Efficacy and Stability of Two in-Office Bleaching Agents in Adolescents: 12 Months Follow-Up

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Objective: *Although there are several clinical studies on in office vital bleaching in adults, there are no Randomized Clinical Trials for the efficacy of this application in adolescents. The aim the study was to evaluate the efficiency of two bleaching systems on adolescents for twelve-months follow-up.* ***Study design:*** *Twenty-eight volunteers, aged between 13-18, randomly divided into two groups. Two commercial in-office bleaching systems were used:* ***G1*** *(n=14): Zoom2 25 % HP with UV light and* ***G2*** *(n=14): Beaming White 36% HP with LED light in a single 3x15minute procedure. The color assessment was made with a spectrophometer; before and after bleaching; 48 hours; 1, 6 and 12 months later. Color enhancement and maintenance of two techniques over 12 months were compared by two ways ANOVA and Student's t test. Sensitivity was evaluated on a scale with Wilcoxon test.* ***Results****: Both groups demonstrated similar and significant tooth color enhancement and did not reveal any statistically significant differences between them. However, a relapse of the tooth shade was observed with the low concentration agent/ultraviolet light system. No sensitivity was observed in any patients.****Conclusion:*** *Two in-office bleaching systems can be used successfully on young permanent teeth. For long-term successful results, high concentration/LED light may be more effective.*

Key words: *In-office bleaching, adolescents.*

INTRODUCTION

Esthetic problems are especially important for teens and can affect their psychosocial development and social relationships.[1] Tooth discoloration is a common esthetic problem in dentistry and in recent years, it has been reported that the population of young patients requesting tooth whitening is increasing.[2, 3]

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For young patients, instead of more aggressive methods such as porcelain veneers or partial crowns, bleaching is a less invasive and cost effective approach for treating discolored teeth after eruption of their permanent canine teeth (13 years <). [4] There are different methods for bleaching procedures with the most commonly being in-office bleaching using 15–38% hydrogen peroxide (HP) and/or dentist-prescribed home-applied bleaching methods with different concentrations (5-35 %). [1,5,6,7] In-office bleaching has advantages including better control of the clinician, avoidance of material ingestion and soft tissue exposure, faster whitening results, reduced total treatment time, better color stability and less discomfort from wearing strips and trays.[5,8,9]

The effectiveness of in-office bleaching systems has been controversial. The question remains whether in-office bleaching products with lower concentrations are as effective as products with higher concentrations and whether some products or some light sources are more effective than others.[7]

Markovic *et al* [10] stated that due to the clinical experience after bleaching seems to indicate that the main effect of color change does not result only from the enamel but reflects alterations in color of the dentin. It was hypothesized that the bleaching effect is a result of degradation of complex organic molecules being responsible for the color of teeth to less complex molecules and results in a reduction or complete elimination of discoloration. Studies assessing color change after bleaching, depending on the maturation stage of teeth

and the role of optical impact of enamel on the whitening effect, are lacking. Clinical researches are still needed to address the effect of power bleaching on the enamel of young permanent teeth.

The aim of this clinical study was to assess the efficiency of two different in-office bleaching procedures in adolescents, achieved with (1) relatively low concentration kit (25% HP) using an Ultra Violet light activation and (2) a high concentration kit (36% HP) using a LED (Low Emission Diode activated in-office bleaching by using a spectrophotometer for a 12 month follow-up.

MATERIALS AND METHOD

Twenty-eight healthy "volunteers aged between 13-18" participated in this study. The Ethics Committee of Gazi University; Ankara, Turkey (03-2011-05) reviewed and approved the research protocol and informed consent form. All of the participants included in the study signed an informed consent form after full explanation of the project.

All participants had six caries-free maxillary anterior teeth without restorations. Inclusion criteria were the patients' willingness to participate in the study and posses whiter teeth and darker teeth than color A2, good oral hygiene, absence of periodontal disease, absence of gingival recession, availability for the study period. Exclusion criteria included subjects with systemic illness, structural alteration of the tooth structure, bruxism, generalized tooth sensitivity, poor oral hygiene, presence of fluorosis, or tetracycline staining, smokers, the presence of restorations, orthodontic bands/brackets in the six anterior teeth of either arch, previous use of bleaching. The patients who did not comply with the follow up appointments were also excluded.

Study design

Personal information, completed medical history and written consent forms prior to the start of the study was obtained. All participants received a professional dental prophylaxis in order to remove possible extrinsic stains 2 weeks before the start of bleaching treatment and asked to brush their teeth twice a day in order to standardize tooth cleaning during the study.

In both groups, the gingiva of all teeth to be bleached was isolated according to the manufacturers' instructions. To prevent saliva from flowing through embrasures, a saliva ejector and cotton rolls were used in the buccal region. An expanded lip retractor was used to protect the lips. Each bleaching agent was applied by one operator (AB) to the maxillary arch, according to the manufacturer's directions. Patients were randomly distributed into two groups according to agents, which are;

G1: (n=14), ZOOM2 (Discus Dental, USA) containing 25% HP, in-office bleaching gel and UV light (Zoom AP, Discus Dental, 350-600nm) was used in a 3x15 minute single visit treatment procedure, and

G2: (n=14), Beaming White (Beaming White, USA) containing 36% HP office bleaching gel and LED accelerator (24W) was used in a 3x15 minute single visit treatment procedure (Table 1).

For both groups, the activator was mixed into the bleaching agent using the proper syringe and then applied 1-2 mm thick on the buccal surfaces of the anterior teeth of the maxillary arch. After three consecutive application sequences of 15 minutes each, the agent was removed using suction and gauze, and teeth were rinsed with water and the gingival isolation and lip retractor were removed. Desensitizer gel was applied at the end of the bleaching procedure.

To provide accurate repositioning and measurements, alginate impressions (Kromopan, LASCOD, Frenze, Italy) were taken and stone casts prepared for each subject's arch. After obtaining models, transparent soft plastic trays were made using a heat and vacuum tray-forming procedure. To standardize the position of the spectrophotometer probe tip at each measurement, holes matching the middle one-third of the labial tooth surface of the six maxillary anterior teeth were drilled in to the tray due to the shape of the probe tip. The trays were used each time to make the spectrophotometric measurement.

Shade determination was always performed under the same conditions by one experienced and qualified blinded examiner (OT) using the spectrophotometer (Vita Easy Shade Compact® -Vita Zahnfabrik, Bad Säckingen, Germany). Two measurements were made for each measurement sequence. When the values were not equal, additional measurements were made until three consecutive equal measurements were obtained, and only one measurement for each tooth was recorded.

Shade measurement was performed on all six maxillary teeth, before bleaching and after bleaching, 48 hours; 1, 6 and 12 months later using a contact-type intraoral spectrophotometer device with a 5mm diameter probe and working with CIELAB (Commission Internationale d'Éclairage L*a*b*) values. The International Commission on Illumination defined CIELAB system in 1967. L* represents the value of lightness or darkness (0 being black and 100 being white); a* is the measurement along the red-green axis negative values indicate green and positive values indicate red; and b* is the measurement along the yellow-blue axis negative values indicate blue and positive values indicate yellow. The L*, a* and b* values were recorded by using the device. Color differences were calculated using the following equation: $\Delta E = [(\Delta L^*)^2 + (\Delta a^*)^2 + (\Delta b^*)^2]^{1/2}$.[11]

The Easyshade had a spectral range 400–700 nm (with a wavelength resolution of 25 nm), and was calibrated according to manufacturer's instruction. Using a positioning jig, colorimeter measurements in the L*a*b* color system were made of the six maxillary anterior teeth. All participants were advised to avoid foods and beverages with dark colors after bleaching for 48 hours and to not use any kind of mouth rinses.

Evaluation of the tooth and gingival sensitivity

The participants recorded their spontaneous perception of tooth sensitivity after bleaching using a five-step scale: 0:none; 1:mild; 2:moderate; 3:considerable; and 4:severe.

Statistical Analysis: The statistician was blinded to the study groups. The data were tabulated in an Excel program for each volunteer's six maxillary teeth and their L* a* b* values for each appointment and was analyzed using SPSS 11.5 (SPSS Inc., Chicago, USA). The values of the degree of change and color maintenance (ΔE) of two bleaching techniques (inter-group comparison) over 12 months were compared by two way ANOVA and time interval comparisons (intra–group) were evaluated by Student's t test with Bonferroni correction. The tooth sensitivity was evaluated by Kruskal Wallis and Mann-Whitney U test.

RESULTS

A total of 25 participants completed the study. Three patients didn't come for follow-ups and one patient from Group 1 and two patients from Group 2 were excluded from the study. Study population included 17 girls and 8 boys, with a mean age of 13,9 years. (Table 1) During follow up period, all remaining subjects were assessed in terms of, radiographically pathologic lesions, sensitivity, pain and any other symptoms. None of the patients reported any of these symptoms. Vitality tests were in normal levels.

Although baseline L* and a* values revealed no statistically significant differences between two in-office bleaching agent groups; b* values were statistically significantly higher in G2 (p=0,040; p=0,611 and p< 0,001) Spectrophotometric shade evaluation values are reported in Table 2.

In Table 3, the mean values of shade changes (ΔE-values and standard deviations) are given for all groups and at each tested time intervals. The values of the degree of change and color maintenance (ΔE) of two bleaching techniques (inter group comparison) over 12 month were compared with two-way ANOVA. Both groups showed a clinically significant improvement in tooth color after treatment, improved lightness and whiteness when comparing base-line shades (p<0.001). In comparison of the two agents, statistical analysis did not reveal any significant differences between them according to ΔE values, after bleaching; 48 hours; 1, 6 and 12 months (p>0.0033).

For Group I (Zoom2) statistically significant differences were observed only among in the period immediately after the bleaching ΔE, initial-48 hours ΔE value and initial-1 month ΔE value (p< 0.01). Among other time intervals there were no significant statistical differences observed at ΔE values (p< 0,001).

In Group 2 (Beaming White), compared to initial-after bleaching ΔE value to initial-6M and initial 12-M time interval ΔE values were showed statistically significant differences.

For both groups, mild sensitivity occurred only during the application period. After treatment with both bleaching agents, no sensitivity was observed in any patients for any time intervals. Despite the absence of statistically significant difference on teeth sensitivity between the two techniques, in both groups only 3 patients presented mild (1) teeth sensitivity during the treatment and it disappeared at the end of application. (Table 4)

Table 1- According to the study groups the whitening products and their contents

Groups	Product	Manufacturer	Content	Light source
Group 1 (N=13)	Zoom2	Discus Dental (USA)	25% Hydrogenperoxide	Ultraviolet light source
Group 2 (N=12)	Beaming White	Beaming White (USA)	36 % Hydrogenperoxide	LED light source

Table 2- Spectrophotometric shade evaluation values

	G1: ZOOM2 (Mean ±SD)			G2: BEAMING WHITE (Mean ±SD)		
	L*	a*	b*	L*	a*	b*
BASELINE	74.7(±3.0)	0.26(±0.76)	18.64(±1.57)	77.4(±1.95)	0.05 (±0.94)	22.6(±3.86)
AFTER BLEACHING	83.6(±1.3)	-0.65(±0.47)	11.34(±1.08)	82.4(±3.35)	-0.02(±0.52)	14.6(±3.48)
48 HOURS	84.4(±1.3)	-0.72(±0.35)	10.32(±1.32)	83.2(±2.89)	0.73(±0.56)	12.7(±3.3)
1 MONTH	85.3(±1.3)	-0.76(±0.30)	10.21(±2.02)	83.3(±2.35)	-0.76(±0.42)	12.2(±2.49)
6 MONTH	86.2(±2.6)	-0.68(±0.31)	10.94(±2.2)	84.6(±2.27)	-0.68(±0.34)	10.7(±1.86)
12 MONTH	82.8(±3.2)	-0.59(±0.34)	12.06(±2.62)	86.0(±1.68)	0.73(±0.37)	10.4(±1.91)

Table 3- ΔE values compared to baseline for both groups

	G1: ZOOM2 ΔE (±SD)	G2: BEAMING WHITE ΔE (±SD)	P Values between two products' $\Delta_{E\ time\ interval}$
Initial- Post Bleaching	11.70(±1.71)	10.04 (±3,80)	0.183
Initial - 48 Hours	13.0(±1.86)	11.7 (±3.64)	0.306
Initial -1 Month	13.8 (±2.14)	12.3 (±3.14)	0.178
Initial -6 Month	12.6 (±3.57)	14.2 (±3.20)	0.250
Initial -12 Month	10.9 (±4.04)	15.1(±2.73)	0.006

Table 4- Tooth sensitivity

Valid percent of participants' intensity of tooth sensitivity with each bleaching system

Systems tested	Percent in population	Intensity of sensitivitiy	Mann-Whitney U test
ZOOM2 (N=12)	3 person 25.0%	1=mild sensitivity	P= .912
Beaming White (N=13)	3 person 23.1%	1=mild sensitivity	

Values taken from participants records of tooth sensitivity on a scale from 0 to 4 after Bleaching.

DISCUSSION

Although there is an increase of young patients' bleaching requests in recent years, there are limited amount of studies about vital bleaching in children and adolescents in the literature. [2,3,12,13] Only few of them were long-term randomized controlled clinical trials and almost all were related with home bleaching with low concentration.[4,14,15,16,17] Therefore, this study aims to contribute the literature about relatively high concentration in-office vital bleaching agents in adolescents and their long term effectiveness and safety.

Some researches have suggested that concentration and contact time are very important for in- office bleaching.[7] The study results of Borges *et al* [18] stated that bleaching with 35% HP gel was more effective than with the 20% gel, without promoting significant adverse effects on enamel surface. According to Matis *et al* [7] although contact time is important, concentration is not as an important factor. In this study at the beginning, concentration differences did not create statistically meaningful differences but at the end of the 1-year follow-up the product which has higher concentration showed more effective results. However, the differences still weren't statistically significant.

After one bleaching session, studies on a higher concentration of hydrogen peroxide reported that their results in ΔE and visual shade scales usually have observed an overall color change of 4.7 to 8.7. [18] In this study the mean ΔE values obtained at the end of the treatment for both groups (G1: 11,71; G2: 10,04) were comparable and higher to the mean ΔE values reported in the literature.[19,20] Only the study by Radz *el al* reported very similar results to our study, after one session of in office whitening, and additionally 3 weeks of at home tray whitening (Philips Zoom White Speed and Zoom Nite White, Discus Dental, USA). Their study subjects showed on average a change of 11.1 shades. It has been stated that tooth bleaching is directly associated with tooth structure and permeability. [22] Thus, our higher values may be associated with the young permanent teeth' capacity of permeability.[4,10]

The bleaching procedures in the present study were performed exactly following the manufacturers recommendations and the results of this preliminary study indicated that both techniques demonstrated similar and significant tooth color enhancement as compared with the baseline and similar results for 48 hours, 1 month, and 6 months. 12-months results were different, but this difference was not statistically significant.

In ZOOM2, (Group1), the mean ΔE values were compared to the baseline and values observed at 48 hours and 1 month were statistically significantly higher. It has been reported that chromophoric dissolved organic matter (CDOM) present in natural waters may transmit photolysis due to exposure to UV radiation, may cause the formation of hydrogen peroxide.[23] It may be expected that endogenous dentinal fluid exposed to UV radiation can lead to the formation of additional hydrogen peroxide and therefore potentiate the bleaching effect, may explain the significant bleaching effect. This effect continued slightly after light application.

In the Beaming white group (Group 2), at 6 and 12 months, significantly higher values of ΔE, were observed compared to the baseline; which may refer to the gained oral hygiene habits, saliva composition but also the higher HP concentration. Within the limitations of this study, immediately after bleaching treatment, the 36 % hydrogen peroxide was showed to have a slightly lower bleaching effect compared to the other group. It showed a higher effect at the initial period in change of b* values (yellow-green) that remained effective in the long term and even provided a continuing whitening effect.

He *et al's* [5] systematic review revealed that the high concentration of bleaching itself can quickly produce enough radicals that react with pigments, and these effect is more significant than the effect of light. For lower concentration of HP (15-20%) products light did create better immediate bleaching effects. They concluded that light induced dehydration might have played an important role in immediate bleaching effect. Because limited data support this observation, however, no consolidated conclusion can be drawn in their Meta analysis and further studies are needed. [5]

The main advantage of in-office bleaching is rapid bleaching. But after applying most in-office bleaching products there is also a rapid reversal in color is occurred. This may be caused due to dehydration.[7] The results of presented study showed that both of the bleaching systems provided whitening right after the application and even continued in the following months, while no color reversal was observed related with dehydration. A slight relapse in tooth shade was observed with the product with lower concentration at the 6-month measurements and continued to darken linearly towards the 12-month measurements. On the other hand, the shade values at the higher concentration group continued to improve until 6-months although the difference between groups were not statistically significant. The lower HP concentration bleaching agent activated with UV light showed more relapse at the end of the one-year period.

Tooth color assessment can be determined by visual evaluation using color shade tabs which is an easy, cost effective, fast but a subjective method.[24,25] Thus, in recent studies instrumental evaluation has been preferred over visual evaluation, which has been reported to be more comparable to the other studies.[24,25] Furthermore, the instrumental evaluation has been preferred over the visual evaluation because it makes the process more practical and

statistically more reliable to compare to the other studies which have used the same evaluation method. [22]

According to Croll and Donly [26]; tooth sensitivity is common for adolescent patient but only causes a mild, transient inflammatory response. Donly *at al's* [4] alternative study results showed that a total of 35% of all participants reported tooth sensitivity with equal incidence in each treatment group. In our study a total of approximately 24 % of all participants reported mild sensitivity during bleaching procedure with equal incidence in each treatment group. There could be speculation that adolescents would have greater sensitivity than adults because they have less dentin thickness.[4] On the other hand there could be less sensitivity because young permanent teeth enamel doesn't have any cracks on their surface or regression on their gingiva due to aging, also their pulp chambers are larger and able to recover more rapidly[4]. Especially for children and adolescence bleaching may be accepted most conservative approach for many cosmetic conditions because this treatment may be readily accomplished without local anesthetics, and without radical, invasive procedures to the teeth.

In adolescents, a low frequency of sensitivity is observed if a proper gingival protection is used. The results of the studies on adult population seem to be more controversial that possibly may be attributed to gingival recession and macro/microscopically open root surfaces, unsealed restoration and tooth tissue margins or to crack lines that were not been diagnosed or properly managed before the application of the bleaching agents.

CONCLUSION

It is necessary to evaluate "in office" bleaching effectiveness and safety for this age group in the pediatric dentistry clinics, because currently, this age group is more demanding about white similes and need to be supervised by a dentist during bleaching procedure.

Both in-office bleaching products provided a similar bleaching effect and improved the lightness during the one-year clinical observation period. There were no statistically significant relapse in terms of color and any discomfort with both products.

Study results indicate that two in-office bleaching systems can be used successfully on young permanent teeth. For more successful long-term results, higher concentration might be more effective.

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