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In-Vitro Evaluation of Cervical Micro Leakage of the Class II Bulk Fill Restorations

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ABSTRACT

The aim of this study is to investigate the influence of the bulk fill flow composite and restorative technique on cervical microlekage of class II bulk fill restorations. Standardized class II cavities (2x3x3mm)were prepared and divided into 8 groups (n=5) and restored. Following the restorative procedures, aging in distilled water for 5 weeks and immersed in basic fuchsine for 24h. The infiltration level of the dye within the tooth/filling at cervical area was analyzed by using a stereomicroscope. Data were statistically evaluated (p≤0.05). % Microlekage of the groups from higher to less is Quixfil, SDR, Grandio flow, Grandio, X+tra fil, X+tra base. Quixfil showed significantly higher leakage than Grandio and X-tra fil (p=0,011). X-tra base showed significantly less leakage than Grandio flow and SDR(P=0,008). It is possible to conclude that using bulk fill flow as an intermediary base provided lower microleakage, indicating better sealing of the tooth-restoration below CEJ.

KEYWORDS Bulk fill, Bulk fill flow, Cervical microleakage, Class II restorations

Introduction & Objectives

Microleakage is defined as the infiltration of oral fluids, bacterial toxins and ions from the gap between the restoration and the tooth. Its actual cause is polymerization shrinkage, which is still a major present-day problem (1). Although the layering technique is used, it prolongs the working time in deep cavities. This made manufacturing companies to explore ways to increase the thickness of composite resins so that they can be placed in the cavity at one sitting at the posterior region. As a result of these efforts, bulk fill composite resins that can be placed in bulk were introduced to the market.

These bulk fill composite resins improve the comfort of both patients and dentists as they are applied at one sitting. Its good marginal intactness and low level of polymerization shrinkage is reported to reduce the likelihood of tooth deformation, postoperative sensitivity, microleakage and secondary decays (2,3).

The aim of this study is to investigate the influence of the bulk fill flow composite and restorative technique on cervical microlekage of class II bulk fill restorations.

Materials and Method

Sample Preparation & Restorative Procedure

Standardized class II cavities (2x3x3mm with the gingival margin 1 mm below the cemento-enamel junction (CEJ) were randomly divided according to the experimental groups (n=5) The polymerizations of all the light-polymerized materials used in the trial were performed using the Demi Plus LED Curing System (Kerr) with a power of 1100-1330 mW/cm^2. We have 8 groups(Table 1-3)

Composites	Name	Type	Manufacturer	Abbreviation	Resin Matrix	Filler w% (V)
	Grandio Flow	Flowable nanohybrid	Voco GmbH, Cuxhaven, Germany	GRF	Bis-GMA, TEGDMA, HEDMA	80%w 60,6%V
	Grandio	Nanohybrid	Voco GmbH, Cuxhaven, Germany	GR	Bis-GMA ve TEGDMA	87%w 71.4%V

	X-tra Base	Bulk fill Flow	Voco GmbH, Cuxhaven, Germany	XB	MMA, Bis-EMA	75%w 58%V
	X-tra Fill	Bulk fill	Voco GmbH, Cuxhaven, Germany	XF	Bis-GMA, UDMA, TEGDMA	% 86 w % 70,1 V
	Surefill SDR	Bulk fill Flow	Dentsply Detrey, Konstanz, Germany	SDR	EBPADMA,TEGDMA	68% w 44% V
	Quixfill	Bulk fill	Dentsply Detrey, Konstanz, Germany	QF	UDMA,TEGDMA, Di- and trimethacrylate resins Carboxylic acid modifieddimethacrylate resin	85.5%w %66.4V

Table 1: The bulk fill composite materials used in this study

Adhesive Systems	Name	Manufacturer	Type	Abbreviation	Composition
	Futurabond NR	Voco, GmbH, Cuxhawen, Germany	Self Etch	FB	Liquid A: Methacryloyloxalkyl acid phosphate Liquid B: Bis-GMA, hroxylmethacrilate, BT, ethanol, organic acids, Fluorides
	Prime&BOND /NT	Dentsply Detrey, Konstanz, Germany	Etch & Rinse	PB	Water Initiators: Silane Di-and trimethacrylate resins Dipenthaerythyritol penta acrylate monophosphate UDMA Nanofillers Amorphous silicon dioxide Photoinitiators Stabilisers Cetylamine hydrofluoride Acetone

Table 2: Componenets and composition of the tested Adhesive systems

Table 3: Restorative Procedure

Group	**Name (Proximal Box depths)**	**Lining**	**Filling Technique**	Adhesive System	Restorative Procedure
1	Grandio (2mm+2mm+2mm)	Non-lining	Increment	Self -etch (Futurobond NR)	Mixing Liquid A and B for 5 seconds. Apply for 20 sec. Dry with an ir jet 5 seconds. Light cure 10 seconds. Apply composite by incremantally or bulk fill technique and light cure 20 sec in each increment.
2	Grandio Flow (2mm)+Grandio (2mm+2mm)	Lining	Increment	Self -etch (Futurobond NR)	
3	X-tra Base (4mm) + Grandio(2mm)	Lining	Bulk	Self -etch (Futurobond NR)	
4	X-tra Base (4mm) + X-tra Fill (2mm)	Lining	Bulk	Self -etch (Futurobond NR)	
5	X-tra Fill (4mm+2mm)	Non-lining	Bulk	Self -etch (Futurobond NR)	
6	Surefill SDR (4mm) + Grandio(2mm)	Lining	Bulk	Etch and Rinse (Prime Bond NT)	Etch 30 seconds Rinse 10 seconds Scrub adhesive for 20 seconds Air-thin for 5 seconds and Light-cure for 10 s. Apply composite by incremantally or bulk fill technique and light cure 20 sec in each increment.
7	Surefill SDR (4mm) + Quixfill (2mm)	Lining	Bulk	Etch and Rinse (Prime Bond NT)	
8	OuixFill (4mm+2mm)	Non-lining	Bulk	Etch and Rinse (Prime Bond NT)	

Aging procedures and microlekage analysis

The samples prepared were left in distilled water in a drying oven at 37°C for a period of 5 weeks. The samples were isolated with 2 layers of nail polish (Flomar, France), leaving 1 mm of their circumference open. All the samples were left in the 0.5% basic fuchsine solution at room temperature for 24 hours. Then, the teeth were washed under running water to remove the dye. After the dyeing procedure, all the teeth were cut in the mesiodistal direction, passing through the middle of restorations with a precision cutting device, isomet 1000.

The dye infiltrations on the cement walls of the cavities were assessed and measured by an experienced observer under a Stereomicroscope with 40 times enlargement (X40). For all sections, pictures of the restoration interface were taken under the X40 stereomicroscope (Leica M27.5, Heerbrugg, Switzerland). The images were analyzed using image analysis software (Trapezium X,S) to assess the percentage of dye penetration relative to the total length of the restoration interface (100%).

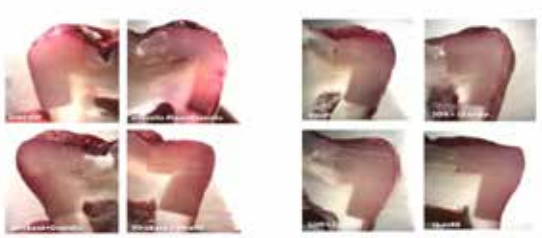
Statistical Evaluation
When evaluating the results obtained in the study, the IBM SPSS Statistics 22 program was used for statistical analyses. Kruskal Wallis test was used for quantitative data to compare the parameters that did not show a normal distribution between more than two groups and the Mann Whitney U test to determine the group causing the difference. The Mann Whitney U test was also used in comparisons of parameters between two groups. Significance was set at p<0.05.

Results and Discussion
The mean percentage leakages of the groups from the cement are shown in Table 4 and figure 1. The highest mean leakage from the cement is seen in the Quixfil group, which is followed by SDR+Quixfil, SDR +Grandio, Grandio flow+Grandio, X-tra base+X-tra fil, Grandio, X-tra fil and X-tra base +Grandio.

Table 4: Microlakage levels of percantage of the teeth

Groups	Bulk Fill Composites	Cementum Microleakage(%) Avarage ± SD(median)
1	Grandio	0,14±0,11 (0,11)
2	Grandio flow+Grandio	0,24±0,14 (0,18)
3	X-tra base +Grandio	0,02±0,02 (0,01)
4	X-tra base+X-tra fil	0,17±0,21 (0,13)
5	X-tra fil	0,12±0,13 (0,03)
6	SDR +Grandio	0,28±0,08 (0,28)
7	SDR +Quixfil	0,34±0,07 (0,33)
8	Quixfil	0,36±0,05 (0,38)

Figure 1: Steromicroscope pictures of the samples.



In Table 5,6,7 there is no statistically significant difference between the cement leakage percentages of the Grandio and Grandio flow+Grandio ;X-tra base+X-tra fil and X-tra fil; SDR+Quixfil and Quixfil groups (p>0.05).

Table 5: Comparison of Microleakage levels of Grandio vs. Grandio Bulk Fill Flow+Grandio

	Cementum Microleakage(%) Avarage ± SD(median)	P
Grandio	0,14±0,11 (0,11)	0,251
Grandio flow+Grandio	0,24±0,14 (0,18)	

Mann Whitney U test used

Table 6: Comparison of Microleakage levels of Xtrabase + Xtrafill vs. Xtrafill

	Cementum Microleakage(%) Avarage ± SD(median)	P
X-tra base+X-tra fil	0,17±0,21 (0,13)	0,754
X-tra fil	0,12±0,13 (0,03)	

Mann Whitney U test used

Table 7: Comparison of Microleakage levels of Xtrabase + Xtrafill vs. Xtrafill

	Cementum Microleakage(%) Avarage ± SD(median)	P
SDR +Quixfil	0,34±0,07 (0,33)	0,754
Quixfil	0,36±0,05 (0,38)	

Mann Whitney U test used

in Table 8, there is a statistically significant difference between the leakage of the Grandio, X-tra fil and Quixfil groups (p<0.05). The leakage rate of the Quixfil is significantly higher than those of the Grandio (p: 0.016; p<0.05) and X-tra fil (p: 0.009; p<0.01).

Table 8: Comparison of Microleakage levels of GRANDİO, XTRAFİL, QUİXFİLL

	Cementum Microleakage(%) Avarage ± SD(median)
Grandio	0,14±0,11 (0,11)
X-tra fil	0,12±0,13 (0,03)
Quixfil	0,36±0,05 (0,38)
P	0,011*

In Table 9, there is a statistically significant difference between the leakage of the Grandio flow+Grandio, X-tra-base +Grandio and SDR +GrandiO (p<0.01). Leakage percentage of the X-tra-base +Grandio group is significantly lower than the Grandio flow+Grandio (p:0.009; p<0.01) and SDR +Grandio (p:0.009; p<0.01) groups. There is no statistically significant difference between the mean cement leakages of the Grandio flow+Grandio and SDR +Grandio (p: 0.465; p<0.05).

Table 9: Comparision of Microleakage levels of the liner groups

	Cementum Microleakage(%) Avarage ± SD(median)	p
Grandio flow +Grandio	0,24±0,14 (0,18)	
X-tra base +Grandio	0,02±0,02 (0,01)	0,008**
SDR +Grandio	0,28±0,08 (0,28)	

*Kruskal Wallis test used * p<0.05 * p<0.01*

A material or technique that would completely eliminate microleakage is not yet available. It has been reported that more leakages occur in the gingival increments at the dentin-cement junction of Class II cavities than in the increments of the enamel (4).
The most reliable method to assess the effectiveness of a material is clinical research, but such research is time-consuming and difficult to standardize. For this reason, marginal leakage is considered the most effective experimental method to evaluate restorative materials and to detect gaps at the interface.

Crim et al. (1991) have reported in their study that when the gingival edges of cavities are at the dentin and cement, microleakage cannot be prevented (5). Similarly, Santini et al. have reported that microleakage cannot be prevented in the presence of cavity edges extending to the cement (6).

Xle et al. (2008) have shown in their study that flowable composite resins reduce leakage by increasing the bonding and adaptation of the restoration to the cavity (7). Similarly, Yazıcı et al. have reported that the microleakage values significantly decrease when flowable composite resin bases are used (8).

Abboud et al. (2004) have stated that since bonding agents

show lower bond strength when restoration edges end at gingival, more microleakage occurs in this area compared to enamel edges (9).

Park et al. (2008) have found in their study that the rate of cuspal deflection increases in the bulk technique as compared to the horizontal and oblique layering technique (10). Contrary to this view, Kuijs et al. (2003) have reported that polymerization shrinkage is more in the layering method (11).

There are also studies showing that both of these two filling techniques produce similar results. Idriss et al. (2003) have shown that there is no significant difference between the bulk and layering techniques in terms of marginal gap size in the class II composite restorations they performed in vitro (12).

In their study, Tunçbilek (2012) accepted the ratio of the lower surface rigidity value to the upper surface rigidity value as the indicator of polymerization rate and found the groups where this value is equal to or greater than 80% as successful. They reported that X-tra base, X-tra fil and SDR flow groups met this criterion whereas Quixfil group failed to meet it (13).

Roggendorf et al. (2011) compared in their study the placement of SDR flow as a single layer in a 4mm deep cavity to the placement of a traditional composite resin in multiple layers and reported that there was no difference between them in terms of internal adaptation

Conclusion

In this study where we used the dying method, which is the most frequently preferred method for detecting microleakage, the microleakage values at cement level from the highest to the lowest were found in Quixfil, SDR, Grandio flow, Grandio, X+tra fil, and X+tra base in that order. The mean cement leakage ratio of the Quixfil group was significantly higher than those of the Grandio and X-tra fil groups. The mean cement leakage ratio of the X+tra base group was significantly lower than those of the Grandio flow and SDR groups. It is possible to conclude that using bulk fill flow as an intermediary base provided lower microleakage, indicating better sealing of the tooth-restoration below CEJ(14).

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