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Original Research

Effectiveness of Flowable Resin Composite in Reducing Microleakage – An *In Vitro* Study

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***Abstract*:**

Background: This study aimed to evaluate the microleakage, when flowable composite is used as a restorative material and a liner.

Materials and Methods: Forty, non-carious, extracted human premolar teeth were used and they were divided into five groups according to the type of composite material used. Group I: Hybrid composite was inserted and cured for 40 s. Group II: Flowable resin composite which was cured for 40 s. Group III: A thin layer of flowable composite was used to line the axial wall of cavity, over that hybrid composite was inserted and cured for 40 s. Group IV: A thin layer of flowable composite was lined on the axial wall of cavity; over that a packable composite was inserted and cured for 40 s. Group V: Group V was a control group. These cavities were not etched and bonded. They were restored with resin modified glass ionomer cement. After thermocycling and dye immersion, each tooth sectioned longitudinally. Each restoration was observed under a binocular stereomicroscope with magnifying loop of ×12 for microleakage.

Results: The results of the study indicate that there was minimum leakage at the enamel margin of all groups. In every group, the leakage at the dentin margin was more than that at the enamel margin. The difference was statistically significant in hybrid and flowable composite (P values are 0.29 and 0.289, respectively).

Conclusion: Similar leakage values were shown by Groups I and II, indicating that flowable and hybrid composites performed equally well in terms of microleakage. The use of flowable composite as a liner under hybrid and packable composite have shown a trend toward less leakage compared to hybrid and flowable composite alone.

***Key Words*:** Dental composite, liner, microleakage

Introduction

The premature loss or failure of restorative materials is often linked to breakdown at the interface between material and tooth structure. Consistent adhesion to tooth structure is the ultimate goal in dentistry. Unfortunately, this is a challenging problem too.[1]

Microleakage has been defined as "a clinically undetectable movement of bacterial fluids, molecules, and ions in microgaps (10^{-6} μm) between the cavity wall and the restorative material applied to it."[1]

Factors causing the formation of marginal gaps and subsequently leakage between the cavity wall and restorative material include-poor adhesion, temperature variables, contractional forces, polymerization shrinkage, inadequate moisture control, and masticatory forces. Microgaps created at the margin cause bacterial ingress precipitating post placement sensitivity due to the interfacial hydrodynamic phenomenon. It also leads to staining, defective restorations, secondary caries, and possible pulpal pathosis.[2-6]

Resin composites are widely used for restoring cervical lesions, as they are esthetic, mercury free and bond to tooth structure with the use of bonding systems. Restoring a cervical lesion with resin composites has always been a problem, especially where no enamel is present for bonding at the gingival margin. As bonding to dentin is more difficult than to enamel, dentin bonding agents are used to improve the marginal seal of resin composite restoration at the composites/tooth interface. They have proven to be effective at reducing but not eliminating the microleakage.[7-10]

The use of flowable composites, as the liner is another recently recommended technique for overcoming the shortcomings of resin composites. These resins are used as an initial thin layer under composites and function as a stress breaker.[11]

Hence, the present study is undertaken to evaluate the microleakage, when flowable composite is used as a restorative material and a liner.

Material and Methods

A total of 40 human premolars, extracted for orthodontic purposes, were used for this study.

Inclusion criteria

1. Teeth were free of caries

2. Teeth were free of white or hypoplastic spots
3. Teeth were free of cracks.

Teeth were stored in distilled water at room temperature. These teeth were used within 1 week of extraction.

Materials used

- Flowable composite (Tetric Flow, Vivadent)
- Hybrid composite (Vivadent)
- Packable composite (Vivadent)
- Acid etchant (vivadent)
- Bonding agent (Excite)™
- Polishing kit (Vivadent)
- Light cured glass ionomer cement (GIC) (Fuji)
- Diamond disc
- 0.5% basic fuchsin
- Nail varnish.

Methodology

Tooth specimen preparation

Eighty Class V cavities were prepared. The bur was replaced after every fifth preparation. The preparation was approximately 3 mm wide, 2 mm high, and 1.5 mm deep.

Restorative procedure

For this purpose, teeth were divided into five groups. Etching and bonding procedures were conducted for 64 cavities by the same operator. Teeth were randomly distributed in four groups.

Group I

Hybrid composite was inserted in increments to fill the complete cavity, with special attention given to marginal adaptation. Each increment of the resin was light cured for 40 s.

Group II

These cavities were filled with flowable resin composite (tetric flow) which was cured for 40 s.

Group III

A thin layer of flowable composite was used to line the axial wall of cavity preparation. After curing the flowable composite for 40 s, hybrid composite was inserted in increments. Each increment of the resin was light cured for 40 s.

Group IV

A thin layer of flowable composite was lined on the axial wall of cavity preparation and cured for 40 s; a packable composite was inserted in increments to fill the complete cavity and light cured for 40 s.

Group V

Group V was a control group. These 16 cavities were not etched and bonded. They were restored with resin modified GIC.

All restorations were finished after 24 h with fine grit diamond burs and softlex discs. Teeth were stored in 37° for 7 day and then thermocycled between 5° and 55° for 25 times. The specimens were immersed in 0.5% basic fuchsin solution and stored for 24 h at 37°C. A diamond disc was used to section each tooth longitudinally. Each restoration was observed under a binocular stereomicroscope with magnifying loop of ×12.

For each restoration, the sectioned half with greater leakage was selected for scoring.

Scoring criteria was as follows:

0 No leakage.
1 Dye penetration from cavosurface margin of the tooth to less than half the length of the prepared wall.
2 Dye penetration from cavosurface margin of the tooth to more than half the length of the prepared wall, but not involving the axial wall.
3 Dye penetration from cavosurface margin of the tooth along the whole length of the prepared wall and also involving the axial wall.

Results

The results of the microleakage study are shown in Table 1.

The Kruskal–Wallis (One-way ANOVA) test was applied to compare the enamel walls and dentin walls of all groups. As P value > 0.05. No significant difference was found in the leakage along enamel walls dentin walls of all the groups.

Group	Mean leakage score (standard deviation)	
	Enamel	Dentin
I	0.1250 (0.342)	0.5000 (0.816)
II	0.1875 (0.544)	0.5000 (0.894)
III	0.0000 (0.000)	0.3125 (0.602)
IV	0.0000 (0.000)	0.3125 (0.612)
V	0.0000 (0.000)	0.2500 (0.683)

Table 1: Leakage score.

Sample number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Group I																
Enamel	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0
Dentine	0	1	2	0	0	0	2	0	0	0	0	0	0	1	2	0
Group II																
Enamel	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0
Dentine	0	1	0	0	0	2	0	0	0	1	0	0	0	1	3	0
Group III																
Enamel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dentine	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	2
Group IV																
Enamel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dentine	0	0	0	2	0	0	0	0	0	0	1	1	1	0	0	0
Group V																
Enamel	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dentine	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0

The paired *t*-test was applied to compare enamel and dentin within the group.

Discussion

Introduction of the acid etch technique by Buonocore (1955) has made microleakage virtually non-existent at enamel cavosurface margins that have been properly etched.[12]

The results of the study indicate that there was minimum leakage at the enamel margin of all groups. This is because of the efficient bonding of composite resin with the enamel. Bond strength with enamel has increased to 20-22 MPA. Polymerization shrinkage of conventional composite causes stress of approximately 18 MPA. Therefore, there was virtually no leakage at enamel margin.[12]

In this study, good results were also obtained with flowable composite. Similar leakage values were shown by Groups I and II, indicating that flowable and hybrid composites performed equally well in terms of microleakage. As we found no noticeable differences, in microleakage by flowable and non flowable composites, it appears that the influence of low elastic modulus on stress development of flowable composites is surpassed by their high contraction strain, resulting in stress levels that are equivalent to those obtained with non flowable material.[13,14]

The combination of a flowable resin liner and a hybrid composite and flowable resin liner and a packable resin restoration has shown a trend toward less leakage.[15]

Resin-rich flowable composites, which have low viscosity adapt as well as hybrid composites to cavity margins. Their low modulus of elasticity allows for plastic deformation, which acts as an elastic buffer and increase the flexibility of the bonded assembly and might act as a shock absorber and thus compensates for contraction shrinkage stress when used as a liner.[16]

These findings are similar to other investigations that proved that a flowable composite liner under a resin composite could reduce microleakage.[17]

In this study, we also found that complete elimination of microleakage at the dentinal margin is not achieved with flowable composite used as a liner.[18]

These inconsistent findings associated with the use of flowable composites can be explained in the following way: Elastic modulus and contraction stress. In this study also, light cured GIC showed minimum leakage among all groups. This may be because of the:

1. Chemical bond between the tooth structure and GIC (ion exchange mechanism).
2. Linear coefficient of thermal expansion of GIC which is close to that of tooth structure.
3. Better penetration of resin modified GIC through the smear layer.[16]

The effect of application of the new generation bulk flowable composite resin as an intermediate layer between composite resin and dentin was evaluated in one study. There was no significantly difference in dye penetration was found between control and experimental groups. Hence, it was concluded that microleakage was not affected by the application of either conventional or new generation flowable composite resin as an intermediate material between composite resin and dentin.[19]

In one *in vitro* study marginal sealing ability of a bulk fill flowable resin composite on both enamel and dentin evaluated. Bulk fill flowable resins provided significantly better marginal seal in dentin, both before and after artificial ageing. While nanohybrid resin composite and bulk fill flowable resin showed similar microleakage values at enamel margins.[20]

Above-mentioned *in vitro* studies[19,20] are supported to our study that shown flowable and hybrid composites performed equally well in terms of microleakage and flowable composite liner under a resin composite could reduce microleakage.

Conclusion

Within the limitations of this *in vitro* study, the findings are:

i. Minimal leakage was observed at enamel margins of hybrid (mean leakage score = 0.125) and flowable composites (mean leakage score = 0.1875). No leakage was observed at enamel margin when flowable composite was used as a liner under hybrid and packable composite (mean leakage score = 0).
ii. The microleakage of flowable resin composite as a restorative material is similar to hybrid composite.
iii. In every group, the leakage at the dentin margin was more than that at the enamel margin. The difference was statistically significant in hybrid and flowable composite (*P* values are 0.29 and 0.289, respectively).
iv. The use of flowable composite as a liner under hybrid and packable composite have shown a trend toward less leakage compared to hybrid and flowable composite (mean leakage score = 0.3125).
v. The control group light cured GIC have shown minimum leakage.

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