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Mercury Exposure and Health Hazards in Dental Patients -A Review

Anushka Jain1, Rohit Sharma2, John Johnson Panadan3, Anjali Sharma4

Post graduate Student1, Professor2, Assistant Professor 3,4

1,2,4 – Department of Conservative Dentistry and Endodontics,Teerthanker Mahaveer Dental College and Research Centre , Moradabad

3— Department of Conservative Dentistry and Endodontics, Mahe Institute of Dental Sciences ,Mahe

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ABSTRACT:

Mercury has long been used in medicinal and industrial applications, making it a common source of chemical exposure and an environmental pollutant. It exists in organic and inorganic forms; inorganic mercury includes elemental mercury and mercury salts, typically encountered through devices like thermometers or ingestion of batteries and laxatives. Organic mercury exposure mainly occurs via contaminated seafood, mercury-based paints, or thimerosal. Dental amalgam, commonly known as silver fillings, has been widely used for centuries to restore decayed teeth, valued for its strength and durability, especially in molar teeth. It consists of about 50% mercury mixed with silver, tin, copper, and zinc. Despite known toxicity concerns, amalgam remains widely used, though the WHO recommended its phase-out in 2007.Both patients and dental professionals face mercury exposure risks from dental amalgam. Acute high-level exposure can lead to neurological problems, severe respiratory complications such as corrosive bronchitis and interstitial pneumonitis.This paper discusses the current knowledge on the exposure, adverse health effects and management of mercury exposure in dental practice.

INTRODUCTION

Mercury has been utilized for centuries in a variety of applications, including medicinal treatments and widespread industrial processes. As a result, it remains a common source of chemical exposure and a notable environmental pollutant. Mercury exists in both organic and inorganic forms. Inorganic mercury refers to mercury that is not combined with carbon. The inorganic form can be further categorized into elemental mercury (commonly known as "quicksilver") and mercury salts. Elemental mercury exposure typically arises from mercury-containing devices like thermometers, while exposure to mercury salts may occur through ingestion of disc batteries or abuse of mercury-containing laxatives.Organic mercury exposure is most often linked to the consumption of contaminated seafood, mercury-based paints, or the use of thimerosal through ingestion or injection.1,2

Dental amalgam is a widely used restorative material made from a combination of metals, primarily mercury, silver, tin, and copper. Dental amalgam restorations, commonly known as silver fillings, have been used in dentistry for centuries. It has been employed in dentistry to treat tooth decay and is valued for its strength and long-lasting performance, particularly in molars where chewing forces are the strongest. Dental amalgam typically contains about 50% mercury by weight, combined with other metals such as silver (Ag), tin (Sn), copper (Cu), and zinc (Zn). Despite well-documented concerns over mercury (Hg) toxicity, dental amalgam continues to be widely used as a restorative material in dentistry. In 2007, the World Health Organization (WHO) recommended phasing out dental amalgam in favor of alternative materials.3,4,5,6

Numerous studies have demonstrated that both patients and dental professionals are at risk of mercury exposure through the use of dental amalgam. Mercury, a heavy metal with distinct physicochemical characteristics, poses significant environmental and health hazards. When amalgam was mixed manually and openly in clinics, the process could lead to substantial mercury vapor emissions, increasing exposure risk. Mercury vapor, released in its elemental form into the air, poses a particular risk. Studies, such as one by Mutter7, have found that mercury vapor is approximately ten times more neurotoxic than lead and exhibits synergistic toxicity when combined with other metals. This is particularly concerning for dental professionals, as around 80% of inhaled mercury vapor is absorbed into the bloodstream. Acute exposure to high concentrations of mercury vapor can result in severe outcomes, including corrosive bronchitis and interstitial pneumonitis8,9,10. The purpose of this paper is to review the current understanding of the potential adverse health effects associated with exposure to mercury (Hg) in dental operatory and its management.

MERCURY EXPOSURE FROM AMALGAM RESTORATIONS

Mercury is widespread in the environment, and humans are commonly exposed to it through air, water, and food sources. In individuals with dental amalgam restorations, mercury exposure can occur primarily during the placement or removal of these fillings. After the amalgam sets, only a minimal amount of mercury is released—well below current health safety standards11. The extent of mercury exposure from amalgam restorations depends on various factors, including the number and size of the restorations, their composition, an individual's chewing habits, the texture of consumed food, teeth grinding (bruxism), brushing behavior, and other physiological variables. When released as a vapor, metallic mercury can be inhaled and efficiently absorbed through the alveoli in the lungs, with an absorption rate of approximately 80%. Inhalation is the main route by which mercury enters the human body. In contrast, absorption through the skin or the gastrointestinal tract is minimal. Organic mercury compounds, such as methylmercury, are readily absorbed by organisms and tend to bioaccumulate as they move through the food chain. Animal studies, including research on monkeys, have shown that mercury released from amalgam restorations can be absorbed and accumulate in various organs, including the kidneys, brain, lungs, liver, gastrointestinal tract, and exocrine glands12. Additionally, organic mercury has been found to cross the placental barrier in pregnant rats and to penetrate the gastrointestinal mucosa when amalgam particles are swallowed during the placement or removal of fillings. In comparison, inorganic mercury ions (Hg^{2+}), although able to enter the bloodstream, have limited ability to cross the blood–brain and placental barriers. Importantly, mercury does not accumulate irreversibly in human tissues. The average biological half-life of mercury in the human body is about 55 days, which is the time it takes for the substance to be transported and excreted. Therefore, mercury that entered the body years ago is unlikely to still be present today.13,14

HEALTH EFFECTS OF MERCURY EXPOSURE

LocalEffects:

Prolonged exposure to mercury from dental amalgam restorations may cause sensitization in certain individuals, increasing their susceptibility to oral lichenoid reactions. Symptoms of an amalgam allergy can include skin rashes around the mouth, head, and neck; itching; swollen lips; and eczema-like lesions within the oral cavity. These manifestations often resolve spontaneously within a few days without intervention. However, in persistent or severe cases, replacing the amalgam restoration with an alternative material may be necessary, which has shown significant symptom improvement. Mercury should not come into direct contact with the skin, as it can be absorbed transdermally. Reports of erythema and elevated urinary mercury excretion have been associated with the cutaneous application of metallic mercury or its salts for antimicrobial, antipsoriatic, or cosmetic purposes.15,16

SystemicEffects:

Studies assessing internal mercury exposure from dental amalgam estimate that individuals absorb approximately 3 µg of mercury per day on average, and up to 7.4 µg per day in cases with extensive amalgam restorations. Amalgam can trigger delayed hypersensitivity reactions in susceptible individuals. Inhalation of elemental mercury vapor may result in acute symptoms such as cough, fever, chills, and dyspnea, along with gastrointestinal complaints like nausea, vomiting, diarrhea, metallic taste, excessive salivation, dysphagia, fatigue, headaches, and visual disturbances17. While ingestion of elemental mercury typically poses minimal risk due to poor absorption in a healthy gastrointestinal tract, individuals with compromised GI mucosa may absorb enough mercury to induce significant irritation.

Unless a gastrointestinal fistula is present, ingested elemental mercury is usually excreted without systemic effects18,19,20.Additional systemic consequences include decreased cellularity in the spleen and lymph nodes, altered organ weights, suppressed delayed-type hypersensitivity reactions, and impaired antibody production. Mercury poisoning is notably harmful to both the nervous and renal systems, with these effects being extensively studied over decades.21,22,23,24

NeurologicalEffects:
Mercury is among the most thoroughly studied environmental neurotoxins, known to impair neural function, cellular structure, and biological processes through various mechanisms. It is especially toxic to the central nervous system, leading to conditions such as cerebellar degeneration observed in both human and animal studies.25,26,27 Clinical signs include ataxia, tremors, and hearing loss. Chronic low-level exposure, in addition to acute toxicity, poses systemic risks. Of particular concern is prenatal and early postnatal exposure, as growing evidence suggests that mercury exposure during this critical developmental window may cause lasting damage to the brain.28,29,30,31,32

RenalEffects:
Mercury-induced renal toxicity typically begins with injury to the proximal tubules, resulting in impaired tubular function and, in severe cases, renal failure with fluid and electrolyte imbalances. Mercury also affects glomerular permeability, vascular resistance, and renal hemodynamics, disrupting normal kidney function. These cumulative effects can significantly compromise renal health, especially with prolonged exposure to organic mercury compounds.33,34,35,36,37,38

MANAGEMENT OF MERCURY POISONING

Immediate considerations and decontamination
Monitoring of vital organ function is essential in the initial management of acute exposure to elemental mercury vapors. Supplemental oxygen, endotracheal intubation, and mechanical ventilation may be necessary. Bronchial lavage should be avoided following pulmonary aspiration, as it can cause mercury particles to spread deeper into the lungs, increasing absorption. Chest X-rays are useful for assessing the extent of mercury dispersion. Notably, smaller mercury droplets are absorbed more rapidly than larger ones.In cases of acute ingestion of inorganic mercury, establishing vascular access for intravenous fluid administration is crucial to prevent shock. Inorganic mercury is highly corrosive and can cause severe tissue injury. Endoscopic evaluation is recommended to assess damage, especially since oropharyngeal edema and upper airway obstruction can occur. To manage airway compromise, intravenous fluid resuscitation along with endotracheal intubation or tracheostomy may be required.39,40

If mercury comes into direct contact with the skin, the affected area should be thoroughly washed with soap and water. For cases involving ingestion of inorganic mercury salts, gastrointestinal decontamination is advised due to their systemic absorption; however, their corrosive nature poses a significant challenge. Despite the risk of gastrointestinal perforation, removing inorganic mercury is beneficial. Whole-bowel irrigation with polyethylene glycol solution can help eliminate residual mercury, and serial abdominal X-rays are necessary for monitoring.41

The use of activated charcoal (AC) in mercury poisoning is debated. While the typical oral dose of AC is 0.5–1 g/kg (up to a maximum of 100 g), its effectiveness in mercury toxicity is uncertain. AC is generally used to bind and eliminate a variety of organic and inorganic toxins, although it is ineffective against substances like hydrocarbons, acids, alkalis, ethanol, and heavy metals. Despite this, there is some belief that AC may bind certain metallic compounds under specific conditions.35,36 Chelating agents such as Penicillamine, Dimercaprol, Meso-2,3-dimercaptosuccinic acid (DMSA, also known as Succimer), and 2,3-dimercapto-1-propane sulfonic acid (DMPS or Unithiol) have been shown to be effective in the treatment of mercury poisoning. Combination therapy using DMSA alongside MiADMSA has demonstrated superior efficacy compared to MiADMSA monotherapy. This combination not only reduces lipid peroxidation but also helps restore catalase activity. Additionally, it allows for a reduced dosage of the chelating agent, enhances clinical recovery, and minimizes potential adverse effects.42,43,43,44,45

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In emergency situations involving high plasma concentrations of mercury or other toxic substances, plasma exchange may be considered as a therapeutic option. It can serve as a potentially beneficial intervention in cases of heavy metal toxicity, including mercury exposure. Hemodialysis is particularly effective for the elimination of water-soluble and dialyzable substances and may be necessary in cases of renal failure.46,47

Certain aquatic plants, including algae, Azolla, and other species, possess the ability to absorb and remove toxic substances from their environment. Chlorella, for example, has been found to facilitate the elimination of mercury from the gastrointestinal tract, muscle tissue, ligaments, connective tissue, and bone. Both Chlorella and cilantro, when consumed as food, may assist in detoxifying neurotoxins such as heavy metals.48,49

Nanotechnology also holds promise in addressing environmental contamination, particularly in reducing water pollution by removing microorganisms, pesticides, insecticides, and heavy metals such as lead, mercury, cadmium, and zinc. Nano-catalysts and nano-filters are capable of purifying wastewater by eliminating toxic contaminants. Among these, carbon nanotubes (CNTs) have shown significant potential for mercury removal. Oxidized CNTs, in particular, offer enhanced adsorption capacity due to increased surface area and improved chemical and electrostatic binding properties.50,51,52,53

CONCLUSION

In summary, while mercury has historically served various industrial and medical purposes, its widespread use—particularly in dental amalgam—remains a significant source of human exposure and environmental contamination. Despite well-documented health risks, amalgam continues to be widely used due to its durability and cost-effectiveness. However, both patients and dental professionals face potential local and systemic health effects from mercury vapor and particulate exposure, with particular concerns for neurological and renal toxicity. Given these risks, understanding the pathways of exposure, the health impacts, and appropriate management strategies is essential.

Reference

1.Bjørklund, G., 1991. Mercury in the dental office. risk evaluation of the occupational environment in dental care (in Norwegian). Tidsskr. Nor. Laege. 111, 948–951.

2. Bittner Jr., A.C., Echeverria, D., Woods, J.S., Aposhian, H.V., Naleway, C., Martin, M.D., Mahurin, R.K., Heyer, N.J., Cianciola, M., 1998. Behavioral effects of low-level exposure to Hg0 among dental professionals: a cross-study evaluation of psychomotor effects. Neurotoxicol. Teratol. 20, 429–439

3. Naleway C, et al. : Urinary mercury levels in US dentists, 1975-1983: reviews of Health assessment Program. J Am DentAssoc 111:37-42, 1985.

4. American Dental Association. Dental Amalgam: Update on safety concerns [Internet]. 2010 [cited 2015 Feb 12]

5.World Health Organization. Future use of material for dental restorations [Internet]. 2012a [cited 2015 Feb 12].

6. World Health Organization. Exposure to mercury: A major public health concern [Internet]. 2012b [cited 2014 Mar 1].

7. Mutter, J. 2011. Is dental amalgam safe for humans? The opinion of the scientific committee of the European Commission. J. Occup. Med. Toxicol. 6(2).

8. Amdur, M.O., J. Doull, and C.D. Klaassen. 1993. Casarett and Doull's Toxicology: The Basic Science of Poisons, 4th ed. New York: McGraw-Hill, Health Professions Division.

9. Mutter, J. 2011. Is dental amalgam safe for humans? The opinion of the scientific committee of the European Commission. J. Occup. Med. Toxicol. 6(2).

10. Schuurs, A.H.B. 1999. Reproductive toxicity of occupational mercury. A review of the literature. J. Dent. 27(4):249–56.

11. Roberson TM, Heymann HO, Swift EJ. Sturdevant's Art and Science of Operative

Dentistry. 5th ed. Missouri: Mosby Inc; 2006. p. 151-64.

12. Hahn LJ, Kloiber R, Leininger RW, Vimy MJ, Lorscheider FL. Whole-body imaging of the distribution of mercury released from dental fillings into monkey tissues. FASEB J 1990;4:3256-60.

13. Takahashi Y, Tsuruta S, Arimoto M, Tanaka H, Yoshida M. Placental transfer of mercury in pregnant rats which received dental amalgam rstorations. Toxicology 2003;185:23-33.

14.Brune D, Gjerdet N, Paulsen G. Gastrointestinal and in vitro release of copper, cadmium, indium, mercury and zinc from conventional and copper-rich amalgams. Scand J Dent Res 1983;91:66-71. 16. Berglund A. Estimation

15. Katzung BG: Basic and Clinical Pharmacology. Lange Medical Publications, California, 2nd edition, p. 607, 732-744, 747, 1982.

16.. Van Titelboom T, et al. : A propos de deux cas d'intoxication a la pommade mercurielle. J Toxicol Clin Exper 5:185-93, 1985.

17.. Kennedy SN, Keogh M, Levin M, Castellini JM, Lian M, Fadely BS, *et al*. Regional variations and relationships among cytokine profiles, white blood cell counts, and blood mercury concentrations in Steller sea lion (*Eumetopias jubatus*) pups. Sci Total Environ. 2021;775:144894

18.Shinoda Y, Akiyama M, Toyama T. Potential association between methylmercury neurotoxicity and inflammation. Biol Pharm Bull. 2023;46(9):1162-8.

19.Jirau-Colón H, González-Parrilla L, Martinez-Jiménez J, Adam W, Jiménez-Velez B. Rethinking the dental amalgam dilemma: an integrated toxicological approach. [Internet]; c2019.

20. Zafar A, Javed S, Akram N, Naqvi SAR. Health risks of mercury. In: Mercury Toxicity Mitigation: Sustainable Nexus Approach. Cham: Springer Nature Switzerland; 2024. p. 67-92.

21. Smart ER, McLead RI, Lawrence CM. Resolution of lichen planus following removal of amalgam restorations in patients with proven allergy to mercury salts: a pilot study. Br Dent J 1995;178:108-12.

22. McCullough MJ, Tyas MJ. Local adverse effects of amalgam restorations. Int Dent J 2008;58:3-9.

23. Forte G, Petrucci F, BoccaB. Metal allergens of growing significance: epidemiology, immunotoxicology, strategies for testing and prevention. Inflamm Allergy Drug Targets 2008;7:145-62. Review.

24. Bains VK, Loomba K, Loomba A, Bains R. Mercury sensitisation: review, relevance and a clinical report. Br Dent J 2008;205:373-8.

25. Moen BE, Hollund BE, Riise T. Neurological symptoms among dental assistants: a cross-sectional study. *J Occup Med Toxicol*. 2008;3:10.

26. Ozuah PO. Mercury poisoning. *Curr Probl Pediatr*. 2000;30:91-99.

27. Holmes P, James K, Levy L. Is low-level environmental mercury exposure of concern to human health? *Sci Total Environ*. 2009;408:171-182.

28. Kern JK, Geier DA, Bj.rklund G, et al. Evidence supporting a link between dental amalgams and chronic illness, fatigue, depression, anxiety, and suicide. *Neuro Endocrinol Lett*. 2014;35:535-552.

29. Mathiesen T, Ellingsen D, Kjuus H. Neuropsychological effects associated with exposure to mercury vapor among former chloralkali workers. *Scand J Work Environ Health*. 1999;25:342-350.

30. Wastensson G, Lamoureux D, S.llsten G, Beuter A, Barreg.rd L. Quantitative tremor assessment in workers with current low exposure to mercury vapor. *Neurotoxicol Teratol*. 2006;28:681-693

31. Andreescu CF. Neurotoxic effects of mercury exposure for dental workers-A literature review. *Evaluation*. 1990;18

32. Siblerud RL, Motl J, Kienholz E. Psychometric evidence that mercury from silver dental fillings may be an etiological factor in depression, excessive anger, and anxiety. *Psychol Rep*. 1994;74:67-80.

Journal of Chemical Health Risks
www.jchr.org
JCHR (2025) 15(4), 820-825 | ISSN:2251-6727

33. Barregard L, Trachtenberg F, McKinlay S. Renal effects of dental amalgam in children: the New England Children's Amalgam Trial; c2007.

34. Agrawal S , Flora G , Bhatnagar P , and Flora SJ 2014 Comparative oxidative stress, metallothionein induction and organ toxicity following chronic exposure to arsenic, lead and mercury in rats. Cell Mol. Biol 60:13–21

35. Bridges CC , Joshee L , van den Heuvel JJ , Russel FG , and Zalups RK 2013 Glutathione status and the renal elimination of inorganic mercury in the Mrp2(−/−) mouse. PLoS One 8: e73559.24039982

36. Bridges CC , Joshee L , van den Heuvel JJ , Russel FG , and Zalups RK 2013 Glutathione status and the renal elimination of inorganic mercury in the Mrp2(−/−) mouse. PLoS One 8: e73559.24039982

37. Burckhardt BC , Drinkuth B , Menzel C , Konig A , Steffgen J , Wright SH , and Burckhardt G 2002 The renal Na(+)-dependent dicarboxylate transporter, NaDC-3, translocates dimethyl- and disulfhydryl-compounds and contributes to renal heavy metal detoxification. J. Am. Soc. Nephrol 13: 2628–2638.12397032

38.Clarkson TW , and Magos L 2006 The toxicology of mercury and its chemical compounds. Crit. Rev. Toxicol 36: 609–662.16973445

39.Brent J, Wallace KL, Burkhart KK, Phillips SD, Donovan JW: Critical care toxicology diagnosis and management of the critically poisoned patient. Philadelphia: ElesevierMosby; 2005.

40. Bates N: Metallic and inorganic mercury poisoning. Emerg Nurse 2003, 11:25–31.

41. Nelson LS, Lewin NA, Howland MA, Hoffman RS, Goldfrank LR, Flomenbaum NE: Goldfrank's toxicologic emergencies. New York: McGrawHill; 2011.

42. 69. Lapus RM: Activated charcoal for pediatric poisonings: the universal antidote. Curr Opin Pediatr 2007, 19:216–222.

43. Mohammad-Khah A, Ansari R: Activated charcoal; preparation, characterization and applications: a review article. Int J Chem Tech Res 2009, 1:2745–2788.

44. Katzung BG, Masters SB, Trevor AJ: Basic and clinical pharmacology. McGrawHill: NewYork; 2009.

45. Yusef M, Neal R, Aykin N, Ercal N: High performance liquid chromatography analysis of D-penicillamine by derivatization with N-(1-pyrenyl) maleimide(NPM). Biomed Chromatogr 2000, 14:535–540.

46. Graeme KA, Pollack CV: Heavy metal toxicity, part I: arsenic and mercury. J Emerg Med 1998, 16:45–56.

47.Rooney JPK: The role of thiols, dithiols, nutritional factors and interacting ligands in the toxicology of mercury. Toxicology 2007, 234:145–156.

48. Forman J, Moline J, Cernichiari E, Sayegh S, Torres C, Landrigan MM, Hudson J, Adel HN, Landrigan PJ: A cluster of pediatric metallic mercury exposure cases treated with meso-2,3-dimercaptosuccinic acid (DMSA). Environ Health Perspect 2000, 108:575–577.

49. Nenov VD, Marinov P, Sabeva J, Nenov DS: Current application of plasmapheresis in clinical toxicology. Nephrol Dial Transplant 2003,18:v56–v58.

50. Dargan PI, Giles LJ, Wallace CI, Thomson AH, Beale RJ, Jones AL: Case report: severe mercuric sulphate poisoning treated with 2,3-dimercatopropane-1-sulphonate and haemodiafiltration. Crit Care 2003, 7:R1–R6.

51. Xue HB, Stumm W, Sigg L: The binding of heavy metals to algal surfaces. Water Res 1988, 22:917.

52 . Sachdeva S, Sharma A: Azolla: role in phytoremediation of heavy metals. Int J Eng Sci 2012, 1:2277–9698.

53. Qu X, Alvarez PJJ, Li Q: Applications of nanotechnology in water and wastewater treatment. Water Res 2013, 47:3931–3946.