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ORIGINAL RESEARCH



# Comparison of microleakage of filled sealant, Giomer and flow composite in sealant therapy of permanent teeth: An invitro study

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## Abstract

**Background: Sealants play a crucial role in preventing decay and caries progression by creating a physical barrier, blocking the accumulation of food particles and microorganisms in pits and fissures. This study aimed to compare the microleakage of filled sealant, Giomer, and flow composite in sealant therapy of permanent teeth.**

**Materials and Method: This invitro study was performed on 135 intact human premolars. In all samples, the tooth surface was etched with 37% phosphoric acid, then ESPE adhesive was applied and cured. The pit and fissures of these teeth were sealed with Beautifil flow, Perma Flow composite, and synergy filler resin sealant, respectively. All samples were subjected to 1000 thermal cycles between 5 and 55 °C, and were placed in an incubator. After washing the samples,1-mm-thick buccal incision sections were prepared, and microleakage was examined by stereomicroscope. In addition, five samples from each group were selected separately to check the edge compliance with SEM. The data was analyzed by Kruskal-Walli's test in SPSS version 24 (α=0.05)**

**Results: There was no significant difference in the amount of microleakage between the three materials of Giomer, filler sealant, and flow composite (p =0.894). In the study with SEM, no significant difference was observed between the microleakage of the three groups (P = 0.232).**

**Conclusion: The study found similar microleakage levels between studied materials. MicAs Giomer, with its fluoride release property, can be recommended as an alternative to sealants.**


**Keywords: Fissure sealants; Flowable composite; dental leakage**

## Introduction

Cavities or dental caries are the most common chronic childhood disease, but they can be effectively prevented. This prevention is a primary goal and mission of pediatric dentistry (1). In recent years, the distribution pattern of cavities has changed significantly. There has been a reduction in proximal and smooth surface cavities due to fluoride, but there has been an increase in occlusal cavities (2). This shift in distribution has highlighted the effectiveness of fissure sealants in reducing cavities (3-6).

Fissure sealant is a material applied to the pits and fissures of teeth to prevent the occlusal caries (7).

Resin-based coatings, developed since the 1960s, have evolved into composites used as fissure sealants for both deciduous and permanent teeth (8). These materials, applied for enhanced efficiency, create micro-mechanical retention in micro-porosities of teeth. Studies show fluoride release's effectiveness in preventing caries by inhibiting demineralization and promoting remineralization. Fluoride also exhibits bactericidal and anti-enzymatic effects on cariogenic bacteria (9).

Recurrent caries at the edges of restorations is significant and can cause pulpal damage or necrosis due to bacteria in the remaining dentin caries or reinfiltration of microorganisms through microleakage (10). Therefore, using compounds with appropriate bonding can prevent caries recurrence by releasing

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fluoride and ensuring the beauty of the tooth structure (11).

Glass ionomers are a combination of fluoroaluminosilicate glass and polyacrylic acid introduced in 1970. Glass ionomers have the potential to remineralize the tooth structure due to their fluoride content, but the wear resistance of these compounds is limited, and their fracture toughness is low (12).

Currently, hybrid materials, which include a combination of glass ionomer and composite, have been developed to overcome the problems of glass ionomer cement (11). Giomer is a popular hybrid material with the feature of releasing fluoride, resulting from the reaction of polyalkonic acid with fluoroaluminosilicate glass components before entering Silica filled urethane resin (12). Giomers possess several desirable properties like, beauty, anti-plaque properties, good fluidity, fluoride release, recharging, suitable physical properties, easy handling, and a smooth and uniform surface. These properties make Giomers a powerful choice for fissure sealant (13).

Beautifil flow is one of the new types of Giomer that, according to the manufacturer, releases six ions of fluoride, sodium, aluminum, strontium, silicate, and borate. It can also limit plaque formation, neutralize acid, release fluoride, and recharge when expose to fluoride-containing products. Suitable physical properties, high surface hardness, excellent esthetic potential and ability to flow in fissures, make it an ideal choice for permanent tooth fissure sealant.

It is important to conduct comprehensive studies which help dentists select better fissure sealants materials available in the market. A new Giomer called Beautifil flow has been introduced as a material with suitable properties that can be used as a filler sealant. However, there is limited research on the microleakage of new tooth-colored restorative materials for fissure sealant of permanent teeth. This study aimed to compare the microleakage between three materials Giomer, filler sealant, and flowable composite as fissure sealants of permanent teeth

**Materials and Method**

In the present interventional-experimental study, 135 healthy human premolars (120 specimens for evaluation of microleakage through dye penetration method and 15 samples for SEM analysis) were selected. The selected teeth were free from caries, cracks, hypoplasia, and any fillings and were extracted for orthodontic treatment. After extraction teeth were preserved in 0.2% thymol solution at 4 ° C for a maximum of 3 months.

Teeth surfaces were cleaned from any debries, brushed with a rubber cap, and rinsed with normal saline for 1 minute. Then teeth surface was etched with 37% phosphoric acid (FineEtch. Spident, USA) for 20 seconds according to the manufacturer’s manuals, then rinsed with water for 15 seconds and dried afterward with air for 10 seconds. Adhesive (3M ESPE Adper Single Bond2, USA) was applied and cured (14).

The teeth were randomly divided into three groups of 40, and fissured sealants were applied separately according to the manufacturer's instructions. Group 1: Giomer material (Beautifil flow. SHOFU, Kyoto. Japan), Group 2: Flowable composite material (Perma Flo. Ultradent, USA), and Group 3: Filler resin sealant (Synergy, Coltene, Switzerland).

All teeth were cured by a standard light curing device under similar conditions and distance from the teeth. At the beginning of each process, the light density of curing device was measured by radiometer. The device was calibrated after preparing each ten samples.

After performing the above steps, the samples of each group were placed separately in a thin mesh fabric and subjected to 1000 thermal cycles between 5 and 55 ° C. Each process consisted of 20 seconds in hot water (55 degrees), 20 seconds in cold water (5 degrees), and it took 10 seconds to transfer from one source to another.

After thermal cycles, all samples were placed in the dye solution as follows teeth apices and forcation areas were sealed with adhesive wax and then all the root and crown surfaces of the teeth up to one millimeter away from the occlusal surface were covered with two layers of nail polish to prevent the microleakage of other areas from interfering with the desired area and distorting the results. After complete drying of the nail polish, the teeth of each group were placed separately in 5% methylene blue dye solution and incubated at 37 °C for 24 hours to allow the dye to penetrate the space between the enamel and the fissure sealant. The teeth were placed in an acrylic generator up to the CEJ area. Afterward, each sample was washed and cut with a TC-3000 cutting machine (CNC Cutting machine, Nemo, Mashhad, Iran) and a diamond disk in the form of buccal lingual and the direction of the longitudinal axis of the tooth from the middle of the fissure sealant. During cutting, water spray was used to cool the disc for preventing fissure sealant and tooth damage. Then, the mesial and distal sections of each were blinded, and according and observed by stereomicroscopy (Trinocular Zoom Stereo Microscope, SMP 200, HP, USA) with 40x magnification to evaluate the amount of microleakage. For each tooth, the section that showed the most microleakage was evaluated. Two blinded observers, separately classified the color penetration. Electron microscopy (SEM) (FEI. model QUANTA FEG 450, USA) was also used for better observation and accurate data analysis. As mentioned above, we utilized five specimens for each group (these samples were not used for testing and were selected for the SEM study). So, five samples from each group are connected to aluminum trunks and covered with a layer of titanium. Finally, to investigate the uniformity of the sealant and tooth interface, the gap between the demineralized enamel and the resin penetration was examined under the electron microscope (15). The stereomicroscope images of samples with 40x magnification were presented in Figure 1.

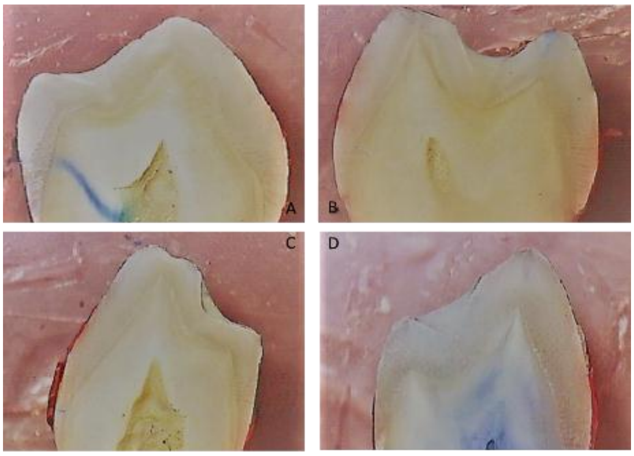


**Figure 1.** Stereomicroscope (40x): A: Grade0, B: grade1, C: Grade2, D: grade3.

The classification of microleakage levels due to dye penetration at the interface of fissure sealant and tooth was performed as follows: Zero degrees: no dye penetration, first degree: dye penetration between 0 and 1.3 enamel and sealant distance, second degree: dye penetration between 1.3 to 2.3 between enamel and sealant, third-degree: dye penetration more than 2.3 between enamel and sealant. Kruskal-Wallis test was used for statistical analysis. The analysis was done at two descriptive and inferential levels. At the descriptive level, the frequency distribution tables, and the mean and standard deviation indices were used to describe the situation of the sample in each of the groups, and at the inferential level, the Kruskal-Walli's test was used to answer the research hypothesis. Analyzes were performed at a five percent error level using SPSS software version 24.

## Results

According to the findings, Giomer group showed microleakage in 8 teeth (20%) in grade 1 and 2 teeth (5%) in grade 2. And there was no dye penetration in 30 teeth (75%). In flow composite group, the microleakage was recorded in 10 teeth (25%) in grades 1 and 1 tooth (2.5%) in grade 3. There was no dye penetration in 29 teeth (72.5%). In Filler sealant group 32 teeth (80%) that did not show dye penetration. 2 teeth (5%) showed grade 2 microleakage. And similarly, 3 teeth (7.5%) showed grade 1 and 3 microleakage (Figure 2).

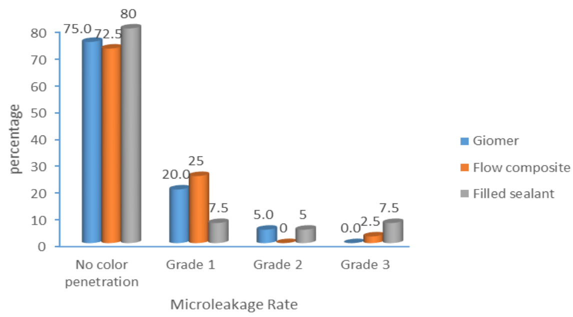


**Figure 2.** Microleakage rate in three materials: giomer, filled sealant and flow composite as fissure sealant in permanent teeth

Kruskal-Walli's test revealed no significant difference between the amount of microleakage of three materials (p = 0.894); as shown in Figure 2. Moreover, we used five additional specimens from each group to check microleakage with SEM (Figure 3,4,5), there was no significant difference between the amount of microleakage of the three groups in the margin of restoration (p = 0.232) (Table 1).


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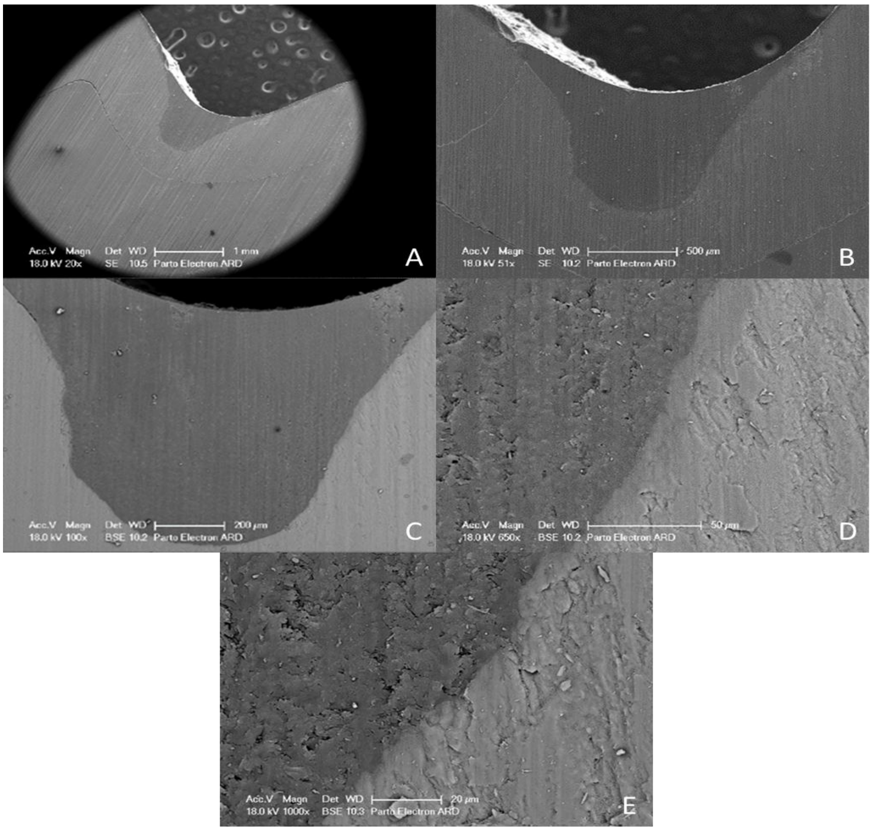

**Figure 3.** SEM micrograph of giomer sample without gap at different magnification

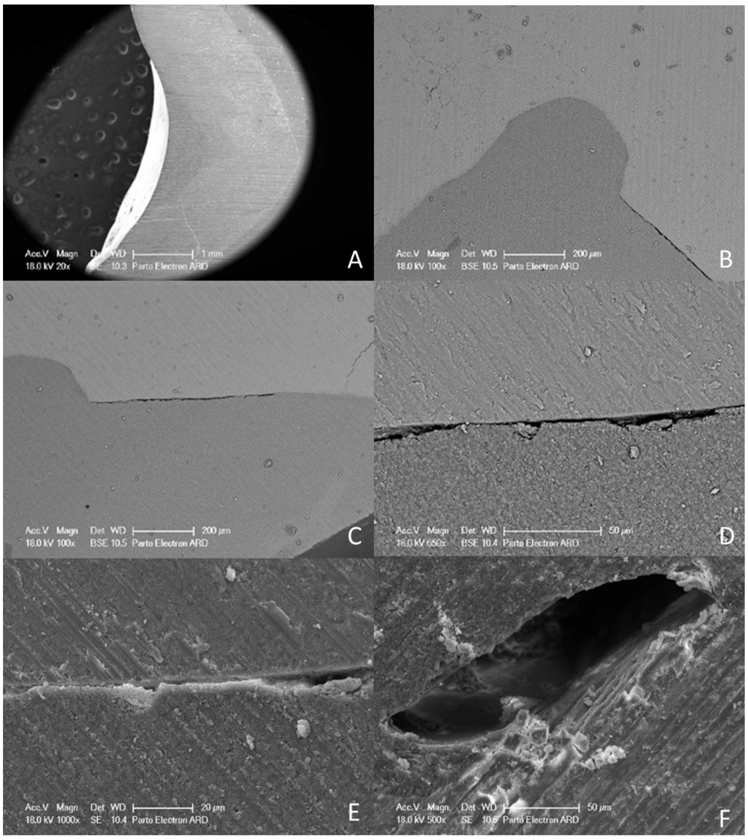

**Figure 4.** SEM micrograph of composite sample with 50µm gap at different magnification



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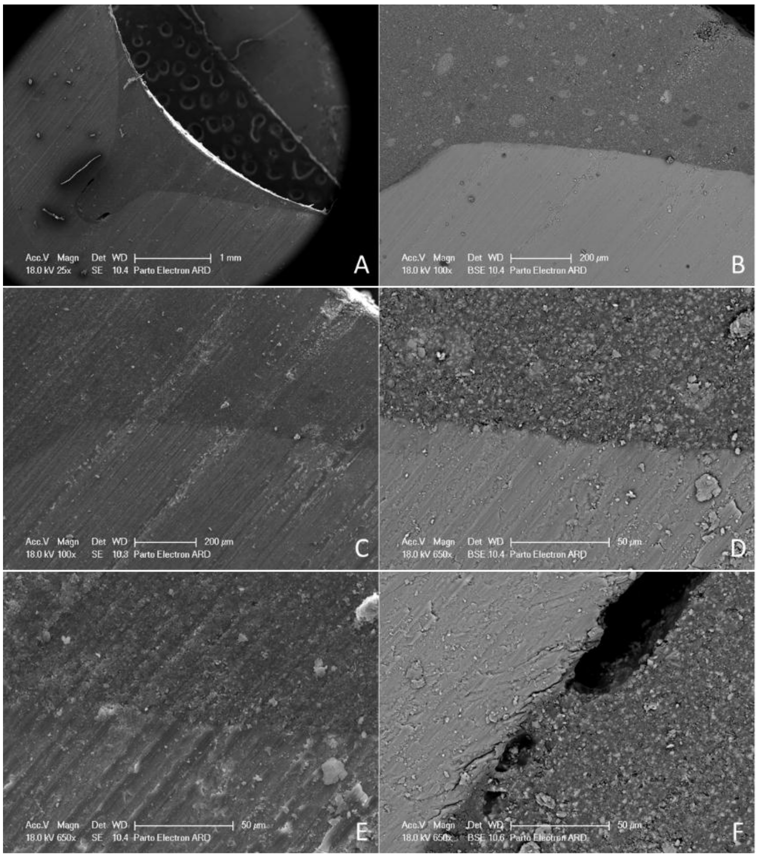


**Figure 5.** SEM micrograph of filled sealant sample with 100µm gap at different magnification

**Table 1.** Microleakage rate in three materials: giomer, filled sealant and flow composite as fissure sealant in permanent teeth measuring by SEM Method

| Group | No | Mean ± SD | P value |
|---|---|---|---|
| Giomer | 5 | 22.00 ± 16.43 | |
| Composite Flow | 5 | 28.00 ± 20.49 | 0.232 |
| Filled sealant | 5 | 29.00 ± 22.31 | |

## Discussion

Microleakage can be considered as an essential feature of restorative materials with potential complications of allergic reaction, possibility of secondary caries and pulp inflammation. Proper adhesion of restorative materials to dental tissue reduces or eliminates microleakage. Therefore, in this study, we attempt to compare microleakage between three common fissure sealants of permanent teeth: Giomer, flow composite and filler sealant.

The dye penetration method demonstrated that all three groups presented different amounts of microleakage. However, in all groups, the highest frequency was related to gradezero (no microleakage detection) as 75% of samples in Giomer group, 72.5% of samples in composite flow samples, and 80% of samples in the filler sealant group had no microleakage. There was no significant difference between the microleakage of studied materials (p = 0.894).

In the study of Heba et al. (16), microleakage of Giomer and Compomer in class II cavities of deciduous teeth were compared and consistent with the results of the present study Giomer had the least microleakage but the difference was not statistically significant. According to their findings, greater microleakage occurred in the cervical area in comparison to the occlusal surface.

The author stated that this result might be due to the fact that in the Giomer group, the cavity was prepared using two-step self-etch bonding. However, in the compomer group, 37% phosphoric acid was used before bonding, resulting in excessive etching of the cavity. Thus, the penetration of resin monomers was incomplete and increased the microleakage in the compomer group. Also, the inability of the compomer



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to provide the desired marginal seal can be due to its composition. Compomer contains more resin matrix than hybrid composites, which increases shrinkage during polymerization (16).

The results of the study conducted by Rini R et al. are consistent with our study, which compared the microleakage of composite, Giomer, and compomer with RMGIC. It was reported that none of the restorative materials evaluated could prevent microleakage. Hybrid composite, Giomer, and compomer showed less microleakage and better marginal adaptability compared to RMGIC at the enamel margins (17).

The ability of caries prevention of Giomer as a fissure sealant was shown in another research. It was concluded that the self-etched primer-bonded Giomer could prevent enamel demineralization, microleakage, and gap formation. They recommended that the S-PRG-based Giomer could be very suitable for protecting pit and fissures of immature permanent teeth (18).

In a laboratory study, Salman et al. (19) measured the microleakage of four Giomer materials, glass ionomer resin, zirconomer, and nano ionomer resins in Class V restorations. It has been reported that none of these materials could eliminate the microleakage in occlusal or gingival margins of Class V cavities, and the results were statistically different. Nanoionomer had the lowest microleakage between materials, followed by glass ionomer modified resin, zirconomer and Giomer. The study found that the Giomer did not produce results consistent with the present study. This could be due to variations in filler content and the use of a bonding resin different from S-PRG. It's also worth noting that the location of restorative materials differed between the two studies, as our study only assessed microleakage in the enamel (19).

The results of the study of Santos et al. (20) on class II restoration were also compatible with the results of the present study. They found no significant differences between thestudied groups and concluded that each preparation method, Giomer, and bulk fill composite could be used in these restorations.

The present study used acid etching method and the fifth-generation bonding were used to prepare the teeth before placing the sealant to provide similar consistent conditions in different groups and eliminate the bonding effect. Some studies have suggested that the use of self-priming primer has been associated with greater microleakage than fifth-generation bonding; Therefore, these studies do not recommend the use of self-primer in fissure sealant therapy. On the other hand, other articles have suggested that using fifth-generation bonding before fissure sealant therapy results in less microleakage compared to the traditional method involving etching, rinsing, and adhesion. (15, 20).

In a three-year clinical study, the beautifil flow and beautifil II restorative Giomers in posterior class I cavities in 20 patients with primary caries on one side of two upper or lower premolars were compared. Two examiners examined patients at 6-month intervals and found no difference in postoperative sensitivity, recurrent caries, and restoration retention. However, beautifil flow demonstrated superior features in marginal integration, discoloration, roughness, and surface morphology compared to beautifil II.

The author suggests that using materials with low elasticity could reduce shrinkage stress during polymerization and partially inhibit the strains caused by temperature changes. Additionally, the low consistency of beautifil flow may lead to lower microleakage due to its ability to flow easily into grooves and fit precisely with cavity walls, while also minimizing water absorption and the impact of occlusal forces at the junction of the restorative material and the tooth (21).

Shingare et al. (22) concluded that for tooth preparation prior to sealing, conventional acid etching alone or with fissurotomy would be a suitable option, irrespective of the type of sealant material used. Similarly, Huseyn et al. (23) observed that enameloplasty increases the amount of penetration but does not impact microleakage levels. Based on this research, the samples of present study were not subjected to enameloplasty. Annan et al. (24) clinically compared sensitivity following treatment with Giomer, Nanohybrid Composite, Compomer, and RMGIC in Class 1 cavities. It was reported that the degree of sensitivity following treatment was not significantly different between mentioned materials. Additionally, the marginal compatibility of marginal sealant and enamel was evaluated by electron microscope. Which showed no statistically significant difference between the groups, which could be due to the small sample size.

Long-term laboratory and controlled clinical studies are needed to assess the performance of different restorative materials thoroughly. In the selection of restorative materials, several other factors should be considered, including oral hygiene, child caries risk, child behavior, residual tooth structure, tooth


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longevity, and treatment conditions, including general anesthesia (1).

## Conclusion

The study results showed no significant difference in microleakage among the three materials. Therefore, Giomer, with its fluoride release properties, could be considered as an alternative to sealants.

**Conflict of Interests:** The authors of this manuscript declare that they have no conflicts of interest, real or perceived, financial or non-financial in this article.

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