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Comparison Between Color Change of Different Bleaching Protocols – Randomized Single-Blinded Controlled Clinical Trial

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ABSTRACT

Introduction: The revolution in the aesthetic industry occurred due to the increased awareness of the patients about the minimal invasive aesthetic treatments. Bleaching is considered one of the most popular non-invasive cosmetic treatment done to lighten tooth shade beyond its natural color. ***Objective:*** To compare between color change following the application of 3 bleaching techniques, (LASER activated bleaching, light-activated bleaching, and chemical activated bleaching) immediately 24 hours after application. ***Procedures****:* Three different groups each of thirteen patients. Patient's assignment to each group was done randomly by using random allocation. On Group A laser bleaching J.W. Power Bleaching NEXT. Group B, light-activated bleaching. While on Group C, chemical activated bleaching (Dash Philips-bleaching system 30% hydrogen peroxide) was applied. By using a sealed coded opaque envelope containing the treatment protocol of the subject, the allocation concealment was done. The envelope was only revealed on the day of bleaching. Assessment of the outcomes took place for teeth shade preoperatively, and post-operative, using a spectrophotometer. ***Results:*** The results of this study were as follows: there was no significant difference in color change between the three assigned groups. ***Conclusion:*** The bleaching techniques tested in the current study protocols resulted in similar color change results tested immediately 24 hours postoperatively.

Keywords: Bleaching, Color change, Laser, Color stability.

INTRODUCTION

The call for aesthetics has increased dramatically. Some factors, such as the patient's awareness and demands, as well as the improvement of the technology of energy-based devices, caused the advancement in the aesthetics market

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worldwide.[1] Bleaching by definition, is a chemical process by which oxidative decomposition of bleaching agents acts to remove external stains from the tooth structure so that a tooth becomes lighter.[2] Bleaching market is divided into two main groups: in-office bleaching and at-home bleaching. Hydrogen peroxide in high concentrations (25% to 40%) and carbamide peroxide as well (35% to 38%), are usually considered to be the agents used in in-office bleaching.[3] Activation of these materials is either done by chemical ways, or by energy sources externally applied such as blue colored halogen curing lamps, advanced LED light, or by using lasers "light amplification by stimulated emission of radiation".[4] Bleaching chemicals are unstable molecules, that dissociate when the tooth surface is exposed to them.[5] Chemical bleaching includes a catalyst and salts of transition metals to bleaching materials that are incorporated before use, to increase the rate of its dissociation and the formation of free radicals.[6]

A light of high intensity in bleaching accelerates the bleaching applied agents by increasing its temperature, thus improving the effect of the treatment.[7] There are different types of external light sources used in the bleaching techniques. Till now, there is a small number of studies that compares them to elaborate the difference in results between them all to introduce the one with the most acceptable outcome.[8]

Lasers were introduced recently to accelerate bleaching effectiveness by improving the oxidation effect of hydrogen peroxide.[9] Laser types used in teeth whitening are argon lasers, diode lasers of a wavelength of (810 nm – 980 nm), or Nd: YAG lasers with a wavelength of 1064 nm.[10]

Additional drawback on enamel as examined through studies on various bleaching systems on extracted bovine and human extracted teeth include dehydration of the tooth structure.[11] The dehydration will make teeth look lighter because inter-prism spaces are filled with air instead of water.[12] studies have shown that teeth will need no less than 30 minutes for the saliva to fill-up the inter-prism spaces and restore the light refraction index of the tooth, bringing back the tooth's original color and regain hydration.[11,12] Thus, teeth should be allowed time to rehydrate for accurate shade evaluation.[13]

The null hypothesis of the current study stated no difference between LASER activated bleaching, light activated bleaching, and chemical activated bleaching on color stability and post-bleaching hypersensitivity over a certain period of time.

MATERIALS AND METHODS

Study Design

This was a randomized single-blind clinical trial

Material

Material's composition and manufacturer's company name are presented in the **Table (1).**

minimum of 13 cases per category, for a total of 39 cases.

Patients were divided into three groups, each with thirteen patients, in this single blinded clinical trial. Using an Excel-generated random allocation, patients were allocated to one of three treatment groups.

Table (1): Materials used in the study, composition and manufacturer's company name.

Material used	Description	Composition	company
ZOOM! In-office bleaching system	Light-activated bleaching agent	25% hydrogen peroxide Potassium hydroxide Potassium nitrate Eugenol Ferrous Gluconate Mentha Piperita Poloxamer glycerin	Discus Dental, Philips, U.S. A
Relief A.C.P.	Amorphous calcium phosphate desensitizing agent	Poloxamer 338 Water Potassium nitrate Mentha Piperita Calcium nitrate Sodium phosphate Sodium saccharin Sodium fluoride	Discus Dental, Philips, U.S. A
Dash in-office teeth whitening	Chemical-activated bleaching agent	30% hydrogen peroxide Water Glycerin Potassium stannate, ammonium hydroxide Etidronic acid Sodium acrylodimethyltaurate copolymer	Discus Dental, Philips, U.S. A
JW Power Bleaching NEXT	Laser-activated bleaching agent		Heydent GmbH Kaufering, Germany,

Methods

Sample Size Calculation:

The findings of Liang S et al. (2013),[14] were used to determine sample size. The approximate minimum required sample size (n) was 10 cases per group, for a total of 30 patients, using an alpha level of 0.05 (5%) and a level of 0.20 (20%), i.e., power = 80 percent. To account for the 25% drop-out rate, the sample size was increased to a

Eligibility criteria:

Inclusion & Exclusion criteria are presented in the **Table (2).**

Before beginning the study, all participants signed a consent document in the local language after being confirmed as eligible.

Randomization:

Patients were divided into three groups, each comprising thirteen patients. Patients were randomly assigned to one of the three treatment groups using Excel generated random allocation. Group (A) received Laser bleaching; J.W. Power Bleaching NEXT is a two-component chair-side bleaching gel in a double-bar cartridge with 35 % active ingredient content (hydrogen peroxide). Group (B) received light-activated bleaching, Philips ZOOM! Bleaching system 25% hydrogen peroxide with light activation machine. Group (C) received chemical activated bleaching, Dash Philips bleaching system 30% hydrogen peroxide. Each group received the treatment according to the manufacturer's recommendations, followed by the desensitizing agent.

Table (2): Inclusion & Exclusion criteria.

Inclusion criteria	Exclusion criteria
Patients must be between 18 and 45 years old to avoid hypersensitivity resulting from the immature pulp in young populations, or the apparent yellowish color of dentin resulting from enamel wear in older populations.	Existing anterior crowns or any restorations on anterior teeth that will interfere with the bleaching process.
Presence of six sound maxillary anterior teeth.	Smoker or alcoholic patient.
Patient having brown or yellowish stains.	Patients suffering from active periodontal diseases and exposed roots.
Good oral health maintained by routine brushing.	Severe internal tooth discoloration.
Generalized tooth staining ranging from A2 or darker according to the value-oriented shade guide (Vita easy shade).	Patient with history of teeth hypersensitivity.
Patient is willing to sign a consent form and can attend all recall visits.	Patient who undergone previous whitening procedure.
	Pregnant and lactating women.

Allocation concealment:

Allocation concealment was done by the Co-investigator 1 and achieved by using sealed coded opaque envelope containing the treatment protocol of the subject. The envelope was opened on the day of bleaching.

Blinding:

Teeth shades were assessed by Co-investigator 2 at base line (preoperatively) using (VITA Classic Easy Shade Spectrophotometer, Vivadent, Germany) and 24 hours after application. The outcome assessor was not aware of the assigned treatment protocol. Accordingly, this was a

single-blinded clinical trial.

Patient Preparation:

- **Oral Hygiene Measures**

Oral hygiene steps were taken at the first visit, as well as scaling of the teeth with an ultrasonic scaler (various 350, NSK, Japan).

Bleaching Protocols:

- **Laser Activated Bleaching Protocol**

A power source was attached to the laser machine (Epic X, BIOLASE Inc., USA) with a wavelength of 940 nanometer. Before using the whitening tip, the system was switched on and put into standby mode. The handpiece was fitted with a whitening tip. Wireless connections were used to link the device's footswitch. The blue L.E.D. blinking light indicates that the footswitch has been linked successfully. To prevent eye damage from the laser beam, the patient and the operator were given Epic protective eyewear. Vaseline was added to the patient's lips, and a cheek retractor was used to pull the lips and cheeks away from the teeth to shield them from the bleaching gel. To prevent gel leakage, the gingiva was properly dried, and a gingival protector liquid dam was added to all exposed gingiva. A light curing system (Dental Woodpecker L.E.D. curing light, Star Dent, China) was used to set the gingival protector for 10 seconds in a back-and-forth motion. To ensure proper isolation, cotton rolls were placed in the vestibules. The cap on the bleaching gel (J.W. Power Bleaching NEXT, Heydent, Germany) was removed, and the gel syringe's mixing tip was added. The gel was then added to the teeth in a thin, even film that did not leave any streaks. To begin the bleaching process, the laser device's power setting was set to power 7W. The bleaching tip had been inserted. The footswitch was pressed for thirty seconds to start firing the laser beam. The arch was divided into two quadrants, with each receiving a 30-second laser beam. For the same gel sample, the procedure was repeated twice. After that, a suction tip was used to extract the gel thoroughly flushed. The teeth were dried and prepared for the gel's second application. Two more laser doses were given after the remaining gel was added to the teeth. The gel was removed with a suction tip, and the teeth were thoroughly rinsed to restore tooth hydration until the liquid dam was removed. The patient was then instructed to wear the drilled special tray for shade recording after treatment. After that, the patient was given the post-operative instructions to follow.

- **Light-activated Bleaching Protocol**

The first step was to properly isolate the treatment area. The patient's lips were rubbed with vitamin E oil. The isoprep retractor for the bleaching kit was installed.

For face protection, a face bib was wrapped around the retractor. Protective eye goggles were given to the patient. The upper and lower labial vestibules got cotton rolls. The gauze was then folded into a triangle and pressed against the buccal mucosa. Following the scalloping of the gingiva, Liquidam was added to all exposed areas. At this point, the Liquidam was light curing "Dental Woodpecker L.E.D. curing light, Star Dent, China" for 5 to 10 seconds with back-and-forth movement. To ensure the patient's comfort, the position was changed to a reclined position. To activate the gel, the bleaching was added to the teeth and combined with the brush. The gel was uniformly added to the teeth. For accurate alignment with the targeted location, the light guide was connected to the zoom light accelerator unit and then placed touching the Isoprep retractor. According to manufacturer's instructions, patients received three patients were given three 15-minute sessions, as per the manufacturer's instructions. Bleaching gel was removed with a suction tip between sessions, and teeth were thoroughly rinsed with air and water spray. After that, the gel was reapplied, and the procedure was repeated. The liquidam cotton and gauze were removed after the procedure was completed, and the patient was given the "relief A.C.P." desensitizing agent in the vacuum sheet for 30 minutes. Finally, the patient was instructed to follow the post-operative instructions.

- **Chemical Activated Bleaching Protocol**

The protocol used was the same as the light-activated bleaching protocol. Following that, a whitening accelerator swab was applied to the teeth as instructed by the maker. The aim of using the swab was to activate the bleaching gel chemically. The bleaching gel was added to the teeth in an even layer. Three 15-minute sessions were given to each of the patients in this group. After each session, the bleaching gel was removed with a suction tip and rinsed with water and air. After that, a gauze was used to clean the teeth. The accelerator and bleaching gel were reapplied, and the procedure was carried out once more. After the procedure was completed, the isolation devices were removed, and the patient was given relief A.C.P. desensitizing agent in a personalized vacuum sheet tray for 30 minutes. Finally, instructions were given for the patient to follow.

- **Color Assessment**

Immediately 24-hours after treatment, each patient's color was registered. The Vita EasyShade Advance 4.0 spectrophotometer was used to measure the shade. Patients were required to wear the

drilled vacuum sheet during each color recording to ensure accurate readings. An outcome assessor was selected to manually record outcomes on an A4 handwritten sheet and in an excel sheet. The assessor had no idea which bleaching method was being used.

RESULTS

- **Color Change (ΔE) (Comparison between Groups)**

After comparing the three groups, it was discovered that there was no statistically significant difference in median **Δ**E in the three groups postoperatively. (*P*-value = 0.170, Effect size = 0.043 **Table (3).**

Vital tooth bleaching is considered an optimum and a minimally invasive approach to treating the extrinsic type of discoloration.[17, 18]

The current research looked at the color consistency of three separate in-office bleaching protocols right after treatment. The results were contrasted between light-activated bleaching (Philips ZOOM!), chemically activated bleaching (Philips Dash), and laser-activated bleaching (JW NEXT heydent). 25 percent, 30 percent, and 35 percent hydrogen peroxide bleaching gel concentrations were used, respectively. Patients enrolled in the study were selected according to inclusion and

Table (3): The mean, SD values and results of two-way ANOVA test for comparison between ΔE, ΔL, Δa, Δb of the cement types regardless of process steps.

	ΔE	**Laser (n = 13)**	**Zoom (n = 13)**	**Dash (n = 13)**	**P-value (between groups)**	**Effect size (Eta Squared)**
Immediate	Median (Range)	12.9 (3.9 – 16.2)	10 (1.7 – 16.5)	7.2 (5.1 – 16.5)	0.170	0.043
	Mean (SD)	12.1 (3.8)	9.8 (4.6)	9.4 (3.7)		

*: Significant at $P \leq 0.05$

DISCUSSION

Bleaching the teeth is one of the most cost-effective cosmetic method[15]. Extrinsic discoloration, on the other hand, is caused by the intake of colored foods and drinks such as coffee, tea, red wine, or tobacco.[16] exclusion criteria. The age group was chosen to range from 18 to 45-years-old. According to the American Dental Association (ADA), children and adolescents should be excluded from

bleaching trials, as not enough evidence is available to ensure the safety of the bleaching procedure on the tooth and pulp health of this age group.[7, 15, 19, 20] The translucent enamel has thinned in elder population as a result of different stimuli such as attrition, abrasion, and erosion, and darker dentin is more visible.[17,21] Smokers and alcoholics were removed from the analysis because they could cause shade results to be inconsistent resulting in errors in the final assessment. Women who were pregnant or nursing were also excluded. Pregnant women should postpone any whitening operation, according to the American Dental Association, due to concerns about the safety of bleaching products and the oral health problems that women face during pregnancy, such as increased acidity of saliva and gingivitis.[7]

Vita easy shade was chosen, instead of manual shade selection in the current study for its accuracy, reliability, reproducibility, and eliminates the errors that might occur from the human eye.[22, 23] Dozic et al. stated that Vita EasyShade is more accurate than colorimeters, such as IdentaColorII and ShadeEye.[23]

The cervical third of the tooth is typically darker and has a height of contour, which will prevent complete adaptation of the spectrophotometer tip. This particular site of colour measurement was chosen because of its wide and flat surface. Meanwhile, the transparent incisor third can scatter light, resulting in defective colour recording.[23-26]

In this study no significant difference between mean age and gender distribution in the three groups was found. This is in accordance with Jain et al.[27] and Ahmed et al.[28] The current study results showed that all three groups produced a whitening effect after treatment. When comparing between the three groups, no statistically significant difference between median ΔE was found immediately post-operative, (*P*-value = 0.170, Effect size = 0.043). Results matched Ahrari et al.,[29] who compared four bleaching protocols and found no significant difference between tested groups. Barcessat[30] and Petra Hahn et al.[31] results were in agreement with the current study. Mariam et al.[32] compared the clinical efficacy of two in-office bleaching systems, an 810-nm diode laser, and a conventional in-office bleaching system. A. Calderini et al.[33] and Ahmet Hazar et al.[34] findings matched the current clinical trial as well. In contrast to the results of this study, Fekrazad et al.[35] who concluded that laser bleaching using diode laser resulted in significantly more effective whitening outcomes, than the conventional in-office technique with Opalescence Xtra Boost®. Calatayud et al.[36] also concluded that diode

laser usage combined with 35 percent hydrogen peroxide had better efficiency than other bleaching protocols in clinical basis. The same for Young et al.[37] and Hayward et al.[38] who both found that using light in addition to the bleaching gel will increase the bleaching efficacy and give lighter color than chemical bleaching protocol. The different findings between studies may be due to the different bleaching gel concentrations used, the baseline color of the examined teeth, and the bleaching gel exposure period.[39]

Throughout the clinical trial, there was no significant improvement in median ΔE in the laser group. These results agree with Ahrari et al.[29], who found out that the laser-activated bleaching technique showed the least color relapse when compared to other in-office and at-home bleaching protocols. Bilichodmath S et al.[40] concluded that diode laser had significantly better results when compared with chemical and LED activated bleaching techniques in addition to the fast technique, which leads to decreased contact between bleaching gel and teeth, as well as increased patient satisfaction.[10] LED activated bleaching results in the present study showed a significant change in ΔE by time (*P*-value = 0.040, Effect size = 0.247). The pair-wise comparison between periods, showed no significant difference in median ΔE postoperatively. Chemical activated bleaching (Philips Dash) group showed a change in ΔE (*P*-value = 0.009, Effect size = 0.359). Bernardon et al.[41] corroborate our findings that light and laser, as modes of the activation, did not influence the degree of brightness of teeth after bleaching. The yellowish color of the teeth was reduced after bleaching, according to the results.

In the current clinical trial, the median b value showed no substantial difference in the laser community. The similar whitening effect in three group could be explained by the oxidative reaction of the peroxide based bleaching agent. When hydrogen peroxide gel gets activated, it dissociates. Releasing hydroxyl free radicals, per-hydroxyl radicals and superoxide anion which will attack and break down the double bond of the protein chains of the stain molecule. Teeth are now absorbing more light with minimal reflection. Thus, teeth will appear lighter in color.[42,43]

The study's null hypothesis was accepted because the tested groups (Chemical activated bleaching, Laser activated bleaching, and Light activated bleaching) had no significant difference regarding color change when tested immediately 24-hours postoperative.

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