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Fluoride Versus Bioactive Glass Effect on Enamel after Cold Light Activated Bleaching and Chemical Bleaching (SEM Study)

Amina E. Ewais[1*], Maha A. Niazy [2], Doaa A. Elsharkawy[3]

Codex : 16/2001

azhardentj@azhar.edu.eg

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ABSTRACT

Purpose: This study was designed to evaluate and compare Fluoride versus Bioactive Glass effect on Enamel after Cold Light Activated Bleaching and Chemical Bleaching. **Materials and Methods:** Forty samples obtained from ten sound bovine central incisors were numbered from 1 to 40. EDAX &SEM analysis was done for all samples, then they were divided into two main groups, the first group was subjected to chemical bleaching using 35% hydrogen peroxide gel and the second group was subjected to cold light activated bleaching using 25% hydrogen peroxide gel. After bleaching, EDAX & SEM analysis for all specimens was done. After bleaching, each main group was divided into two subgroups according to the remineralizing agent used. The first subgroup was treated by fluoride gel and the second was treated by bioactive glass gel for 3 minutes twice daily for 10 consecutive days. EDAX and SEM analysis were done for all Specimens after remineralization. **Results**: Calcium and phosphorus levels were significantly decreased after bleaching with both chemical and cold light bleaching techniques. Ca &p levels were significantly increased after using fluoride or bioactive glass. Higher remineralization results were obtained with bioactive glass. Bleached enamel appeared porous with multiple surface irregularities which disappeared after using fluoride or bioactive glass. **Conclusion**: In-office bleaching has deleterious effect on enamel surface causing decrease of calcium and phosphorus which can be reversed by using remineralizing agents. Bioactive glass has superior effect than fluoride in restoring enamel minerals.

KEYWORDS

In-office bleaching, fluoride, bioactive glass.

INTRODUCTION

People are continually hoping for esthetic perfection, and this includes a beautiful smile with white teeth. The use of peroxides to

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1. Dentist at Ministry of Health, BDS 2006, Faculty of Dentistry, Tanta University.
2. Professor of Operative Dentistry, Operative Dentistry Department, Faculty of Dental Medicine for Girls, Al –Azhar University.
3. Lecturer of Operative Dentistry, Operative Dentistry Department, Faculty of Dental Medicine for Girls, Al –Azhar University.

* Corresponding author Email: aminaewais@yahoo.com

achieve tooth bleaching is not a recent approach, since there is some evidence from earlier in the middle of the XIX century that showed hydrogen peroxide (HP) as one of the materials able to change tooth color [(1)]. Usually, the technique for in-office bleaching uses 35% HP, this can be made alone or in conjunction with light, which can speed up the color changing process [(2)].Although the efficacy of bleaching agents to vital and non-vital teeth is well documented, the widespread use of bleaching generates some concern about the effects promoted by these agents onto the bleached substrate [(3)].

Some alterations in the enamel such as increase of roughness, porosity and decreased microhardness have been found. When tested with a scanning electron microscope, the enamel appeared with increase of porosity, erosion and superficial demineralization. Contra indicatory results have also been found and showed minimal alteration [(4)].

It may be possible to reverse this damage by using remineralizing agents on the affected tooth. One of these agents is bioactive glass, this material is capable of bonding chemically to hard dental tissues and its components are oxides of calcium, sodium, phosphorus and silica in ratios that impart bioactivity. In vivo, these glasses are able to form a layer of hydroxyapatite on teeth surfaces [(5)].

The importance of fluoride in the dental enamel demineralization- remineralization process is well-known. Similarly, the use of fluoride therapies could be useful against any deleterious effect of bleaching agents on dental enamel [(6)]. This study aimed to compare the effect of bioactive glass and fluoride on bleached enamel.

MATERIALS AND METHODS

Ten sound bovine central incisors were used in this study. The teeth were examined to be free from decay or cracks. They were cleaned by a soft brush to remove any plaque. The roots were cut at the CEJ. Each crown was sectioned mesio-distally into 2 halves and then each half was sectioned in an inciso-cervical direction into two halves to give a total of 4 specimens from each tooth. Each sample was embedded in a Teflon ring containing chemically cured acrylic resin exposing the buccal surface. Blocks were numbered from 1 to 40 and stored in saline at room temperature until used. EDAX & SEM analysis was done for all specimen. The experimental groups were (A1&A2) where A1 was the chemical bleaching group and A2 was the light bleaching group. After bleaching, each group was subdivided into two groups (B1&B2), where B1 was treated with fluoride gel and B2 was treated with bioglass gel.

Samples were cleaned and dried. Dash® (chemically activated bleaching gel containing 35% hydrogen peroxide) was applied according to the manufacturer's instructions to the buccal surfaces of A1 group, in a 1-2mm thickness layer for 3 consecutive cycles; each of them was 15 minutes. After each cycle, samples were dried and cleaned thoroughly. For Cold light bleaching group (A2), Zoom® (light activated bleaching gel containing 25% hydrogen peroxide) was applied also for 3 cycles , 15 minutes each and it was activated by Philips Zoom Speed®light device all over the 3 cycles. After Bleaching, Ca & P levels of all specimens were measured again using EDAX, enamel morphology was examined by SEM.

The bioactive glass gel used consisted of bioactive glass powder with median particle size smaller than 20 nms dispersed in 5% cellulose gel with a concentration of 5000 ppm. The fluoride gel used (Flor-opal®) consists of 5000 ppm fluoride.

After bleaching and EDAX analysis, fluoride gel & bioactive glass gel were applied to the buccal surfaces of B1 &B2 groups by an insulin syringe to control their volume respectively for 3 minutes twice daily for 10 consecutive days[(7).] A pH cycling model was adopted to resemble the changes in the oral cavity [(8)]. All samples were embedded daily in demineralizing solution for 1 hour and then in artificial saliva for 23 hours. The pH of artificial saliva and demineralizing solution was set to be 7.2 and 4.5 respectively [9]. Ca & P levels of each specimen after remineralization were measured using EDAX& SEM at magnification 2000X.

Microstat Crop was used for statistical analysis in this study. One-way Analysis Of Variance was used to evaluate difference between selected groups. Difference was considered statistically significant when p≤ 0.05.

RESULTS

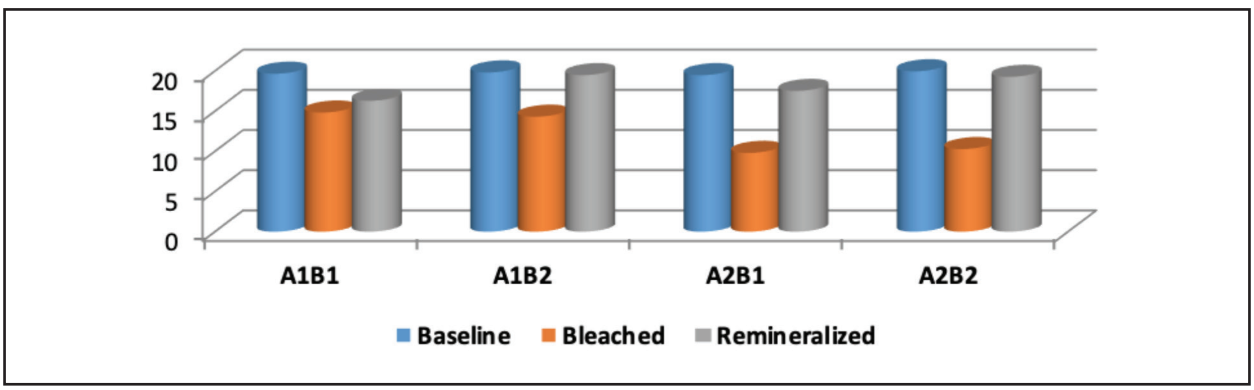
Effect of bleaching and remineralizing agents on calcium and phosphorus content

After bleaching with either cold light or chemical technique, there was statistically significant decrease in Ca and P levels. After remineralization with either fluoride or bioglass, there was statistically significant increase in Ca and P content in all groups (P≤ 0.05), fig (1&2) and table (1).

Table (1): *Comparison of Ca & P levels weight % for all groups.*

		Baseline		Bleached		Remineralized		P value
		Mean	SD	Mean	SD	Mean	SD	
Calcium								
Chemical bleaching (A1)	Fluoride (B1)	19.66	3.37	14.83	3.13	16.29	3.45	0.0094*
	Bioglass (B2)	19.82	3.37	14.31	3.95	19.48	3.26	0.0024*
Light Bleaching (A2)	Fluoride (B1)	19.48	4.87	9.81	2.45	17.52	5.43	0.00009*
	Bioglass (B2)	19.96	2.346	10.28	1.94	19.27	3.34	0.0000*
Phosphorus								
Chemical bleaching (A1)	Fluoride (B1)	11.65	2.37	7.05	1.36	10.81	1.98	0.0002*
	Bioglass (B2)	11.32	2.23	7.84	2.35	11.25	2.24	0.002*
Light Bleaching (A2)	Fluoride (B1)	11.60	1.68	6.59	1.65	9.14	0.90	0.0000*
	Bioglass (B2)	11.73	1.54	7.17	1.94	11.51	1.48	0.0000*

*Significance level p≤0.05, *significant*



Figure(1) Column chart representing levels of Ca at different stages

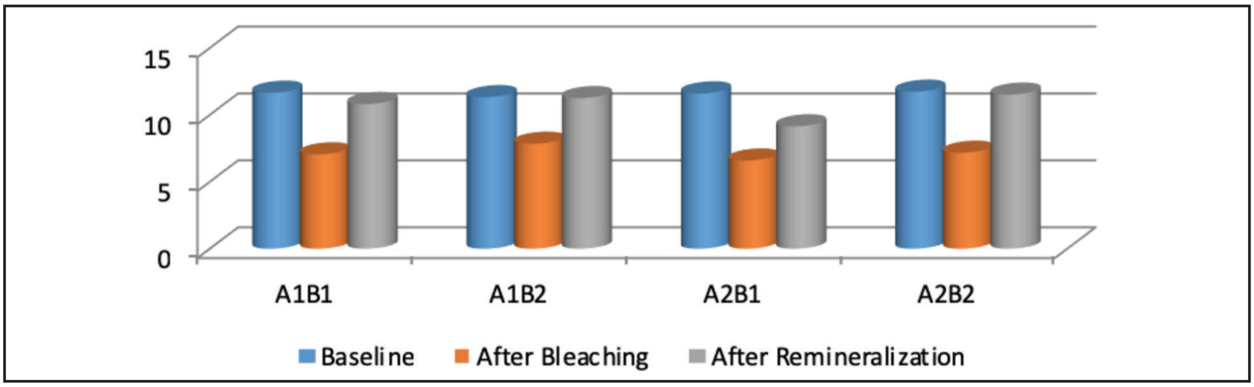


Figure (2) Column chart representing levels of P at different stages.

Comparison between remineralizing agents

When comparing the percent change of Ca &P content after remineralization (table 2), a statistically significant difference ($P \leq 0.05$) was found between Fluoride and bioglass in remineralization of chemical group, while there was no difference between the agents with the light group. There was a significant difference in Ca levels between the cold and the chemical bleaching methods but there was none with the P.

Surface morphology under sem

Morphology of untreated enamel Fig (3A) showed enamel that appeared homogenous, free of pores and intact. After bleaching, (fig 3 B), enamel appeared porous and had an etched like appearance. Increased surface irregularities and significant depressions are obvious in both bleaching groups. After fluoride application (fig 3C), enamel appeared less porous, more uniform and closer to normal appearance. Bleached enamel after bioglass application (fig3 D)**,** showed deposits that appeared firmly attached to the surface.

Table (2): *Comparison between the remineralizing agents regarding the percent change of Calcium and phosphorus in both bleaching groups:*

Ca	Fluoride		Bioglass		P value
	Mean	SD	Mean	SD	
Chemical	8.52	8.13	24.82	21.85	0.0201*
Light	40.24	22.28	45.51	14.36	0.269 NS
P value	0.0003*		0.011*		
P					
Chemical	32.00	20.11	28.97	20.39	0.371 NS
Light	27.38	18.2	36.51	19.59	0.148 NS
P value	0.299NS		0.205NS		

*Significance level p≤0.05, *significant, NS=non-significant*

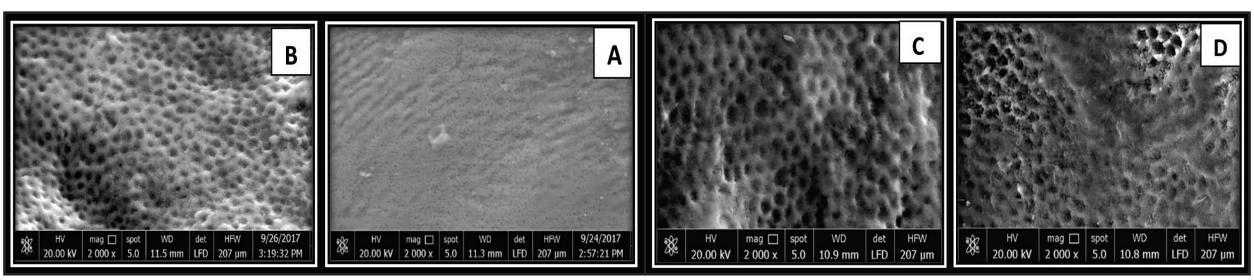


Figure (2) **(A):** Untreated enamel. (B): bleached enamel**.** (C): fluoride treated enamel. (D): bioglass treated enamel.

DISCUSSION

In 1877, bleaching technique was reported. In contrast to more aggressive methods such as crowns or bonded veneers, tooth bleaching is considered a more conservative method to change teeth color. Even though many of bleaching agents have been suggested, hydrogen peroxide still remains the most commonly used agent [10].

In this study, when evaluating enamel minerals after bleaching, results showed that there is significant decrease in calcium and phosphorus levels in enamel after bleaching with both techniques. Decreased calcium and phosphorus levels may be a result of the low concentrations of Ca and P ions and high concentrations of sodium and chloride ions in the bleaching gel which leads to under-saturation with respect to hydroxyapatite[11].

This result was supported by another study[12] which proved that tooth bleaching with hydrogen peroxide leads to significant decrease in enamel mineral content. However, this result is in disagreement with another study[13] which reported that Ca & P concentration in enamel were not affected by bleaching with HP, but they performed bleaching for 3 sessions, a session per week for 8 minutes.

In this study, when comparing the effect of chemical bleaching with cold light bleaching regarding calcium, results showed that bleaching with cold light caused higher calcium loss than chemical bleaching. This may be attributed to the large light-absorption spectrum in the light activated agent, which helps to speed up the bleaching process by increasing the temperature of the gel causing extra demineralization[14]. Also, calcium bonded weakly to the hydroxyapatite[15] which may be easily affected by temperature rise leading to more calcium loss. This result was in consistent with another study[16] which proved that the light irradiation during 35% HP bleaching increased the calcium loss more than the non-light activated bleaching. However, this result is in disagreement with other study[17] which reported that the acidic gel was the major factor that caused enamel demineralization whereas light had no effect, however, in their study, light bleaching was done in 3 sessions; 8 minutes each.

When comparing the effect of fluoride with bioactive glass on Ca & P content of enamel, results showed that the higher remineralizing effect was achieved by bioactive glass. This may be due to the small particle size of the bioglass which increases the surface area giving higher remineralization results [18]. Also, bioactive glass has the key factor of remineralization which are (Ca^{+2} and $(Po4)^{-3}$) providing a solubility gradient which helps in mineral deposition[19-20], while fluoride needs enough salivary Ca & P ions to drive the remineralization process. This result is supported with another study[21] which reported that bioactive glass has a higher capacity to enhance mineral content of enamel than topical fluoride. However, this result is inconsistent with other study[22] which reported that the remineralizing effect of fluoride and bioglass is equal; however their results were based on measurement of gingivitis, bacterial counts and plaque.

CONCLUSION

Both bleaching techniques tested have a demineralizing effect on enamel surface by decreasing Ca & P. Bioactive glass could offer an advantage over fluoride in remineralization of bleached enamel.

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