ABSTRACT

Aim: The aim of this study was to evaluate mercury levels in wastewater and in patients during the removal of dental amalgam restorations.

Materials and methods: To test for mercury levels, patients were tested before and after amalgam restoration removal. To test for mercury emissions, samples of constant volume of wastewater from high-speed drills were collected before and during amalgam restoration removal.

Results: Although the systemic mercury levels were lower than the limit of biological tolerance, all patients had increased levels after dental restorations. All samples of wastewater had increased mercury levels too.

Conclusion: The urinary levels of mercury increased with dental amalgam removal using a high-speed drill. During the process of amalgam removal, water used for cooling the dental drill was contaminated with mercury.

Clinical significance: The mercury released by the physical action of the drill, the replacement material and especially the final destination of the amalgam waste can increase contamination levels that can be a risk for human and environment health.

Keywords: Dental amalgam, Mercury, Dental materials.

INTRODUCTION

Mercury has shown to be a heavy metal that can cause very serious damage to human health when individuals are chronically exposed to it. From the moment it enters the body, three chemical events occur, expressing its toxicity and future consequences: (a) Hg\(^{2+}\) reacts avidly with sulfhydryl groups of protein, causing a change in their three-dimensional structure, with a subsequent loss of biological activity; since Hg\(^{2+}\) is concentrated in the kidney during normal processing, this is the target organ that experiences the greatest intoxication; (b) with the mentioned three-dimensional change, some proteins become immunogenic, leading to a proliferation of B lymphocytes that produce immunoglobulins to bind to new antigens (tissues with collagen are particularly sensitive to this); and (c) forms of alkyl mercury, such as CH\(_3\)Hg\(^{+}\), are particularly lipophilic and bind avidly to the proteins in tissues rich in lipids, such as neurons (myelin is particularly susceptible to breakdown by this mechanism).\(^1\)\(^,\)\(^3\)

The system most affected, and that can bring about the most harmful results, is the central nervous system (CNS). The results include tremors, numbness, language disorders, abnormal reflexes, disturbances in nerve conduction, alterations in spelling, balance disorders, headache, pupillary reflex changes, memory disturbances, difficulties in concentration, and motor coordination problems.\(^4\)\(^,\)\(^5\)

Mercury and its compounds have certain therapeutic properties, being used in medicines, such as laxatives, antihistamines, antiseptics and in silver-mercury amalgam in dental fillings.\(^4\) Conventional dental amalgam is an alloy composed of 65% silver (Ag), 28-29% tin (Sn), 6% copper (Cu), and 1% zinc (Zn). Mercury was added to the alloy because of its ability to agglutinate fine particles, forming a metal alloy at room temperature.

It is believed today that the occupational route seems the most efficient for potential mercury contamination of the population.\(^6\)\(^,\)\(^9\) Dental health professionals are also at risk of mercury contamination, bringing concerns regarding the handling of dental amalgam. Based on that risk, some European countries have restricted the use of mercury in dental offices. Sweden is a classic example.\(^10\)

Combining these factors with environmental issues, Norway recently banned the production, import, export and...
sale of products that use mercury-containing substances.\textsuperscript{10} This has ultimately generated various forms of opposition to such action, and questions about the impact on the environment have been frequent because 50\% of environmental contamination is from natural causes and another 42\% is from burning fossil fuels.\textsuperscript{11-14}

This study was carried out to evaluate the mercury potential contamination from amalgam over patients and wastewater from dental offices. For that purpose, patients were evaluated before and after the removal of old restorations and wastewater was tested before and during amalgam removal using high speed drills. The hypothesis of this study was that there were significant differences between patients and water before and after the amalgam removal.

MATERIALS AND METHODS

The total sample was composed of 10 patients, five women and five men aged between 20 and 40 years, who had an indication for replacement of amalgam by composite restorations in Black’s class II cavities in upper or lower molars. The project was duly approved by the ethics committee, and all patients signed the informed consent form prior to taking part in any procedure of this study.

To evaluate patient mercury levels, urine was collected at the UNISUL Laboratory, University of Southern Santa Catarina from each patient immediately group patients before (GPB) the restorative procedure and 48 hours group patients after (GPA). Cold-vapor atomic absorption spectrophotometry (CVAAS) was used as a method for urine testing. The threshold limit value (TLV ≤ 5 µg creatinine) was used as a parameter, as proposed by the World Health Organization.\textsuperscript{9}

Individuals that had previously reported some risk of additional exposure were excluded. Exclusion criteria sought to avoid any additional source of mercury exposure, including professional activity that could result in additional exposure to mercury, a diet rich in seafood, and use of cosmetics, especially hair dye.\textsuperscript{4,5}

All restorations were removed by the same professional using a KaVo high-speed drill (KaVo Extra Torque, Kavo do Brazil Ind. Com. LTDA, Joinville, Brazil) under intense refrigeration with carbide burs compatible with the cavity size. Patients with teeth that did not allow a perfect seal of the operative field with a rubber dam (Lençol de Borracha-Angelus\textsuperscript{®}, Londrina, Brazil) were also excluded.

All results were statistically compared using the Paired Student’s t-test at 1\% significance level for comparisons between dependent groups (GPB × GPA).

Patients who would remove old amalgam fillings were selected to analyze the potential for contamination of wastewater. A 5 mm\(^3\) sample of water used for cooling the high-speed drill was collected before (control group) and during (test group) the removal of dental amalgam. That means it was wastewater that would go straight into the sewer. All patients received total isolation with rubber dam to prevent contact with saliva and incorporation of organic material.

A suction unit (Aspira Max, D-express, Curitiba, Brazil) was used to collect wastewater. A 0.05 mm diameter nylon net filter was attached to the end of the suction unit to prevent amalgam micro particles to be aggregated during the collection.

The waste water mercury levels were determinate by means of atomic absorption spectrophotometer with graphite furnace as a method. As a parameter was used the limit value recommended as standard by the environmental bodies, as proposed by the Brazilian National Environmental Council.\textsuperscript{13,15}

All results were statistically compared using the Paired Student’s t-test at 1\% significance level for comparisons between dependent control and test groups (CG × TG).

RESULTS

Increased levels of mercury contamination were found in patients, as shown in Table 1. The results showed a statistically significant difference for the dependent samples GRA × GRB (p = 0.009747), regardless of the use of a rubber dam. Despite this, all results were below the biological exposure limit recommended by the WHO (1991).\textsuperscript{9}

As shown in Table 2, the potential for contamination of wastewater containing mercury was statistically significant compared to the control group. It was observed that the simple removal of a certain amount of restoration, without any additional means of contamination, was able to produce increased levels of mercury contamination were found in patients, as shown in Table 1. The results showed a statistically significant difference for the dependent samples GRA × GRB (p = 0.009747), regardless of the use of a rubber dam. Despite this, all results were below the biological exposure limit recommended by the WHO (1991).\textsuperscript{9}

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<table>
<thead>
<tr>
<th>Sample</th>
<th>Absolute isolation</th>
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<tbody>
<tr>
<td></td>
<td>Before (µg creatinine)</td>
</tr>
<tr>
<td>1</td>
<td>0.56</td>
</tr>
<tr>
<td>2</td>
<td>1.8</td>
</tr>
<tr>
<td>3</td>
<td>0.66</td>
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<tr>
<td>4</td>
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<td>5</td>
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<td>7</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
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<td>9</td>
<td>1.93</td>
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<td>0.44</td>
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<td>0.009746977</td>
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<td>Standard deviation</td>
<td>0.702415673</td>
</tr>
<tr>
<td>WHO (TLV)</td>
<td>≤5</td>
</tr>
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</table>
null
of the exposure to mercury from dental amalgam seem not so obvious, but it could be possible to use procedures for mercury recovery from dental amalgam. Another way to solve this problem could be repairing the amalgam restorations using composite resins. When a part of the amalgam restoration and/or the cusp is fractured, that is a common problem, the professional could chose for repair this restoration instead of remove all of it.

Further studies and broader discussions are recommended to assess the actual environmental impacts of this contamination and lead to safe clinical practices. Ecotoxicological testing to determine the deleterious effects of physical or chemical agents upon aquatic organisms is vital for human health.

CONCLUSION

According to the results obtained and analyzed in this study, it can be concluded that:

1. The urinary levels of mercury increased with dental amalgam removal using a high speed instrument. A rubber dam as a mechanical barrier was unable to prevent the increase in systemic mercury levels.

2. During the removal process of amalgam fillings, contamination of water used for cooling the system occurs. This water is discarded and may contaminate the sewage of dental clinics with mercury.

ACKNOWLEDGEMENT

The authors would like to thank FAPESP (State of Santa Catarina Foundation of Support for Research) for the financial support of this study.

REFERENCES


