Master was jointly developed by Dr. Rade D. Paravina and Vita Zahnfabrik. The University of Texas Health Science Center has executed a licensing agreement with VITA Zahnfabrik, dealing with commercialization of Vita Bleachedguide 3D-Master. Dr. Paravina is a paid consultant for Vita Zahnfabrik.

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