International Journal of Psychosocial Rehabilitation, Vol. 24, Issue 01, 2020
ISSN: 1475-7192

Amalgam Tattoo - A Review

[1]P. Kuzhalvaimozhi, [2]Delphine Priscilla Antony, *[3]Dhanraj Ganapathy

ABSTRACT:

Amalgam is one of the most versatile materials used in dentistry and used as a restorative materials for past 150 years.Amalgam has various constituents such as silver,tin,zinc and mercury-a toxic constituent.It produces harmful effects in the body,by passing through cell membrane,cross blood brain barrier and enters central nervous system and cause immunological and psychological problems.Amalgam tattoo results from inadvertent deposition of amalgam within oral mucosa and alveolar bone during dental procedures. Overtime ,metallic particles from dental amalgam leach into soft tissue causing discolouration.

KEYWORDS*: Amalgam,tattoo,discoloration*

I. INTRODUCTION

Amalgam is an excellent and versatile restorative materials used in dentistry since 150 years because of its durability, bacteriostatic effects, low cost, ease of application, and strength. It contributes to almost 75% of all restorative materials used by the dentist. When aesthetics is not a concern it can be used in individuals in all ages, poor oral hygiene conditions and also in stress bearing areas.(1). Amalgam has been suggested as a filling material since 1819 by Bell, an English chemist. It is widely used because of its strong nature and they provide a durable chewing surface. Popularity of amalgam is decreasing nowadays due to aesthetics, health effects and environmental pollution.(2). It is due to the concern raised by both doctors and patients about the adverse effects that follow amalgam restoration.(1). Mercury present in the amalgam have high volatility and galvanic action, has been found to continuously vaporise and release into the body, and people with amalgam are seen to have high contents of mercury in their body.(3,4). The high content in amalgam leads to various conditions such as mercury toxicity, gingivitis, bone loss, mouth sores, oral lesions, pain and discomfort, burning mouth, sore throat, chronic inflammatory response (5).

[1]*Undergraduate Student, Department of Prosthodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical And Technical Sciences, Saveetha University, Chennai, India.*
[2]*Department of Conservative Dentistry, Saveetha Dental College and Hospitals, Saveetha Institute of Medical And Technical Sciences, Chennai – 600077 Tamil Nadu, India.*
[3]*Professor and Head Department of Prosthodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical And Technical Sciences, Chennai – 600077 Tamil Nadu, India.*

II. HISTORY

Dental amalgam was first used by the Chinese.Su Kung in Material Medica.(6). In 1528, Johannes stokers recommended amalgam as a filling material(7). In 1578, Li Shihchen recommended a dental mixture of 100 parts mercury with 45 parts silver and 900 parts tin(6).

In 1826, Traveau described a " silver paste filling material" and produced amalgam (8). In 1833, Crawcours brothers filled the tooth cavity by removing the diseased tissue in the tooth and placed amalgam on occlusal surface without knowing any relation to dental anatomy, and this created "Amalgam War" in 1845 and this was considered as a malpractice(6). In 1877, New departure creed and its leader J. Foster Flagg managed to change this attitude towards amalgam by publishing the results of his laboratory test and 5-year clinical observation of new alloys with 60% of silver and 40% of tin in 1881.(9,10). The amalgam was universally accepted as a restorative material resulted from the investigations of Black in 1895,1896,1908 by combining the principles of cavity design, extension of cavity into immune areas and the development of an alloy with the composition of 68.5% silver, 22.5% tin,5% gold,1% zinc, so Black advanced amalgam into modern times.(11,12). In 1937, Gayler performed extensive studies of setting reactions of dental amalgam and the influence of amalgam components on expansion due to formation of gamma-1 phase (Ag-Hg) and contraction due to formation of gamma-2 phase(Sn-Hg).(13). In 1959, Dr. Wilmer Eames (14) promoted low mercury to alloy mixing ratio. The mercury to amalgam ratio, dropped from 8.5 to 1.1. In 1963, the formula was again changed that high copper dispersion alloy was introduced.(15). In 1979, Greener claimed that there is misinterpretation of Gayler said that, if Cu was substituted for tin concentration of tin dropped below 25% expansion could occur, but if Cu was substituted for silver so that tin concentration was maintained at 27% , no excess expansion occurred and this resulted in 25-30 year delay in the development of amalgam resistant to corrosion(16).

III. COMPOSITION

The composition of amalgam alloy is Silver 40-70%, tin 12-30% and copper 12-24% and also include indium 0.4% , Zinc 1%, and palladium 0.5% (17,18,19,20). Silver is used to increase the strength of the alloy and also for expansion. Tin lengthens the setting time. Copper increase the strength, reduces corrosion, and creep and therefore reduces marginal deterioration. Zinc is added to prevent the oxidation of other metals and it is also helps to keep the alloy from turning dark(21). Some researchers believed that zinc containing amalgam is contaminated with moisture, it cause delayed expansion(22,23).

Dental amalgam are of two types, and they are low copper and high copper amalgam. High copper amalgam has high strength, less corrosion, and tarnish and less creep compared to loos copper, and also has less chance of marginal failure(21).

Modern amalgam are produced from pre proportional or pre capsulated alloy consisting of 42-45% mercury by weight. These are convenient to use and provide some assurance that amalgam has not been contaminated(24).

IV. TOXICITY OF DENTAL AMALGAM

When amalgam was first introduced, many dentists were concerned about inserting a highly toxic metal into a patients mouth and this controversy was termed as “First amalgam war”. Their concerns were quietened later when mercury was said to be safe to use as it stabilizes in the hardened amalgam and didn’t come out. Since it was not expensive and are frequently used. The controversy surfaced again in 1926 when a German physician showed that mercury escaped from the filling in the form of dangerous vapour and this was called “Second amalgam war”. The third amalgam war initiated when they found out that mercury vapour escapes from the filling and into the patients mouth, making its use unethical**.**(5). Exposure to mercury in human individuals with amalgam restoration occurs during the placement or removal of dental restorations. Once the reaction is complete, less amount of mercury is released, that is far below the current health standard. Exposure to mercury from restoration depends on the number and size of restoration, composition, chewing habits, food texture, grinding, brushing of teeth, and many other physiological factors. As a vapour, metallic mercury could be inhaled and absorbed through the alveoli in the lungs at 80% efficiency. It is the main route of entry of mercury into the human body, whereas the absorption of metallic mercury through skin or via the gastrointestinal tract is very poor.Mercury does not collect irreversibly in human tissues. The average half life of mercury is 55 days for transport through the body to the point of excretion. Thus mercury that came into the body years ago may no longer be present in the body(24). Vapours of mercury are released during insertion, condensation and the carving of amalgam. It can also be released during further processing and removal. The amount of mercury in the restoration can be reduced by about 6-10% by good condensation(5). Toxicity from mercury could occur through exposure to organic, inorganic, and elemental forms of mercury. According to decreasing toxicity of mercury it is classified as organomercury (methyl and ethyl mercury), mercury vapour, and inorganic mercury. Various diagnostic methods exist to detect the level of mercury in body, including tests for blood, urine, stool, saliva, hair analysis, and others. These tests may determine if mercury is in the body and/or if it is being excreted. A study(25) conducted by measuring the intraoral vapour levels over a 24-hour period in patients with at least nine amalgam restorations showed that the average daily dose of inhaled mercury vapour was 1.7 μg (range from 0.4 to 4.4 μg), which is approximately 1% of the threshold limit value of 300 to 500 μg/day established by WHO, based on a maximum allowable environmental level of 50 μg/day in the workplace. According to Berdouses *et al*. mercury exposure from amalgam can be greatly increased by personal habits such as, chewing and brushing. Berglund et al in 1993, determined the daily release of mercury vapour from amalgam restorations made of alloys of the same types and batches as those used in the *in vitro* part of the study.(26).He carried out a series of measurements on each of eight subjects before and after amalgam therapy and found that none of the subjects were occupationally exposed to mercury. The amalgam therapy, that is, from 3 to 6 occlusal amalgam surfaces and from 3 to 10 surfaces in total-had very little influence on the intraoral release of mercury vapour, regardless of amalgam type used, effects was not found on mercury levels in urine and saliva(25).

V. HEALTH EFFECTS IN ADULTS DUE TO MERCURY EXPOSURE

An investigation on 20,000 people in the New Zealand Defence Force between years 1977–1997 was done to find out association between amalgam restorations and disorders related with nervous system and

kidney. No significant correlation between amalgam restorations and chronic fatigue syndrome or kidney disease was observed. A slightly elevated risk for multiple sclerosis was reported, but may have been due to confounding variables.(27). In another study, where few patients believed that their amalgam restoration made them ill, medical examination including physical examination, electrocardiogram, abdominal sonography, and blood chemistry was done. The study concluded that symptoms of the patients were due to psychological factors. There was no connection between the mercury levels in the patient's blood, urine, and saliva and their symptoms.(28).The association between amalgam and multiple sclerosis was assessed via a systematic review and meta-analysis. Three case control studies and one cohort study met their inclusion criteria. The meta-analysis revealed a slight nonstatistically significant increase between the presence of amalgam restorations and multiple sclerosis. The study does not provide evidence for or against an association.(29).Halbach *et al* evaluated the internal exposure to amalgam-related mercury and estimated the amalgam-related absorbed dose of mercury. The integrated mercury absorbed from amalgam restorations was estimated at up to 3 μg per day for an average number of restorations and 7.4 μg per day for a high amalgam load. The authors concluded that these estimates are below the tolerable dose of 30 μg per day established by WHO(30).

VI. HYPERSENSITIVITY REACTIONS

Amalgam is capable of producing delayed hypersensitivity reactions in some individuals. These reactions usually present with dermatological or oral symptoms. The constant exposure to mercury in amalgam restorations may sensitize some individuals, making them more susceptible to oral lichenoid lesions. These oral lesions are rarely noticed by the affected individuals and cause no discomfort. There is evidence that a certain percentage of lichenoid lesions are caused by amalgam restorations, but other restorative materials can also cause lichenoid lesions.(31).It was also noted that the restorations associated with lichenoid lesions are poorly contoured, corroded and old. Hence corrosion of amalgam restoration or perhaps the biofilm present on such restorations may contribute to the development of hypersensitive reaction rather than material itself.(32). Symptoms of an amalgam allergy include skin rashes in the oral, head and neck area, itching, swollen lips, localized eczema-like lesions in the oral cavity. These clinical signs usually require no treatment and will disappear on their own within a few days of exposure. However, in some instances, an amalgam restoration will have to be removed and replaced with alternate restorative material. The replacements have led to significant improvements.(33). Although mercury allergy is rare but sometimes hypersensitivity to it may lead to dermatitis or type IV delayed hypersensitivity reactions most often affecting the skin as a rash(34).

VII. AMALGAM TATTOO

Amalgam tattoo is an unintended sequela of dental treatment. Amalgam tattoo results from inadvertent deposition of dental amalgam within the oral mucosa or alveolar bone during dental procedures. Over time, metallic particles from dental amalgam leach into the soft tissue, causing discolouration.

Clinically, amalgam tattoos appear as blue-black or blue-gray asymptomatic pigmentation, most commonly involving the gingival surfaces. Radiographically, they appear as radiopaque particles at the site of the lesion, but in many cases these particles are too small or too diffuse to be identified. Microscopic examination reveals dark solid fragments or numerous fine granules dispersed along collagen bundles and around blood vessels, frequently surrounded by inflammatory infiltrate.(35,36,37).Amalgam tattoos are lesions that are caused by traumatic implantation of dental amalgam into soft tissue. It is the most common localized pigmented lesion in the mouth. Amalgam debris are able to enable immunological adaptive reactions where tissue reaction to amalgam tattoo depends on the amalgam particles size and composition. The residual elements of amalgam tattoo develop noxious effects where the mercury passes from the tissue fluid into the blood stream and accumulates in the kidneys. Amalgam particles can get embedded into the soft tissues of the mouth accidentally, most commonly in the gingiva, during amalgam removal(5). This is also another way in which amalgam tattoos are formed. Amalgam tattoos often do not require treatment, as the mercury present in dental amalgam is not in a free state and does not pose a health hazard. However, amalgam tattoos in an esthetic region can be of cosmetic concern, especially for patients with a high smile line. Various techniques have been described to treat amalgam tattoos depending on their size, location and complexity.The management of large lesions is challenging when there is limited availability of donor tissue. This deficiency could be overcome by utilising allografts such as acellular dermal matrix. The incidence of amalgam tattoo has been reported to be around 8% in previously surveyed samples .Amalgam tattoos can be of esthetic concern, especially when located in the maxillary anterior region. Various techniques have been described for the management of amalgam tattoos depending on their size, location and complexity(38,39,40). Small superficial lesions can be removed using rotary instruments (round or diamond bur) in the form of a localized gingivoplasty. However, large lesions require advanced management. Kissel and Hanratty described a two-stage surgical treatment in which a connective tissue graft was placed deep to the pigmented area followed by gingivoplasty of the overlying tissue (41). Although this technique results in a favourable outcome with minimal scarring and good color match, the limitation in availability of donor tissue can be disadvantageous. Shiloah et al. utilised an epithelialized free soft tissue graft to treat amalgam tattoos.(40). The epithelialized free soft tissue graft was placed over the curetted bone in the maxillary anterior region; however, this technique has a significant risk for scarring and poor color match. Furthermore, Griffin et al. utilized acellular dermal matrix as an onlay graft over the completely excised amalgam tattoo (38). In this study, the full thickness of the soft tissue outlining the amalgam tattoo was excised before the acellular dermal matrix was placed over the surgical site. The authors suggest that acellular dermal matrix is a viable option in treating large amalgam tattoos, which are otherwise very difficult to treat with autogenous grafts. However, previous studies have reported that uncovered acellular dermal matrix may not increase the zone of keratinized tissue as predictably as an autologous soft tissue graft, which is of importance in the esthetic zone (41) Shah et al. utilized an alexandrite laser to remove amalgam tattoo on the buccal mucosa and gingiva over the course of three treatments at 8-week intervals (39). Mercury released into the oral cavity by laser ablation may elicit an intense inflammatory response and may also play a role in triggering oral neuropathy and lichen planus (42,43,44) Furthermore, when ablating relatively thin soft tissues (e.g., facial gingival and alveolar

mucosa) using lasers without irrigation, there is an apparent risk of irreversible bone damage due to the excessive heat generated by lasers. A two-stage surgical approach can be used to remove amalgam tattoos, beginning with a subepithelial connective tissue graft and acellular dermal matrix to increase tissue thickness and allow removal of amalgam fragments in bone, followed by gingivoplasty of the surface tissue. In conclusion, clinicians need to be aware of various treatment strategies for amalgam tattoos in esthetic zones that result in esthetically appealing outcomes(40).

REFERENCES

1. Berry TG, Summit JB, Chung AK, Osborne JW. Amalgam at the new millennium. J Am Dent Assoc. 1998;129:1547–56.

2. Dunne SM, Grainsford ID, Wilson NH. Current materials and techniques for direct restorations in posterior teeth. Part 1: Silver amalgam. Int Dent J. 1997;47:123–36.

3.Rathore, M., A. Singh, and V.A. Pant, The dental amalgam toxicity fear: a myth or actuality. Toxicology international, 2012. 19(2): p. 81.

4.Roberts, H. and D. Charlton, The release of mercury from amalgam restorations and its health effects: a review. Operative dentistry, 2009. 34(5): p. 605-614.

5.Reshma HK, Manish Ranjan, Consequences of Amalgam restoration on soft tissues of the oral cavity. Int J Of Scie and res.2017;6:1916-1919.

6.Ring ME. An illustrated history. New York: Harry N Abrams, Inc.; 1985. Dentistry.

7.Hoffmann-Axthelm W. History of dentistry. In: Koehler HM, editor. translator.Chicago: Quintessence; 1981. pp. 43–156.

8.Campbell JM. Glasgow: Bell and Bain; 1981. Dentistry then and now; pp. 265–6

9.Amos Westcott. Metallic pastes for filling teeth. Am J Dent Sc. 1844;4:211.

10.Evans TW, Messrs . Vol. 3. Paris: White and Co., Dent Newsletter; 1849. Experimenting with cadmium in the tin mixture: Preserve the color better and absorbed the mercury; p. 9.

11.Black GV. An investigation of the physical characters of the human teeth in relation to their disease, and to practical dental operations, together with physical charecters of filling materials. The Dental Cosmos. 1895;37:553–61. 637-61.

12.Black GV. The physical properties of the silver-tin amalgams. Dental Cosmos. 1896;38:965–92.

13.Gayler ML. Dental amalgams. J Inst Metals. 1937;60:407–19.

14.Eames WB. Preparation and condensation of amalgam with a low mercuryalloy ratio. J Am Dent Assoc. 1959;58:78–83.

15.Innes DB, Youdelis WV. Dispersion strengthened amalgam. J Can Dent Assoc. 1963;29:587–93.

16.Greener EH. Amalgam-yesterday, today and tomorrow. Oper Dent. 1979;4:24–35.

17.Osborne JW, Norman RD. 13-year clinical assessment of 10 amalgam alloys. Dent Mater. 1990;6:189–94.

18.Letzel H, van't Hof MA, Marshall GW, Marshall SJ. The influence of the amalgam alloy on the survival of amalgam restorations: A secondary analysis of multiple controlled clinical trials. J Dent Res. 1997;76:1787–98.

19.Berry TG, Osborne JW. Effect of zinc in two non-gamma-2 amalgam systems. Dent Mater. 1985;1:98–100.

20.Osborne JW, Berry TG. Zinc-containing high copper amalgams: A 3-year clinical evaluation. Am J Dent. 1992;5:43–5.

21.Hatton, J.F., B.S. Ber, and G.P. Stewart, Dental repair material. 2013, Google Patents.

22..Yamada T, Fusayama T. Effect of moisture contamination on high copper amalgam. J Dent Res. 1981;60:716–23.

23.Osborne JW, Howell ML. Effects of water contamination on certain properties of high copper amalgams. Am J Dent. 1994;7:337–41.

24.Roberson TM, Heymann HO, Swift EJ. Sturdevant's Art and Science of Operative Dentistry. 5th ed. Missouri: Mosby Inc; 2006. pp. 151–64.

25.Berglund A. Estimation by a 24-hour study of the daily dose of intra-oral mercury vapour inhaled after release from dental amalgam. J Dent Res. 1990;69:1646–51.

26.Berdouses E, Vaidyanathan TK, Dastane A, Weisel C, Houpt M, Shey Z. Mercury release from dental amalgams: an in vitro study under controlled chewing and brushing in an artificial mouth. J Dent Res. 1995;74:1185–93.

27.Bates MN, Fawcett J, Garrett N, Cutress T, Kjellstrom T. Health effects of dental amalgam exposure: a retrospective cohort study. Int J Epidemiol. 2004;33:894–902.

28.Bailer J, Rist F, Rudolf A, Staehle HJ, Eickholz P, Triebig G, et al. Adverse health effects related to mercury exposure from dental amalgam fillings: toxicological or psychological causes? Psychol Med. 2001;31:255–63.

29. Aminzadeh KK, Etminan M. Dental amalgam and multiple sclerosis: a systematic review and meta-analysis. J Public Health Dent. 2007;67:64–6.

30.Halbach S, Vogt S, Köhler W, Felgenhauer N, Welzl G, Kremers L, et al. Blood and urine mercury levels in adult amalgam patients of a randomized controlled trial: interaction of Hg species in erythrocytes. Environ Res. 2008;107:69–78.

31.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.

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

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

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

35.Buchner A and Hansen LS. Amalgam pigmentation (amalgam tattoo) of the oral mucosa. A clinicopathologic study of 268 cases. Oral Surgery, Oral Medicine and Oral Pathology 1980; 49:139-147.

36.Harrison JD, Rowley PS and Peters PD. Amalgam tattoos: light and electron microscopy and electronprobe micro-analysis. The Journal of Pathology 1977; 121:83-92.

37.Neville BW, Damm DD, Allen CM and Bouquot JE. Oral and Maxillofacial Pathology. W.B. Saunders Company, 2008.

38.Griffin TJ, Banjar SA and Cheung WS. Reconstructive surgical management of an amalgam tattoo using an acellular dermal matrix graft: case reports. Compendium of Continuing Education in Dentistry 2005; 26:853-854, 856-859; quiz 860-861.

39.Shah G and Alster TS. Treatment of an amalgam tattoo with a Q-switched alexandrite (755 nm) laser. Dermatologic Surgery 2002; 28:1180-1181.

40.Shiloah J, Covington JS, and Schuman NJ. Reconstructive mucogingival surgery: the management of amalgam tattoo. Quintessence International 1988; 19:489-492.

41.Harris RJ. Gingival augmentation with an acellular dermal matrix: human histologic evaluation of a case--placement of the graft on periosteum. The International Journal of Periodontics & Restorative Dentistry 2004; 24:378-385.

42.Campbell CM and Deas DE. Removal of an amalgam tattoo using a subepithelial connective tissue graft and laser deepithelialization. Journal of Periodontology 2009; 80:860-864.

43;Donetti E, Bedoni M, Guzzi G, Pigatto P and Sforza C. Burning mouth syndrome possibly linked with an amalgam tattoo: clinical and ultrastructural evidence. European Journal of Dermatology 2008; 18:723-724.

44.Forsell M, Larsson B, Ljungqvist A, Carlmark B and Johansson O. Mercury content in amalgam tattoos of human oral mucosa and its relation to local tissue reactions. European Journal of Oral Sciences 1998; 106:582-587.