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EVALUATION OF THE EFFECT OF DIFFERENT REMINERALIZING AGENTS ON STAINS ABSORPTION AND SURFACE ROUGHNESS OF FRESHLY BLEACHED TEETH (AN IN-VITRO STUDY)

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ABSTRACT

Background: Although no clinically remarkable damages because of vital bleaching of dental hard tissues has been described in literature, there are scientific reports demonstrated alterations of the histological aspects and composition of bleached dental enamel. It is observed that bleaching with 10% carbamide peroxide may result in a decrease of the calcium, phosphate and also of the fluoride amount in enamel. It was shown that demineralization of bleached enamel could be balanced by a remineralization period following the bleaching period. **Purpose:** To evaluate the effect of different remineralizing agents on stains absorption and surface roughness of freshly bleached teeth. **Design:** An in-vitro study. **Methods:** A total of 72 intact sound freshly extracted human upper anterior teeth was collected, scaled, polished and stored in distilled water and divided into 4 equal groups (18 each) according to the enamel surface treatment applied immediately after bleaching measurements; group A was received no surface treatment and served as a control group. In group B: the enamel surface was treated by fluoride varnish, while group C enamel surface was treated by CPP-ACP without fluoride & group D by CPP-ACP with fluoride. **Results:** The study showed that group A is affected by the most significant color change after 2 and 4 weeks with staining, followed by group C and group B, while group D showed the least color change after the same periods. Group A showed the highest significant surface roughness values after 2 and 4 weeks with staining, followed by group B and group C, while group D showed the least surface roughness values after the same periods. **Conclusion:** Remineralizing agents have a significant effect on decreasing stain absorption and surface roughness of freshly bleached enamel.

Keywords: Color change, Surface roughness, Casien phosphopeptide amorphous calcium phosphate, Fluoride, Bleaching.

INTRODUCTION

Tooth discoloration varies in etiology, appearance, localization, severity, and adherence to tooth structure. It may be classified as intrinsic, extrinsic, or a combination of both[(1)]. Intrinsic discoloration is caused by incorporation of chromatogenic material into dentin and enamel during odontogenesis or after eruption. Exposure to high levels of fluoride, tetracycline administration, inherited developmental disorders and trauma to the developing tooth may result in pre-eruptive discoloration. After eruption of the tooth, aging and pulp necrosis are the main causes of intrinsic discoloration. On the other hand coffee, tea, carrots, oranges, and tobacco give rise to extrinsic stain[(2)].

Management of teeth discoloration can be done by different lines of treatment, starting from the most conservative to the least one. Scaling and polishing of the teeth remove many extrinsic stains. For more resistant discolorations, various bleaching techniques may be attempted. Tooth bleaching can be performed externally (vital bleaching), or intracoronally in root-filled teeth (non-vital bleaching). Although no clinically remarkable damages

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because of vital bleaching of dental hard tissues have been described in literature, there are scientific reports which demonstrate alterations of the histological aspects and composition of bleached dental enamel[3]. It is observed that bleaching with 10% carbamide peroxide may result in a decrease of the calcium, phosphate and also of the fluoride amount in enamel.[4] It was shown that demineralization of bleached enamel could be balanced by a remineralization period following the bleaching period[5,6].

Remineralization of hard dental tissues is defined as the process whereby calcium and phosphate ions are supplied from a source external to the tooth to promote ion deposition into crystal voids in demineralized enamel to produce net mineral gain. Fluoride is considered to be essential in the remineralization process, yet its ability to promote net remineralization is limited by the availability of calcium and phosphate ions[7- 9].

Several mechanisms are available for aided remineralization. The most well known is the delivery of topical fluoride[10]. More recently, this has led to introduction of new materials containing calcium and phosphate ions[11]. Different technologies are used for remineralization of demineralized teeth. One technology involves, first, casein phosphopeptide amorphous calcium phosphate (CPP-ACP) with or without fluoride. The second is a new concept involves tricalcium phosphate (TCP). Since all systems rely on calcium and phosphate compounds, their effect is mainly based on an enhancement of the natural capacity of saliva to remineralize mineral loss[12].

Although CPP-ACP and tricalcium phosphate have been already shown to prevent enamel demineralization and promote remineralization of subsurface enamel lesions, there is no enough data in the literature revealing their effect on stain absorption and surface roughness of bleached teeth. Thus, studying the effect of these remineralizing agents on bleached tooth surface regarding stain absorption and surface roughness would be valuable.

MATERIALS AND METHODS

Study design: In-vitro study.

Study setting: The study was made in the laboratories of the Department of Operative Dentistry, Faculty of Dental Medicine, Boys, Cairo, Al-Azhar University.

Materials:

a. Bleaching agent: High concentration bleaching.

b. Staining agent: Tea solution.

c. Remineralizing agents:

1. Fluoride Varnish
2. CPP-ACP without fluoride
3. CPP-ACP with fluoride

Methods:

- A total of 72 intact sound freshly extracted human upper anterior teeth was collected, scaled, polished and stored in distilled water.
- The selected teeth were divided into 4 equal groups (18 each) according to the surface treatment applied immediately after bleaching measurements; group A was received no surface treatment as a control group. In group B, enamel surface was treated by fluoride varnish, in group C by CPP-ACP without fluoride & in group D by CPP-ACP with Fluoride.
- Each group was measured for both stain absorption (using spectrophotometer)[3] and surface roughness (using profile gauge)[13].
- After that, the teeth of all groups was bleached, the remineralizing agents was applied on the teeth of groups B, C and D according to manufacturer's instructions, then all teeth were measured for color and surface roughness.
- All teeth were stored in artificial saliva for 4 weeks, during which all teeth was immersed in a

tea solution periodically[3]. After 2 weeks and 4 weeks, the teeth of all groups were reassessed for colour and surface roughness and discoloration.

Statistical Analysis:

Data were collected, revised, coded and entered to the Statistical Package for Social Science (IBM SPSS) version 20. Qualitative data were presented as number and percentages while quantitative data were presented as mean, standard deviations and ranges when parametric. The comparison between two groups regarding quantitative data with parametric distribution was done by using Independent t-test. The comparison between more than two independent groups regarding quantitative data with parametric distribution was done by using One Way Analysis of Variance (ANOVA). The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant as the following: $P > 0.05$: Non significant, $P < 0.05$: Significant, $P < 0.01$: Highly significant.

RESULTS

Effect of remineralizing agents on stain absorption and surface roughness of bleached teeth:

This means that group A (control) showed the most significant color change after 2 and 4 weeks of aging with staining, followed by group C (casein phosphopeptide amorphous calcium phosphate), group B (fluoride varnish), while group D (casein phosphopeptide amorphous calcium phosphate with fluoride) showed the least color change after the same periods.

This means that group A (control) showed the highest significant surface roughness values after 2 and 4 weeks, followed by group B (fluoride varnish), group C (casein phosphopeptide amorphous calcium phosphate), while group D (casein phosphopeptide amorphous calcium phosphate with fluoride) showed the least surface roughness values after the same periods.

TABLE (1): Comparison of color change results between all groups after 2 and 4 weeks of aging and staining:

	Control group (Group A)	Group B	Group C	Group D	One Way ANOVA test	
					F	p-value
Color change after 2 weeks	10.72 ± 2.4	4.31 ± 1.06	6.09 ± 0.6	4.24 ± 2	29.647	0.000*
Color change aft er 4 weeks	11.77 ± 1.9	5.09 ± 1.8	7.61 ± 2.4	4.84 ± 1.7	24.007	0.000*

*ns; non-significant (p >0.05) *: significant (p < 0.05)*

TABLE (2): Comparison of surface roughness results between all groups after 2 and 4 weeks of aging and staining

	Control group (Group A)	Group B	Group C	Group D	One Way ANOVA test	
					F	p value
Surface roughness after 2 weeks	0.2495 ± 0.0002	0.2497±0.0001	0.2495±0.0001	0.2494±0.0002	5.700	0.003*
Surface roughness after 4 weeks	0.2498 ± 0.0003	0.2496±0.0001	0.2495±0.0001	0.2493±0.0002	10.400	0.000*

*ns; non-significant (p >0.05) *: significant (p < 0.05)*

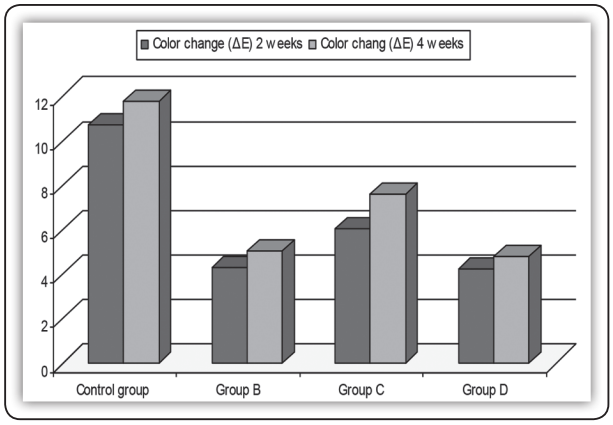

Fig. (1): Chart comparison of color change results between all groups after 2 and 4 weeks.

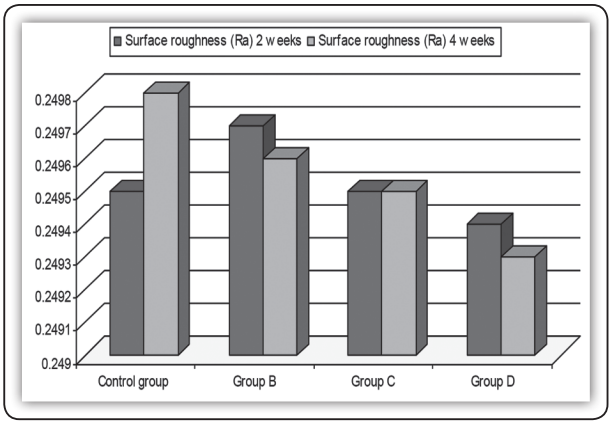

Fig. (2): Chart comparison of surface roughness results between all groups after 2 and 4 weeks of aging and staining.

DISCUSSION

Effect of remineralizing agents on stain absorbtion and surface roughness of bleached teeth:

In this study, the results were shown in tables (1, 2) and illustrated in figures (1, 2). Opalescence Boost, with its content of 40% hydrogen peroxide, potassium nitrate & fluoride, when applied on 2 sessions of 20 minutes each, to give a total of 40 minutes of application, had a highly significant effect on the surface roughness of enamel after whitening. The bleaching has played an important role in increasing the surface roughness and color change of examined teeth (Control group), while application of remineralizing agents on enamel surfaces of bleached groups: (A2), (A3) and (A4) may have caused a significant reduction of their surface roughness and color change after 2 and 4 weeks. These results may be due to mineral loss, decreased surface micro-hardness, increased surface roughness, morphological alterations, and increased permeability have been reported as undesired effects of bleaching agents on the dental structures. A consequence of the acid nature of bleaching agents. The application of remineralizing agents on the enamel surfaces of bleached groups helped the enamel remineralization, causing reduction of their surface roughness and color change, specially after 4 weeks[14].

This results were in agreement with Mori et al[15] study, the highest level of mineral loss occurred immediately after bleaching. However, they also found that progressive enamel remineralization observed after daily contact with saliva.

Also, this study was in agreement with Setien et al[16] who stated that Increased enamel porosity after bleaching may contribute to the fact that bleached enamel stains immediately after bleaching. Also, the predisposition of enamel to stain after whitening was greater after the application of 35% hydrogen peroxide.

The current results agreed also with Goldberg et al[17] and Rodrigues et al[18] results, which stated that the application of bleaching gels caused a significant decrease in enamel surface hardness and increase in surface roughness, after the bleaching treatments.

This results were in disagreement with Adeyemi et al[19] who observed that bleached enamel is not susceptible to staining with clorhexidine, tea, and artificial saliva cycles. This difference may be due to using different materials and/or methods.

Also, in this study, results presented in tables (1, 2) and illustrated in figures (1, 2) showed that Casein Phosphopeptide Amorphous Calcium Phosphate with Fluoride (A4) showed the most signifi-

cant color stability and staining resistance compared to Fluoride Varnish (A2), Casein Phosphopeptide Amorphous Calcium Phosphate (A3) and Control Group (A1) which were second, third and last respectively in this study.

Also showed that application of different remineralizing agents caused a significant decrease in surface roughness of bleached teeth compared to the control group (A1), with group (A4) showed the most significant reduction in surface roughness compared to each of group (A3) and (A2), which showed lower roughness reduction respectively. Also found that remineralizing agents gave their best results in terms of decreasing surface roughness after 4 weeks more than after 2 weeks of bleaching.

These results may be due to the remineralizing capacity of CPP-ACP and Fluoride, which has a high effect. However, the added benefits of fluoride are promoting remineralization by stimulating the absorption of calcium and phosphate ions found on the rich CPP-ACP paste. [3]

The current results were agreed with Kim et al[20] study which proved that fluoride and CPP-ACP enhanced the remineralization of enamel surface, which had been demineralized after bleaching.

This was also in agreement with Singh et al[3] who concluded that application of CPP-ACP and fluoride on enamel surface caused a reduced total color change after immersing in tea solution, compared to untreated teeth samples. It also agreed with Endo et al [21] study which demonstrated that CPP-ACP and Fluoride was shown not only to reduce the sensitivity, but also reduced the stain absorption in the period immediately after bleaching, when the surface was still demineralized.

It was also supported by Vasconcelos et al[22], who concluded that the mixture of a paste containing CPP-ACP to the at-home bleaching agents was able to prevent negative changes of hardness, roughness and morphology on bleached enamel.

This results were in disagreement with Públio et al[23] study, which showed that CPP-ACP and neutral fluoride treatments did not prevent the accumulation of pigments on remineralized enamel surfaces when these surfaces were exposed to cigarette smoke, and that although CPP-ACP promotes the absorption and precipitation of calcium and phosphate ions, deposition of these ions can occur in an irregular way and might increase the susceptibility to enamel staining. However, their samples were not stored in artificial saliva after surface treatment, which may explain how these results were achieved.

Also, the fluoride application to the enamel surface, remineralization was enhanced, leading to decreasing of surface alterations and preventing precipiatation of stains. Therefore, after fluoride application, the enamel must be exposed to saliva for sufficient time to enable the appropriate saturation of ions to allow for fluorapatite or fluorohydroxyapatite generation on the enamel surface[23]. This disagreed with Ferreira et al [24], who found that fluoride application did not repair morphological changes on enamel after dental bleaching, and also allowed stain absorption.

CONCLUSION

Under the limitations of this study, the following can be concluded:

1- Remineralizing agents have a significant effect on decreasing stain absorption and surface roughness of freshly bleached enamel.

2- Casein phosphopeptide amorphous calcium phosphate with fluoride (CPP-ACPF) found to have the greatest effect on decreasing stain absorption and surface roughness.

3- Application of remineralizing agents after bleaching has high benefits.

4- Tea with its acidic pH caused discoloration and increased surface roughness of untreated bleached enamel within a period of 2 and 4 weeks of aging and periodical staining.

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