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REVIEW

Adverse effects of amalgam on stomatologists

Efectos adversos de la amalgama en los estomatólogos

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ABSTRACT

Mercury is used in stomatology for the elaboration of amalgams used in the restoration of teeth treated for caries, as it generates affections on the nervous, renal, immune and sexual systems, as well as behavioural disturbances. Staff working in stomatological practices are chronically exposed to mercury vapour and therefore constitute a population at toxicological risk. For the literature review, 42 bibliographies were consulted in order to describe the adverse effects of dental amalgam on patients and dental personnel.

Keywords: Mercury; Poisoning; Oral Medicine; Risk; Dental Amalgam; Dental Amalgam.

RESUMEN

El mercurio es utilizado en estomatología para la elaboración de las amalgamas empleadas en la restauración de los dientes tratados por caries, pues genera afecciones sobre el sistema nervioso, renal, inmune y sexual, además de perturbaciones en el comportamiento. El personal que labora en la práctica estomatológica está expuesto crónicamente a vapores de mercurio y por esto constituye una población de riesgo toxicológico. Para la revisión bibliográfica se consultaron 42 bibliografías con el objetivo de describir los efectos adversos de la amalgama dental sobre los pacientes y el personal estomatológico.

Palabras clave: Mercurio; Envenenamiento; Medicina Oral; Riesgo; Amalgama Dental.

INTRODUCTION

Mercury is a chemical element, metallic, symbol Hg, atomic number 80, atomic weight 200,59. It is a silvery-white liquid at room temperature (melting point -38,4ºC or -37,46º F); it boils at 357ºC (675,05º F) at atmospheric pressure. It is a noble metal, soluble only in oxidizing solutions. Solid mercury is as soft as lead. The metal and its compounds are very toxic. Mercury forms solutions called amalgams with some metals (e.g., gold, silver, platinum, uranium, copper, lead, sodium, and potassium).[(1)]

In agriculture, mercury was used as a fungicide in seed preservation, in the paper industry, and in producing sodium chloride, acetaldehyde, the widespread PVC, and other products. It finds its way into water, as industrial effluents, and through the soil.[(1)]

Occupational mercury poisoning has been known since ancient times and was very common in specific trades, particularly among hatters. In industries related to felting, but from 1953 onwards, hydrargyrism began to be studied when poisoning was detected in Japanese fishermen and their families.[(2)]

Then, deaths of cats fed with fish and mollusk remains began to appear; mercury was finally detected in water and fish flesh, exceeding normal concentrations by up to 10 000 times. This proves the phenomenon of concentration in aquatic organisms' food or trophic chain.[(2)]

It has been classified as a hazardous material due to the severe damage it causes to health and the

environment. Due to its interesting chemical properties, this metal has been widely used in industry and medicine.[3]

From a stomatological point of view, mercury enters the body by four routes:

1. from the oral and nasal cavity, mercury vapors reach the blood circulation and through the nerves directly to the brain.[3,4]
2. Mercury vapor, when inhaled, enters the lungs via the respiratory tract and from there passes into the bloodstream, where some of the vapor is transformed into mercury ions (Hgo→ Hg+2), where it is oxidized to form mercury ions (Hgo→ Hg+2). It is then stored in organs such as the liver and the kidney.[3,4]
3. During the removal of amalgam from old restorations and due to high-speed drilling, mercury vapor is generated which can enter the respiratory system.[3,4]
4. In the preparation of amalgams, small amounts of mercury may be spilled on the skin or remain in the environment, from which it evaporates and contaminates the work area.[3,4]
5. In stomatology, mercury is used for the preparation of amalgams used in the restoration of teeth treated for caries. The typical dental amalgam is a metallic grey alloy composed of liquid mercury (50 %), silver (35 %), copper (2 %), tin (13 %), and a small portion of zinc. The mercury makes alloying between the materials possible and facilitates the hardening of the restorative material once it has been placed in the tooth. A typical occlusal filling in a human molar contains between 750-1000 μg of Hg and has a 7-9 year lifespan.[5]

Dental amalgam is the primary source of mercury in health care and is the major contributor to the body burden of mercury in people who wear these restorations, while in non-wearers, fish is the common source of mercury in the population.[6]

Dental amalgam has been used since the 19th century as one of the best restorative materials, not only because of its durability and adaptability in posterior dental cavities but also because of its 'cost-effectiveness.' Economic evaluations emphasize the latter aspect, as dental amalgam is the most expensive dental restorative material if environmental costs are included in the financial calculation.[6]

Currently, there is a worldwide trend to rule out the use of mercury in human activities. In fact, in stomatology, there is a great controversy about the safety of using dental amalgam in patients, and attempts have been made to demonstrate the occupational risk to which dentists and dental assistants are exposed. In this regard, dental techniques that do not use mercury have been developed.

Therefore, the following scientific problem is posed: What are the adverse effects of dental amalgam on patients and dental personnel?

Objective

To substantiate the effects of dental amalgam on stomatologists.

To describe the adverse effects of dental amalgam, the oral manifestations that occur as a possible cause of mercury intoxication, and the adverse effects of mercury exposure to dental amalgam in children and pregnant women.

DEVELOPMENT

What is mercury?

Mercury is a halogen present in countless sources in nature.

What are the predisposing factors for the use of amalgam?

The clinical picture of mercury poisoning is very complex. It must be assumed that this is why the symptomatology of certain pictures is rarely associated with mercury as the primary causative agent of the entity.[7]

Symptoms and signs of patients with chronic mercury intoxication include depression, loss of appetite, irritability, poor concentration, insomnia, memory loss, headaches, and urination disturbances.[8]

Atmospheric concentrations of metallic mercury in dental practices are primarily determined by its residues on the floor, the eventual occurrence of metal spills, and the exposures that may occur during the preparation, insertion, polishing, and removal of dental amalgams. The type of ventilation equipment present, the characteristics of floors, walls, ceilings, room cleaning practices, personnel hygiene, and the instrument used for amalgamation also play a role.[9]

Toxic effects of elemental or metallic mercury can include decreased kidney function, immunodeficiency, dermatitis, gingivitis, pregnancy complications, and neurological symptoms such as tremor, spasms, weakness, fatigue, memory loss, depression, polyneuropathy, carpal tunnel syndrome, and mild visual dysfunction.[10]

Some research has observed effects that compromise higher neurological functions such as attention,

concentration, neuromuscular coordination, and mood. This supports the fact that the elimination of mercury once absorbed and stored is a very slow process. This could favor the occurrence of cumulative effects derived from occupational exposure for prolonged periods at low concentrations, as is the case of stomatologists.

Mercury and its compounds can be classified according to their degree of toxicity. Organic mercury compounds are more toxic than elemental mercury vapor, the latter being of greater importance in stomatology. Mercury vapor is 80-90 % absorbed by the respiratory tract as it reaches the alveoli and enters the bloodstream.[11]

Due to its high lipophilic property, it crosses the erythrocyte cell membrane, where it is oxidized. However, the oxidation rate is slower than the circulation time of mercury vapor from the lungs to the brain, allowing unoxidized inorganic mercury (Hg^o) to cross the blood-brain barrier rapidly. Mercury in the brain is oxidized and retained, increasing the plasma membrane's permeability to calcium, which causes neurotoxicity.[12]

Mercury can affect the body if inhaled or if it comes into contact with the eyes or skin. Inhalation of mercury vapor due to accidental spills during dental practice, the release of mercury during dental work, breathing contaminated air in the workplace, or contact with the skin are all reasons that indicate that an occupational risk of mercury poisoning exists in dental practice.[13]

Exposure to mercury (Hg) vapor from dental amalgams has been recognized as a potential health risk for dental personnel for many years, especially among those who use manual methods for amalgam preparation, which is common in developing countries. The risk of mercury poisoning is higher for occupationally exposed dental personnel than for patients carrying amalgams, and this is supported, among other research, by publications in several countries such as the USA and Sweden.[14]

In Switzerland, 3 % of 390 randomly selected individuals were believed to have experienced systemic reactions related to their amalgam dental fillings.15 Stomatologists and dental assistants are exposed to mercury via the respiratory route, inhalation of mercury vapor, and dermal route due to direct contact with amalgams, where mercury can pass through intact skin and constitute an additional entry point into the body.[16]

Amalgam dental fillings are the primary source of permanent low-level exposure to mercury vapor (Hg°) and inorganic mercury (Hg(II)) for the general population. Mercury concentrations in blood and urine reflect the total internal mercury load. However, measurements of total mercury in blood cannot be related to a particular source of exposure as they contain food-borne organic mercury, and it is known that the different mercury species show marked differences in their distributions in plasma and blood cells.[17] Therefore, the simultaneous exposure to inorganic and organic mercury and the peculiarities of its distribution in blood fractions make it necessary to determine both types of mercury in plasma and erythrocytes to determine the contribution of amalgam to the total internal mercury load.

A randomized, control group clinical study in adult patients on mercury exposure from dental amalgam, following the kinetics of total mercury and inorganic mercury in blood and urine after removal of dental amalgam fillings, with constant monitoring of exposure to food-borne methylmercury by monitoring blood levels of organic mercury has shown that:

1. Determination of the level of inorganic mercury in plasma and erythrocytes is the indicator of mercury absorption from amalgam.[18,19,20]
2. Determination of total mercury in whole blood includes 47 % organic mercury, even in populations with low fish intake. Due to its high mobility, methylmercury is evenly distributed in the tissues within a few days after absorption. In the blood, a small portion is bound to plasma proteins, while 90 % or more accumulates in erythrocytes. It is known that inorganic mercury is excreted equally via the intestinal and renal routes, whereas organic mercury is predominantly eliminated via the intestinal route. This explains the strong correlation between urinary mercury concentration and amalgam surface area, and therefore, urinary mercury concentrations are widely used as a measure of exposure to mercury from amalgam dental fillings.[18,19,20]
3. The ratio of urinary mercury to amalgam surface area is 0,09 μg/l per amalgam surface area, i.e., 10 amalgam surfaces increase urinary mercury levels by 1 μg Hg/L, which is consistent with values obtained by other authors.[18,19,20]
4. Mercury vapor is released from dental amalgam fillings; some are exhaled, and some are absorbed. The absorbed mercury dose from amalgam is 2,7 μg/day/person for an average number of fillings of 7,4. If this amount consisted entirely of inorganic mercury (Hg(II)), it could be compared with the tolerable intake figure for inorganic mercury proposed by the WHO of 0,23 μg/day/kg body weight, which gives a value of 15 μg/day for a 65 kg person, i.e., well above the value of mercury from amalgam.[18,19,20]

Cases of mercury inhalation poisoning have been known for centuries. Intention tremors, gingivitis with excessive salivation, and erethism characterize chronic mercury poisoning. Erethism consists of bizarre behavior with excitement, excessive shyness, and even aggressiveness.[21]

Which oral manifestations become more frequent in our practice?

The visible mercury lesions that we usually find clinically on the oral mucosa, referred to as stains or

pigments of various colors, range from black to blue to greyish tones. The presence of these strange metallic elements in the tissues is sometimes due to accidents during obturation and sometimes to the diffusion power of mercury as a halogen. These stains have been clinically described as amalgam tattoos.[22]

The oral mucosa reacts differently, showing specific changes in each tissue component. The underlying connective tissue shows the metallic contents as microspheres or amorphous deposits.[22]

The most significant finding is determined by vascular involvement. The vessel walls of the tissue change color to that of the halo described in the stratum basale but with a more accentuated hue. The metallic microspheres adhere with a specific positive tropism to the endothelial cells. The tissue locally reacts with a moderate mononuclear-type inflammatory response.[22]

What will be the adverse effects caused by high mercury concentrations in children and pregnant women?

A significant public health issue has been to investigate the possible occurrence of a neurological disorder associated with prolonged exposure to elemental mercury vapor (Hg0).[2,18] Children are known to be particularly vulnerable to elemental mercury, with a risk of impaired central nervous system development, personality, motor function, and behavioral disorders.[23]

Randomized studies on a sample of 534 children aged 6-10 years with an average of 15 tooth surfaces with caries compared the results of the neuropsychological examination and renal function of children whose caries were filled using dental amalgam. Urinary mercury excretion was a marker of absorbed dose and was positively associated with the number of amalgam fillings. The conclusion was that mercury exposure from dental amalgam was not associated with any adverse neuropsychological effects during the 5 years of observation.[24,25,26]

The overall importance of dental amalgams, especially from the mother who contributes significantly to the body burden of mercury (Hg) in the fetus and early childhood, stems from the fact that some studies have postulated that mercury exposure can cause neurodevelopmental disabilities in infants, immunological, sensory neurological, motor and behavioral dysfunctions similar to traits defined or associated with autism spectrum disorders (ASD) and that these similarities extend to neuroanatomy, neurotransmitters, and biochemistry.[31,32]

Children's susceptibility to adverse effects from mercury exposure may change over time, depending on the stage of development. The first exposure of children to environmental contaminants takes place during prenatal development through transplacental transport, as the human placenta does not represent a real obstacle to the transport of elemental mercury (Hg0) and methylmercury (MeHg).[33]

Evidence of the diffusion of mercury from the mother to the fetus has been determined in human studies. It suggests that the fetus is exposed to a higher dose of mercury when the mother undergoes amalgam restorations and much more exposed when undergoing the removal of old amalgams, as mercury vapor concentrations in the air in the area of the procedure can reach values of 388 μg/m3 and 1500 μg/m3 respectively.34, 35 In addition, it has been determined that trace amounts of elemental and inorganic mercury in saliva are taken up by oral bacteria that, in turn, release methylmercury as a product.36 These are sulfate-reducing bacteria (SRB) found in the mouths of approximately 10 % of periodontally healthy subjects, while among patients with periodontitis, the frequency of SRB presence increased significantly (58-72 % of patients).[33]

One study found a strong positive correlation (rho=0,79) between maternal and cord blood mercury levels. Hg levels in cord blood were significantly associated with the number of maternal amalgams. The mean values of Hg concentrations were 0,63 μg/L (range 0,14 to 2,9 μg/L) and 0,80 μg/L (range 0,15 to 2,54 μg/L) of maternal and cord blood, respectively. However, none of the mercury concentrations in cord blood reach the level that is considered hazardous for neurodevelopmental effects in children exposed to mercury in utero (EPA reference dose for Hg of 5,8 μg/L in umbilical cord blood).[38]

On the other hand, babies of pregnant women with ≥ 6 amalgams were 3,2 times more likely to be diagnosed with autism (severe) compared to the mild autism spectrum disorder of babies of pregnant women with ≤ 5 amalgams. The above calls for measures such as public policy on dental amalgam, which should consider Hg exposure in women before and during childbearing age and the possibility of subsequent fetal exposure and adverse outcomes.[38]

What signs and symptoms characterize elevated mercury concentrations in humans?

On the question of whether having amalgam dental fillings can lead to symptoms attributable to amalgam, several studies have explored the relationship between subjective symptoms purportedly due to amalgam (weakness, fatigue, dizziness, headache, susceptibility to infection, anxiety, depression, insomnia, diffuse joint, and muscle pain, among others.) and measurements of mercury in urine and plasma before and after administration of a chelator or placebo, or between amalgam carriers with subjective symptoms attributed to amalgam, symptom-free amalgam carriers and non-amalgam carriers, or by comparing symptom intensity and several amalgam surfaces. The results have not been able to relate subjective symptoms to the presence of amalgam fillings and have revealed that knowing that one is a carrier of amalgam fillings is why subjective symptoms are attributed to amalgam.[39]

In recent years, concern has arisen over whether prolonged exposure to low concentrations of mercury vapor from amalgam can cause or exacerbate degenerative diseases such as amyotrophic lateral sclerosis, Alzheimer's disease, multiple sclerosis, and Parkinson's disease. Speculation has become much more intense about Alzheimer's disease after the brains of patients with Alzheimer's disease were found to have elevated mercury concentrations. However, several epidemiological investigations have not provided any evidence for the role of amalgam in these degenerative disorders, including a long-term study of 1462 women in Sweden, an analysis of 587 twins in Sweden33 and a study of 129 nuns aged 75-102, which included eight cognitive function tests.[27,28,29,30]

The WHO indicates that the number of amalgam tooth surfaces and the levels of mercury in brain necropsies are related and that in some exposures to mercury due to dental amalgam, even though the concentration in the brain is low, adverse events may develop, mainly in genetically susceptible individuals. This is especially true when it has been shown that urinary mercury concentrations may not reflect the tissue retention of mercury in the brain.

It does not reflect the tissue retention of mercury in more sensitive tissues such as the brain and endocrine glands. Finally, the Health and Learning Environment and Developmental Disabilities Health and Learning Collaborative (2008) published a consensus statement reporting that mercury exposure can lead to autism spectrum disorders.[40] From a clinical restorative point of view, dental amalgam remains an excellent filling material in the subsequent sector; however, due to growing concern about mercury as a persistent, bioaccumulative, and toxic (PBT) chemical. Globally, almost 3800 tonnes of mercury are used annually for anthropogenic use, of which it has been estimated that 6-8 % is used in dentistry. About 2000 tonnes is the global emission of mercury released annually into the environment due to human activities, such as mineral processing and fossil fuel combustion.[40]

The National Institute of Occupational Security Health has developed the following guidelines to reduce the risk of mercury exposure:

- Store reagents in sealed containers.
- Wash hands before eating, smoking, or drinking.
- Avoid skin contact with reagents.
- The worker should be aware of the potential risk of reagents in the workplace.
- Actively participate in courses and training given by the employer on occupational health and safety.
- Prevent contamination at home: change contaminated clothing and wash with soap and water.[41]

Practitioners are encouraged to follow best management practices in the use and disposal of dental amalgam to limit its potential environmental effects: the use of pre-encapsulated alloy and mercury; the recycling of amalgam at all levels of procedures; not using or pouring disinfectants containing sodium hypochlorite, chlorine, iodine and hydrogen peroxides, among others, into the drains of the dental unit and the dental office in general, and the use of amalgam separators. As health professionals, we are legally responsible for the proper collection, which should be carried out for greater safety; using gloves, it should be collected in labeled glass containers, amber in color, containing a little water inside, there to dispose of them, never pour it together with common waste such as bloody gauze among others, store them in the place where the stomatological institution has designated, which will be the 'amalgam waste container' so that the corresponding government institutions can then send them to specialized companies so that the waste, both large and fine amalgam particles, can be recycled.[41]

In October 2013, the Minamata Convention on Mercury addressed concerns regarding the potential risk to human health and environmental damage from intentional mercury releases; countries adhering to the convention, including Peru, agreed to phase down its use in industry. However, regarding dental amalgam, no binding or measurable targets were required to achieve these goals.

CONCLUSIONS

A detailed description of the possible adverse effects of mercury exposure in children and an updated description of the impact of exposure to mercury from dental amalgam on pregnant women were described. The main signs and symptoms of chronic mercury poisoning, such as depression, loss of appetite, irritability, poor concentration, insomnia, memory loss, headaches, and urination disturbances, were described. And argue the rules to reduce the risk of mercury exposure.

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