

# Effect of Surface Polishing on Mercury Release from Dental Amalgam After Treatment 16% Carbamide Peroxide Gel

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## Abstract:

**Objectives:** This study evaluated the effect of surface polishing on mercury release from dental amalgam after treatment with 16% carbamide peroxide gel.

**Materials and Methods:** Ninety-six samples from two different amalgam brands were prepared in truncated cone-shaped PVC polymer molds with an external surface area of 195 mm<sup>2</sup>. Half of the specimens were polished with green and red rubber, a brush and tin oxide paste at low speed. Samples were treated with 16% carbamide peroxide gel in tubes containing 3 mL of carbamide peroxide gel and 0.1 mL of distilled water for 14 and 28 hours. Subsequently, carbamide peroxide gel on the sample surfaces was rinsed away with 7.0 mL of distilled water until the volume of each tube increased to 10 mL. The mercury level of each solution was measured using the VAV-440 mercury analyzer system. Considering the surface area of each amalgam disc, mercury amounts were calculated in µg/mm<sup>2</sup>. Data were analyzed using two-way ANOVA.

**Results:** There were significant differences between the mean levels of mercury release from polished vs. unpolished amalgam surfaces after treatment with 16% carbamide peroxide. Increasing the storage time from 14 to 28 hours did not result in significant changes in the amount of mercury release. There was no significant interaction effect between amalgam surface polish and storage time statistically.

**Conclusion:** Polished amalgam restorations release less mercury after treatment with carbamide peroxide bleaching gel in comparison with unpolished amalgam restorations.

**Key Words:** Dental Amalgam; Carbamide Peroxide; Bleaching Agent; Mercury; Laboratory Research.

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## INTRODUCTION

Night-guard bleaching is an effective and simple method for regaining the esthetic appearance of intrinsically discolored or stained teeth. There is concern about the adverse effect

of bleaching materials on existing restorations in the oral cavity. Many studies have reported that there is little evidence of bleaching agents causing significant changes in dental materials, including glass-ionomer cements, ceramics

and gold. However, many in vitro studies have reported a significant increase in mercury release from dental amalgam after treatment with peroxides [1-3]. Bleaching agents such as carbamide peroxide decompose into free radicals, which theoretically have the potential to corrode metal alloys such as dental amalgam existing in or near the teeth being whitened [4]. Mercury is contained in dental amalgam from which it can be released into the oral cavity and distributed throughout the body as a result of being inhaled or swallowed. So, ionic mercury leached out from amalgam restorations may present a risk to the dental patient [5, 6]. Treatment duration, the pH and concentration of the bleaching agent, aging and surface polishing of amalgam restorations are some of the factors that control mercury release from dental amalgam exposed to carbamide peroxide bleaching agent [6]. Therefore, it is of clinical importance to find ways to reduce mercury release from amalgam restorations following a routine procedure such as home bleaching. This study assessed the effect of surface polish of dental amalgam on the amount of mercury release after treatment with 16% carbamide peroxide bleaching gel. The null hypothesis was that polishing dental amalgam does not decrease the amount of mercury release after treatment with 16% carbamide peroxide gel.

## MATERIALS AND METHODS

### Amalgam Sample Preparation

Two commercially available dental amalgams were selected for this in vitro experimental study. The characteristics and chemical compositions of these materials are summarized in Table 1. Forty-eight samples from two amalgam brands (totally 96 samples) [(Oralloy Magicap S, Coltene Co. 235 Ascot Parkway, Cayahoga Falls, Ohio. 44223 /USA) and (SDI-GS80, Southern dental Industries Limited, Bayswater, Victoria 3153, Australia)] were selected for the purpose of the study. The amalgam capsules were mixed according to the manufacturers' instructions with a dental amalgamator (Doumat 2, Degussa, Frankfurt, Germany). Each amalgam disc was prepared in a truncated cone-shaped PVC polymer mold with a diameter of 9 mm at the base and 8 mm at the top and a height of 3 mm. The external surface area of each amalgam disc was 195 mm<sup>2</sup>. The specimens were removed from the molds after 60 minutes and stored in sealed glass tubes containing distilled water for 24 hours at room temperature. Subsequently, half of the specimens were polished with green and red rubber (DTZ Geozalee 307-14167 Berlin, Germany), a brush and tin oxide paste mounted on a slow-speed contra-angle hand piece without water coolant.

**Table 1.** Composition of amalgam alloys by weight percentage and their properties

	<b>Manufacturer</b>	<b>Composition</b>	<b>Properties</b>
<b>SDI-GS80</b>	Southern dental Industries Limited, Bayswater, Victoria 3153, Australia	40% Ag 31.2% Sn 28.7% Cu	High-copper, admixed amalgam, consisting of lathe-cut and spherical particles, alloy-to-mercury ratio of 1-0/96 (w/w)
<b>Oralloy Magicap S</b>	Coltene Co. 235 Ascot Parkway, Cayahoga Falls, Ohio. 44223/USA	58.3% Ag 28.3% Sn 13.33% Cu	High-copper, unicompositional spherical alloy, alloy-to-mercury ratio of 1-0/91 (w/w)

The specimens were again immersed in distilled water at room temperature (24°C) for 1 month. Then, the amalgam discs were removed from the tubes and dried with cotton wool.

### Bleaching Treatment

Forty-eight samples were prepared from each amalgam brand.

Twenty-four samples from each group were polished and the other 24 were not polished.

All of the samples were treated with 16% carbamide peroxide gel (Nite White, Discus Dental, Inc. Culver City, USA) in tubes containing 3 mL of carbamide peroxide gel and 0.1 mL of distilled water in a manner that the entire amalgam disc surfaces were coated with the gel.

According to the manufacturer's instructions, this gel should be used 1-2 hours per day and we chose 2 hours per day for our study. Half of the samples in each group (12) were kept in these tubes for 14 and 28 hours.

After these periods, the amalgam samples were removed from the assay tubes, and carbamide peroxide gel on the sample surfaces was carefully rinsed with 7.0 mL of distilled water until the volume of each tube was 10 mL.

### Released Ion Measurement

Mercury levels of each solution were measured using the VAV-440 mercury analyzer system (Thermo Jarrell Ash Co. SH-22 Model, Franklin, Massachusetts, USA).

The chemical reaction in this system was based on the cold-vapor atomic absorption method.

The solution was treated with nitric acid and sulfuric acid in the presence of potassium permanganate and potassium per sulfate to oxidize all the mercury to mercuric ions ( $\text{Hg}^{2+}$ ).

Then the excess oxidant was neutralized with hydroxylamine hydrochloride. Stannous chlo-

ride solution reduced the mercury in the solution to metallic mercury.

The mercury vapor was carried toward the absorption cell by argon gas flow.

The mercury vapor absorbed light with 253.7 nm wavelength.

Mercury concentration in each solution was determined by comparing it with a standard curve of known mercury levels.

### Statistical Analysis

Considering the surface area of each amalgam disc, mercury levels were calculated in  $\mu\text{g}/\text{mm}^2$ . Data were analyzed using two-way ANOVA.

## RESULTS

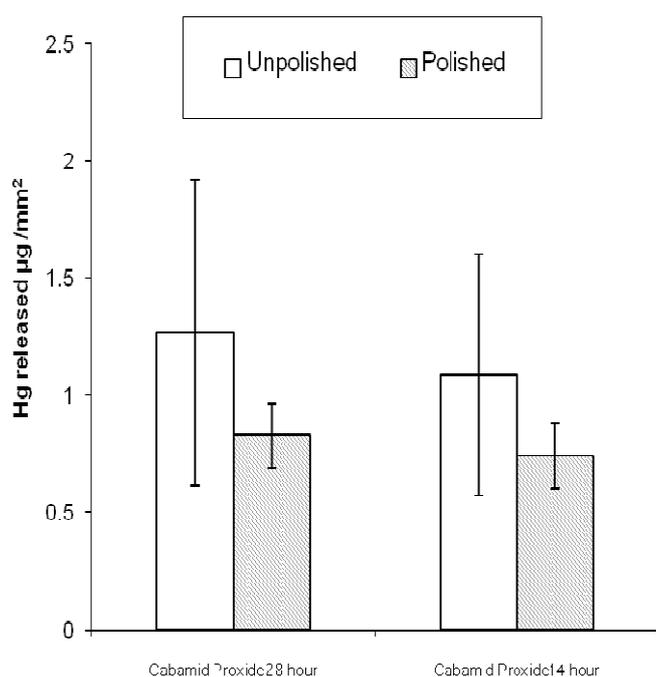
The mean levels of mercury released from amalgam samples after 14- and 28-hour treatments are summarized in Table 2 and Graph 1. Two-way ANOVA showed significant differences between the mean levels of mercury release from polished vs. unpolished amalgam surfaces after treatment with 16% carbamide peroxide gel ( $P=0.015$ ).

Two-way ANOVA indicated that increasing the storage time from 14 to 28 hours did not cause significant changes in the amount of mercury release ( $P=0.385$ ).

In addition, there was no statistically significant interaction effect between amalgam surface polish and storage time ( $P=0.768$ ).

**Table 2.** Mercury ion released from amalgam samples after 14 and 28 hours of treatment

Mean±SD levels released in $\mu\text{g}/\text{mm}^2$	14 hours	28 hours	Total
<b>Polished</b>	0.740±0.139	0.828±0.136	0.784±0.140
<b>Unpolished</b>	1.087±0.513	1.265±0.652	1.176±0.574



**Graph 1.** Mercury ion release from polished and unpolished amalgam samples following treatment with 16% carbamide peroxide in two treatment durations.

## DISCUSSION

The results of the present study showed that less mercury is released from polished amalgam after treatment with 16% carbamide peroxide bleaching agent as compared to unpolished amalgam; therefore, the study's null hypothesis was rejected.

According to literature, polishing high-copper amalgam surfaces has no influence on the longevity of the restoration [7]. It is suggested that carefully placed and carved high-copper amalgam restorations may have the same longevity as polished restorations [7]. Reavis-Scruggs [8] indicated that burnishing silver amalgam restorations alone creates surface smoothness, improved marginal seal, decreased corrodibility and decreased dissipation of mercury vapor. Therefore, dental practitioners may prefer to omit the polishing procedure to save time in the office. However, after post-carve burnishing of amalgam restorations it is

likely that excess amalgam remains beyond the margin, which necessitates finishing/polishing to remove the excess amalgam [7].

Reaction of the surface area of amalgam samples with carbamide peroxide decreases after polishing; therefore, the amount of mercury release diminishes [4,6]. Additionally, scanning electron microscopy and x-ray energy dispersive microanalysis in a study carried out by Ferracane et al suggested that unpolished amalgam surfaces have a slightly greater surface concentration of gamma-1 phase than polished surfaces, which is a potential source for mercury release [9].

The results of a study carried out by Canay et al. showed that unpolished amalgam has a higher corrosion rate in comparison with the polished amalgam [4]. The corrosion current density is rather low for polished surfaces, and burnishing increases resistance of dental amalgam to corrosion [4]. In addition, the chemical dissolution of mercury phase and its diffusion to the outer surface is easier on unpolished amalgam surfaces. As a result, Canay et al suggested that the existing amalgam restorations should be polished prior to bleaching procedures [4].

Although it has been reported that the greatest amount of mercury release occurs during polishing and removal of amalgam without high volume evacuation [10], according to a study carried out by Sweeney et al [5], if polishing dental amalgam would be carried out under moist conditions and high-volume evacuation, the mercury exposure is minimized to levels not exceeding the threshold level value (TLV), which is  $50 \mu\text{g Hg}/\text{m}^3$  of air [5].

Body exposure to mercury is a potential hazard and might result in adverse effects. The World Health Organization (WHO) guideline for maximum intake of mercury is  $40 \mu\text{g}/\text{day}$  [11]. In the present study, the average amounts of mercury released from each unpolished and polished amalgam disc were about  $1.2 \mu\text{g}/\text{mm}^2$  and  $0.8 \mu\text{g}/\text{mm}^2$ , respectively. The total

surface area of each amalgam disc was 195 mm<sup>2</sup>. Therefore, the average mercury release from unpolished samples was 234 µg and 468 µg over 14- and 28-hour periods, respectively. In addition, the average mercury release from polished samples was 156 µg and 312 µg over 14- and 28-hour periods, respectively. According to the White Nite gel instructions, the product should be used two hours per day. As a result, the maximum release of mercury using 16% carbamide peroxide in this study was 33.4 µg/day for unpolished samples and 22.3 µg/day for polished samples, both of which are in the safe range of mercury intake. In the present study, mercury release is expressed as the amount released per unit surface area of specimen as a standard form, to be comparable with other studies, which is the same method used by Al-Salehy et al [3,12]. Rotstein et al reported that mercury released from amalgams immersed in 10% CP solutions after 48 hours was between 23 and 161 µg/mL [13]. Al-Salehi recalculated the data reported by Rotstein et al and reported that considering the 1.9 cm<sup>2</sup> surface area of the samples the amount of mercury release would be 0.6-4.24 µg/mm<sup>2</sup> [3], which is consistent with the results obtained in our study. Similarly, the data reported for mercury release by Hummert et al [14] and Mackert and Berglund [15] after recalculation were 0.014-0.020 and 0.016 µg/mm<sup>2</sup>, respectively. It has been reported in some studies that mercury release from dental amalgam after bleaching is time-dependent [6,16,17]. In the present study, the increase in mercury release from 14 to 28 hours was not statistically significant, which might be attributed to the fact that the diffusion rate of mercury is inversely proportional to the film thickness of the oxide layer covering the amalgam restoration [18] because mercury atoms must pass through the oxide film to reach the environment. The layer formed by corrosion, which covers the amalgam samples, inhibits further corrosion in vitro. In the oral

cavity, this layer dislodges as a result of mastication and occlusion; therefore, mercury release may be time-dependent in vivo.

According to a study carried out by Rotstein et al, the size of amalgam samples in the current study was approximately the same as a Class I or Class II amalgam restorations in a molar tooth [6].

Patients may have more than one posterior amalgam restoration in their mouth, so these patients may be in danger of higher-than-maximum mercury intake after treatment with 16% carbamide peroxide gel in the home bleaching technique. In addition, patients who abuse over-the-counter products by prolonged contact periods of the bleaching agent with amalgam restorations may expose themselves to the risk of increased total mercury intake [6].

Therefore, it is prudent to minimize mercury release from amalgam restorations as much as possible, and one of the most effective ways is to polish the existing amalgam restorations in the patients' mouth, which is the same conclusion as reached by Canay et al [4].

## CONCLUSION

Within the limitations of this study, it was concluded that polished amalgam restorations release less mercury after treatment with carbamide peroxide bleaching gel in comparison with unpolished amalgam restorations.

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