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A comparative study of the effects of two carbamide peroxide bleaching agents on the structure of enamel

Estudo comparativo do efeito de dois agentes clareadores à base de peróxido de carbamida sobre a estrutura do esmalte

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ABSTRACT

Objective
Considering that different sources of carbamide peroxide bleaching agent may cause greater or lesser damage to the enamel and may have reduced effectiveness in dental whitening, the aim of this study was to compare the effects on the structure of enamel of two bleaching agents, drugstore-compounded and commercial carbamide peroxide bleaching agents.

Methods
The specimens in the first group (drugstore-compounded carbamide peroxide) and second group (commercial carbamide peroxide) were treated with to 16% carbamide peroxide for 4 h per day for 20 days. The third group served as a control and was kept in artificial saliva during the test period. After the treatments, all specimens were examined via scanning electron microscopy.

Results
Changes in the enamel morphology were similar in both experimental groups, but these changes were greater than those observed in the control group. The changes were mild and included only pores.

Conclusion
There were no differences regarding damage to the enamel between drugstore-compounded and commercial carbamide peroxide bleaching agents.

Indexing terms: *Dental enamel. Microscopy, electron, scanning. Tooth bleaching.*

RESUMO

Objetivo
Comparar por microscopia eletrônica de varredura, os efeitos sobre a superfície do esmalte de um agente clareador à base de peróxido de carbamida comercial e outro preparado em farmácia de manipulação.

Métodos
Os espécimes do primeiro grupo (confeccionado em farmácias de manipulação) e do segundo grupo (peróxido de carbamida comercial) foram tratados com peróxido de carbamida a 16% por 4 horas durante 20 dias. O terceiro grupo (controle) foi preservado em saliva artificial durante todo o experimento. Após os tratamentos, todas as amostras foram examinadas por microscopia eletrônica de transmissão.

Resultados
As alterações foram sutis e compreenderam apenas poros. As alterações na morfologia do esmalte nos grupos experimentais foram similares, mas foram maiores do que aquelas observadas no grupo controle.

Conclusão
Não foram observadas diferenças na superfície do esmalte dentário entre os agentes clareadores à base de peróxido de carbamida comerciais e aqueles adquiridos em farmácias de manipulação.

Termos de indexação: Esmalte dentário. Microscopia eletrônica de varredura. Clareamento dental.

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INTRODUCTION

The color of the tooth is an important issue for dentists and patients who want to improve the appearance of their teeth1. As a result, many studies have been developed with the aim of improving techniques or creating products to whiten teeth without risk to the health of patients.2,3,4,5 The most commonly used products for bleaching teeth are hydrogen peroxide and carbamide peroxide[6-7].

Carbamide peroxide has been suggested as a safe option for bleaching vital teeth. Most of the available systems employ carbamide peroxide at concentrations ranging from 10 to 35%[8-9].There is much controversy regarding the effects of different concentrations of bleaching agents on the enamel structure[2,10-11]. A study evaluating the effects of various concentrations of carbamide peroxide on the enamel revealed that bleaching agents with lower concentrations of this agent (10 and 16%) caused fewer changes to the enamel surface[12].

The bleaching of vital teeth with carbamide peroxide can be accomplished by means of bleaching agents applied in the dentist's office or dental bleaching gels that are used at home under the supervision of a dentist. Such products are generally manufactured by leading companies with worldwide recognition. However, it is also possible to purchase of these bleaching agents from compounding pharmacies that can offer the same product at a lower cost. It is possible that different sources of such a product may result in more or less damage to the enamel and may have reduced effectiveness in tooth whitening. A study analyzing the concentration of carbamide peroxide in bleaching agents prepared by compounding pharmacies noted that the products tested did not have the expected 16% concentration of carbamide peroxide[13].

The present study was carried out to compare the effect on the enamel surface of a 16% carbamide peroxide gel that was industrially produced with that of an agent that was made in a compounding pharmacy. We hypothesized that the origin of a product may interfere with its ability to change the enamel surface, resulting in changes in the structure of the enamel.

METHODS

Specimen preparation

Thirty upper and lower human premolar teeth donated by the Teeth Bank of the Metropolitan Union of Education and Culture (UNIME) were used in this study. Removal of residual soft tissues and teeth cleaning was performed with the aid of Greyce 7 curettes, Robinson brushes, pumice stone and deionized water used with a disk coupled to a low speed motor. The separation of the crowns from the root portion and the buccal surfaces from the lingual or palatine surfaces was completed with the use of a Precision-Cutter ELSAW (ElQuip®, São Carlos, SP). The bases of one-half-inch PVC cylinders were sealed with red wax (Epoxiglass®, Diadema - SP, Brazil). Inside each cylinder, the dental surface was placed in the center of the sealing wax and allowed to settle so that the wax directly contacted the selected face of the specimen, followed by the inclusion of the other faces in orthophthalic resin.

The 30 specimens were prepared and randomly divided into 3 groups: Experimental Group I consisted of 10 specimens treated with a 16% carbamide peroxide gel prepared in a compounding pharmacy (Formula®, Salvador, BA); Experimental Group II consisted of 10 specimens treated with 16% carbamide peroxide gel (Whiteness Perfect® FGM, Joinville, SC); and a Control Group that consisted of 10 specimens without any bleaching treatment. The specimens were immersed in remineralizing solution at 37 °C. The experimental protocol, which was executed for 20 days, was based on the following procedures: brushing with white fluoride toothpaste (Oral-B Pró-saúde® with 1.100 ppm fluoride, Procter & Gamble, Brazil) for 2 minutes with the aid of brushing simulation equipment (ElQuip®, São Carlos, SP) adjusted to 540 cycles; Pro-Health® with 1100 ppm fluoride(Procter & Gamble, Brazil) for 2 minutes with the aid of brushing simulation equipment (ElQuip®, São Carlos, SP) adjusted to 540 cycles, simulating the average time of normal brushing. The specimens were dried and the shade was determined by measurement against the VITA Easyshade® Advance spectrophotometer (VITA Zahnfabrik H. Rauter GmbH & Co., KG), followed by thermal cycling of the specimens with a Thermal Cycle Simulation machine (ElQuip®, São Carlos, SP) that applied 100 thermal cycles of 55ºC, 37ºC and 5ºC, 5 seconds each, to simulate the temperature variations in the oral cavity. Subsequently 16% carbamide peroxide, either from a compounding pharmacy or the industrially produced gel, was applied; the specimens were maintained for 4 hours at 37 °C in a plastic collection container. Then, the specimens were rinsed with deionized water, brushed and dried again and a second determination of the enamel shade was performed, followed by re-immersion of the specimens

in remineralizing solution at 37 °C for 24 hours. This procedure was repeated during the 20-day trial.

Processing for Scanning Electron Microscopy (SEM)

The samples were removed from the resin cylinders, and the enamel surfaces were prepared for SEM. The specimens were placed on aluminum stubs with colloidal silver adhesive and sputter-coated with gold in a Bal-Tec SCD 050 apparatus (Bal-Tec SCD 050, Liechtenstein). The enamel surface was examined at 200X, 400X, 1,000X, 2,400X and 5,000X magnifications with an SS-550 Superscanscanning electron microscope (Shimadzu®) operated at 10-15 kV. A scan of the entire buccal and palatal surfaces was performed, and the most critical areas were selected for the SEM photomicrographs. The photomicrographs were evaluated by two independent researchers. In the qualitative descriptive histological study, enamel surfaces were examined for the presence of pores, erosions, loss of the aprismatic layer, grooves and craters according to type of bleaching agents.

RESULTS

Similar alterations were observed to the enamel morphology of the teeth treated with the both types of bleaching agents. Although some alterations such as pores have been detected in the experimental groups, no potentially damaging change in surface of the enamel was observed. The characteristics of the enamel surface associated with the experimental and control groups were described below.

Pores and some irregularities in the enamel surface could be observed in both experimental groups of specimens (Figure 1A,B). At higher magnification, the morphologic surface alterations became more pronounced in all the groups. In the experimental groups, the alterations included pores, erosions and craters (Figure 1C). Compared to the control group (Figure 1D), the experimental groups had increased porosity. The unbleached enamel from the control group exhibited a surface that was not completely smooth because there was a small loss of the aprismatic layer. In all the groups, some grooves could be noted on the enamel surface.

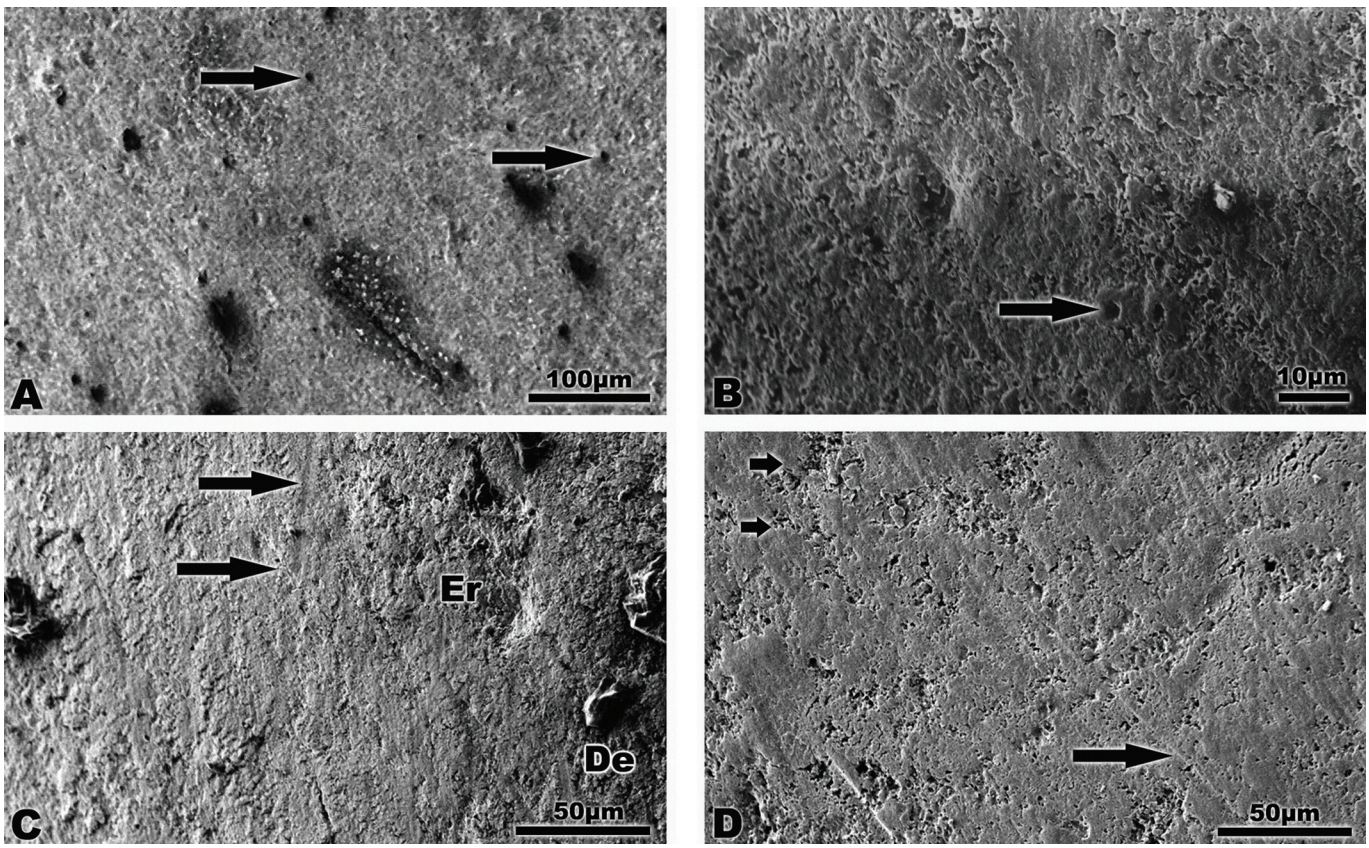

Figure 1. Scanning electron micrographs showing regions of enamel treated with two types of bleaching agents, 16% carbamide peroxide gel from a pharmacy (A and B) and a commercial brand of 16% carbamide peroxide gel (C) and an unbleached enamel surface (D). (A) Note the presence of many pores (arrows) on the enamel surface. (B) A high-magnification view of the enamel revealing many irregularities on the enamel surface. Observe the presence of two pores (arrow). (C) The enamel surface exhibiting many irregularities. Note an erosion (Er), grooves (arrows) and residual debris (De) on the enamel surface. (D) Control group. Some grooves (arrow) on the enamel surface and the partial loss of the aprismatic layer (small arrows) can be noted.

DISCUSSION

In the present study, the effects of drugstore-compounded and industrialized bleaching agents on the structure of tooth enamel were compared using two commercially available 16% carbamide peroxide agents. These agents slightly affected the enamel, producing small structural changes that were not observed in the control group. The most common enamel defects in the specimens from the two different bleaching agents were some pores.

In our study, SEM was used to examine the enamel surface after the tooth bleaching treatments. Many studies have employed this tool to characterize the physical properties of enamel after tooth whitening. SEM has traditionally been considered the gold standard in the studies of enamel surfaces treated with several different agents[14-15].

Using SEM, this study evaluated the possible effect of carbamide peroxide on the enamel surface using agents with a low concentration of carbamide peroxide (16%). The side effects of low concentrations of carbamide peroxide on enamel are controversial. Basting et al.[16] evaluated the microhardness of enamel exposed to different concentrations of carbamide peroxide agents for different bleaching times. Their findings showed a decrease in the microhardness values in the all groups. Oltu & Gurgan[12] studied the effect of three bleaching agents containing 10, 16 or 35% carbamide peroxide on the enamel by infrared absorption spectroscopy and X-ray diffraction analysis. These authors observed that 10 or 16% carbamide peroxide did not change the enamel, whereas 35% carbamide affected its structure. Considering the above findings, the present study evaluated only the effects of 16% carbamide peroxide gel, because the use of low concentrations of carbamide peroxide is always recommended over higher concentrations.

In our study, no difference between the 16% bleaching agents was found, showing that the effects on enamel treated with drugstore-compounded and industrialized carbamide peroxide gels were similar. Different results might have been expected because variations in the chemical composition and conditions of storage among the products could exist. Martin et al.[13], who analyzed the concentration of 16% carbamide peroxide bleaching agents prepared by dispensing pharmacies and that of a commercially available product, observed that neither of the bleaching agents presented the expected concentration of 16%. Our findings showed that possible physical or chemical differences between the bleaching agents caused by errors during manufacture did not influence the enamel surface.

However, some alterations on the enamel surface were observed in the experimental samples compared to control, consisting principally of small pores, craters and erosions. Grooves were present on the enamel surface in all the groups and were related to the tooth extraction[17] or to the polishing treatments.[3] In the experimental groups, grooves were more clearly prominent, possibly because the enamel surfaces were treated with carbamide peroxide. Indeed, morphologic surface alterations, including the partial removal of the aprismatic layer, an increased depth of enamel grooves, and the exposure of the enamel prisms, were much more pronounced after bleaching.[6] In the present study, these changes were small and most likely have no clinical impact.

Pores were alterations only observed in the experimental groups. In the enamel, pores arise as a result of spaces created between single crystals in the prism cores and those between prisms. The smaller pores observed in the experimental groups may be associated with the spaces within the prisms themselves[18-19]. These pores could be created by the action of the bleaching agents on the organic or inorganic elements of the enamel matrix[20].

Some small alterations observed on the enamel surface may be related to an initial process of demineralization. Oltu & Gurgan[12], for example, showed changes in the inorganic composition of enamel subjected to carbamide peroxide. It is possible that demineralization could be provoked by the pH of the carbamide peroxide agents employed in the study[16]. Sa et al.[3] evaluated the effects of bleaching agents with different pH values on the human enamel and observed that the agents with low pH values induced alterations in the enamel surfaces. An in vitro study showed loss of calcium from the enamel exposed to 10% carbamide peroxide[21]. Indeed, some bleaching agents are acidic and could affect the enamel, dentin and cement. Miranda et al.[6] evaluated the influence of in-office bleaching agents on human enamel morphology. The pH values of 35% carbamide peroxide gel were 6.4 and 3.8. The demineralizing action provoked by the low pH of the carbamide peroxide could be similar to phosphoric acid. When phosphoric acid is applied to the enamel surface, the acid selectively removes some ends of the enamel prisms. As a consequence, pores and enamel crystallites are exposed, resulting in a retentive surface[22]. The clinical significance of this amount of calcium loss must be examined because human saliva could reverse the demineralization caused by low pH. In the present study, the pH of the bleaching agents was measured. The pH of these agents was neutral, indicating that these products did not contribute to enamel demineralization.

To simulate the environment observed in the oral cavity and the remineralizing potential of saliva, the specimens were kept in a remineralizing solution. The lack of marked changes in the enamel surface in the groups may also have been influenced by the exposure of the specimens to this solution. The remineralizating potential of artificial saliva was observed by Klaric et al.[23] when they evaluated the influence of five bleaching agents on enamel and dentin surface of 125 human third molars.

CONCLUSION

In summary, the present findings showed that 16% carbamide peroxide agents caused small microstructural changes to the enamel surface. There was no difference in the degree of injury to the enamel when the two groups here in available were compared. However, the findings must be interpreted with caution because this study was performed in vitro and evaluated only bleaching agents that originated from a single compounding pharmacy.

Collaborators

RP DE ARAÚJO was responsible for the research and writing the article. DB DE ARAÚJO participated in the research. MC AGUIAR participated in analysis and interpretation of results, and writing the article.

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