ORIGINAL ARTICLE

DENTAL AMALGAM: EFFECTS OF ALLOY/MERCURY MIXING RATIO, USES AND WASTE MANAGEMENT

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Background: Silver dental amalgam is one of the oldest filling materials used in dentistry. The American Dental Association (ADA) has estimated that billions of amalgam restorations have been placed in patients in the last 150 years. Due to the presence of mercury and mishandling during the filling make it more controversial. The objective of this study was to conduct a survey of the use of different brands and to assess any deviations in practice from the hand mixing manual method of elemental mercury and alloy in a pestle/mortar and encapsulated form. **Methods:** A questionnaire was sent to 250 of randomly selected dental practitioner in various localities of Karachi. Data was analysed to record the specified brands used along with their powder/liquid (P/L) ratio and the different methods for disposing off mercury in this study. **Results:** The most commonly used form of dispensing method was hand mixing (57%) and only 30% of the dentists followed the manufacturer instruction for hand mixing ratio. Eighty-seven percent of dental amalgam restoration was performed and 13% removed by the dentist per month and the method of disposing the amalgam wastage that 55%, 25%, and 20% dentists were used the sink, bin and other methods respectively in their dental clinics. **Conclusion:** Amalgam restoration is still popular filling material in the posterior region of the mouth but we need to create awareness among the dentists who do not follow the ADA specifications.

Keywords: Dental amalgam, alloy mercury ratio, amalgam wastage, amalgam dispensing

INTRODUCTION

Dental amalgams containing approximately 50% elemental mercury have been used for dental restoration for more than 150 years because they are malleable, durable, and more affordable than gold or composites.[1] Silver paste was used to restore the tooth in 7th century in china[2] and created different metal mixture in Germany to fill the cavities in 16th century[3]. The development of amalgam like material was influenced by French and English in 18th century. Black GV, an American dentist standardised both cavity preparation and amalgam manufactures in 1896, he developed a workable amalgam formula that provided for most clinically acceptable performance and his recipe remained unchanged for seventy years but most of the fillings fell out or the teeth split apart from the expansion of the amalgam and still the debate continues in both positive and negative aspects.[4–6]

Dental amalgam is produced by mixing liquid mercury with solid particles of an alloy of silver, tin, copper, and sometimes zinc, palladium, indium. This material is shown to undergo specific macro-mechanical retention within the tooth and have proved to possess properties that are satisfactory for a variety of clinical applications.[7] Dental Amalgam alloy may be classified as follows:

1) Particles shapes[8]
   I. Late cut alloy particles
   II. Spherical/spheriodal alloy particles
2) Composition of alloy particles
   I. Percentage of copper
      a) Low copper alloy
      b) High copper alloy
         i. Single composition alloy
         ii. Dispersed modified alloy
   II. Percentage of zinc [9]
      a) Zinc containing alloy
      b) Non zinc or zinc free alloy.

The dispensing of mercury and alloy can be classified[8] as

1) Powder in small sachet or envelope or as a tablet/ liquid in bottle
2) Pre-proportioned powder/liquid in capsules
3) Semi-auto dispensers (two hoppers one is filled with powder, the other with liquid)
4) Volume dispensers (glass bottles containing powder and liquid separately)

Table-1: Composition of dental amalgam alloy[8]

	Weight (%) Limits prior to 1986 (conventional alloys)	Currents limits
Silver	65 (min)	40 (minimum)
Tin	29 (max)	32 (maximum)
Copper	6 (max)	30 (maximum)
Zinc	2 (max)	2 (maximum)

Amalgam use in dentistry has been embroiled in controversy for the last 30 years, which has led to widely differing strategies. Scandinavian countries have begun to phase out the use of amalgams completely.[10–12] In January 2008, Norway and Sweden totally banned

mercury fillings. Denmark also banned the mercury fillings in the same year in April. Norwegian Minister of the Environment Erik Solheim said, 'Mercury is among the most dangerous environmental toxins'.[13] American Dental Association, the US Centres for Disease Control and Prevention, the US Public Health Service and the World Health Organization support the use of dental amalgam to fill cavities but with strict observance of amalgam waste protocols.[14] Amalgam manipulation and waste management in dental office is the most important factor during the amalgam filling, if this not strictly regulated according to the different health organization, more chances to the risk of occupational exposure as well as environmental pollution from this neuro- and nephrotoxic metal.[15] American Dental Association has described the best management practices for amalgam wastage.[16] They are:

DO's

- Use percapsulated alloys and stocks a variety of capsules sizes.
- Recycle used disposable amalgam capsules.
- Salvage, store and recycle non-contact amalgam (scarp amalgam).
- Salvage (contact) amalgam pieces from restorations after removal and recycle the amalgam waste.
- Use chair-side traps, vacuum pump filters and amalgam separators to retain amalgam and recycle their contents.
- Recycle teeth that contain amalgam restorations. (Notes: Ask your recycler whether or not extracted teeth with amalgam restorations require disinfection).
- Manage amalgam waste through recycling as much as possible.
- Use line cleaners that minimize dissolution of amalgam.

DON'Ts

- Use bulk mercury.
- Put used disposable amalgam capsules in biohazard containers (red bags) or regular garbage.
- Put non contact amalgam waste in biohazard containers, infections waste containers (red bags) or regular garbage.
- Put contact amalgam waste in biohazard containers, infectious waste containers (red bags) or regular garbage.
- Rinse devices containing amalgam over drains or sinks.
- Dispose of extracted teeth that contain amalgam restorations in biohazard containers (red bags), sharp containers or regular garbage.
- Flush amalgam waste down the drain or toilet.
- Use bleach or chlorine–containing cleaners to flush wastewater lines.

The concept of using the encapsulated form have extra advantage that they are proportioned by the manufacturer, and may help to reduce the risk of a atmospheric mercury contamination, a uniform and reproducible mix is produced, and also gives a shorter trituration time.[8] The mechanical properties required for the ideal posterior restorative material include compressive fracture strength and elastic modulus due to the stresses developed in the back of the mouth during mastication.[17] Therefore, to maximise the functional characteristics of hand-mixed amalgam restoration that is essential to use the optimum powder to liquid mixing ratio recommended by the manufacturer is utilised in clinical practice.

We conduct a survey of the use of different brands of dental amalgam by dentists practicing in Karachi and to assess any deviations in practice from the hand mixing manual method of elemental mercury and alloy in a pestle/mortar and encapsulated form.

MATERIAL AND METHODS

A questionnaire was sent to 250 randomly selected dental practitioners in various localities of Karachi. The queries on dental amalgam pertained to different brands application by the practitioners for restorative purposes. The questionnaire required to record the specified brands used along with their compliance to recommended powder/liquid (P/L) and encapsulated or otherwise. Different methods of disposing off mercury were also inquired.

RESULTS

Out of 250 questionnaires distributed (Dental Survey Form), we received back 200 questionnaires. Among these, 94% of dentists performed dental amalgam restoration and only 6% did not use amalgam in their dental clinics. The most commonly used form of dispensing method was hand mixing (57%) and only 30% of the dentists followed the manufacturer's recommended hand mixing ratio, whereas 43% of the dentists were using the encapsulated form of dispensing. The different brands, dispensing and ratio of alloy/ mercury used by the dentists are shown in Table-2. Average numbers of amalgam restorations performed and removed per month are shown in Table-3. Table-4 shows various methods used by dentists for disposal of amalgam wastage.

Table-2: Brands, dispensing and ratio of alloy/ mercury used for dental amalgam restoration

Variable		%
Brand type alloy/mercury	Dispersalloy	47
	Corrosion resistant alloy	29
	Admix alloy	15
	Others	9
Dentist using alloy/mercury (hand mixing) dispensing form		57
Dentist using encapsulated dispensing form		43

Table-3: Proportion and percentage of amalgam restorations performed/removed per month

Variable	Number	%
Average number of amalgam restorations performed per month	54	87
Amalgam restoration removed by dentist per month	8	13

Table-4: Methods of disposing off amalgam wastage

Variable		%
Methods for disposing of amalgam wastage by the dentists	Sink	55
	Bin	25
	Other (Container, Bottle containing water	20
	ADA recommended methods	0
Dentist squeezed out extra mercury after mixing alloy/mercury		73
Dentist do not squeezed out extra mercury after mixing alloy/mercury		27

DISCUSSION

Dental amalgam exposure to various media in the mouth is an important consideration for different clinical conditions. Practitioners need to be aware of effects of any change in alloy mercury mixing ratio which may influence the properties and finally affect the clinical performance. In our study population, more number of dentists preferred using hand mixing and therefore had more chances to make an error when mixing. In hand mixing 70% used their own alloy/mercury ratio and did not follow manufacturer's instructions. These compositional variations in alloy powder formulation may influence the quality of dental amalgam in terms of its restorative properties and environmental hazards. Development of these formulations is based on physical, chemical and biological factors to achieve the desired standard. It is necessary to meet desirable physical and mechanical properties of dental amalgam to achieve the best possible clinical performance.

Amalgam is the most frequently used dental filling material in Pakistan because it is inexpensive and more durable than other kinds of dental fillings.[18] The ADA has estimated that billions of amalgam restorations have been placed in patients in the last 150 years.[19] Due to socioeconomic condition still the dental amalgam is the material of choice for posterior restoration. We observed that dentists performed 87% and removed 13% dental amalgam.

Amalgam restoration is still popular filling material in posterior region of mouth. We need to evaluate different parameters and awareness among the dentists who are not following the criteria setup by International Standard Organization. Our study showed that 27% of dentists do not squeeze out extra mercury after hand mixing which may result to affect the properties and risk to health and environment.

Another important area we need to emphasise is the method of disposing off dental amalgam wastage in clinics. None of the clinics followed the instructions for wasting amalgam and disposing extra mercury according to ADA specifications. Our study showed that 55% of the clinics used sink, 22% used bin and 12% used other methods for disposing of amalgam wastage.

CONCLUSION

Amalgam restoration is still popular filling material in posterior region of the mouth but we need to create awareness among the dentists who do not follow the ADA specifications.

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