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Repair vs replacement of composite restorations with secondary caries: A narrative review of current clinical strategies

Abstract

Secondary caries remain a leading cause of restoration failure and replacement in contemporary dental practice. The aim of this paper is to review current clinical criteria guiding the decision-making process between repair and replacement of composite restorations affected by secondary caries. Additionally, the paper assesses the effectiveness of surface conditioning techniques and prepares a repair protocol for recurrent caries. The electronic database search was carried out using PubMed and Google scholar databases with the keywords: "secondary caries", "repair", "replacement", "surface conditioning", "minimally invasive dentistry". The reference lists of selected articles were manually searched for appropriate studies. The literature search included publications from 01/01/2015 to 15/05/2025 and was limited to English language. Studies show that it is preferable to perform a repair rather than a replacement whenever possible. Surface conditioning techniques like bur roughening, air abrasion, acid etching, and the use of salinizing and adhesive agents can enhance the success of the repair method. However, evidence on how effective these methods are is less certain. When deciding between repair and replacement, clinicians should consider restoration material properties, patients caries risk, their personal experience, and the decay advancement. The currently obeyed rules of minimally invasive dentistry favour the decision of repair. Many methods of increasing the effectiveness of a restoration repair have been introduced. This study presents an exemplar repair protocol using air abrasion.

Keywords: secondary caries, repair, replacement, surface conditioning, minimally invasive dentistry.

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INTRODUCTION

Secondary caries are a common reason for the restoration loss and the replacement [1,2]. However, in light of minimally invasive dentistry, there is an ongoing debate on whether a repair protocol may be advantageous. Many academic authors suggest that restoration repair should be performed only if it is clinically possible [1,3,4].

The aim of this paper is to review the current clinical criteria guiding the decision-making process between repair and replacement of composite restorations affected by secondary caries. Additionally, the article aims to assess the effectiveness of surface conditioning techniques and to establish a repair protocol for recurrent caries. In order to achieve this, an electronic database search was carried out using PubMed and Google scholar databases with the keywords: "secondary caries", "repair", "replacement", "surface conditioning", "protocol", "minimally invasive dentistry". The reference lists of selected articles were hand searched for appropriate studies.

Due to technological advancements in the dentistry field, the literature search was limited to publications from 01/01/2015 to 31/12/2023. The search was also restricted to English language.

Secondary caries

Secondary caries is defined as a pathological lesion that develops next to a tooth restoration [5]. Its' formation is mainly caused by accumulation of dental plaque in the marginal gap, which is the space between the filling and the surrounding enamel [5]. Marginal leakage can be associated with incorrect polishing of the restoration margin, polymerization shrinkage of the material or chipping of a filling fragment [5]. In the literature are distinguished two types of secondary caries: an outer lesion, which develops next to the restoration, perpendicular to the tooth surface, which is of the same etiopathogenesis as primary caries, and an inner lesion, which occurs along the walls of the restoration [6]. Secondary caries is seen as one of the most common reasons for restoration loss or replacement [1]. A study performed by Mjor et al [7] showed the percentage of replaced fillings in adults due to a secondary caries diagnosis was approximately 50%, slightly higher in the case of amalgam restorations (57%) than according to composite (47%). These results show that more dentists carry out treatment focused on replacement. Early detection of secondary caries allows for less invasive options of treatment. There are several methods available for the early detection of these lesions, including visual inspection, tactile examination, radiographic imaging, laser fluorescence and assessments using quantitative light-induced fluorescence [8].

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Advantages and disadvantages of repair and replacement

Clinicians can choose between repair and replacement of the failed restoration due to secondary caries based on their advantages and disadvantages. Conventionally, such restorations were completely removed and replaced [9]. However, in the context of minimally invasive dentistry, there is a current shift towards the repair of partially defective restorations [10,11]. While repaired restorations are more likely to require further treatment compared to replaced ones, they result less frequently in more invasive procedures, such as root canal therapy or tooth extraction [12]. Repairing restorations not only slows down the restorative spiral of escalating hard tissue loss, it reduces potentially harmful effects on the dental pulp, is less costly in terms of time and financial resources, less likely to result in iatrogenic damage to adjacent teeth and in most cases is less painful and therefore does not require local anesthesia [13]. Kanzow and Wiegard found that the longevity of repaired restorations is comparable to those of replaced restorations, so repair can be seen as beneficial when it increases the longevity of dental restorations to a similar extent as full restoration replacement [14].

However, the most important clinical indicator which should be taken into account when deciding between replacement and repair is the extent of recurrent caries. As the depth of secondary caries increases, dentists are more likely to replace a restoration than to repair it [9].

Criteria for repair and replacement of restorations

The decision to repair or replace composite restorations is often at the discretion of the clinician [15,16]. Nevertheless, an updated version of the FDI criteria for evaluating dental restorations has recently been published and should be used as a foundation for making this decision [17]. The possibility of a minimally invasive approach depends on the location and size of the defect, and on whether it is accessible for repair [4]. Severe marginal demineralisation or caries with cavitation and suspected undermining caries that are localized and accessible can be repaired, while deep caries or exposed dentin, that is not accessible for repair, should be treated by a full restoration replacement [1]. It is possible that the restoration presents with multiple clinical problems in addition to secondary caries, such as marginal staining or fracture of the restorative material. In this situation, it may be more reasonable to replace the whole restoration than to carry out several repairs [17]. High risk patients, such as those who irregularly attend visits, with periodontal problems, those who use removable partial dentures and those whose teeth have previously been endodontically treated, are not considered for repair [3,18].

Uncertainty of the restoration material eradicates the possibility of repair due to the risk of ineffective adhesion, which can lead to an unsatisfactory clinical outcome [19,20]. Hence, it has been found that dentists are more likely to repair a failed restoration if they placed the original restoration themselves [13]. Figure 1 presents a decision tree, that can be used as an aid to decide whether to repair or replace a restoration.

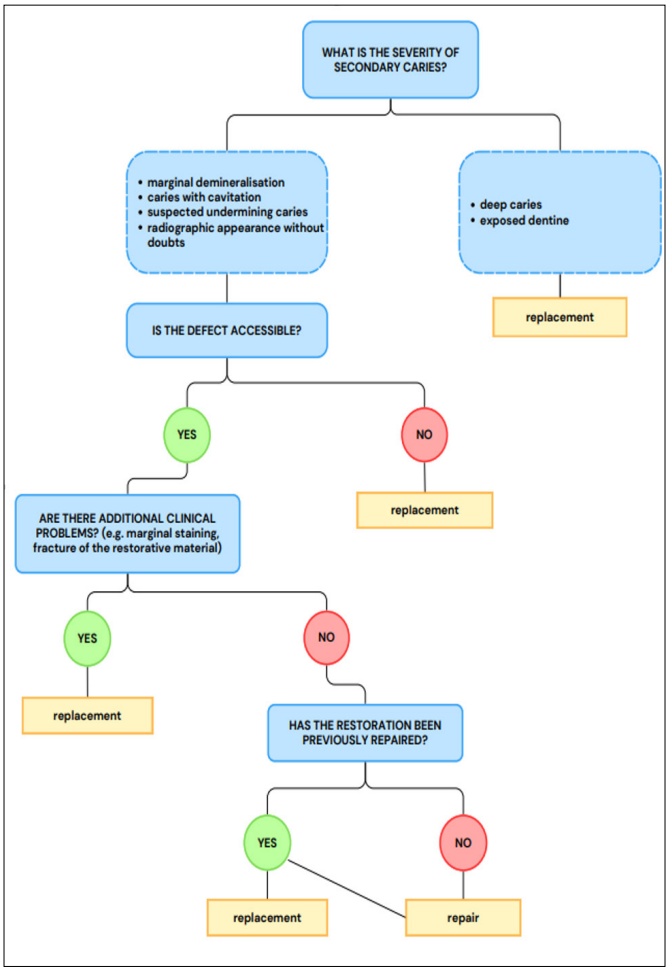

FIGURE 1. Repair and replacement decision tree.

Effect of surface conditioning on the repair success

Bonding between the old composite restoration and new repair can occur thanks to an oxygen-inhibited layer of unpolymerized resin [20]. For a repair to be successful, a durable bond has to be established and should be in the range of 15 to 25MPa [21,22]. This can be carried out through surface conditioning that maximizes macromechanical or micromechanical retention as well as by the use of appropriate chemical adhesion [23,24].

A course diamond bur rotating at high speed with constant water spray and air abrasion causes both “micro” and “macro” retentive features. Although course burs produce larger roughness than fine and medium burs, variation in the diamond bur grits does not affect the composite repair bond strength [25]. Air abrasion is typically applied using chairside devices, through which abrasion particles of aluminum oxide are applied for approximately 10 seconds from a distance of 10mm to obtain a clean and rough surface [21]. It has been suggested that micromechanical interlocking, created by air abrasion, may be the main bonding mechanism underlying the successful composite repair [21]. High-powered lasers are an alternative that shows similar microtensile bond strength to air abrasion through the process of removing the resin matrix from the composite surface and therefore creating a rough surface into which silane can penetrate [21,22,26].

Acid etching has a cleansing and degreasing effect on surfaces but does not affect the surface morphology [27]. While phosphoric acid does not change the surface roughness and therefore has been shown to be ineffective in increasing the

bond strength of repaired restorations [27], hydrofluoric acid, due to its greater aggressiveness, can significantly increase this characteristic feature [28].

The ability of monomers and solvent systems to penetrate into the composite surface depends both on the chemical affinity of the materials and on the degree of hydration of the composites. Intermediate bonding agents have an important role in composite repair [29]. Those including silane may improve the wettability of the adhesives on the irregular surfaces, thus facilitating the infiltration of adhesives into the irregularities [30]. Additionally, salinizing agents link inorganic filler particles to organic resin polymers, as silanes consist of a methacrylate group on one side, that reacts with intermediate adhesive resin and composites, and a reactive silanol group on the other side, that forms siloxane bonds with the inorganic filler particles of the old resin composite [30]. This significantly increases the bond strength [31].

Composite repair procedure

Below is an example protocol for composite restoration repair with air abrasion usage [32-34].

1. Ensure appropriate conditions of the working field – rubber dam isolation on the tooth being repaired.
2. Administer the local analgesia if required.
3. Begin cavity preparation with the removal of the failed part of the restoration and cleaning the tooth-restoration margin (especially if the recurrent caries occurred as a result of a microleakage). Next, finish the decayed walls and finally the pulpal wall.
4. Bevel the cavity margins, as indicated clinically (usually 0,5-1 mm wide), and place a 1 mm wide bevel on the margin of the material to be repaired. This increases the bonding surface area and has a positive effect on the esthetics of the restoration – the composite used to repair will blend in with the existing filling and surrounding tooth tissues. This stage is carried out using a fine-grit diamond bur under water cooling.
5. Perform air-abrasion perpendicularly with 50μm Al_2O_3 at a distance of 10mm for 4 seconds.
6. Apply the adhesive material, photopolymerize according to the manufacturer's instructions.
7. Apply resin composite incrementally, photopolymerize, finish, and polish to obtain a physiological shape.
8. Apply the last increment of composite and its photopolymerization and follow with removal of rubber dam
9. Adjust the restoration in occlusion, remove composite overhangs and perform final polishing.

RESULTS

The reviewed studies report that secondary caries is the primary cause for the replacement of restorations made from frequently used materials, including amalgam, composite, glass-ionomer and resin modified glass-ionomer restorations. Nevertheless, amalgam restorations have the highest incidence of replacement due to secondary caries. Although many publications emphasize that repair of restorations is favored due to being minimally invasive, extensive decay may require replacement to ensure treatment success. To make an informed decision between repair and replacement, clinicians should familiarize themselves with the recently published FDI criteria and apply these guidelines during treatment. When restoration repair is chosen, surface conditioning techniques should be used to enhance the bond strength. Air abrasion is the most readily available chairside technique, which has been incorporated into the presented repair protocol.

CONCLUSION

According to the literature, restoration repair and replacement after the caries diagnosis are the most common procedures in typical clinical practice. When considering the factors that influence the decision between repair and replacement, the clinician should take into account the properties of the restoration material, the patient caries risk, their own experience and, most importantly, the decay advancement. The currently obeyed rules of minimally invasive dentistry favors the decision to repair. Therefore, in most situations when it is possible, this is the recommended method. Restoration repair is a challenging procedure, from both a clinical and technical point of view, which is the reason why many methods increasing its effectiveness have been introduced into the repair procedure.

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