Effect of Two Bleaching Agent Products on Mercury and Silver Ion Release from Dental Amalgam

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Abstract:
Objective: Bleaching of the teeth is considered as a safe, effective, and conservative procedure to treat discolored teeth. The aim of the present study was to compare the amount of mercury and silver released from amalgam after applying two brands of carbamide peroxide 16% bleaching gel.

Materials and Methods: For this experimental study, 384 amalgam tablets were prepared. The samples were kept in distilled water for a month and then were randomly classified into three groups (two experimental and one control groups). The experimental groups were placed in two different Carbamid Peroxide 16% gels (Kimia, Iran, and Nite White, USA) and the control group was placed in Phosphate Buffer with pH=6.5. Then the amount of the released mercury and silver ion was determined using AVA-440 analyzer system based on cold-vapor atomic absorption method after 14 and 28 hours. ANOVA and Tukey HSD tests served for statistical analysis.

Results: Carbamid proxide 16% gels caused a significant increase in the amount of mercury and silver released from amalgams in experimental groups (P<0.001). The amount of Mercury and silver released from amalgams in Kimia gel was significantly more than Nite White 16% (P<0.001). The mercury release was not time-dependent (P>0.05) but the silver release was (P<0.05).

Conclusion: Carbamid peroxide bleaching gels increase mercury and silver release from dental amalgams. The gel brand seems to have a significant influence on the amount of ion released from the dental amalgam.

Key Words: carbamide peroxide; Tooth Bleaching; Ion Exchange; Dental Amalgam

INTRODUCTION
Appearance is of great importance in social relations. Therefore, in recent years, there has been an increased demand for tooth bleaching in order to improve the whiteness and perceived esthetic appearance of tooth tissue [1,2]. It is believed that current home bleaching agents whiten discolored tooth structure through decomposition of peroxides into unstable free radicals. These radicals further breakdown into large pigmented molecules either through an oxidation or a reduction reaction [3,4]. Although the results of previous studies on these materials are inconclusive, recent evidence have indicated that bleaching chemicals might have potentials for adverse effects on tooth structure, and on physical properties, surface morphology and color of
various restorative materials [5,6]. Since amalgam is still a widely used restorative dental material, any interaction between amalgam and vital bleaching materials could be of clinical significance [7-9]. Previous studies have examined the changes in surface levels of mercury, silver, tin, and copper of dental amalgam treated with carbamide peroxide and hydrogen peroxide [1,9-11]. In-vitro studies have shown that the amount of ion release from amalgam depends on the carbamide peroxide brand tested [10,5,7].

The present study investigated the effect of two carbamide peroxide home bleaching products on the release of mercury (Hg) and silver (Ag) from dental amalgam.

MATERIALS AND METHODS

Specimen Preparation

This study was done on samples of four commercially available dental amalgams. Table 1 summarizes the chemical compositions of these alloys. Ninety-six specimens of each of the four dental amalgam brands were prepared as follow: The amalgams were automatically mixed in a dental amalgamator according to the manufacturers' instructions. The freshly prepared mixed was condensed with hand condensers into truncated cone PVC mold with 9.0 mm in bottom diameter and 8.0 mm in top diameter and 3.0 mm in height with 1.95 cm² effective external surface area. The specimens were left in the molds for 60 minutes for initial setting and then were removed and placed in four assay test tubes containing distilled water for 24 hours at 37°C. Half of the samples in each group (48 samples) were polished to achieve a smooth, shiny surface. This stage was also performed with the use of green and red rubber (DTZ Geozalee 307-14167 Berlin, Germany), and then a brush and tin-oxide paste at low speed. After this final polishing stage, specimens were once again stored in separate tubes containing distilled water for one month.

Bleaching Treatments

The specimens were treated with either Kimia (Kimia CO, Tehran, Iran) or Nite white (Nite white. Discus dental, Inc. Culver City, USA) 16% carbamide peroxide gels (Table 1). Each of the experimental samples was sealed in individual assay test tubes containing 3.0 ml carbamide peroxide gel and 0.1 ml distilled water. In control groups, samples were sealed in similar assay test tubes containing 3.0 ml of 0.1 M phosphate buffer at 6.5 pH. At two time points of 14 hours and 28 hours, the carbamide

Table 1. Compositions of Zinc free amalgam alloys and carbamide peroxide gels used in this study.

<table>
<thead>
<tr>
<th>Material</th>
<th>Manufacturer</th>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amalgam</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cinalux</td>
<td>Sh. Dr. Faghihi, Dental Co. Tehran, Iran</td>
<td>Ag=49% Sn=29% Cu=22%</td>
</tr>
<tr>
<td>Cinamix</td>
<td>Sh. Dr. Faghihi, Dental Co. Tehran, Iran</td>
<td>Ag=43% Sn=31% Cu=26%</td>
</tr>
<tr>
<td>SDI-GS80</td>
<td>Southern Dental Industries Limited, Victoria, Australia</td>
<td>Ag=40% Sn=31.2% Cu=28.7%</td>
</tr>
<tr>
<td>Orally Magicap S</td>
<td>Colltene Co. Ohio, USA</td>
<td>Ag=58.3% Sn=28.3% Cu=13.33%</td>
</tr>
<tr>
<td>Carbamide Peroxides</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nite White 16%</td>
<td>Discus Dental, Inc. Culver City, USA</td>
<td>Amorphous calcium phosphate, potassium nitrate, Carbamide peroxide 16%</td>
</tr>
<tr>
<td>Kimia 16%</td>
<td>Kimia Co. Tehran, Iran</td>
<td>Carbamide peroxide 16%</td>
</tr>
</tbody>
</table>
peroxoide gel on the sample surface was carefully rinsed with 7.0 ml distilled water then distilled water was increased in test tubes until volume of tubes reach 10 ml. Following this stage, mercury and silver levels of each solution were measured using the VAV-440 analyzer system (Thermo-Jarrell Ash Co, model SH-22, Franklin, Massachusetts, USA).

**Statistical Analysis**
Changes in the level of mercury and silver after treatment with either 16% Kimia carbamide peroxide and 16% Nite white carbamide peroxide gel in two time points (14 hours and 28 hours) were recorded and the difference between the group means was analyzed statistically through the use of ANOVA followed by Tukey-HSD tests.

**RESULTS**
ANOVA test showed that there was significant difference in ion release between experimental and control groups (P=0.001). Carbamide peroxide treatments resulted in a significant release of Hg and Ag in all tested amalgams.

Tukey HSD test showed that, significant difference existed in release of Hg and Ag ions between control group and experimental groups (Table 2). In experimental groups, increase in Hg and Ag release was detected from 14 hours to 28 hours. This increase was statistically significant for Ag release (Fig 1).

**DISCUSSION**
Possible absorption of mercury released from dental amalgam during mouth guard bleaching by the oral, respiratory, and gastro-intestinal mucosa can increase the total mercury body burden. This increase will lead to a higher risk of a variety of toxic systemic effects [8,12]. Thus, it is important to investigate various factors affecting ion release from amalgam exposed to commonly used bleaching agents. This study assessed the effect of treatment duration on mercury and silver release from dental amalgam exposed to two carbamide peroxide agents.

This study, similar to Al-Salehi et al study [10], expressed ion release in a standard form,
namely as an amount release per unit surface area of specimens. However, in some previous studies [13,14] concentration of mercury released from the samples has been reported as mg per ml. Therefore, our results could not be compared with these investigations.

Our results indicated that carbamide peroxide treatments caused increased mercury and silver release from dental amalgam. Similar findings have been reported in other studies [6-10,15,16].

Distributions and compositions of 8 to 10 distinct phases in dental amalgam depend on the specific amalgam alloy, preparation and placement methods, and patient characteristics [9,17]. Thus, great variations may exist in physical, mechanical and corrosion characteristics of amalgams. For most dental amalgams, anticorrosion effect is mainly resulted from the presence of tin and copper. A thin passive film of an oxide protects tin-containing phases against corrosion [18]. Presence of a low-stability tin – mercury phase in low-copper amalgams makes them more vulnerable to corrosion. In our study, we used high-copper amalgams, which contains no or reduced tin-mercury phase, and the resistance of tin – copper replacement against corrosion is higher. Thus, it seems logical to suppose that oxidation by the bleaching agents decreases surface level of tin and copper in the external amalgam surface. In the present study, similar to a previous study [9], the bleaching agents seemed to remove protective surface films and to expose the silver – matrix. This might have accelerated degradation on the amalgam surface. Increased silver and mercury levels in both the carbamide peroxide groups supports this hypothesis.

Results showed ion releasing is significantly higher with Kimia 16% carbamide peroxide gel than 16% Nite white carbamide peroxide gel. Factors found to enhance ion release in previous studies have been duration of treatment, and composition and pH of the bleaching agent [7,8,10,19-22]. The role of pH may be explained by the effect of increased acidity of the environment on the stability of some of the amalgam phases. Dissolution of the protective film of tin-oxide formed on the surface of the Ag-Hg-Sn (gamma-1) matrix phase might be also influential. It has been reported that kimia and Nite white carbamide peroxide agents have pH of 3.7 and 7.4 respectively [22,24].

Some studies have indicated that prolonged carbamide peroxide treatment caused increased mercury release from dental amalgam [8,9].

In this study, however, increase in Hg release from 14 hours to 28 hours was not significant. Previous investigations performed carbamide peroxide treatments according to the manufacturers' instructions. In this study, however, the amalgam specimens were immersed in carbamide peroxide solution for an extended time. It is clear that the effect of continuous 14 and 28 hours exposure to both carbamide peroxide gels is lower than common intermittent exposure in patients (Fig 1). However, mouth guard

<table>
<thead>
<tr>
<th>Ions</th>
<th>Groups(1)</th>
<th>Groups(2)</th>
<th>Mean Diff. Groups (1-2)</th>
<th>P Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hg release</td>
<td>Control 0.172 0.0639</td>
<td>Kimia 1.217 0.550</td>
<td>-1.045</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Kimia 1.217 0.55</td>
<td>Nite White 0.764 0.077</td>
<td>-0.592</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Nite White 0.764 0.077</td>
<td>+0.452</td>
<td>0.001</td>
<td></td>
</tr>
<tr>
<td>Ag release</td>
<td>Control 0.024 0.028</td>
<td>Kimia 2.167 0.639</td>
<td>-2.142</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Kimia 2.167 0.639</td>
<td>Nite White 0.867 0.584</td>
<td>-0.843</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Nite White 0.867 0.584</td>
<td>+1.299</td>
<td>0.000</td>
<td></td>
</tr>
</tbody>
</table>

*Tukey HSD test, Mean Diff= Mean Difference
bleaching usually requires frequent repeated applications of the bleaching agents. The cumulative effect of such applications is not known. These changes might be of clinical significance.

Finally, cause and effect relationship between mouth guard bleaching and amalgam tissue toxicity requires further in vivo investigations.

**CONCLUSION**

This study investigated the amount of mercury and silver released from dental amalgams after applying two marked brands of Iranian and foreign carbamide peroxide 16% bleaching gels. Findings confirmed that the brand of bleaching gel have a significant influence on the amount of ion released from the dental amalgam. The amount of mercury released from amalgams was not time dependent but silver-release was time dependent.

**ACKNOWLEDGMENTS**

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