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Effect of Liners on Microleakage in Class II Composite Restoration

(Pengaruh Pelapik Tampalan pada Kebocoran Mikro di Komposit Restorasi Kelas II)

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ABSTRACT

This study was carried out to evaluate the microleakage of Class II cavities restored with various types of lining materials. Four types of composite resins (Esthet-X-Denstply, USA, Filtek™Z350-3M ESPE, USA, Beautifil- Shofu, Japan and Solare P-GC, Japan) were used and the lining were the Fuji IXGP (GC, Japan), the Beautifil flow (Shofu, Japan), the Filtex™Z350 flow (3M ESPE, USA) and the Esthet-X flow (Denstply, USA). All the specimens were thermocycled and immersed in 0.5% basic fuschin dye for 24 h. The microleakage was scored using the ISO microleakage scoring system. The data were entered using SPSS version 12.0 and analyzed using STATA software programme. This study showed that none of the materials used in this study was able to eliminate microleakage. However, it was shown that the glass ionomer cement was better in reducing the incident of microleakage at the cervical margin. Among the flowable composite resin, Filtex™Z350 flow showed less microleakage at the cervical margin.

Keywords: Cervical margin; class II cavities; flowable composite resin; glass ionomer cement; microleakage

ABSTRAK

Penyelidikan ini dilakukan untuk menilai kebocoran mikro dalam pemulihan Kelas II yang ditampal dengan berbagai jenis bahan pelapik tampalan. Empat jenis resin komposit (Esthet-X-Denstply, Amerika Syarikat, Filtek™Z350-3M ESPE, Amerika Syarikat, Beautifil-Shofu, Jepun dan Solare P-GC, Jepun) digunakan dan bahan pelapik tampalan yang digunakan adalah Fuji IXGP (GC, Jepun), Beautifil flow (Shofu , Jepun), Filtex flow ™Z350 (3M ESPE, USA) dan Esthet-X flow (Denstply, USA). Semua spesimen yang diuji melalui proses kitaran terma dan direndam dalam 0.5% pewarna asas fuschin selama 24 jam. Data kebocoran mikro bagi pemulihan ini berasaskan sistem pemarkahan ISO kebocoran mikro. Data ini dimasukkan dengan menggunakan SPSS 12.0 dan dianalisis menggunakan program perisian STATA. Kajian ini menunjukkan bahawa tidak ada bahan pelapik yang digunakan mampu menghalang kebocoran mikro tampalan. Namun begitu, kajian ini menunjukkan bahawa penggunaan bahan berasaskan kaca ionomer mampu mengurangkan kebocoran mikro bagi pemulihan Kelas II. Antara resin flowable komposit, Filtex flow ™Z350 telah menunjukkan pengurangan kebocoran mikro apabila digunakan sebagai pelapik untuk pemulihan Kelas II.

Kata kunci: Kaca ionomer; kebocoran mikro; komposit resin flowable; pemulihan Kelas II

INTRODUCTION

Flowable composite resins have gained popularity in the last decade and have been used in a wide range of composite resin restorations. The viscosity is lower due to the reduced filler load (Gallo et al. 2010). Thus, it is easy to apply especially in areas which are difficult to assess. Over the years, the physical and mechanical properties of composite resins have improved, however polymerization shrinkage remain as one of the major problems leading to failure of direct composite resin (Peutzfeldt & Asmussen 2002). The flowable composite resin also faces the same problem. It was found that the polymerization shringkage in flowable composite resin is much higher due to lower filler load (Chung & Greener 1990). Therefore, it will have the same problems as existing composite resins such as the formation of microscopic marginal gap at the tooth-restoration interface (Gallo et al. 2010; Neme et al. 2002), marginal staining, reduce mechanical properties, increased wear (Chung & Greener 1990) and post-operative sensitivity (Sharma et al. 2011). These may subsequently lead to failure of the restoration, increase risk of secondary caries formation or development of pulpal pathology (Neme et al. 2002).

Flowable composite resin was postulated to be able to reduce the microleakage (Leevailoj et al. 2001; Olmez et al. 2004; Peutzfeldt & Asmussen 2002). It has been recommended to be used as the first increment for Class II restorations (Peutzfeldt & Asmussen 2002) because it has better flow (Lee et al. 2003), therefore able to improve adaptation to the irregular surface of the cavity preparation and reduce the formation of voids (Chuang et al. 2001).

This *in vitro* study aimed to evaluate the marginal microleakage in Class II cavities restored with various types of lining materials as the first increment followed by composite resin restoration.

Materials and Methods

Restoration and Preparation of the Specimens

Forty premolars extracted due to orthodontic treatment or periodontal problems were collected. They were intact with no caries and restorations. Class II slot cavities were prepared on the proximal surfaces of 40 premolars that were randomly allocated into four groups of ten teeth each. The cervical margins were located 1 mm apical to cement-enamel junction.

The restorative materials and the types of bonding were placed according to the manufacturers' instructions as in Table 1. Four types of composite resins (Esthet-X-Denstply, USA, Filtek™Z350-3M ESPE, USA, Beautifil-Shofu, Japan and Solare P-GC Japan) were used to restore the mesial cavities (acting as control). Three types of flowable composite resins - Esthet-X flow (Denstply, USA),

TABLE 1. List of materials

Materials	Composition			Manufacturer
Filtek™ Z350-*nanofilled* (Restorative material)	Fillers	:	Combination of aggregated zirconia/silica cluster filler	3M ESPE, USA
	Particles size	:	Cluster particles size of 0.6 to 1.4 microns (with primary particles size of 5-20 nm and a non-agglomerated 20 nm silica filler	
	Filler loading	:	78.5% by weight (59.5% by volume)	
	Resin	:	Bis-GMA, UDMA, TEGDMA and bis-EMA resins	
	Adhesive sys	:	Adper ™ Single Bond 2	
Filtek™ Z350 flow - *nanofilled* (Lining material)	Fillers	:	Combination of non-agglomerated; 75 nm silica nanofiller, 15-20 nm zirconia nanofiller and loosely bound agglomerated zirconia/silica cluster	3M ESPE, USA
	Particles size	:	0.6 to 1.4 µm	
	Filler loading	:	65% by weight (55% by volume)	
	Resin	:	Bis-GMA, TEGDMA and bis-EMA resins	
	Adhesive sys	:	Adper ™ Single Bond 2	
Beautifil - *Giomer* (Restorative material)	Fillers	:	Multi-functional glass fillers and S-PRG fillers are based fluoro-boroaluminosilicate glass	SHOFU, Japan
	Particle size	:	0.01 to 5.0 µm (mean 1.0 µm)	
	Filler loading	:	81.5% by weight	
	Resin	:	Bis-GMA/ TEGDMA	
	Adhesive sys	:	FL-Bond Etchant	
Beautiful flow - *Giomer* (Lining material)	Fillers	:	Multi-functional glass filler, improved S-PRG fillers based on fluoro-boroaluminosilicate glass	SHOFU, Japan
	Particle size	:	0.01 to 3.0 µm (mean: 0.8 µm)	
	Filler loading	:	54.5% by weight (34.6% by volume)	
	Resin	:	Bis-GMA/ TEGDMA resin	
	Adhesive sys	:	FL-Bond Etchant	
Esthet-X flow – *liquid microhybrid* (Lining material)	Fillers	:	Combination of barium fluoro alumino boro silicate glass	DENTSPLY Caulk. USA
	Particles size	:	Mean 1 µm and nanofiller 0.04 µm	
	Filler loading	:	-	
	Resin	:	Bis-GMA adduct, TEGDMA and bis-EMA resins	
	Adhesive sys	:	Prime and Bond NT (nano-technology light cured dental adhesive)	
Solare P - *microhybrid* (Restorative material)	Fillers	:	Silica, fluoro-aluminosilicate glass and pre-polymerized resin fillers	GC Corporation, Japan
	Particles size	:	Mean 0.85 µm	
	Filler loading	:	Silica (13%), Fluoro-aluminosilicate (24%), Pre-polymerized resin (28%) – by volume	
	Resin	:	-	
	Adhesive sys	:	Unifil Bond self-etching	
Fuji IXGP (Lining material)	Powder	:	95% alumino- silicate glass Liquid : 5% polyarcylic acid	GC Corporation, Japan
	Adhesive sys	:	GC dentine conditioner	

the Filtex™Z350 flow(3M ESPE, USA), the Beautifil flow (Shofu, Japan) and one type of glass ionomer cement - Fuji IXGP (GC, Japan) were used as a lining.

The restorations were then completed with the respective composite resin. The thickness of the lining materials were 1.0 mm thick and verified with a periodontal probe. The materials were adapted using narrow siquveland matrix band to ensure appropriate contouring at the proximal areas. The restorations were cured using light cured 'Spectrum 800' (Dentsply) (470 nm wavelength). The proximal surfaces of the restoration were finished using the medium and fine soflex discs.

All the specimens were thermocycled at 5^0C and 55^0C for 500 cycles and then immersed in 0.5% basic fuschin dye for 24 h. All the specimens were then rinsed with distilled water and dried. Two layers of varnish were applied 1 mm away from the cavity margins. The specimens were then sectioned in mesio-distal direction. The extent of the microleakage was scored using the ISO microleakage scoring system (ISO/TS *11405:2003)* as in Table 2 and Figure 1.

EVALUATION OF THE MICROLEAKAGE

All the specimens were evaluated by a single examiner. Three readings were taken, with two of the readings were to check for intra-examiner reliability. Intra examiner reliability was obtained using STATA statistical software by computing weighted kappa. The values of weighted kappa was 0.72. This kappa was in an acceptable range that indicated an acceptable level of consistency. Kappa statistic showed acceptable intra examiner reliability. The data were entered using SPSS version 12.0 and analyzed using STATA software programme.

RESULTS

Descriptive comparison of the marginal microleakage was done on the control and test groups. Four different composite resins; Esthet-X, Filtek ™Z350, Beautifil and Solare P with lining materials (test group) namely; Esthet-X flow, Filtek ™Z350 flow, Beautifil flow and Fuji IXGP flow. The control group were the composite resins without lining meterials.

The microleakage score was collapsed into either having microleakage leakage or no microleakage (Table 3, Figures 2 and 3). The comparison between Esthet-X and Esthet-X flow lining; Filtek ™Z350 and Filtek ™Z350 flow lining; as well as Beautifil with Beautifil lining cannot be compared statistically due to lack of variation in the data where the three groups either all did not have any microleakage or all had miroleakage. Only the cavities restored with Solare P without lining and cavities lined with Fuji IXGP and restored with Solare P reveals higher frequency of six specimens (60%) having microleakage in cavities without lining (control) compared with only

TABLE 2. Scoring system for the extent of microleakage

	Occlusal score		Cervical score
Score 0	No dye penetration	Score 0	No dye penetration
Score 1	Dye penetration into enamel	Score 1	Dye penetration into ½ of the cervical wall
Score 2	Dye penetration into the dentine, not including the pulpal wall/gingival floor	Score 2	Dye penetration into all the cervical wall
Score 3	Dye penetration into the dentine including the pulpal wall	Score 3	Dye penetration into cervical and axial wall

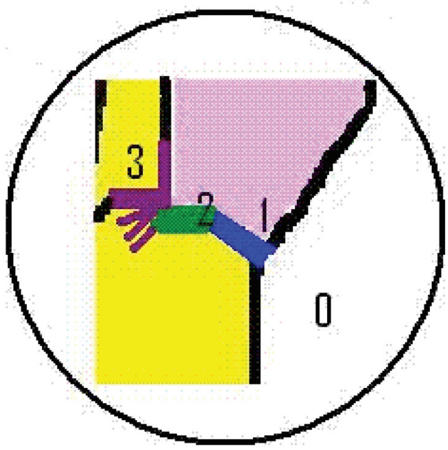
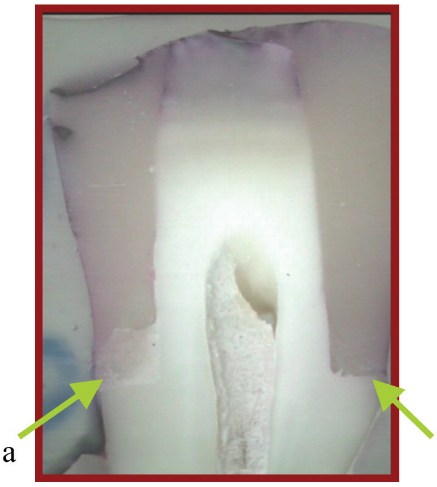


FIGURE 1. The extension of microleakage at the cervical margin

TABLE 3. The presence of marginal microleakage at cervical margin in cavities restored with and without lining (n=10)

Materials	Microleakage	
	Yes *n* (%)	No *n* (%)
Esthet-X		
Without lining	0	10 (100)
Lining with Esthet-X flow	0	10 (100)
Filtek ™Z350		
Without lining	0	10(100)
Lining with Filtek ™Z350 flow	1(10.0)	9(90.0)
Beautifil		
Without lining	1(10.0)	9 (90.0)
Lining with Beautifil flow	0	10(100)
Solare P		
Without lining	4(40.0)	6(60.0)
Lining with Fuji IXGP flow	7(30.0)	3(30.0)



a b

FIGURE 2. Microleakage score 0 for (a) Fuji IXGP and (b) Solare P

a b

FIGURE 3. Microleakage (a) score 3 for Filtek™ Z350 flow and (b) score 2 for Filtek™ Z350

three specimens (30%) in cavities lined with Fuji IXGP (test group).

The comparison of microleakage score at cervical margin in control and test group were done by using Fisher's exact test (Table 4 and Figures 4 and 5). In the control group, there was a significant difference between the four different composite resin in their extent of microleakage (p=0.001). All the teeth restored with Esthet-X had a microleakage of score 3 where the dye penetrated into cervical and axial wall. Bonferroni correction Pos hoc test revealed that the microleakage score in the Esthet-X was significantly worse than the Solare P. On the other hand, Solare P demonstrated better seal with more than half of the cavities (six specimens) showed either having no leakage or only microleakage into halves of the cervical wall.

In the test group (Table 4), the composite resin restorations were lined with their respective lining materials at the cervical margin. It was found that there was a significant difference in the extent of microleakage between the four lining materials. Bonferroni correction Pos hoc test showed that there was a significant difference when Fuji IXGP was placed at the cervical margin compared with other lining materials i.e. the flowable composite resins. Fuji IXGP lining material demonstrates the best microleakage score with seven of specimens having no microleakage. Filtek ™Z350 flow demonstrated a better microleakage score in comparison with other flowable resins. However the difference was not significant statistically.

DISCUSSION

This study was done on Class II slot restoration due to increased demand for posterior composite resin restoration. It was to evaluate and compare the extent of marginal microleakage at the cervical area in Class II cavities

TABLE 4. Microleakage score at cervical margin in control and test group (n=40)

Types of composite resin	Cervical margin										
	Microleakage score control group n (%)				p-value		Microleakage score test group n (%)				p-value
	0	1	2	3			0	1	2	3	
Esthet-X	0	0	0	10 (100)		Esthet-X flow	0	0	1 (10)	9 (90)	
Filtek ™Z350	0	0	2 (20)	8 (80)	0.001[a]	Filtek ™Z350 flow	1 (10)	3 (30)	2 (20)	4 (40)	<0.001[b]
Beautifil	1	0	0	9 (90)		Beautifil flow	0	0	0	10 (100)	
Solare P	4 (40)	2 (20)	1 (10)	3 (30)		Fuji IXGP flow	7 (70)	3 (30)	0	0	

[a] Pos hoc test revealed that the microleakage score in the Esthet-X was significantly worse than the Solare P (p=0.018)
[b] Pos hoc test revealed that the microleakage score in FujiIXGP flow was significantly better than Esthet-X flow (p<0.001), Filtek ™Z350 flow (p=0.042) and Beautifil flow (p<0.001)

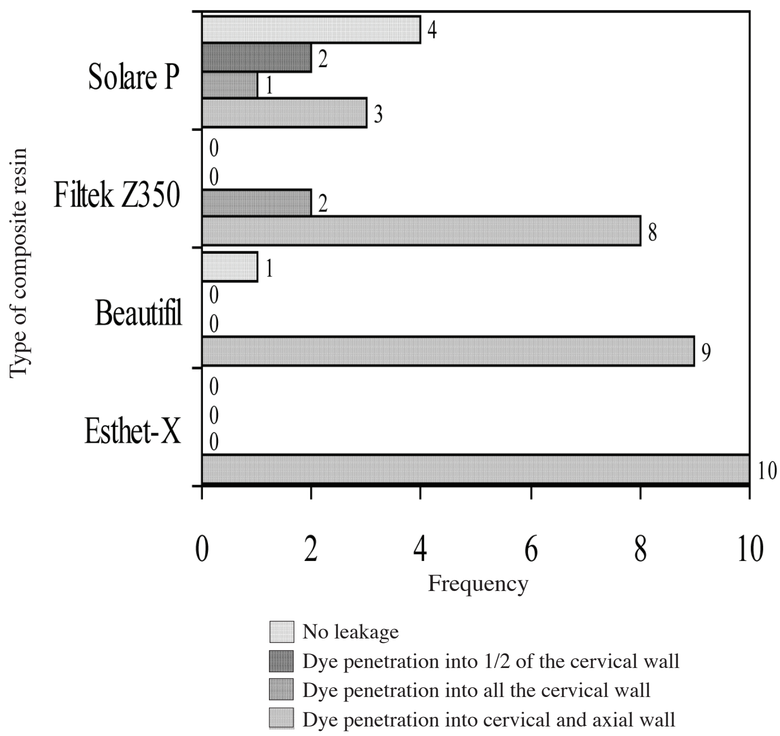


FIGURE 4. Microleakage score at cervical margin in control group

restored with four different types of composite resins and lining materials: Esthet-X, Filtex™ Z350, Beautifil and Solare P, Esthet-X fow, Filtex™ Z350, Beautifil flow and Fuji IXGP.

Numerous researches on microleakage in relation to flowable composite resin have been carried out with a view to improve the performance of these materials in clinical service. Some have shown that there were no significant differences in microleakage with or without the use of flowable composite when the gingival margin was placed in the enamel (Neme et al. 2002; Tredwin et al. 2005). Other studies showed that the leakage was greater when the margins were placed in the cementum or dentine (Benzos 2001; Civelek et al. 2003; Tredwin et al. 2005). On the other hand, some studies found that using flowable resins as a lining decreased the incidence of microleakage by improving the marginal seal. (Estafan et al. 2000; Leevailoj 2001; Olmez et al. 2004). The differences in all of the results may be related to the different types of materials used, the location of the restoration, type and size of the cavities, the operator factors (professional skills during the restorative procedures) and research methodology. It is therefore difficult to make direct comparison amongst various research findings. However, these findings can

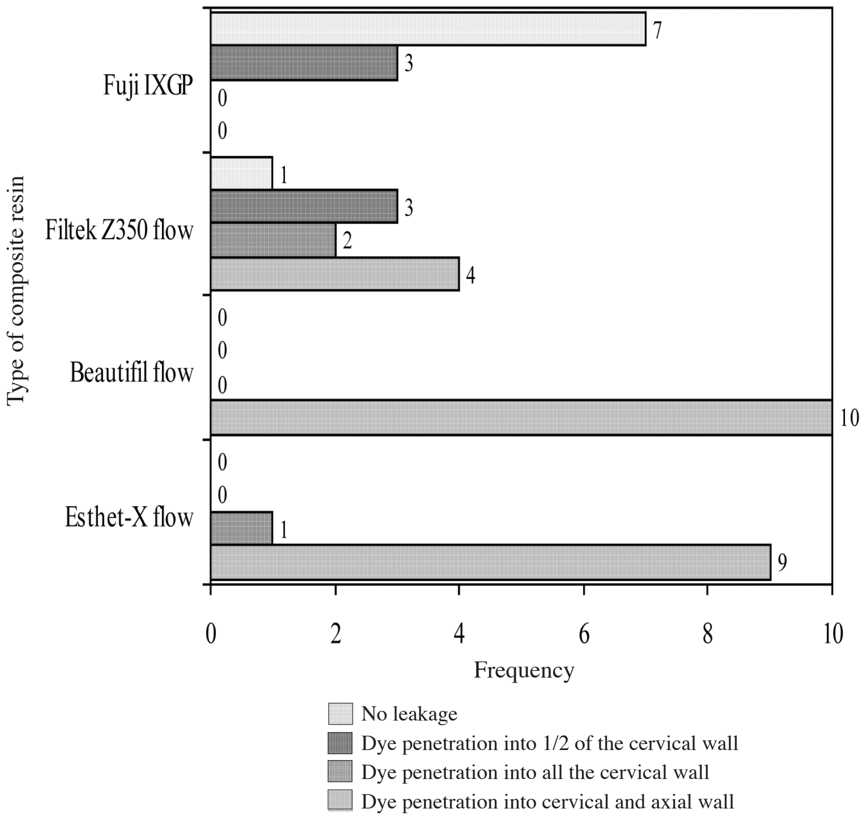


FIGURE 5. Microleakage score at cervical in test group

serve as a guide to the extent of microleakage that will occur with the materials investigated.

In this study, the cavity restored with composite resins (Esthet-X, Beautifil, Filtek™ Z350 and Solare P) demonstrated more microleakage at the cervical margin than the cavities lined with flowable composite. The improvement in delivery system of flowable composite might lead to an acceptable cavosurface marginal adaptation and resulted in reduction of marginal gap between the respective composite restoration and tooth structure. Furthermore, the low elastic modulus of flowable composites may help in absorbing the shringkage stress of the overlying highly loaded resin (Estafan et al. 2000).

In a control group, Solare P showed less extent of microleakage where only three of the specimens showed penetration of the dye into the cervical and axial wall compared with the other types of composite resin tested. In contrast, Esthet-X demonstrated the worst microleakage which resulted in dye penetration into the cervical and axial wall for all specimens. Leevailoj et al. (2001) found that significantly higher leakage was noted at the cervical margin in Class II cavities with cervical margin placed 1 mm below the cemento-enamel junction.

A study done by Pashley (1992) showed that the presence of smear layer and smear plugs are able to reduce dentine permeability and removing this layer may have resulted in increased dentine permeability. This observation may explain the worse microleakage score in Exthet-X at the cervical margin followed by Beautifil and Filtek™ Z350. On the other hand it may also explain the least microleakage score in Solare P. The self-etching primer did not totally remove the smear layer in comparison with the total etch technique despite the type of etching used. Therefore the tubules remain sealed and resulted in less microleakage.

When Fuji IXGP was used as a lining material at the cervical margin, it exhibited the ability to reduce microleakage where seven specimens showed no microleakage. On the other hand, when Solare P was used without lining, there were three specimens showing leakage into cervical and axial wall. This is in agreement with studies carried out by Chuang et al. (2003) and Hembree (1989). Hembree (1989) investigated the use of glass ionomer cement as a lining material in Class II cavities prepared on molar teeth with gingival margin placed in dentine/cementum. It was found that 24 out of 26 specimens using glass ionomer cement (Ketac Bond) as a liner underneath composite resin restoration showed less leakage to no leakage. The group with no glass ionomer cement liner showed moderate to gross leakage.

Chuang et al. (2003) in their study demonstrated that in deep Class II cavities (1 mm below the cemento-enamel junction) resin modified glass ionomer cement (RMGIC) showed similar or better marginal sealing than the flowable resin, compomer and composite resin. Therefore, it can be concluded that glass ionomer cement was able to provide better seal than the composite resin. This may be attributed by the type of bonding mechanism established between tooth structure and restoration materials. The chemical bonding between glass ionomer cement and dentine structure is well established through its polar and ionic attractions. This is supported by Anusavice (2003) that this ionic attraction has resulted in a more superior bond between glass ionomer cement and dentine compared with the microretentive bond between composite resins and dentine.

CONCLUSION

It can be concluded that Filtek™ Z350 flow was superior to Beautifil flow and Esthet-X flow in preventing microleakage at cervical margins below cemento-enamel junction. The use of glass ionomer restorative material such as Fuji IXGP has the ability to provide good seal at cervical margin. Therefore, in clinical situation, if the cavity margin is placed below the cemento-enamel junction, it is advisable to line the cavity with glass ionomer cement to reduce the incidence of microleakage.

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