Amalgam use and waste management by Pakistani dentists: an environmental perspective

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استخدام الملغم وتدبير نفاياته لدى أطباء الأسنان الباكستانيين: وجهة نظر بيئية

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الخلاصة: لتقييم استخدام الملغم amalgam وبروتوكولات تدبير نفاياته التي يمارسها أطباء الأسنان الباكستانيون، أجريت دراسة عرضية شملت 239 من أطباء الأسنان في إسلام أباد وروالبندي، تم اختيارهم بناءً على الملائمة وعلى الاعتيان وفق المجموعات. واتضح أن الملغم هي أكثر المواد التي تستخدم في ترميم الأسنان وأنه اختيار تفرضه العوائق المالية لدى المرضى. وفيما يعتقد 90.4٪ من أطباء الأسنان أن الملغم من عوامل الخطر فإن 46.4٪ منهم يعتبرونه من الأخطار التي تتهدد البيئة. وقلة قليلة منهم (5.9٪) لديهم أداة فاصلة للزئبق في عياداتهم. إن بروتوكولات تدبير نفايات الملغم وتدوير الزئبق ينبغي أن تدخل باكستان.

ABSTRACT To assess amalgam use and waste management protocols practised by Pakistani dentists, a cross-sectional study was made of 239 dentists in Islamabad and Rawalpindi, recruited by convenience and cluster sampling. Amalgam was the most frequently used restorative material, with the choice dictated by patients' financial constraints. While 90.4% of dentists perceived amalgam as a health risk, only 46.4% considered it an environmental hazard. The majority disposed of amalgam waste in the trash, down the sink or as hospital waste. Very few (5.9%) had an amalgam separator installed in their dental office. Amalgam waste management protocols and mercury recycling should be introduced in Pakistan.

Utilisation de l'amalgame et gestion des déchets par les dentistes pakistanais : une approche environnementale

RÉSUMÉ Afin d'évaluer l'utilisation de l'amalgame et les protocoles de gestion des déchets mis en œuvre par les dentistes pakistanais, une étude transversale a été réalisée chez 239 dentistes d'Islamabad et de Rawalpindi, recrutés par échantillonnage de commodité et en grappes. L'amalgame était le matériau de restauration le plus fréquemment utilisé, ce choix étant dicté par les contraintes financières des patients. Alors que 90,4 % des dentistes estimaient que l'amalgame représentait un risque pour la santé, ils n'étaient que 46,4 % à le considérer comme un risque pour l'environnement. La plupart d'entre eux jetaient les restes d'amalgame dans la poubelle, dans l'évier ou le traitaient comme un déchet hospitalier. Un très faible nombre d'entre eux (5,9 %) avait un séparateur d'amalgame dans leur cabinet dentaire. Des protocoles de gestion des déchets d'amalgame et le recyclage du mercure devraient être introduits au Pakistan.

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Received: 25/12/07; accepted: 28/02/08

Introduction

The dental profession is one of the largest end-users of mercury [*1*]. Amalgam manipulation and its waste management in the dental office, if not strictly regulated, contribute to the risk of occupational exposure as well as environmental pollution from this neuro- and nephrotoxic metal [*1*]. The routes of mercury pollution from the dental office include: unregulated disposal of amalgam waste in the regular municipal waste or the domestic sewerage wastewater; high-risk methods of amalgam manipulation [*2*]; disposal of extracted teeth in hospital waste that is often incinerated; and autoclaving/heat sterilizing of amalgam-filling dental instruments [*1*].

Amalgam use in dentistry has been embroiled in controversy for the past 3 decades, which has led to widely differing strategies. Scandinavian countries have begun to phase out the use of amalgams completely [*3–5*], whereas organizations such as the American Dental Association, the US Centers 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 [*2*].

In 2004, the global anthropogenic release of mercury into the environment was more than 5000 metric tons, of which about 50% originated from Asia [*6*]. There are few data on the use and disposal of dental amalgam in Pakistan, and the Pakistan Dental Association, the main national dental body, has no official consensus regarding amalgam waste management in dental settings. The aim of this study therefore was to assess the extent of amalgam use and waste management protocols practised by Pakistani dentists. These baseline data can support recommendations for an amalgam waste-management protocol for the country. To the best of our knowledge, this the first study to document this aspect of dentists' practices in Pakistan.

Methods

A cross-sectional study was conducted over a period of 5 months from February to June 2007 in the twin cities of Rawalpindi and Islamabad. Islamabad, the capital city, has a population of 1.04 million, while Rawalpindi, its adjoining city, has a population of 3.04 million. The 2 cities have 3 undergraduate teaching dental hospitals and 3 tertiary-level government hospitals that have dental departments, and all 6 institutions also provide graduate level training in various clinical dental specialities.

The target population was full-time or part-time practising licensed dental practitioners in Islamabad and Rawalpindi. According to the Pakistan Medical and Dental Council (PMDC), the number of registered, practising dentists in these 2 cities was 524 [*7*]; based on a confidence level of 95% and confidence interval of 3, a sample size of 352 was calculated.

Participants were recruited by 2 sampling techniques in 2 consecutive phases. In phase 1, all the dentists working in the 6 dental hospitals were approached to participate in the study. The total number of dentists working in these hospitals at the time of the survey was 256.

In phase 2, cluster sampling was employed to access sufficient private practitioners to reach the target sample size of 352. For this the cities were administratively divided into 15 sections: Islamabad into 5 sections and Rawalpindi into 10. Out of the total number of registered dentists, 349 practised in Rawalpindi and the rest in Islamabad [*7*]. Based on the population proportions, all 5 sections of Islamabad and 5 from Rawalpindi, randomly selected by the lottery method, were targeted in order to obtain an equal representation from both cities. As private dental practices in Pakistan are not obliged to register with any central body, dental clinics within each cluster were identified from the local medical directories of Rawalpindi and Islamabad respectively and systematic selection of every 6th clinic was made. Phase 1 was followed by phase 2 to minimize the risk of duplication since many dentists augment their morning employment in a teaching and/or public dental hospital with evening private practice on a part-time basis. Duplication was avoided by asking dentists in phase 2 if they had already participated in the study. One dentist from each clinic (the first one who came forward) was asked to complete the questionnaire. The number of dentists/clinics identified in phase 2 was 96.

The data were collected using was a self-administered, 2-page structured questionnaire developed based on standard, validated questions gleaned from relevant publications [*8–10*]. The questions were closed-ended and in the English language since the medium of dental education in Pakistan is English. It was pilot tested on 13 dental practitioners and revised according to the evaluation. The study was administered by a team of volunteer dental students, who systematically visited the subjects' dental teaching institutes, teaching hospitals, public hospitals and private dental offices. Standard procedures of informed consent were used, including guarantees of anonymity and confidentiality. Some questionnaires were completed on the spot and others were filled out at leisure and collected at a later visit. No honorarium was offered. Dentists not returning the filled questionnaire after 2 recalls were considered as unwilling to participate. Data collection was conducted over 3 months from March to May 2007.

The study was reviewed by the Institutional Review Board of the Human Subjects Committee of Riphah University, Islamabad and granted exemption status.

The answers to each question were numerically coded and the data were

entered into *SPSS*, version 10.0. Since the nature of this cross-sectional study was descriptive, the results were analysed by descriptive statistics including frequencies and percentages.

Results

Of the 352 dental practitioners invited to participate in the study, 103 refused, giving an overall participation rate of 70.7% [189/256 (73.8%) in phase 1 and 60/96 (62.5%) in phase 2]. Ten questionnaires from suspected unlicensed dental practitioners were discarded. The results of this study were therefore based on 239 completed questionnaires, although some dentists did not answer every question.

Background characteristics

The characteristics of the study group are summarized in Table 1. The female to male ratio was 1:1.2. The respondents were graduates from 14 out of the 19 recognized dental colleges in Pakistan. A majority of the respondents were young graduates (56.5%) with fewer than 5 years of experience and a high proportion had postgraduate qualifications (13.8%).

Use and preparation of amalgam

The dentists' choices of material for fillings were decided primarily by patients' financial constraints (210, 87.9%) and the clinical indications of the tooth to be restored (175, 73.2%), but also aesthetic demands (124, 51.9%) and patient's choice (75, 31.4%). The self-declared frequency of use of amalgam was as follows: 147 (61.5%) dentists using it often/fairly often, 74 (31.0%) using it always/almost always and only 18 (7.5%) never/almost never using it. In comparison to other filling materials, amalgam was again most frequently used as the choice of filling material (211, 88.4% of dentists), followed by composite resin (140, 58.5%) and glass ionomer cement (128, 53.5%).

The most common protocol of amalgam manipulation was the mechanized capsule system practised by 106 (44.4%) dentists with 83 (34.7%) still using the manual method of elemental mercury and alloy in a pestle and mortar while 46 (19.2%) used both methods. The dental assistant was the person mostly commonly in charge of the trituration according to 191 (79.9%) dentists, although 34 (14.2%) shared the responsibility.

Beliefs about health risks

An overwhelming 216 (90.4%) dentists believed amalgam to be a health risk to both dental personnel and patients alike, but only 111 (46.4%) thought it to be an environmental pollutant. Therefore when asked whether amalgam fillings should be completely phased out and replaced with non-mercury based fillings, only 43 (18.0%) and 59 (24.7%) dentists strongly agreed and agreed somewhat respectively. However, 77 (32.2%) and 59 (24.7%) dentists disagreed strongly or disagreed somewhat to the same question.

Frequency of amalgam waste generation

To determine the monthly frequency of amalgam waste-generating procedures, the respondents were asked to quantify the average number of new amalgam fillings done, removal of old amalgam restorations and the extraction of teeth containing amalgam restoration in the past 3 months. The results are summarized in Table 2. Placement of new amalgam restorations was the most frequently carried out procedure by the

Table 1 Characteristics of the studied dentists (*n* = 239 respondents)

Characteristic	No.	%
Sex		
Female	110	46.0
Male	129	54.0
Year of graduation		
Past 5 years	136	56.9
5–10 years ago	49	20.5
> 10 years ago	37	15.4
Level of dental qualification		
Bachelor/Doctor of Dental Surgery (BDS/DDS)	161	67.4
Postgraduate trainee	45	18.8
Postgraduate specialist	33	13.8
Clinical setting		
Hospital practice only	117	49.0
Private practice only	58	24.3
Both hospital and private practice	59	24.7
Place of graduation		
Islamabad	88	36.8
Peshawar	40	16.7
Lahore	33	13.8
Karachi	30	12.6
Multan	20	8.4
Jamshor	10	4.2
Abbotabad	7	2.9
Quetta	5	2.1
Foreign qualified	6	2.5

Some frequencies do not add to 239 as respondents did not answer all questions.

Table 2 Distribution of dentists by estimated number of amalgam waste-generating procedures per month in their practice (*n* = 239 respondents)

Item	0–5 procedures		6–10 procedures		11–15 procedures		> 15 procedures	
	No.	%	No.	%	No.	%	No.	%
Placement of new amalgam restorations	21	8.8	12	5.0	39	16.3	165	69.0
Removal of old amalgam restorations	72	30.1	120	50.2	37	15.5	10	4.2
Extraction of teeth containing amalgam restorations	55	23.0	13	5.4	21	8.8	143	59.8

Some frequencies do not add to 239 as respondents did not answer all questions.

majority of the dentists (165, 69.0%), followed by extraction of teeth containing old amalgam fillings (143, 59.8%).

Analysis by clinical setting showed that 34/58 private practitioners (58.6%), 87/117 public hospital dentists (74.4%) and 42/59 dentists working in both settings (71.2%) carried out > 15 new amalgam fillings per month. For the removal of old amalgam fillings, 29 private practitioners (50.0%) performed only 0–5 removals per month while 87 public hospital dentists (74.4%) and 38 dentists working in both settings (64.4%) performed 6–15 removals per month. A similar trend was seen in extraction of amalgam restored teeth with only 1 private practitioner performing this procedure > 15 times a month, while 98 hospital dentists (83.7%) and 48 practitioners in both settings (81.4%) performed this with the same frequency.

Management of amalgam waste

Self-rated knowledge regarding the best management of amalgam waste was limited for 135 (56.5%) and moderate for 86 (35.9%) dentists. Only 4 (1.7%) dentists rated it as excellent and 11 (4.6%) as good. The ratings were reinforced by the findings on protocols practised for disposal of contact and non-contact amalgam waste (Figure 1). Although the disposal practices showed a variation according to the category of amalgam waste, only 6 dentists, all private practitioners, claimed to store it in a sealed container for recycling. The overwhelming majority disposed of it in the trash and/or down the sink. The option of disposal as part of hazardous hospital waste was practised mainly by hospital-based dentists (95, 81.2%). When questioned on the use of an amalgam separator, 14 dentists (5.9%) claimed their dental office had one installed in the drainage, while half the dentists (119, 49.8%) said they did not. Interestingly, 45 (18.8%) dentists did not know whether they had an amalgam separator installed or not and 59 (24.7%) did not know what an amalgam separator was.

Discussion

As the study sample included graduates from all the major cities of the country (from 14 out of the 19 recognized dental colleges) and their characteristics were congruent with PMDC statistics, it can be assumed to be representative of the average Pakistani dentist. The sex distribution of 1:1.2 was very close to the female to male dentist ratio of 1:1.1 in Pakistan [7]. The proportion of dentists with postgraduate qualifications (13.8%) was nearly twice the national average of 5.7% [7], but this is consistent with the fact that most of the dental specialists in Pakistan are concentrated in the larger cities. A majority of the respondents were young graduates (56.5%) with fewer than 5 years of experience. This is consistent with the growth of dental professional manpower in Pakistan, where the number of new dental graduates has tripled in the past 5 years as a result of the rapid growth of new private dental colleges [*11*].

Patients' financial constraints dictated the choice of filling material by most of the dentists in this study (87.9%). This naturally leads to amalgam being the most frequently used dental filling material because it is inexpensive and more durable than other kinds of fillings. Consequently we found that the number of amalgam waste-generating procedures in the average dental office in Pakistan was high. This finding differs from 2 cross-sectional surveys of dentists from Saudi Arabia who favoured composite and glass ionomer restorations over amalgam [*12,13*], a fact which could be attributed to the differences in gross national product between the 2 countries [*14*].

Although over 90% of the dentists in our study thought amalgam was a health risk, less than half believed it was an environmental pollutant and therefore protocols of amalgam manipulation were high-risk practices with little or no observance of standard mercury handling recommendations. This finding, however, is consistent with the Saudi study [*13*].

Although more than half of the dentists advocated the continued use of amalgam, very few of them (5.9%) had an amalgam separator installed in their dental offices. An overwhelming majority disposed of amalgam waste in the trash, down the sink or in the hospital hazardous waste that is eventually incinerated. While 6 dentists claimed to store the amalgam waste in sealed containers for recycling, on further questioning

they did not know of any mercury recycling company and these containers were inevitably thrown into the trash.

The findings of our study are consistent with other studies in developing countries in Asia. Studies in Palestine and Bangkok found that most dental waste, including amalgam, was thrown in the regular trash [*15,16*], while 1 study reported that dentists at a teaching hospital in New Delhi, India, were not aware of biomedical waste management and needed training [*17*]. New Delhi releases 51 kg of mercury through amalgam waste annually from hospital and dental clinic disposal, which, according to a health care news report, is unregulated and reckless [*18*]. However, in contrast, a study in a dental teaching hospital in Turkey showed that hazardous waste collection rules were obeyed most of the time [*19*].

Despite its acknowledged health hazards, amalgam is popular among Pakistani dentists as a dental restorative material due to its durability and low cost; therefore phasing it out or banning its use will be difficult. Encouraging best management practices for amalgam waste, from an environmental perspective, is a more viable option but one which requires strict adherence for maximum effectiveness. Legislation for occupational and environmental safety have paved the way for implementation of these protocols in developed countries [*20,21*]. Developing countries lag far behind in this scenario and Pakistan is no different.

The issue of mercury pollution has been taken up on a global platform by the mercury programme of the United Nations Environment Programme (UNEP), which is currently in collaboration with different countries although the list does not include Pakistan [*22*]. UNEP offers a full range of technical support and activities for reducing mercury use and release into the environment. We recommended that Pakistan joins the UNEP mercury programme and begins with the establishment of mercury recycling companies for the dental profession. At a local level, it is recommended that the Pakistan Dental Association takes a lead role in training dental professionals to adopt the best practices for amalgam waste management in the dental setting. Implementation of protocols can be begin with training and awareness-raising and at a later stage, involve legislative control.

Although our study group can be assumed to be representative of the average Pakistani dentist, the generalizability of the results of this study was limited by the cross-sectional design and partial use of a convenience sample. The reliability of the questionnaire was not checked due to the anonymous nature of the survey. Since dental clinics in Pakistan are not officially registered with any central body, there was some selection bias because dental clinics that were not listed in the local medical directories were not sampled. Additionally, Pakistan has nearly 70 000 unlicensed dental practitioners [*11*]—as compared to 7456 qualified dentists [*7*]—whose role in amalgam use and its waste management has not been addressed. Further research on a larger scale and inclusive of unlicensed practitioners is called for.

Acknowledgements

The authors would like to acknowledge the crucial role played by the Department of Community Dentistry, College of Dentistry, Riphah International University, Islamabad in the provision of administrative costs incurred in conducting this research.

The authors would also like to express their gratitude to all the 2007 2nd year dental students of the College of Dentistry, Riphah International University, who volunteered their time for data collection. Special thanks are due to Dr Faisal Moeen, Assistant Professor, College of Dentistry, Riphah International University for his invaluable input and advice.

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Healthcare waste management

WHO Programme activities on healthcare waste management include developing technical guidance materials for assessing the quantities and types of waste produced in different facilities, creating national action plans, developing national healthcare waste management (HCWM) guidelines and building capacity at national level to enhance the way HCW is dealt with in low income countries.

Further information on WHO's work in healthcare waste management is available from the WHO Centre for Environmental Health Activities (CEHA) (http://www.emro.who.int/ceha/index.asp).