

Historical Development and Current Challenges of Dental Amalgam

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Abstract

Background: Dental amalgam has been through the years a material of dental restoration very used and controversial.

Objective: To carry out a literature review on the historical development of dental amalgam and identify measures to solve its harmful effects.

Material and Method: A literature review was conducted in January 2018. 17 impact journals and 10 specialized websites were examined. The MEDLINE, Ebsco, PubMed, Scielo databases were consulted using the descriptors: "dental amalgam", "dental material". Articles in English and Spanish were included, preferably from the last 5 years. 40 articles were obtained. The study was circumscribed to 23 bibliographical references.

Analysis and Integration of Information: Professionals and health organizations, throughout history, have been advocates and detractors of dental amalgam. At present its use in dentistry is not excluded, but its gradual replacement by alternative restorative materials is supported.

Conclusions: There are divided criteria on the use of amalgam as a restorative material. The global tendency to gradually replace the amalgam is increasing, representing a challenge for this material, staying in the preference of dentists. Measures are implemented at a global level to solve the harmful effects of mercury on human health.

Keywords: *Dental Amalgam; Dental Material; Mercury*

Introduction

Dental amalgam has been over the years one of the most used and most controversial dental restoration materials. Undoubtedly, it has been the subject of discussion, criticism, praise and research among scientists, professionals and patients. So what makes this grayish material, formed by a mixture of metals among which stand out silver, mercury, zinc or copper, unsightly for many but at the same time with unparalleled strength and durability, so controversial and contradictory? When making an analysis of the main criteria that have been handled over the years, you can see a differentiation in terms of the guidelines that have governed the use or not of dental amalgam as a definitive material in dentistry, leading to professionals and international organizations in the field of general health and dentistry, to make decisions about this material, establishing themselves as detractors or defenders of the product. That is why the present study intends to carry out a literature review on the historical development of dental amalgam and identify measures to solve its harmful effects.

Material and Method

A literature review was conducted in January 2018. 17 impact journals and 10 specialized websites were examined. In the search, articles published in the last 5 years were prioritized. The databases MEDLINE, Ebsco, PubMed, Scielo were consulted using the descriptors: "dental amalgam", "dental material" and their counterparts in Spanish. Articles were included in both English and Spanish. They were

obtained 40 articles that were selected with the purpose of conserving only those that best described the elements of the review. In this way, the study was limited to 23 bibliographical references.

Analysis and integration of information

Historical Recount

The amalgam is a gray metallic alloy composed of liquid mercury (50%), which after years of research remains the only element that can bind the other components [1]: silver (35%), copper (2%), tin (13%) and sometimes zinc [2,3].

To recognize some of the first reports we have of the appearance of amalgam as a material for dental restoration, we have to go back to the beginning of the 19th century, specifically to 1826, when, coming from the Parisian city, Mr. M. Tareau, offered a silver paste as permanent restoration in dentistry, which had the particularity of being formed by silver filing, obtained at that time from coins, and mercury, both components that were mixed without actually forming a true alloy. The only apparent problem with this material was that once placed, in many cases the dental tissue fractured easily, so most of the dentists of the time decided to ignore the amalgam and continued using gold in folio and other materials [4,5].

However, this position was not adopted by the Londoners who continued with its implementation, and even moved the good news to New York in 1836, carrying out large campaigns to promote the new material, cheaper than gold, widely used at that time. But the American dentists, about 400, were not convinced by the amalgam, so much so that in 1840 Dr. CA Harris created the American Society of Dental Surgeon, predecessor institution of the current American Dental Association, which banned its use in all dentistry consultations. In spite of this prohibition, many dental professionals saw in the amalgam a possibility of giving the less favored layers of society an opportunity for attention, so in 1855 the American Society of Dental Surgeons finally lifted the prohibition [4,6].

The years after the second decade of the twentieth century represented a boom in the use of amalgam as a permanent material in dentistry, beginning in the 1870s the so-called amalgam boom, sponsored by Dr. JF Flagg, until 1916, with the presentation, on the part of Dr. GV Black, of the modification of the principles of form, resistance and retention of the dental cavities restored with amalgam; principles that are still taught today [4,6].

But in 1926 with the report of Dr. Alfred Stock of the Kaiser Wilhem Institute of chemistry in Germany, a war against amalgam would be unleashed. In said report, Dr. Stock described his personal experience with the material, identifying these restorations as emitters of mercurial vapors, this being the genesis of the largest controversy surrounding dental amalgam that has its validity in our days [4,6].

This controversy increased with the development of alternative restoration materials that had as a fundamental characteristic that they were more aesthetic, simulating the tone of natural teeth; This journey began in the early twentieth century with the appearance of silicates that had the disadvantage of the wear suffered shortly after being placed. At the end of the 40's, polymethylmethacrylate acrylic resins, which were insoluble to oral fluids, easy to maneuver and of low cost, but with a low resistance to wear and shrinkage of very high polymerization, and therefore much marginal filtration [7].

The era of modern resins emerged from the 60's with the appearance of the particulate resins; In the mid-70s' small particle resins emerged and at the end of the same decade the microparticles appeared. At the end of the 80 'the hybrid compounds (autocuradas) arise, and at the end of the 90' the fluid and condensable resins. At the beginning of the 21st century, microhybrid compounds began to be used, and throughout these years new materials have been developed up to the most recent, the nanohybrid (light-cured) resins, which have come to stay [7,8].

With several decades of confluence of these two variants of dental materials fundamentally, has posed a real challenge for amalgam, the ability to stay among the priorities of use, seeing how other materials such as resins have evolved to become the primary options for many dentists.

Controversy over the use or not of dental amalgam

The literature addresses the issue of the risks of the implementation of dental amalgam as a final restorative material in a very broad way, multiple criteria of specialists are noted and of course important organizations within the health field have been participants in the debate, issuing their official opinions on the subject.

At the end of the 1990s, the World Health Organization held a Consensus Statement on the use of Dental Amalgam, also approved by the General Assembly of the International Dental Federation in September 1997 in Seoul, Korea [9], where, in the first place, the importance of the successful use of amalgam as a dental restoration material for more than a century was recognized, it was also suggested that these restorations were harmless, that in some cases they caused allergic reactions, and that the small amounts of mercury released these restorations, especially in their placement and removal, did not represent any danger to health. Finalizing this statement with a conclusive conclusion: "... The weight of current evidence is that contemporary dental restorative materials, including dental amalgam, are safe and effective. There are occasions, however, in which adverse biological reactions occur to the materials and they must be treated individually. WHO recognizes that it is very important to continue to monitor the safety and effectiveness of all dental restorative materials" [9].

In news published on January 19, 2013 on the official website of the World Health Organization, the positive reception was expressed by this organization and others such as the International Dental Federation and the American Dental Association, of the international agreement (Convention of Minamata) [10] on mercury signed in Geneva, Switzerland, and put into effect on August 18, 2017. This treaty establishes a series of protection measures designed, in general, to eliminate mercury emissions at the environment, for example, coal-fired power plants, or the use of mercury in artisanal gold mines, which according to the document are the main sources of mercury emissions into the environment [11,12].

Of course, in this international agreement, there is an article aimed at eliminating the risks of mercury in the health sector. Specifically, the gradual elimination of the use of mercury in instruments used in medical care such as thermometers, arterial measuring instruments and dental amalgam is proposed, measures firmly supported by the WHO [12,13].

The world organization itself in a report published on its official website, reveals that a group of experts organized by the WHO, assured in 2009 that the short-term global ban of the use of amalgam would constitute a public health problem and for the dentistry sector, therefore, it was necessary that this substitution be carried out gradually, promoting the prevention and development of research to obtain favorable material alternatives [14].

On August 26, 2014, the European Commission and the Scientific Committee on Emerging and Recently Identified Health Risks for Health, published a report entitled "The safety of dental amalgam and alternative restorative materials for patients and users", after reviewing a total of 102 investigations on the subject, facilitated by industrial associations, universities, professional organizations, national authorities and non-governmental organizations, with the aim of evaluating the efficacy and safety of dental amalgam and other alternative materials such as resins, cement glass ionomer, ceramics and gold alloys, according to the latest scientific data, and in whose document professionals from Swedish, Dutch, German, Danish, Norwegian, Swiss and French universities worked [15,16].

In 2008, this committee noted that amalgam as a definitive restorative material was safe, this being one of the main updates of the new document, since the most recent one states that the use of this dental material should be governed by the particular characteristics of each patient, recommending its non-use for the care of children and pregnant women, which as it is known are prioritized population groups and monitored for the importance that these stages of development reverse, being the fetal stage the most vulnerable. It is important to highlight that the document highlights dental amalgam as an effective material, in addition it recognizes that the systemic effects of mercury are well documented; in general, it acts on the skin, eyes, nervous system, kidneys, lungs, etc. [14] however, the evidence that these systemic alterations are a product of the amalgam is weak, according to the committee; including that alterations that occur in the oral cavity that may be related to this restorative material, such as allergic reactions or associations with the appearance of lichenoid lesions, have an incidence lower than 0.3% [5].

Regarding the dental health personnel, he argues that he probably suffers the greatest exposure to mercury, however, investigations suggest that they do not reflect adverse effects that can be attributed to said exposure, and he also recognizes that these mercurial exposures of professionals and patients can be decreased by the implementation of appropriate clinical techniques [15].

The document also evaluates in general terms alternative materials, stating that they also have clinical limitations and toxicological risks. For example, they contain a wide variety of organic substances that chemically react within the tooth cavity and in the vicinity of oral tissues during placement (release of bisphenol (BPA)). Some of the monomers used as alternative materials are cytotoxic for in vitro and mutagenic pulpal and gingival cells and cause allergic reactions [15].

Finally, this committee concluded that the use of amalgam as a restorative material is not currently excluded, but it did recognize the need to continue researching and developing new alternative materials with a high degree of biocompatibility [15].

Paradoxically with what is stated in these documents, with respect to the need for the gradual reduction of the use of amalgam, data obtained suggest that a total of one billion amalgam restorations are placed annually in the world [1]. Many countries in the world continue producing this material, among which stand out China, the United States, Colombia, Italy and many others continue to implement its use among those that highlight countries in Africa, Eastern Europe and Latin America [16].

Knowing that in 2017 the agreements approved by the WHO proposed in the Minamata Agreement were put into practice, in coming years the new generations of alternative materials to the amalgam will reach their full prominence, but until then we must implement measures that help to solve the harmful effects of mercury on human health.

Measures to reduce the harmful effects of dental amalgam

At a global level, many countries have adopted public health measures regarding dental amalgam. For example, in Nigeria, the government has launched a publicity campaign on the characteristics of this type of restoration [17], in Canada and Germany it is recommended to avoid the placement and removal of amalgam during pregnancy and patients with kidney problems, and specifically in the country, specifically in Germany, its use in children is prohibited. Other nations such as France, Finland and Austria advocate the use of alternative materials for the treatment of pregnant women, examples such as Norway, Denmark and Sweden have banned their use since 2008 [18]. The European Union, recently announced its decision to ban, from July of 2018, the use of dental amalgam in patients under 15 years of age, infants and pregnant women [17].

Possible alternatives for rapid resolution are being developed that contribute to the non-use of amalgam in at-risk patients, such as children, pregnant women, infants, etc., such as the distribution of material with labels that highlight non-use in these population sectors, or the call for public computerization on the possible adverse effects of dental amalgam [17].

In addition, advances have been observed in recent years such as: the use of pre-encapsulated alloy and mercury and the use of so-called amalgamators to mix different components [18], which has been replacing the traditional mortar for manual use, which increases the risk of suffering from mercury poisoning.

Currently, various environmentally friendly procedures are used to remove mercury from dental amalgams. An example of this is the companies that collect remains of amalgams to recycle them; others use mechanisms such as separation by sedimentation, electrolysis, centrifugation, filtration, etc., to achieve optimal waste management.

In Cuba it is estimated that a total of 7 million dental restorations are placed annually, of which 75% correspond to amalgams. However, the National Department of Dentistry of the Ministry of Public Health of Cuba, intentionally, and foreseeing the gradual decrease in the use of this material, increases every year the amount of self-healing and light-curing resins in the dental services of the country.

In our country, aware of the importance of protecting patients, health personnel and the environment from exposure to mercury vapors, measures have been taken regarding the deposition of waste and the handling of waste. dental amalgam in dental surgeries [19]. For example:

- Conservation of dental amalgam in sealed containers.
- Preservation of amalgam leftovers in bottles or covered containers, always adding a water seal.
- Deposit of the mixture and the capsule, when it is not confirmed by the amalgamator, in a container intended for this purpose.
- When cleaning the filter of the spittoons of the dental units, the residues containing amalgam should be deposited in the bottles with lid and water seal.
- It is established, perform all the health personnel who are in contact with this material, periodic check-ups.
- There is a National Commission in the Ministry of Public Health of Cuba, which includes, among others, the National Department of Dentistry and the Department of Environmental Health, which meets systematically to evaluate the measures taken for the treatment of medical materials containing mercury, including dental amalgam.

The professional risks generated by mercury, related to the preparation of amalgam, can be reduced by applying the appropriate standards to restrict the contact of dentists, assistants and patients with mercury metal, and also managing the reduction of concentration of mercury in the environment of work [2].

Being consistent with this approach, the International Institute of Oral Medicine and Toxicology, (IAOMT); institution created in 1981, conformed by dentists and doctors with a solid scientific base, focused on the toxicity linked to health; has developed an official Detoxification Protocol, with the objective of minimizing any exposure of patients and dental personnel to mercury vapors, which is easy to understand and implement in the areas of dental consultations [20,21].

1. Maintain cold amalgams: during their removal, constant cooling must be guaranteed over the restoration. The Occupational Health and Safety Administration of the United States (OSHA) argues that amalgams should never be removed dry, recognizing that research has found levels of 4000 mg/m³ of mercury a half meter from the aerator when it is used dry.
2. Use of ejectors: an aspiration should be maintained near the area where the amalgam is being removed (less than 1 cm), to evacuate the vapors from this area of the oral cavity.
3. Provide an alternative source of air: every patient who is placed or removed an amalgam should have an available air source and be instructed not to breathe through the mouth during the procedure. For example: nasal masks used with nitrous oxide anesthesia equipment.
4. Immediate removal of the mercury alloy or restoration fragments: once the restoration has been sectioned into large pieces to reduce exposure, they should be sucked up or removed immediately from the oral cavity. Recently, the IAOMT approved the use of rubber dams indiscriminately at this time of the procedure, despite the fact that some dentists suggested the permanence of the amalgam fragment underneath. In this step the patient is again insisted on not breathing through the mouth or swallowing any portion of restoration.
5. Washing and changing gloves: once the amalgam restoration has been eliminated, rinse the patient's mouth with water for around 30 seconds, remove the used gloves and replace them with new ones.
6. Immediate cleaning of the patient: the IAOMT recognizes this procedure in case the patient has splashes on the face, and includes the change of the protective clothing placed, for example, the bibs.
7. To consider the alimentary aid: the suitable nutritional contribution is recommended to execute it before, during and after proceeding with the amalgam. This adequate diet is not synonymous with eating more, but refers to the ingestion of certain foods that help eradicate the remains of mercury that may remain in the body. For example, it is recommended to drink plenty of water and consume dairy products such as milk or liquid yogurt on the day of withdrawal from the restoration. Consuming foods rich in ascorbic acid (vitamin C) such as citrus fruits and green vegetables is another indication, because it is suggested that these foods act as antioxidants.
8. Keep the room ventilated: it is recommended to install fans or purifiers in the premises used for these work with dental amalgam.

It should be considered that much literature suggests that the critical moments for the release of mercury vapors are during the placement and removal of amalgam restorations [1,21], therefore, it is recommended that, in the case of withdrawals, these procedures be implemented in defective and non-functional restorations.

As health professionals, we are generally responsible for the management of amalgam residues, and we must be consistent with the measures adopted and established to protect the health of patients and maintain a healthy environment in our dental department.

Conclusions

- There are divided criteria on the use of amalgam as a restorative material.
- The global trend to gradually replace amalgam is increasing, representing a challenge for this material, maintaining the preference of dentists.
- Measures to resolve the harmful effects of mercury on human health are implemented at a global level.

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