

Effect of 10% Carbamide Peroxide on Mercury Release from Two Types of Dental Amalgam

Aghajani F.^a, Khorshidian A.^{a*}

^aDental Research Center, Tehran University of Medical Sciences, Tehran, Iran

KEY WORDS

Tooth-bleaching agent,
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ABSTRACT

Statement of Problem: The chemical reactions occur at the amalgam surface when exposed to bleaching agents. Mercury ion is released from dental amalgam when bleached.

Purpose: The aim of this in vitro study was to investigate the effect of carbamide peroxide (CP) on the release of mercury ion from two types of spherical dental amalgam.

Materials and Method: Two commercial brands of dental amalgam, Cinalux and GS-80, were selected. 18 amalgam discs of any brand were prepared in silicon moulds according to the manufacturer's instructions. After 60 minutes, the discs were removed and individually immersed in artificial saliva (AS) for 24 h at 37 °C. Then, the discs of any amalgam were divided into two equal test group (A) and control group (B). Each specimen in the test group was treated in eight-hour cycles with 10% CP. The specimens of the control group was treated in similar cycles with AS. All of the solutions were taken for Hg ion release determination, using cold-vapor atomic absorption mercury analyzer system. The data were analyzed using General Linear Model followed by Repeated Measures ANOVA.

Results: The results indicated that the bleaching agent significantly caused more mercury ion to be released into the solutions ($p < 0.05$) but artificial saliva did not show this effect. The release rate of mercury from the Cinalux during the two weeks of treatment period with 10% CP showed an increase from 11.63 µg/lit in the first day to 228.85 µg/lit in the last day. The release rate from GS-80 showed a decrease from 130.96 µg/lit in the first day to 80.68 µg/lit in the last day.

Conclusion: Treatment with %10 carbamide peroxide increased mercury release from dental amalgam in comparison with the artificial saliva. The release of Hg from 2 brands of dental amalgam was in a safe range.

* **Corresponding author.** Khorshidian Azam, **Address:** Dental Research Center, Tehran University of Medical Sciences; Ghods St., Enghelab Ave., P.O. Box: 14155-5583, Postal code: 14174-14411 Tehran/Iran ; **Tel:**021-88986677; **Fax:** 021-88986688; **E-mail:** khorshidian_a@yahoo.com

Introduction

Esthetic dentistry has become an essential part of contemporary dentistry. Night mouthguard bleaching is a popular treatment for correcting tooth discolor-

ations [1]. This technique, the so called home bleaching procedure, is done with bleaching agents. The product commonly used is 10% carbamide peroxide that is usually applied to the external surfaces of the teeth

by using a prefabricated tray [2-4]. Carbamide Peroxide can release highly unstable radicals and cause adverse effects in the mouth, such as adverse effects on restorative materials [5].

Although bleaching agents are routinely applied to the anterior dentition, its surplus may carelessly contact with the amalgam-restored posterior teeth in patients with amalgam restorations and may increase the vulnerability of these amalgam restorations to damage. Mercury dissolution from amalgam has occurred in both artificial saliva and bleaching agents [3, 6-7]. Mercury's potential health hazards have been the subject of controversy since the introduction of amalgam into dentistry [6]. Ingestion, inhalation, or absorption of mercury by patients may be toxic to body tissues, causing a variety of systemic adverse effects that are dose-related [7-9]. Mercury is released from amalgam either in mercury vapor or mercuric ion forms [10]. Recently, it was reported that 10% carbamide peroxide increased the levels of mercury on the surfaces of amalgam restorations and its release to the surrounding medium after bleaching [4, 11-13].

There is concern that peroxide generated by tooth bleaching agents may cause enhanced mercury ion release from dental amalgam following contact, so this study was designed.

The aim of this study was to assess the effect of 10% carbamide peroxide on the mercury release from two commercially available dental amalgams.

Materials and Method

In this in-vitro study, two types of spherical alloy of amalgam commercially used in dental treatments, Cinalux (Faghihi Company / Iran) and GS-80 (SDI, Australia) were selected. The chemical compositions of these alloys are summarized in Table 1.

Table 1 Compositions (%) of the 2 amalgam alloys tested, according to the manufacturers

Amalgam	Silver	Copper	Tin	Mercury
GS-80	40	28.7	31.3	48.9
Cinalux	49	29	29	29

The amalgams used in this study were nearly the same in their alloy composition. Eighteen specimens of each of the two amalgam brands were prepared according to the manufacturer's instructions. Each amalgam capsule was automatically mixed in a dental amalgamator (Dentine, Esfahan/Iran). The amalgam mix was condensed by hand condensers into silicon molds with 10×5×3 mm cavities with a similar force. The total surface area of the amalgam discs was 1.9 cm². The specimens were left for initial setting in the molds for 60 minutes and then removed and placed in the artificial saliva (AS) solution at temperature of 37°C for 24 hours. Then, the specimens of each amalgam type were polished according to the standard procedure performed with silicon carbide paper (Grit number 600) and placed in fresh AS solution again.

The samples of the two amalgams were randomly divided into the experimental and control groups. Nine specimens of each amalgam brand were sealed in individual glass tubes containing 10 ml of 10% carbamide peroxide solution (PH= 3.8) in order to bleach in cycles. The other 9 specimens of each amalgam brand were sealed in similar tubes containing 10 mL of artificial saliva (PH= 7), which served as a control. The tubes were placed in a dry incubator at 37°C for 8 hours. After incubation, the amalgam specimens were removed from the tubes, and sealed again in individual glass tubes containing 10 mL of artificial saliva. They were then placed in a dry incubator at 37°C after 16 hours. The amalgams were removed from the tubes. This procedure was repeated every day for 2 weeks.

In the weekend, we could not change the solution; therefore, the measurements were not entirely done. 720 measurements were done. Between every procedure, the samples were rinsed with 2ml distilled water and carefully wiped with cotton wool. The atomic absorption instrument used for ion release measurements was carefully calibrated each time. Mercury concentration in each of the samples tested was measured, using the Mercury Analyzer System based on the cold vapor atomic absorption method developed

by Hatch and Ott [14]. All the mercury in solutions was oxidized to mercuric ions (Hg^{++}). Then, any excess oxidant was neutralized. The mercury in the solutions was reduced to metallic mercury by addition of stannous chloride solution. A pump circulated the air in a closed-loop system, evaporated the mercury, and carried it through the absorption cell. The vapor in atomic form absorbed the light at a wavelength of 253.7 nm. The change in energy transmitted through the cell was detected by a UV-sensitive phototube. Changes in the mercury concentration for each tested specimen were recorded. The differences between the means of the groups were analyzed statistically through repeated measures ANOVA and general linear model.

Results

Concentrations of mercury in the solution ($\mu g/lit$) after exposure of the amalgam specimens to 10% carbamide peroxide during the treatment are shown in Figure 1. A comparison of mercury concentrations in bleaching solution after an 8-hour exposure of the 2 amalgam groups to 10% carbamide peroxide is summarized in Table 2. The results showed statistically significant differences between Cinalux and GS-80 during the period of 1, 4, 5, 7, 8, 9 and 10th days of treatment with 10% CP.

The release rate of mercury increased. The range of the release from Cinalux following treatment with CP was 11.63-228.85 $\mu g/lit$. In this period, the range of the release from GS-80 was 30.71-130.95 $\mu g/lit$, showing a decrease. The specimens of the two types of amalgam exposed to AS showed non-significant concentrations of mercury. The accumulation of mercury

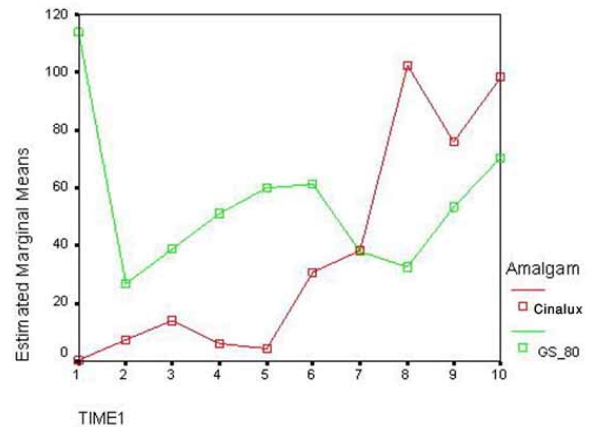


Figure 1 Mean concentrations release of Hg during treatment from 2 brand of amalgam specimen exposure to 10% carbamide peroxide

release following artificial saliva treatment (16 hours) was not considerable (less than 0.2-0.5 $\mu g/lit$). Therefore, it was not identified by cold vapour atomic absorption. The range of the concentration of mercury in all AS solutions was less than 0.2-0.5 $\mu g/lit$. The results show that there are significant differences between the control and test groups in each brand of amalgams ($p < 0.05$).

Discussion

The two amalgam brands tested released mercury into the solution after 8-hour/day exposure to carbamide peroxide. An 8-hour/day exposure is almost the same as usual treatment period of patients that undergo bleaching. A previous study revealed that mercury release from amalgam was associated with enhanced oxidation, corrosion, and dissolution of the amalgam surface, which occurred during exposure to bleaching

Table 2 Statistical comparison of mercury concentrations in solution between the 2 type of amalgam after 8 hour exposure to 10% carbamide peroxide

Type of amalgam	release of Hg ($\mu g/lit$) in day by day of treatment									
	1	2	3	4	5	6	7	8	9	10
Cinalux	11.63	13.23	14.22	12.02	17.27	46.77	95.35	191.39	216.03	228.85
GS-80	130.95	30.71	39.02	62.20	86.42	70.16	41.40	35.27	57.75	80.68
Comparison between 2 groups	$p < 0.001$	NS	NS	$p < 0.001$	$p < 0.05$	NS	$p < 0.05$	$p < 0.001$	$p < 0.001$	$p < 0.05$

NS= Not significant

agents [11]. The release rate of mercury from the Cinalux in the treatment period with the 10% CP showed an increase, while the release rate of mercury from the GS-80 showed a decrease. A previous study showed that mercury release from amalgam was time-dependent. Cinalux and GS-80 exhibit different behaviors in the 8-hour exposure to bleaching agent. Possibly, this was related to concentrations of different metals in their alloys or may be related to other factors, such as the distribution and availability of mercury in the set amalgam. Our results are in agreement with those of Rothstein, Neme and Canays et al. who found significantly higher amounts of mercury in solutions of carbamide peroxide-treated amalgams as compared with saline controls and showed variations in mercury release among different amalgam brands tested [2, 15-16]. The changes in physical, mechanical and corrosion characteristics are related to the nature of the amalgam matrix and the corrosive environment of the mouth. The mercury matrix phase is a major phase in any set amalgam and an important source for continuous and sometimes prolonged mercury release, which may be increased by exposure to heat, acids, or other agents [9, 3, 17].

In this study, carbamide peroxide may have facilitated the degradation of the amalgam surface. Acidic environment significantly affects corrosive behavior of the alloys and particularly the amalgam, so mercury release can be related to this acidic PH rather than the effect of the peroxide by-products itself. The maximum concentration of mercury was measured 228 µg/lit/day for Cinalux and 130 µg/lit/day for GS-80. The World Health Organization (WHO) guideline for maximum intake of mercury is 40 µg/day [18]. Thus, the amount of released mercury in this study is acceptable. It is difficult to make direct comparisons between our data and published reports in scientific journals due to lack of standardization of experimental details and the form of data presentation. The release of metal ions from restorations had been reported to be time dependent and proportional to the surface area

of the restoration [2, 7].

The range for mercury release reported in the present study for 10% CP is about 11.69-228.85 µg/lit from Cinalux and 30.71-130.95 µg/lit from GS-80; less than that is reported by Steinberg [7] and Salehi [12] but also higher than those reported by Certosimo [19]. Rotstein et al. tested the effects of 10% CP on four different amalgams (Megalloy, Mega+, Nongama2, Valiant PhD) and reported mercury release to be: 140.5, 39.2, 22.9, 161 µg/ml after 48 hours of treatment, respectively. The amounts were higher than the present study [2].

Treatment with 10% carbamide peroxide (bleaching agent) significantly enhanced mercury ion released from 2 types of dental amalgams compared to a control solution ($p < 0.05$). Cinalux and Gs-80 demonstrated different behaviors in mercury release. For example, at first Gs-80 released higher amounts of mercury than later. Possibly, this was related to the concentrations of the different metals in its alloy. Therefore, the difference in mercury release may be related to other factors, such as the distribution, compositions and availability of mercury in the set amalgam. These changes are related to the nature of the amalgam matrix. Two brands of amalgam differed in the amounts of mercury release, but also the amounts of mercury release from them were in the satisfactory range, did not have adverse effects and can be safely used on a short-term basis in bleaching cycles.

Conclusion

Treatment with 10% CP significantly enhanced subsequent mercury ion released from dental amalgams compared to a control solution. Cinalux and GS-80 differed in the amounts of mercury release after bleaching. The results demonstrated that in short-term bleaching with 10% carbamide peroxide did not adversely affect the two types of amalgam tested.

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