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The Effect of Carbonated Beverage on the Surface Morphology of Bleached Enamel- an *In Vitro* Study

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Abstract
Aim: *The purpose of this study was to evaluate the effect of carbonated beverage, Coca-Cola on 15% carbamide peroxide gel bleached enamel under Scanning Electron Microscope (SEM).*
Materials and Methods: *40 premolars were embedded into acrylic blocks with their buccal enamel surface exposed. They were divided into 5 groups (A,B,C,D and E) and each group having 8 number of teeth. Group A served as an unbleached group and group B,C,D and E were treated using 15% carbamide peroxide gel. Following this, group C, D and E were exposed to Coca-Cola once, twice and thrice respectively, at 6 hourly interval by immersing the samples in 32.5 ml of Coca- Cola. This entire procedure was carried out for 7 days and the surface morphological changes of enamel were examined under SEM. Morphological changes on enamel surface were evaluated using Yeh et al (2005)modification of Hobson's acid-etch pattern on enamel.*
Results: *In comparison to group A, statistically significant values were found in group B (p=0.037), C (p=0.027), D (p=0.011) and statistically more significant value in group E(p=0.004).Further,in relation to group B, statistically significant value was observed only in group E (p=0.025).*
Conclusion: *From the present study, it can be concluded that 15% carbamide peroxide gel causes significant morphological alterations on enamel surfaces. These alterations were increased further by the exposure to carbonated beverage Coca-Cola especially with the increase in the number of exposures to Coca-Cola.*
Key Words: *15% Carbamide peroxide, carbonated beverage, Coca-Cola, Scanning Electron Microscope.*

Introduction

Home bleaching also referred to as "nightguard vital bleaching", or "matrix-bleaching" represents one of the conservative form of esthetic treatment for the discoloured teeth. This technique utilizes 10-35% carbamide peroxide which is placed in a custom-fitted tray. The patient places the tray with the material in the mouth for several hours or overnight while the teeth lightens within a few days, weeks or months depending on the nature of discoloration.[1,2,3,4]

Despite the advantages offered by this bleaching treatment, the effect of carbamide peroxide bleaching agent on dental hard tissues is rather controversial. Some studies have demonstrated no significant effect of carbamide peroxide on human enamel.[5] Contrary results have shown morphological alterations on bleached enamel, thus suggesting an erosive process.[6,7,8,9]

Since carbamide peroxide in nightguard bleaching remains in contact with the tooth structure for a longer period, it is possible that hydrogen peroxide and urea, which are its degradation

products, penetrate into enamel subsurface and change the organic matrix during the bleaching procedure. Thus, physical properties of the bleached enamel might differ from those of the unbleached ones.[10]

Similarly, tooth erosion is a common dental problem which results in the loss of hard tissue from the tooth surface by a chemical process. Lifestyle changes and a rise in the consumption of acidic foods and carbonated beverages/soft drinks in younger generation have led to an increase in the prevalence of dental erosion around the world in the recent years. At the same time, attractive teeth have always been their typical primary concern.[11] Although both bleaching and dietary acids are capable of causing changes in the dental hard tissues on their own, but it is still not clear whether the bleached enamel is more prone to acid dissolution or additional surface changes following the exposure to carbonated beverages/ soft drinks.

Hence, the purpose of this *in vitro* study was to evaluate the effect of 15% carbamide peroxide bleaching gel alone on the enamel and the effect of exposure to carbonated beverage, Coca-Cola, on 15% carbamide peroxide gel bleached enamel surface morphology under Scanning Electron Microscope.

Materials and Methods

40 freshly extracted human premolar teeth, extracted due to orthodontic or periodontal reasons were selected for the study and were stored in distilled water until used. All 40 teeth were embedded in the acrylic blocks with their buccal enamel surface exposed in such a way that each block consisted of two embedded teeth. In total, 20 blocks were obtained and were divided into 5 groups, each group having 4 blocks, leading to 8 number of teeth samples. Later, the samples were cleaned using pumice slurry and an attached rubber cup in a slow rotating hand piece. Among the groups assigned, as shown in Table 1, Group A served as an unbleached group and group B,C,D and E served as experimental groups.

The samples from group A were covered with cotton pellets soaked in the distilled water, while rest of the samples from group B, C, D and E were subjected to the bleaching treatment, using15% carbamide peroxide gel available in the syringe form (Opalescence PF, Ultra dent products, USA). The gel was evenly applied to the buccal enamel surface of the samples and left for eight hours in a 100% humidity container. After 8 hours, the bleaching gel was removed by brushing and rinsing with tap water for 30 seconds. This gel treatment was carried out on a similar daily basis for 7 days. Following this, except group B, the samples from group C,D and E were assigned for the exposure to carbonated beverage, Coca-Cola. The pH of Coca- Cola, which was found to be 2.14, was measured using a digital pH meter. Using a measuring vessel 32.5 ml of Coca- Cola was dispensed into a plastic container.

Samples from group C, D and E were subjected to 10 cycles of Coca-Cola exposure by immersing them into the container having Coca- Cola for 5 seconds and removing them for another 5 seconds. This process was carried out only once in group C, twice and thrice at 6 hourly interval in the group D and E respectively. This entire process was again carried out on a daily basis for 7 days and finally, samples were stored in the distilled water for additional 7 days before subjecting them to scanning electron microscope (SEM) study. The SEM examination of the samples was done at the magnification of 200X, 500X and 1000X and the morphological changes on enamel surface were evaluated using *Yeh et al (2005)*[12] modification of Hobson's acid-etch pattern on enamel, as shown in Table 2.

The results were statistically analysed with the statistical package SPSS 11.5 window version using Pearson Chi-Square test, to compare the degree of enamel surface morphological changes among the various groups.

Table1: Treatment Procedure

GROUP	PROCEDURE
A	Unbleached group
B	15 % carbamide peroxide gel treatment only
C	15 % carbamide peroxide gel treatment and exposure to Coca-Cola once a day
D	15 % carbamide peroxide gel treatment and exposure to Coca-Cola twice a day at 6 hrs interval
E	15 % carbamide peroxide gel treatment and exposure to Coca-Cola thrice a day at 6 hrs interval

Table 2: *Yeh et al*, Modification of Hobson's acid-etch pattern of enamel

Degree I	Minimal change with micropitting only
Degree II	Prismatic enamel structure visible and sparsely distributed
Degree III	More-obvious prismatic structure apparent
Degree IV	Complete loss of aprismatic surface (prismatic enamel observed throughout the surface)
Degree V	Typical etched pattern over entire surface (honey-combed/fish-scale appearance)

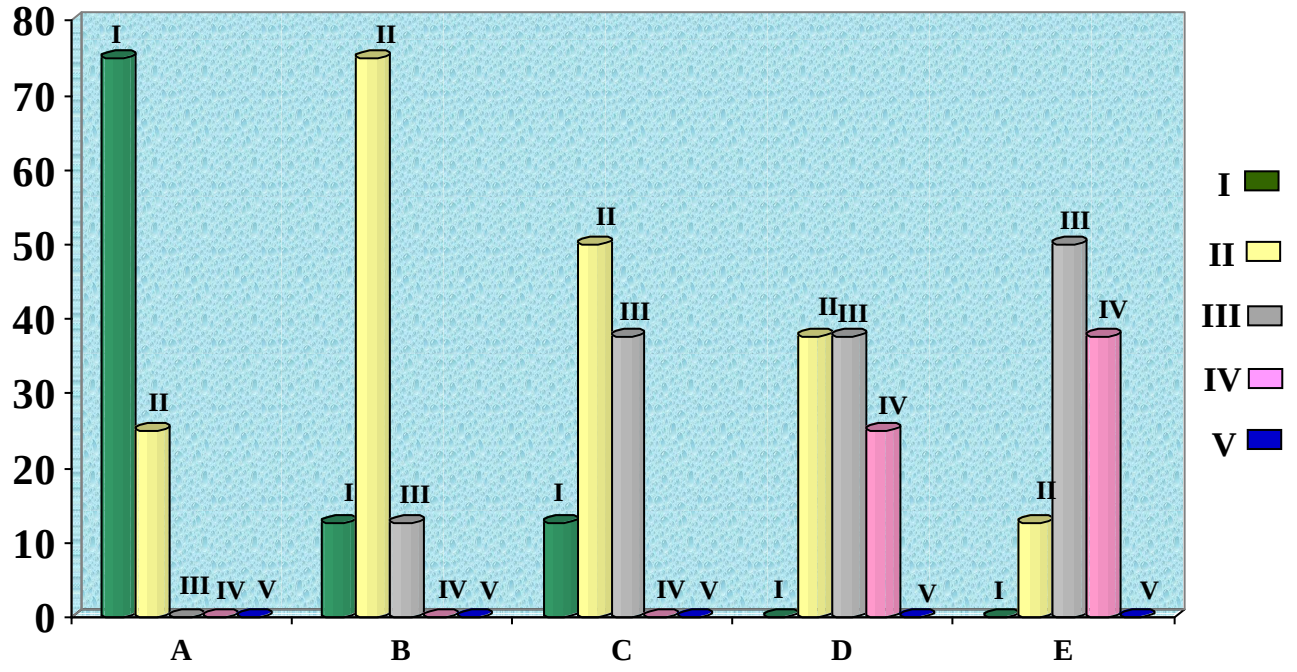
Table 3: Results

GROUP	SAMPLES	I	II	III	IV	V
A	Unbleached group	75%	25%	0	0	0
B	Treatment	12.5%	75%	12.5%	0	0
C	Treatment	12.5%	50%	37.5%	0	0
D	Treatment	0	37.5%	37.5%	25%	0
E	Treatment	0	12.5%	50%	37.5%	0

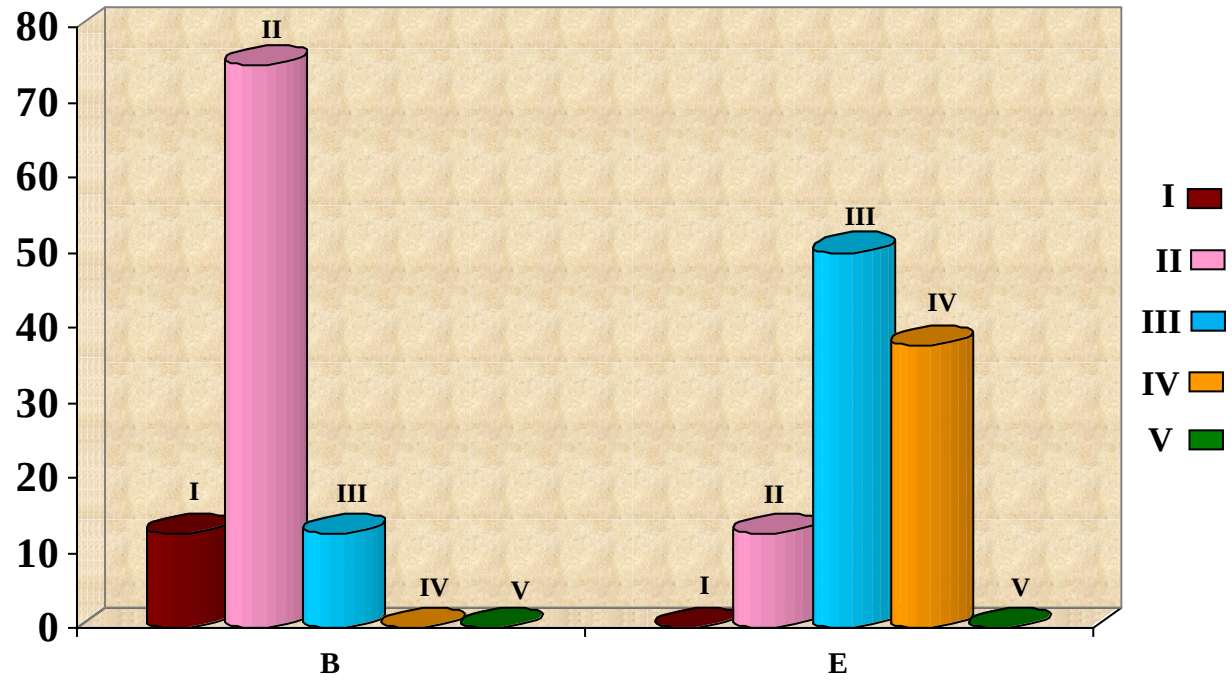
Table 4: Statistical Analysis (Chi-Square Test)

GROUP	VALUE	P
A vs B Pearson Chi-Square	6.571	0.037 sig
A vs C Pearson Chi-Square	7.238	0.027 sig
A vs D Pearson Chi-Square	11.200	0.011 sig
A vs E Pearson Chi-Square	13.333	0.004 hs
B vs E Pearson Chi-Square	9.371	0.025 sig

Graph 1: Comparison of Degree of Enamel Surface Morphological Changes among the Groups



Graph 2: Comparison of Degree of Enamel Surface Morphological Changes Between Group B & E



Result

The results, as shown in Tables 3,4 and Graphs 1 and 2, the following interpretations can be drawn. In comparison to group A, statistically significant enamel surface alterations were found in all the experimental groups i.e group B (p=0.037), group C (p=0.027), group D (p=0.011) with most significant alterations in group E (p=0.004). However, in relation to group B, statistically significant enamel alterations were observed in group E (p=0.025) but not in group C and D.

Discussion

The result of the present study showed that 15% carbamide peroxide bleaching gel (group B) caused significant morphological changes on the enamel surface. Various studies have concluded that 10-16% carbamide peroxide bleaching causes significant alteration on enamel topography, with 16% carbamide peroxide showing more decrease in the enamel hardness when compared to 10% carbamide peroxide.[13]

Further, it has been concluded that carbamide peroxide caused local changes in enamel microstructure similar to those of initial caries and also electron probe analysis showed lowered concentration of calcium and phosphorous.[14]

Similarly, findings from group C,D and E signify the role of carbonated beverage, coca cola, in causing further damage to already altered enamel surface following 15% carbamide peroxide bleaching. This can be attributed to the acidic pH of coca- cola which was found to be 2.14.According to one study, it was reported that cola type drink with pH 2.3 could lead to increased morphological changes due to its acidic nature and subsequent erosive effect causing mineral loss and enamel decalcification.[15]

Another study showed that enamel was softened and its hardness was significantly decreased as a result of demineralization following immersion in cola drink.[15,16,17]

The role of acidic exposure on the bleached enamel has been reported in one study, which concluded that the use of 37% phosphoric acid for etching led to more surface enamel dissolution in carbamide peroxide bleached enamel when compared to unbleached ones.[18]

However, no studies have been found regarding the effect of carbonated beverages on the bleached enamel. In this context, the result of the present study shows that carbonated beverage, Coca-Cola, is capable of causing significant additional morphological change in enamel surface treated with 15% carbamide peroxide gel, especially with increase in the number of exposures to Coca-Cola.

It is suggested that the increase in the morphological alteration on the bleached enamel following acid exposure could be due to infiltration of the enamel's crystallite protein matrix by hydrogen peroxide and urea which in turn may increase the enamel solubility in acid.[16]

Probably, in the present study, the above mechanism could be attributed to the role of Coca-Cola, which was found to have an acidic pH (2.14) in causing the further morphological changes in the bleached enamel.

However, regarding the clinical significance of the above findings, further studies are required, particularly considering the role of other factors like saliva on enamel.

Nevertheless, it would look prudent to ad vice the patients, who would undergo carbamide peroxide bleaching, to avoid acidic beverages/carbonated drinks or take precautionary measures to minimise enamel surface changes.

Conclusion

The 15% carbamide peroxide used in nightguard bleaching is capable of causing surface enamel changes. Further, significantly additional morphological alterations were seen when bleaching was followed by exposure to carbonated beverage Coca- Cola, which was found to be acidic in pH especially with increase in the frequency of exposure. Therefore, it would be useful to ad vice the patients to avoid carbonated beverages while undergoing 15% carbamide peroxide bleaching treatment.

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