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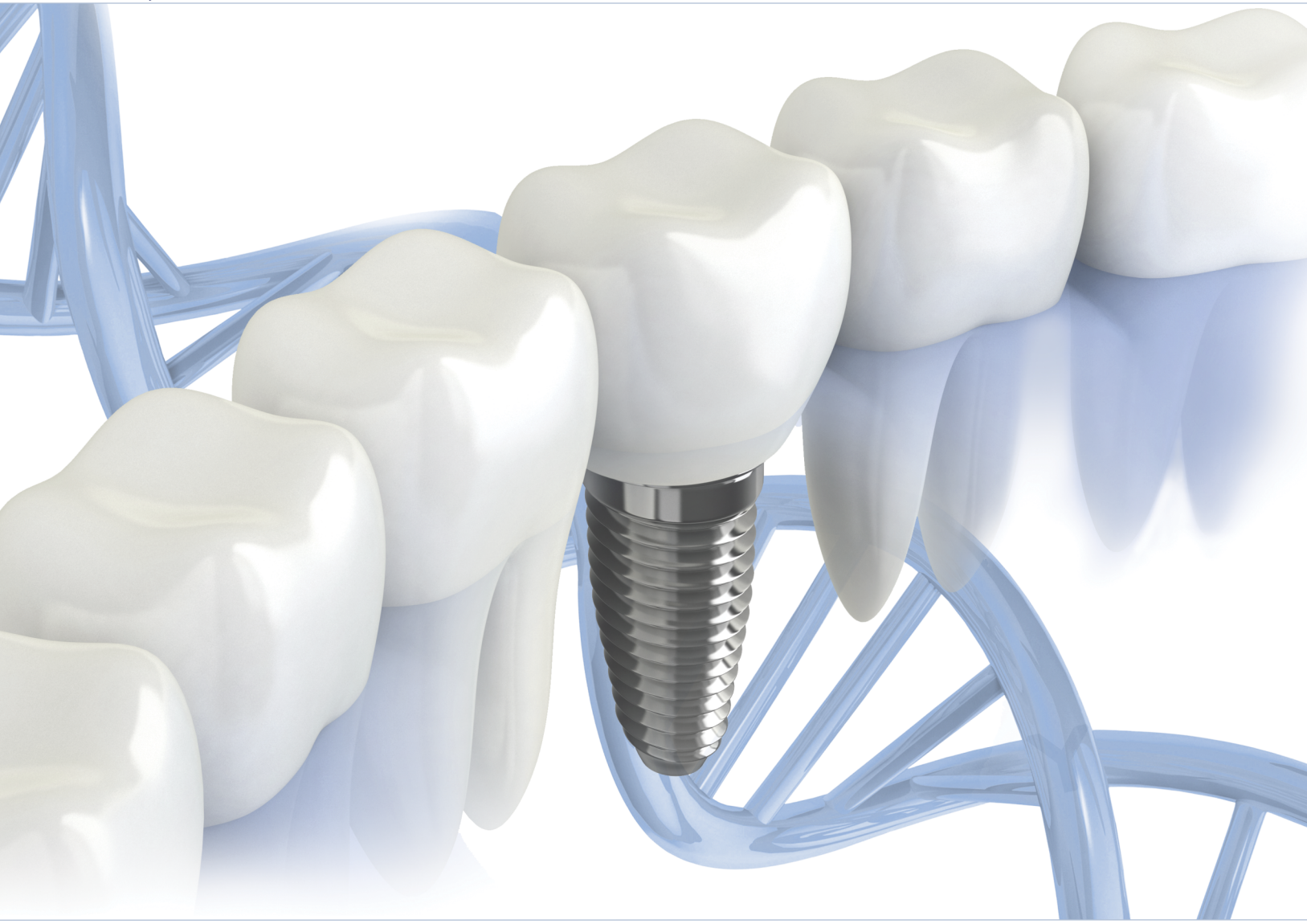

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Original Research

Clinical Evaluation of Color Change and Tooth Sensitivity with In-office and Home Bleaching Treatments

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Abstract

Background: Among the number of vital bleaching techniques currently available to the clinicians, home bleaching and in-office bleaching are widely used in dental practice. **Aim and Objectives:** The aim of this *in vivo* study was to compare the clinical performance, durability, and related tooth sensitivity with two vital bleaching procedures (in-office and at-home bleaching), in a split-mouth design. **Patients and Methods:** Thirty adult participants having teeth shade mean of A2 or darker were selected for the study. One-half of the maxillary arch of each patient received in-office bleaching with 35% hydrogen peroxide gel, and the other half received 16% carbamide peroxide night guard bleaching. Shade evaluation was done with shade guide and spectrophotometer at 1, 2, 3, and 4 week intervals during bleaching and postoperatively at 3 and 6 month intervals. Tooth sensitivity was recorded using the visual analog scale during the experimental period. **Statistical Analysis:** Collected data of color and sensitivity readings were subjected to statistical analysis using SPSS/PC version 20 software. Intergroup comparison through unpaired *t*-test and within the groups using paired *t*-test was done. **Results:** At-home and in-office bleaching procedures are equally effective in producing tooth whitening. Color evaluation after 3 and 6 months showed more color decline for in-office bleaching procedure. For sensitivity parameter also, in-office procedure recorded higher sensitivity compared to home bleaching ($P < 0.05$). **Conclusion:** Both the bleaching procedures are equally effective in producing tooth whitening. In-office bleaching recorded higher levels of tooth sensitivity and greater color rebound than home bleaching.

Keywords: *Bleaching, shade guide, spectrophotometer, tooth sensitivity, visual analog scale*

Introduction

The teeth are an integrated part of facial esthetics and are involved in complex social, cultural, and psychological interactions. It is generally perceived that whiter teeth enhance the beauty of a person's smile. As a result, the demand for whiter and brighter teeth is increasing among today's patients.[1] Tooth whitening is one of the fastest growing areas in cosmetic and restorative dentistry. Bleaching is a procedure, which involves lightening the color of a tooth through the application of a chemical agent, to oxidize the organic pigmentation in the tooth. Teeth are whitened by materials such as hydrogen peroxide (HP) and carbamide peroxide (CP), by the initial diffusion into enamel and dentin. These oxidizing agents, after diffusion, break down to produce unstable, free radicals. These free radicals attack organic pigmented molecules, reflect less light, thus creating a "whitening effect."[2]

Vital tooth bleaching is considered a safe, effective, minimally invasive, nondestructive, and well-accepted procedure for the treatment of discolored teeth. The most frequently used vital bleaching techniques are "power bleaching" (in-office) and "at-home bleaching." Within these two categories of bleaching techniques, there are other variables such as type and concentration of bleaching agent used and it's application time.[2] Clinical studies comparing the efficacy and durability of these techniques are not abundant.

Common clinical adverse effects of bleaching are hypersensitivity and gingival irritation. Browning *et al*. observed dentinal hypersensitivity in 77% of participants and 22% of soft tissue sensitivity after bleaching procedures.[3] Tooth sensitivity, which is one of the most common side effects of bleaching treatment, normally persists for up to 4–7 days after the conclusion of bleaching treatment. Tooth sensitivity

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during whitening has been associated with microscopic surface defects and subsurface pores in enamel. It has been theorized that these defects allow rapid ingress of the whitening agent toward the pulp, and this results in sensitivity.[4]

Apart from dentinal sensitivity, the long-term stability of whitening effect is perhaps the most uncertain aspect of the bleaching therapy. The reported recurrence rate of tooth discoloration after 2 years is 10%, after 5 years is 25%, and after 8 years is 49%. For tray bleaching, Haywood reported regression of whitening effect in 26% of cases at 18 months.[5] Dietschi *et al*. in their *in vitro* study, comparing in-office and home bleaching procedures, found that at-home bleaching produces a pronounced bleaching in deeper tooth tissues, which would probably maintain the lighter color for a more extended period than in-office bleaching.[6]

Considering these findings, this study evaluated the degree of color change, color relapse, and tooth sensitivity associated with in-office and at-home bleaching treatments. The null hypothesis tested was, there is no difference in clinical performance, developed sensitivity and durability between the two bleaching treatments.

Patients and Methods

After getting clearance from the Ethics Committee, research protocol was approved by Dr. NTR University of Health Sciences (D138601056). Thirty volunteers were selected for this clinical research, according to the inclusion and exclusion criteria [Table 1].

Table 1: Inclusion criteria and exclusion criteria

Inclusion criteria
Caries-free anterior teeth without restorations on labial surfaces
Absence of tooth sensitivity (stimulated sensitivity using air syringe)
Patients older than 18 years
Anterior teeth, determined to be A2 shaded (VITA shade guide) or darker
Patients who could read and sign the consent form and are willing to attend the follow-up visits
Exclusion criteria
Patients with dentinal sensitivity equal to or greater than mild
Patients, who had undergone tooth whitening procedures previously
Teeth with severe internal discoloration (tetracycline stains, fluorosis, or pulpless teeth)
Patients having habits such as smoking, pan chewing, or parafunctional habits
Patients with periodontal disease or to be treated for periodontal disease
Patients who had noncarious cervical lesions or anterior teeth with exposed incisal dentin
Pregnant and lactating women

Experimental design

For a better comparison, a split-mouth design was selected, in which the same patient was submitted to two different bleaching treatments in the right and left maxillary hemiarches. For all the participants, elastomeric impressions were taken, and two study models were prepared. One model was used to fabricate the night guard for home bleaching procedure. Customized vacuum-formed bleaching trays were fabricated using 0.035 inch (1.5 mm) thick and 5 × 5 inch soft vinyl night guard sheets (3A Medes, Goyang-si, Korea). Bleaching trays were inserted into the patients' mouth for evaluating it's adaptation, and adjustments were done. The trays and the bleaching gel tubes were given to each volunteer with instructions.

The second cast was used to construct a positioning jig and to ensure proper repositioning of spectrophotometer probe for each dental component to be evaluated, using polyvinyl siloxane impression material (Ad-Sil, Prime Dental Products Pvt. Ltd., Thane, India). In that, window openings were prepared on the central part of the labial surface of each tooth, using a metallic device of 3 mm radius, with well-formed borders.

Bleaching procedure

After oral prophylaxis, registration of the initial shade of the maxillary teeth was done using a Vitapan classical shade guide (VITA Zahnfabrik, Bad Sackingen, Germany) and an easy shade compact spectrophotometer (VITA Zahnfabrik H, Bad Sackingen, Germany). At the same time, the degree of tooth sensitivity of each participant was evaluated, using the visual analog scale (VAS), and the bleaching procedure was carried out.

For in-office bleaching, all the teeth in the assigned quadrant to be treated with in-office bleaching procedure were isolated with rubber dam (Hygenic, Coltene Whaledent, USA). A light cure resin gingival barrier (Pola Office) was placed around the cervical margins of the teeth and cured for 20 s. A 35% HP gel (Pola Office, Southern Dental Industries, Victoria, Australia) was applied on the tooth surface and left undisturbed for 15 min. The bleaching material on the teeth was activated using Quartz Tungsten Halogen light (Elipar 2500, 3M ESPE, Germany). The bleaching gel was refreshed for every 15 min during a 45 min application period. After this period, the bleaching gel was removed with cotton rolls, and the teeth were washed, dried, and received an application of 2% neutral sodium fluoride (Nupro Gel, Dentsply) for 4 min. A total of 3 sessions were performed with an interval of 7 days between each session. Visual and Spectrophotometric evaluation of color alterations was made at each session, before, and immediately after the bleaching treatment in an illuminated room.

Night guard bleaching was accomplished with 16% CP (Pola Night, Southern Dental Industries, Australia) by placing gel in the internal facial aspect of the tray that

was used for 3 weeks, in an 8 h daily regimen in the nights. The bleaching outcome was evaluated qualitatively using a visual method with the aid of a shade guide and quantitatively using a spectrophotometer after 1 week (T1), 2 weeks (T2), 3 weeks (T3) during treatment, and posttreatment at 12 (T4) and 24 weeks (T5) from the start of the treatment. Two blinded, previously calibrated examiners participated in the color evaluation.

Tooth sensitivity for each hemi-arch was evaluated and recorded in each session by asking the volunteers to classify the sensitivity during bleaching treatment as absent, mild, moderate, or severe using VAS.

Statistical analysis

Statistical analysis was carried out using SPSS/PC version 20 software (SPSS software, IBM, Karnataka, India). Color and sensitivity parameters were evaluated with two variables (group and time) through unpaired *t*-test. Intergroup comparison between the two bleaching procedures was evaluated using unpaired *t*-test and intragroup comparison, i.e., at different time intervals, within the procedure was evaluated using paired *t*-test. The level of confidence was established at $\alpha = 0.05$.

Results

The effectiveness of tooth bleaching, indicated by the color difference between the different time periods, was evaluated by spectrophotometer and was determined by the values of ΔE [Figure 1]. The magnitude of this variation was determined from the average of L* a* b* values.

$$\Delta E \text{ CIELAB} = \sqrt{(L^*1 - L^*2)^2 + (a^*1 - a^*2)^2 + (b^*1 - b^*2)^2}$$

- Parameter L* - Both bleaching regimes resulted in a pronounced increase in enamel lightness parameter L* from baseline without any statistical difference. However, the decrease in bleaching effect is most apparent in the decrease in lightness parameter "L" at 6 months
- Parameter a* - Both bleaching regimes resulted in a continuous decrease in a* values over time and slight increase in values at T4 and T5. At T2 and T5, home bleaching group recorded statistically lower values compared to in-office bleaching group, suggestive of greater shift on the green–red axis to a less pronounced red hue component of teeth
- Parameter b* - Both bleaching regimes resulted in a continuous decrease in b* values over time in the sense of a color change in the direction of a more bluish appearance.

On comparing home bleaching and in-office bleaching treatments using visual method [Table 2], there was no statistical difference between the treatment procedures. Observing the longevity of lightness of bleached teeth after 3 and 6 months suggests that both the bleaching groups have shown color rebound. Decline in lightness of teeth was statistically more significant in in-office group ($P < 0.05$) when compared to at-home bleaching group.

In-office bleaching group recorded higher sensitivity scores [Figure 2] throughout the treatment procedure compared to home bleaching group, and the difference was statistically significant ($P < 0.05$).

Discussion

Among various vital bleaching procedures, (1) at-home technique is more cost effective; the value of the dental color obtained is sustained for long periods, but important changes in this value are not observed before 7th day

Table 2: Mean, standard deviation shade guide scores for at-home and in-office bleaching treatments

Variables	Home bleaching		In-office bleaching		*t*	*P*
	Mean	SD	Mean	SD		
Baseline	6.47	0.81	6.50	0.78	−0.1087	0.9138
T1	5.07	0.50	4.97	0.49	0.7639	0.4480
T2	3.70	0.59	3.76	0.36	−0.4989	0.6198
T3	2.86	0.42	3.00	0.20	−1.7159	0.0915
T4	2.94	0.37	3.26	0.26	−3.9139	0.0002*
T5	3.11	0.15	3.38	0.22	−5.4491	0.00001*

*P<0.05. SD: Standard deviation

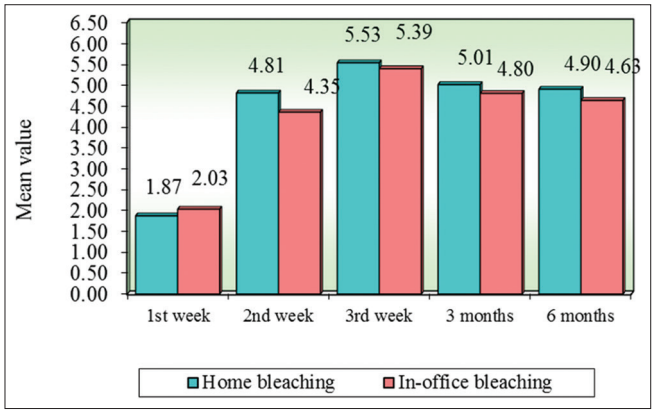

Figure 1: Mean rank values of ΔE with the two bleaching methods at different time intervals

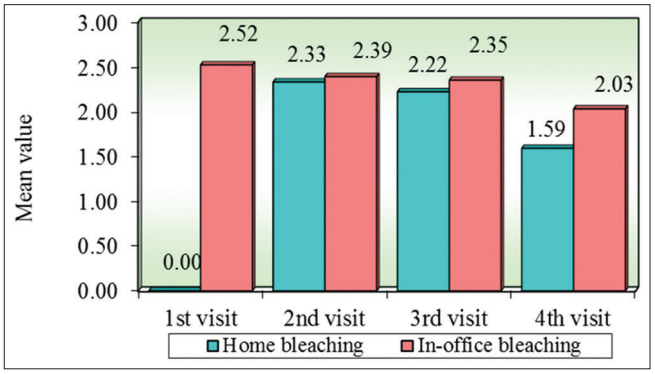

Figure 2: Sensitivity scores at different time intervals for both the groups

of the treatment and (2) in-office procedure that uses photoactivation of high concentrated gel of peroxide allows changes in the color of the enamel immediately. Thus, the present study was intended to compare the efficacy of these two vital bleaching procedures.

Split mouth design is characterized by subdividing the mouth of the participants into homogeneous and experimental units such as quadrants within the patient. This design allows for simultaneously comparing two bleaching techniques in the same patient, reducing the influence of tooth-related and patient habit variables commonly observed in the bleaching treatment.[7] Minimizing the depending variables on the bleaching procedure, i.e., same environmental and habitual conditions of oral cavity results in minimal bias or standard deviation for the study.

To standardize the position of color recording at all times, a custom positioning tray was made. This putty guide also prevented light contamination during the color evaluation. The use of spectrophotometer has become more popular in recent studies because of its ease of use and it being lightweight, with precise measurement that allows color analysis in small areas.[7] The effectiveness of tooth bleaching, indicated by the color difference between the initial condition and posttreatment periods, was determined by the values of ΔE. Under experimental conditions, the human eye can perceive ΔE of 1 or higher, but under clinical conditions, difference must be 3.3 or above to be detected.[8] In our study, based on teeth which showed no significant difference in color at baseline, ΔE scores higher than the values acceptable under clinical conditions were achieved at all time intervals for both the groups.

In-office bleaching technique basically involves the application of 30%–35% HP and heat or a combination of heat and light or lasers to the enamel surface. Several clinical studies have evaluated the use of supplementary light on the effectiveness of vital bleaching procedure in in-office technique. The light source heats the HP, thereby increasing the rate of decomposition of oxygen to form oxygen-free radicals and thus enhances the bleaching effect.[9] In a study by Browning and Swift, it was stated that light sources used during power bleaching procedure do not generate sufficient heat to damage teeth. They concluded that high concentrations of chemicals are responsible for faster whitening and that light sources are, therefore, superfluous in the whitening process.[10]

Enamel dehydration occurs during in-office bleaching process, either due to isolation or due to acidic nature of bleaching material, which may result in a temporary whitening effect. Such whitening effect dissipates upon the rehydration of the enamel.[10] Thus, the final color evaluation for in-office bleaching procedure was postponed for 1 week after the cessation of in-office bleaching treatment. This avoided any dehydration effect from being included erroneously in the color evaluation data.

Both bleaching groups produced highly significant increase in lightness parameter L* ($P < 0.0001$) from baseline to postbleaching (after 3 weeks). Regarding a* values, which were diminished during the procedure, indicating a color shift on the green–red axis to a less pronounced red hue. The b* values diminished during the procedure, reflecting a color change in the direction of a more bluish appearance. Results revealed that there was no significant difference between the groups regarding the degree of whitening (ΔE = overall color change). Therefore, the null hypothesis stating that the "degree of bleached teeth in both groups is statistically the same," was accepted. Indeed, both protocols were effective in promoting tooth bleaching, and this finding is in agreement with previous studies.[7,11,12]

The long-term stability of bleaching is perhaps the most uncertain aspect of the therapy, as many factors must be considered when attempting to predict the outcome, including the etiology and original degree of discoloration, dietary and smoking factors, and patient age.[13] There was a regression of color for both in-office and home bleaching groups after 3 and 6 months showing rebound effect. Li *et al*. evaluated the color regression of bleached teeth in experimental environments and explored the relationship between color change and bulk mineral loss. It was concluded that the regression of lightness is significantly correlated with the density change of teeth hard tissues, as no color regression and mineral content change were found in an anhydrous environment.[13,14] In correlation with these studies, the present study reported greater color relapse with in-office bleaching compared to that of home bleaching treatment group. This may be attributed to the amount of time available for remineralization of bleached teeth in oral environment. With home bleaching procedure, demineralization and remineralization are a continuous cycle during treatment period itself, whereas for in-office bleaching, remineralization takes place after cessation of bleaching procedure that could be the reason for higher rebound values in in-office technique.

Tooth sensitivity is a side effect commonly reported in the literature after vital tooth bleaching. In this study, the hemiarches bleached with in-office technique (35% HP) resulted in a higher degree of tooth sensitivity when compared to the hemiarches treated with the home bleaching technique. The reported sensitivity was moderate and more severe on the day of the gel application for in-office group, and it virtually disappeared after 4 days for most of the patients. This finding was in accordance with the other previous studies.[14,15] Cooper *et al*. showed that a very fast passage of HP occurs through the dental structure, i.e., within 15 min after application, so larger amounts of reactive species may arrive to the pulp, leading to a more intense inflammatory response and tooth sensitivity.[16] Contrary to these results, Zekonis *et al*. found higher sensitivity for home bleaching (10% CP) when compared to in-office bleaching (35% HP).[17] The

reason could be the absence of a desensitizing agent in the formulation of the bleaching agent and different concentrations used in their research. However, sensitivity of teeth even though is a common side effect, it did not overwhelmed the advantage of bleaching.

Conclusion

Within the limitations of this *in vivo* study, it can be concluded that home bleaching and in-office bleaching are equally effective in obtaining tooth whitening. There was color regression for both bleaching procedures at 3-month and 6-month follow-up periods. Regression of color and posttreatment teeth sensitivity were significantly higher for in-office bleaching treatment.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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