



## Research Article

### UTILIZATION OF *SAMANYA SHODHANA* IN THE PURIFICATION OF EXCESS MERCURY OBTAINED FROM DENTAL OPERATORY- A PRELIMINARY STUDY

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#### ABSTRACT

**Background:** Concerns about toxicity of Mercury and disposal of excessive Mercury has led to decreased usage of Mercury in dental profession but still tooth colored restorative materials are not affordable by all the classes of any society. The disposal of excess Mercury has always been a matter of concern. Thus, in the present study, we attempted to evaluate a simple procedure from *Rasa Shastra* using lime powder, garlic and rock salt for recycling of excess Mercury obtained from dental operatory.

**Materials and methods:** The excess Mercury was recycled by the standard procedure explained in Ayurveda texts (*Samanya shodhana*) using *Sudha churna* (lime powder), *Lashuna kalka* (paste of *Allium sativum* L.) and *Saindhava lavanaa* (rock salt). The commercially available Mercury and recycled Mercury was analyzed by inductively coupled plasma mass spectrometry (ICP-MS) for the detection of elements in ppm level.

**Results:** It was found that the excess impure Mercury contained 5138 ppm, 2866.1 ppm and 0.371 ppm of Silver, Copper and Tin respectively. After *Shodhana*, the level of Silver, Tin and Copper was markedly reduced. Purified Mercury showed a level of 119.5ppm Silver, 0.5324 ppm Copper and 0.3233 ppm Tin.

**Conclusion:** *Samanya shodhana* is a simple promising procedure which can be used for Mercury recycling. The procedure doesnot require sophisticated equipments and maneuver. Further, the materials used in the procedure are easily available and affordable at low cost.

**KEYWORDS:** Dental amalgam, ICP-MS, Mercury, *Rasa Shastra*, *Shodhana*.

#### INTRODUCTION

*Rasa shastra* is an age old medical science dealing with the use of metals and minerals in the treatment of diseases. Howbeit, these minerals cannot be administered in human body in their original form because of their potential ill effects. Thus, for medicinal use, these metals and minerals must be purified (*Shodhana*). The *Shodhana* not only remove the impurities but also alter their physical, chemical and biological properties.<sup>[1]</sup>

Amalgam has satisfactorily served the dental profession for more than 150 years and has numerous advantages such as low cost, ease of application, strength, durability, and bacteriostatic effects.<sup>[2]</sup> Toxicity of Mercury has always been a matter of debate and has led to a decreased of dental

amalgam. True allergy to Mercury is a rare event although there is an association between amalgam restorations and oral lichenoid lesions. Howbeit, such reactions are reported to occur in response to composites also.<sup>[3,4]</sup> Similarly, no significant link has been found between the usage of Mercury with diseases like multiple sclerosis and Alzheimer's disease.<sup>[5]</sup> Recently ADA has endorsed amalgam as being safe for pregnant women. In dental clinics, excess Mercury may be released during any step from trituration to carving and finishing. Additionally, dentists are exposed to Mercury vapors during removal of old restorations. The disposal of excess Mercury has always been a matter of concern. Traditionally, radiograph developing or fixer

solutions are used to store the excess Mercury gained during the process. In a recent survey it was found that 6% of the dentists were disposing Mercury into the drain, 39% into the dustbin, and 42% were storing the excess Mercury in glycerin and water and only 10% participants had separator installed at their workplace.<sup>[6]</sup>

Recycling of excess Mercury obtained from dental operatory could be an uprising event in dental profession especially if the procedure is done by Ayurvedic means. Since the available literature focusing on recycling of excess Mercury by Ayurveda for dental use is lacking, in the present study we attempted to evaluate a simple procedure from *Rasa Shashtra* using lime powder, garlic and rock salt. We further assessed the content of Silver, Tin and Copper in purified samples keeping commercially available chemically pure Mercury as control by Inductively coupled plasma mass spectrometry (ICP-MS). This might provide a safe method so that this asset (dental amalgam) of dental profession could be preserved.

#### **MATERIALS AND METHODS**

The study was conducted in the Conservative Dentistry and Endodontics unit, Faculty of Dental Sciences, Institute of Medical Sciences (IMS), Banaras Hindu University (BHU) in collaboration with Department of Rasa Shashtra, Faculty of Ayurveda, IMS, BHU and Department of Chemistry, Institute of Science, BHU. As a routine procedure Mercury and dental alloy were triturated to obtain dental amalgam which was squeezed through chamois leather to remove extra Mercury. This excess Mercury along with extra amalgam particles was collected from the under graduate and post graduate clinics.

#### **Purification of Mercury (*Parada Samanya Shodhana*)**

Purification of Mercury was done in the Department of Rasa Shashtra, Faculty of Ayurveda, IMS, BHU Varanasi. Figure 1 show ingredients used in the *Shodhana* process. Grinding (*Mardana*) of 120 gm of collected impure Mercury and an equal amount of lime powder (*Sudha churna*) was done in a granite *Khalva yantra* for eight hours a day for three consecutive days. The obtained mass was washed and filtered through a double folded cloth to obtain the Mercury. The procured Mercury was then taken in a *Khalva yantra* to which 120 gm of *Lashuna kalka* (paste of *Allium sativum* L.) and half the amount of rock salt (*Saindhava lavanaa*, 60 gm) were added. These were again ground (*Mardana*) until the mixture turned black (Figure 2). Washing and decanting were applied with the help of lukewarm

water for several times to get clear Mercury (Figure 3).

#### **Inductively coupled plasma mass spectrometry (ICP-MS) analysis of commercial available Mercury, collected impure Mercury and Ayurvedically recycled Mercury**

##### **Digestion of Mercury**

Digestion of Mercury was done in the Department of Chemistry, Institute of Science, BHU, Varanasi. One milliliter Mercury was taken each from the commercially available Mercury, collected Mercury and Ayurvedic recycled Mercury in separate clean glass flasks and were labelled as Sample A, B and C respectively. All the digestion vessels were washed with 10% HCl, rinsed with de-ionized water before preparing standards, reagents and samples. An ultrasonic cleaner with heating bath (Toshcon, Toshniwal process instruments pvt. Ltd. India) was used for digestion process. The digestion mixture of HNO<sub>3</sub>, HCl & H<sub>2</sub>O<sub>2</sub> in the ratio of 3:1:1 was added slowly to the samples of Mercury till all the Mercury appeared to be dissolved. The resulting solution was completely digested in hot water bath followed by filtration through whatman # 40 filter paper and diluted to 50 ml with Millipore water (Figure 4).

##### **ICP-MS**

ICP-MS was done in the Department of Chemical Engineering, IIT, BHU. This technology uses an ICP with MS for elemental analysis by generation of ions. The ICP is involved in generation of a high temperature plasma source at 10,000 degree Celsius, through which the pre-treated sample is passed. The elements in the sample at such high temperature are ionized and directed further into the MS. The MS then sorts the ions according to their mass/charge ratio followed by directing them to an electron multiplier tube detector. This detector then identifies and quantifies each ion.

#### **RESULTS**

##### **Recycling of Mercury by *Samanaya Shodhana***

Over a period of 6 months 126 grams of Mercury was retrieved from under- and post graduate clinic of Conservative Dentistry. Six grams of mercury was kept for ICP-MS and 120 gram Mercury was used for *Samanaya shodhana* (Ayurvedic purification). The purification method took a period of six days; three days for grinding in lime powder and another three days for *Mardana* (grinding) with garlic and rock salt. The procedure led to a loss of 24 grams of Mercury and yielded 96 gram of silvery white Mercury. The detailed results of purification of Mercury by *Samanaya shodhana* are shown in table 1.

**Table 1: Results obtained from *samanaya shodhana* of Mercury**

| Sl No. | Details   | Result    |
|--------|---|-----------|
| 1.     | Quantity of collected excess Mercury obtained from dental operatory       | 120 grams |
| 2.     | Quantity of Lime powder ( <i>Sudha churna</i> ) taken                     | 120 grams |
| 3.     | Quantity of <i>Allium sativum</i> ( <i>Lasuna kalka/ garlic</i> ) taken   | 120 grams |
| 4.     | Quantity of rock salt ( <i>Saindhava Lavana</i> ) taken                   | 60 grams  |
| 5.     | Quantity of obtained Mercury by <i>Shodhana</i> ( <i>Shodhit Parada</i> ) | 96 grams  |
| 6.     | Difference  | 24 grams  |

**Analysis of Ag Sn and Cu in commercially available Mercury, collected Mercury and recycled Mercury**

The commercially available Mercury, excess Mercury with impurities and purified Mercury were digested for ICP-MS. It was observed that the excess Mercury contained 5138 ppm, 2866.1 ppm and 0.371 ppm of Silver Copper and Tin respectively. After purification the level of Silver, Tin and Copper were markedly reduced as shown in table 2. The values were more close to the values of these elements measured in commercially available Mercury.

**Table 2: Values of Ag, Cu and Sn (in ppm) in sample A, B and C**

| Elements    | Sample A Commercially available Mercury (in ppm) | Sample B Collected excess Mercury (in ppm) | Sample C Purified Mercury (in ppm) |
|-------------|--|--|------------------------------------|
| Silver (Ag) | 11.69  | 5138                                       | 119.5                              |
| Copper (Cu) | 1.1069   | 2866.1                                     | 0.5324                             |
| Tin (Sn)    | 0.1045   | 0.371                                      | 0.3233                             |

**DISCUSSION**

As of 2015, 67% of Indian population is still rural (dataworldbank.org). Similar situation has been observed in neighbouring South-east Asian countries. Dental caries is an omnipresent disease which can affect all age groups in any area. Introduction of tooth colored restorative materials has led to a decrease in the usage of dental amalgam but tooth colored materials are not affordable by all the classes of any society. Dental amalgam has served the dental profession satisfactorily for more than sixteen decades. Concerns about toxicity of Mercury and disposal of excessive Mercury has led to decreased usage of Mercury in dental profession, however, in Ayurveda, after purification (*Shodhana*) Mercury is still used for the treatment of various ailments. Thus, the present study was conducted to find a simple method for the purification of impure Mercury from dental operatory. Furthermore, the purity of recycled Mercury was assessed by ICP-MS.

In our study, we adopted a simple method from the standard Ayurvedic rasa text, *Rasatarngini*. [7] We used lime powder, garlic and rock salt for the purification of Mercury collected from dental operatory. We speculate that the possible impurities in the Mercury collected Mercury would be the reaction products of Mercury and constituents of alloy powder. As Zinc free high Copper amalgam was used in the present study, Zn as a possible impurity was ruled out. Thus, Silver, Tin and Copper in

elemental form or as compounds were expected to be the potential impurities.

In the first step impure Mercury is ground (*Mardana*) in *Khalva yantra* (mortar-pestle) with lime powder for three consecutive days followed by filtering through muslin. It has been stated that this process reduces the drug to fine particle exposing maximum part and forces each particle to come into contact with the purifying drug allowing soluble impurities to go into the solution. [8] Since this method alone cannot procure total amount of Mercury thus remaining Mercury was collected after washing the mixture with ample amount of hot water washing all the soluble impurities. [9] This procured Mercury is later triturated with equal proportion of peeled garlic cloves and half part *Saindhava Lavana*. Garlic contains organic sulphur. As per modern chemistry sulphur is only element which detoxifies the Mercury due to its higher affinity for active sulphhydryl groups. Secondly the role of garlic in the *Shodhana of Parada* can be explained by using HPLC technique, which showed that zinc as an impurity is being effectively removed from the *Parada* by triturating it with garlic. Finally the Mercury is washed with hot water to remove salt and garlic particles. In a recent study Chavan P S et al postulated heat generated during trituration, alkaline nature of lime powder, *Kshariya* property of rock salt and the sulphur content of garlic



(alliin and allicin) as possible underlying mechanisms responsible in removing the impurities Mercury.<sup>[10]</sup>

After purification, it was intended to check the efficacy of the Ayurvedic method chosen. For the quantitative determination of metals and metalloids atomic absorption spectroscopy (AAS) and inductively coupled plasma mass spectroscopy (ICP-MS) are proven to be most accurate and sensitive elemental analytical methods available.<sup>[11]</sup> In trace elemental analysis, compared to AAS, ICP-MS has advantages such as high speed, precision and sensitivity and it is capable of the determination of a range of metals and several non-metals at concentrations below one part in 10<sup>12</sup>. Thus, we chose ICP-MS over AAS. Since, Zinc free DPI dental alloy was used for the fabrication of samples consisting of 48% Ag, 22% Cu and 30% Sn, therefore, concentrations of only Ag, Sn and Cu were determined. The commercially available Mercury was used for establishing baseline values. It was found that the excess impure Mercury (Sample B) contained 5138 ppm, 2866.1 ppm and 0.371 ppm of Silver, Copper and Tin respectively. After purification the level of Silver, Tin and Copper were markedly reduced. Sample A and sample C gave ballpark figures as shown in table 2. Owing to the simplicity of the Ayurvedic method described above and its ability to reduce the impurities to marked extent, the method provided here can be used in all the dental section for recovery and recycling of mercury for reuse.

## CONCLUSION

*Samanya shodhana* is a simple promising procedure which can be used for Mercury recycling. The procedure doesnot require sophisticated equipments and maneuver. Further, the materials used in the procedure are easily available and affordable at low cost.

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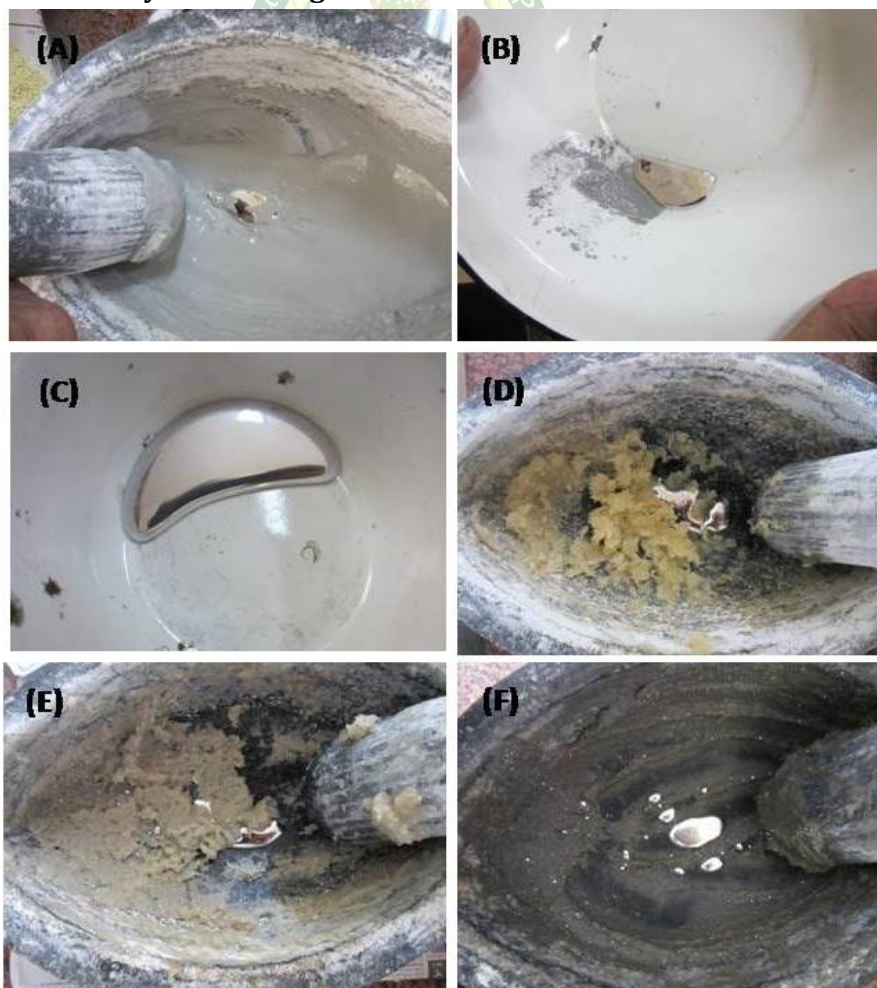
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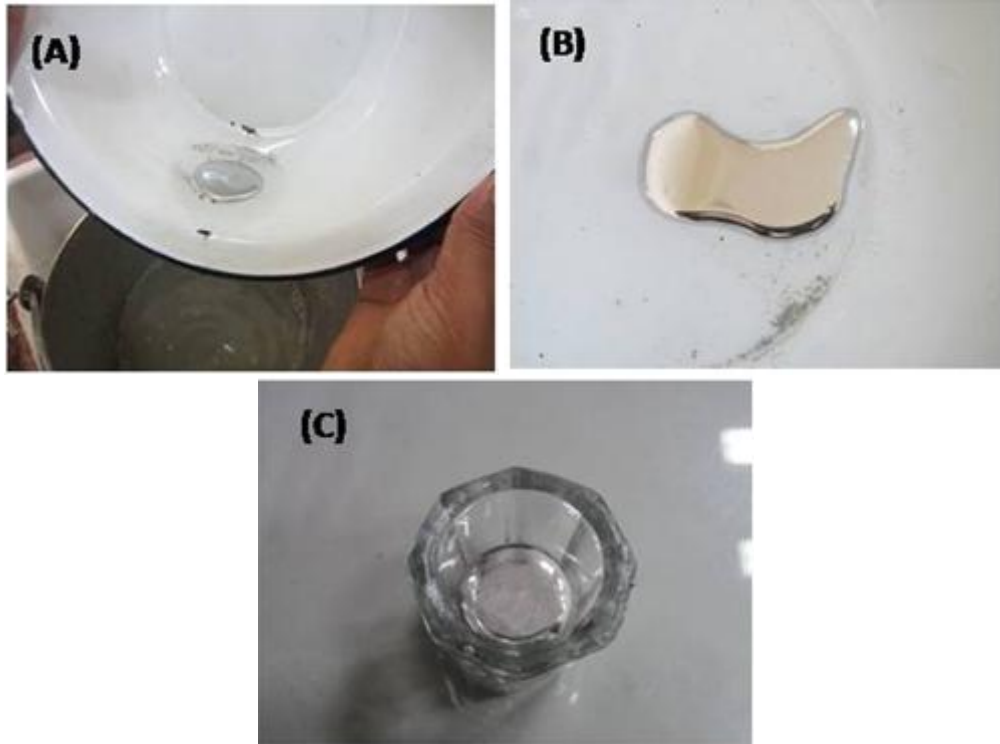
**Figure 1: A) Collected excess Mercury, B) Lime powder, C) Cloves of garlic, D) Ground Rock Salt**



**Figure 2: A) Trituration of excess Mercury with lime powder (done over a period of three days); B) Washing is done with hot water; C) The obtained Mercury appeared Silver; D-F) Trituration of obtained Mercury with fresh garlic cloves until it turned black**



**Figure 3: A-C Washing with hot water to obtain purified silvery white Mercury**



**Figure 4: Digestion of Mercury (A-D)**

