Evaluation of Relation between Mercury Concentration in Saliva with Number and Surfaces of Amalgam Fillings

F. Agha Hosseini,1 P. Begianian Vaziri 2

1 Associate Professor, Department Of Oral Medicine, Faculty of Dentistry; Tehran University of Medical Sciences, Tehran, Iran
2 Associate Professor, Department Of Oral Medicine, Faculty of Dentistry; Hamedan University of Medical Sciences, Hamedan, Iran

Statement of Problem: Amalgam is the most widely used dental restorative material. However, because of continuous low-level release of Mercury from amalgam fillings, its safety has been questionable.

Purpose: The aim of this study was the evaluation of concentration of Mercury in saliva before and after amalgam fillings and its relation with numbers and surfaces of amalgam fillings.

Materials and Methods: In an analytic interventional study we surveyed concentration Mercury in saliva before and after amalgam fillings. Twenty-five Patients (9 male, 16 female) who referred to oral medicine department of Tehran university of medical science and Haj- Abdol- Vahab medical center who had no amalgam fillings were selected and the samples of saliva (5cc) was collected before fillings. After that all of posterior decayed teeth were filled in an appointment with amalgam and, 24 hours later, the second samples of saliva (5cc) was collected. The amount of saliva Mercury before and after filling was measured and its difference was analyzed by paired t-test.

Results: In this study the mean of Mercury in saliva was 0.00896 µg/ml before and 0.16404 µg/ml after amalgam fillings. The mean of number of fillings was 1.96 and mean of size of surfaces was 76.43 mm² and mean of consumption amalgam was 4.1 units.

Conclusion: There was no significant correlation between age (P=0.677), sex, number of fillings (P=0.055), number of surface of filling (P=0.059) and size of surfaces of fillings (P=0.072), with Mercury levels in saliva after amalgam fillings. There was a significant relation between Mercury level of saliva after fillings and amalgam amount (P= 0.036). Therefore amalgam may be designate a significant source for Mercury release in saliva. Since this is a preliminary study, it needs supplementary evaluations in saliva, blood and urine in different periods after amalgam fillings.

Key words: Amalgam; Saliva; Mercury

Amalgam is the alloy of one or more metal with Mercury.1 Amalgam is the most widely used restorative material for dental filings, which has been used in dentistry more than 165 years.2,3

More studies have been carried out on advantageous of amalgam than on other materials. In 1979, American Dental Association (ADA) showed that in U.S.A. more than 57 million class I and 53 million class II fillings were accomplished by amalgam.
Mercury is a heavy metal element that has poisonous properties. Its systematic acute and chronic effects on different systems of body including central nervous system, digestive system, skin and oral tissues have been described.\(^{(1,2,4,5)}\)

The main concern, related to releasing Mercury from amalgam in the saliva is:

1- The potential toxic effects of Mercury
2- The possibility that Mercury may induce adverse immunological effects.

With regard to the latter, there have been a number of reports suggesting that amalgam fillings may induce oral lichen planus or oral lichenoid lesions and decreasing the antioxidant activity of saliva.\(^{(2,4,6)}\)

Pizzichini and his colleagues in 2002 have observed a significant relation between Mercury and number of amalgam restorations or the total surfaces of amalgam either in women or men.\(^{(4)}\)

Leistevuo and his colleagues compared individuals with or without amalgam, and reported that the amalgam fillings might be continuous resources of organic Mercury which is more poisoned than inorganic Mercury and the organic Mercury is fully absorbed by the human intestine.\(^{(7)}\)

Since the Mercury leakage into saliva may be a source of oxidative damage to the oral tissues,\(^{(1,2)}\) accomplishment of many studies should be done to confirm or deny those subjects. Thus in this research, we have studied Mercury concentration in saliva before and after amalgam fillings.

However the auxiliary objectives and goals like determining the saliva Mercury concentration before and after fillings, determining the relation of saliva Mercury level after fillings with the number of fillings and number of filling surfaces, age and sex of the individuals, have been considered as well.

**Materials and Methods**

In an interventional study, we surveyed concentration Mercury in saliva before and after amalgam fillings between June 2002- June 2003. According to a pilot study, 25 patients (9 male, 16 female) who referred to oral medicine department of Tehran University of medical science and Haj-Abdol-vahab medical center who had no amalgam fillings were selected. Patients who had been taking medicine containing Mercury and those whose fish consumption had been more than twice per month were excluded from this study. The informed consent was obtained from all patients at the beginning to the study.

At first 5cc of saliva was collected by spitting method in a special prepared tube by Atomic Energy Organization, and kept in freezer at \(-18\) to \(-20^{\circ}\)C. (This was performed for prevention of probability absorption of Mercury by the glass wall). If patient had one or two caries preparation all fillings were performed in one appointment. In cases that patients had more than two caries, all cavities prepared in one appointment and filling of them performed in the other day in one appointment too. The conditions and type of materials were the same in all patients.

Exactly 24 hours after the last fillings, second samples of saliva (5cc) were collected in the same methods.

Patient should not eat anything or brush at least one hour prior to the second sampling. For measurement of the consumed amalgam, initially the prepared amalgam (2- units) has been divided (one unit) and located inside the cavity then the next half to be divided and so on, therefore the volume of the remained amalgam is initially minus from the volume of consumed amalgam and the volume of consumed amalgam has been achieved, plus the amalgam shavings which were exited during working or after forming the filling, were separated by the surgery suction having filter and its volume were deducted from the total volume of the consumed amalgam.

For measurement of filling surfaces, the formula of regular geometric shapes was used so that
any operative surface of the teeth was divided into regular geometric forms, the surface of each was calculated and separated and this was done by taking advantage of periodontal scaled probe and the special formulas for geometric shape and then all the surfaces were added and the total surface of the filling was calculated. Number of fillings and number of fillings surfaces were measured simply by counting method.

For measurement of Mercury in the saliva, the tubes containing saliva (before and after filling) were transferred to Chemical laboratory of Atomic Energy Organization in frozen form. For the purpose that the operator was not informed of the nature of saliva after and before filling the single blind of the samples was randomly coded and the lab. Reply was presented in the same manner.

In the laboratory of Atomic Energy Organization, after melting the samples and selection of suitable volume of saliva, the amount of Mercury was measured by cold vapor atomic absorption spectrometry (CVAAS). Mercury concentration before and after amalgam filling compared using paired t test and the relation assessed by regression analysis.

Results
The number of patients participating in this study were 25 persons (9 males and 16 females) with average age of 21.6 years old with the range of 13-39 years old. There was not significant relation between amount of saliva Mercury after fillings with the age and sex of the studied patients (P>0.05).

The average of saliva Mercury before amalgam filling was 0.00896 micro gram/ml, with the standard deviation of 0.022264 and the same was 0.16404 micro gram/ml with the standard deviation of 0.31873 after amalgam filling. Paired t-test showed that their difference was significant (Table I) (P=0.024).

The mean number of fillings was 1.96 and mean of the size of surfaces was 76.43mm$^2$ and mean of consumption amalgam was 4.1 units.

As it is obvious in table I, the amount of Mercury in saliva after filling has significant relation with quantity of used amalgam (P=0.036) but with the number of amalgam surfaces, number of amalgam fillings and size of filling surfaces has had no significant relation (P>0.05).

Table I shows the relation between difference in amount of Mercury before and after amalgam filling with the number of amalgam surfaces, number of fillings, size of surfaces and amount of consumed amalgam. As observed, the difference between the amount of saliva Mercury before and after amalgam fillings with the quantity of the consumed amalgam has had significant relation (P=0.035) while no significant relation with the size of filling surfaces (P=0.074) and number of filling surfaces (P=0.054), was observed.

The difference of saliva Mercury before and after amalgam filling has had weak significant relation with the number of amalgam fillings (P=0.049).

Saliva Mercury concentration before amalgam filling was 8.96±22.264 nanogram/ml. This value increased significantly into 164.04±318.73 nanogram/ml (P=0.024).

Table I- Evaluation of relation between salivary Mercury level after amalgam fillings with, number of fillings, number of filling surfaces, quantity of consumed amalgam and size of filling surfaces

<table>
<thead>
<tr>
<th>Group</th>
<th>$b$</th>
<th>Standard error</th>
<th>P-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of filling surfaces</td>
<td>0.156</td>
<td>0.078</td>
<td>0.059</td>
<td>Not significant</td>
</tr>
<tr>
<td>Number of amalgam filling</td>
<td>0.179</td>
<td>0.88</td>
<td>0.055</td>
<td>Not significant</td>
</tr>
<tr>
<td>Size of filling surfaces</td>
<td>0.006301</td>
<td>0.003</td>
<td>0.072</td>
<td>Not significant</td>
</tr>
<tr>
<td>Amount of consumed amalgam</td>
<td>0.126</td>
<td>0.056</td>
<td>0.036</td>
<td>Significant</td>
</tr>
</tbody>
</table>
Table II- Evaluation of relation between difference of Mercury level before and after amalgam fillings with number of filling surfaces, number of amalgam fillings, size of filling surfaces and amount of consumed amalgam

<table>
<thead>
<tr>
<th>Group</th>
<th>β</th>
<th>Standard error</th>
<th>P-value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of filling surfaces</td>
<td>0.160</td>
<td>0.078</td>
<td>0.054</td>
<td>Not significant</td>
</tr>
<tr>
<td>Number of amalgam fillings</td>
<td>0.185</td>
<td>0.088</td>
<td>0.049</td>
<td>Weakly significant</td>
</tr>
<tr>
<td>Size of filling surfaces</td>
<td>0.006293</td>
<td>0.003</td>
<td>0.074</td>
<td>Not significant</td>
</tr>
<tr>
<td>Amount of consumed amalgam</td>
<td>0.128</td>
<td>0.056</td>
<td>0.035</td>
<td>Significant</td>
</tr>
</tbody>
</table>

Discussion

Amalgam is the most widely used dental restorative material. However, the safety for its use is questionable, due to probability for release of the Mercury. (2)

Many researches have been done for determining the Mercury quantity in blood, urine, saliva, hair and nail. However, unfortunately, the normal level of saliva Mercury amount has not been mentioned in guideline principles of WHO.

Many researches attributed the existing symptoms of oral damages like lichen planus or ulcers, irritations, decrease antioxidant activity of saliva, to amalgam Mercury. (2,10,11)

The significant contribution of the present research work is to determine relationships among many independent variables such as number of amalgam fillings, number of filling surfaces, total size of the filling surfaces, quantity of the consumed amalgam, age, and sex with the amount of saliva Mercury after amalgam filling. Meanwhile no relation was found to exist between the saliva Mercury after and before filling.

In Ganss’ study the average of saliva Mercury was 0.297 mg/ml and in this study it was 0.16404 μg/l (ppm) after fillings and 0.00896 μg/ml before filling. The reason of such difference requires more studies. In the present study, the amount of saliva Mercury was higher after amalgam fillings to the saliva Mercury prior to any fillings (P=0.024). This was in conformity with the researches of Edlund and Bjorkman (5) in 1996, Pizzichini (1) in 2000 and Levistevuo and his colleagues in 2001. (7)

Although it is in contrary to the results of Ganss who had not found any relation between saliva Mercury after and before filling.

In 2001, Levistevuo had taken advantage of the CVAAS Technique like the present study. (7) In that research the amount of saliva Mercury has been higher significantly after teeth filling. Moreover in the latter study it has been declared that the amalgam filling is a continuous resource of organic Mercury which is more poisonous than its non-organic one. (4)

The amount of saliva Mercury after amalgam filling and difference of Mercury level before and after filling (Table I and II) has had strong significant relation merely with the amount of consumed amalgam in our research (respectively P=0.036, P=0.035) and in none of the global studies no relation has been studied between the saliva Mercury and number of consumed amalgam which is considered one of the most important difference of our studies from the other similar ones.

In studies of Pizzichini and his colleagues a considerable relation has been existed between the saliva Mercury with the quantity of amalgam filling and general size of the amalgam surfaces (1,4) but our study didn’t show such relation (Table I).

The Mercury can be solved in saliva in form of vapor from the materials of the amalgam corrosion or Mercury free particles. (13) The amount of Mercury in the saliva in our patients has been increased significantly after fillings. So, it can be resulted that amalgam filling may
be as an important resource for releasing the Mercury to the saliva and such Mercury can be absorbed systematically upon swallowing and to be concentrated in the body tissues. It is obviously necessary to do comprehensive research to reply the questions such as, safety of amalgam consumption, determining the normal amount of saliva Mercury, relation of Mercury of saliva with systemic absorption and amount of blood Mercury, general activity of saliva antioxidants and changes of oral microbial flux, in different periods after amalgam fillings.

Acknowledgement
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References: