Original Article

Received: July. 2010

Accepted: Nov. 2010

Survey of Urine Mercury Concentration Rate of Hamadanian Dentists with over 4 Years of Experience

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ABSTRACT

Statement of the problem: In recent years, amalgam has been considered a danger for dentistry personnel due to toxicity of mercury (Hg).

Purpose: This study aimed at investigating the relationship between scientific indices and dentists' urine Hg level through measuring its concentration rate among dentists with over four years of experience.

Materials and methods: Thirty dentists with over four years of experience in clinic completed a questionnaire related to practical indices such as working time in clinic, the number of amalgam restorations, waste disposal methods, the number of amalgam repair finishes per day, and the number of amalgam-repaired teeth in dentists' oral cavity. Thirty urine samples were collected from the participants and the urine specific weight was measured on the same day with a refractometer. After completion of preparation stages, Hg was extracted from the upper organic layers of the solution by potassium bromide and measured by a spectrophotometer at a wavelength of 48 nanometer in µgHg/L. Urine creatinine of each sample was measured and the Hg concentration obtained was divided by creatinine concentration. The urine Hg values were reported in terms of µg Hg/gr.cr. Data were analyzed by t-test, Pearson's correlation coefficient and linear multi-variate regression test.

Results: The urine Hg level rate was 31.62–in average lower than admissible threshold level. Totally, 11 samples were greater than threshold level. Among the practical indices in the study, the method of cleaning amalgam-contamionated instruments, the method of amalgam waste disposal and the number of restorations carried out showed a significant relationship with urine Hg level ($P< 0.05$). The number of restorations carried out plays an important role in determining urine Hg levels.

Conclusion: The Hg concentrations were lower than the admissible level. The most influential factor was the number of restorations carried out.

Keywords: Dental amalgam, tooth restoration, Hg toxicity, dentists, urine analysis.

INTRODUCTION

Corresponding Author: N. Ronaci Address: Dept. of Oral Medicine, Faculty of Dentistry, Hamadan Univercity of Medical Sciences, Hamadan, Iran.Tel:09183160690 E-mail:neginjavrose@yahoo.com Dental amalgam with a history of over 100 years is used as the most common restorative material but there are concerns about Hg toxicity; therefore, some countries have reduced its

use since late 1900s. The review of numerous papers confirms that Hg plays an important role in forty chronic diseases, of which periodontal diseases, immune system diseases, cardiovascular problems, hormonal problems and eye chronic diseases, and digestive and neural system disorders can be mentioned.[1-3]

As the dentistry personnel have the greatest contact with this material, there is a high risk of contamination with Hg in these individuals. Dentists are most likely to be contaminated through inhaling Hg vapors in the clinic.[4-6]

The leakage of vapors from amalgam capsules, imperfectly-mixed amalgams, Hg unsuitable for health, mechanical amalgamators, ultrasonic condensers, the heat from old amalgam picking and application of amalgam repair finish are the sources of increasing these vapors in the dental clinic, which enter blood circulation through respiratory membranes.[3]

The human body cannot keep metal Hg; therefore, much of Hg is dissipated through urine. [7, 8]

Research has shown that there is a linear relationship between Hg vapor concentration in air and Hg concentration in urine. In addition, Hg in blood has a direct relationship with Hg vapor concentration in air. As Hg concentration in blood has a three-day half-life, urine analysis tests are used to assess long-term exposures. [9, 10]

Studies on urine and blood Hg concentration focus on the necessity of awareness from dentist's professional exposure potential. [11-12]The amount of permissible threshold of urine Hg concentration has been reported to be 35 µg of Hg. It is difficult to guarantee safety and there is always the risk of Hg toxicity for dentists. Creating suitable conditions to remove amalgam wastes and observing the principles of Hg health can help reduce this danger. [13-14]

This study was performed to measure Hg concentration in dentist's urine that had work experience of more than 4 years and to examine the relationship between practical indices and Hg level.

MATERIALS AND METHODS

Forty dentists with over four years of experience in the clinic filled in a questionnaire which included working duration in the clinic in terms of year, the number of amalgam restorations each day, working hours in a week, number of replacements of previous amalgam restorations each week, the manner of mixing amalgam and Hg (manual or mechanical), the method used for cleaning instruments contaminated with the material, the waste disposal method, work place conditions (ventilation and floor coverings), number of amalgam restoration finishes each week, the number of teeth restored with amalgam in dentist's oral cavity. Ten cases were excluded from the study due to lack of cooperation, consuming fish and antifungal drugs which produce Hg.

Each subject provided 125 mL of urine sample in a polyethylene bottle which was sent to the laboratory to be tested. As at-work sampling influences the amount of urine Hg, sampling was carried out before the start of work and preparation stages were carried out on three samples in a week.

The specific weight of each urine sample was measured by a refractometer and then digestion process of samples was carried out by thick strong nitric acid and sodium permanganate in a flask in one hour. After the flask temperature reached the room temperature, the sample was transferred to a separator funnel. By using amine hydroxyl hydrochloride the extra amount of permanganate was removed and a transparent solution was obtained. Adding some drops of purple metacresol indicator and then some NaOH with pH=0.1%, solution was reduced to two. 20 mg/L of ditizone indicator was added to deposit copper and bismuth and then bromur potassium 40% was added to obtain $H_2Hg_3Br_4$. The resultant solution contained a chloroform layer which was discarded and the liquid phase contained $H_2Hg_3Br_4$ is solution. First, 10 mm of buffer solution was added to the liquid phase so that the pH reached 6. Then, 10 mm of ditizone was added. The solution was stirred for two minutes and was left to be separated into two liquid and chloroformic phases. Then the Hg available in chloroformic layer was extracted using a wavelength of 485 nanometer by a spectrophotometer in 10 µgHg/lit.

To allow for individual differences and kidney function of every person, urine creatinine was measured. The concentration of Hg values was corrected by the related formula regarding the calculated specific gravity. The concentration obtained was divided by urine creatinine (gr/lit). Data were analyzed by t-test, Pearson's correlation coefficient and linear multi-variate regression test.

RESULTS

The Hg concentration varied from 7.69 to 64.46 µg Hg/gr.ct. 37.9% of cases were more than the permissible threshold value (35 µg) and 62.06% were less than this value; 37% and 24.1% were less than 20 and more than 50 µgHg, respectively. The average urine Hg concentration was 31.62, which appears to be less than the permissible value. The results related to the variables are presented in Tables 3–1.

The data in Table 2 shows that dentists' urine Hg concentration has significant correlation with four independent variables of the number of amalgam restorations each day, the method of cleaning instruments contaminated with amalgam, amalgam waste disposal method and the teeth restored with amalgam in dentist's oral cavity ($P>0.05$).

The data in Table 3 shows that the variable of the number of daily amalgam restorations plays the most important role in determining the amount of urinary mercury

in dentists since a change of one standard deviation unit in the number of daily amalgam restorations results in 0.489 of standard deviation change in urinary mercury, demonstrating the greatest change regarding beta valves of the Table. This change was allocated the highest Pearson's correlation coefficient.

Table 1: Pearson's correlation coefficient of urinary Hg concentration of dentists with predictor variants

Predictor variants (independent)	Pearson's correlation coefficient	Sig (1-taild)
Dental work history (year)	-0.011	0.478
Amalgam restoration number/day	0.60	0.000
Cleaning method of contaminated instruments with amalgam	0.5	0.003
Disposal method of amalgam wastes	-0.338	0.037
Number of amalgam-restored teeth of dentist	0.368	0.025

Table 2: Linear multivariant regression analysis Results for a group of Predictor variants of urinary Hg amounts of Dentists

Predictor variants (independent)	Non-standard regression index		Standard regression index $Beta$	t	P value
	B	Std:Ert			
Constant value	-11.35	18.79	-	-0.604	0.552
Dental work history (year)	0.178	0.289	0.105	0.615	0.545
Amalgam restoration number/day	4.14	1.323	0.489	3.13	0.005*
Cleaning method of contaminated instruments with amalgam	8.579	5.964	0.237	1.428	0.164
Disposal method of amalgam wastes	-4.779	10.522	-0.069	-0.454	0.654
Number of amalgam-restored teeth of dentist	1.667	0.879	0.323	1.859	0.071

*: significant

DISCUSSION

For a long time contact with mercury and its vapors has been considered a risk factor for the health of dental, which might occur through direct dermal contact with mercury, its component or through inhaling its aerosols. Approximately 80% of the initial exposure is through inhaling its aerosols. Mercury vapor concentration is estimated to be 20 mg/m^3 at 25°C: the higher the temperature, the higher the concentration. Mercury accumulation in the body depends on the quantity, duration and the number of exposures and various individual-related metabolic factors. The retention time of mercury varies with its half-life in organs from several days to a month. Kidneys are one of the main organs involved in mercury retention. Mercury in blood is removed through urine and stool in the form of Hg^{++} ion, which takes 50-60 days for complete removal from urine. Therefore, urine has a main role in measuring urine absorption level by urinary mercury volume as an index. It has been shown that there is a direct relationship between urinary mercury level, normal function of the kidneys and mercury level in blood and saliva. In fact, urinary mercury results from filtration of blood circulation toxin into the kidneys; therefore, it is compatible with transitional changes of mercury absorption fromoutside.[4,5,12,13]

The results of this study are expressed in µg Hg/gr.cr, the level varying from 7.69 to 64.46. The average of working years for dentists was 12.9. It was specified that 37.9% of them had 30–40 working hours, 6.8% had less than 20 hours and 13.7% more than 40 hours a week. Also, 37.4% had mercury levels more than 35 µg/gr.cr, 62.06% had less than this in urine and 37% of dentists had less than 20 µg/gr.cr. 24.1% of dentists had values more than 50 µg/gr.cr. It is evident that dentists in this study exhibited an increase in absorption of Hg, which is legitimized only by their jobs. On the whole, 11 of dentists had values more than permissible value (35 µg/gr.cr) while they worked 24–52 hours a week 6 days of the week, and carried out 4–8 amalgam restorations a day. Among the influential factors, the number of daily amalgam restorations plays the most important role in determining urinary mercury level.

Not surprisingly there was a remarkable statistical relationship between the number of daily amalgam restorations and the method of cleaning amalgam-contaminated instruments with dentists' urinary mercury concentration, which confirms the results of similar studies based on which urinary mercury level increases with the increase in amalgam restorations.[3,8,9,14]

In addition, the relationship between urinary mercury concentration and the method of cleaning amalgam-contaminated instruments is ascribed to the release of mercury vapors during the stages of

amalgam-contaminated instrument sterilization, which is dependent on ventilation conditions of sterilization location.

Lack of relationship between dentists' working experience with urinary mercury concentration is attributed to biological half-life of body's mercury (55 days); therefore, if there is no exposure of more than permissible value mercury is excreted from the body and does not accumulate. The average of dentists' urinary mercury concentration was 31.62 µg/gr.cr in this study, which less than permissible value.

Lack of relationship in this regard is logical but in a similar study the value reported was almost twice. In a study on 28 samples of urine, Kelman reported the mercury concentration 76.9 in dentists and 97.5 in dental staff; the staff showed a remarkable range of mercury concentration compared to the dentists.[11]

Lack of relationship between daily working hours and urinary mercury is ascribed to factors with higher effect such as daily amalgam restorations the positive correlation of which was confirmed in this study. Lack of relationship between the number of amalgam-restored teeth of dentists with urinary mercury might be attributed to the effect of this parameter in during a short period of time (almost one week) while other studies have focused on it.[3,4,15,16]

It is suggested that dentists regularly evaluate the amount of mercury in their nail and hair. In addition, their blood mercury concentration should be monitored. Determining the amount of mercury vapor in workplace by dosimetry can be helpful.

CONCLUSION

1. The average amount of urinary mercury level in this study was less than the permissible threshold value of 31.62.
2. The method of cleaning amalgam-contaminated instruments and amalgam waste disposal has a relationship with urinary mercury level but restoration finishing was not influential.
3. Among the factors of work experience, daily working hours, working days in a week, the number of daily amalgam restorations and the number of restorations in dentists' oral cavities, the number of daily restoration is the most important factor in increasing urinary mercury in dentists.

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