Caspian J of Dent Res

Original Article

# Gingival microleakage in class II composite restorations using different flowable composites as liner: an in vitro evaluation

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**Received: 20 May 2014 Accepted: 7 Dec 2014**

## Abstract

**Introduction:** One of the main disadvantages of composites is marginal microleakage; using flowable composites as a liner beneath composite restorations has been recommended to reduce microleakage. The aim of this study was to assess the microleakage of class II restorations with different flowable composites liners.

**Materials &Methods:** 45 extracted premolars teeth with class II cavity preparation (90 cavities) were divided into five groups and filled as follows: 1.control group: hybrid composite (Z250) 2. Z250+surefil SDR flow 3.Z250+filtek supreme xt flow composite 4.Z250+Grandio flow 5.Z250+Tetric flow. Mesial and distal cavities were filled using snowplow and layering technique, respectively. After that, the samples were immersed in 0.5% fuchsin solution and sectioned. Gingival microleakage was then graded. Data were analyzed using Kruskal Wallis and Mann Whitney U test.

**Results:** There was no significant difference between the snowplow and layering methods. Microleakage of Tetric flow and Grandio flow liners was significantly higher than the control group. Other flowable composites showed no significant difference in comparison with the control group.

**Conclusion:** In the present study, the results indicated that the flowable composites were not effective on reducing gingival microleakage.

**Keywords:** Composite resins, Dental leakage, Dental cavity lining, Polymerization

***Citation for article:*** Lotfi N, Esmaeili B, Ahmadizenouz G, Bijani A, Khadem H. Gingival microleakage in class II composite restorations using different flowable composites as liner: an in vitro evaluation. Caspian J Dent Res 2015; 4:10-6.

# بررسی آزمایشگاهی ریزنشت جینجیوالی در ترمیم های کامپوزیتی کلاس II با استفاده از کامپوزیت های قابل سیلان مختلف به عنوان لاینر

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## چکیده

**مقدمه:** مهمترین معایب کامپوزیت ها، ریزنشت لبه ای آنها است. یکی از روش های پیشنهادی جهت کاهش ریزنشت، استفاده از کامپوزیت های قابل سیلان به عنوان لاینر در زیر ترمیم کامپوزیتی می باشد. هدف از این مطالعه بررسی ریزنشت ترمیم های کلاس II با استفاده از انواع لاینرهای کامپوزیت های قابل سیلان می باشد.

**مواد و روش ها:** ۴۵ دندان پرمولر کشیده شده با تهیه حفرات کلاس II (نود حفره) به ۵ گروه تقسیم و بدین ترتیب ترمیم شدند: گروه ۱ (کنترل): کامپوزیت هیبرید به تنهایی (Z250) گروه۲ : Z250+ Sure fill SDR flow گروه۳ Z250+Filtek supreme XT:flow گروه ۴: Z250+Grandio flow گروه ۵: Z250+Tetric flow حفرات مزیالی و دیستالی به ترتیب با روش snowplow و لایه لایه ترمیم شدند. پس از آن نمونه ها در محلول فوشین ۰/۵٪ غوطه ور شده و برش داده شدند. سپس ریزنشت جینجیوالی درجه بندی گردید. یافته های حاصل با آزمون هایKruskal wallis و mannwhitney u test مورد تجزیه و تحلیل قرار گرفت.

**یافته ها:** بین دو روش Snowplow و لایه لایه تفاوت معنی داری یافت نشد. ریزنشت لاینرهای Tetric flow و randio flow به طور معنی داری بیشتر از گروه کنترل بود و سایر کامپوزیتهای قابل سیلان، هیچ تفاوت معنی داری را در مقایسه با گروه کنترل نشان ندادند.

**نتیجه گیری:** در مطالعه حاضر، یافته ها نشانگر این بود که کامپوزیت های قابل سیلان در کاهش ریزنشت جینجیوالی تاثیری ندارد.


**واژگان کلیدی:** کامپوزیت رزین ها، نشت دندانی، لاینر حفره دندانی، پلیمریزاسیون

## Introduction

Recently, improvements in adhesive systems and properties of resin composites with increasing esthetic demands by patients have increased the use of composites instead of amalgam on the posterior segment. [1-3] Despite many advantages of composites, one important drawback is polymerization shrinkage that causes marginal microleakage, post-operative sensitivity and recurrent caries. [1-3] Most posterior composites have a high amount of fillers that reduce polymerization shrinkage. Use of a liner as an intermediate layer has been suggested to overcome the problems associated with polymerization shrinkage. [3, 4] Flowable composites due to their low elastic modulus have been recommended as a flexible layer to reduce contraction stresses. [5] Studies showed different results such as more microleakage by using flowable composites [6,7], no significant difference between flowable composites[8], flowable composite has no effect on decreasing microleakage[9] and use of flowable materials improved marginal integrity of posterior composites and decreased gingival margin microleakage. [10,11] Recently a new flowable composite called SDR (Smart Dentin Replacement) has been introduced to dentistry. SDR differs from conventional resin by the incorporation of SD resin (stress decreasing resin) technology. When SDR is exposed to visible light, the increase of stress with time is greatly reduced. Low volumetric shrinkage is due to a combination of SDR which is a urethane dimethacrylate structure and has a high molecular weight (849gr/mol for SDR resin compared to 513gr/mol for Bis-GMA in conventional resin) and a polymerization modulator chemically embedded in the center of the SDR monomer and impart optimized flexibility that adjust shrinkage stress. Also high percent of filler (68% weight) causes high strength of resin network. [11]

Sure Fill SDR flow is used as a base and liner in class I and II restorations. Manufacturers claim that it can be placed in 4mm thickness. Some of the advantages of SDR are: 1.fluoride containing 2.radiopaque resin composites restorative material 3.low polymerization shrinkage 4.optimized handling for easy placement and adaptability to cavity preparation. [11]

The aim of this study was to compare gingival microleakage in class II composite restorations using different flowable composite linings.

## Methods

A total of 45 non-carious freshly extracted human premolars were used in this study. The teeth were stored in thymol 0/5% at room temperature. A scaling was used after cleaning with a rubber cup and slurry of pumice. Standard class II cavities were prepared[12] on the mesial and distal surfaces of each tooth using 0.8 fissure bur (DRENDELL+ZWEILING, Quezon city, Philippines) and a water-cooled high speed air turbine handpiece (Diatech Dental AG, Heerbrugg, Switzerland).

The cavities measured 2mm axial depth and 3mm in buccolingual widths. All cavities were placed 1mm below cementoenamel junction. Cavosurface margins were prepared sharp without bevel. Automatrix system was used for proximal surface filling.

All cavities were etched with 37% phosphoric acid (Ivoclar Vivadent, Schaan, Lichtenstein) for 30s in enamel and 15s in dentin. Then, the prepared cavities were rinsed by using water and afterward air dried. After that, single bond (3M ESPE, St. Paul, MN, USA) adhesive was applied with a microbrush (according to the manufacturer´s instructions) and light cured by Valo LED curing unit (Ultradent products Inc, UT, USA,) light curing device for 40 second at 1000 mW /cm². The intensity of the light curing unit was verified by a radiometer after every 5 specimens. Composition and manufacture of composites are shown in table 1.

The teeth were randomly divided into: 1 a group of 5 specimens as the control group and 4 groups of 10 specimens as the study groups. In the control group, both mesial and distal cavities (N=10) were filled with an A2 shade of Z250 composite. Incremental technique [12] was utilized to restore the cavities in which the thickness of each layer was not more than 2mm.The layers were light cured for 40s at 750mw/cm² according to the manufacturers´ instruction. In group 2 to 5, Surefil SDR flow, Filtek supreme xt flow, grandio flow and Tetric flow were used respectively as a liner in mesial and distal cavities. In mesial cavities, snowplow filling technique was used [3]; in this method, a thin layer of flowable composite was placed over gingival floor without curing and 1mm of Z250 composite was placed on unset flowable composite then the combined increment was light cured for 40s. The rest of the cavity was restored similar to the control group.

In distal cavities, one layer (less than 2mm) of flowable composite was placed on gingival floor and light cured, the rest of the cavity was restored with Z250 composite the same as control group. Polishing and finishing of the samples were conducted with Sof-Lex disks (3M ESPE, St. Paul, MN, USA). All samples were stored in artificial saliva for 24h, then thermocycled for 500 cycles between 5˚c and 55˚c with a dwell time of 30 seconds. After thermocycling, all teeth were dried and covered with two coats of nail varnish 1mm short of the margins. Apical foramen of the teeth was sealed with sticky wax.

Next, the samples were immersed in 0.5 Basic fuchsin dye for 24hr. After that, they were rinsed with tap water. The teeth were then mounted on epoxy resin. The samples were sectioned in mesiodistal line axis with a double-faced diamond disc (Nemov, Mashhad, Iran).

Dye penetration was determined under a stereomicroscope (Meiji Techno Co, LTD, 45176, Tokyo, Japan) at 40× and defined according to the scoring scale [1] below 0: no dye penetration

1: dye penetration less than ½ of the gingival floor (from margin to ½ of the gingival floor)

2: dye penetration more than ½ of the gingival floor (from ½ of the gingival floor up to the axial wall)

3: dye penetration along the axial wall

The data were statistically analyzed by Kruskal-Wallis analysis of variance to determine any statistical significant differences in microleakage scores among the groups at a p-value of 0.05. Mann-Whitney u-test was performed to compare the groups with each other at the 0.05 significance level.



[ DOR: 20.1001.1.22519890.2015.4.1.2.9 ]

[ DOI: 10.22088/cjdr.4.1.10 ]

**Table1. Composition and manufacture of composite materials tested in the study**

| Composite | Resin composite | Filler composite | Filler weight | Average filler size | manufacture |
|---|---|---|---|---|---|
| Sure fill SDR flow | Modified UDMA, TEGDMA, EBPDMA | Barium,Strantium, Al-fluoro-silicate glass | 68% | 20 µm | Dentsply-DeTrey,UK |
| Grandio flow | Bis-GMA,TEGDMA, HEDMA | Silicate | 80.2% | Nanoparticles 0.04-3µm (mean 0.7) | VOCO GmbH, Cuxhaven, Germany |
| Tetric flow | Bis-GMA,TEGDMA, UDMA | Barium glass, ytterbium Trifluoride,Ba-Al-fluorosilicate glass, SiO2, | 64.6% | | Ivoclar Vivadent, Schaan, Liechtenstein |
| Filtek supreme xt flow | Bis-GMA,TEGDMA, Bis-EMA | ZrO2-SiO2 | 65% | 75nm silica Nanofiller+5-10 nm zirconia Nanofiller+0.6-1.4µm zirconia/silica | 3M ESPE, St. Paul, MN, USA |
| Z250 | Bis-GMA,UDMA,Bis-EMA | ZrO2-SiO2 | 60% | 0.01-3.5µm | 3M ESPE, St. Paul, MN, USA |

## Results

Microleakage scores are shown in table 2. Regardless of the use of the flowable composite resin, there was no significant difference in the microleakage of class II cavities restored with snowplow or layering technique. Tetric flow (in both snowplow and layering method) and Grandio flow (in snowplow method) significantly increased microleakage compared to the control group (p=0.004 and p=0.01, respectively). The lowest amount of microleakage was observed in Surefil SDR flow group however, the difference was not statistically significant in control group. Grandio flow and Filtek supreme xt flow increased microleakage compared to the control group but the difference was not significant. Figure 1 shows comparison of the microleakage in different groups.

**Table2. Number of samples showing each microleakage score at gingival margins in the study group**

| Method | | Microleakage scores | | | | |
|---|---|---|---|---|---|---|
| | | 0 | 1 | 2 | 3 | Total |
| Snowplow Group | SDR | 2 | 4 | 2 | 2 | 10 |
| | Filtek Supreme XT flow | 0 | 2 | 4 | 4 | 10 |
| | Grandio flow | 0 | 0 | 4 | 6 | 10 |
| | Tetric flow | 0 | 0 | 2 | 8 | 10 |
| | Total | 2 | 6 | 12 | 20 | 40 |
| Layer Group | Z250 | 1 | 4 | 3 | 2 | 10 |
| | SDR | 6 | 1 | 1 | 2 | 10 |
| | Filtek Supreme XT flow | 0 | 3 | 3 | 4 | 10 |
| | Grandio flow | 0 | 2 | 5 | 3 | 10 |
| | Tetric flow | 0 | 0 | 2 | 8 | 10 |
| | Total | 7 | 10 | 14 | 19 | 50 |

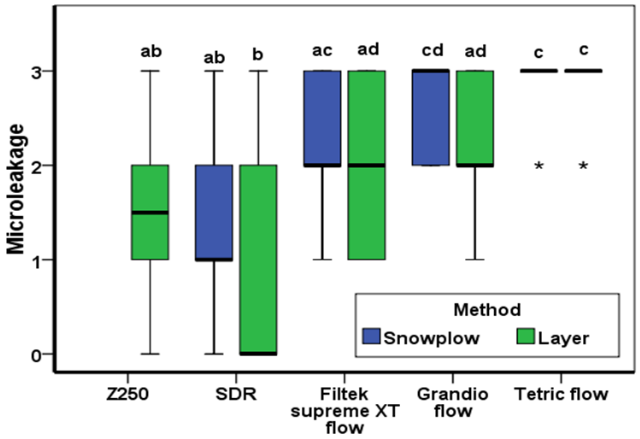


**Figure1. Median microleakage in study groups with the same letters showed no significant difference**

## Discussion

The result of the present study showed that Surefil SDR flow as a liner had lower microleakage than other flowable composites (tetric flow, grandio flow, filtek supreme xt flow). Monomers of composites linked together to form a network when they were exposed to light. This polymerization process needs moving monomers physically closer together. This process results in polymerization shrinkage in which Van der Waals link changes to covalence link. Resin composites create a lot of stress during polymerization shrinkage that causes microleakage. [13]

In the current study, the findings were in accordance with the ones demonstrated in other studies in which Surefil SDR flowable composite showed lower microleakage. [11,14-15] Current composites contain organic resin matrix and inorganic fillers; when they are exposed to light cure, polymerization and volumetric shrinkage rapidly occurs; However, in Surefil SDR flow the increase of polymerization stress is reduced with time which is due to SDR patented urethane dimethacrylate structure in this composite. [11] Urethane with incorporated photo active groups is able to control the polymerization kinetics. [16]

One mechanism to decrease shrinkage stress is to delay the gel point. The gel point shows the increase of viscosity when network is forming. In the pre gel phase, the formed polymer chains are very flexible. In this phase, the viscosity of polymers is still low, so shrinkage stress can be compensated by plastic flow that happens during the pre-gel phase. The time that material can not compensate the polymerization shrinkage (time until gelation) determines the final tensions in the material. Surfill SDR flow shows a delay in the gel point. [16] Considering the increased flow capacity, lower stress builds up and better interfacial integrity of Surefil SDR flow has the lowest shrinkage rate (3-4 folds lower) compared to other flowable composites. [16]

In this study, microleakage was evaluated only on dentinal surfaces. Based on previous studies, microleakage in dentin was more than in enamel because of the higher bond strength between composite and enamel than dentin with a tubular structure. [17, 18] Flowable composites were recommended in some studies [10, 19] as an interfacial layer due to their lower elastic modulus which can compensate contraction stress and act as a stress breaker and shock absorber. However, in the present study, a different result was obtained.

In this study, except for Sure fill SDR flow, all other flowable composites demonstrated higher microleakage compared to the control group in both layering and snowplow techniques. Tetric flow composite showed the highest microleakage which was in accordance with the results of other studies [6, 7, 9, 20-22]; in fact, flowable composites had more polymerization shrinkage because they had dilute monomers and less fillers. [23] Generally, increasing the amount of the inert materials in composites (organic and inorganic fillers) may reduce the overall shrinkage of composites due to the less monomer availability for the polymerization reaction. But high filler loading results in a high degree of stiffness that can lead to high shrinkage stress, so increasing the volume fraction of filler does not invariably produce a fundamental reduction in shrinkage. [16]

According to the result of the current study, there was no significant difference in the microleakage of Grandio flow composite (with 80.2% weight filler) and Filtek Supreme XT flow (with 65% weight filler). However, the microleakage of Tetric flow (64.6% weight filler) and Filtek Supreme XT flow with similar amount of filler was significantly different, it can be concluded that the amount of filler alone does not reduce the microleakage and other factors including chemical properties and size of matrix and filler may affect the microleakage as well. [24] TEGDMA with low molecular weight in chemical compound of flowable composites caused the increase of polymerization shrinkage. [25,26] UDMA and BIS_GMA with high molecular weight in chemical compound of Z250 composite decreased the polymerization shrinkage. [27, 28] This in vitro study showed that only Surefil SDR flow composites had lower microleakage than Z250 composite although the difference was not significant. High molecular weight and flexibility around the centered modulator imparted high qualify to Surefil SDR flow. Surefil SDR flow had low polymerization shrinkage and stress, and also high depth of cure. As a result, it is suitable for bulk placement (4mm) in class I and II cavities. [11]

In a study by Chuang et al. [19] Snowplow was recognized as an appropriate method to decrease microleakage. In this method, a thin layer of flowable composite is placed in the cavity without curing, afterwards a layer of hybrid composite is placed on it and both layers are cured simultaneously. [3] In the current study, however, there was no significant difference between the snowplow and layering technique which was in agreement with the results of Sood et al. [29]

Different results in various studies may be because of variable flowable composites with variable chemical compounds. The rate of microleakage can be increased with occlusal loading. Campos et al. study contributed the breaking down of bond depending on the intensity and duration of loading. Therefore, it is recommended that further studies be carried out under occlusal loading. [30]

## Conclusion

The results of this study showed that the flowable composites had no effect on the decrease of gingival microleakage.

## Acknowledgments

We would like to thank Dr. Evangeline Foronda for the English editing and Dental Materials Research Center of Faculty of Dentistry of Babol for supporting this study.

**Funding:** This study was a part of thesis and research project (Grant No: 9235717) which was supported and funded by Babol University of Medical Sciences.

**Conflict of interest:** There was no conflict of interest.

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