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Original Article

Comparative Evaluation of Micro Leakage in Class V Composite Resin Restorations Using Two Bulk Filled Resin-Composites and One Conventional Composite (Grandio)

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Abstract

Title: Comparative evaluation of microleakage in class V composite resin restorations using two bulk filled resin-composites and one conventional composite (Grandio).

Research and objective: Polymerization shrinkage of dental composites are still a challenge and restrictions on the use of which is and One of the factors for treatment failure and need to be replaced and repairing, leakage between restorative material and cavity walls due to the contraction. In order to overcome these problems Bulk filled composites with lower shrinkage introduced. Therefore the aim of this study is to evaluation of Class V restorations using conventional composites and bulk filled composites.

Methods: In this study, in the buccal and lingual surfaces of 30 extracted premolars, V-shaped cavities were prepared and samples using a single bond bonding were restored in three groups as follows: Group 1: Composite bulk filled (Filtek). Group 2: Composite bulk filled (X-tra base). Group 3: conventional composite Grandio. After thermocycling of the samples, microleakage was evaluated on occlusal and gingival of the restorations by dye penetration technique under a microscope with a magnification of 20. Data were analyzed using SPSS software version Sixteenth and Jonckheere and MannWhitney nonparametric tests where significance level was %0/05.

Results: The results of this study showed that the difference of leakage at occlusal and gingival margins was significant between groups, also the difference of leakage at the edge of occlusal in comparison with gingival in each of the groups was significant. Comparing of the leakage composites in Bulk filled groups 1 and 2 (Filtek and X-tra base) showed a significant correlation with conventional composite However, comparing the two composite Bulk filled had no significant relationship.

Conclusion: The results of this study showed that the use of Bulk filled composites rather than conventional composites in class V cavities expanded on the root surface reduced leakage. But there was no statistical difference between Bulk filled composites (X-tra baseandFiltek).

Keywords: microleakage, Bulk-filled composite

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INTRODUCTION

Given the considerable progress in resin composite restorative materials, their usage has increased in deep and extensive cavities although the success rate varies [1,2]. All composite restorations have degrees of polymerization shrinkage [3]. Resin composites used in dental restorations

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have shown shrinkage less than 1 to 6%, demonstrating that the amount depends on things like application techniques, their composition and terms of curing [4].

The process of passing bacteria and their toxins between the cavity walls and the edge of restorationisMicroleakage which is due to the creation of polymerization shrinkage toward stronger binding between enamel - composite and light source [5,6].

Actions such Oblique layering techniqueor cavity designing bylowest C factorcan be performed to reduce polymerization shrinkage and microleakage [7].

Over time, high viscosity resin composite was introduced which has lower polymerization shrinkage and consequently less leakage due to increased concentration of filler, but due to the high consistency, it is difficult to adaptation the material to the internal walls of the cavity [8].

Considering recent changes in filler content or organic matrix, a new generation of composites have been introduced as bulk-filled composites. It is alleged that these composites have low polymerization shrinkage and are applicable as a major advantage to reduce microleakage arising from this polymerization shrinkage [9,10].

These new materialshave been offered in two forms of high and low viscosity (flowable). Bulk filled composites with low viscosity reduce application time and don't need pack them. Therefore, they have been welcomed by the majority of dentists [11].

Studies have been done on the cusp deflection of the composites but there is little information about microleakage and their comparison with conventional composites with higher polymerization shrinkage. The results ofMorthy et al [11] showed that flowable bulk filled composites have significant difference in reducing cusp deflection compared with conventional composites which areused Oblique layering technique. There was no significant difference in terms of microleakage between Bulk filled flowablecomposites and conventional composite.

This is despite the fact that the results of the study by Scotti et al [12] revealed that Bulk filled flowable composite has lower microleakage at gingival margin compared to non-flowable Nanohybrid composite.

Kapoor et al assessed the effect of technique of applying the composite on gap formationand the results showed that Bulk filled composites compared to conventional composites showed better marginal adaptationand lower gap formation [13].

As there is no clear information about the advantages of using Bulk filled composites than conventional composites and conflicting results of previous studies have been reported, therefore, this study aimed to evaluate the marginal microleakage of two different of Bulk filled composites(Filtek and X-tra base) compared to a conventional composite (Grandio).

The null hypothesis of this study: the microleakage of Bulk filled composites(Filtek bulk filled and X-tra base) and conventional composite (Grandio) in class V restorationsis the same.

MATERIALS AND METHODS

This in vitro study was carried out on human upper premolar teeth that were extracted for orthodontic treatment about 3 months ago. The teeth were stored in formalin solution 10%after extraction. A week before the start of the experiment, the teeth cleaned of debris and soft tissue mass and 30 healthy teeth without cavities, cracks, wear, restoration and congenital anomalies had been chosen and were stored in distilled water at room temperature. V-shaped Class V Cavityinbuccal and Lingualsurface of each tooth with the width of 3 mm, height of 3mm and the depth of 3mm has been preparedusing a cylindrical diamond bur No. 835 (Diatech, Scissdertal, Switzerland) with air-water cooling and standard preparation such as occlusal cavity was 2mm above the CEJ and gingival margins was 1mm lower than the CEJ.

Each cavities on the buccal or lingual was considered as asample. Diamond bur was replaced for preparing each 5 cavities. Cavities were etched with phosphoric acid etching gel 37% (Ultra Etch, Ultradent, South Jordan, USA) for 15 seconds and then rinsed with water and then dried for 10 seconds. Two layers of an adhesive (Single bond2, 3M ESPE, USA) was applied on the cavitiesfor 15 seconds using saturated applicator and thinnedwith a gentle flow of air and then light cured for 10 seconds. The prepared samples were randomly divided into three groups based on the composite (n = 20):

In Group 1, the cavitieswere filled bulklywith a bulk filled flowable resincomposite (Filtek bullk fill, 3M ESPE, St Paul, USA) according to the manufacturer's instructions andwere cured for 20 seconds by the LED Demetron A2(kerr, USA) operating in standard made at a light intensity 1200mW/cm^2.

In group 2, thecavitieswere mass filled with a flowable composite resin fiber bulk filled X-tra base, VOCO, USA))

according to the manufacturer's instructions and cured for 20 seconds by the same optical device.

In Group 3, the cavities were mass filled with a conventional flowable composite resin light (Grandio, Voco, USA) according to the manufacturer's instructions and were cured for 20 seconds by the optical device. The materials used in this study are presented in Table 1. Then finishing and Palyshyng for three groupshad been done using polished milling and discs soflex (3M, ESPE, St.Paul, MN, USA) and samples were kept in distilled water in order for a week to complete the polymerization.

Samples were subjected to 3000 thermal cycles, between 1 ± 5 and 1 ± 55 ° C for 30 seconds [14].

Micro leakage measurement

The root apices of teeth sealed with sticky wax after the thermal cycles to measure microleakage and teeth surface covered with two layers of nail polish to 1mm nearthe cervical margin. samples were immersed for 72 hours in Fuchsin2% and then were rinsed under the water for 2 minutes, and dried and longitudinallysectioned in the middle of the restorationbuccolingually using diamond disk from the middle of restorationusingnon-stops machine (Albany, New York 12207. USA)[15] and 20 samples were preparedfor each group by 2 persons as a blind direction to measure the microleakage by a stereo microscope (Wild M3C Heerburg, Switzerland) at ×40 magnification and were ranked as follows in occlusal and gingival margins: (0 = no influence of color, 1 = dye penetration to 1/3 of depth of the cavity, 2 = dye penetration to 2/3 of depth of the cavity, 3 = dye penetration to entire depth of the cavity).

Data were statistically analyzed using SPSS software version 20, Jonckheere-test, Mann-Whitney U and Chi-squre. The significance level was set at 0.05.

RESULTS

The mean and standard deviations of the three groups are summarized in Table 2. Results showed that there was a significant difference between the average microleakage in the three groups (P ≤0.05).The maximum microleakage is forX-tra base composite (Bulk filled) and the lowest microleakage relates toGrandio composite (Conventional).

Micro Leakage at occlusal and gingival margin is significant (Table 3) (P ≤0.05). In each group,micro leakage at gingival margin was significantly more compared to the occlusal margin of the restoration.

Mann-Whitney U analysis and comparison of each two composites showed (Table 4) that no statistically significant difference was observed between the microleakage of the two Bulk filled composite (Filtek andX-tra base). On the other hand, comparing the amount of microleakage of each of the two Grandio composite showed statistically significant difference. Microleakage at occlusal composite of Filtek and X-tra base of Grandio composite increased, but Bulk filled composites microleakage at the gingival margin was lower than the Grandio composite.

Also pair comparison of microleakage of X-tra base resin composite and Grandio compared with Grandio and Filtek showed an increase, but the second and third levels ofX-tra base composite micro leakage showed a decrease compared to Filtek, although there was no statistically significant difference (P>0.05).

DISCUSSION

The widely use of light-cured composite resins has been developed in restorative dentistry and it's not only for

Table 1: Materials used in the study

Composition	Manufacturer	Type/color	Material
Bis-GMA, UDMA, Bis-EMA, TEGMEDA Fillers: 69%vol 84%wt	Voco, Germany	Low-viscosity-Flowable composite resin-(A3)	Grandio (Conventional)
Methacrylates, Bis-EMAOrganic Fillers (75% wt, 58% vol silica)	Voco, Germany	low-viscosity-Flowable resin composite for bulk fill Shade: Universal	X-tra base (Bulk filled)
Bis-GMA, UDMA, Bis-EMA (6)-Procrylat resins, zirconia/ silica (particle size 0.1-5μm), YbF3(particle size 0.1-5μm) Fillers, Inorganic filler loading: approximately 64.5% by weight (42.5% by volume)	3M ESPE/St. Paul, MN, USA	Low-viscosity- Flowable resin composite for bulk fill (A3)	Filtek Z250 (Bulk filled)
HEMA, Bis-GMA, dimethacrylate, polyacrylic and polyitaconic Acid, water, ethanol	3M, ESPE/St. Paul, MN, USA	Etch & rinse adhesive	Adper Single Bond2
Phosphoric acid %37	Scotchbond Universal Etchant	Etching gel	Phosphoric acid %37

Table 2: Distribution of leakage in the groups

Degree of microleakage Group	N (%)					P value
	0	1	2	3	Total	
Group 1						
Filtek	4 (10)	16 (40)	11 (27.5)	9 (22.5)	40 (100)	0.03%
Group 2						
X-tra base	14 (35)	17 (42.5)	4 (10)	5 (12.5)	40 (100)	0.038%
Group 3						
Grandio	11 (27.5)	16 (40)	7 (17.5)	6 (15)	40 (100)	0.001%

Table 3: Distribution frequency of micro leakage instudied groups at the occlusal and gingival margins

Degree of microleakage Group	N (%)					P value
	0	1	2	3	Total	
Group 1						
Filtek						
Occlusal	3 (15)	10 (50)	7 (35)	0 (0)	20 (100)	=0%0/100
Gingival	1 (5)	6 (30)	4 (20)	9 (45)	20 (100)	
Group 2						
X-tra base						
Occlusal	6 (30)	11 (55)	3 (15)	0 (0)	20 (100)	
Gingival	8 (40)	6 (30)	1 (5)	5 (25)	20 (100)	
Group 3						
Grandio						
Occlusal	7 (35)	12 (60)	1 (5)	0 (0)	20 (100)	
Gingival	4 (20)	4 (20)	6 (30)	6 (30)	20 (100)	

*Jonckheere-tes

aesthetic reasons but also due to adhesion properties of these materials to the tooth structure and more conservative turning to prepare the cavities [16]. Resin-based composites have a shrinkage caused by polymerization which forms the gap between the tooth and the restoration and subsequent microleakage [17].

A new generation of composites as bulk-filled composites have been introduced after recent changes in filler content or organic matrix. It is alleged that the composites have low polymerization shrinkage as a major advantage to reduce microleakage caused by the polymerization shrinkage [9,10].

This study aimed to assess microleakage in class V restorations in bulk filled composite (Filtek and X-tra base) in comparison with a conventional composite (Grandio).

There are various ways to testmicroleakage, including: Air pressure technique, bacteriological studies, evaluation by Radioisotopes, analysis of materials' activation by neutron, electrochemical studies, using scanning electron microscopy, evaluation by chemical tracer and dye penetration methods [18].

So far, gold - standard method has not been introduced to evaluate for microleakage. In this study, we used dye penetration because it requires no sophisticated equipment and laboratory and it is a non-destructive method. Thus, longitudinal studies on the margin of restoration will bepossible [19].

Studies suggest the tracer dyeto be used thatits particle size is equal to or smaller than bacteria (about 2 microns), thusFuchsine2% with particle size smaller than the bacteria is used [20]. The fuchsin used in this studycan be attached to carious dentin. Hence the samples were selected without carious, restoration or crack.

Although the storage time to dye penetration is different from 10 seconds to 180 days, Ernst et al [21] showed that 30 minutes seems to be sufficient for the dye penetration to determine the marginal infiltration. However, penetration time of 48 hours is applied in most papersto determine the gap. In this study, the dye penetration time was 48 hours.

Heat changes are the fundamental factors which could be effective on marginal seal due to differences in coefficient of thermal expansion between the teeth and composite. So in order to create conditions similar to oral environment and stress at a marginal seal, it is necessary to apply thermocyclinginmicroleakage studies [22]. Two temperature ranges are used in applying the thermal cycles as the upper limit of 45-60 °c and lower limit of 4-15°c. Many scholars including Phillips and Peterson (1996) applied 15 ° and 45 ° to heat cycles, while Grieve and his colleagues (1993) have recommended thermocycling at 5 and 55 degrees. Hot and cold baths for 10, 15, 30, 60 or 120 seconds are recommended for immersion of the samples. Harper et al. (1980) showed that the actual thermal changes in the mouth are relatively small. And real-time results are obtained when the short duration to be exposed to the whole heat and between the two bathrooms, enough time should be allowed to sample to return body temperature [19,23]. Stress have been occurred during the process of the thermocycling due to a difference in coefficient of thermal expansion coefficient and tooth structure at the interface between the tooth restoration and restorative materials [19,24]. According to Standard ISO TR 11450 (1994), the samples should be

at least 500 cycles at 5 and 55 degrees in the water under thermocycling as well. But some studies have suggested that the number of cycles is very low to be close to clinical conditions. Therefore, in this study, samples after cavity preparations and filling, undertake thermocycling for 3000 times between 5 and 55 ° C for 30 seconds for more similar clinical conditions [24].

The survey by Sidhu in 1994 showed that marginal sealin some cases which surfaces such as enamel etched with 37% phosphoric acid for 15 seconds, is better than that in not etched dentin surfaces [25]. It was also reported that although etching enamel for 5 seconds creates a bond strength equal to the etching for 15 to 30 seconds, but thepattern to be microleakage barrier [26]. So in this study, 37% phosphoric acid etching for 15 seconds was appliedof etching could not inhibit microleakage.

According to Daneshkazemi et al., the total-etch bonding had less leakage at occlusal and gingival margins in class V composite restorations compared to self-etch [27].

In this study, adper single bond2was used after etching the cavity for 15 seconds and rinsing for 10 seconds and then thinned with air for a few seconds to remove excess water. In addition, the cavity is not completely dried but bonding is used as Wet Bond that there is a small amount of moisture remaining in the cavity. Since class V composite restorations lackmacromechanical retention, marginal integrity will not be affected by macromechanical retention of the restoration.Laboratory microleakage studies is usually done on class V restoration [24].

In this study, flowable composites were used in all groups. Due to the increased flow properties in flowable composites, this will increase the wettability and easily adapted to inner walls of cavities.

Results of the study show that in all groups, there is some degree of microleakage in all groups and it seems that none of the three studied composites do not provide a complete marginal seal.

The study also showed that microleakage at gingival margin in each of the groups was significantly more compared to the occlusal restoration and it is clear that marginal steal at gingival margin restoration is less than occlusal which is due to better and stronger enamel band in occlusal because the enamel has an inorganic and hemogenous structure. Also the absence of dentinal fluid in its structure has bettermentinfiltration of monomer in micro tags after etching and resulted in better micromechanical bond [28]. But dentin is a dynamic substrate that contains a significant proportion of the water and organic matter thatdamages bonding system by the current adhesive process.

The researchers also stated that bond strength in the cementum is lower than teeth enamel. As a result, a higher microleakage at the gingival margin can be expected [29]. De Munck et al [24] and Manhart et al [30] showed that the Microleakage in Class V restorations in the occlusal marginwas significantly different with gingival margin and the microleakage at gingival margin was higher than the occlusal in all studies. The results based on laboratory studies it has been found that microleakage in gingival marginin Class II restoration was more compared to the proximal walls.

Jahankahir analysis showed that there is a significant statistical difference between the marginal occlusal and gingival microleakage. It was shown using Mann-Whitney U and binaryanalysisthat,themicroleakage between the two composites (Filtek Bulk filled and X-tra base) statistically showed no significant difference and the study by Morthy and colleagues confirmed these results, but comparing each of the two composite with Grandio composite showed that there is significant difference in the microleakage. It was found that the microleakage of Filtek and X-tra base composites on the occlusal margin is more than Grandio, but the microleakage of Bulk filled composites at the gingival margin is lower than Grandio composite. The reason for this difference can be attributed to lower internal stress caused by internal polymerization. Thepre-gel phase of these composites is longer than conventional composites because Polymerization modulator is used in their formulation that can react with CQ and reduce shrinkage and increase the coefficient of linear bands and as a result, lead to lower shrinkage stress and better maintain of marginal seal.On the other hand, the combination of matrix composites is different from each other. Grandio composite has TEGDMA in its matrix whick lacks in Bulk filled composites. TEGDMA is a diluent with low molecular weight and can be formulated in combination with high molecular weight monomersand normally increases stress due to contraction of the composite. Manufacturers tend to reduce shrinkage stress by limiting or eliminating TEGDMA from composite structures [31].

Two by two comparison of composites showed that the statistical difference in X-tra base composite microleakage with Grandio composites was higher compared toGrandio and Filtek composites and analyzing the first and second grade microleakage ofX-tra base and Filtek compositesand also comparing them with each other indicate that the amount of microleakage in X-tra base is less than Filtek. However, as stated above, the difference between the two were not statistically significant. These

differences can be attributed to the chemical composition and characteristics of the organic matrix composites, and filler characteristics such as particle size, shape and distribution within the organic matrix and the ability of these materials to band the enamel and dentin that are structurally different.

Abed and et al in a study on the degree of conversion and the surface hardness of the Bulk filled composite (X-tra fil and QuiXfil) compared with conventional Grandio composite showed that although X-tra fil composite has the highest degree of conversion and Grandio composite has the highest surface hardness in Vickers test,a statistically significant difference between the composite and surface hardness was not observed in the degree of conversion and surface hardnees between the composite and all composites had sufficient surface hardness. Vickers data analysis was confirmed depth of curing4 mm for Bulk filled composite.

Marovic et al [32] studied the degree of conversion and polymerization shrinkage of Bulk filled flowable composite and showed that the Bulk filled flowable composites have less polymerization shrinkage than the conventional flowable composites and have a higher level of conversion (to a depth of 4 mm).

CONCLUSION

Under the limitations of this study, the use of bulk filled flowable composites compared to conventional composites in class V cavitiesreduces the amount of microleakage, especially at the dentin margin.

RECOMMENDATIONS

1. For more similarity to the results in clinical situations, another clinically designed study is recommended.
2. In this study, only one type of conventional composite and the two Bulk filled composites were compared in degree of microleakage. It is advisable in future studies several types of conventional composite and Bulk filled to be compared.
3. Also in this study composite microleakage had been compared and more studies are required in terms of features, to evaluateother properties such as micro-hardness, shear bond strength, degree of conversion and etc.

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