



Clinical Evaluation of the Effectiveness of Different Bleaching Therapies in Vital Teeth



Letícia Cunha do Amaral Gonzaga de Almeida, DDS, MS¹
 Heraldo Riehl, DDS, MS, PhD²/Paulo Henrique dos Santos, DDS, MS, PhD³
 Maria Lúcia Marçal Mazza Sundfeld, DDS, MS, PhD⁴
 André Luiz Fraga Briso, DDS, MS, PhD⁵

The aims of this in vivo study were to compare the effectiveness and color stability of at-home and in-office bleaching techniques and to evaluate whether the use of light sources can alter bleaching results. According to preestablished criteria, 40 patients were selected and randomly divided into four groups according to bleaching treatment: (1) at-home bleaching with 10% carbamide peroxide, (2) in-office bleaching with 35% hydrogen peroxide (HP) without a light source, (3) in-office bleaching with 35% HP with quartz-tungsten-halogen light, and (4) in-office bleaching with 35% HP with a light-emitting diode/laser. Tooth shade was evaluated using the VITA Classical Shade Guide before bleaching as well as after the first and third weeks of bleaching. Tooth shade was evaluated again using the same guide 1 and 6 months after the completion of treatment. The shade guide was arranged to yield scores that were used for statistical comparison. Statistical analysis using the Kruskal-Wallis test showed no significant differences among the groups for any time point ($P > .01$). There was no color rebound in any of the groups. The bleaching techniques tested were equally effective. Light sources are unnecessary to bleach teeth. (Int J Periodontics Restorative Dent 2012;32:303–309.)

¹Postgraduate Student, Department of Restorative Dentistry, Faculty of Dentistry of Araçatuba, São Paulo State University–UNESP, Araçatuba, São Paulo, Brazil.

²Deceased; Postgraduate Professor, Hospital for Rehabilitation of Craniofacial Anomalies, São Paulo University–USP, São Paulo, Brazil.

³Assistant Professor, Department of Dental Materials and Prosthodontics, Faculty of Dentistry of Araçatuba, São Paulo State University–UNESP, Araçatuba, São Paulo, Brazil.

⁴Associate Professor, Department of Restorative Dentistry, Faculty of Dentistry of Araçatuba, São Paulo State University–UNESP, Araçatuba, São Paulo, Brazil.

⁵Associate Professor, Department of Biostatistics, Faculty of Dentistry of Araçatuba, São Paulo State University–UNESP, Araçatuba, São Paulo, Brazil.

Correspondence to: Prof Adj André Luiz Fraga Briso, Departamento de Odontologia Restauradora, Faculdade de Odontologia de Araçatuba–UNESP, Rua José Bonifácio, 1193 Vila Mendonça, CEP: 16105-050, Araçatuba, SP, Brazil; fax: 55-18-36363349; email: alfbriso@foa.unesp.br.

Nightguard vital bleaching was the first bleaching technique considered to be safe and effective.^{1–4} However, to accelerate the bleaching process, high concentrations of hydrogen peroxide (HP) have been used widely, either alone or associated with heat or light sources. Light-irradiated in-office bleaching has the potential advantages of less chairside time and quicker results.⁵ However, the high concentration of peroxide associated with light sources could increase tooth sensitivity⁶ and color rebound.⁷ Light sources also generate heat,^{8,9} which can cause pulpal damage.^{6,10}

Despite the fact that light sources have been introduced into the dental market, the real advantages and potential biologic consequences have only recently been studied and questioned.^{5,10–12} Some authors doubt whether light sources really accelerate the bleaching process or provide better clinical results. There are also concerns as to whether professionals know the potential risks and benefits of this technique or have simply succumbed to the marketing for “power bleaching.”

Table 1 VITA Classical Shade Guide arranged in value order

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

The purposes of this study were to compare the effectiveness of at-home and in-office bleaching systems and to evaluate whether the use of different light sources alters clinical bleaching results. Three null hypotheses were tested: (1) there is no difference between the at-home and in-office techniques, (2) light sources do not influence the clinical results, and (3) bleaching using a high concentration of HP does not interfere with color rebound.

Method and materials

The research project was approved by the local ethics committee in human research (protocol no. 2007-01120). Each participant was informed of the benefits and possible risks involved in the experiment. They also read and signed a consent form.

Forty volunteers were selected after clinical and radiographic examination. The inclusion crite-

ria consisted of nonsmokers free of caries, good general and periodontal health, between 18 and 28 years of age, and being able to return for periodic examinations. Patients with nonadequate restorations, who were pregnant or nursing, who had previously undergone tooth-bleaching procedures, who were under orthodontic treatment, or who had severe fluorosis or tetracycline stains were excluded from this study.

Subjects were randomly divided into four groups ($n = 10$) according to the bleaching techniques used. Volunteers in group 1 had their teeth bleached with the home-bleaching technique using 10% carbamide peroxide (CP; Whiteness Perfect, FGM). Maxillary and mandibular alginate impressions were taken. Casts were trimmed appropriately, and vestibular reservoirs were prepared with two coatings of nail varnish (Risqué, Niasi). Vacuum-formed bleaching trays were fabricated and trimmed

at the cervical level. Volunteers were instructed to apply a drop of CP gel at the buccal surface of each tooth inside the tray and to use the tray for 4 hours/day for 21 days. Patients in groups 2 to 4 were submitted to three bleaching sessions with 35% HP (Whiteness HP, FGM) either without the use of light sources (group 2), using halogen light (group 3), or using light-emitting diode (LED)/laser light irradiation (group 4). A labial retractor was positioned, and gingival tissue was isolated using a fluid, light-cured resin dam (Top Dam, FGM) before application of the product. The bleaching product was applied at the tooth surface and left undisturbed for 10 minutes. The product was then removed and reapplied two more times, followed by removal and washing under abundant tap water. Each session was performed in 30 minutes; the interval between sessions was 7 days.

Patients in group 2 did not undergo treatment with light-source

Table 2 Mean scores (standard deviations) attributed to the patients according to time evaluation*

Group	Baseline	First evaluation	Immediately postbleaching	1 wk postbleaching	1 mo postbleaching	6 mo postbleaching
1	5.4 (1.26) ^a	2.8 (1.22) ^{a,b}	1.7 (0.82) ^b	1.9 (0.73) ^b	1.9 (0.73) ^b	2.0 (0.66) ^b
2	5.2 (2.34) ^a	2.3 (1.49) ^{a,b}	1.2 (0.63) ^b	1.3 (0.67) ^b	1.3 (0.67) ^b	1.3 (0.67) ^b
3	4.8 (1.93) ^a	2.1 (1.10) ^{a,b}	1.1 (0.31) ^b	1.4 (0.51) ^b	1.8 (1.22) ^b	1.8 (1.22) ^b
4	4.7 (0.94) ^a	1.9 (0.56) ^a	1.0 (0.00) ^b	1.0 (0.00) ^b	1.0 (0.00) ^b	1.0 (0.00) ^b

*Same letters in each row signify similar results.

irradiation. In group 3, bleaching gel was irradiated using a halogen lamp (Ultralux, Dabi Atlante) at 400 mW/cm² and 450 to 500 nm for 20 seconds. Two teeth were activated at a time until all teeth had received light irradiation. For group 4, an LED/laser source (Whitening Lase II, DMC Equipamentos) was applied. This light source is composed of six LEDs that generate a blue light with an intensity of 120 mW/cm² and wavelength of 470 nm. The device also includes three diodes for infrared laser emission at a wavelength of 808 nm and potency of 0.2 W. The bleaching gel was irradiated during the first 3 minutes after application.

Color evaluation

One trained evaluator recorded the initial color of the maxillary central incisors using the VITA Classical Scale (VITA Zahnfabrik), with lower scores denoting lighter tooth shades

(Table 1).^{6,9} The color was evaluated before bleaching, after the first and third weeks of bleaching, and 1 and 6 months after treatment.

To prevent measurement bias, the same qualified evaluator, who did not know the treatment assignment or the previous tooth color, performed all measurements under standardized lighting conditions. When disagreement arose, a second examiner performed the assessment until a consensus was reached. Photographs for register shade-matching according to the VITA Shade tab were taken using a digital camera (Nikon D70; lens: 105 mm 1:2.8D DG Macro, Sigma; flash: EM- 140 DG Ring Flash, Sigma).

Statistical analysis

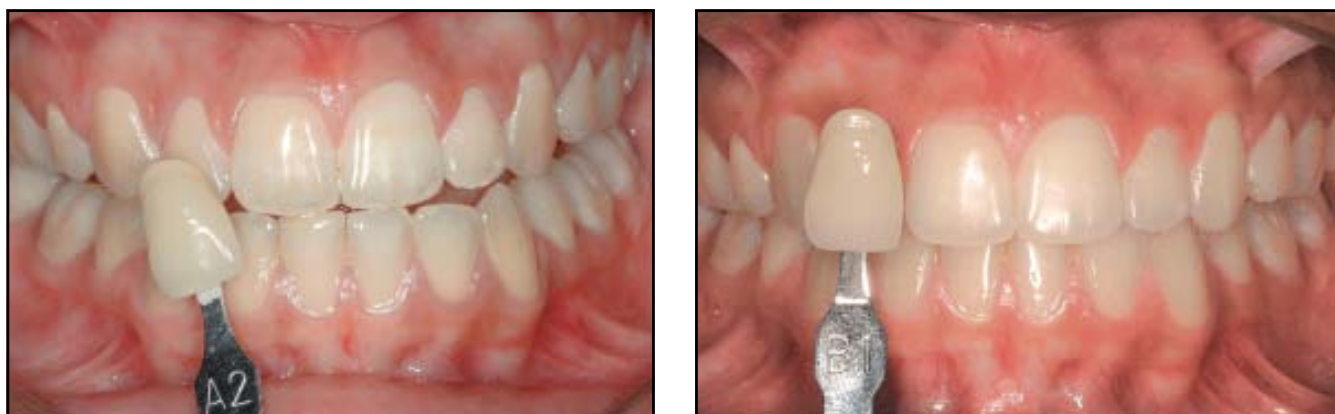
The Kruskal-Wallis test using the initial scores was used to verify if all groups had similar baseline shade values. The Kruskal-Wallis test, using each time point's evalu-

ation score minus the initial score (Δ), was used to compare color alteration among groups. The shade scores for the same group at each time point were compared using the Kruskal-Wallis test. Significant differences between groups were evaluated using the Dunn test. All statistical tests were carried out at a significance level of 5%.

Results

All volunteers completed the study. Statistical analysis showed no significant differences among groups at baseline ($P = .7526$).

When each technique was analyzed individually, no significant differences were found between baseline and 1-week values for at-home bleaching or a single in-office session with 35% HP (Table 2). However, after the bleaching treatment was completed, all protocols used caused significant shade alterations (Figs 1 to 4, Table 2).



Figs 1a and 1b Color change after 3 weeks of bleaching with 10% CP in a tray. (left) Shade A2 at baseline; (right) shade B1 postbleaching.



Figs 2a and 2b Color change after three sessions of in-office bleaching with 35% HP without a light source (group 2). (left) Shade A2 at baseline; (right) shade B1 postbleaching.

Statistical analysis showed that there were no significant differences among groups regarding bleaching effect ($P > .05$) at all times. No color rebound was verified statistically in any of the groups (Table 2).

Discussion

All null hypotheses were accepted. There was no difference between the in-office and at-home bleaching techniques at any of the time

points examined. The light sources did not influence the clinical results. Bleaching using HP in high concentrations did not accelerate color rebound.

The method of color evaluation used in this study was the VITA shade scale, which is the technique most widely used in daily clinical practice.³ It is a quick, simple procedure and has been used successfully in many studies,^{3,5,11–14} providing clinically relevant results. Successful bleaching implies visu-

ally detectable differences in tooth shade.¹³ Moreover, some clinical studies have compared the method of shade evaluation, contrasting the VITA shade guide with objective methods, and the results verified that there were no statistically significant differences among these methods.^{4,11,15}

With regard to the bleaching agents, the in-office method using 35% HP was evaluated with and without the use of light sources. As a reference, at-home bleaching



Figs 3a and 3b Color change after three sessions of in-office bleaching with 35% HP with a halogen lamp (group 3). (left) Shade A2 at baseline; (right) shade B1 postbleaching.



Figs 4a and 4b Color change after three sessions of in-office bleaching with 35% HP with an LED/laser (group 4). (left) Shade A3 at baseline; (right) shade B1 postbleaching.

was performed using 10% CP. This technique is a well-approved, safe, and effective method of bleaching therapy²⁻⁴ and considered the gold standard compared to other systems.¹⁰

In all groups, the initial color did not differ from the color after the first session of in-office treatment or after the first week of at-home treatment. These data are similar to those from previous studies showing that 2 to 6 weeks of bleaching treatment are necessary

when using the at-home system.² With regard to in-office bleaching, Gottardi et al¹⁴ evaluated the number of sessions necessary to achieve patient satisfaction using 35% HP and a high-intensity light. The authors found that more than one session is often necessary.¹⁴

In this study, the at-home technique using 10% CP for 3 weeks and 4 hours/day proved just as effective as three sessions (90 minutes) of in-office bleaching. After treatment, all techniques resulted in signifi-

cant shade alterations compared to baseline values. There were no statistical differences among the four groups; the techniques showed a mean color change of 3.7 to 4.0, as measured using the VITA Shade Guide (Table 2).

Zekonis et al⁴ compared 14 days of at-home and 60 minutes of in-office bleaching (the same proportion used in this study). Their results showed that the at-home system produced significantly lighter teeth than the in-office treat-

ment.⁴ This discrepancy might be a result of the bleaching saturation that occurred in the present study after 21 days of at-home and 90 minutes of in-office treatment. This saturation was clear in the LED/laser group: The standard deviation between the measurements taken at the end of treatment compared to 180 days later was 0 (Table 2).

There were also no statistically significant differences between in-office groups with or without light sources regarding the color change after bleaching. It is worth noting that the objective of this study was not to compare the light sources and their characteristics, but rather to evaluate widely used techniques that use quartz-tungsten-halogen light and LED/laser as a complement to in-office bleaching. Heat and light sources are used to accelerate the decomposition of HP to form oxygen and perhydroxyl free radicals, increasing the efficacy of bleaching.⁶ However, this effect was not confirmed in the present study or in other reports.^{4,5,9–12,16}

Light source-mediated acceleration of the chemical reaction necessary for bleaching can occur through thermocatalysis or photolysis.¹⁰ However, in dental bleaching, the use of thermocatalysis is contraindicated since the increase in temperature could damage the pulp tissue.^{6,10,12} The energy required for the release of hydroxyl radicals from hydrogen peroxide through direct excitation by light (photolysis)¹⁰ can only be provided by high-frequency light (corresponding to a wavelength of

248 nm or less), which makes photolysis difficult and unsafe when performed in the oral cavity.¹⁰

There were no significant differences among the groups with regard to color stability after 6 months, and there was no significant color rebound in any of the groups. It is known that the teeth are dehydrated immediately after bleaching, especially when sources of light or heat are used. This causes an illusory effect of bleaching, which tends to disappear after rehydration.¹³ However, in this study, this effect was eliminated by evaluating the color 1 week after HP bleaching sessions.

When comparing in-office dental bleaching with or without the use of light sources, Marson et al found similar results to those obtained in this study: All groups were similar, showing no color return.¹¹ Dietschi et al, in their in vitro study comparing in-office and at-home bleaching, found that at-home bleaching produces a pronounced bleaching in deep tooth tissue, which would probably maintain the lighter color for a more extended period than in-office bleaching.¹⁶ However, these findings were not confirmed in this in vivo study. The authors explain that neither the incorporation of heat or light sources nor the use of peroxide in higher concentrations could compensate for the reduced contact time between bleaching product and dental tissues that characterizes in-office bleaching.¹⁶

The results obtained in the present study raise questions regarding the usefulness of light

sources and products with high concentrations of peroxides for the purpose of tooth whitening. Dental bleaching should not be considered merely an esthetic treatment, but also as a therapy in which a drug is applied to the surface of vital teeth. Such a view considers the need to establish the relationship between time and concentration for an individual dose of bleaching product.

Conclusions

- All bleaching techniques tested were effective for whitening of vital teeth.
- Light sources tested did not improve in-office bleaching results.
- More than 1 week of at-home bleaching using 10% CP or more than one 30-minute session of in-office bleaching with 35% HP is necessary to produce clinically significant color changes.
- After 6 months, no statistical color rebound was observed in any of the groups.

References

1. Donly KJ, Segura A, Henson T, Barker ML, Gerlach RW. Randomized controlled trial of professional at-home tooth whitening in teenagers. *Gen Dent* 2007;55:669–674.
2. Leonard RH Jr, Haywood VB, Phillips C. Risk factors for developing tooth sensitivity and gingival irritation associated with nightguard vital bleaching. *Quintessence Int* 1997;28:527–534.
3. dos Santos Medeiros MC, de Lima KC. Effectiveness of nightguard vital bleaching with 10% carbamide peroxide—A clinical study. *J Can Dent Assoc* 2008;74:163–163e.
4. Zekonis R, Matis BA, Cochran MA, Al Shetri SE, Eckert GJ, Carlson TJ. Clinical evaluation of in-office and at-home bleaching treatments. *Oper Dent* 2003;28:114–121.
5. Papathanasiou A, Kastali S, Perry RD, Kugel G. Clinical evaluation of a 35% hydrogen peroxide in-office whitening system. *Compend Contin Educ Dent* 2002;23:335–340.
6. Nathanson D, Parra C. Bleaching vital teeth: A review and clinical study. *Compendium* 1987;8:490–497.
7. Garber DA. Dentist-monitored bleaching: A discussion of combination and laser bleaching. *J Am Dent Assoc* 1997;128(suppl):26S–30S.
8. Sulieman M, Rees JS, Addy M. Surface and pulp chamber temperature rises during tooth bleaching using a diode laser: A study in vitro. *Br Dent J* 2006;200:631–634.
9. Patel A, Louca C, Millar BJ. An in vitro comparison of tooth whitening techniques on natural tooth colour. *Br Dent J* 2008;204:E15.
10. Buchalla W, Attin T. External bleaching therapy with activation by heat, light or laser—A systematic review. *Dent Mater* 2007;23:586–596.
11. Marson FC, Sensi LG, Vieira LC, Araújo E. Clinical evaluation of in-office dental bleaching treatments with and without the use of light-activation sources. *Oper Dent* 2008;33:15–22.
12. Hein DK, Ploeger BJ, Hartup JK, Wagstaff RS, Palmer TM, Hansen LD. In-office vital tooth bleaching—What do lights add? *Compend Contin Educ Dent* 2003;24:340–352.
13. Luk K, Tam L, Hubert M. Effect of light energy on peroxide tooth bleaching. *J Am Dent Assoc* 2004;135:194–201.
14. Gottardi SM, Brackett MG, Haywood VB. Number of in-office light-activated bleaching treatments needed to achieve patient satisfaction. *Quintessence Int* 2006;37:115–120.
15. Al Shethri S, Matis BA, Cochran MA, Zekonis R, Stropes M. A clinical evaluation of two in-office bleaching products. *Oper Dent* 2003;28:488–495.
16. Dietschi D, Rossier S, Krejci I. In vitro colorimetric evaluation of the efficacy of various bleaching methods and products. *Quintessence Int* 2006;37:515–526.

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