

Microleakage of Different Self-adhering Materials

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Abstract. Purpose: This in vitro study evaluated the microleakage of glass carbomer (Glass Fill, GCP Dental, Vianen, Netherlands), resin-modified glass ionomer (Fuji II LC, GC, Japan) and self-adhering flowable composite (Vertise Flow, Kerr, USA) materials. **Materials And Methods:** Class V cavities were prepared in the occlusal margin of enamel and gingival margin of dentin on both buccal and lingual surfaces of 45 human molar teeth and restored with self-adhering materials according to manufacturers' directions (n=15). The specimens were immersed in 2% basic fuchsin dye at 37°C for 24 hours. The teeth were sectioned into two pieces buccolingually in an occlusoapical direction and evaluated for microleakage using a stereo microscope (30×) and the degree of microleakage was evaluated using specific scoring criteria. The data were analyzed using Kruskal-Wallis, Mann-Whitney U, and Wilcoxon signed-rank tests. **Results:** When the self-adhering materials were compared, Glass Fill showed the highest leakage scores but was statistically different from only Vertise flow in the gingival surfaces (p<0.05). In the occlusal surfaces all tested self-adhering materials exhibited similar degrees of microleakage at the enamel margins (p>0.05). **Conclusion:** Glass Carbomer based self-adhering material showed more microleakage than resin based self adhering materials in the gingival surfaces, but in the occlusal surfaces all of the tested materials showed good performance.

Keywords: Self-adhering materials, glass carbomer, microleakage.

1 Introduction

Within the last fifty years, various dental materials have been introduced to the market and a large amount of them relate to the adhesive dentistry. Adhesion dentistry is performed in nearly every restorative dental practice today. Once clinically effective bond strengths were achieved to dentin and enamel, the development emphasis is shifted to reducing the complexity of the technique through the use of fewer bottles and chemical agents [1]. Numerous simplified adhesives have been introduced e.g. resin-modified glass ionomer cements (RMGICs), one-step bonding agents, self-adhering resin cements, self-adhering flowable resin composites, and glass carbomer cement.

Glass ionomer cements (GICs) comprise a category of bioactive dental materials. Improvement of GICs led to the development of light-cured RMGICs, which have enhanced flexural strength, diametral tensile strength, elastic modulus, and wear resistance compared with GICs [2].

Glass carbomer, a new glass ionomer-based restorative material, has been developed in recent years. Glass carbomer is distinguished from glass ionomer by its nano-sized powder particles and fluorapatite crystals. The belief that glass ionomers turn into fluorapatite-like material over time led to the inclusion of fluorapatite in glass carbomer [3]. Compared with conventional GICs, glass carbomer has significantly better mechanical and chemical properties (e.g. strength, shear, and wear) [4]. The clinical application of glass carbomer is similar to that of conventional GICs, except that heat application during the setting reaction is recommended. Heat can be applied with a special light-curing device during setting in glass fill. Recent studies have documented the beneficial effects of heat on glass ionomers [5-7].

More recently, self-adhering flowable composite was introduced to address the time-consuming procedure used with traditional materials [8]. These restorative materials, which are primarily direct composite resins, have two important components: an acidic monomer used for etching, such as

glycerophosphatedimethacrylate (GPDM), and the other one is hydroxy-ethyl methacrylate (HEMA), which is widely used in adhesive dentistry to enhance resin penetration and wetting. Although, it sounds nice of self-bonded flowable composite, in studies high water absorption was demonstrated regarding this material [9,10]. On the other hand, Bektas and et al. [11] demonstrated statistically higher shear bond strength and lower microleakage scores in Vertise Flow when used with a bonding system.

All of these restorative materials are even more useful when a patient may be uncooperative during treatment and also for pediatric or elderly patients. They have been proposed as an adhesive-free restorative material indicated for the restoration of small class I cavities, class V cavities, and non-cariious cervical lesions, as well as for a lining in class I and class II restorations, pit and fissure sealings, and porcelain repairs [12]. However, an effective seal at the tooth/restoration interface is very important properties of materials that are used in dentistry. Achieving such a seal would minimize microleakage and its consequences, such as postoperative sensitivity, pulp inflammation, and recurrence of caries. Therefore, the aim of this study was to determine and compare the microleakage of Glass Carbomer, resin modified glass ionomer and self-adhering flowable composite materials. For the purpose of this study, the null hypothesis assumed that there were no statistically significant differences between the microleakage of self-adhering materials.

2 Material and Methods

2.1 Specimen Preparation

A total of 45 human third molars were used for the microleakage tests. After removing the soft tissue remnants, the teeth were stored in 0.01% thymol aqueous solution at 4°C and were used within 3 months following extraction. Standard Class V cavity preparations (mesiodistal width=4 mm, occlusogingival length=2 mm, and depth=2 mm) were performed on the buccal and lingual tooth surfaces with a cylindrical diamond bur in an air/ water-cooled high-speed turbine. A single operator prepared the standard cavities without beveling, such that the occlusal margin was in enamel and the gingival margin was in dentin. Teeth were randomly separated into three groups with 15 teeth in each group and restored. The commercially available self adhering materials tested in this study are listed in Table 1.

Table 1. Material, manufacturer, lot number and composition of the materials used in study.

Material	Manufacturer	Lot	Composition
GCP Glass fill	GCP Dental, Vianen, Netherlands	7103067	Fill: fluoro-aluminosilicate glass, apatite, polyacids Gloss: modified polysiloxanes
Fuji II LC	GC Corporation, Tokyo, Japan	1403061	Alumino-fluorosilicate glass, polyacrylic acid, 2-hydroxyethylmethacrylate, 2,2,4-trimethyl hexamethylenedicarbonate, triethylene glycol dimethacrylate
Vertise Flow	Kerr, Orange, USA	3422056	GPDM; Prepolymerized filler, 1-micron barium glass filler, nano-sized colloidal silica, nano-sized Ytterbium fluoride.

Group 1 was restored with Glass Fill (GCP Dental, Vianen, Netherlands) and light cured at 60°C for 60 s using a special thermo-cure lamp (CarboLED, 1400 mw/cm²; GCP Dental, The Netherlands). Group 2 was restored with Fuji II LC and group 3 was restored with Vertise Flow (shade A2) and cured for 20 s with a light-emitting diode (LED; BlueLexGt 1200; Monitex, Taiwan). All the restorations were made according to manufacturer's instructions and finished with carbide bur without water.

All the tooth surfaces except the restoration and a 1 mm zone adjacent to its margins were covered with two coats of varnish. The coated teeth were then immersed in 2% basic fuchsin dye solution for a period of 24 hours at 37°C. After the removal of the dye, the coatings were stripped from the teeth by scraping. The teeth were then thoroughly washed in water and sectioned into two pieces buccolingually in an occlusoapical direction through the middle of restoration by using a diamond disk which was mounted on a hand piece with water cooling.

The extent of the microleakage was noted according to the following scoring criteria:

- 0. No marginal leakage
- 1. Up to 1/3 of cavity depth from enamel junction
- 2. 1/3-2/3 of cavity depth
- 3. >2/3 of cavity depth but not involving the axial wall
- 4. Up to the axial wall.

Each section was then observed with a stereomicroscope (SZ-PT, Olympus, Japan) with magnification of 30×. Maximum dye penetration was selected for grading the microleakage. The amount of microleakage of both pieces was assessed. Scoring was evaluated and recorded via two evaluators.

2.2 Statistical Analysis

For each specimen, the microleakage score was obtained by calculating the mean of occlusal and gingival microleakage scores measured from two sections. Statistical analyses were performed using Kruskal-Wallis and Mann-Whitney *U*-tests. All specimens were evaluated by the two operators at two times to evaluate measurement error, and kappa scores were estimated. The level of statistical significance was set at $P < 0.05$.

3 Results

The assesment of microleakage revealed interexaminer kappa scores exceeding 0.9 for all tests. None of the self-adhering materials tested completely eliminated leakage from restoration margins. Table 2 shows the extent of leakage at the enamel and dentin margins of the restorations.

When the self-adhering materials were compared, Glass Carbomer Cement showed the highest leakage scores but was statistically different from only Vertise flow in the gingival surfaces ($p < 0.05$). Vertise flow and Fuji II showed similar microleakage scores in the gingival surfaces.

In the occlusal surfaces all tested self-adhering materials exhibited similar degrees of microleakage at the enamel margins ($p > 0.05$). Little or no microleakage was observed in the occlusal surfaces, and any difference was not statistically significant ($p > 0.05$) (Table 2).

Table 2. Distribution of microleakage scores of the self-adhering materials.

	Dye leakage at occlusal margin				Dye leakage at gingival margin			
	0	1	2	3	0	1	2	3
GCP Glass Fill	5	4	1	0	1	4	3	2
Fuji II LC	4	6	0	0	4	5	1	0
Vertise Flow	6	4	0	0	2	6	2	0

4 Discussion

Knowledge of material properties is an important issue in clinical and scientific dentistry. Material characteristics and its clinical abilities affect clinical selection, and therefore clinical performance. Although there are some limitations of in-vitro studies, they have an important place in the knowledge of new materials. In this study microleakage of RMGIC, self-adhesive resin composite and Glass Carbomer cement were evaluated.

In our study, microleakage evaluation was made by dye penetration. This method is the most used evaluation technique in dental materials. It is an easy to perform, fast and economical technique. But the shortcoming of the technique is the subjectivity of reading the specimens [13]. In our study, all specimens were evaluated by the two operators at two times to evaluate measurement error. In the occlusal side, all materials demonstrated statistically indifferent penetration scores and were mostly similar. On the gingival side, range between penetration scores interleaved. But statistically significant values only demonstrated between Glass Fill and Vertise Flow so our hypothesis was rejected.

In our study, there were no significant differences between the microleakage of occlusal and gingival margins which applied Vertise flow, a little increase at occlusal margin draws the attention. Whereas

healthy enamel surface is to be desired for better bonding, whereby low microleakage can be achieved [14]. Vichi et al. [15] found that Vertise Flow demonstrated the lowest microleakage score and interestingly this material showed better bond strength performance at dentin surface. Lower microleakage score in Vertise Flow group could be associated with this less enamel thickness of gingival margin. However, in another study [11], researchers found higher microleakage values at gingival margin than occlusal margin, but the difference was not statistically meaningful. It has been reported that Vertise Flow takes hygroscopic expansion, and this might improve the polymerization leakage/shrinkage of the material [16]. Self-adhering flowable composite is based on the bonding technology that uses glycerophosphatedimethacrylate (GPDM) to etch enamel and dentin, and hydroxyethyl methacrylate (HEMA) to enhance wetting and penetration by resin into dentin [17]. This resin bonds chemically between the phosphate groups of a GPDM monomer and the hydroxyapatite of tooth structure and also micromechanically between the polymerized monomers of the self-adhering flowable composite resin and the collagen fibers and smear layer of dentin [9,18].

Conventional GICs have excellent properties such as anticariogenic effect due to fluoride release, biocompatibility and chemical adhesion to the tooth structures. Glass ionomers also have low thermal expansion and observed values close to the normal tooth structure [19-21]. But some disadvantages like fragility, aesthetic deficiency and inferior mechanical properties [22,23] have led researchers to further develop this material. It has been reported that glass carbomer has significantly better mechanical and chemical properties. Also, command setting with the application of heat with a special LED curing device is another advantage of the material [24]. Moshaverinia et al. [23] reported that N-vinylpyrrolidone containing polyacids, nano-hydroxy and fluoroapatite were positively affected by conventional glass ionomer cements mechanical properties. Analogous to the glass carbomer cement, RMGICs were developed to overcome conventional glass ionomers inadequate features [4]. Through the addition of methacrylate groups into the glass ionomer cement, more aesthetic and better mechanical properties could be obtained.

Fuji II LC showed mostly similar microleakage values at gingival and occlusal margins. Diwanji and et al. [25] found statistically higher microleakage values in Fuji II LC than in Fuji IX in class I restorations, but they didn't find any difference in class V restorations which was statistically significant. In contrast to the present study, Rekha and et al. [26] found higher microleakage values in Fuji II LC than in Fuji IX. In both studies, cavity conditioner was used. In another study [27], microleakage of Fuji II LC Improved (GC Corporation, Japan) and Fuji II (GC Corporation, Japan) was evaluated after immersion in coffee, tea, coca-cola, lime and saline solution. At the cervical margin, researchers found more microleakage values at gingival margin, than in occlusal margin. Fuji II showed statistically significant values only in cola and lime when compared to saline solution. However, Fuji II LC Improved also showed statistically significant values in tea and coffee at the occlusal margin in addition to cola and lime. These restorative materials are widely used in elderly patients in non-carious cervical lesions. Dental professionals should make dietary counselling to reduce marginal leakage and discoloration in such cases.

Fuji II LC also contains triethylene glycol dimethacrylate (TEGDMA). This component is usually used for most of dentin bonding agents and resin composites. Including of TEGDMA provides enhanced wear resistance, fluidity and lower microleakage [28].

Çehreli et al. [4] found the greatest value of dye leakage was considered in the uncoated glass carbomer specimens, followed by the uncoated glass ionomer group. There was no significant difference between the microleakage values of coated glass ionomer, coated glass carbomer in class V restorations. In the uncoated glass carbomer group, catastrophic internal and surface crack lines, were distinct all specimens. In the coated restorations, the surface gloss used with the glass carbomer cement was more effective in its sealing ability as compared to the resin-based surface coating applied to the conventional GIC.

5 Conclusion

Glass Carbomer based self-adhering material showed more microleakage than resin based self adhering materials in the gingival surfaces, but in the occlusal surfaces all of the tested materials showed good

performance. These self-adhering materials can be used for older patient or pediatric patients as it is practical and easy to bond to tooth structures without any bonding agent.

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