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In-Office Bleaching Techniques: Laboratory Investigation of the Effect on Color Change and EnamelMicromorphology

***Muazaz Fawzi Hamed*[1]*. Ashraf Ibrahim Ali Ibrahim* [1]*. Huda Abed El-haliem Mohammed*[1].**

1 *B.Dent.culty of Dentistry, Baghdad University Post graduate Student in Department of Operative Dentistry Faculty of Dentistry Mansoura University.*

2 *Associate Professor, Department of Operative Dentistry Faculty of Dentistry Mansoura University.*

3 *Lecturer, Department of Operative Dentistry Faculty of Dentistry Mansoura University.*

Abstract:

Objectives: This study was conducted to evaluate and compare the effect of different in-office bleaching techniques on color change and enamel surface micromorphology**.**

Materials and Methods: Three different bleaching agents(one light-activated and two chemical-activated) were selected for this study. Sixty sound human permanent maxillary central incisors were selected andfixedin cylinder plastic mold (2 cm width and 1cm height) fabricated with using self- polymerized acrylic resin.Teeth were assigned into two groups according to the test conductedon, color test group (n=30), and themicro-morphology test group(n=30). Each group was further classified into three subgroups(n=10) according to the bleaching material used. The subgroups of each bleaching material were tested for enamel color change assessment usingaspectrophotometer and for surface micromorphology assessment by a non-contact optical profilometer before and after bleaching application. Data for each test wastabulated and statistically analyzed.

Results: Regarding color change analysis,all tested bleaching materials were effective on tooth color whitening,there was statistical significant differenceinthe mean value of all tested groups (P=0.011). With higher mean values recorded for Zoom group followed by Dash and Boost groups. Regarding the results of surface micromorphology, all the tested bleaching materials showed no statistical significant difference in enamel surface roughness after bleaching(P=0.591).

Conclusions: All thetestedin-officebleaching systemswere effectivelywhiten teeth, with light-activated systemexhibited higher whitening potential than chemical-activatedbleaching systems, with insignificant changein enamel micromorphology.

Introduction

Nowadays, the main concern of most people is to have attractive beautiful white smile. So that the cosmetic dentistry becomes the new topic that focuses on the improvement of the overall smile appearance. Tooth staining is a common aesthetic problemwhich could be due to either intrinsic or extrinsic factors.[1]There are many approaches for improving tooth color that can be as simple as whitening tooth pastes or professional at the dentist's office such as scaling, professional bleaching, crowns and veneers.[2-4]

Bleaching of teeth has become an important part of esthetic dentistry, demonstrating the most conservative esthetic solution for discolored teeth that produces safer and more acceptable outcomes in a short duration of time.There are two modalities of bleaching treatment for vital teeth, including at-home and in-office bleaching techniques.[5]

In-office bleaching technique has many advantages including, the process istotallycontrolled bythe dentist, protection of soft tissue, avoidance of material ingestion and utilizing high concentration ofbleaching products which promote faster and immediate whitening results that may improve patient satisfaction and motivations.[1] While, at-home bleaching is considered easy and effective method of bleaching mildly discolored teeth using custom soft tray loaded with low concentration of peroxide agents worn by patient at night.[6]

Contemporary bleaching products are mainly based on hydrogen peroxide or carbamide peroxide. The mechanism by which teeth are whitened dependentupon the oxidation of largechromophore molecule responsible for tooth structure discoloration. The dental structure's permeability and low molecular weight of bleaching agent provide free access of hydrogen peroxidethrough the organic matrix of toothstructure. The degradation of hydrogen peroxide results in oxygen and perhydroxyl free radicals, which then oxidize the staining molecules and break down the long chains organic molecules into short colorless chains leading to a reduction in stainsof tooth.[7, 8]

There are different methods to accelerate tooth bleaching such as light and chemical-activated bleaching agents. The main advantage of light bleaching is its ability to heat and stimulate the hydrogen peroxide, there are different types of light activation, such as light emitting diodes, plasma arc lamps, halogen lamps and lasers.[9]In chemical bleaching the effective ingredient in most whitening products is hydrogen peroxide (HP) that may be provided as hydrogen peroxide or carbamide peroxide which is a steady complex that breaks down in contact with water to release hydrogen peroxide.[10]Recently,an expedite method of in-officebleaching has been introducedusing ultrasonic energy that result in an increased productionof free radicals.[11]

Although,the widespread success of bleaching products concerning with their efficacy in whitening of teeth, there is no general agreement about possible negative effects on enamel structure. Research about the influence of peroxide-based products on the chemical and physical properties of tooth structure has been controversial. Some studies stated that there was no evident change in morphology of enamel surfacefollowing bleaching treatment.[12-17]However, others have found alterations in surface morphology, calcium loss and changes in chemical composition of enamel.[18-20]Thus, this study was performed to evaluate the effect of three different in-office bleaching systems on color change and enamel micromorphology.

Aim of Study

This study was intended to evaluate and compare the effect of different in-office bleaching techniques on the color change and enamel surface micromorphology.

Null hypothesis

This study was conducted to testthe null hypothesis that, the tested in-office bleaching techniquesneither differ in its bleaching efficacy nor in changingthe enamel micromorphology.

I. Materials and Methods

Three different types of commercially available in-office teeth bleaching materials which are; one light-activated bleaching agent (Zoom) and two chemical-activated agents (Opalescence X-tra Boost, Dash)were used in this study.

A total number of 60 human permanent incisors extracted due to periodontal diseases were obtained from Outpatient Clinic, Oral Surgery Department, Faculty of Dentistry at Mansoura University. All collected teeth were examined to be free from any cracks ,defects, and caries. Theywere cleaned from any calculus deposits and attached periodontal tissues using ultrasonic scaler (Guilin Woodpecker, Guangxi, China) and thoroughly washed under running water.

Specimen preparation

Each tooth was transversely sectioned at the cemento-enamel junction by means of a diamond instrument (Isomet, Buehler, USA) and the root was discarded. For easy holding and to prevent any possible contamination during application of bleaching agents, each tooth was fixed in polyvinyl chloride (PVC) mounting cylinder plastic mold of 2 cm width and 1cm height, utilizing self-polymerized acrylic resin (Acrostone, Egypt). The blocks were numbered for each group by correction pen (water proof, china)(Figure2).

Study design

The 60 prepared specimens were divided into two groups corresponding to the test conducted on, color change test group (n=30), and the micro-morphology test group(n=30). Each group was further divided into three subgroups(n=10)according to the bleaching material used (Figure 3).

Bleaching techniques

- Zoom (Light-activated bleaching agent)

Zoom gel was applied on the labial surface of each tooth by supplied brush in a layer thickness of 1-2 mm according to manufacture′s instructionsfor 3 cycles,each of them was15 minutes. The gel was activated by using Philips Zoom speed light device that was applied for15 minutes to the teethfor each cycles.

- Dash (Chemical-activated bleaching agent)

The dash chemical accelerator was applied on the labial surface of each tooth followed by the dash bleaching gel. The bleaching gel was applied in a layer of thickness 1-2 mm according to manufacture′s instructions and remained on the teeth for15 minutes for the three sessions for each tooth.

- **Opalescence X-tra Boost (Chemical-activated bleaching agent)**

Opalescence X-tra boostbleaching gel wasexpresseddirectly onto the labial surface ofeach tooth ; in a layer thickness of approximately 1-2 mm; according to manufacture′s instructions. Before using, syringes were joined together, dry material was introducedfrom its syringe into the syringe comprising the hydrogen peroxide, the produced mixing bleachingmaterial then expressed back and forth from one syringe to another25 times to be completely mixed. After mixing, syringes were detached and the mixture was expressed directly onto the labial surface of the teeth.Bleaching gel was remained on the teeth for15 minutes of three sessions for each tooth.

Testing procedures

Color change measurement

The color of specimens was evaluated using a reflective spectrophotometer (Model RM200QC, X-Rite, Neu-Isenburg, Germany). They were tested for color measurement at three times, baseline, after staining and after exposure to bleaching agents. Before each measurement, the spectrophotometer was calibrated. For each specimen, three measurements were taken and the average was recorded.

Micromorphological evaluation

The evaluation of the surface roughness was carried out using a non-contact optical profilometer at baseline and after bleaching, three measurements were done at the middle one third of facial enamel surface foreach tooth and the average was recorded. The result used to compare enamel surface roughness before and after bleaching.

Results

The numerical data explored for normality using Shapiro-Wilk test, showed that the data fall within the normal distribution curve, then analyzed using One-Way ANOVA to detect the effect of the one variable (type of bleaching material) on enamel color change and surface micromorphology.

Enamel color change

The results of the one–way ANOVA test including mean values and standard deviation of enamel color change (ΔE) between stained and bleached samples, that there was significant difference between the mean of all tested groups (P=0.011),with the highest mean value recorded for Zoom group (31.2±5.4), followed by Dash group (25.8±9.4) and the lowest in Boost group (24.8±6.3)(Table1, Figure 1).

The post-hoc Tukey test showed that there was a significant difference in enamel color change (ΔE) betweenZoomand Dashgroups(P1=0.014), alsosignificant difference between Zoom and Boost groups

(P2=0.047).While,the Dash group showed no significant difference when compared to Boost group (P3=0.889) (Table1, Figure 1).

Table1. Results ofOne–way ANOVA test showing the effect of different bleaching agents on enamel color change

		Study groups			
		Zoom	Dash	Boost	P- VALUE
Beforebleaching	Mean±SD	34.6±6.4	33.1±12.0	30.0±7.1	0.238
After bleaching	Mean±SD	31.2±5.4	25.8±9.4	24.8±6.3	0.011
	Post-hoc	P1=0.014* P2=0.047*	P3=0.889		

Enamel micromorphology

In addition, the results of the one–way ANOVA test,including mean values and standard deviation of enamel surface roughness after bleaching of three tested groups,that there was nostatistical significant difference between the mean of all tested groups (Zoom, Dash, Boost) (P=0.591) (Table 2, Figure2,3).

Table2. Results ofOne–way ANOVA test showing the effect of different bleaching agents on enamel micromorphology

		Study groups			
		Zoom	Dash	Boost	P- value
Before bleaching	Mean±SD	5.09±0.30	5.08±0.2	5.06±0.3	0.626
After bleaching	Mean±SD	5.13±0.04	5.10±0.07	5.13±0.09	0.591

Fig.3Representative three dimensional profilometric image of enamel surface roughness of dash bleaching agent group, (a) unbleached , (b) bleached

Correlations between enamel color change (ΔE) and surface micromorphology

The Pearson’s correlation test showed that there was no significant correlation between enamel color change and surface micromorphology.

In-office bleaching is more popular and superior to home bleaching in many ways, including dentist control, soft-tissue protection and guard against material ingestion, less treatment time, immediate results and more patient satisfaction.[21]

The first, null hypothesis of this study, which anticipated that there will be no significant effect of different in-office bleaching techniques on color changewas totally rejected.

The results of this study regarding enamel color change revealed that all the tested bleaching agents were effective on tooth color whitening. This result in agreement with Russo et al.[22] whostated that in-office bleaching system produced a more powerful bleaching effect than other bleaching system.

Also, the result of color change showed that therewassignificant differencein the ΔE mean valueof two chemically-activatedgroups as compared to light-activated group.The light-activated bleaching system resulted in highest mean value, followed bychemically-activatedgroups. This result may be referred to the combination of a light source with hydrogen peroxide, lead to activate hydrogen peroxide and accelerate the chemical redox reaction of the bleaching process and improved the whitening efficacy of bleaching agent.[23]

The result of the present study in agreement with Liang et al.[24] who compared the tooth whitening efficacy of light and chemical- activated in-office bleaching systems and found that activation of peroxide based bleaching agents with light gives better whitening results.

The result of the present study contradicts to Almeida et al.[25] who evaluated the effectiveness of different bleaching techniques and found that light sources did not improve in-office bleaching results. This contradiction may be due to their trial to activate chemically-activated bleaching agents by a light source where these agents were not indicated for light activation.

In addition , the results of enamel color change revealed thatthere was no significant difference between two chemically-activated bleaching agents. This result may be attributed to that the both products have the same mode of action and time of application.This result in line withSa et al.[26] who stated that nosignificant in the effect of different concentrations of hydrogen peroxide on the resultant color after bleaching and advised the use of bleaching agents with lower concentrations.

The second, null hypothesis of this study, whichanticipated that there will be no significant effect of in-office bleaching techniques on the enamel surface micromorphology was accepted.

Regarding, the results of surface roughness showed no significant difference in surface roughness values for all tested groups before and after bleaching.

The result of the present study in agreement with Dionysopoulos et al.[27]who studied the effect of in-office tooth bleaching on enamel surfaceand found that the surface roughness was not significantly increase following in-office bleaching procedure. Also, the result of the present study contradicts to Anaraki et al.[28]who evaluated the effect of different bleaching techniques on surface roughness of enamel and found that the both techniques could increase enamel surface roughness. This contradiction may be attributed to use a different light source (diode laser) while in the present study lightemitting diodewas used.

Conclusion

1.All tested in-office bleaching systems were effectivelyproduceda teeth whitening.

2. The light-activated bleaching system produced a pronouncedwhitening result than chemical-activatedbleaching system.

3.All tested bleaching systemsdid not alter enamelmicromorphology.

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