Original Article

Comparison of Microleakage of a Self-adhesive Composite with a Conventional Flowable Composite and Resin Modified Glass Ionomer Cement in Class V Restorations

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Received 4 September 2022 and Accepted 13 December 2022

Abstract

Introduction: Self-adhering flowable composite resins were recently introduced to combine the merits of both adhesive and restorative technologies in one product. This study aimed to evaluate the microleakage of a self-adhering flowable composite in comparison with a conventional flowable composite and resin-modified glass ionomer cement in class V cavities. **Methods:** In this *in vitro* experimental study, class V cavities were prepared in the buccal and lingual surfaces of 20 sound human molars (40 cavities). The cavities were randomly divided into 4 groups (n=10) and restored with Vertise Flow self-adhering flowable composite in group A, Premise conventional flowable composite in group B, etched with 37% phosphoric acid and restored with OptiBond Solo Plus + Vertise Flow in group C, and Fuji II LC glass ionomer in group D. The specimens were thermocycled for 1000 cycles (5-55˚C), immersed in 0.5% basic fuchsine dye solution for 24 h, sectioned, and observed under a stereomicroscope. Data were analyzed by SPSS software using the Kruskal-Wallis, Npar, and Wilcoxon signed rank tests (alpha=0.05). **Results:** The Kruskal-Wallis test showed that the degree of microleakage was not significantly different among different groups at the enamel margin (P=161) or the dentin margin (P=467). The Wilcoxon signed rank test revealed that the difference in microleakage between the dentin and enamel margins was significant within all four groups (P<0.05). **Conclusion:** The microleakage of self-adhesive composite, self-adhesive composite with separate etching and bonding, flowable composite, and glass ionomer cement was the same at both dentin and enamel margins.

Keywords: Dentin adhesion, Dental Leakage, Enamel adhesion, Resin-composite

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Moidi M, Hoseinifar R, Shahrokhi F, Soltanianzadeh M. Comparison of Microleakage of a Self-adhesive Composite with a Conventional Flowable Composite and Resin Modified Glass Ionomer Cement in Class V Restorations. J Dent Mater Tech. 2022; 11(4): 249-256.

Introduction

The demand for tooth-colored restorations has substantially increased over the past decades. Composite resins are the most widely used esthetic restorative materials (1). The reasons for this widespread popularity are their excellent esthetics, the need for minimal cavity preparation, micromechanical bonding, and satisfactory dental bonding. An optimal bond to a dental substrate can help in the adhesion of restorative materials and eliminate the need for the preparation of a retentive form, which requires the removal of sound tooth structure. An optimal bond between the restorative materials and the tooth structure can effectively decrease microleakage and its subsequent complications (1).

The durability of class V restorations and prevention of microleakage in cervical restorations, especially in the absence of enamel at the gingival margin, are major challenges in restorative dentistry(2). Marginal microleakage leads to subsequent tooth hypersensitivity, marginal discoloration, secondary caries, and pupal damage (3). The absence of enamel at the gingival margin of cervical lesions is a major challenge (4). Therefore, the significance of the provision of a complete seal should be considered at the time of treatment for the success and f

One common concern in the composite restoration of teeth is the time-consuming process of enamel and dentin surface preparation due to the possibility of saliva contamination of the cavity during the procedural steps, which can negatively affect the longevity of the restoration and may necessitate repetition of the preparation steps (7, 8). This is particularly important in class V restorations, which are close to the gingival margin and adjacent to the gingival crevicular fluid because of more difficult isolation of these areas (9). Composite resins and glass ionomers are widely used for the restoration of cervical lesions (2). The use of flowable composites in these cavities was recently recommended as an efficient alternative to conventional composites (10). The flowable composites have excellent esthetics and low viscosity (8, 11, 12), which enhances their delivery into the cavity and adaptation to the walls, compared to conventional composites (13, 14).

Self-adhering flowable composites were recently introduced to address the time-consuming application of conventional composites (15). These composites combine the merits of both adhesive and restorative technologies in the same product (16). The composition of these composites includes glycerophosphate dimethacrylate (GPDM) to etch the enamel and dentin and hydroxyethyl methacrylate to enhance wetting and resin penetration into dentin. These resins are bonded to the phosphate groups of the GPDM monomers and hydroxyapatite of tooth structure by chemical bonding. Moreover, polymerized monomers are micromechanically interlocked between the dentin collagen fibers and the smear layer (16, 17).

The use of composite resins that do not require the separate application of adhesive will save time and minimize errors (18). This study aimed to assess the degree of microleakage of self-adhering flowable composite in comparison with conventional flowable composite and resin-modified glass ionomer in cervical cavities.

Materials and Methods

This *in vitro*, experimental study evaluated 20 sound molar teeth with no caries or decalcification, which had been extracted or were under orthodontic treatment within three months before the study onset (IR.KMU.REC.1395.922). The collected teeth were washed under running water, and the tissue residues and debris were removed from the surface of the samples. A scaler was used for this purpose. Then, the surface of the samples was polished with a prophy brush and pumice paste with a low-speed handpiece. Immediately after polishing, the teeth were disinfected in 0.5% chloramine T solution for one week and were subsequently stored in distilled water at room temperature (25℃).

Next, 80 standard class V cavities with 4 mm mesiodistal width, 1.5 mm depth, and 2 mm occlusogingival height were prepared in the buccal and lingual surfaces at the midpoint of the cementoenamel junction (half of the cavity was in the enamel and the other half in dentin). The cavities were prepared with a high-speed handpiece and 0.8 straight fissure diamond bur under copious water irrigation. The bur was replaced after the preparation of five cavities. The samples were then randomly divided into 4 groups of 10 for the application of different restorative materials. Table I presents the characteristics of the adhesives and restorative materials used in this study.

Table I: Characteristics of the adhesives evaluated in this study

Material	Manufacturer	Chemical composition
Vertise Flow self-adhering composite Batch numbr:5842135 A2 shade	Kerr, Orange, CA, USA	GPDM, methacrylate co-monomer, prepolymerized filler, 1-µm barium glass filler, nano-sized colloidal silica, Nano-sized ytterbium fluoride. pH:1.9
OptiBond Solo Plus Batch number:35960	Kerr, Orange, CA, USA	
Premise flowable composite Batch number:5923029	Kerr, Orange, CA, USA	Prepolymerized filler, barium glass, silica filler, ethoxylated bis-phenol-A-dimethacrylate, Triethylene glycol dimethacrylate, light-cure initiators and stabilizers, organophosphate dispersant
Fuji II LC Batch number:002563	GC, Tokyo, Japan	
Etchant gel	Kerr, Orange, CA, USA	37.5% orthophosphoric acid, silica thickener
Cavity Conditioner Batch number:1605031	GC, Tokyo, Japan	20% polyacrylic acid solution

Group A: After 20 seconds of rinsing, excess surface moisture was removed by a cotton pellet. Then, the entire cavity was filled with an A2 shade of self-adhering flowable composite (Vertise Flow Self-Adhesive, Kerr) and cured for 20 seconds with a light curing unit and a light intensity of 460 mW /cm^2.

Group B: After 20 seconds of washing, the surface was gently dried with airflow for 5 seconds, etched with 37% phosphoric acid gel for 15 seconds, and washed for 20 seconds. Excess surface moisture was removed by cotton pellets. The surface was impregnated with a thin layer of bonding agent (OptiBond Solo Plus, Kerr, USA). The bonding agent was rubbed softly with an applicator for 15 seconds. Then, it was thinned with gentle airflow for 3 seconds, and the second layer was bonded, and re-thinned by airflow. Next, it was cured for 20 seconds. After that, the cavity was filled with conventional flowable composite (Premise, Kerr, USA) and cured for 40 seconds.

Group C: After 20 seconds of washing, the surface was gently dried with airflow for 5 seconds, etched with 37% phosphoric acid gel for 15 seconds, washed for 20 seconds, excess surface moisture was removed by cotton pellets, and the surface was impregnated with a thin layer of bonding agent (OptiBond Solo Plus, Kerr, USA). The bonding agent was gently rubbed with an applicator for 15 seconds, thinned gently with airflow for 3 seconds, and then the second layer of bonding agent was added, thinned again by airflow, and cured for 20 seconds. Next, the cavity was filled with the A2 shade of self-adhering flowable composite (Vertise Flow self-adhesive, Kerr, USA) and cured for 20 seconds with a light curing unit with a light intensity of 460 mW/cm^2.

Group D: After 20 seconds of rinsing, the surface was gently dried with airflow for 5 seconds. Cavity conditioning was performed with 20% polyacrylic acid (Cavity Conditioner; GC, Japan) for 10 seconds, rinsed for 20 seconds, and excess surface moisture was removed by a cotton pellet. The cavity was filled with glass ionomer (Fuji II LC; GC, Japan), and cured for 20 seconds. After 24 hours, finishing and polishing procedures were carried out using a silicone bur and a polisher for all specimens.

After restoration, the teeth were incubated in distilled water at 37℃ for 24 hours. In the next step, the restorations underwent aging (1000 thermal cycles, at 5℃ for 30 seconds and at 55℃ for 30 seconds with a transfer time of 10 seconds) (19, 20). The apex of the teeth was filled with sticky wax to prevent dye penetration. Afterward, the teeth were coated with 2 layers of nail varnish, except for the class V restoration area and a 1-mm margin around it. The samples were immersed in 0.5% basic fuchsine solution for 24 hours. The teeth were then rinsed and mounted in acrylic blocks. They were longitudinally sectioned at the center of the restoration occluso-gingivally using a 0.3 mm double-sided diamond disc. The sectioning process was performed under water irrigation to eliminate the debris, and the sectioned samples were inspected under a stereomicroscope (ZEISS- Stemi DV4) at ×40 magnification.

The dye penetration was scored as follows (21): Score 0=no dye penetration, score 1=dye penetration to 1/2 of the gingival or occlusal wall, score 2=dye penetration by more than 1/2 of the gingival wall but not reaching the axial wall, and score 3=dye penetration reaching the axial wall. The data were analyzed by SPSS software using the Kruskal-Wallis and Wilcoxon signed rank tests at the significance level of P<0.05.

Results

The study was conducted on 20 teeth in 4 equal groups with 10 cavities.

The degree of microleakage in the study groups is presented in Tables II and III. The Kruskal-Wallis test showed that the degree of microleakage at the enamel margin was not significantly different among the groups (P=0.161). Based on this test, the degree of microleakage at the dentin margin was not significantly different among the groups either (P=0.467). The Wilcoxon signed rank test showed that the difference in the degree of microleakage at the dentin and enamel margins was significant within all four groups (P<0.05). In all groups, the degree of microleakage was significantly higher at the dentin margin than at the enamel margin.

Table II: Frequency of different degrees of microleakage at the dentin and enamel margins in the study groups

Groups	Enamel margin				Dentin margin			
	Score 0	score 1	Score 2	score 3	Score 0	Score 1	Score 2	Score 3
A	0	10	0	0	0	1	6	3
B	2	7	1	0	0	0	9	1
C	4	4	2	0	0	3	6	1
D	1	4	5	0	0	2	5	3

A: self-adhering flowable composite (Vertise Flow Self-Adhesive)

B: phosphoric acid 37%+OptiBond Solo Plus+ conventional flowable composite

C: phosphoric acid 37%+OptiBond Solo Plus+ self-adhering flowable composite (Vertise Flow Self-Adhesive)

D: polyacrylic acid 20%+ glass inomer

Table III: Descriptive statistics of marginal microleakage at the dentin and enamel margins

		N	Mean	Std. Deviation
Enamel	A	10	1.10	.316
	B	10	.90	.568
	C	10	.80	.789
	D	10	1.40	.699
	Total	40	1.05	.639
Dentin	A	10	2.20	.632
	B	10	2.10	.316
	C	10	1.80	.632
	D	10	2.10	.738
	Total	40	2.05	.597

A: self-adhering flowable composite (Vertise Flow Self-Adhesive)

B: phosphoric acid 37%+OptiBond Solo Plus+ conventional flowable composite

C: phosphoric acid 37%+OptiBond Solo Plus+ self-adhering flowable composite (Vertise Flow Self-Adhesive)

D: polyacrylic acid 20%+ glass inomer

Discussion

Composite resins are commonly used for dental restorations, especially in the anterior teeth due to the increased demand of patients for cosmetic restorations (22). Recently, self-adhering composite resins were introduced to the market with a behavior similar to that of self-adhesive cements. Thus, it is important to assess the clinical efficacy of this novel type of composite *in vitro*.

Among different characteristics, marginal leakage greatly affects the clinical success of restorations (23). Prevention of marginal leakage is a key goal in restorative dentistry. Accordingly, many scholars consider the microleakage as an index to assess the superiority of restorative materials over each other (24). Class V cavities are the most efficient for the evaluation of the clinical characteristics of the adhesives. In the present study, class V cavities were prepared with their occlusal margin in the enamel and gingival margin in the dentin. The results showed no significant difference among the tested composites in terms of microleakage either at the enamel or at the dentin margin.

The polymerization shrinkage is very high in class V cavities with a C factor of 5, and thus, it is imperative to assess the microleakage in such cavities (25). The study results showed that the degree of microleakage was significantly higher at the dentin margin than the enamel margin in all four groups due to the structural differences between the enamel and dentin, better etching of enamel, lower mineral content and higher water content of dentin, and presence of dentinal tubules (23, 26).

In group A, in which the self-adhesive composite was used without etching and bonding, the dentin microleakage was significantly greater than the enamel microleakage due to the characteristics of the Vertise Flow self-adhesive composite. Because of the acidic phosphate group in this composite, the GPDM monomer has potent acidity to etch the tooth structure (27). It has been shown that Vertise Flow opens the dentin tubules and exposes the collagen network fibers with microporosities, which is similar to the effect of acid etching with phosphoric acid. Due to the presence of this functional monomer in its composition, Vertise Flow has strong acidity.

The present results found no significant difference in the degree of microleakage at the enamel margin among different groups. Moreover, the degree of microleakage at the dentin margin did not significantly differ among different groups, demonstrating the acceptable clinical sealing ability of Vertise Flow self-adhesive composite without the need for additional etching and bonding; although, there are some limitations in the handling of these materials.

Some studies showed that the use of adhesive agents prior to the application of self-adhesive composites increased the bond strength and decreased the microleakage at the enamel and dentin margins (16, 28). However, several other studies found no significant difference when a flowable non-adhesive composite was used without etching according to the manufacturer's instructions, which was in line with the present findings (10, 29, 30).

Bektas et al. in 2013 evaluated the microleakage of the Vertise Flow composite and showed no difference between the degree of microleakage of the Vertise Flow self-adhesive composite and a conventional composite used with OptiBond Solo, which was in line with the present results (16). Ferrari et al. also showed that Vertise Flow self-adhesive composite had a lower degree of leakage than all other self-adhesive composites (31). In a study by Lane et al., the degree of microleakage of the WetBond self-adhesive composite was not different from that of the conventional composites, which was in line with the present results; however, separate application of bonding agent resulted in a reduction in microleakage (32).

Asefzadeh et al. examined the degree of microleakage of the wet bond self-adhesive composite and reported that the microleakage of the self-adhesive composite was significantly lower than that of the conventional composite at the gingival margin; however, the microleakage of the conventional composite was significantly lower than that of the self-adhesive composite at the occlusal margin (9). On the other hand, in our study, there was no difference between the occlusal microleakage of the conventional and self-adhesive composites, probably due to lower pH and higher acidity of the GPDM monomer in the Vertise Flow composite, resulting in better etching and subsequent bonding to the enamel.

Some studies have reported that the storage of restored teeth in water increases the marginal adaptation and decreases the microleakage due to hygroscopic expansion. It has been shown that the Vertise Flow has high water sorption and higher hygroscopic dimensional changes that decrease the microleakage. In addition, Vertise Flow contains fluoride ions, which have been shown to increase the durability of the bond after aging in water (33). Increased bond strength may be due to the reaction of fluoride with adhesive components that causes dentin remineralization. The use of self-adhesive resin may form non-infiltrated and partially demineralized dentin. It has been claimed that the acidic monomer creates a space containing insoluble calcium and phosphorus during the self-etch process. Fluoride-releasing cements release fluoride into this space and decrease the risk of tooth demineralization. A similar effect has been observed in the use of self-adhesive fluoride-containing composites that can protect the adhesive tooth-restoration interface after aging (34).

Farmer et al. in 2014 revealed that the marginal leakage of a self-adhesive composite was higher in the dentin surface and lower in the enamel surface in comparison with glass ionomer, which is consistent with our findings (35). In the present study, the degree of microleakage in glass ionomer was numerically higher at the enamel margin in comparison with the self-adhesive composite due to the weaker acidity of glass ionomer than the self-adhesive composite and weaker bond to enamel; however, the leakage was greater at the dentin margin due to the chemical bonding of glass ionomer and calcium, compared to the self-adhesive composite.

Conclusion:

The microleakage of self-adhesive composite, self-adhesive composite with separate etching and bonding, flowable composite, and glass ionomer cement was the same at both dentin and enamel margins.

Conflict of interest:

The authors have no conflicts of interest to disclose.

Acknowledgment:

None

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