Effect of hydrogen-peroxide-based home bleaching agents on enamel hardness

Isana Álvares Ferreira
Guilherme Carpena Lopes
Luiz Clovis Cardoso Vieira
Élito Araujo
Department of Operative Dentistry,
Universidade Federal de Santa Catarina,
Florianópolis, Brazil.

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Abstract
The aim of this in vitro study was to examine the effect of four commercial hydrogen-peroxide-based home bleaching agents on enamel microhardness. Fifteen human molars conserved in water for no more than 3 months were sectioned mesio-distally. The buccal and lingual surfaces were included in self curing acrylic resin, and the 30 specimens were ground until 600 grid (n=6). At baseline, 6 indentations (Vickers) were made on each of the 6 surfaces of each group, under load of 100g for 30s. Bleaching procedure was performed for 2 weeks with: 4.5% hydrogen-peroxide (Perfecta, Premier), 5.5% hydrogen-peroxide (DayWhite, Discus Dental), 7.5% hydrogen-peroxide (DayWhite, Discus Dental), a polyethylene-strip whitening system containing 5.3% hydrogen-peroxide (Whitestrips, Procter&Gamble) and 10% carbamide peroxide (Opalescence, Ultradent) was used as control. After bleaching time, the specimens were rinsed and maintained in fresh artificial saliva, changed daily. A t-test compared each bleaching agent before and after treatment. The results showed that none of the five commercial home bleaching agents reduced the enamel microhardness. It was concluded that all the five commercial home bleaching agents evaluated in our study showed no adverse effects on enamel microhardness.

Key Words:
hydrogen-peroxide, carbamide peroxide, bleaching, enamel, hardness

Correspondence to:
Isana Álvares Ferreira
Universidade Federal de Santa Catarina,
Centro de Ciências da Saúde
Departamento de Estomatologia, Dentística,
Campus Universitário, Trindade
CEP: 88015-000 - Florianópolis,
Santa Catarina, Brasil
Fax: 0055 48 234 1788
E-mail: isanaalvares@hotmail.com
Introduction
The search for a more conservative cosmetic dentistry has turned dental bleaching into the first option for the treatment of teeth with changes in color. Teeth bleaching must not be considered a new technique within dentistry, once it has been performed for more than a century\(^1\). The home bleaching technique, settled by Haywood and Heyman in 1989\(^2\), recommends the use of 10% carbamide peroxide with a custom tray. Several changes regarding products and techniques have been recently introduced thus disposing hydrogen-peroxide-based bleaching agents in low concentrations and techniques which make the traditional use of trays unnecessary.

The 10% carbamide peroxide, when in contact with saliva and oral fluids, dissociates itself in 7% of urea which afterwards decomposes itself into ammonia and carbon dioxide and 3% hydrogen peroxide\(^3\), which consequently degrades itself into water and free nascent oxygen\(^4\). Because they present acid characteristics, bleaching agents may alter the mineral content of the teeth after bleaching\(^5,6\) and this would alter the enamel microhardness\(^7\), possibly leading to a reduce on dental resistance to wear by abrasion, attrition, abrasion and erosion. However, the effects that home bleaching have on hard tissues, mainly on enamel, are very contradicting\(^8\). Some researches states that the bleaching treatment, containing carbamide-peroxide-based products, does not affect the enamel microhardness\(^9\)\(^12\). New hydrogen-peroxide-based materials available on market, present higher concentrations than the hydrogen peroxide resulting from the dissociation of the 10% carbamide peroxide. A recent research on 3% hydrogen peroxide gel manipulated in a pharmacy resulted on the enamel microhardness decrease\(^13\). Besides, similar changes were reported in other researches using 10% carbamide peroxide\(^7\)\(^8\)\(^14\)\(^17\). Thus, it can be assumed that hydrogen peroxides tested on the present work, once the contact for a longer period with a hyper mineralized situation. The saliva presents a large remineralization potential. The dynamism of the process may help to explain our results. The main goal of this study was to analyze the effect of four hydrogen-peroxide-based bleaching systems on enamel microhardness.

Material and Methods
Fifteen human molars, stored in water for a maximum of 3 months, were sectioned in a mesio-distal direction in equal halves. The buccal and lingual surfaces were embedded in chemically-activated acrylic resin (AcryliMet, South Bay Technology Inc., San Clemente, CA), an area of approximately 3 mm x 3 mm remaining exposed. The thirty specimens were polished with sand-paper of 220, 360, 440, and 600-grit. Five groups were prepared as per treatment modality (n=6): Group 1 – 4.5% hydrogen peroxide (Perfecta, Premier); Group 2 – 5.5% hydrogen peroxide (DayWhite, Discus Dental); Group 3 – 7.5% hydrogen peroxide (DayWhite, Discus Dental); Group 4 – a polyethylene-strip whitening system containing 5.3% hydrogen peroxide (Whitestrips, Procter&Gamble); and control, Group 5 – 10% carbamide peroxide (Opalescence, Ultradent). The solutions had their pH measured using pHmeter (Geaka, São Paulo, Brazil).

Prior to the experiment, 6 indentations (Vickers) were made, separated 0.1 mm, on each of the 6 surfaces in each group, using a Shimadzu hmv-2000 (Shimadzu, Tokyo, Japan). Bleaching procedure was carried out for 30 minutes, twice a day (30 minutes AM and 30 minutes PM) for 2 weeks, to the exception of the control group that was carried for 2 hours per day for 2 weeks. During the bleaching procedure the specimens were put in a Tupperware containing artificial saliva to active a more adequate simulation of the clinical situation. The saliva did not cover the specimens. The bleaching solutions were applied over the enamel. The Tupperware was closed and maintained at 37°C. Following each daily bleaching session, the teeth were washed with deionized water and stored in artificial saliva (Dermus Pharmacy) at 37°C, the saliva being changed daily.

At the end of the treatment period, the teeth had the Vickers hardness measured, with 6 indentations separated 0.1 mm, cut into each of the 6 surfaces of every group. A t-test compared each bleaching agent pre and post treatment.

Results
Mean microhardness before and after treatment, as well as the measured pH, are presented on Table 1. None of the five commercial home bleaching agents reduced the enamel microhardness when compared to the measurement conducted prior to bleaching. However, specimens submitted to bleaching with DayWhite 5.5% gel presented an increase of enamel microhardness (p≤0.031).

Discussion
The effectiveness and safety of the hydrogen and carbamide peroxides used in dental bleaching have been recently researched\(^18\)\(^20\). Contradicting results among laboratorial works can be explained due to variations in the methodology applied, such as time of exposure, pH of solution, type of teeth and mainly the storage environment\(^15\). Some works show that when the specimens are storage in artificial saliva or exposure to oral environment in situ\(^21\), no changes in the superficial hardness of enamel is observed\(^9\)\(^12\), considering that the saliva presents a large remineralization potential. The dynamism of the process may help to explain our results. The enamel contact with the bleaching solution slightly below the critical pH for a short period (30 minutes) followed by the contact for a longer period with a hyper mineralized solution of artificial saliva seems to be unable to result in demineralization. Thus, in our study no reduce in the enamel microhardness was noticed. On the other hand, an increase...
Table 1 - Mean microhardness values (SD in parentheses) before and after treatment

<table>
<thead>
<tr>
<th>Bleaching Agents</th>
<th>pH</th>
<th>Microhardness (Baseline)</th>
<th>Microhardness (After Treatment)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opalescence (Carbamide Peroxide10%)</td>
<td>6.5</td>
<td>332.1(33)a</td>
<td>331.4(34)a</td>
</tr>
<tr>
<td>DayWhite (7.5% Hydrogen Peroxide)</td>
<td>5.1</td>
<td>325.7(42)a</td>
<td>331.3(45)a</td>
</tr>
<tr>
<td>DayWhite (5.5% Hydrogen Peroxide)</td>
<td>6.6</td>
<td>324.6(35)a</td>
<td>350.8(42)b</td>
</tr>
<tr>
<td>Whitestrips (5.3% Hydrogen Peroxide)</td>
<td>6.0</td>
<td>332.2(25)a</td>
<td>340.1(27)a</td>
</tr>
<tr>
<td>Perfecta (4.5% Hydrogen Peroxide)</td>
<td>7.1</td>
<td>316.1(34)a</td>
<td>323.8(38)a</td>
</tr>
</tbody>
</table>

Values followed by different lower case letters mean statistical difference between the two evaluations at p<0.05

of about 8% in the microhardness of specimens from group 5.5%HP (Day White) was observed.

A research compared the effects of primary components from 10% carbamide peroxide (3% of hydrogen peroxide and 7% urea) over the enamel. In this study it was attained as one of the results that the bleaching enamel with 3% hydrogen peroxide (pH 6.4) presented a significant reduce on its superficial microhardness. Based on this work, it could be assumed that bleaching products used in the present research based on hydrogen peroxide with higher concentrations and lower pH could lead to a similar reduction in the enamel microhardness. However, the results show that none of the groups evaluated suffered any decrease. Two possible conjectures could be done to explain the difference between these two works. The first, time of exposure of the gel over the enamel was three hours a day, while in this study, the period of time applied over the specimens was 30 minutes, twice a day. Second, the composition of the commercial bleaching products seems to have solutions which are able to perform a remineralization action. The enamel demineralization happens in a pH of 5.5 (critical pH)22. Thus, we could expect a reduction on the enamel hardness of group 7.5% (Day White) once it presents a pH below the critical (pH 5.1) and because it was the lowest of the products tested (Table 1). However, some component of its formulation makes its use unable to produce negative effects over the enamel hardness.

Bleaching agents once presenting acid characteristics could alter the mineral content of the teeth after bleaching (3,5,6) and this would alter the enamel microhardness. Bleaching solutions with a pH moderately low reduce in vivo the saliva pH during the first 5 minutes. After 15 minutes of treatment the pH increases above the average23. This is possibly due to chemical reactions of the carbamide peroxide, neutralizing the saliva acidity24-25. So, it is believed that due to the presence of urea, resulting from the carbamide peroxide breakdown and responsible for the pH increase, the demineralization does not occur and, consequently, there are no changes in the enamel microhardness, a fact that was observed in the carbamide peroxide group.

The findings of the present study demonstrated that the bleaching systems evaluated showed no adverse effects on enamel microhardness, being able to be safely indicated for home dental bleaching.

References


