Mercury Vapor Release during Insertion and Removal of Dental Amalgam

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Clinical Relevance
Using dental amalgam poses minimal risk to dental personnel if handled and disposed of properly in an adequately ventilated room.

SUMMARY
During a clinical simulation of insertion and removal of dental amalgams, mercury vapor levels increased slightly, but never exceeded the TLV of 0.05 mg/m³. The addition of indium to dental alloy did not affect the amount of mercury vapor released under these conditions.

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INTRODUCTION
Occupational exposure to mercury vapor is a hazard faced by dental personnel. Recent studies documented that dentists and dental auxiliaries who were exposed to dental amalgam had a higher urinary mercury concentration when compared to dentists who did not work with dental amalgam (orthodontists, oral surgeons) or persons who were not occupationally exposed to mercury (Lehto & others, 1989; Akesson & others, 1991). Another study found higher concentrations of mercury in the pituitary glands of dental staff (Nylander & others, 1989).

The source of mercury exposure in the dental office is the handling of dental amalgam. Several studies have measured the amount of mercury vapor released to the atmosphere during the placement and removal of dental amalgam. Eames and Palmertree (1979) found that during the placement of dental amalgam the amount of mercury vapor released exceeded the threshold limit value (TLV) of 0.05 mg/m³ recommended by the Occupational Safety and Health Administration. The TLV is
the maximum amount of mercury vapor to which a worker may be exposed for an 8-hour day, over a 40-hour work week. Studies have found that the amount of mercury vapor measured after the removal of dental amalgam also was elevated above the TLV (Brune, Hensten-Pettersen & Beltesbrekke, 1980; Cooley & Barkmeier, 1978; Reinhardt, Chan & Schulein, 1983; Richards & Warren, 1985). The level was greatly reduced if high-speed evacuation and water spray was utilized.

These procedures all contribute to the mercury vapor levels that accumulate in the dental operatory, and studies have shown that 10% of the operators in the United States exceed the TLV (Langan, Fan & Hoos, 1987). The trend, therefore, is to reduce the amount of mercury vapor released to the atmosphere through proper handling and disposal of amalgam.

Recently a dental amalgam called Indisperse has been developed that contains indium in the alloy powder. A study by Powell, Johnson, and Bales (1989) has demonstrated a significant decrease in mercury vapor released to the atmosphere during the setting reaction when indium is added to the amalgam reaction. As the amount of indium added to the alloy increased from 0% to 14%, a significant decrease in mercury vapor released during setting was recorded.

The question arises of what effect indium may have on the mercury vapor released from dental amalgam during condensation and removal of amalgam in a clinical setting. The purpose of this study is to measure the amount of mercury vapor released into the breathing zone of the operator during the placement and removal of several amalgams during a clinical simulation and to investigate differences in vapor release from high-copper amalgams as opposed to amalgams that contain indium. The significance of the study is to determine if the use of indium amalgams will significantly decrease the exposure of dental personnel to mercury vapor.

### Table 1. Restoration Placement Timed Sequence

<table>
<thead>
<tr>
<th>TIME</th>
<th>ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:00-0:15</td>
<td>trituration</td>
</tr>
<tr>
<td>0:15-4:00</td>
<td>condensation</td>
</tr>
<tr>
<td>4:00-4:15</td>
<td>trituration</td>
</tr>
<tr>
<td>4:15-7:00</td>
<td>condensation</td>
</tr>
<tr>
<td>7:00-10:00</td>
<td>carving</td>
</tr>
<tr>
<td>10:00-10:10</td>
<td>suction</td>
</tr>
<tr>
<td>10:10-13:00</td>
<td>carving</td>
</tr>
<tr>
<td>13:00-13:10</td>
<td>suction</td>
</tr>
</tbody>
</table>

### Table 2. Amalgam Removal Procedure Sequence

<table>
<thead>
<tr>
<th>TIME</th>
<th>ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:00-5:00</td>
<td>high speed/water spray high volume evacuation</td>
</tr>
<tr>
<td>5:00-5:15</td>
<td>rinse</td>
</tr>
<tr>
<td>5:15-10:00</td>
<td>high speed/water spray high volume evacuation</td>
</tr>
<tr>
<td>10:00-10:15</td>
<td>rinse</td>
</tr>
</tbody>
</table>
in Table 2.

Placement of the amalgam and the control restorations was conducted in a random order. Removal followed the same order.

Between each insertion and removal, new rubber dams were placed, evacuation tips replaced, and plastic coverings for the dental chair replaced. The operator changed gloves and mask.

Prior to the project, the ventilation of the operatory was adjusted to ensure constant and adequate air flow and stable room temperature.

Data Collection

Mercury vapor levels were obtained using a vapor analyzer (Jerome Gold Film Mercury Vapor Analyzer, Model #411, Jerome, AZ 86331) interfaced to an IBM XT computer using Lab Tech Notebook (Laboratory Technologies Corporation, Wilmington, MA 01887) software. A background mercury level was taken before each insertion and removal run. Three readings, 1 minute apart, were taken, and the average was recorded as background. A background concentration greater than 0.008 mg/m³ was considered unacceptable, and no procedure was performed until the room had reached a lower level of mercury vapor concentration. Mercury vapor readings were started at the first trituration for condensation runs and at the 45 minute entry for removal runs. Air samples were taken every 45 minutes for 10 seconds over a 15-minute period. An interval of 15 minutes was chosen, because during trial runs mercury vapor readings began to return to initial background levels by that time. The measurements were done at a level of the breathing zone of the operator, 12 inches above the operating field.

A mask (Aseptex, 3M Dental Products, St Paul, MN 55144) was placed on the intake port of the mercury analyzer for each insertion and removal to simulate the clinical condition. During trial runs, it was found that amalgam removal resulted in contamination of the internal filters, probably due to released particulate matter. Use of the face mask eliminated this problem.

Statistical Analysis

Five samples of each alloy and control were run. The average reading at each time was plotted and the area under the plot calculated. The total amount of mercury vapor released during the test period was calculated according to the formula described by Powell and others (1989). Data were analyzed by one-way ANOVA.

RESULTS

The average mercury vapor readings during insertion and removal procedures at 0-15 minutes for each material are presented in Figures 1 and 3. The average background reading for the control during condensation was 0.003 mg/m³; for the amalgams, it was 0.005 mg/m³. The average background for the control during removal was 0.003 mg/m³, and for amalgams it was 0.004 mg/m³. At no time during the procedures did the mercury vapor concentration measured at the dentist’s breathing zone exceed the TLV of 0.05 mg/m³.

The total amount of mercury vapor released during insertion and removal procedures when measured over a 15-minute interval is presented in Figures 2 and 4. Statistically significant differences between the amalgams and the control were found for insertion (P = 0.006) and removal (P = 0.026). No differences were found among the amalgams.
DISCUSSION

Mercury vapor readings during amalgam condensation were very low, well below the TLV of 0.05 mg/m³. A previous study by Eames and Palmertree (1979) found mercury vapor concentrations exceeding the TLV for a variety of condensation techniques. The difference in findings is most likely due to a difference in ambient air mercury vapor concentrations. The maximum increase in mercury vapor readings above background levels was small (average range 0.004 to 0.006 mg/m³) that high or uncontrolled mercury vapor concentrations in the operating area could confound the results. Other factors affecting mercury vapor concentration could be the type of amalgam used and the measuring device.

The present study also found mercury vapor concentrations for dental amalgam removal to be well below the TLV, a finding supported by other studies (Brune & others, 1980; Cooley & Barkmeier, 1978). One study obtained different results. Under similar test conditions that included the use of water cooling and air aspiration, Richards and Warren (1985) measured a maximum mercury vapor concentration of 0.11 mg/m³ in the dentist's breathing zone. The peak reading reached in the present study for any sample was 0.011 mg/m³, a level that, when compared to the background value, represented an increase of only 0.007 mg/m³. Another study, while recording higher mercury vapor concentrations (and higher background levels) than recorded presently, found a similar result of small increases in mercury vapor concentration (Cooley & Barkmeier, 1978). Again, the ambient air levels, type of amalgam, and type of measuring device could account for the differences in results.

Indium did not result in less mercury vapor release from dental amalgam when compared to other higher amalgams during insertion and removal under clinically simulated conditions. Nor was a difference found between spherical and dispersed-phase amalgams. An in vitro study found no difference in mercury vapor release from low-copper and high-copper set dental amalgam (Ahmad & Stannard, 1990). A difference with regard to mercury release was found in an in vitro setting with a tin- and copper-free amalgam alloy; it released more mercury than did low- or high-copper alloys (Chew & others, 1989; Dérand, 1989).

A difference was found between the total amount of mercury vapor released during insertion and removal of dental amalgam when compared to the composite control (Figures 2 and 4). The clinical significance of this finding is unknown. In the present study, background levels of mercury vapor were kept below 0.008 mg/m³. At no time did levels exceed 0.015 mg/m³ during any single run for insertion or removal. Both insertion and removal of dental amalgams resulted in increases of mercury vapor release of less than 0.010 mg/m³. This small range of measurement challenged current mercury measuring devices. The mercury vapor in ambient air of many dental offices exceeds the increase caused by dental amalgam procedures (Nilsson & Nilsson, 1986), leading one to reason that, if ambient mercury vapor concentration exceeds 0.010 mg/m³, control of other factors such as adequate room ventilation and amalgam waste disposal may be more important for reducing the exposure of dental personnel. When proper field isolation, water coolant, and high-volume evacuation were used in a well-ventilated clinic setting, low levels of mercury vapor were released to the atmosphere.

A study of particulate inhalation during amalgam removal found that even with water coolant and high-volume evacuation, the dentist inhaled a moderate amount of amalgam particles (Nimmo & others, 1990). This particulate matter may be a larger contributor to ambient mercury levels than vaporized mercury, and this finding reinforces the need to wear face coverings.
during operative procedures involving dental amalgam.

CONCLUSIONS

There were no significant differences with regard to mercury vapor release during insertion and removal of dental amalgam when measured under simulated clinical conditions for the following dental amalgams: a dispersed-phase amalgam (Dispersalloy); a spherical amalgam (Valiant); and a dispersed-phase amalgam containing indium (Indisperse).

There was a significant difference with regard to mercury vapor release during insertion and removal of restorations given the above conditions when the amalgam materials were compared to a composite resin material (Prisma APH).

At no time did mercury vapor levels exceed the TLV of 0.05 mg/m³ during insertion or removal of the amalgam or composite resin materials.

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References


