

Amalgam Restorations and Future Perspectives

Marilia Mattar de Amoêdo Campos Velo*, Cassiana Koch Scotti, Natália Almeida Bastos, Adilson Yoshio Furuse, José Mondelli

Department of Operative Dentistry, Endodontics and Dental Materials, Bauru School of Dentistry, University of Sao Paulo, Bauru, Brazil

Abstract

Although adhesive dentistry and aesthetic restorative materials have had significant development, choosing the ideal material to restore dental structures is still controversy. The aim of this chapter is to describe the properties of the dental amalgam and demonstrates how cavity is prepared for amalgam in classes I and II, as well as restoration procedures are carried out. Despite its limited indication for non-aesthetical areas, dental amalgam restorations are quite useful in posterior teeth and its use is very important when treating special patients. In the case of elderly people, the use of amalgam can restore large tooth substance losses with simple procedures and low cost. The same reasons make it the preferred material for patients at high risk to dental caries, like adolescents. Although they are the preferred material for many clinical cases, amalgam restorations are also likely to fail in the daily practice and all procedures and restorations must be done with caution. The future perspectives related to continuing its use in teaching and dentistry were also addressed in the present chapter.

Keywords: Dental amalgam; Dental materials; Mercury

Introduction

Although adhesive dentistry and aesthetic restorative materials have had significant development [1], choosing the best material to restore dental structures is still controversy. A recent systematic review of the literature highlights the benefits of dental amalgam restorations in posterior teeth compared to resin composites [2]. Indeed, the dental amalgam has been the chosen material for more than 150 years, especially due to its excellent long-term clinical performance and low cost [2,3]. However, a gradual decrease in the use of amalgam has been noticed in some countries [4], especially because it is a non-aesthetical and it is not easily available material. Besides, its potential risk to human health has been called into question at the Minamata Convention due to the presence of mercury and possible damages caused by environmental emissions of residues that are manipulated inappropriately [5].

Therefore, resin composites have become more commonly used in the last years in many places, regardless of the patients' risk management decision. On the other hand, in several countries, the amalgam is still chosen for posterior teeth. In 2003, a research carried out in the United Kingdom showed that 49% of dental surgeons used amalgam instead of resin composites as restorative material. The main reasons for choosing amalgam were its lower technical sensitivity in procedures, higher resistance to tooth wear, lower cost for patients, lower postoperative tooth sensitivity and higher clinical longevity [6]. Likewise, data collected in Brazil throughout 2004 pointed out that, with the exception of the South region, where aesthetical demands were prominent, amalgam was the most used material in posterior teeth compared to resin composites and glass ionomer cement [7]. In some previous studies, it has been indicated that more extensive resin composites restorations tend to more fractures than amalgam and amalgam restorations may present satisfactory clinical performance for more than 12 years [8].

Literature Review

It is important to highlight that the researches did not correlate amalgam restorations with adverse health effects [9-12]. Nevertheless, in relation to their clinical longevity, their great performance and success rate is well established [2]. Thus, amalgam is still a great option for some clinical cases. Despite its limited indication for posterior teeth and non-aesthetical anterior areas, its use is very important when treating special patients. In the case of elderly people, the use of amalgam can restore

large tooth substance losses with simple procedures and low cost. The same reasons make it the preferred material for patients at high risk to dental caries [13], like adolescents. It presents excellent performance for occlusal cavities of pits and fissures and can help with chewing for many years. The amalgam is an adequate solution for the cervical area of posterior teeth, as it can be well polished and tolerate gingival tissues. In the anterior teeth, it can also restore the lingual face with remarkable advantages for patients that are more likely to have cavities in the cingulum. Caries lesions in the cementum area, which are a serious clinical problem, will be a source of relief for the dentist and the patient alike because they are easy to restore, as well as the restorative properties and the longevity of the amalgam.

Although they are the preferred material for many clinical cases, amalgam restorations are also likely to fail in the daily practice. According to Healy and Phillips, the failures can be attributed to the preparation of cavities (56%) and incorrect manipulation of the material, while only 4% of those failures have been associated with other factors. In this sense, the dentist must be selective when indicating amalgam restorations, and in order to use them appropriately, as they are not an adhesive material, it is essential to know how to conduct the cavity preparation. Thus, this chapter aims to demonstrate how cavity is prepared for amalgam in classes I and II, as well as restoration procedures are carried out. By the end of the chapter, future perspectives related to continuing its use in teaching and dentistry will be addressed.

Preparing Cavity for Classes I and II

The procedures for preparing cavities adequately have evolved, but they are still based on the principles professed by Black in 1908.

***Corresponding author:** Dr. Marilia Mattar de Amoêdo Campos Velo, Department of Operative Dentistry, Endodontics and Dental Materials, Bauru School of Dentistry, University of Sao Paulo, Bauru, Brazil, Tel: 34935817004; E-mail: mariliavelo@yahoo.com.br

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The preparation for classes I and II will be addressed simultaneously according to Mondelli et al. [14].

Amalgam is not an adhesive material. So, after removing carious tissue and cavity preparation, both occlusal and proximal boxes must have their external walls converged on occlusal (self-retentive format). In order to preserve dental structures as much as possible, it is necessary to have a cavity width equivalent to a quarter or a third of the intercuspal distance, reaching pits and fissures but always preserving cusps. The preparation must be made with the aid of a carbide drill (n.245) or diamond burs (n.1149) in the shape of an inverted cone with a round end, which delineate the self-retentive preparation (external walls converged on occlusal), flat pulpal and gingival walls and round internal angles (offering better distribution of chewing forces). For the proximal boxes, the same drill/bur must be used to delineate the axial and gingival walls and to create a 0.25 mm space from the adjacent tooth, which allows finishing the cavity preparation and the restoration to come, as well as cleaning and accommodating the interdental papilla. Although proximal boxes have increased depth, they have the same shape of the occlusal box.

Characteristics of class I cavity preparation

- Flat pulpal wall perpendicular to the longitudinal axis of the tooth;
- External walls converged on occlusal;
- Round internal angles;
- Well-delineated cavosurface angle (Figure 1).

Characteristics of class II cavity preparation

Occlusal box: Identical to the one described in class I cavity preparation.

Proximal boxes:

- Lingual and buccal walls converged on occlusal, following the slant of corresponding faces;
- Hollenback reverse curve on lingual and vestibular walls, creating a straight angle with the proximal surface of the tooth;
- Flat axial walls converged on occlusal;
- Flat gingival walls perpendicular to the longitudinal axis of the tooth;
- Round axiopulpal angle;
- Marked and without bevel cavosurface angle (Figure 2).

All those characteristics must conform to the fundamentals of cavity preparations. The carious tissue can be removed before delineating the shape. The affected deep dentin area corresponding to the uninfected dentin can be preserved during operation, while the infected dentin must be completely removed. The carious dentin is removed with the use of hand instruments, such as curettes or sharp dentin spoon in proportional sizes to the carious lesion; however, when the dentin is resistant to the instruments, spherical steel drills at low rotation that have the same size of the cavity must be used.

As to retention, in simple cavities, when the depth of a cavity is equal to or greater than its cavity width, it will be self-retentive [15]. Complex cavities, besides individual retention of each box, are interdependent; because of that, some additional procedures can be employed. Additional retention can be carried out by means of grooves or channels on the vestibular and lingual walls of the proximal box or

the slant of the gingival wall in the axiopulpal direction with a round drill [14]. For endodontically treated teeth with serious coronary destruction, prefabricated, fiber-reinforced or metal pins can be used to retain amalgam restorations [14].

Finishing the preparation employs different hand instruments depending on the wall being worked on or the proximal face of the restoration. The axe is used to make the surrounding wall uniform, which is necessary to have a straight, well-delineated cavosurface angle. For the gingival margin of the proximal box, trimmers are used to make that wall uniform and remove remaining spicules from the preparation. The gingival margin trimmers are also useful for making the axio-pulpal angle round.

After that procedure, the last step of the preparation is cleaning the cavity, in which remaining particles of the cavity walls are removed and the restorative material is applied to a clean cavity. One of the best cleaning agents is the calcium hydroxide solution [16]; after preparation, the depth of the cavity, as well as the protective material to be used, must be evaluated so that the cleaning agent can be chosen [14].

Clinical Procedures for Amalgam Restorations

Firstly, it is important to point out that, in the case of deep cavities,



Figure 1: Characteristics of class I cavity preparation.

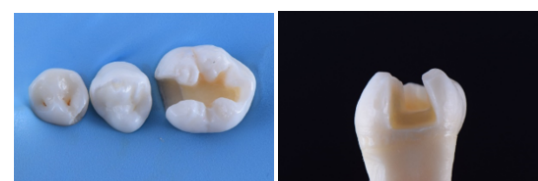


Figure 2: Characteristics of class II cavity (occlusal and proximal).



Figure 3: Application of cavity varnish.

the preparations must have compatible protective materials of the dentin-pulp complex. After that procedure, this sequence of clinical steps applies (Figures 3-6).

Evaluation of occlusal contacts

Before restorative procedures, the initial occlusal contacts must always be checked as it helps the dentist make the final occlusal adjustments to the restoration and decide whether contacts will only be applied to the restoration or the remaining tooth, but always avoiding tooth/restoration interface area.

Use of cavity varnish

Before inserting and condensing the restorative material into the cavity, varnish must be applied so that the tooth/restoration interface

is immediately sealed [17], which also seals the dentin-pulp complex electrically. Preferably, the varnish must be copal resin-based [18], two thin layers of it (about 5 µm thick) used to result in the occlusion of 80% of dentinal tubules [19]. An alternative to cavity varnish is the use of adhesive systems [20], which are not as soluble as varnish and allow corrosive products to be formed before degradation of that layer. It is worth noting that, should adhesive be used, it is better to choose a self-conditioning system in which acid primer will only alter the smear layer and not remove it completely (Figure 3).

Adapting the wedge and the matrix

In restorations of proximal faces, after applying the cavity varnish, the metal matrix (universal or individual) must be adapted and stabilised by means of wooden wedges and possibly impression compound sticks so that the amalgam is condensed in the cavity properly and the cervical adaptation of the restorative material is made. It is essential to check if the metal matrix adapted to the cavity walls touches the cavosurface angle of the proximal boxes and surpasses the height of marginal ridges; after that, it must be stabilised with a wooden wedge in the right size (keeping the tooth contour), which is key for the re-establishment of the proximal contact point (Figure 4).

Amalgamation

Amalgam trituration is carried out mechanically in an amalgamator following recommendations from the manufacturers of pre-encapsulated alloys, since altering the time of trituration can result in unsatisfactory mechanical properties of the materials [21-23].

Condensation

It aims to fill the cavity and attach the material to the walls and angles so as to reach the densest mass possible and must be carried out quickly and immediately after trituration in a contamination-free environment. The amalgam must be taken to the cavity with the aid of a plastic or metal amalgam holder and the condensation must begin by the proximal boxes and retentions using Ward condensers from 1 to 6 (manual condensation), starting with the smaller ones, which alters pressure on the mass (smaller diameter generates more pressure), and increasing as the cavity is filled (Figure 5). This procedure must take up to three or four minutes after amalgamation.

Sculpture

It must be made soon after condensation, when the amalgam presents minimum resistance to the cut made with instruments, which can be noticed by running a sharp instrument on the surface of the restoration. If the “amalgam cry” is heard, it is already resistant to the cut and then it can be sculpted. The sculpture aims to re-establish the anatomy, shape and function of teeth and can be made with the aid of several instruments. One important feature during this stage is the maintenance of shallow grooves and slight slants of cusp slopes avoiding areas with low material thickness, which could be more susceptible to fracture. Another relevant feature is the reproduction of marginal ridges and proximal regions using matrices and wedges well-adapted to the cervical regions, which makes it easier to obtain an adequate proximal contour without cervical excesses.

Post-sculpture polishing

It is the act of rubbing the amalgam that has been just condensed with metal instruments that have a wide contact surface. Pre- and post-sculpture polishing can reduce surface roughness up to 10 times, which facilitates finishing and polishing restorations, improves adaptation of



Figure 4: Re-establishment of the proximal contact point with metal matrix adapted stabilized with a wooden wedge.



Figure 5: Manual condensation using Ward condensers from 1 to 6.



Figure 6: Post-sculpture polishing.

the material to cavity margins and reduces micro-infiltrations. Besides, it can avoid plaque accumulation and protect physical, mechanical and biological properties of the amalgam [24-27]. Polishing requires initial crystallisation of the alloy so that mercury does not come up on the surface of the restoration nor damage the anatomy obtained from the sculpture (Figure 6).

Occlusal adjustment

After sculpture, the occlusal adjustment must be carried out in a way that the patient occludes with a slight pressure, as the amalgam that has just crystallized does not reach its maximum mechanical properties until the occlusal contacts evaluated before restoration are checked, which is quite a neglected clinical step. Hollenback 3S or multi-laminated drills in order to remove restorative material excesses. It is important not to adjust interproximal surfaces at this point so that the restoration ridges are not fractured.

Finishing and polishing

Finishing and polishing must take place at least 24 hrs after restoration in order to have smooth surface, refined sculpture, corrected occlusion, higher resistance to corrosion and reduced biofilm accumulation, which improves clinical performance of the restoration [28]. Finishing requires strips of steel sandpaper on proximal faces, as well as multi-laminated drills made of steel or tungsten carbide at low rotation or refrigerated carbide at high rotation should coarser adjustments be necessary. Initial polishing is obtained with a sequence of abrasive rubber tips (brown, green and blue) or pumice-based pastes applied with a rubber cup or a Robinson brush, while final polishing uses zinc oxide paste + absolute alcohol + felt disk or zinc oxide + tin oxide + absolute alcohol [18]. The final aspect of the amalgam restoration is showed in the Figures 7-9.

Amalgam Restoration Repairs

The clinical performance of well-prepared amalgam restorations has been reported for 12 years. However, failures during preparation or restoration may occur, which decreases its longevity. As the concept of minimally invasive dentistry develops, we may conclude that most failures in amalgam restorations can be repaired over time and that restorations do not need to be totally replaced [12,16]. The most common failures are: fracture of the bulk or margins of restorations; secondary caries; restorations without contour or proximal contact; cervical excesses. In many of those situations, provided that there is space enough for a retentive box [12], restoration repair must be suggested in order to preserve a healthy dental structure [29] and to minimise clinical time and mercury exposure [30].

Discussion

Future perspectives on teaching and dentistry

Despite the long history and popularity of dental amalgam as a restorative material, there have been periodic concerns regarding the potential adverse health effects arising from exposure to mercury in amalgam. For that reason, as well as its increasingly reduced use in daily practice due to patients' aesthetical demands, the amalgam has been appearing in the context of public health services, which has raised some discussion about the indication of it and also its prolonged presence in academic teaching [14].

The United Nations Environment Programme (UNEP) has ceased discussions about an international agreement called the Minamata Convention on Mercury aiming to reduce significant environmental

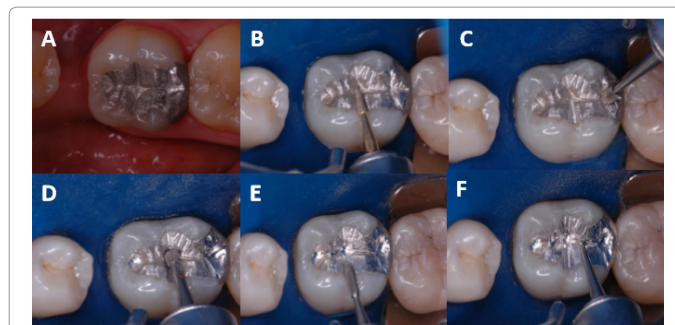


Figure 7: Clinical sequence of finishing of amalgam restoration. Finishing requires with multi-laminated drills made of steel.

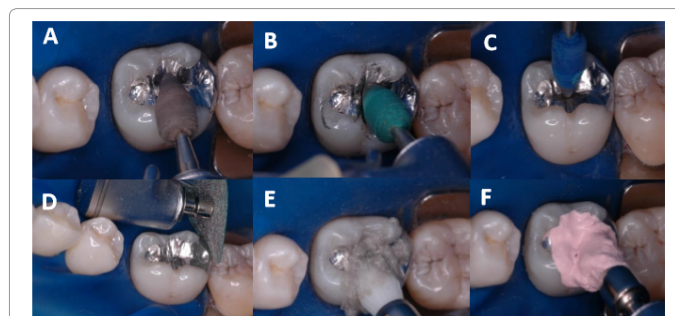


Figure 8: Clinical sequence of polishing of amalgam restoration. Initial polishing with a sequence of abrasive rubber tips and Pumice-based pastes applied with a Robinson brush and final aspect of amalgam restoration.

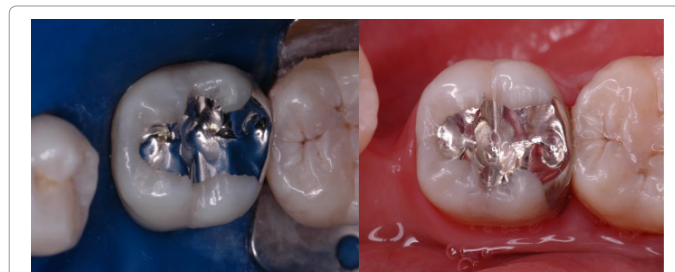


Figure 9: Final aspect of the amalgam restoration after finishing/polishing.

impacts on health caused by air pollution and mercury emissions and including provisions that deal with several products containing that chemical element. Some of them shall be banned as of 2020. Amalgam restorations have not been prohibited, but the agreement provides for the gradual decrease in the use of that material without prohibitive measures or deadlines for ban.

Because dental amalgam is not one of the major contributors to mercury emissions into the air, if amalgam waste is significantly reduced with the best practices of waste management, it actually does not and will not contribute to global demand and/or pollution estimates attributed to the three types of mercury. Furthermore, the researchers did not correlate amalgam restorations with adverse health effects [9-12] and they did not show a valid link between amalgam in the oral cavity and systemic disease. Thus, with the necessary caution, good sense and within the knowledge and based on relevant studies, the teaching and use of dental amalgam may continue in clinical cases in which aesthetics is not the predominant factor [31].

Conclusion

Despite the long history and popularity of dental amalgam as a

restorative material, its use has been reducing in clinical practice due to the aesthetic requirement of patients. However, dental amalgam restorations are still a great option for some cases, such as special patients and with the necessary caution, good sense and within the knowledge and based on relevant studies, the teaching and use of dental amalgam may continue in clinical cases in which aesthetics is not the predominant factor.

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