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Mercury and Arsenic Levels Among Lebanese Dentists: A Call for Action

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Amalgam is one of the most versatile and practical dental filling materials available. Mercury (Hg), which constitutes about 50% of amalgam, is the only metal which is liquid at room temperature, a property key to its success as a filling material. Its symptoms include effects on the central and peripheral nervous systems and on the renal system. The classic neurologic effects of mercury toxicity are tremor, gingivitis and erethism (Chang et al. 1995; Gelband 1998). It has also been associated with stillbirths and birth defects in pregnant women and affects newborn infants through breast-feeding (Warfvinge 1995; Drexler and Schaller 1998; Oskarsson et al. 1996). Arsenic (As), another metal, which was used until the early eighties in dental surgery, causes neural disorders, vital organ damage and eventually death. Exposure to As is through contact, ingestion, and inhalation (Farmer and Johnson 1990; Wilhelm and Idel 1996). In Lebanon there has not been any study addressing the occupational exposure of dentists to either mercury or arsenic.

The purpose of the study was to evaluate the occupational exposure of Lebanese dentists to mercury and arsenic in the greater Beirut area, and to examine whether those levels are within the acceptable levels of 1 μg /g for As and 5 μg /g for Hg (ATSDR 2000; W.H.O. 1991). The study also investigated the effects of age, gender, years of practice, and specialty on the mercury levels among those dentists.

MATERIALS AND METHODS

Ninety-nine dentists from the greater Beirut area representing 11.2% of the total dentists in the area were randomly selected from the list of practicing dentists compiled by the Lebanese Order of Dentists. The dentists were contacted by phone. Around 97% of the contacted dentists agreed to take part in this project.

The dentists completed a questionnaire designed to assess the different factors that may contribute to their occupational exposure to Hg and As. These included age, sex, specialty, and years of practice.

Hair samples were collected from the interviewed dentists after completing the questionnaire. Samples were taken from the area just above the neck region and

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were cut as close as possible to the skin. For each dentist, a weighed amount of hair was digested in 70% nitric acid using a microwave oven (Yamashita and Kishi 1996). The samples were then assayed for their total mercury and arsenic concentrations by Inductively Coupled Plasma Mass-Spectrometry (ICP-MS) (Jun et al. 1993; Yamashita and Kishi 1996).

The accuracy of the analysis was regularly checked by running mercury and arsenic standards after every 10 samples. The regression coefficients of the standard curves were greater than 0.99 and the standards were read with an error less than 2%.

Information collected from the questionnaire along with the hair mercury concentrations were analyzed using SPSS 9.0. In the analysis, the mercury concentration in hair was taken as the dependent variable and was log transformed to accommodate its distribution. All other variables were used as independent variables.

One-way ANOVA and student t-tests were performed in order to compare the means of mercury concentrations among the levels of the independent variables. For those tests, the continuous independent variables were transformed into discrete ones. P values less than 0.05 denoted significant differences. Logistic regression analysis was performed after transforming the continuous dependent variable into a discrete variable with two levels: level 0 with concentrations less than or equal to 5 μg Hg/g hair and level 1 with concentrations greater than 5μg Hg/g hair. A p value less than or equal to 0.05 denoted a statistical difference.

RESULTS AND DISCUSSION

The reproducibility of the test results was examined by analyzing the mercury content of the same hair sample four times. The mean level of mercury was 0.121 μg/g with a standard deviation of 0.013 μg/g. The same hair samples were then spiked with 5 ppb of mercury and the percent recovery was determined. The mean percent recovery was 84.15 % with a standard deviation of 8.91 % (Table 1).

The arsenic concentrations in the hair of the dentists ranged from 0 μg/g to 0.233 μg/g with an average of 0.022 μg/g and a standard deviation of 0.039 μg/g (data not shown). Those levels are well below the threshold value of 1 μg/g hair. A level of As in hair below 1 ppm is considered a typical background level in unexposed populations (ATSDR 2000). The results obtained in our study revealed that arsenic levels in the hair of the dentists were below the threshold level. Data for adults in Europe and the USA range from 0.01 to 0.17 ppm (Wilhelm and Idel 1996). Such low concentration of As found in our study may be because dentists in Lebanon refrained from using arsenic in dental surgeries during the 1980's.

Moreover, the mean mercury concentration in this study group was 4.11 μg/g with a standard deviation of 3.61 μg/g and a range between 0 μg/g to 24.16 μg/g. This mean value is below the threshold level of 5 μg/g. However, 25.25% of the dentists had Hg mean concentrations greater than 5 μg/g and 7.07% of them had

concentrations above 10 μg/g (Table 2).

As shown in Table 3, the sample of the dentists surveyed consisted of 89 males (89.90%) and 10 females (10.10%). On the other hand, 59.60% of the dentists were below the age of 45. The results showed a significant effect of age ($p = 0.027$) in relation to mercury concentration in the hair of dentists.

Table 4 reveals that 45 % of the dentists in this study had some specialization. Among those, the average concentration of mercury was 3.7 μg/g as compared to 4.1 μg/g in the non-specialized group. A marginal significant difference was recorded between those two groups ($p = 0.766$).

Based on their practice patterns, dentists were divided into 3 categories: 0-10 years of practice, 10-20 years of practice, and above 20 years of practice. Around twenty eight percent had 0 to 10 years of experience, while 51.02% had between 10 and 20 years of experience and 21.43% had greater than 20 years of experience. The mercury content was not affected by the years of practice (Table 4).

Biological monitoring of occupationally exposed dentists to mercury can be achieved through different tests such as 24-hour urine mercury determination, blood level monitoring and hair analysis (Batista et al. 1996). Hair has been proven to be a suitable biological indicator for long-term mercury and arsenic exposure and is used in risk assessment (Kingman et al. 1998; Farmer and Johnson 1990). At the same time, it is easy to collect and is stable during storage (Foo et al. 1993; Wilhelm and Idel 1996; Wilhelm et al. 1996).

Discrepancies exist in the literature with respect to the threshold levels indicative of Hg intoxication. The range of values is from 5 μg Hg/g hair to 6 μg/g (Grandjean 1984; Katz and Katz 1992). According to W.H.O., the maximum allowable methylmercury concentration in hair is 5 μg/g hair.

In this study, the mean mercury concentration in hair of dentists was 4.11 μg/g, which is below the threshold level. The relatively high standard deviation observed in our study reflect the non homogeneity of our sample. This is in spite of the fact that those dentists practiced in the same area of Lebanon, but had different specialties and may have followed different precautionary measures. It is interesting to note that 25% of the dentists included in this study had a mercury concentration above the acceptable baseline of 5 μg/g.

The mean values obtained in this study were higher than those reported by Scarlett et al. (1988) who reported 2.98 ppm in the hair of dentists. In other studies, higher levels of mercury were reported (Noguchi et al. 1980; Kim et al. 1989; Saengsirinavin and Pringsulaka 1988). The high levels of mercury among dentists may be due to the fact that dentists using amalgam can be exposed to elemental mercury (Hg^0) in their clinics as a result of both amalgam preparation and restoration. Such occupational exposure has initiated several studies on ambient air concentrations of mercury vapors in clinics. The concentrations

ranged from 20 to 170 $\mu g/m^3$ (Warfvinge 1995). According to the World Health Organization, the threshold limit for occupational exposure in dental clinics is currently 50 $\mu g/m^3$ (W.H.O. 1991). Mercury vapor exposure may therefore be considered a potential health risk in many clinics despite hygienic procedures taken to reduce the risk of such exposure.

Another important factor that may contribute to the varied levels of mercury may be related to the dietary habits of the dentists. Unfortunately, there are no studies conducted in Lebanon on either the mercury levels in the Lebanese diet or the fish consumption by the Lebanese population. Fish intake has always been considered as a major contributing factor to high levels of mercury in humans. Published studies (Harakeh et al. 1985; Kouyoumjian et al. 2001) have indicated much lower concentration of Hg in the Lebanese fish than the threshold level of 0.5 ppm (FAO/W.H.O. 1994).

In the current study, there was no significant difference between the levels of mercury among male and female dentists tested. This is in contrast to what has been reported by Kim et al. (1989) and Dumont et al. (1998) who found that male dentists have higher mercury levels than female dentists. Others reported similar findings with no correlation between sex and mercury concentration in the hair (Ott et al. 1991).

Age seemed to have a significant effect on the mercury levels. This is similar to what was reported by Francis et al. (1982) despite its contrast with what was found by others (Ott et al. 1991; Batista et al. 1996).

Specialty and years of practice were other parameters tested. The results indicated that specialty or years of practice did not significantly influence mercury content. However, at a confidence level of 90%, the absence of specialty led to a greater Hg accumulation in hair ($p=0.056$, data not shown). In general, most of the specialties do not involve the use of amalgams such as dental restoration, oral surgery or implantology. Some specialized dentists might, however, be exposed to elevated levels of Hg. In this study, one of the oral surgeons tested had a mercury concentration as high as 19.4 $\mu g/g$. This is may caused by the removal of amalgam fillings from his patients prior to surgical operations.

In making any comparisons in results reported in different studies, one has to keep in mind the differences in the ways the hair samples were collected, sample size, the analytical techniques used, and statistical analyses. The conclusions from this study are that mercury concentration exceeded the threshold value of 5 $\mu g/g$ in 25% of the dentists. Of this group, 28% have mercury levels exceeding 10 $\mu g/g$. Arsenic, on the other hand, did not seem to be a heath hazard. Further research is needed to delineate the risk factors that have led to such high levels of mercury.

Table 1. Reproducibility and recovery study.

	1	2	3	4	Mean (SD)
Unspiked samples ppb	0.107	0.116	0.127	0.136	0.121 (0.013)
Spiked with 5 ppb	0.261	0.327	0.321	0.362	0.352 (0.037)
Total expected conc. after spiking	0.358	0.372	0.377	0.393	0.375 (0.014)
% Recovery	71.471	87.918	85.166	92.032	84.150 (8.910)

Table 2. Mean mercury concentration in the hair of dentists (μg Hg/g) and percentage (%) of those with concentrations above 5 and/or 10μg/g.

Sample	%	Mean (SD)
Total population	100	4.11 (3.61)
Dentists with Hg conc. > 5 μg/g	25	8.53 (4.55)
Dentists with Hg conc. > 10 μg/g	7	14.44 (5.28)

Table 3. Mercury concentration in the hair of dentists (μg Hg/g) in relation to their personal profile.

Personal Profile	No. of subjects	%	Hg concentrations		Values	
			Mean (SD)	Range	t	P (ANOVA)
Female	10	10	3.01 (2.36)	0.00-6.81	-0.525	0.601
Male	89	90	4.35 (3.71)	0.33-24.16		
Age						
≤ 45 years	59	60	3.55 (3.03)	0.00 – 19.44	-2.251	0.027
> 45 years	40	40	4.95 (4.23)	0.39 – 24.16		

Table 4. Mercury concentration in the hair of dentist (μg/g) in relation to their practice patterns.

Practice Patterns	No. of subjects	%	Hg concentrations		values	
			Mean (SD)	Range	t	P (ANOVA)
No specialty	52	54	4.1 (3.0)	0.00 – 12.6	0.298	0.766
specialized	44	46	3.7 (3.0)	0.81– 19.4		
Years **(#)**						
0 - 10	27	28	3.5 (2.3)	0.00 – 10.3	0.841	0.434
10 – 20	50	51	4.0 (3.3)	0.39 – 19.4		
> 20 years	21	21	5.3 (5.3)	0.85 – 24.2		

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