

Mercury Levels In Seafood and Among Dentists Who Consume It

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Abstract:

Background: Mercury is a naturally occurring metal which exists in three forms: Elemental (metallic), inorganic and organic forms. Elemental mercury is a shiny silver white liquid (quicksilver) obtained by refining of mercuric sulphide in cinnabar ore. Inorganic mercury compounds or mercury salts are formed when mercury combines with other salts like chlorine, sulphur or oxygen. When inorganic mercury is methylated or combines with organic agents it forms organic mercury. Organic mercury gets ingested in the body mainly by the consumption of seafood. Mercury is also stated to cause various adverse health effects like gastrointestinal disturbances, dermatitis muscle weakness and neurological disorders. In dentistry, amalgam which is an alloy of mercury is used in various restorative procedures. In recent years the use of amalgam has become a controversy stating the various adverse effects of mercury. Hence a study to estimate the mercury levels in various fresh and salt water fish, and in practising dentist who consume it has become necessary

Aim: To determine the levels of mercury in the most frequently consumed fresh and salt water fish and in practising dentist who consume it.

Materials and Methods: A total of 60 subjects, dentists and non dentists from different fresh and sea water areas in Karnataka were selected as a part of the study. Urine and hair samples were collected for estimating organic and inorganic mercury in the body. Informed consent was taken. Mercury level in the fish they consume were evaluated.

Results: The organic mercury level in seafood was found to be much higher than the inorganic mercury level contributed by amalgam.

Conclusion: Thus inorganic levels of mercury does not seem to pose a threat as much as the organic levels observed in hair which remains fairly constant for a longer period of time. Hence in a coastal region where the present study was undertaken fish being a staple food the risk could probably be attributed to more of an organic toxicity than an inorganic one. Thus amalgam is relatively safe to be practised and the controversy against it should be re-evaluated.

Keywords: Amalgam safety, seafood, dentists, mercury.

I. Introduction

Amalgam is an alloy that contains mercury as one of its components. Mercury is liquid at room temperature, it is alloyed with solid metals like silver, tin, copper and zinc¹. Amalgam has been used for restorative purposes for the past 150 years. It has got high strength, durability, dimensional stability, and biocompatibility. Studies have proved amalgam has got higher survival rate than tooth coloured restorative materials². In spite of all these advantages dental amalgam is losing its popularity as a restorative material because it contains mercury as its main ingredient. Studies have proved that mercury is a poisonous metal. It was during 1800s the phrase 'mad as hatter' was coined because of the chronic mercury exposure that the felters faced because mercury was used in hat making. In 1940s and 1950s mercury became known as the product that caused acrodynia, also known as pink disease. Some of the more recent occurrences include exposures in Minamata Bay in Japan (1960), mercury contaminated fish in Canada and methylmercury treated grain in Iraq (1970). All this has raised questions whether to continue using dental amalgam or not. Mercury is present in different physical and chemical forms. The three forms are elemental (Hg^0), inorganic (Hg^+) and organic forms. Elemental form is raw form from cinnabar ore. Inorganic form is formed when it combines with metals like sulphides and chlorides³. This inorganic form is converted to organic form when it enters the food chain. Restorative procedures like mixing, condensing and removal produce mercury vapours which get deposited in the body as inorganic mercury (Hg). These mercury vapours get stagnant in the dental colleges and clinics which later becomes a threat to the health of the dentists practicing there. It is stated that mercury has deleterious effect on kidney and central nervous system. A number of authors have maintained that the use of amalgam results in significant adverse health effects although other reports assert that the health risk from amalgam restorations is negligible for the majority of dental personnel and patients⁴. Elemental mercury which is released into the atmosphere is deposited into soil and water and gets methylated to methyl mercury (MeHg). Seafood is the major source of organic mercury in the human body.

Among fishes, the sea water fish is said to have more organic mercury in their body than fresh water fish. In freshwater, methyl mercury tends to latch onto decaying organic matter like dead plants and animals. It then breaks down with the help of sunlight. In saltwater, methyl mercury latches on to chloride which does not easily breakdown. This mercury is likely to be ingested by marine animals. Because sunlight does not break it down in seawater, the lifetime of methyl mercury is much longer in the marine environment⁵. In Karnataka there are many fresh and sea water areas. The mercury content of these fish gets accumulated in the body of dentists consuming them. Since mercury is universally present and its toxicity being a well established fact, dental amalgam has become a very controversial subject. Hence a study to estimate the mercury levels in various fresh and salt water fish, and in practicing dentists who consume it has become necessary.

Aims And Objectives Of The Study

To determine the levels of organic mercury in the most frequently consumed fresh and salt water fish and levels of organic and inorganic mercury among dentists and nondentists consuming these fish .

II. Materials And Methods

A total of 60 subjects, dentists (with more than 10 years of practise) and non dentists either males or females from different fresh and sea water areas in Karnataka were selected as a part of the study. Informed consent was taken from them. Mercury content in the various fresh and sea water fish which the subjects consume in that particular area was also evaluated.

Procedure for estimation of mercury in fish muscle:

A portion of dorsal muscle tissue was dissected. Muscle samples were acid digested with(mixture H₂SO₄-HNO₃ 2:1 v/v) and subjected to cold vapour atomic absorption spectrometry⁶.

Procedures for scalp hair collection and measuring organic Hg:

A single strand of hair was collected and tested with Advanced mercury analyser to estimate the mercury levels⁷

Procedures for urine collection and measuring inorganic Hg:

Mid stream urine samples (50 ml) were taken and subjected to Cold vapour technique together with Atomic Absorption Spectrophotometer for analysis⁸.

Subjects consuming fresh water fish are divided into two

- Group 1: Dentists consuming fresh water fish (n=15)
- Group 2: Non dentists consuming fresh water fish (n=15)

Subjects consuming salt water fish are divided into two

- Group 3: Dentists consuming salt water fish (n=15)
- Group 4: Non dentists consuming salt water fish (n=15)

III. Results

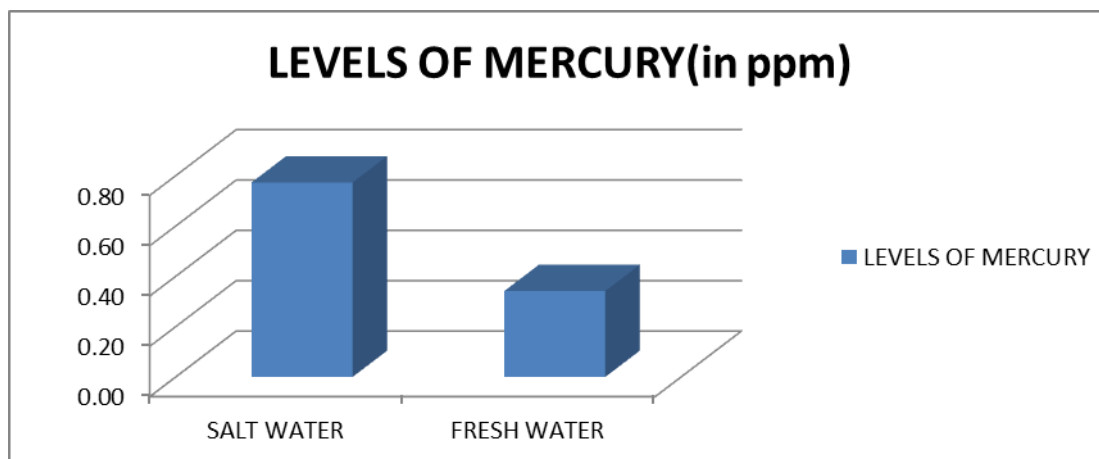
Level of organic mercury between salt and fresh water fish:

The amount of mercury in salt water fish was 0.773 ppm whereas in fresh water fish the amount of mercury was 0.341 ppm. Salt water fish had higher amount of mercury than fresh water fish. The result was statistically significant (p value< 0.001).Table1, Figure 1.

Table 1:Comparison between mercury levels in Salt water fish and Fresh water fish: T TEST

| | FISH TYPE | N | Mean(ppm) | Std. Deviation | T | df | Sig. (2-tailed) |
|-------------------|-------------|---|-----------|----------------|-------|----|-----------------|
| LEVELS OF MERCURY | SALT WATER | 5 | 0.7732 | 0.136454 | 4.772 | 8 | 0.001 |
| | FRESH WATER | 5 | 0.3414 | 0.149408 | | | |

Figure 1: Comparison between mercury levels in Salt water fish and Fresh water fish: T TEST



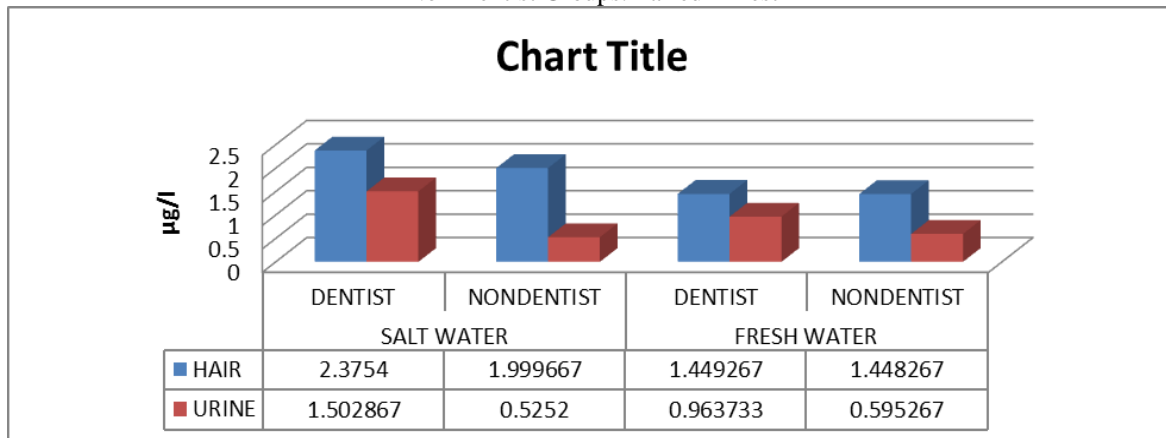
Levels of mercury in hair and urine of fish eating dentists and non dentists:

On evaluating the hair samples it was found that in sea water fish eaters the mean organic mercury level among dentist was 2.45 µg/l and 2.0 µg/l among non dentists. Among fresh water fish eaters the mean organic mercury level among dentist and non dentist was 1.45 µg/l. Dentists had higher levels of inorganic mercury in urine than non dentists. In sea water fish eaters the mean inorganic mercury level among dentist was 1.5 µg/l and 0.53 µg/l among non dentists. In fresh water fish eaters the mean mercury level among dentist was 0.96µg/l and 0.6 µg/l among non dentists. The amount of mercury in hair was higher than mercury in urine in both salt water as well as fresh water. The results were statistically significant(p<0.001).Table 2,Figure 2.

Table 2:Comparison Of The Urine And Hair Levels Of Mercury In Freshwater And Salt Water Dentists And Non Dentist Groups: Paired T Test

| Paired Samples Statistics | | | Paired Differences | | | T | df | Sig. (2-tailed) | | |
|---------------------------|--------------------|--|--------------------|----------------|----------|----------------|----------|-----------------|----|------------------|
| FISH TYPE | DENTIST/NONDENTIST | Mean(µg/l) | N | Std. Deviation | Mean | Std. Deviation | | | | |
| SALT WATER | DENTIST | Hair (organic mercury from fish) | 2.3754 | 15 | 0.719178 | 0.872533 | 1.036093 | 3.262 | 14 | 0.006 |
| | | Urine (inorganic mercury from amalgam) | 1.502867 | 15 | 0.849534 | | | | | |
| | NONDENTIST | Hair (organic mercury from fish) | 1.999667 | 15 | 0.84289 | 1.474467 | 0.876078 | 6.518 | 14 | <0.001 |
| | | Urine (inorganic mercury from amalgam) | 0.5252 | 15 | 0.407928 | | | | | |
| FRESH WATER | DENTIST | Hair (organic mercury from fish) | 1.449267 | 15 | 0.468883 | 0.485533 | 1.205509 | 1.56 | 14 | 0.141 |
| | | Urine (inorganic mercury from amalgam) | 0.963733 | 15 | 1.033043 | | | | | |
| | NONDENTIST | Hair (organic mercury from fish) | 1.448267 | 15 | 0.696356 | 0.853 | 0.837136 | 3.946 | 14 | 0.001 |
| | | Urine (inorganic mercury from amalgam) | 0.595267 | 15 | 0.468702 | | | | | |

Figure 2: Comparison Of The Urine And Hair Levels Of Mercury In Freshwater And Salt Water Dentists And Non Dentist Groups: Paired T Test



IV. Discussion

Mercury exists in various chemical forms. The important forms are the metallic form, also called the elemental form (Hg^0), the inorganic form (Hg^{+}) and the organic methyl mercury compounds. Elemental mercury is used in the manufacturing of various equipments like batteries, bulbs, thermometers, switches and dental amalgam. Elemental mercury rapidly volatilizes so spilled mercury from gauges or other equipments poses a risk for inhalation. Potential sources of mercury exposure include imported jewellery, outdated paints, pesticides, barometers, broken thermometers, antique clocks, mirrors and lamps. People who live near incinerators, hazardous waste sites, chlorine manufacturing plants or other industrial mercury sources may also be at increased risk of exposure through air, soil, dust or water contamination (ATSDR,1999). Amalgam which is an alloy of mercury has been in use as a restorative material for many years but its practise has been under constant surveillance in the recent years. This is because of the fact that mercury is known to cause various health disorders like gastrointestinal disturbances, skin rashes, dermatitis, insomnia, paresthesia and malfunctioning of the central nervous system. Mercury poisoning can result from vapour inhalation, ingestion, injection or absorption through skin. Once inhaled, elemental mercury is mostly converted to an inorganic divalent or mercuric form by catalase in erythrocytes. Amalgam is prepared by mixing mercury with the alloy powder to obtain a proper consistency, mixed amalgam is milled by hand thus removing excess mercury. Studies have shown that handling amalgam in this manner increases the potential for Occupational exposure to elemental mercury vapour. The excess mercury is spilled on to the floors, counters, around the chair and in waste baskets while later gets accumulated in the human body. Inorganic mercury in the environment is methylated to organic mercury, thus formed methyl mercury enters the aquatic food chain to become the predominant dietary source of mercury in humans. The highest levels of methyl mercury are found in predatory fish and sea mammals, therefore fish and dental amalgam are the two major sources of human exposure to organic (MeHg) and inorganic mercury Hg respectively⁹. The exposure and body burden of mercury can be estimated by monitoring of mercury in hair(organic mercury),and urine mainly (inorganic mercury)¹⁰. In the case of seafood, certain bacteria transform elemental mercury into methyl mercury which gets accumulated in the body of fish and later moves up into the food chain which includes humans who consume them¹¹. This organic form of mercury gets accumulated in hair strands on long term consumption of seafood. In this study, the average mean value of organic mercury in salt water fish (0.77ppm) was significantly higher than fresh water fish (0.34ppm). The maximum permissible level of methyl mercury given by FDA is (1 ppm) or 1000 µg/l. On comparing the hair samples it was found that in sea water fish eaters the mean organic mercury level among dentist was 2.45 µg/l and 2.0 µg/l among non dentists while on the other hand in fresh water fish eaters the mean organic mercury level among dentist and non dentist was 1.45 µg/l. This is in accordance with the study conducted by D. Babi¹² et al and Chatterjee M et al¹³. The presence of mercury in urine, generally represents recent exposure to inorganic and/or elemental mercury. However, inorganic mercury can accumulate in the kidney and gets excreted through the urine. Our study is also in accordance with other studies showing that dentists had higher levels of inorganic mercury in urine than non dentists. In sea water fish eaters the mean mercury level among dentist was 1.5 µg/l and 0.53 µg/l among non dentists. In fresh water fish eaters the mean mercury level among dentist was 0.96µg/l and 0.6 µg/l among non dentists.

Comparing organic and inorganic mercury, the inorganic mercury stays in the body for a very short amount of time. The half life of elemental mercury being 55 days. It is then later excreted through urine. Thus inorganic levels of mercury does not seem to pose a threat as much, as organic levels observed in hair which remains fairly constant for a longer period of time.

The following recommendations should be considered to minimize mercury vapour exposure in dental clinics¹⁴

1. Use an amalgamator with a closed arm.
2. Use of pre amalgamated capsules
3. Various techniques of handling amalgam should be standardised
4. Proper training and health surveillance for dental staff should be provided.
5. Floor coverings should be nonabsorbent, seamless and easy to clean. Avoid the use of carpets where there is potential chance of mercury spillage.
6. Collect and store dry dental amalgam waste in a designated, airtight container

V. Conclusion

Thus amalgam is relatively safe to be practiced and the controversy against it should be re-evaluated and more longitudinal studies should be conducted with the same group of dentists to evaluate the various mercury levels with time.

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