



## Replacement of fractured amalgam restoration in shallow cavities using a new category of adhesive system: case report

Substituição de restaurações de amálgama rasas e fraturadas utilizando uma nova categoria de sistema adesivo: relato de casos clínicos

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### ABSTRACT

Several failures have been related in amalgam restorations that require repair or replacement. **Objective:** The aim of this case report was to demonstrate a usual clinical condition found in the dental office: fractured in amalgam restorations associated with the esthetic patient desire. **Case report:** Seven fractured amalgam restoration replacements, probably due to improper cavity design, were performed in two patients. Three different operators accomplished the replacements. It was applied a “multi-mode” adhesive system using the selective enamel etching technique and a nanofilled resin composite with good mechanical properties and polishing. At the end, satisfactory esthetic results were achieved for all restorations. However, differences among operators were detected, stressing the importance of professional training and esthetic desire. **Conclusion:** Thus, it was concluded that the resistance and retention form of amalgam design was the major concern on the failed amalgam restorations in this study. In addition, amalgam restorations must be replaced carefully to prevent damage the dental remaining, and the resin composite has been selected as a preferred option for amalgam replacement, since it is more conservative and esthetic.

### KEYWORDS

Dental amalgam; Dental restoration failure; Acid etching, dental; Dentin-bonding agents; Composite resins.

### RESUMO

Diversas são as falhas relacionadas às restaurações de amálgama, sendo necessário o reparo ou a substituição. **Objetivo:** O objetivo deste relato de casos clínicos foi apresentar uma condição comumente encontrada no consultório odontológico: restaurações de amálgama rasas fraturadas aliadas ao desejo do paciente de restaurações estéticas. **Caso clínico:** Foram realizadas em duas pacientes sete trocas de restaurações de amálgama fraturadas, provavelmente devido à profundidade inadequada dos preparos cavitários. As substituições foram executadas por 3 operadores diferentes, utilizando-se um sistema autocondicionante “multi-mode” com a técnica de condicionamento seletivo do esmalte e uma resina composta nanoparticulada com boas propriedades mecânicas e polimento. Ao final, pode-se verificar resultados estéticos satisfatórios para todas as restaurações, porém com variação entre os operadores, salientando a importância do treinamento do profissional, assim como atender o desejo estético do paciente. **Conclusão:** Dessa forma, pode-se concluir que a forma de resistência e retenção dos preparos para amálgama foi a principal causa das falhas das restaurações neste estudo. Além do mais, na presença de restaurações de amálgama com falhas, estas devem ser reparadas ou substituídas criteriosamente para evitar prejuízo ao remanescente dental; sendo a resina composta o material de eleição para substituição, por ser mais conservador e estético.

### PALAVRAS-CHAVE

Amálgama dentário; Falha de restauração dentária; Ataque ácido dentário; Adesivos dentinários; Resinas compostas.

## INTRODUCTION

Among the most common procedures in the dental office, the restorative ones are the most accomplished [1]; although they are not the most long lasting [2]. The replacement of amalgam restorations by composite resin has grown nowadays because most patients seek for aesthetics looks of natural teeth.

In the literature, it is found several reasons for the replacement of restorations [1-4]. According to Pimenta et al. [2] the factors are divided into two categories: new diseases and technical failures. Within the new diseases are: a secondary caries, primary caries; attrition or tooth fracture by trauma; pulpal problems and periodontal disease. In technical failures have been reported: when the marginal integrity is compromised, fractured cusps adjacent to restorations; restorations' contour inappropriate; contact points disabled; cervical excesses or defects, loss of shape or wear, loss of restoration for lacking of retention due to cavity preparation poorly executed and color change.

Generally, several factors are associated with failure of restorations [1-4]; however, professionals rarely report more than one factor [5], the most reported one is the presence of secondary caries [1-4]. It may also occur in recurrent caries due to caries of inadequate removal, being the restoration done on caries tissue [2]. In the presence of caries associated with restorations, one of the major difficulties of the professional is to determine if the caries lesion is active, inactive or in slow progression [2], using the patient's caries risk to guide treatment decisions [2]. Due to the difficulty in determining the state of disease progression associated with the restorations, in most cases, the replacement is performed.

The evaluation and the criteria used by the dentist to determine the need for replacement are of crucial importance to establish the actual need of treatment [2]. However, the decision

should take into consideration of the repetitive restorative cycle, because the replacement of every restoration replaced healthier dental tissue is lost increasing the cavity and decreasing the resistance of the dental element [3]. Thus, there are opportunities of less invasive treatments for deficient amalgam restoration: repair, marginal seal, which can be performed with high resin flow or a new finish and polish [6].

Due to the variety of materials available currently, the same patient may receive multiple treatment indications when subjected to assessments by different professionals and even for the same clinical diagnoses at different times [7]. Professionals prefer to replace restorations rather than repair them, especially those not made by them [8].

Currently, universities have discussed key issues to repair or to replace restorations, such as prevention, also, more precise diagnosis of caries and teachings about repair restorations. In this way, the restorations can be repaired to be kept longer and when necessary replaced appropriately and carefully.

According to the information above, with the evolution of adhesive restorative materials, replacement of restorations gained an ally that behaves satisfactorily for restorations in both anterior and posterior teeth. These composites are classified as nanoparticle [9,10] and they are able to look as natural teeth. Besides having good surface smoothness and at the same time withstand masticatory forces. Therefore, in these clinical cases reported we have utilized a new adhesive system "multi-mode", using the technique of selective etching of enamel associated with a nanoparticle composite.

## CASE REPORTS

### *Overview of Clinical Cases:*

It was performed a clinical and radiographic examination of two female patients, both with regular oral hygiene, at Araçatuba Dental School and confirmed the need for replacement

of amalgam restoration, besides the desire of patients for esthetic restorations.

Three operators with diverse levels of education performed the procedures: operator A- professional with PhD, operator B - Ms student and, operator C - undergraduate student in dentistry.

The operator A performed the exchange of restorations in case I, the operators B and C performed the substitutions in case II, teeth 36/37 and teeth 46/47, respectively.

The general procedures performed are described in Table 1.

### Case Report I

A 24-year-old patient had the teeth 36 and 37 with amalgam restorations, which were non-retentive and fractured. The general steps of the procedures are illustrated in Figure 1.

Tooth 36: On the occlusal surface were inserted increments of resin composite A3.5B, then the mixture of ocher and a brown pigment was applied with a brush on the major and minor grooves. Finally it was inserted increments of A2E resin. On the buccal surface were placed increments of A3.5B resin, following with white pigment applied on increments, mimetizing the existing white spot on this face, ending the restoration with increments obtained with the mixture of resins A1D and A1E.

Tooth 37: On the occlusal surface were inserted A3.5B resin increments, and then the mixture of ocher and brown pigments, was applied, finalizing the restoration with increment of A3E resin.

### Case Report II

A 23-year-old patient had teeth 36, 37, 46 and 47 also with amalgam fillings disabled.

**Table 1** - General procedures performed to exchange the amalgam restoration

Procedure	Description
Selection of resin color (ambient light)	Initial prophylaxis with pumice and water, teeth were dried and light-cured composite resin increments were placed on the tooth surface. Then, the teeth were hydrated by saliva/water and combination of colors of composites closest to the natural tooth was chosen.
Isolation of the operative field	Absolute isolation using rubber dam (Figure 1A).
Removal of disabled fillings	With spherical diamond burs # 1013 and ½ Carbide burs (KG Sorensen, Barueri, São Paulo, Brazil) under water cooling, in order to be moderate.
Prophylaxis	With pumice and water, to eliminate the residues generated during the previous procedure.
Selective etching of the enamel	37% Phosphoric acid (Condac 37-FGM, Joinville, Santa Catarina, Brazil) was applied on enamel (Figure 1A) for 30 s, after the enamel was rinsed with water for 20 s and dried with absorbent paper.
Adhesive system	One-Step Self-Etching Adhesive “multi-mode” Scotchbond Universal (3M ESPE, Seefeld, Germany) was applied and rubbed on the tooth tissue for 20 s using an adhesive applicator (Kerr, Joinville, Santa Catarina, Brazil) (Figure 1B), gentle air jet applied for 5 s to volatilize the solvent and the adhesive was photoactivated for 10 s, according to the manufacturer's instructions.
Composite	Filtek™ Z350 XT (3M ESPE, St. Paul, Minnesota, USA) accommodated in oblique increments and each increment light-cured for 20s using LED device Radii Plus (SDI, São Paulo, Brazil). Colors used: A1 dentin; white dentin; A3, 5 and B2 Body; A1, A2 and A3 enamel; Translucent CT.
Colors	White, ocher and brown pigments Kolor + Plus® (Kerr, Joinville, Santa Catarina, Brazil) (Figure 1C) was applied with the aid of a fine brush 000 and photoactivated for 20 s.
Occlusal adjustment, finishing and polishing	Figure 1D shows the appearance of restoration immediately after insertion of the composite resin. For occlusal adjustment it was used carbon paper Accu Film II® (Parkell, New York, USA). After identifying the areas of interference, the finish was done with diamond tip 3195F and 3195FF (KG Sorensen, Barueri, São Paulo, Brazil) and for polishing it was used yellow and white abrasive polishes Jiffy®Polishers (Ultradent, Indaiatuba, São Paulo, Brazil), ending with silicon carbide brush (Kerr, Joinville, Santa Catarina, Brazil).

Tooth 36: chosen for the non-removal of pigmented grooves for the restorative procedure was the most conservative. B2B resin composite increments were inserted, following with resin in dentin white color, finalizing the restoration with CT translucent resin increments.

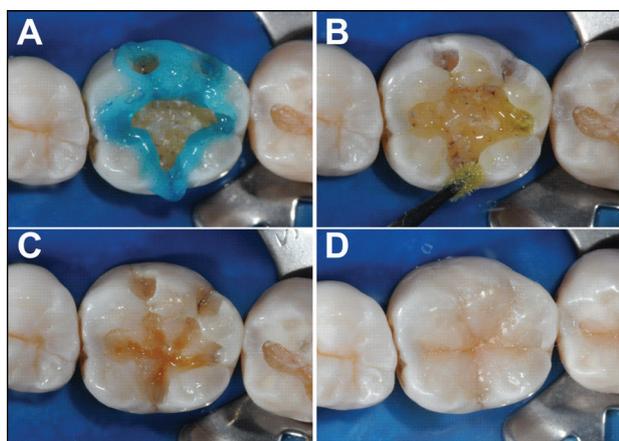
Tooth 37: On the occlusal surface were placed B2B composite resin increments, subsequently it was applied ocher pigment on the main and secondary grooves, finalizing the restoration with CT resin.

Teeth 46 and 47: The 46 tooth had pigmented grooves; however, the patient requested to remove them. During the amalgam restoration removal of the 46 tooth, we also removed caries subjacent to the restoration. In both teeth were inserted increments of B2B composite resin, and then it was applied to the mixture obtained with brown and ocher pigment and increments of CT resin.

The initial and final appearance of all restorations can be observed in Figure 2.

## DISCUSSION

In clinical practice, conditions commonly found are shallow amalgam restorations with in mass fractures or only at the borders, due to lack

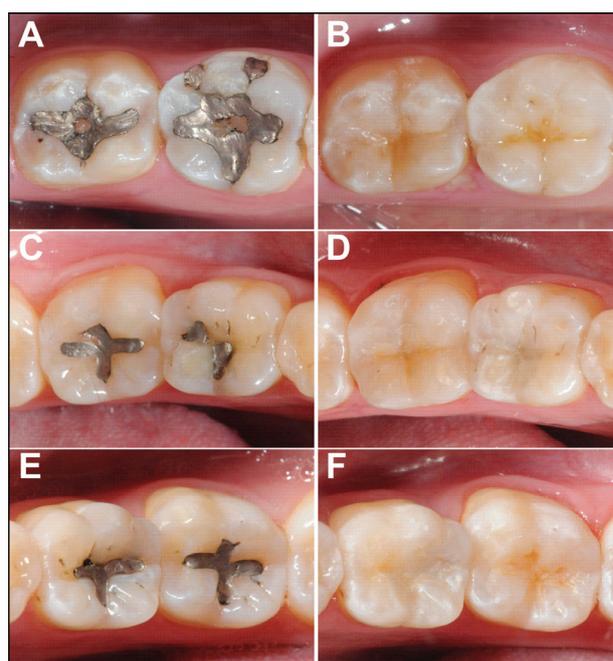


**Figure 1** - Sequence for replacement of restorations: case report I, tooth 36. A: Cavity preparation and selective enamel conditioning; B: Adhesive system application C: Insertion of composite resin and mixture of brown and ocher pigments photoactivated D: Appearance of restoration immediately after insertion of composite resin.

of professional attention, especially in relation to the shape and depth of the cavity preparation, in addition to the condensation, the honing, the polishing and the occlusal adjustment. As the amalgam does not support a very high incidence of tension, the cavities must be prepared so that the material has a thickness of at least 2mm to resist the mastication forces and not to be exposed to excessive stresses [11].

It is essential to observe the characteristics of the amalgam cavity preparation concerning the resistance and retention forms [12]. The resistance form is related to the depth and inclination of the walls of the cavity to allow adequate volume of material and prevent localized stresses. In the retention form, which also is given by the slope of the walls, is intended to prevent displacement of the restoration during chewing [12] because the strength of the amalgam support more compression loads than tensile and flexion loads [11].

Although in the cases described the failures are probably related to the preparation. Restoration quality may also be affected by the alloy composition. The conventional alloy that are



**Figure 2** - After/Before amalgam replacement. A/B: Teeth 36 and 37; C/D: Teeth 36 and 37; E/F: Teeth 46 and 47.

with a low copper content are more susceptible to the occurrence of marginal fractures, corrosion, tooth pigmentation, superficial porosity and dissolution of the material [11]. However, with the introduction of alloys with high copper content, the occurrence of the marginal fracture decreased by the slightly presence or absence of the game2 phase and lower amount of mercury, consequently less corrosion, porosity and dissolution, improving surface smoothness and mechanical properties [11].

However, with the development of adhesive restorative materials, composite resin has been the material of choice for restoring posterior teeth, due to aesthetic and good results in long-term [10,13].

The clinical performance of the composite resin is influenced by several intrinsic factors of the material as the matrix formulation, the type and amount of loading particles and its degree of conversion [14]. In opting for the resin as a restorative material must be respected: the occlusion; cavity preparation, the adhesive systems with the correct application forms [15]; polymerization shrinkage respecting the resin increases thickness and the number of walls that are in contact with the increment during photoactivation [14] because the C factor is directly related to the union of restoration to the tooth structure [15].

The latest innovation of the resins was the development of the nanoparticle composite resin that contain particles in the nanometer range [9], joining the good mechanical properties of the hybrid composite resin, the higher polishing of the microparticle composite resin [9,10], decreased in the wear rate [16] and reduced polymerization shrinkage [17]. Their longevity and aesthetic appearance also depends on the quality of the finishing and polishing techniques used [18].

Although several studies show that the longevity of amalgam restorations is superior to composite resin [19], in this clinical report, the

shallow preparations prevented the insertion of an appropriate volume of amalgam, probably interfering with the strength of the restoration to the masticatory forces, soon the use of composite resin was considered the best option to preserve the remaining tooth structure as it does not requires more invasive preparations for its retention.

In this study, it was used a new adhesive system "multi -mode" Scotchbond Universal, which it has in its composition: the bifunctional acid monomer 10-MDP (10-metacriloloxidecil dihydrogen phosphate) and copolymer "Vitrebond". The 10-MDP can demineralize the substrate and allow the penetration of resin monomers simultaneously uniting chemically to dental substrate [20]. Yoshida et al. [20] shows that the union of the MDP to hydroxyapatite increases the resistance of the adhesive interface due to the formation of stable "nanolayers" in the hybrid layer, and the deposition of the salt MDP-Ca along the "nanolayers" which explains the high stability of this union. The copolymer "Vitrebond" has hydrophilic characteristics that allows the adhesive system and has greater tolerance to moisture dentin, in addition to form bonds with calcium from hydroxyapatite [21] allowing it to be used both in the conventional way as in self-etching.

The conventional adhesive systems do not affect the enamel with the same depth as the phosphoric acid does, then the selective etching of the enamel is preconized by some authors [22,23] and it was used in these clinical cases as the protocol. This technique is suitable for improving the marginal integrity and lower marginal discoloration of the restoration [23].

The operator's experience in working with a particular material is also decisive, the operator A performed the restorations of the clinical case I and chose to use white pigment and composite resin to copy the white spot present on the buccal surface of the tooth 36 and the mixture of ocher and brown pigments on the major and minor grooves to generate

a natural appearance copying the pigmented grooves of the other teeth. The clinical case II was performed by operator B and it was not used pigment in tooth 36 because there was no deep enough to insert it. In tooth 37 was used the ocher pigment. The operator C that performed the restorations in tooth 46 and 47 chose the mixture of pigments ocher and brown but in different saturations. The esthetics results were satisfactory for all patients, however varied between operators, being important to evaluate the aesthetic desire of the patient as well as training the use of materials.

The restoration longevity depends of many factors such as the specialized skill, the materials and techniques utilized. The success of the restoration also depends on the commitment of the professional to encourage the patient to take care of their oral health with appropriate hygiene measures, since good oral health increases the longevity of restorations [3].

A restoration that does not restore function and esthetics should be replaced [24]. However, aesthetics can be subjective, what bothers or is required to professional will not bother the patient, the opposite is also true. Therefore, careful consideration is essential to avoid inappropriate treatments, damaging the remaining dental and unnecessary spending in public health [2]. Dentists should base on photographs, radiographs and own experience and knowledge [4], because the set of information will help improve the diagnosis and treatment decision, furthermore the professional must always educate his patients about the need for restoration repair or replacement and the its benefits and disadvantages.

In these clinical reports it was observed that the failures were related to resistance forms and retention of the cavity preparation, they are common factors related to the need for replacement of amalgam restorations, as well as the presence of recurrent caries, regardless the restorative material used,

currently, the composite resin is the material of choice for restoration replacement by not requiring more invasive preparations and be aesthetic. Moreover, it can be verified that the operator influence on the outcome of restorative procedures, because the constant training along and the scientific knowledge are essential in employment and correct indication of the material, being the success measured by the longevity of the restoration.

## CONCLUSION

It can be concluded that it is important to respect the forms of resistance and retention of amalgam preparations; in the presence of failed amalgam restorations, they must be repaired or carefully replaced to avoid damaging the remaining tooth, being the composite resin the material of choice to be more conservative and aesthetic.

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