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Original Article

Correlation Between Mercury Concentrations in Hair and Dental Amalgam Fillings

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Abstract

To examine possible association between dental amalgam fillings and mercury burden, we measured the mercury concentrations in scalp hair samples from 74 female Japanese subjects aged 26-64 years who had a dietary habit of little fish-consumption. The hair mercury concentrations in the subjects with multiple amalgam fillings were significantly higher than those in the subjects with no amalgam fillings, and correlated with the number of amalgam fillings in the following regression equation: log Hg = 0.084 amalgam fillings + 3.377 (r = 0.339, p = 0.003). In addition, multiple regression analysis demonstrated that the hair mercury concentrations were significantly correlated with the amalgam fillings (r = 0.292; p = 0.014) and age (r = 0.284; p = 0.017) but not significantly with the body mass index (r = 0.060). A regression equation of log Hg = 0.071 amalgam fillings + 0.011 age + 0.006 BMI + 2.72 was obtained (r = 0.447), with 0.200 of the determination coefficient. These findings suggest that the dental amalgam fillings positively influence mercury accumulation in the hair and also, probably, in the body.

KEY WORDS: amalgam, hair, mercury, aging, body mass index (BMI)

Introduction

Anti-Aging Medicine is defined as the medicine which makes maintaining health and youth possible while growing older. The aim of this medicine is not simply to extend the life span, but to prevent age-associated physical and mental decline and maintain a high quality of life thus enabling continued social productivity.

The dentistry field also has a deep involvement in toxic metal contamination. It is becoming evident the influence on aging which dental materials used in dental treatment. The medical field is also hoping that dentists will make active efforts to diagnose and improve these conditions. It is clear that the Anti-Aging Medicine region in which dentistry is involved is very diverse. Close cooperation between the dentistry and medical fields will make it possible to implement the above methods thus resulting in a high level of Anti-Aging Medicine.

Mercury is well known as a toxic metal in the human body and at high levels, it causes liver and kidney damage as well as neurological symptoms/disorders¹). This toxic metal not only inhibits various enzymatic reactions and metabolic processes, but also enhances lipid peroxidation, progression of atherosclerosis and the risk of myocardial infarction and/or stroke, leading to death²⁻⁵).

Recently, an increasing interest in the health hazards associated with mercury exposure has been raised, and the mercury release from dental amalgam fillings has been blamed for a variety of health complaints ⁶⁻¹⁰. In particular, prenatal exposure to mercury may affect the blood pressure and ability to respond to sensory stimuli in the exposed fetus and in infants later in life ¹⁰⁻¹⁴. Thus,

dental amalgam fillings and restorations have become increasingly recognized as a potentially significant source of inadvertent chronic exposure to mercury, particularly in populations with no dietary dependency on foods of marine origins. Over the past decade, in the Western countries with little mercury intake from fish consumption, mercury release from dental amalgams has been blamed for a variety of health complaints⁶⁻¹⁰.

The purpose of this study was to examine the possible relation between dental amalgam fillings and mercury concentration in hair, a suitable biomarker of mercury burden $^{3,15)}$. In this study, scalp hair mercury concentrations were examined in 74 female Japanese adults aged 26-65 years who had a dietary habit of little fish-consumption. The relation between the number of dental amalgam fillings and hair mercury concentration was examined using regression analysis, and the contribution of amalgam fillings to mercury burden was discussed.

Materials and Methods

Subjects and Materials

Scalp hair samples, well known as a suitable specimen for monitoring human exposure to mercury, were used in this study. On the basis of informed consent, scalp hair samples (the first 2-3cm proximal to the scalp, total weight of about 200mg) from 74 female subjects aged 26-65 years old who had 0-4 amalgam fillings and a dietary habit of little fish-consumption were collected at the outpatient clinic of Tsurumi University School of Dental Medicine and collaborative dental clinics (Table 1). Dentists counted the number of amalgam fillings for each patient. The data of body weight and height of each subject were obtained using a questionnaire and the corresponding body mass index (BMI) was calculated. The study protocol was approved by the ethical committee of Tsurumi University.

Table 1 Subject characteristics

Amalgam Filling Teeth	Number of Subjects	Age(year)		BMI	
		Mean	Range	Mean	Range
0	10	48.4	39-62	23.0	18.9-27.1
1	13	45.1	25-59	19.9	15.8-25.6
2	26	51.7	39-61	22.2	17.9-26.9
3	12	52.8	45-64	21.3	18.2-24.6
4	13	52.1	40-63	21.5	17.7-34.8

Analysis of hair mercury

The hair samples (75 mg each) were weighed, placed in 50-mL plastic tubes, and washed with acetone and with 0.01% Triton solution, in accordance with the procedures recommended by the Hair Analysis Standardization Board¹⁶). Each washed hair sample was then mixed with 10 mL of 6.25% tetramethylammonium hydroxide (TMAH, Tama Chemical, Kawasaki-city, Kanagawa) and 50 µL of 0.1% gold solution (SPEX Certi Prep, Metuchen, NJ, USA), then dissolved at 75°C by shaking for 2 hours. After cooling the solution to room temperature and adjusting its gravimetric volume, the obtained solution was subjected to mercury analysis. The mercury concentrations were measured using inductively coupled plasma mass spectrometry (ICP-MS, Agilent-7500c, California, USA) by the internal standard method, as previously reported $^{17-19}$, and were expressed as ng/g hair (ppb).

Statistical Analysis

The hair mercury concentrations were distributed in a nearly log-normal manner, and so converted to their logarithmic values for statistical analysis. The geometric mean (geomean) rather than the arithmetic mean was used to represent the hair mercury concentrations. Statistical significance was determined by one-way ANOVA, and the difference between individual groups was estimated using Scheffe test and Fisher's LSD test. The associations between hair mercury concentration and the number of amalgam fillings, subject age and BMI were determined using a multiple regression analysis.

Results

A scattered plot showing the association between the number of amalgam fillings and hair mercury concentrations is shown in Figure 1. The hair mercury concentrations in the subjects with 2 or more amalgam fillings were significantly higher than those in the subjects with no amalgam fillings (Table 2). In addition, the hair mercury concentration was significantly correlated with the number of amalgam fillings (AF) in the following regression equation of log Hg = 0.084 AF + 3.377 (r = 0.339, p = 0.003). Using this regression equation, we estimated one increment of amalgam fillings associated with a 1.2-fold increase in the hair mercury level.



Relation between the number of dental amalgam fillings and hair mercury Fig. 1. concentrations in 74 female Japanese subjects. The relation between the number of amalgam fillings and hair mercury level was examined using simple regression analysis (r = 0.339, p = 0.003).

> **: Significantly different (p < 0.01) from no amalgam filling group: *: p < 0.05

Influence of amalgam fillings on hair mercury Table 2 concentration

Amalgam Filling Teeth	Hair Mercury Concentration (ppb)		Scheffe Test	Fisher's Test
	Geomean	Log Hg ± S.D.	p value	p value
0	1,687	3.2270 ± 0.2163		
1	3,095	3.4906 ± 0.3041	0.311	0.0306*
2	4,278	3.6312 ± 0.3134	0.009**	0.0003***
3	4,529	3.6560 ± 0.2463	0.021*	0.0007***
4	3,983	3.6003 ± 0.2168	0.055	0.0023**

*: p < 0.05

: *p* < 0.01 *: *p* < 0.001

The results of a multiple regression analysis showed that the hair mercury concentration was significantly correlated with the number of amalgam fillings (r = 0.292, p = 0.014) and patient age (r = 0.284, p = 0.017) but was not significantly correlated with their BMI (r = 0.060, p = 0.620) (*Figure 2* and *Table 3*). Thus, the regression equation of log Hg = 0.071 AF + 0.011 Age + 0.006BMI + 2.72 was obtained (r = 0.447, p < 0.001), with the determination coefficient of 0.200.



Fig. 2. Relation between aging and hair mercury concentrations in 74 female Japanese subjects.

The relation between the age and hair mercury level was examined using a simple regression analysis (r = 0.353, p = 0.002).

Table 3Multiple regression analysis: Relation of hair
mercury concentration with amalgam fillings,
age and BMI in female subjects

	Partial R	Simple R	T value	p value
Amalgam	0.292	0.339	2.516	0.014*
Age	0.284	0.353	2.443	0.017*
BMI	0.060	0.111	0.496	0.621

Determination Coefficient = 0.200

Partial R: Partial regression coefficient with multiple regression analysis Simple R: Simple regression coefficient with simple regression analysis

*: There is a significant (p < 0.05) relationship with hair mercury concentration.

Discussion

Hair mineral analyses have been used in forensic medicine, in screening populations for toxic metal poisoning and in monitoring environmental pollutants²⁰⁾. Mercury, especially organic methyl mercury, is well known to be a toxic metal and accumulates in human kidneys, liver and fat-rich tissues such as brain and adipose tissue. In addition, it accumulates with age-dependency and gender-difference (1.5-fold higher in male than in female) in Japanese population²¹⁻²³⁾.

In the present study, a significant, positive relationship between the number of dental amalgam fillings and hair mercury levels in Japanese women was demonstrated (*Figure 1* and *Table 2, 3*). These results are compatible with the findings in pregnant Italian women reported by Luglie *et al.*⁹). They have demonstrated that the number of amalgam fillings positively influenced the mercury concentration in the amniotic fluid of pregnant Italian women ⁹). In an experimental study, Takahashi *et al.*²⁴) reported that mercury vapor released from amalgam fillings in pregnant rats was distributed to maternal and fetal organs in significant amounts depending on the number of amalgam fillings.

Some epidemiological studies have shown that prenatal exposure to mercury may affect the blood pressure and responsibility to sensory stimuli in the infants in later life ¹⁰⁻¹⁴). Therefore, pregnant women should avoid mercury exposure.

Recently, Yasuda *et al.*¹⁹ reported that in Japanese men the hair mercury concentration is related to the BMI, which is well known to be associated with overall mortality. Higher BMI is reported to be a high risk factor for various diseases such as metabolic syndromes and cancers ²⁵⁻²⁷, and also to be one of the strongest predictors of death from cardiovascular disease in men (relative risk, 2.90) ²⁸. Thus, mercury exposure seems to be correlated with not only obesity, but also with aging ¹⁹). These findings suggest the possibility that dental amalgam fillings may play some role in the pathogenesis of cardiovascular diseases, cancer and physiological senescence.

The present study demonstrated a significant relation between dental amalgam fillings and hair mercury concentrations in Japanese women who had a dietary habit of little fish-consumption. These findings suggest that in addition to dietary mercury intake, dental amalgam fillings also contribute to mercury accumulation in the body.

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