Pesquisa Brasileira em Odontopediatria e Clínica Integrada 2024; 24:e220172
https://doi.org/10.1590/pboci.2024.028
ISSN 1519-0501 / eISSN 1983-4632

CRITICAL REVIEW

The "Phase Down" of Dental Amalgam Restorations – What are the Criteria for Replacement and Indication?

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Academic Editor: Alessandro Leite Cavalcanti

Received: November 23, 2022 / **Review:** March 09, 2023 / **Accepted:** March 20, 2023

How to cite: Miranda DA, Silveira LE, Schirm JA, Lima ILA, Manzi FR. The "phase down" of dental amalgam restorations – What are the criteria for replacement and indication? Pesqui Bras Odontopediatria Clín Integr. 2024; 24:e220172. https://doi.org/10.1590/pboci.2024.028

ABSTRACT

Objective: To guide professionals about the criteria for replacing amalgam restorations and inform them about the new guidelines regarding the use/indication of this (amalgam) material after the Minamata Convention – COP-4. **Material and Methods:** The articles were selected from the databases (PubMed, Scielo, Bireme), and relevant articles on the subject between the years 2003-2021 were selected. Recently, social media have been flooded with dental treatments that aim to perform restorations only with composite resins or other types of esthetic material and completely replace all dental amalgam restorations, irrespective of their time in place, size, and functionality. **Results:** Although improperly, it has been noted that this information reaches patients, and they are led to believe in the inaccurate data that is passed on, such as, for example, (that amalgam leads to) permanent contamination by mercury, causing systemic problems and the loss of the tooth. **Conclusion:** The "phase down" of amalgam in research and teaching has previously been observed in several countries worldwide; however, its use is still necessary given particular circumstances, which, theoretically, make it a material with exact indication.

Keywords: Dental Materials; Dental Amalgam; Long Term Adverse Effects.

Introduction

The easy access of patients, especially to social networks, has been a matter of concern to professionals in the field of dentistry. At present, professionals have presented themselves as specialists in "safe removal" (of amalgam), with highly unnecessary protocols for its replacement, involving the exaggerated use of personal protective equipment, together with an arsenal of drugs, indicating the replacement of all amalgam restorations in the oral cavity, and contraindicating the definitive use of this material in dentistry.

As described in the Technical Opinion of the Ministry of Health No. 6/2022-CGSB/DESF/SAPS/MS, the new generations of dentists do not receive detailed training to perform amalgam restorations, with a focus on contemporary teaching, research, and technological development in adhesive materials, which allow less invasive restorative procedures to be performed. The "phase down" of amalgam in research and teaching has previously been observed in several countries, including Brazil [1]. However, its use is still necessary given particular circumstances, which, theoretically, make it a material with very precise indications [2]. Recommendations regarding removing all amalgam restorations by alleging risks of dental structure fractures and contamination by mercury are highly controversial and devoid of scientific evidence [2,3]. This study aimed to "guide professionals about the criteria for replacing amalgam restorations and inform them about the new guidelines regarding the use/indication of this (amalgam) material."

Materials and Methods

The relevant articles on the subject were selected from PubMed, Scielo, and Bireme databases from 2003 to 2021.

The Ministry of Health's technical note favors amalgam compared to composite resins (for restorations) in permanent posterior teeth (Class I and II). Furthermore, in this report, low-quality evidence with clinically significant differences shows that amalgam restorations versus composite resin restorations have a lower risk of failure and adjacent caries [1]. Resin composite and amalgam restorations have acceptable success rates and similar failure modes [4,5]. The prevalence of cusp fractures in teeth restored with amalgam and teeth restored with composite resin does not differ significantly [6-8]. Longitudinal clinical studies have indicated that composite resin restorations may have significant clinical durability, with longevity comparable to amalgam restorations in many cases. This body of information can be proven through the studies presented in Table 1, which makes it clear that the simple fact of having an amalgam restoration is not the exclusive criterion for replacing it [9-22].

Therefore, the only conditions that require the replacement of amalgam or composite resin restorations should be based on clinical and radiographic criteria defined by the FDI (Federation Dentaire Internationale) and USPHS (United States Public Health Service) [22,23], i.e., the presence of recurrent carious lesions, esthetic requirements, fracture of restoration, loss of contact point, anatomical shape and fracture of tooth structure associated with radiographic examinations [7,8,24].

Failures are evident when the restoration attains a degradation process and prevents adequate performance, which can be for functional, aesthetic, and biological reasons [22,23]. Although amalgam has fallen into disuse, it is known that when dental amalgam is well adapted, it reduces the possibility of adjacent caries over time due to the formation of oxides on the cavity margins because of natural corrosion of the material, mainly in alloys with a high copper content [25].

Table 1. Studies have tested the fracture rate and durability of amalgam and composite resin restorations.

Authors	Amalgam	Resins	Period of Evaluation
Van Nieuwenhuysen et al. [9]	Failures occurred in 28% of amalgam restorations. The highest percentage of extractions was related to complete amalgam restorations in premolars. The mean time of survival was 12.8 years for amalgam fillings.	Failures occurred in 30% of resin restorations. The mean time of survival was 7.8 years for resin restorations.	17 years
Wahl et al. [10]	In 10,082 teeth restored with amalgam, the prevalence of cusp fracture was 1.88%.	In 787 teeth restored with resin composite, the prevalence of cusp fracture was 2.29%.	-
Tyas [11]	Secondary caries were the main reason for replacing restorations, predominantly affecting amalgam restorations in Class I and V cavities. Teeth are restored with amalgam fractured almost twice as often as teeth restored with composite resin. The mean age of replacement for amalgam was 13.6 years (?)	The mean age of resin composite at time of replacement was 7.1 years(?).	-
Mannocci et al. [12]	The survival rate of amalgam found in this study was 91.3%;	The survival rate of teeth restored with fiberglass post and composite resin was 90%.	5 years
Opdam et al. [13]	For amalgam, they revealed a survival rate of 89.6% in 5 years and 79.2% in 10 years.	For resin composite, they revealed a survival rate of 91.7% in 5 years and 82.2% in 10 years.	Between 5 and 10 years
Bernado et al. [14]	The survival rate of amalgam restorations was 94.4%.	The survival rate of resin composite restorations was 85.5%.	7 years
Burke and Lucarotti [15]	Amalgam restorations, Class I have a mean survival time of 10 years before reintervention (58%) compared with large amalgam fillings, such as Class II (43%).	Composite resin and glass ionomer restorations have a worse performance than amalgam restorations.	10 years
Opdam et al. [16]	In the high-risk group, composite resin and amalgam restorations showed comparable performance, with amalgam performing better in more minor restorations.	Composite resin restorations showed better survival for the combined risk group and the low-risk group.	12 years
Heintze and Rousson [17]	The ratio of Class I/Class II restorations did not significantly influence the results. The mean success rate of amalgam fillings was 94%.	The general survival rate of resin composite restorations was 90%. The frequency of caries adjacent to restorations was low in most studies, with a mean prevalence of around 3% after 10 years. The mean survival rate of resin composite restorations was approximately 92%.	10 years
Moraschini et al. [18]	The mean survival rate of amalgam ranged from 76%, with a mean annual failure rate of 1.71.	The mean survival rate of amalgam ranged from 56% with a mean annual failure rate of 3.17%, respectively.	5 years
Naghipur et al. [19]	Sixty-six amalgam restorations (5.9%) failed. Long-term failures (over two years) occurred in 43 amalgam restorations (3.8%). In 12 years, the probability of survival was 91.5% for amalgam.	Resin restorations showed 1.3 times more propensity to failure; 134 Resin Composite restorations (7.9%) failed. Long-term failures (over two years) included 77 resin composite restorations (4.5%). In 12 years, the probability of survival was 86% for resin composite.	12 years
Burke and Lucarotti [20]	In 4 years. the results indicated a cumulative rate of reintervention by direct restoration, crown, or extraction of 66.1% for single-surface restorations (i.e., Class I and Class V), 67.5% for two-surface, 63.0% for three-surface restorations and 55.8% for four-surface restorations, however, their data did not include details of the materials used.	For composite restorations, 34% survived for 15 years, with approximately 43% surviving for up to 10 years and approximately 59% for five years. When the data concerning extraction time were reanalyzed, it was apparent that about 83% of teeth restored with a composite restoration survived for 15 years.	15 years
Worthington et al. [21]	Low-certainty evidence suggested that composite resin restorations may have a failure rate nearly twice that of amalgam restorations.	The risk of restoration fracture does not appear to be greater with composite restorations, but there is a much greater risk of developing secondary caries.	3 years

In contrast, the evidence presented in Table 1 shows that the longevity of composite resin restorations may be lower than that of amalgam restorations under similar circumstances [14,18,20,21]. Longitudinal studies [20,26] have indicated that over half of composite resin restorations require contouring, polishing, or repair within a mean time of 15 years. Meanwhile, when some fracture occurs in amalgam restorations, they must be replaced. The main factors that influence the survival of restorations include the patient's age, the position of the tooth in the arch, the dentist's experience, the technical quality of the procedure, and the specific treatment needs of the patient, such as the size of the restoration and index of biofilm in the oral cavity [2].

The Minamata Convention – COP-4 and its impact on Dentistry

Minamata Convention on Mercury is a global agreement that promoted a worldwide reduction in the use of mercury (including amalgam fillings) to reduce the impact of mercury on the environment [22,27]. Mercury is ranked among the top ten chemicals of most significant concern to public health, according to the World Health Organization (WHO). The Conclusion of the Minamata Convention in Geneva 2022, known as COP 4-Minamata, did not classify amalgam fillings as an imminent risk to people's health [27].

This convention, in which the main discussion was based on the control of mercury, was named after a city in Japan where severe health damage occurred due to mercury pollution in the mid-20th century. In this city, industrial wastewater was contaminated with mercury, which damaged local public health and became known as "the Minamata disease." This convention provides for controls and reductions in a range of products, processes, and industries in which mercury is used, released, or emitted.

The mercury present in dental restorations is found in an inorganic form, and up to now, no changes in people's health have been reported [22,28]. Studies have shown that the levels of mercury released from these fillings are so low that even levels much higher than those associated with a mouthful of amalgam fillings do not pose an imminent health risk [25,28].

Patients and professionals who continuously use amalgam may be exposed to a low-intensity level of mercury over a long period, and it has been pointed out as a possibility of mercury accumulation in the central nervous system, causing damage such as fatigue, depression, irritation, memory loss and gingival inflammation [7,8]. However, the ADA (American Dental Association) and the FDI have reaffirmed that amalgam is a safe, durable restorative material that plays an important role in public health services—moreover, no cases in the literature related to these health professionals [2,22].

The guidelines have indicated marketing only in pre-dosed capsules, the prohibition of use of this material for the treatment of deciduous teeth in patients under 15 years of age, and restricted use in pregnant and lactating women, except when considered extremely necessary by the dentist, based on the individual requirements of each patient. It should be emphasized that the guidelines are not prohibitive or state a deadline for banning, as the most significant source of human contamination does not occur from the mercury contained in an amalgam restoration but from ingesting fish from contaminated water [22,24].

The sensible and safe, scientifically based and environmentally sustainable protocol requires the use of complete PPE attire and biosafety materials, absolute isolation of the operative field, use of a carbide steel drill, diamond or new tip, conventional suction, filter separating metal particles and abundant washing of the oral cavity [5,8,25].

Conclusion

Overall, the body of evidence suggests that both amalgam restorations and composite resin restorations are effective, long-lasting, and safe, and depending on factors related to the tooth, type of occlusion, and the patient's oral hygiene index, failures may occur in both types of restorations. The "phase down" of dental amalgam in terms of teaching and clinical applicability means that many dentists incorrectly replace these restorations without any criterion. This applies to patients who, faced with erroneous information about the material and its toxic effects, demand that dentists make decisions about esthetic restorations in the oral cavity. The scientific and clinical evidence bodies are strong: there is no risk of contamination and systemic effects when using metal restorations.

Authors' Contributions

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All authors declare that they contributed to a critical review of intellectual content and approval of the final version to be published.

Financial Support

None.

Conflict of Interest

The authors declare no conflicts of interest.

Data Availability

The data used to support the findings of this study can be made available upon request to the corresponding author.

References

[1] Brasil. Ministério da Saúde. Departamento de Saúde da Família. Coordenação-Geral de Saúde Bucal. Parecer técnico nº 6/2022-CGSB/DESF/SAPS/MS. Brasília: Ministério da Saúde; 2022. [In Portuguese].

[2] Food and Drug Administration. Information for patients about dental amalgam fillings. 2020. Available from: https://www.fda.gov/medical-devices/dental-amalgam-fillings/information-patients-about-dental-amalgam-fillings. [Accessed on 18 September, 2022].

[3] Lauterbach M, Martins IP, Castro AC, Mario B, Henrique L, Amaral H, et al. Neurological outcomes in children with and without amalgam-related mercury exposure. Seven years of longitudinal observations in a randomized trial. JADA 2008; 139(2):138-145. https://doi.org/10.14219/jada.archive.2008.0128

[4] Naghipur S, Pesun I, Nowakowski A, Kim A. Twelve-year survival of 2-surface composite resin and amalgam premolar restorations placed by dental students. J Prosthet Dent 2016; 116(3):336-339. https://doi.org/10.1016/j.prosdent.2016.02.005

[5] Heintze SD, Rousson V. Clinical effectiveness of direct class II restorations - A meta-analysis. J Adhes Dent 2012; 14(5):407-431. https://doi.org/10.3290/j.jad.a28390

[6] Estay J, Martín J, Viera V, Valdivieso J, Bersezio C, Vildosola P, et al. 12 years of repair of amalgam and composite resins: A clinical study. Oper Dent 2018; 43(1):12-21. https://doi.org/10.2341/16-313-C

[7] Moraschini V, Fai CK, Alto RM, Dos Santos GO. Amalgam and resin composite longevity of posterior restorations: A systematic review and meta-analysis. J Dent 2015; 43(9):1043-1050. https://doi.org/10.1016/j.jdent.2015.06.005

[8] Opdam NJ, Bronkhorst EM, Loomans BA, Huysmans MC. 12-year survival of composite vs. amalgam restorations. J Dent Res 2010; 89(10):e1063. https://doi.org/10.1177/0022034510376071

[9] Van Nieuwenhuysen JP, D'Hoore W, Carvalho J, Qvist V. Long-term evaluation of extensive restorations in permanent teeth. J Dent 2003; 31(6):395-405. https://doi.org/10.1016/s0300-5712(03)00084-8

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[10] Wahl MJ, Schmitt MM, Overton DA, Gordon MK. Prevalence of cusp fractures in teeth restored with amalgam and with resin-based composite. J Am Dent Assoc 2004; 135(8):1127-1132; quiz 1164-5. https://doi.org/10.14219/jada.archive.2004.0371

[11] Tyas MJ. Placement and replacement of restorations by selected practitioners. Aust Dent J 2005; 50(2):81-89; quiz 127. https://doi.org/10.1111/j.1834-7819.2005.tb00345.x

[12] Mannocci F, Qualtrough AJ, Worthington HV, Watson TF, Pitt Ford TR. Randomized clinical comparison of endodontically treated teeth restored with amalgam or with fiber posts and resin composite: Five-year results. Oper Dent 2005; 30(1):9-15.

[13] Opdamÿ NJM, Bronkhorst EM, Roeters MJ, Loomans BAC. A retrospective clinical study on longevity of posterior composite and amalgam restorations. Dent Mater 2007; 23(1):2-8. https://doi.org/10.1016/j.dental.2005.11.036

[14] Bernardo M, Luis H, Martin MD, Leroux BG, Rue T, Leitão J, et al. Survival and reasons for failure of amalgam versus composite posterior restorations placed in a randomized clinical trial. J Am Dent Assoc 2007; 138(6):775-783. https://doi.org/10.14219/jada.archive.2007.0265

[15] Burke FJ, Lucarotti PS. How long do direct restorations placed within the general dental services in England and Wales survive? Br Dent J 2009; 206(1):E2; discussion 26-27. https://doi.org/10.1038/sj.bdj.2008.1042

[16] Opdamÿ NJM, Bronkhorst EM, Loomans BAC, Huysmans DNJM. 12-year survival of composite vs. amalgam restorations. J Dent Res 2010; 89(10):1063-1067. https://doi.org/10.1177/0022034510376071

[17] Heintze SD, Rousson V. Clinical effectiveness of direct class II restorations - A meta-analysis. J Adhes Dent 2012; 14(5):407-431. https://doi.org/10.3290/j.jad.a28390

[18] Moraschini V, Cheung KF, Alto RM, Santos GO. Amalgam and resin composite longevity of posterior restorations: A systematic review and meta-analysis. J Dent 2015; 43(9):1043-1050. https://doi.org/10.1016/j.jdent.2015.06.005

[19] Naghipur S, Pesun I, Nowakowski A, Kim A. Twelve-year survival of 2-surface composite resin and amalgam premolar restorations placed by dental students. J Prosthet Dent 2016; 116(3):336-339. https://doi.org/10.1016/j.prosdent.2016.02.005

[20] Burke FJT, Lucarotti PSK. The ultimate guide to restoration longevity in England and Wales. Part 10: key findings from a ten million restoration dataset. Br Dent J 2018; 225(11):1011-1018. https://doi.org/10.1038/sj.bdj.2018.1029

[21] Worthington HV, Khangura S, Seal K, Mierzwinski-Urban M, Veitz-Keenan A, Sahrmann P, et al. Direct composite resin fillings versus amalgam fillings for permanent posterior teeth. Cochrane Database Syst Rev 2021; 8(8):CD005620. https://doi.org/10.1002/14651858.CD005620.pub3

[22] FDI World Dental Federation. Amalgam (Part 2): Safe use and phase down of Dental Amalgam. Adopted by FDI General Assembly September, 2021 in Sydney, Australia. Available from: https://www.fdiworlddental.org/amalgam-part-2-safe-use-and-phase-down-dental-amalgam. [Accessed on 18 September, 2022].

[23] Marquillier T, Doméjean S, Le Clerc J, Chemla F, Gritsch K, Maurin JC, et al. The use of FDI criteria in clinical trials on direct dental restorations: A scoping review. J Dent 2018; 68:1-9. https://doi.org/10.1016/j.jdent.2017.10.007

[24] Rho YJ, Namgung C, Jin BH, Lim BS, Cho BH. Longevity of direct restorations in stress-bearing posterior cavities: A retrospective study. Oper Dent 2013; 38(6):572-582. https://doi.org/10.2341/12-432-C

[25] Schmalz G, Widbiller M. Biocompatibility of Amalgam vc Composite – A Review. Oral Health Prev Dent 2022; 20(1):149-156. https://doi.org/10.3290/j.ohpd.b2831749

[26] Ástvaldsdóttir Á, Dagerhamn J, van Dijken JW, Naimi-Akbar A, Sandborgh-Englund G, Tranæus S, et al. Longevity of posterior resin composite restorations in adults – A systematic review. J Dent 2015; 43(8):934-954. https://doi.org/10.1016/j.jdent.2015.05.001

[27] UN Environmental Programme. Minamata Convention on Mercury (COP-4). Bali, Indonesia; March 2022. Available from: https://www.mercuryconvention.org/sites/default/files/documents/submission_from_organization/ADA_and_IADR_DentalAmalgam.pdf [Accessed on 15 September, 2022].

[28] Barrett S. How "provoked" urine metal tests are used to mislead patients. 2019. Available from: https://quackwatch.org/related/Tests/urine_toxic/ [Accessed on 22 September, 2022].