Original Article

Effect of adding ribbond fibres on marginal adaptation in class II composite restorations in teeth with affected dentine

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ABSTRACT

Objective: To evaluate the feasibility and effect on marginal adaptation in class II composite restoration reinforced with polyethylene fibres in teeth with affected dentine using scanning electron microscopy.

Method and material: Class II cavities with dimension 1.5 ± 0.25 mm pulpal depth and 4 ± 0.25 mm buccolingual width/.were prepared on proximal surfaces extracted human molars or premolar with affected/sound dentine on gingival margin. The etching priming and restorations were done in prepared samples as per manufacture directions. The samples were divided in 2 groups depending on use of ribbond inserts in composite restorative material. Samples were finished, stored in distilled water and then thermocycled manually and then sectioned longitudinally through the restorations. The marginal adaptation was evaluated using scanning electron microscope (SEM).

Result: The result showed that there was a definite gap all along the interface between caries affected dentine and the composite material in both the groups. The bigger gap was present in group II compared to group I.

1. Introduction

The excellent aesthetic qualities and improved mechanical properties have made dental composites, the material of choice for restoring teeth. The bonding of composite material with different substrates, with a dentin bonding agent, has found to be satisfactory according to the literature.¹ Despite good micro - mechanical bonding, there exist some kind of polymerization shrinkage within the composite material during and after curing.² This polymerization shrinkage can increase to a greater extent while bonding with substrate other than sound dentine. According to Fusayama's research carious dentin consists of two distinct layers: an outer layer of bacterially infected dentin, and an inner layer of affected dentin.³ The outer layer (caries-infected dentin) has been characterized as highly demineralized, physiologically unremineralizable and showing irreversible denatured collagen fibrils with a virtual disappearance of cross-linkages. The inner layer (caries-affected dentin) is uninfected, partially demineralized and physiologically remineralizable, therefore should be preserved during clinical treatment. Consequently, in cavity preparation for a composite restoration after removal of caries-infected dentin, large areas of the cavity floor are composed of caries-affected dentin. Therefore, in clinical settings, bonding substrate

is commonly caries affected dentin, not normal dentin.

The previous reports have shown that the caries affected dentine (CAD), with more sclerosed intertubular dentine, is more acid resistant and is less permeable to bonding agents.^{4–6} This can undermine dentine hybridization and reduce tag formation in caries affected dentine (CAD). To overcome the polymerization shrinkage, various methods have been advocated including curing techniques, incremental build up, addition of reinforced glass or polyethylene fibre. The reinforced polyethylene fibre is also supposed to provide reinforcement and limit shrinkage in material while setting. Previous studies showed that the incorporation of polyethylene fibers in a composite resin matrix can help to improve gingival marginal adaptation in Class II cavities.⁷

The gingival seat in class II cavity design is most prone to marginal leakage because of inaccessibility and limitation to curing light. The presence of caries affected dentine (CAD) on the gingival seat might be an additional factor to be considered for the marginal adaptation.⁸ The present pilot study evaluated the feasibility and effect of adding polyethylene fibre Ribbond (Ribbond Inc., Seattle, WA, USA) on marginal adaptation in Class II composite restorations in teeth with caries affected dentine.

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2. Material and method

Freshly extracted human premolars and molars with caries lesion on proximal surface extended below CEJ (cementoenamel junction) were used in this study. The teeth were stored in 0.1% thymol, solutions after extraction and cleaned of gross debris using a hand scaler and were placed in deionized water for 24 h before starting the experiment. All the infected proximal carious dentin was excavated leaving only caries affected dentine (CAD). The CAD was identified using the combined criteria of visual examination and surface hardness with the use of a sharp dental explorer. The samples with gingival cavosurface margin having CAD were selected for restoration ($n = 4$). The modified class II cavity (proximal box only) were prepared on the selected samples, keeping a fixed dimension 1.5 ± 0.25 pulpal depth and 4 ± 0.25 mm buccolingual width. Proximal slot were prepared using a high-speed turbine KaVo, Germany under water cooling using standard (125 μ m) and fine (63 μ m) diamond burs (straight flat end 111/014, flat end tapered fissure 172/023, and tapered conical end 160/016, Mani Inc., Japan). The dimensions of the cavities were measured using a vernier calliper (Mitutoyo, Bombay Tools Center Bombay Pvt Ltd Mazgaon, Mumbai).

The samples were divided into two main experimental groups ($n = 4$) on the basis of use of Ribbond material within composite restoration are as follows:

- Group 1: Microhybrid universal composite resin, shade A2 (Z250, 3 M/ESPE, St. Paul, MN, USA) with one bottle adhesive system (control group-without ribbond). ($n = 2$)
- Group 2: Ribbond (Ribbond Inc., Seattle, WA, USA) fibres added in between the same composite material as in group I. ($n = 2$)

The samples in both groups received etching, primer and composite restorations in 2 mm increments as per manufacturer's directions. The curing of primer and composite restoration was done from occlusal direction, using a LED light-curing unit (Elipar S10, 3 M ESPE) at 1200 mW/cm.² The Ribbond fibre of size approximately 1 mm was added in-between restoration with 0.5 mm thickness composite material surrounding all around the fibre in group 2 samples. The rest of composite restoration technique used was same as in Group I. After curing, the gingival margins contoured and polished with Composite polishing kit (Shofu Co., Japan). The samples were stored in distilled water for 24 h. All the samples were exposed to 500 thermal cycles at 5 °C–55 °C in and dwell time of 30 s.

The samples were then sectioned in two halves with the restored gingival cavosurface margin in each section. The gingival cavosurface margins were analyzed at 500–5000 $\times$ magnification in a scanning electron microscope (Carl-Zeiss NTS GmbH, Germany). The marginal adaptation was classified into as “Continuous margin” if the interface between the restoration and tooth was continuous and exhibit less than 1 μ m gap and “Gapped margin” if the interface had gaps more than 1 μ m wide.^{1,9}

The in-built ruler of scanning electron microscope (SEM) was used to measure the total length of gingival margin. The length of non-continuous/imperfect margin (marginal gap $> 1 \mu$ m) was then evaluated.

3. Results

The result showed that there was a definite gap present at interface of CAD and the composite material in both the groups. The most of the substrate showed sclerosed dentine structure without formation of any resin tags in the affected dentin layer with and without the use of Ribbond. The gap was present in both the groups irrespective of Ribbond and the gap was greater (average 25 μ m) in group 2 compared to group 1 (10 μ m average) (see Figs. 1 and 2).

Fig. 1. SEM scanning electron microscope image of interface between dentine and restorative material in Group 1.

Fig. 2. SEM scanning electron microscope image of interface between dentine and restorative material in Group 2.

4. Discussion

The marginal adaptation of restorative material on gingival cavosurface margin, particularly below cementoenamel junction, poses a challenge to prevent marginal leakage.⁹ In the present study, the marginal adaptation was calculated as continuous or interrupted, on percentage basis of whole length of gingival margin. However the gap considered for calculation of interrupted margin was set at 1 μ m.

The affected dentine usually present with multiple calcified dentinal tubules and changed morphological dentine structure.⁶ No resin tag was formed when bonding with the sclerosed dentinal tubule was attempted in the both the samples. Thus limitations of bonding with affected dentine substrate need to be researched. Using AFM nanoindentation, Marshall et al. measured the mechanical properties of caries-affected transparent dental layers.¹⁰ It was found that carious-affected dentin showed either little change or lower values of elastic modulus and hardness, which was not significantly different from the underlying

noncarious dentin zone.¹¹ Using electron microscopy, it was demonstrated that intermolecular crosslinks of collagen fibrils still remained in the caries-affected dentin, and collagen fibrils were present with distinct banding structure closely resembling those in noncarious dentin.¹² There has been limited information on the chemical structure of the caries-affected dentin substrates.

In present study, the marginal adaptation was checked and expressed in percentage of gapped/continuous using scanning electron microscope pictures. It is one the reliable method to evaluate the margin as this is truly quantitative and non destructive in nature.⁶

The polyethylene fibre in between the composite material can decreases the volumetric contraction of composites. It also provides fracture resistance to deformation during the subsequent loading. The fibres in the restoration can also resist the separation of composite material from gingival margin while curing.¹³ However the results of this study does not support the hypothesis that marginal adaptation of composite resins to caries-affected dentin with Ribbond fibre increases in comparison to samples without Ribbond fibres, although the marginal gap were somewhat lower (but not significantly) in Group 1. The gap was present in both the groups irrespective of Ribbond and the gap was greater (average 25 µm) in group 2 compared to group 1 (10 µm average).

5. Conclusion

The amount, size, technique of placement and conditioning of fibre are some factors that need to be researched in follow up studies. The other factor to combat the polymerization shrinkage, while using affected dentine as substrate include the use of glass fibres incremental build up, light curing techniques, sandwich techniques alone or in combination with different reinforcing fibres. Thus, within the limitations of this study, addition of polyethylene fibre in composite material does not improve the marginal adaption particularly on affected dentine in gingival margin.

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Conflict of interest

None.

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