The effect of 16% carbamide peroxide on the enamel surface:  
A scanning electron microscopic study

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ABSTRACT

Purpose: The purpose of this investigation was to evaluate the effect of 16% carbamide peroxide bleaching agent on enamel surface morphology.

Materials & Methods: Twenty-five bovine incisor teeth were selected. The specimens were subjected to 16% carbamide peroxide for a period of two weeks 8 hours daily. A control area on each tooth was covered and sealed. The specimens were examined under a scanning electron microscope. Fisher’s exact test was used for understanding the correlation between surface roughness and bleaching (a=0.05).

Results: Bleaching agent, presented varying degrees of alteration in tooth surface from slight (44.4%) to moderate (38.9%). The control group and only 14.7% of experimental specimens showed no alteration. Statistical analysis, Fisher’s exact test recognized that there was a correlation between bleaching agent and enamel surface morphology (P<0.05).

Conclusion: 16% carbamide peroxide could cause slight and moderate alterations in enamel surface. Although severe alteration was not observed.

Keywords: Carbamide Peroxide, Surface roughness, Enamel.

INTRODUCTION

The vital teeth present changes in color that substantially compromise smiling. Vital bleaching is rapidly gaining popularity among patients and dentists as a conservative technique to lighten natural teeth.¹ In some studies, scanning electron micro-graphic evaluations of natural teeth, have indicated that no major changes in surface texture occur when teeth are bleached with 10% carbamide peroxide.²⁻⁴ Many studies have evaluated the potential adverse effects of carbamide peroxide agent. When using SEM evaluations, changes in enamel⁵⁻¹² and dentin surface morphology¹² were reported. Although the bleaching agent is applied on the enamel surface, the oxidation process of carbamide peroxide takes place within the teeth by an interaction with their structural components.¹³

The aim of this invitro study was to determine, using scanning electron microscopy (SEM), if the 16% carbamide peroxide used in the nightguard vital bleaching technique caused any change in the surface texture of the treated enamel.

MATERIALS & METHODS

Twenty five non carious bovine incisors teeth were selected. They were kept in 0.5% formalin in room temperature for ten days. Extrinsic stains of the teeth were removed with a dental prophylaxis using Nupro prophylaxis fluoride paste (Dentsply, preventive care, York, PA 1704, USA). The prophylaxis was performed at least two weeks prior to initiating the active study phase. Then specimens were stored at 100% humidity and 37°C. The roots of the teeth were embedded in acrylic resin blocks.
The cementum adjacent to the exposed enamel was sealed with nail varnish. A thin plastic night-guard (.020 coping Material #3720, Buffalo Mfg Co) was fabricated using a vacuum-forming machine (STA-Vac, Buffalo Mfg Co) for each acrylic resin block. The mesial half of the facial surface of each tooth served as control. This area was covered with a plastic (25Mm thickness), sealed with inlay was then coated twice with nail varnish. Effectiveness of sealing was evaluated by placing teeth prepared in a dye solution for 24 hours. Following immersion, the covering was removed and the surface visually assessed to confirm the lack of dye penetration.

Two drops of a 16% carbamide peroxide gel, Vivastyle (Ivoclar Vivadent AG, Bendererstrass 2 FL-9494, schaan, Lichtenstain) were placed in each tooth form night-guard, and the night-guard was seated on the acrylic resin block. The teeth were kept at 100% humidity and 37°C, 8 hours daily for 2 weeks.

The night-guard was then removed and the teeth were rinsed for 2 minutes with tap water to remove the carbamide proxide. The teeth were then immersed in an artificial saliva solution (1% sodium chloride, 1% albumin and 0.1% sodium azide) fourteen hours. After the bleaching treatment was completed, the protective coating was removed from the mesial half the tooth. All samples were rinsed with distilled water.

The crowns of the teeth were separated from roots with a diamond disc (Isomet. Buchler). The specimens were sputter coated with approximately 500Mm of gold (E 5000 polaron, Hotfield, Pa) and prepared for scanning electron microscopy (JSM 829.Leol, Tokyo, Japan). All specimens were observed at magnifications of X300 and X5000.

“Surface roughness” refers to small-scale surface irregularities. The enamel alterations were classified according to Ernest et al. : no alterations, slight alterations, moderate alteration (deeper clefts and slight alterations in surface roughness) and severe alterations (loss of superficial structure). Fisher’s exact test was used to determine relationship between bleaching agent and enamel surface morphology.

RESULTS

All twenty-five control surfaces presented a similar appearance. These surfaces showed no alteration or changes indicating that the tested gel did not penetrate under the wax-covered surface in the mesial half of the teeth surface (Fig1). The distal half of the teeth which were exposed to the bleaching agent, presented varying degrees of alteration in tooth surface from slight (44.4%-Fig2) to moderate (38.9-Fig3). All of the specimens in control group and only 14.7% of experimental specimens showed no alteration(Fig4).

Fig 1. Surface of enamel that has been protected from direct contact with 16% carbamide peroxide during bleaching. (Original magnification X200 and X5000).

Fig 2. Surface of enamel that has been exposed to 16% carbamide peroxide for two weeks. (Original magnification X200 and X5000).

Statistical analysis Fisher’s exact test recognized that there was a correlation between using the bleaching agent and enamel surface morphology (P<0.05)(Fig3).
DISCUSSION

The aim of this study was to determine the effect of 16% carbamide peroxide on enamel surface morphology which had not yet been studied. The observations were solely based on the scanning electron microscope appearance of specimens after exposure to the bleaching agent.

There are some controversies in effect of carbamide peroxide on enamel surface morphology,\(^{(2,14)}\) in a comparison of the enamel surface morphology between any two different teeth, there are certain inherent differences between the enamel surfaces. For this reason, the approach of using a covered portion of the same tooth as the control for the surface morphology was adopted. It was not expected that the bleaching agent would migrate laterally and cover surfaces. Therefore even though the exposed and covered surfaces appear identical preoperatively, and postoperatively they differ subtly from their preoperative condition.\(^{(2)}\)

In this study, the bleaching time exposure was 8 hours daily for two weeks. This time interval had been used in two previous studies.\(^{(15,16)}\)

A study of the effects of external bleaching noted that changes in the chemical or physical structure of enamel must be of concern to any dentist who utilized bleaching technique as a treatment for whitening teeth.\(^{(17)}\) That study concluded that the bleaching effect may manifest itself over the long term through the occurrence of increased enamel attrition or cuspal fracture particularly on already weakened restored teeth.

The results of this study demonstrated that various degrees of alteration in the surface enamel, although severe alteration was not observed. Some investigators observed increases porosities on surface treated with phosphoric acid followed by 35% hydrogen peroxide.\(^{(18,19)}\)

The porosities could have resulted from the action of acid or the peroxide with a low pH.\(^{(3)}\)

According to the manufacturer, 16% carbamide peroxide, Vivastyle consists of more peroxide than the other bleaching agents, in addition pH value is lightly lower than these of the other bleaching agents evaluated by Demarks, International Study Program (DIS). This in consistent with a subsequent study by Covington et al.\(^{(20)}\) They reported that enamel treated with a low pH carbamide peroxide agents showed slight surface erosion under SEM.

McGuckin et al\(^{(11)}\) claimed that enamel surface alteration were evident with all of bleaching agents regardless of the pH level. Basting et al\(^{(14)}\) claimed that the acidic properties of bleaching agents, the prolonged contact time between the lightening product and dental surface can cause these superficial changes. Loss of mineral can be related to the acidic properties agents, even though Leonard et al\(^{(21)}\) observed an increase in the pH levels of 10% carbamide peroxide after its dissociation in the mouth. In future studies will be needed using some methods for eliminating the previous surface roughness of bleached enamel.

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