Effects of carbamide peroxide containing bleaching agents on the morphology and subsurface hardness of enamel

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The purpose of this study is to evaluate the effects of nightguard bleaching agents (Karisma and Yotuel) on the enamel surface of forty anterior teeth. Ten teeth of each group were evaluated with SEM and ten teeth of each group were tested with a microhardness tester. Morphologic alterations were observed on the enamel surfaces with SEM. Karisma group showed a significant decrease in enamel hardness ($p<0.05$) and microhardness values of enamel were increased significantly in Yotuel group ($p<0.05$).
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INTRODUCTION

Nightguard vital bleaching technique was first described in dentistry by Haywood and Heymann[1] in 1989. This technique has been referred to as home bleaching, matrix bleaching, mouthguard bleaching or dentist-prescribed / home applied bleaching.[2-4] The technique involves the application of a weaker bleaching solution to the teeth in a custom-made, vacuum-formed appliance.

The efficacy of bleaching depends on many factors, ranging from the type of stain, through the condition of teeth, to patient compliance during and following treatment. The effectiveness depends upon the cause of the stain; where, how deeply, and how long the stain has permeated the structure of the tooth; and how well the bleaching agent can permeate to the source of the discoloration and remain there long enough to release deep stains. If the stains are on the surface or subsurface of the tooth, the process is fairly simple.[3,4]

Most of home-bleaching agents contain carbamide peroxide. Carbamide peroxide is usually used at a concentration of 10% to 15% in dental bleaching. Upon exposure to oral fluids, 10% carbamide peroxide has been shown to break down during oxidation into its constituent parts-water, urea, and oxygen.[5] Ten- percent carbamide peroxide is equivalent in strength to 3% hydrogen peroxide. This concentration is considerably milder than the 30% to 35% hydrogen peroxide generally used for in-office vital bleaching techniques. Because of the lower concentrations of the bleaching agent, more time is required to achieve comparable bleaching results.[6]

Various effects of carbamide peroxide on teeth have been studied.[7-17] There is some concern that continued long-term treatment will result in dissolution of the enamel matrix. The effects of bleaching agents on tooth structure is not clear and some controversy exists. Some investigators have indicated no major changes in surface of enamel when teeth are bleached with 10% carbamide peroxide.[6,13,17] But several studies have demonstrated some structural alterations on the surface of enamel after 10 % carbamide peroxide.[7,8,12,15]

The purpose of the study was to examine the effects of a 10% carbamide peroxide containing whitening gel Karisma (Confi-Dental, USA) and a new home bleaching agent Yotuel (Biocosmetics, Spain) which contains 12% carbamide peroxide, xylitol and potassium fluoride on human surface enamel and on microhardness of enamel *in vitro.*

MATERIALS AND METHODS

Forty non-carious intact, human maxillary incisors extracted for periodontal reasons were used in the study. The teeth were removed any hard or soft tissue remaining and cleaned with flour of pumice with a rubber by a slow-speed handpiece. Then the teeth were stored in 0.9% saline solution in room temperature until the experiment began. The enamel surface of the teeth was examined under a dissecting microscope to eliminate teeth with cracks. The roots of the extracted teeth were trimmed. Halves of the buccal surfaces were

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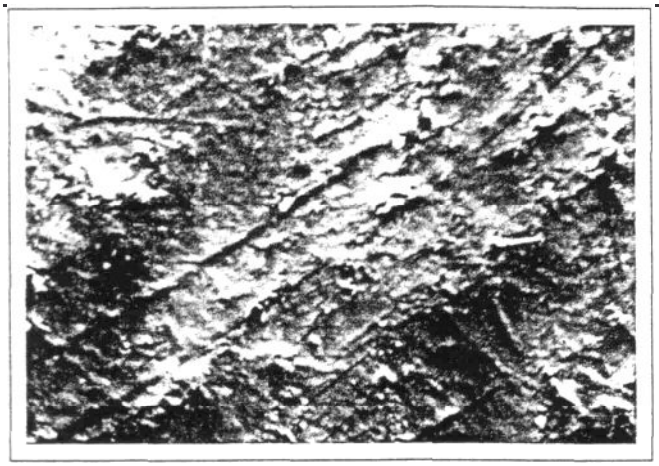

Figure 1. Untreated enamel surface.

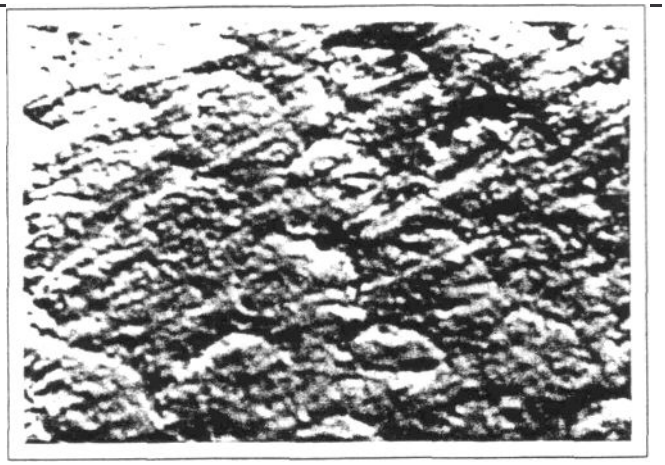

Figure 2. Enamel surface exposed to Karisma.

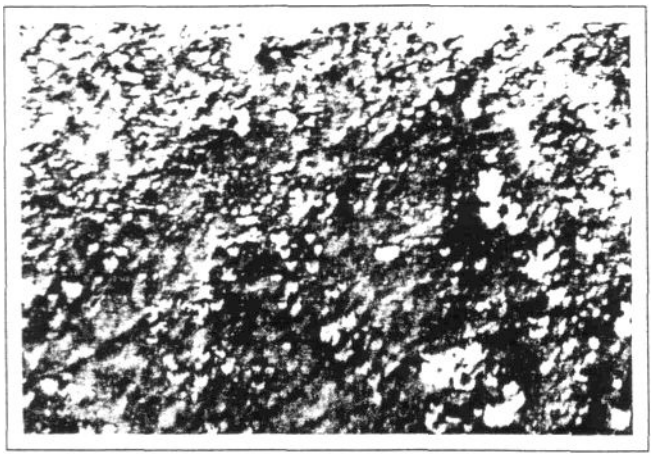

Figure 3. Enamel surface exposed to Karisma.

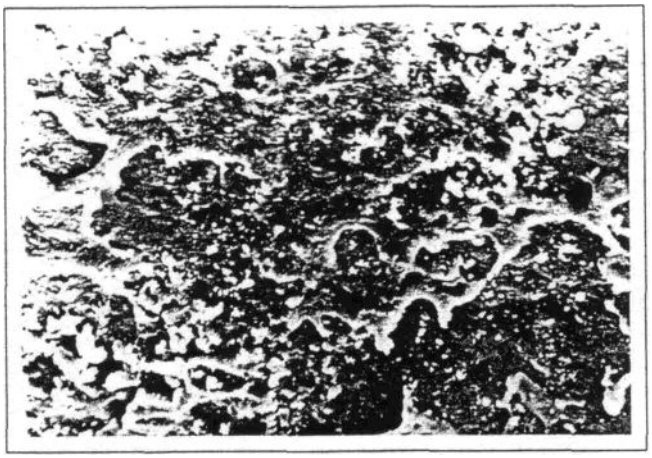

Figure 4. Enamel surface exposed to Yotuel.

coated with an acid-resistant varnish. The other half of the surface served as control. The specimens were divided into two groups.

In Group 1, Karisma, which contains 10% carbamide peroxide was applied to the 20 teeth according to the instructions of the manufacturer. The whitening agent was applied to the teeth about 2 mm thickness. After 6 hours exposure time the teeth were cleaned with tap water and placed into the synthetic saliva. This procedure was repeated everyday for four weeks.

In Group 2, Yotuel, which contained xylitol and potassium fluoride with 12% carbamide peroxide, was applied to the other 20 teeth about 2 mm thickness. After 3 hours exposure time the teeth were cleaned and placed into the synthetic saliva. This procedure was repeated everyday for four weeks.

Following completion of the whitening treatment, ten teeth of Group 1 and ten teeth of Group 2 were prepared for evaluation of enamel surface morphology using scanning electron microscopic techniques (Jeol. 840A). Another ten teeth of Group 1 and ten teeth of Group 2 were used for microhardness assessments. Enamel blocks were cut using water as a cooling agent.

Slabs were embedded in the acrylic resin. Vestibul faces of the teeth were sanded and each slab was placed on the rotating table of microhardness tester (Shimadzu, Kyoto). Two indentations spaced 100 μ apart were made with a Vicker's diamond under a 100-gram load for 15 s. at the two sides of each enamel slab. The mean value of two hardness measurements on half of teeth was used as the representative hardness number in the statistical analysis. Data from microhardness assessments were analysed by paired samples t test.

RESULTS

The SEM image of the untreated tooth is shown in Figure 1. The surface morphology of enamel treated with bleaching agents was considerably altered when compared with untreated enamel surface. Some samples treated with Karisma demonstrated a surface dissolution (Figure 2). In this group, the mineral mobilized from the prism peripheries was deposited on the enamel (Figure 3).

Yotuel caused slighter morphologic alterations to the enamel surfaces. The deposition of calcium fluoride-like material on the enamel was examined in Yotuel samples. The deposits densely packed with large

amounts of microgranules. coated the enamel partly (Figure 4).

The results between the hardness values of bleached and control groups, indicated that these agents had a significant effect on the hardness of enamel. The means and standard deviations of the hardness for the groups are listed in Table 1. A significant decrease in enamel hardness was observed between the half of the bleached tooth and half of the corresponding control tooth in Karisma treated group ($p<0.05$). For teeth treated with Yotuel, there was statistically significant increase in enamel hardness ($p<0.05$).

Table I. The means and standart deviations of the microhardness for the experiment groups.

	Karisma		Yotuel	
	Control	Bleached	Control	Bleached
n	10	10	10	10
mean	382.12	364.31*	389.62	439.64*
SD	23.02	20.48	20.58	22.59

* $p < 0.05$

DISCUSSION

The treatment of discolored vital teeth with nightguard vital bleaching has become one of the most popular esthetic treatments in dentistry. Since the introduction of nightguard vital bleaching, there has been much interest and concern expressed regarding the potential effects of the bleaching solution on teeth.[18-20] Bowie[19] and Cooper[20] suggested that peroxide molecules enter the pulp chamber of teeth treated with 10% carbamide peroxide- Bitter,[7] Shannon,[9] Rotstein[14] and Wolf[21] demonstrated the surface alterations in the enamel topography of specimens exposed to 10% carbamide peroxide bleaching agents.

In another study Rotstein *et al.*[22] reported a loss of strength and higher solubility of enamel, dentin, and cementum after bleaching. These agents changed the original ratio between the organic and inorganic components of the tissues and increased the solubility.

In our study, the alteration in surface morphology with the 10% carbamide peroxide gels is similar to those described by other investigators. For teeth treated with Karisma demineralization of the enamel prism periphery were observed. Protein-denaturating property of the agent will enhance the chemical destruction of the protein matrix around the enamel crystallites, consequently a layer of loosely bound crystallites will be formed.[23,24] It appeared that to be deposition of small and amorphous precipitates mineral had been lost from prism peripheries. Even a possible effect on the surface at enamel from bleaching may be considered negligible, compared to the 5 to 10 µ loss of enamel from every rubber cup prophylaxis over the life of a patient.

Teeth treated with Karisma showed a change in hardness of enamel surface. Microhardness values of enamel were less than values of controls. McCracken[10] reported that softening of enamel occurred bleaching with 10% carbamide peroxide, *in vitro.* However Shannon et al.[9] found that there were no statistically significant differences in microhardness values among •enamel slabs treated with 10% carbamide peroxide bleaching agents. However many procedures performed in dentistry and some food stuffs damage to surface enamel, but remineralization action of saliva should play an important role.

SEM images showed large particles of CaF_2 like material covered the enamel surface treated with Yotuel. This effect may be related to fluoride content of material. Also, neutral pH of material may cause a deposition of considerable amounts of CaF_2 like material.[25] The effect of fluoride inhibits demineralization and possible surface change. The deposition of CaF_2 on enamel surface seals the pores to protect the enamel acid attacks. Also, Yotuel contains xylitol and potassium. The sugar alcohol xylitol is not fermented by most oral micro-organisms and is non-cariogenic since it does not support acid formation by dental plaque bacteria.[26-28] Xylitol has been incorporated into fluoride-containing toothpastes and mouthrinses. *In vitro* studies have suggested that fluoride and xylitol exert an additive inhibitory effect on growth of and acid formation by streptococcus sobrinus and on acid formation by streptococcus mutans. So, xylitol has been attributed non-cariogenic and anticariogenic.[29,30]

Another way, it has been suggested that high levels of potassium in the dentinal fluid can maintain pulpal sensory nerves in a depolarized state, reducing hyper-sensitivity.[31] The whitening agents with the combination of fluoride, and potassium may reduce surface porosity, and sensitivity. Further clinical investigations are required for this hypotheses.

CONCLUSION

In this *in vitro* study, scanning electron microscopic evaluation revealed surface alterations in enamel topography for teeth with the bleaching solutions for four weeks. Teeth have demonstrated a significant decrease in hardness on the surface of enamel after 10% carbamide peroxide. Teeth treated with 12% carbamide peroxide, xylitol, potassium and fluoride containing whitening gel showed a significant increase in microhardness of enamel. Incorporation of a remineralizing and desensitizing agents within a tooth whitening system may reduce surface solubility and sensitivity.

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