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Clinical comparison between two bleaching techniques: A 180-day follow-up study

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Objective: The aim of this clinical study was to compare tooth shade, color rebound, and tooth sensitivity after using either a combined bleaching technique (CBT) or a deep bleaching technique (DBT) to lighten stained teeth. CBT is a two-stage bleaching process consisting of an initial in-office bleaching treatment session using 35% hydrogen peroxide (HP) followed by a 7-day at-home bleaching session with 6% HP. DBT involves a 7-day at-home bleaching session with 6% HP prior to the initiation of a two-stage CBT process. **Method and Materials:** Thirty-six volunteers were recruited in this split-mouth design randomized clinical trial. Tooth shade was objectively evaluated by using a spectrophotometer and shade guide tabs. Tooth and gingival tissue sensitivity were self-evaluated by recording any tooth or gingival sensitivity on a daily basis. **Results:** Both CBT and DBT presented satisfactory whitening effects. Although DBT resulted in a better shade change, the two bleaching techniques had a similar rebound effect. CBT was associated with a lower frequency of tooth sensitivity, but both bleaching techniques can be considered safe from a clinical standpoint. **Conclusion:** The results indicate that CBT might potentially be preferred to whiten teeth, thus promoting the shade change, and avoiding gingival and tooth sensitivity.*(Quintessence Int 2013;44:601–607; doi: 10.3290/j.qi.a29702)*

Key words: combined bleaching technique, deep bleaching technique, randomized controlled trial, tooth bleaching

Cosmetic dentistry has become an important part of restorative dental practice. Displaying a more esthetically pleasing appearance helps to improve self-confidence and esteem. Great amounts of money and time are being invested in attempts to improve the appearance of teeth. Whiter teeth are key to an attractive smile.[1] For this reason, lighter colored teeth have become increasingly desirable and popular.

Although there are plenty of methods to successfully improve tooth color (including whitening toothpastes, professional cleaning to remove stains and tartar, tooth bleaching, micro-abrasion of enamel, and placement of crowns or veneers), tooth bleaching has become one of the most popular esthetic treatments. This is because of its noninvasive nature and confirmed effectiveness.[2] Bleaching is a chemical treatment of stained tooth surfaces using a bleaching agent, namely hydrogen peroxide (HP), or products transformed into HP (ie, carbamide peroxide). HP is an effective bleaching agent because of its instability and tendency to undergo dissociation, producing oxygen and free radicals. The bleaching mechanism consists of an oxidation reaction with the release of free radicals.[3] The reactive oxygen species formed in the decomposition reaction can react with the complex organic molecules in the tooth structure and split them into smaller, less complex molecules, which reflect more light waves, therefore creating an appearance that is lighter in color.[4] When carbamide peroxide is used, it breaks down into HP and urea, thus enabling the HP to react with staining organic materials. Solutions of 10% carb-

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amide peroxide usually contain the equivalent of 3.3% HP.

The procedures of tooth bleaching can be performed either in the dental office ("in-office bleaching") or at home by patients ("at-home bleaching"). The effectiveness of in-office or at-home bleaching methods has been documented extensively.[5,6] When compared to at-home bleaching, in-office bleaching has been shown to rapidly lighten the teeth. However, considerable color rebound within 2 weeks of tooth bleaching was also observed in several studies.[7,8] At-home bleaching usually requires 2 to 4 weeks of treatment, but generally results in less color rebound and the bleaching effect lasts longer.[9] Garber[10] suggested that combining both treatments could shorten the whole bleaching time and enhance the whitening effect, and termed this a "combined bleaching technique" (CBT). CBT combines the advantages of the two bleaching methods and has been widely accepted as an effective bleaching technique.

A different technique, known as a "deep bleaching technique" (DBT), has recently become popular among dental professionals.[11] This technique involves an at-home bleaching treatment prior to an in-office bleaching session, followed by a subsequent at-home bleaching session. It has been claimed that at-home bleaching conditions the teeth by increasing their permeability, thus greatly promoting the effectiveness of the in-office procedure.[11] Deep bleaching involves a first at-home bleaching session to increase the permeability of the tooth surface, followed by CBT sessions afterwards. In this case, more favorable results may appear. However, the literature does not provide information about the effectiveness of this bleaching method.

Previous studies have shown that tooth sensitivity was the most prevalent side effect associated with tooth bleaching, followed by irritation of the gingival tissue.[12] However, the majority of these effects were reported to be transient and disappeared within 24 to 48 hours after the bleaching treatment was finished.

The aim of the present study was to evaluate the amount of tooth color change, rebound rate, and tooth sensitivity associated with the use of CBT and DBT, and to provide evidence to aid in the clinical selection of tooth bleaching techniques.

METHOD AND MATERIALS

Prior to enrollment, each subject received a comprehensive oral and dental screening. A signed consent form was obtained from all eligible and enrolled subjects. The form and research protocol were reviewed and approved by the Ethical Committee at the Guanghua School of Stomatology, Hospital of Stomatology, Sun Yat-sen University.

The inclusion criteria were:

- aged between 18 and 30 years
- all six maxillary anterior teeth present, and free from any signs of defects, caries, loss of vitality, or restorations
- six maxillary anterior teeth present that are A2 or darker shade on the Vita Classic Shade Guide (Vita Zahnfabrik)
- willing to refrain from the use of tobacco products during the study period
- willing to sign the consent form
- able to return for scheduled follow-up examinations.

The exclusion criteria were:

- a history of any medical disease that may interfere with the study or require special considerations
- pregnant or lactating females
- a history of allergy to HP
- current or previous use of professionally applied or prescribed in-office or at-home whitening agents
- presence of a gross pathology in the oral cavity (excluding caries)
- Loe and Silness Gingival Index score greater than 1
- tetracycline-stained teeth or dental fluorosis
- presence or use of an orthodontic appliance on the maxillary anterior teeth.

All subjects received supragingival scaling at least 1 week, but not longer than 2 months, prior to the bleaching procedures. Extrinsic stains were removed for more accurate assessment of baseline color.

A total of 36 subjects were enrolled in the split-mouth design study. All subjects

were randomly assigned by flipping a coin to decide which side of the maxillary anterior arch would be using DBT while the other side would be using CBT, namely left-right randomization. The subjects were informed about the bleaching procedures as shown in Table 1. DBT used 6% HP gel (Beyond Technology) in a half-arch tray on the maxillary anterior right or left side for at-home bleaching for the first 7 days, followed by three 8-minute applications of 36% HP gel in-office bleaching (Beyond Technology) and 6% HP gel at-home bleaching for another 7 days. CBT had a triple 8-minute application of 36% HP gel in-office bleaching, followed by 6% HP gel at-home bleaching for 7 days.

At the baseline appointment, tooth color evaluation was carried out using two methods: *(1)* subjective shade guide (SG) matching of the middle-third of the maxillary anterior teeth using the Vitapan Classic Shade Guide (Vita Zahnfabrik) arranged by value order (lightest to darkest), as recommended by the manufacturer; and *(2)* an objective evaluation of the same area using a spectrophotometer (Olympus Crystaleye, Olympus) to determine the CIELab value of the middle-third of the teeth. Three independent readings were taken and the mean value was plotted. All evaluations were carried out under the same conditions and by the same dentist. The three coordinates of the CIELab color space values, L*, a*, and b*, were recorded using the previously mentioned spectrophotometer. At each evaluation time point, the shade of the six maxillary anterior teeth was measured three times, with the active point of the spectrophotometer positioned on the central third of each tooth, and the average of three readings was calculated to represent the shade of the tooth.[13] L* represents lightness (L* = 0 yields black, and L* = 100 indicates diffuse white); a* is a measurement along the red-green axis (positive a* indicates magenta while negative a* indicates green); b* is a measurement along the yellow-blue axis (positive b* indicates yellow while negative b* indicates blue). The overall color change (ΔE) was calculated according to the formula $\Delta E = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$.

A visual analog scale (VAS) was introduced to record daily tooth and/or gingival sensitivity on all subjects. VAS is an instrument that measures a characteristic or attitude that is believed to span a continuum of values and cannot be objectively measured. VAS criteria are: 0, no pain; 1 to 3, slight pain and endurable; 4 to 6, moderate pain, almost endurable; and 7 to 10, severe pain, cannot endure. Subjects who suffered more than moderate sensitivity on either side of their maxillary arch were asked to return to the clinic for desensitizing gel. If any of the subjects, after using the desensitizing gel, still experienced more than moderate sensitivity, they were asked to withdraw from the study.[9] During the baseline appointment, an alginate impression (Jeltrate PLUS, Dentsply Caulk) was taken of the maxillary arch of each subject. The impression was then poured with die stone (Heraeus Kulzer) to create a cast. For each subject, two individual bleaching trays were fabricated: the first one was fabricated with facial reservoirs on only one side of the maxillary anterior teeth (left or right), and the second one was fabricated with facial reservoirs on both sides.

Table 1 Study groups

Study group	DBT	CBT
7 days at-home bleaching (6% HP)	+	-
Triple application of an 8-min in-office bleaching (36% HP)	+	+
7 days at-home bleaching (6% HP)	+	+

The subjects were instructed on how to load the gel into the tray on the side with the reservoirs and how to place the tray, as well as how to remove the gel. The trays were given to the subjects to wear at home for 1 hour per day for 7 days. The side with the reservoirs that was bleached was identified as the DBT and the side that did not receive the initial bleaching for 7 days was identified as the CBT. After the at-home bleaching, both DBT and CBT had the same treatment. In-office bleaching was performed on both sides of the maxillary anterior arch on the 8th day. The second bleaching tray with reservoirs on both sides was given to the subjects for 1 hour of at-home bleaching per day on both sides of the maxillary anterior arch for 7 days start-

ing on the 9th day, immediately after the in-office bleaching.

After baseline, follow-up evaluation appointments were made for all subjects at 7, 30, 90, and 180 days post-bleaching for shade table matching, digital photographs, and colorimeter readings.

Throughout the 180 days of the study, the subjects were asked to brush their teeth with a non-whitening dentifrice at least twice a day to standardize their oral hygiene.

Statistical analysis was done using PASW Statistics software for Windows, version 18.0 (SPSS). Changes in the values measured using the spectrophotometer from baseline to day 1, day 7, day 30, day 90, and day 180 posttreatment were calculated for each subject for each treatment. The treatments were compared for differences in gingival sensitivity, baseline shade, and rebound rate using repeated measures analysis of variance (ANOVA) VAS scores. SG values were analyzed using the Mann-Whitney rank test. A difference between treatments was considered significant if a confidence level of $\alpha < 5\%$ was achieved.

RESULTS

Thirty-six volunteers were enrolled in this study and all subjects completed the bleaching procedures and participated at the follow-up appointments as well. The distribution of gender showed 7 males and 29 females. The ages of the subjects ranged from 20 to 28 years, with an average age of 24.1 years.

The DBT and CBT treatments were significantly different immediately after finishing all bleaching procedures ($P < .001$). CBT had less shade change in lightness, yellowness, and overall color change (ΔL*, Δb*, ΔE, and ΔSG) than did DBT ($P < .05$). However, there was no significant difference in shade change in redness (Δa*) between the CBT and DBT ($P > .05$). The computed data are presented in Table 2. The before and after treatment situations are shown in Figs 1 and 2.

According to Table 3, there were no significant differences in overall rebound rate (ΔE and ΔSG) between the DBT and CBT treatment ($P > .05$).

Tooth sensitivity occurred in 36.7% of all subjects in the CBT group and in 56.7% of all subjects in the DBT group. DBT was associated with significantly higher tooth sensitivity than CBT ($P = .02$) as shown in Table 4. No subjects dropped out of this clinical study. Forty-eight hours after the bleaching procedure was finished, the symptoms of tooth sensitivity disappeared spontaneously.

Gingival sensitivity occurred in 27.8% of CBT subjects and 47.2% of DBT subjects. DBT was associated with significantly higher gingival sensitivity than CBT

Table 2 Mean (± standard deviation) rebound rate (n = 36)

Treatment	Days posttreatment	ΔL*	Δa*	Δb*	ΔE	ΔSG
CBT	1	3.61 ± 2.25	-1.66 ± 0.91	-4.39 ± 1.78	6.13 ± 2.57	-4.97 ± 2.75
	7	3.32 ± 2.35	-1.56 ± 0.94	-4.32 ± 1.68	5.92 ± 2.50	-4.81 ± 2.92
	30	3.10 ± 2.27	-1.50 ± 0.91	-4.06 ± 1.72	5.54 ± 2.58	-4.61 ± 2.86
	90	2.60 ± 2.41	-1.42 ± 0.91	-3.89 ± 1.77	5.20 ± 2.57	-4.16 ± 3.04
	180	2.34 ± 2.30	-1.27 ± 0.93	-3.76 ± 1.86	5.04 ± 2.45	-3.95 ± 3.02
DBT	1	4.41 ± 2.59	-1.92 ± 0.99	-6.09 ± 2.22	8.01 ± 2.95	-6.42 ± 3.04
	7	4.15 ± 2.70	-1.79 ± 1.02	-5.87 ± 2.00	7.68 ± 2.86	-6.18 ± 3.04
	30	3.90 ± 2.52	-1.73 ± 0.97	-5.48 ± 2.00	7.18 ± 2.81	-5.83 ± 3.18
	90	3.60 ± 2.72	-1.67 ± 1.01	-5.04 ± 1.98	6.76 ± 2.78	-5.33 ± 3.20
	180	3.10 ± 2.76	-1.54 ± 1.02	-5.06 ± 2.10	6.45 ± 2.79	-5.06 ± 3.21

($P = .03$). Twenty-four hours after the bleaching procedure was finished, the symptoms of gingival sensitivity disappeared spontaneously.

DISCUSSION

This study implemented a split-mouth design, which is considered an established and widely accepted design for studies on bleaching.[5,14-16] The SG is commonly used to determine the lightness of teeth. Although this method is quick and simple to use, it can be subjective, as it may be influenced by individual variability as well as several other parameters, such as the experience and age of the examiner, eye fatigue, external light conditions, background and interior color, and the angle of perception.[17] Furthermore, comparing SG results is often difficult due to lack of standardization.[18] In contrast, the use of a spectrophotometer excludes human error and facilitates unbiased and reproducible results.

The standard deviations of ΔE, ΔL*, Δa*, Δb*, and ΔSG were relatively large when compared to the mean values in the present study. This implies that the relapse rate of the bleaching treatment varies widely among individuals. This is likely to be caused by a number of reasons. First, it is believed that each subject has a varying inherent potential for lightness, so that even using identical bleaching techniques results in different levels of efficacy for different individuals. Second, the relatively small

Fig 1 Before the bleaching treatment.

Fig 2 After the CBT and DBT treatment.

Table 3 Mean values of color rebound

Time (days)	Treatment	ΔE (mean ± SD)	ΔSG (mean ± SD)
7	CBT	1.23 ± 0.89	0.16 ± 1.45
	DBT	1.39 ± 1.01	0.24 ± 1.53
30	CBT	1.43 ± 0.99	0.36 ± 1.48
	DBT	1.58 ± 0.92	0.58 ± 1.70
90	CBT	1.77 ± 1.38	0.81 ± 2.00
	DBT	2.07 ± 1.52	1.08 ± 2.32
180	CBT	2.13 ± 1.31	1.02 ± 1.97
	DBT	2.34 ± 1.24	1.36 ± 1.98

Table 4 Tooth and gingival sensitivity incidence

Treatment	Total subjects (n)	Tooth sensitivity (%)	Gingival sensitivity (%)
CBT	36	13 (36.7%)	10 (27.8)
DBT	36	20 (56.7%)	17 (47.2)

sample number in this study may contribute to a high level of variance. Finally, individual diets significantly affect the frequency and amount of pigment absorption, which has been shown to closely correlate with the rebound rate after bleaching.

The smallest perceivable difference for the two patches of color is approximately 1.0 ΔE units. The color changes observed in this study were 6.13 ± 2.57 for CBT and 8.01 ± 2.95 for DBT. Thus, the ΔE values of both CBT and DBT were perceivable by the human eye after bleaching. The American Dental Association (ADA) guidelines for acceptance of tooth bleaching products states that the ΔE value specified must be due to higher L* and lower b* values. In the present study, the two bleaching techniques were acceptable according to the ADA guidelines. Matis et al[9] reported that when 36% HP was used for triple 15-minute in-office bleaching sessions, the subsequent 15% CP for 7 days at home would be effective.

CBT is a widely used technique in dental clinics due to its shorter total bleaching time and high bleaching effectiveness. In the present study, the SG changes were 4.97 ± 2.75 for CBT and 6.42 ± 3.04 for DBT, at 1 day post-bleaching. There is a need for further studies to explore DBT. This is the first published study to evaluate the effectiveness of DBT and to compare its outcome to CBT. The present results suggest that DBT may be more effective then CBT in terms of tooth whitening. This may be due to the fact that DBT involves a longer period of bleaching and may result in greater overall effectiveness. However, the difference between CBT and DBT cannot be identified by human eyes.

In regards to the rebound effect, the present study shows that, after the bleaching procedures were completed, tooth color slowly decreased in lightness (L*) and increased in yellow color (b*). During the same follow-up period at 7, 30, 90, and 180 days, the rebound effect of L* was the same for the two tooth bleaching techniques. The color changes in the b* value was similar at day 7, while there were more changes in b* at the follow-up days 30, 90, and 180 when comparing DBT with CBT. The current result revealed that the color rebound of yellowness is more obvious in DBT than in CBT at the same follow-up periods. A possible reason would be an increasing permeability of enamel in DBT, so that the rebound easily appeared.

Previous studies have shown that tooth sensitivity is the most prevalent side effect associated with tooth bleaching, followed by gingival irritation.[12] In the present study, higher rates of tooth sensitivity were induced by DBT when compared with CBT. The possible reason was that the first at-home bleaching session increased the permeability of the teeth, making it easier for the bleaching agent to stimulate the tooth pulp. Thus, DBT is not recommended for patients exhibiting tooth defects, dentin hypersensitivity, or dental fluorosis.[22]

CONCLUSION

Within the limits of the present study, both CBT and DBT presented satisfactory effects. DBT resulted in a better shade change but the two bleaching techniques had a similar rebound effect. CBT was associated with a lower frequency of tooth sensitivity. Overall, CBT might be regarded as clinically preferred.

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REFERENCES

1. 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.
2. Joiner A, Hopkinson I, Deng Y, Westland S. A review of tooth colour and whiteness. J Dent 2008;36(Suppl 1):S2–7.
3. Lima DA, Aguiar FH, Liporoni PC, Munin E, Ambrosano GM, Lovadino JR. In vitro evaluation of the effectiveness of bleaching agents activated by different light sources. J Prosthodont 2009;18:249–254.
4. Bruzell EM, Johnsen B, Aalerud TN, Dahl JE, Christensen T. In vitro efficacy and risk for adverse effects of light-assisted tooth bleaching. Photochem Photobiol Sci 2009;8:377–385.

5. Matis BA, Mousa HN, Cochran MA, Eckert GJ. Clinical evaluation of bleaching agents of different concentrations. Quintessence Int 2000;31:303–310.
6. Auschill TM, Hellwig E, Schmidale S, Sculean A, Arweiler NB. Efficacy, side-effects and patients' acceptance of different bleaching techniques (OTC, in-office, at-home). Oper Dent 2005;30:156–163.
7. 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.
8. Matis BA, Cochran MA, Franco M, Al-Ammar W, Eckert GJ, Stropes M. Eight in-office tooth whitening systems evaluated in vivo: a pilot study. Oper Dent 2007;32:322–327.
9. Matis BA, Cochran MA, Wang G, Eckert GJ. A clinical evaluation of two in-office bleaching regimens with and without tray bleaching. Oper Dent 2009;34:142–149.
10. Garber DA. Dentist-monitored bleaching: a discussion of combination and laser bleaching. J Am Dent Assoc 1997;128(Suppl):26S–30S.
11. Sulieman MA. An overview of tooth-bleaching techniques: chemistry, safety and efficacy. Periodontol 2000 2008;48:148–169.
12. 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.
13. Meireles SS, Demarco FF, dos Santos Ida S, Dumith Sde C, Bona AD. Validation and reliability of visual assessment with a shade guide for tooth-color classification. Oper Dent 2008;33:121–126.
14. Mokhlis GR, Matis BA, Cochran MA, Eckert GJ. A clinical evaluation of carbamide peroxide and hydrogen peroxide whitening agents during daytime use. J Am Dent Assoc 2000;131:1269–1277.
15. Matis BA, Hamdan YS, Cochran MA, Eckert GJ. A clinical evaluation of a bleaching agent used with and without reservoirs. Oper Dent 2002;27:5–11.
16. Matis BA, Cochran MA, Eckert GJ, Matis JI. In vivo study of two carbamide peroxide gels with different desensitizing agents. Oper Dent 2007;32:549–555.
17. Yap AU, Sim CP, Loh WL, Teo JH. Human-eye versus computerized color matching. Oper Dent 1999;24:358–363.
18. Kielbassa AM, Beheim-Schwarzbach NJ, Neumann K, Nat R, Zantner C. In vitro comparison of visual and computer-aided pre- and post-tooth shade determination using various home bleaching procedures. J Prosthet Dent 2009;101:92–100.
19. Joiner A. Tooth colour: a review of the literature. J Dent 2004;32(Suppl 1):3–12.
20. Deliperi S, Bardwell DN, Papathanasiou A. Clinical evaluation of a combined in-office and take-home bleaching system. J Am Dent Assoc 2004;135:628–634.
21. Kugel G, Perry RD, Hoang E, Scherer W. Effective tooth bleaching in 5 days: using a combined in-office and at-home bleaching system. Compend Contin Educ Dent 1997;18:378,380–383.
22. Matis BA, Wang Y, Eckert GJ, Cochran MA, Jiang T. Extended bleaching of tetracycline-stained teeth: a 5-year study. Oper Dent 2006;31:643–651.
23. Reinhardt JW, Eivins SE, Swift EJ Jr, Denehy GE. A clinical study of nightguard vital bleaching. Quintessence Int 1993;24:379–384.