Composite resin support of undermined enamel in amalgam restorations

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Abstract

Purpose: Previous reports suggested that cusp fracture strength increased with the use of bonded composites. The purpose of this study was to assess fracture resistance of undermined cusps when supported by a layer of bonded composite, in extensive occlusal carious lesions.

Methods: Primary and permanent molars in children that were treated included those with extensive occlusal caries with undermined enamel in one or more cavity walls. Following local anesthesia and rubber dam application, cavity outline was prepared with a #330 tungsten bur, and the carious lesion removed. If an unsupported cusp was present, the inner enamel wall and the dentine floor adjacent to this wall was etched with a gel containing 37% phosphoric acid, rinsed and dried and Scotch bond multipurpose applied; a 1-mm layer of Z100 was applied to the unsupported cusp and polymerized; a nongamma 2 amalgam or Z100 was used to restore the tooth.

Results: The children were re-examined after 6, 12, or 24 months. A total of 42 restorations were placed in 39 children (26 boys and 13 girls), ranging in age from 4 to 16 years (mean age 9 years, 6 months). This is a preliminary report on 30 restorations, followed up from 6 to 24 months. All 30 restorations were successful in preventing cuspal fracture. Four teeth developed caries in the proximal surface, but were unrelated to the restoration.

Conclusions: It was concluded that bonded composite can prevent fracture of unsupported cusps. (Pediatr Dent 21:118–120, 1999)

When the carious lesion results in an undermined cusp, it is common practice to restore the tooth with a crown to protect the cusp from fracture. When the patient is a child, the use of stainless steel crowns is the treatment of choice both in primary and permanent molars. Often, parents are reluctant to accept this treatment modality because of the unsightly appearance of metal crowns and will search for an alternative. Recently introduced stainless steel crowns with composite facing have not been tested in controlled clinical trials; therefore, the alternative for consideration is the use of bonded composite to reinforce undermined cusps.

One disadvantage of a large amalgam restoration is that dental amalgam does not bond to tooth structure and therefore will not reinforce the remaining tooth structure in a significantly compromised tooth. It has been suggested that the use of an adhesive dentine liner beneath an amalgam restoration might increase the fracture resistance of the restored tooth. However, in another study, no such increase in fracture resistance was found.

A recent study investigating the influence of bonded amalgam restorations on the fracture strength of teeth demonstrated that the majority of failures seen for the adhesive groups were at the tooth/amalgam interface—indicating that improvements in bonding still need to be made. Furthermore, a study to test fatigue of resin-bonded amalgam restorations showed that fracture resistance after 24-h storage was significantly stronger than a corresponding copal varnish group. However, no significant differences between the bonded amalgam and the copal varnish group were found for the 500-day storage. This suggests that the strengthening effect of an adhesive resin on teeth restored with MOD amalgam restorations was transient.

A recent study reported that unsupported enamel with bonded composite can recover up to 65% of the lost cuspal stiffness.

The purpose of this pilot study was to assess fracture resistance of undermined cusps, when supported by a layer of bonded composite and restored with amalgam, in extensive occlusal carious lesions.

Methods

Sample selection

Primary and permanent molars in children that were treated in the undergraduate and graduate pediatric dentistry clinic at the Faculty of Dental Medicine in Jerusalem, Israel were selected.

The criteria for selection of the assessed teeth included molars that had undermined cusps due to extensive occlusal caries with undermined enamel in one or more cavity walls. Before the restorative procedure, informed consent was obtained from the parents after an explanation that included our routine treatment with metal crown for molars with unsupported cusps, and the possibility that the alternative treatment could prevent the need of a crown. The risk of cusp fracture was mentioned, and the need for a crown in the event of cusp fracture was explained.

The treatment protocol was discussed with the clinical instructors that were supervising residents and senior dental students. When an unsupported cusp was diagnosed, the author was consulted and consensus reached regarding the selection criteria.
The same routine was utilized for the follow-up examinations and the evaluation of the treatments was in most cases done with the operator and the author reaching a consensus regarding the evaluation criteria.

**These molars were treated according to the following protocol**

Following local anesthesia and rubber dam application, cavity outline was prepared with a #330 tungsten bur, and the carious lesion removed with a round bur (Fig 1 and 2). In very deep carious lesions following caries excavation, the deep dentine area was protected with Vitrabond liner (3M Dental Products, St. Paul, MN). If an unsupported cusp was present, the inner enamel wall and the dentine occlusal floor adjacent to this wall was etched with a gel containing 37% phosphoric acid, rinsed and dried, and Scotch Bond Multi-purpose (3M Dental Products, St. Paul, MN) was applied following the manufacturer's instructions. The other cavity walls were not bonded. A 1 mm layer of Z100, a hybrid composite, (3M Dental Products, St. Paul, MN) was applied to the unsupported cusp and polymerized for 40 sec (Fig 3). A nongamma 2 amalgam (Silmetal, Gyvatam, Israel) was used to restore the tooth (Fig 4), and was applied directly to the polymerized composite and cavity walls without any material at the composite/amalgam interface. In cases where the cavity was smaller than 2 mm, the entire cavity was filled with composite.

The children were re-examined after 6, 12, or 24 months. The quality of the restoration was assessed using the criteria described by Cvar and Ryge⁷ for marginal adaptation, marginal discoloration, and secondary caries. These criteria were modified to include cuspal integrity of the reinforced cusp. Cuspal integrity criteria were dichotomized as cuspal fracture or intact cusp, and were determined after a visual and tactile examination with a probe. Bite-wing radiographs were taken and examined for the presence of caries and the quality of the bonded composite including adaptation to the tooth and presence of bubbles.

**Results**

A total of 42 restorations were placed in 39 children (26 boys, 13 girls) ranging in age from 4 to 16 years (mean age 9 years, 6 months). The distribution of the treated teeth is presented in Table 1. The distribution of the 30 teeth that were re-examined is presented in Table 2. From the follow-up, 11 teeth were re-examined after 6–9 months, seven were re-examined after 12 months, nine after 18 months, and three after 24 months.

All 30 teeth were Alpha for marginal adaptation, while four demonstrated secondary caries in the proximal surface that were unrelated to the restored surfaces. All 30 restorations were successful in preventing cuspal fracture. In most cases, the enamel/composite interface was internal and marginal discoloration proved not to be relevant as an evaluation criteria. Moreover, the amalgam/composite interface, which is more amenable to clinical examination, is not part of the Cvar–Ryge criteria.

**Discussion**

Dental amalgam continues to be one of the most widely used restorative materials in dentistry because of its ease of manipulation, adequate physical properties, proven longevity, and low cost.⁸ Although probably not the same mechanism, bonded composite restorations in previous reports published since 1984 suggest that cusp fracture strength increases with the use of bonded composites,⁹ and that the bonded restorations...
demonstrated higher cusp reinforcement when compared with the MOD preparation and the nonbonded restorative procedures.\textsuperscript{10}

In another study on preventive resin restorations (PRR), Simonsen and Landy\textsuperscript{11} showed that mean fracture resistance was highest for teeth restored with Scotchbond and the composite P-30. The clinical phase of this study consisted of the examining 16 patients who had 41 first permanent molars treated with PRR after seven years. No evidence of cusp fracture were reported, and the authors concluded that the use of resins in PRR appear to minimize or eliminate any weakening effect of cavity preparation. A recent study clearly demonstrated that compomers are superior to amalgam in preventing cuspal fracture.\textsuperscript{12}

The aim of this study was to examine the effect of supporting undermined cusps with a layer of bonded composite in large occlusal amalgam restorations. The rationale for this procedure as compared to a full composite resin restoration was based on the fact that the polymerization shrinkage may rupture the weakened enamel, causing a gap or even fracture of the cusp.\textsuperscript{13} More importantly, the introduction of improved dentine bonding agents made it possible to develop a continuous bonding of the resin material from dentinal wall to enamel wall, thus reinforcing the weakened tooth structure.\textsuperscript{10} Of the 30 restorations, four were only composite. These were also successful, but the sample size was too small to draw any conclusions.

This preliminary report is the first in vivo study suggesting that bonded composite can prevent fracture of undermined cusps in large amalgam restorations. Clinical studies should assess whether composite only restorations could prevent cusp fractures. As polymerization shrinkage is a function of the volume of the composite material,\textsuperscript{14} it causes the composite, which has bonded to the cavity walls, to pull towards the center of its mass. This force can create tension that can be relieved by placement technique. Therefore, such a filling should be inserted in increments in such a way that the reinforced cusp should be polymerized first and additional increments polymerized without connection to the opposite wall to prevent cuspal deflection. The smallest possible volume of composite should be inserted to complete the last increment.

Of the 30 restorations evaluated, 19 teeth were followed for more than a year. Although the sample size and the follow-up periods are small, there is enough evidence to suggest the clinical application of this technique; therefore saving the child a more invasive procedure—a metal crown. Longer follow-up periods and a larger sample may confirm the merit of bonding composite to unsupported cusps.

It was concluded that bonded composite can prevent fracture of undermined cusps in primary and permanent molars that were restored with amalgam, and the use of preformed metal crowns was avoided.

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