Original Article

Comparison of Microleakage in Class V Restorations Using Different Composite Resins and Techniques

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Abstract

Introduction: The aim of this study was to compare microleakage in Class V restorations using different composite resins and application techniques. **Methods:** In this study, 60 cavities were prepared on the buccal and lingual surfaces of samples, 3 mm length (mesio-distal), 3 mm height (cervico-occlusal) and 2 mm depth. Samples were randomly divided into 6 groups. In Group 1, Grandio (Voco GmbH, Cuxhaven, Germany) was used with bulk technique, in Group 2 by horizontal incremental technique and in Group 3 by oblique incremental technique. SonicFill (Kerr, CA, USA) in Group 4, Filtek Bulk Fill Posterior Restorative (3M ESPE, st. Paul, USA) in Group 5, and Estelite Bulk Fill flow (Tokuyama, Japan) in Group 6 were used with bulk technique. After thermal cycle, samples were incubated in 0.2% methylene blue solution for 24 hours. They were sectioned longitudinally from the middle of cavity (buccolingually). Microleakage was evaluated by stereomicroscope (Nikon SMZ25, Tokyo, Japan). Kruskal-Wallis and Mann-Whitney U tests were used for statistical analysis. **Results:** Microleakage at the cervical margin was higher than the occlusal margin. There was no statistically significant difference between groups at the occlusal margin, but there was a significant difference between groups at the cervical margin ($P_=0.02$). In Groups using incremental techniques, less microleakage was observed. There was no statistically significant difference between groups using bulk technique. **Conclusion:** The use of incremental techniques in the restoration of cervical lesions may reduce microleakage.

Keywords: Microleakage, Bulk Fill composites, Class V restorations.

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Introduction

It is known that there is more than one etiological factor in formation of cervical lesions. While these factors such as abrasion, attrition, erosion and abfraction are included in the etiology of non-carious cervical lesions, poor oral hygiene, dry mouth and dietary habits are among factors that provoke the formation of caries in the cervical area (1). Composite resins are one of the most preferred materials in restoration of cervical lesions. However, it has been observed that cervical restorations have higher failure rates and survival rate is not satisfactory compared to occlusal and anterior restorations (2). Clinical failure in cervical restorations can have economic implications for both patient and dentist, which can question physician skills (3).

The composite resins used in restorative dentistry have an average volumetric shrinkage of 1.5-3 % (4). Microleakage, a result of shrinkage, is an important factor affecting clinical success of the restoration. It is defined as the passage of bacteria, oral fluids and ions between the restorative material and the cavity wall (5). Dye penetration and radioisotope tests, electrochemical and microscopic examination methods, use of chemical agents and bacterial methods are used to measure microleakage. Air pressure method and neutron activation analysis are also used. Of these, dye penetration test is the most preferred method because it is cheap and inexpensive, and it allows fast and direct measurements (6).

There is a need for improvements in dental materials and application techniques to extend survival of restorations in the cervical region. The incremental technique, which has been used for many years in restorative dentistry, has an important role in polymerization shrinkage and the microleakage reduction. However, it has some disadvantages like lengthy procedure and risk of voids and contamination between composite layers (7). In recent years, bulk fill composite resins have been introduced, which show low polymerization shrinkage and greater curing depth eliminating risk of voids and contamination (8). Although, there are various studies evaluating different composite resins application techniques on microleakage in the literature (9-11), but studies evaluating the effect of these techniques on microleakage in class V cavities are limited.

The aim of this study is to compare the microleakage in Class V restorations using different composite resin and application techniques.

Materials and Methods

In this in vitro study, the effects of different composite resin and application techniques on microleakage in Class V restorations were evaluated. The materials used in the study are shown in Table I.

Table I: Composite resins and their composition in this study.

Composite /Manufacturer	Type	Composition
Grandio (Voco, Cuxhaven, Germany)	Nano Hybrid composite	BisGMA, BisEMA, TEGDMA, UDMA, Silanize barium aluminyum silikat cam
Sonicfill (Kerr, CA, USA)	Bulk fill composite	BIS- GMA, BIS- EMA, TEGDMA, Silikat, barium cam
Filtek Bulk Fill Posterior Restoratif (3M ESPE, st. Paul, USA)	Bulk fill composite	BisGMA, BisEMA, modifiye UDMA
Estelite Bulk Fill flow (Tokuyama, Japan)	Flowable Bulk fill composite	Bis-GMA, BisMPEPP, TEGDMA Supranano spherical filler (spherical SiO2-ZrO2) (200nm)

For this study 30 extracted premolar teeth, without caries, cracks and discoloration were used. The remnants on the teeth were removed with a rotating brush under running water. Teeth were stored in distilled water containing 1% thymol. 60 cavities were prepared on the buccal and lingual surfaces of the teeth, 3 mm length (mesio-distal), 3 mm height (cervico-occlusal) and 2 mm depth using fissure bur (FG-211 C, MDT Micro Diamond Technologies Ltd., Israel) using water spray. The bur was changed every five cavities. The enamel margins on the occlusal walls of the cavities were beveled at an angle of 45°. Clearfill ™ Tri-S Bond (Kuraray Noritake Dental, Tokyo, Japan) was applied to all cavity surfaces in accordance with the manufacturer's instructions. It was polymerized by LED light source (Elipar S10, 3M - ESPE, Seefeld, Germany) for 10 seconds. Before each light source application, the light intensity was calibrated using a Bluephase meter (Ivoclar Vivadent; Schaan, Liechtenstein, Germany). Samples were randomly divided into 6 groups. Composite resins and application techniques used in each group are shown in Figure 1 and Table II.

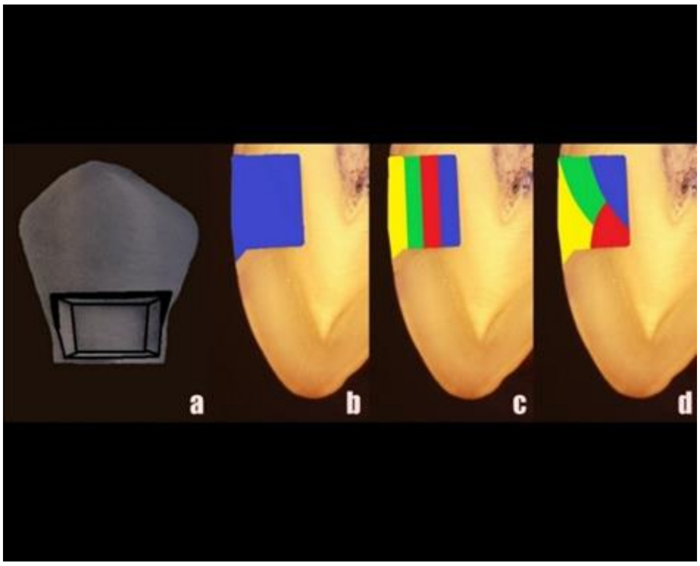

Figure 1: Composite resin application techniques (a. Box cavity b. Bulk technique c. Horizontal incremental technique d. Oblique incremental technique)

Table II: Composite Resins and Placement techniques

Groups	**Composite**	**Placement technique**
Group 1	Grandio (Voco GmbH, Cuxhaven,Germany)	Bulk
Group 2	Grandio (Voco GmbH, Cuxhaven,Germany)	Horizontal incremental
Group 3	Grandio (Voco GmbH, Cuxhaven,Germany)	Oblique incremental
Group 4	SonicFill™ (Kerr, CA, USA)	Bulk
Group 5	Filtek Bulk Fill Posterior (3M, St. Paul, MN, USA)	Bulk
Group 6	Estelite Bulk Fill Flow (Tokuyama, Japan)	Bulk

Finishing and polishing of all restorations were completed using finishing diamond burs and finishing discs (OptiDisc, Kerr, Switzerland). To simulate thermal changes in the oral cavity, all samples underwent thermocycling in a thermocycler (Thermocycling Machine, Esetron, Ankara, Turkey) between 5°C and 55°C with a dwell time of 30 s and a transfer time of 10 s for 1000 cycles. Samples were then sealed with two layers of nail varnish leaving 1 mm of space around restorations. Samples were immersed in 0.2% methylene blue solution for 24 hours. At the end of 24 hours, teeth were washed under running water. The dye was removed. Teeth were divided into two equal parts longitudinally in the bucco-lingual direction. Dye penetration depth at the margins of restoration was examined by the same researcher at × 40 magnification using stereomicroscope (Nikon SMZ25, Tokyo, Japan) and dye penetration depths at the tooth-restoration interface was scored (Figure 2) (Table III).

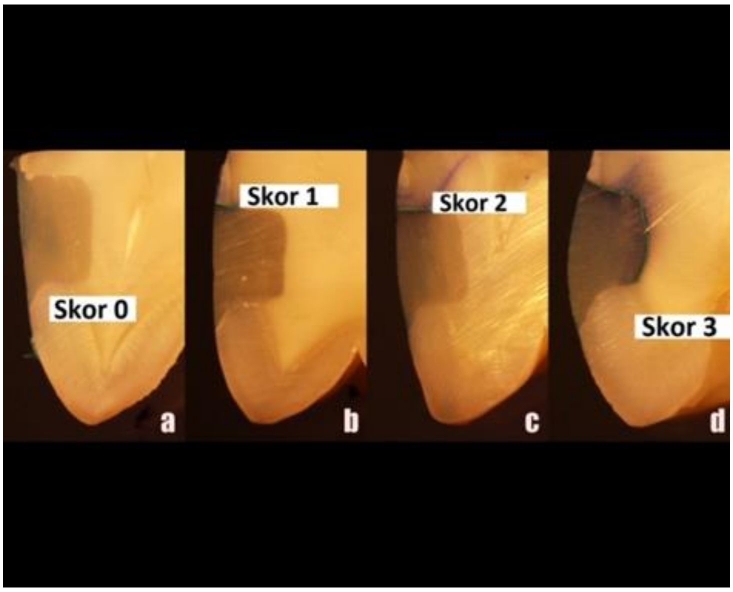

Figure 2: Microleakage scores

Table III: Microleakage scores

Table 3:	Microleakage scores
Score0	No dye penetration.
Score1	Dye penetration in the outer half of the occlusal /cervical wall.
Score2	Dye penetration in the inner half of the occlusal /cervical wall.
Score3	Dye penetration including the axial wall.

The Kruskal-Wallis test was used to compare the differences among groups. The Mann- Whitney U test was used for post hoc comparisons, and the Bonferroni correction was applied. The significance level was set at P <0.05.

Results

In this study, while different composite resins and application techniques were used, microleakage scores of the occlusal margin ranged between "0-1" and the microleakage scores of the cervical margin ranged between "1-3". Results are shown in Table IV.

Table IV: Comparision of microleakage results according to Kruskal-Wallis Test

		Occlusal				Cervical			
Groups	n	Mean rank	Median	IQR	P	Mean rank	Median	IQR	P
Group1	10	36.50	1	1.25		36.00	3	1.50	
Group2	10	34.50	0	1.00		18.65	1	1.00	
Group3	10	29.90	0	1.00	0.534	16.45	1	1.50	0,020
Group4	10	27.10	0	0.25		34.15	3	2.00	
Group5	10	28.90	0	1.00		37.95	3	2.25	
Group6	10	26.10	0	0.25		39.80	2	1.00	

According to Kruskal-Wallis test results, no statistically significant difference was found between groups in terms of microleakage values at the occlusal margins (P = 0.534). There was a statistically significant difference in terms of microleakage values at the cervical margin (P=0.02). Statistical analyses for differences between groups were performed using Mann-Whitney U test (Table V). Although microleakage in group 2 and 3 was lower than other groups, but this was not statistically difference (Bonferroni corrected Mann-Whitney U test).

In all groups, it was observed that microleakage observed in the cervical margin of class V restorations was more than microleakage observed in the occlusal margin.

Table V: Comparison of microleakage results according to Man-Whitney U test in cervical.

	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Group 1		P=0.019	P=0.025	P=0.710	P=0.577	P=0.933
Group 2			P=0.244	P=0.018	P=0.035	P=0.010
Group 3				P=0.018	P=0,030	P=0.010
Group 4					P=0.454	P=0.459
Group 5						P=0.614

Bonferroni-corrected Mann-Whitney U test.

Discussion

Microleakage in the tooth-restoration interface is an important factor affecting survival of dental restorations. Microleakage leads to discoloration at margins of the restoration, post-operative sensitivity, recurrent caries, pulpal inflammation and consequently failure of the restoration (12). In this study, microleakage in class V restorations was compared using different composite resins and application techniques. There is no significant difference between groups in terms of microleakage on the occlusal margin. The most values of microleakage was observed in Group 1, where Grandio (Voco, Cuxhaven, Germany) was placed as bulk. On the cervical margin, there was more microleakage than occlusal margin. In Group 2 and Group 3 where Grandio was placed incrementally, microleakage is less than other groups with statistically significant difference. The microleakage in Group 6 with the Estelite Bulk Fill flow (Tokuyama, Japan) was less than the Group 1.4.5, where other bulk fill composites and Grandio are used as bulk. However, there was no statistically significant difference.

Various dye solutions are used such as nitrate, 2% aniline blue, 0.2-2% or 10% methylene blue, 5% eosin, 20% fluorescent, 0.25% toluidine blue, 2% erythrocin, 0.05% crystal violet, 0.5-2% basic fucsin, 50% silver in dye penetration tests 2% methylene blue is the most preferred dye solution for evaluating microleakage in restorative dentistry (13). Therefore 2% methylene blue was preferred in this study. For the evaluation of penetration depth, samples were bucco-lingually sectioned and evaluated under stereomicroscope. However, the disadvantage of this method is that three-dimensional microleakage can only be traced in two dimensions and the differences in the density of the microleakage cannot be determined.

Thermal cycles are performed to mimic the oral environment prior to microleakage tests (14). In the literature, studies reporting that different thermal cycle applications have no significant effect on microleakage results (15,16), but Trowbridge et al. (17) found that increase in the thermal cycle time may cause an increase in microleakage in vitro compared to the oral cavity environment. Barnes et al. (18) reported more microleakage in laboratory conditions in their study comparing microleakage in laboratory and clinical conditions. Class V restorations show more microleakage on the cervical margin than occlusal margin (19). In this study, we observed similar results. The reason for higher microleakage in cervical margin than occlusal margin may be due to thinner enamel tissue in cervical margin, structure of dentin tubules, and beveled enamel on the occlusal margin.

As in many studies related to microleakage, in this study, scoring system was used to evaluate microleakage. However, recently, thanks to new developments in image analysis software, quantitative microleakage measurement methods have become more popular (20).

Although there are studies reporting that incremental technique can be preferred according to bulk technique in posterior resin restorations because of better marginal adaptation (21), there are also studies stating that neither bulk nor incremental technique is superior to each other in terms of microleakage (22). Moezyzadeh et al. (23) reported that in the restorations using bulk technique, higher microleakage was observed than in restorations using incremental technique. Incremental techniques are known to reduce stresses occurring at the tooth-restoration interface (24). In this study, less microleakage was observed in Groups 2 and 3, where incremental techniques were used, compared to Group 1.

The most common types of monomers in composite resins are bisphenol-A glycidyl methacrylate (BIS-GMA), ethoxylated bisphenol-A dimethacrylate (EBPADMA), triethyleneglycol dimethacrylate (TEG-DMA) and urethane dimethacrylate (UDMA). The increase in the BIS-GMA / TEG-DMA rate reduces shrinkage due to a lower conversion caused by a more restricted reaction environment (25). Also, TEG-DMA-rich composite resins increase the shrinkage caused by the antiplastication effect (26). Bisphenol-A glycidyl methacrylate (BIS-GMA) is less flexible than other monomers (27). In addition to BIS-GMA in composite resins, monomers such as BIS-EMA and UDMA are added to reduce shrinkage stresses (28). In cases where shrinkage stress exceeds the bonding strength of composite resin to dental tissues, microleakage, secondary caries, marginal coloration and post-operative sensitivity may develop (29). The elasticity modulus of restorative materials can also be considered as one of the factors that cause microleakage. Composite resins with a low modulus of elasticity can provide sufficient flexibility to compensate for stress caused by polymerization shrinkage. The shape and size of inorganic fillers in composite resins play an important role in determining the physical properties of composite resins. While polymerization shrinkage decreases due to increase in the amount of filler, modulus of elasticity may increase (30). Although composite resins used in this study contain similar monomers, there are differences in monomer ratios, filler particle ratios, and elasticity modules. However, no significant difference was found between the restorations using bulk technique in terms of microleakage. Comparing SonicFill, which has a high filler rate, which has been flowable with sonic energy, Estelite Bulk Fill with high flow rate and Filtek Bulk Fill Posterior Restorative with high filler particle content, there was no significant difference in terms of microleakage. Volumetric shrinkage, elastic modulus and degree of conversion of composite resins significantly affect shrinkage stress. These three properties of composite resins are interrelated and the difficulty of determining which of them are effective makes, the polymerization shrinkage stress (31) and therefore the microleakage more complex.

In addition, the mineral structure of the teeth (32) and cavity design (C-factor) (33) are known to affect microleakage. For this reason, teeth with caries and discoloration were not used in this study. Box-shaped cavity design is preferred, which has been reported to reduce shrinkage stresses.

Conclusions

Within the limitations of this in vitro study, application of incremental techniques in class V restorations can reduce microleakage. There is no significant difference in microleakage in class V restorations between bulk fill composite resins containing different monomer, elasticity modulus and filler particle ratio.

Conflict Of Interest

The authors have no conflict of interest to declare.

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