






## Mercury Loss From Dental Amalgam Fillings

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### Abstract

**Objective:** To compare the amount of mercury in new and old dental amalgam restorations. **Material and Methods:** This study analyzed twenty samples of dental amalgam restorations, dividing into two groups. Group 1 consisted of samples of new dental amalgam restoration (n=10) and group 2 consisted of samples of old dental amalgam restoration (5-years old) (n=10). In each group, the mercury involved in the dental amalgam restoration was calculated using the cloud point extraction (CPE) method. The new dental amalgam restorations are taken from the patients' mouth after condensation and analyzed directly after setting. The old dental amalgam restorations are removed from the patients' mouth, after 5 years of use by the patients, and then they are analyzed. The independent-samples t-test was used to analyze the differences (p<0.05). **Results:** For new amalgam restorations, the mean of mercury was 0.1281 µg/mL, while for old restorations it was 0.1029 µg/mL. There was a significant difference between the new and old amalgam restorations in the amount of mercury available (p<0.001). **Conclusion:** There is a significant loss of mercury over a five years period in the patient mouth.

**Keywords:** Dental Materials; Dental Alloys; Dental Amalgam; Mercury.

## Introduction

Amalgam is a direct restoration that fills a cavity in a tooth structure to restore its shape and function to its normal condition. This cavity is done inside the tooth to remove dental caries [1]. Dental amalgam is an alloy result from the reaction of mercury (Hg) with silver-tin (Ag-Sn). This is in addition to varying amounts of copper (Cu) and trace amounts of zinc (Zn) [2]. After the reaction of the mercury (Hg) with the powder alloy, around half of the final filling material consists of Hg, and the remaining amount is a combination of Ag, Sn and Cu [1].

The statistical analysis of the American population from 2001 to 2004 showed that more than 180 million of the American people have more than 1 billion dental restorations, and most of these restorations are dental amalgam [3].

There is a debate about the safety of mercury involved in the final restoration of the dental amalgam after its placement inside the tooth. One assumption said that dental amalgam does not release amalgam after the placement of the restoration. The US Food and Drug Administration (FDA) showed that amalgam loses traces of Hg vapor [4]. The debate has continued until the moment whether mercury loss from the dental amalgam restoration is safe or not and the safety threshold differs in different individuals [5]. Therefore, this research aims to calculate the amount of Hg in new and old dental amalgam restorations.

## Material and Methods

### Study Design and Sample

This experimental study analyses twenty samples of dental amalgam restorations ( $n=20$ ), after dividing them into two groups. Group 1 consisted of samples of new dental amalgam restoration ( $n=10$ ) and group 2 consisted of samples of old dental amalgam restoration (5-years old) ( $n=10$ ).

In each group, the mercury involved in the dental amalgam restoration is calculated using the cloud point extraction (CPE) method [6-8] and then comparing the results between the two groups. The new dental amalgam restorations are taken from the patients' mouth (10 patients) after condensation and analyzed directly after setting. The old dental amalgam restorations are removed from the patients' mouth (10 patients), after 5 years of use by the patients, and then they are analyzed.

The cloud point extraction method was done with optimal conditions (pH value, volume of the reagent used for detection of the mercury, volume of the surfactant used for the detection of the mercury, equilibrium temperature and incubation time) to show which is the better condition or parameter in which we can calculate the amount of mercury in the dental amalgam restoration. So, the optimum conditions were 9.6 pH, 0.5 mL of the reagent (diphenylthiocarbazone) 0.5 mL of the surfactant (Triton X-114, Merck KGaA, Darmstadt, Germany), 50°C temperature, and 25 min. incubation time. In addition, validation of this method of cloud point extraction for determination of the un-known mercury available in the dental amalgam restoration is done by determination of the known concentration of mercury available in the form of salt (mercuric chloride) [9,10].

The equipments which are used for doing the procedure with cloud point extraction were the spectrophotometer (Model 1600, Shimadzu Corp., Kyoto, Japan) with double beam UV-visible recording, a digital pH meter (inoLab pH 720, Xylem Analytics Germany Sales GmbH & Co. KG WTW, Weilheim, Germany) for all pH measurements, a thermo bath (Circulator England, Thermo Fisher Scientific Inc., London, England) maintained as the best incubation temperature for the cloud point extraction, and phase separation was assisted using a centrifuge PLC 03 (Gemmy Industrial Corp., Taipei, Taiwan).

### Data Analysis

Data were analyzed using IBM SPSS Statistics for Windows, Version 19.0 (IBM Corp., Armonk, NY, USA). The independent samples t-test was used to analyze the differences. The significance level has been considered 0.05.

### Ethical Aspects

The study was conducted in accordance with the ethical principles of the Helsinki Declaration. This study was approved by the local ethics committee, Protocol No. COD#UoB#EthB-00923.

### Results

The results are shown in Table 1. There is a significant difference between the two groups in the amount of mercury available in dental amalgam restoration (Table 2). So, there is a significant loss in mercury over 5 years period of using mercury by the patient and subjecting mercury to different conditions such as drinking hot tea or coffee and doing the polishing procedure in the dental clinic.

**Table 1. The Hg concentration in the new and old amalgam restoration.**

Sample No.	New Dental Amalgam Restoration Hg concentration (µg/mL)	Old Dental Amalgam Restoration Hg concentration (µg/mL)
1	0.138	0.104
2	0.118	0.103
3	0.134	0.099
4	0.137	0.098
5	0.120	0.110
6	0.125	0.104
7	0.117	0.109
8	0.128	0.099
9	0.131	0.097
10	0.133	0.106

**Table 2. Statistical analysis of the measurements.**

Groups	N	Mean	Standard Deviation	Standard Error Mean	p-value
New Dental Restoration Hg Concentration (µg/mL)	10	0.1281	0.00778	0.00246	<0.0001
Old Dental Restoration Hg Concentration (µg/mL)	10	0.1029	0.00458	0.00145	

### Discussion

People doing several dental amalgam fillings for restoration of their teeth could be a major source of exposure to inorganic Hg. The FDA considered dental amalgam fillings safe for adults, 6 years children and children above 6 years. People allergic to mercury or any other metals in the dental amalgam filling should not use dental amalgam, because this may result in an oral lesion or any contact reaction [1,11-13].

Most of the studies investigated the release of Hg vapor from amalgam restoration through the investigation of the amount of Hg in blood or urine. In this study, the loss or release of mercury is investigated through the mathematical calculation of the concentration of the Hg in the new amalgam and comparing it with the mercury concentration in the old amalgam, using the cloud point extraction (CPE) method. This

method is a useful technique for the detection of trace metals in some substances [8]. It has several advantages since it is a straightforward procedure, relatively inexpensive and environmentally safe [14]. It involves a set of analytical methods [6]. Recently, the cloud point extraction method and its procedure of metal chelate extraction have been respected [7].

It was assumed that dental amalgam is inert and does not lose mercury after its placement onto the tooth surface [15]. The US Food and Drug Administration (FDA) informed that the release of the mercury vapor is low, and both of ADA agency and the American Dental Association (ADA) agency agreed that dental amalgam restoration is safe [1,16]. While, other studies investigated the mercury level in the blood, urine and assumed that it has an effect on the health of the patient who has dental amalgam filling in his mouth [17-22]. In the current study, the results show that the change in the amount of Hg available in the amalgam restoration is significant over the 5 years period, since the difference between the new and old amalgam filling in the amount of mercury is significant. So, amalgam filling could have an effect on patient health due to significant loss of Hg from amalgam restoration.







In this study, the loss of Hg is measured directly from the amalgam filling at different periods of time, while other studies measured it indirectly by measuring its level in the urine or blood and correlated it to the dental amalgam restoration of the patient [17-22]. Anyway, in the indirect measurement, the increase in the level of the mercury in the blood and urine could have different sources other than dental amalgam restoration, such as daily occupational exposure to mercury.

Further future studies are recommended to investigate the association between the loss of mercury and the clinical health problems of the patient. In addition to that, it is recommended to do an investigation on the mercury available in the dental amalgam restoration in more groups at different time scales, such as less than 5 years and more than five years. Another recommendation is to select a larger number of samples.

## Conclusion

There is a significant difference between the new and 5-years old dental amalgam filling in the level of mercury. This shows that the loss of mercury over a 5 years period in the patient mouth is significant.

## Authors' Contributions

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All authors declare that they contributed to critical review of intellectual content and approval of the final version to be published.

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## Conflict of Interest

The authors declare no conflicts of interest.

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