The influence of flowable composite liner on microleakage of class II packable composite resin restoration with different application techniques (Comparative study)

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ABSTRACT

Background: This in vitro study was conducted to evaluate and compare the influence of flowable composite and different application techniques of class II packable composite restoration on dentinal leakage.

Materials and methods: Thirty human freshly-extracted Maxillary premolars were selected for this study. Conventional Class II MOD cavities were prepared in the sample teeth which were then divided into five groups .Each group consist of ten boxes either MO or DO according to the restorative procedure used except group A which consist of twenty boxes(ten teeth with MOD amalgam restoration). Group A: ten teeth where restored by amalgam- (SDI Australia) high strength admix amalgam type.Group B: ten teeth in which the mesio-occlusal (MO) sides were restored by {adhesive + flowable composite + one bulk packable composite (Filtek P60)}. Group C: ten teeth in which the disto-occlusal (DO) sides were restored by {adhesive +one bulk packable composite, (Filtek P60)}.Group D: ten teeth in which the mesio-occlusal (MO) sides were restored by {adhesive + flowable composite + successive build up technique for packable composite, (Filtek P60)}. Group E: ten teeth in which the disto-occlusal (DO) sides were restored by {adhesive+ successive build up technique for packable composite, (Filtek P60)}. After thermocycling and immersion in 2% methylene blue, the teeth were sectioned longitudinally mesio-occluso-distal and dye penetration was evaluated using a stereomicrscope, microleakage was recorded in mm.

Results and Conclusions: ANOVA test and least significant difference (LSD) test were used to analyze the results, and the results showed that the use of flowable composite resin as a liner with packable composite resin decreases the amount of dentinal microleakage, and the restorative technique of packable composite whether it is bulk build up technique, or incremental successive build up technique has no difference on the improvement of microleakge value, and the packable resin composite restoration whatever applied with different application techniques or restored with or without flowable composite it still had or scored higher microleakage than amalgam restoration.

Keywords: packable composite, microleakage, flowable composite. (J Bagh Coll Dentistry 2012; 24(4):19-24).

INTRODCUTION

Resin composites were introduced into dental practice as esthetic restorative materials for anterior teeth when they were first developed. However, the growing demand for more esthetic restorations and minimal loss of tooth substance in cavity preparations has made posterior composites an attractive alternative to amalgams, and the use of esthetic materials for the restoration of posterior teeth has increased over the past years. This was achieved due to the development of several bonding systems and improved mechanical and physical properties [(1).] Packable composites are claimed for use in stress bearing posterior restorations with improved handling properties, as an application technique similar to the manipulation of amalgam can be used for the placement. Easier establishment of physiological interproximal contacts in Class II restorations, the use of metal matrix bands and wooden wedges, and possible bulk curing of the restorations are advantageous [(2).]

These materials had many problems including marginal leakage because of polymerization shrinkage, low resistance to wear, fracture in the body of the restoration, voids, sensitivity after placement and insufficient proximal contact. The success rate of these posterior restorations was very high in early clinical evaluations, but started to drop after 5 years [(3).] Several clinical techniques have been proposed to minimize the problem of polymerization shrinkage. One way to reduce of contraction stress is the incremental layering of resin–based composites during placement to minimize bridging between cavity walls and to reduce shrinkage stresses through the sequential use of small volumes of material, but the benefit of the incremental technique for reducing polymerization contraction stresses is somewhat controversial [(4).] The use of flowable composite has been suggested as a mean to reduce the possibility of microleakage [(5)].

The purpose of this study was to evaluate and compare the influence of flowable composite on dentinal leakage in class II cavity filled with packable composite (Filtek P60) using two placement techniques:

A. Bulk technique.

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B.Incremental (successive cusp build up technique).

MATERIALS AND METHODS

Thirty extracted sound (non-carious and non-restored maxillary premolars were selected in this study. The teeth were cleaned, polished using dental scaler and pumice, and were stored in distilled water until use.

Before cavity preparation the teeth were mounted in an autopolymerizing acrylic resin blocks which's confined in a casting metal mould for all the teeth. The specimens were positioned with the long axis of the tooth, parallel to the sides of the mould for mounting; the parallelism was done using surveyor. Each tooth was removed from the resin block when the polymerization was observed; then remounted into the blocks and fixed with sticky wax after completion of resin polymerization.

Cavity preparation

All of the teeth received a mesio-occlusal-distal (MOD) cavity preparation with long shaft cylindrical diamond bur No. 836 of 1.25 mm width (Diatech diamant AG, Swiss) using a high-speed air/water-cooled hand piece, that fixed to modified dental surveyor in order to standardized the cavity preparation (A new bur was used for every five preparations). This will create two boxes (mesial and distal box); the plate of the surveyor was fixed in horizontal plane. The specimens then placed on the surveyor table, and the parallel sided diamond bur is passed between the mesial and distal box to create a Mesio-Occluso-Distal cavity. The cavities were prepared following a standardized pattern in which the class II cavity had an average length of 8.0 mm (distance between mesial and distal marginal ridge), width of cavity was 1.25 mm, while the depth was 2.0 mm occlusally [6]. The proximal box had an axial depth of 1.5 mm and buccolingual width of 4.0 mm; the buccal and lingual walls are parallel to each other Figure 1. The cervical margin of the proximal box was located 1.0mm below the CEJ.

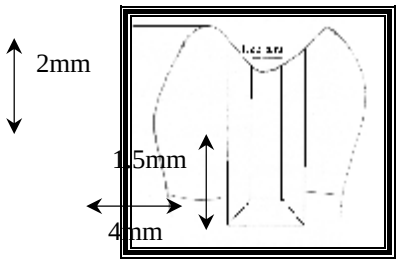

Figure 1

The specimens were then randomly divided into five groups, with ten boxes each except group (A) which consist of twenty boxes (ten teeth with MOD amalgam restoration).

Restorative Procedure

In order to simulate a clinical situation, the prepared teeth were removed from the acrylic block and lined up with proximal contacts in upper jaw models. The teeth were mounted to the models using dental wax and the missing teeth were completed with plastic teeth, group (A) was restored by dental amalgam (SDI Australia admix type) in conventional way, while the other four groups which restored by composite (Filtek p60); all the teeth were cleaned with distilled water coming out through the tip of the triple syringe of the dental unite and dried with oil free air for 15 second, Before etching a metal matrix band was adjusted in the matrix retainer ivory No.1, then the retainer and the band were seated around the tooth which is held by the upper model , a wooden wedges No.1 are used between the band and the adjacent teeth to prevent overhanging of the resin martial, then the enamel and dentine were etched with 35 % phosphoric acid (Scothbond Etchant Gel) for 15 seconds according to manufacture's instruction, etching gel was applied to all of the prepared cavity wall approximately 0.5 mm beyond un prepared tooth surface using dispensing tips for application The .Preparations was rinsed with an air/water spray for 10 seconds followed by gentle drying for 5 seconds. The excess water was blotted using a cotton pellet; the surface should appear glistering without pooling of water, leaving the tooth moist [7].

Immediately after blotting the excess water, 2 coats with fully saturated brush tip of an (Adper Single Bond) was applied onto the etched tooth surface for 15 second with gentle agitation, then gently air dried for 5 seconds to evaporate solvents and light cured for 10 second, according to the manufacturer's instructions for placement [7].

The teeth were then restored:

Group B: ten teeth in which the mesio-occllusal (MO) side were restored by {adhesive (3M ESPE, USA) + flowable composite Tetric N-flow, Ivoclar Vivadent Schaan/Liechtenstein, shade A3 + one bulk packable composite Filtek P60,shade A3,3M USA }.

Group C: ten teeth in which the disto-occlusal (DO) side were restored by {adhesive (3M ESPE, USA)+one bulk packable composite, Filtek P60, shade A3, 3M USA}.

Group D: ten teeth in which the mesio-occlusal (MO) side were restored by {adhesive (3M ESPE, USA) + flowable composite Tetric N-flow, Ivoclar Vivadent Schaan/Liechtenstein,

shade A3 + successive build up technique for packable composite Filtek P60, shade A3,3M USA till the cavity completely filled}.

Group E: ten teeth in which the disto-occlusal (DO) side were restored by {adhesive (3M ESPE, USA) + successive build up technique for packable composite Filtek P60, shade A3, 3M USA, till the cavity completely filled.

Thermocycling and Leakage Evaluation

The restored teeth were stored for 24 hours in distilled water. After which the teeth were subjected to thermocyclings for 500 cycles between 5˚c and 55˚c with a dwell time of 30-second in each bath [6].The apices of the specimens were sealed with sticky wax, and all tooth surfaces were covered with two coats of clear nail polish with exception of 1.0 mm around the tooth-restoration margins and allowed to air dry. All specimens were then immersed in 2% methylene blue dye for 24 hours. After removal from the dye, the teeth were rinsed under running water and the nail polish scrapped off. The teeth were sectioned along the mesio-distal direction, coincident with the center of the restoration, with a water cooled diamond saw (Dentarum, UK).The dye penetration of the gingival margins of each section was evaluated independently by two observers using a stereomicroscope type (Hamilton, BioVision 320) at a magnification of X40 and dye penetration was recorded in mm

RESULTS

The descriptive statistics which represent the mean values and standard deviation (SD) and standard error (SE) with the maximum (Max) and minimum (Min) values of the microleakage in millimeters (mm) of the packable composite used in class II cavities are represented in Table (1).

Table 1: Mean, standard deviation (SD), standard error (SE), minimum (min), and maximum (max) microleakage values in mm for all groups.

	Mean	Max	Min	SD	SE
GA (Amalgam)	0.145	0.27	0.08	0.073	0.023
GB (Bulk+flowable)	1.36	1.8	0.9	0.335	0.106
GC (Bulk without flowable)	1.75	2.2	1.3	0.303	0.096
GD (Increment+flowable)	1.37	1.9	0.8	0.3596	0.1138
GE (Increment without flowable)	1.79	2.2	1.4	0.2514	0.0796

It is clear from the bar chart Figure (2), that group A control group (amalgam),has the lowest mean microleakage value (0.145mm), while group E (incremental without flowable), has the highest mean value of microleakage (1.79 mm).

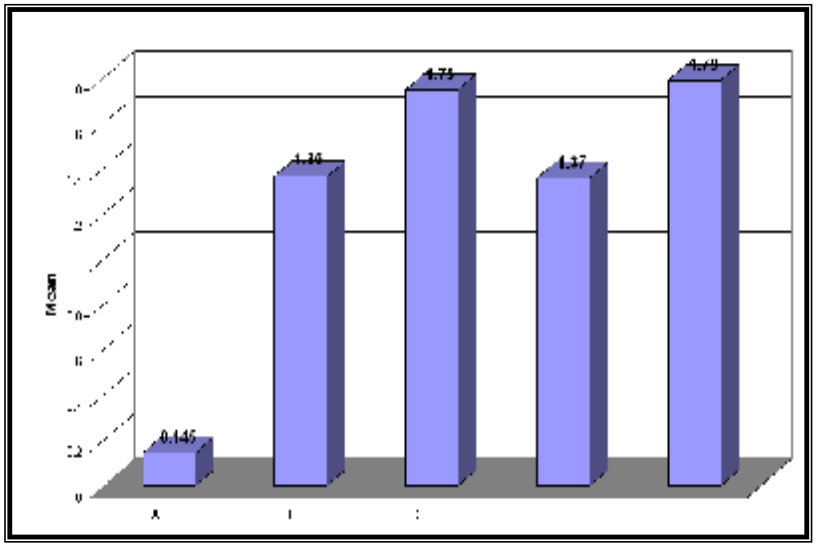

Figure 2: Means of microleakage values in (mm) for the five groups.

The statistical analysis of data by one - way ANOVA showed a statistical significant difference ($P < 0.01$) among five estimations of means value. These results are presented in Table 2.

Table 2: ANOVA test of microleakage mean values for five groups.

S.O.V	d.f.	SS	MS	F	P-value
Between groups	4	17.8283	4.4571	55.46	0.000
Within group	45	3.6165	0.0804		
Total	49	21.4448			

Further analysis of all data is needed to examine the difference between groups so least significant difference (LSD) of microleakage of packable composite was done as shown in Table (3).

Table 3: LSD between groups

Figure 1	Figure 1	Figure 1	Figure 1
A&B	-1.22	0.000	HS
A&C	-1.60	0.000	HS
A&D	-1.215	0.000	HS
A&E	-1.645	0.000	HS
B&C	-0.385	0.000	HS
B&D	-0.005	0.977	NS
B&E	-0.425	0.018	S
C&D	0.390	0.044	S
C&E	-0.04	0.779	NS
D&E	-0.430	0.001	HS

DISCUSSION

The mean microleakage value for the control group in present study was (0.145) consistent with the mean microleakage value found in another study done by Gallato [8]. So the control group of the present study has an accepted mean microleakage value, also it gives a high significant difference value with all the experimental groups, where this result agrees with other study by kohalmi [9] who found that in case of deep Class II cavities the amalgam had better adaptation at the gingival margin than the composite resin materials.

The effect of flowable composite

According to the results which has been shown in this study by ANOVA one way analysis and (LSD) between groups. The group B {bulk + flowable} gives less mean value of microleakage 1.36 in comparison to group C {bulk without flowable}, 1.75 with high significant difference between both groups, also group D {incremental + flowable} have a less mean value of microleakage 1.37, compared to group E {incremental without flowable} which have a mean value of microleakage 1.79 and statically there is a high significant difference between both groups. According to these results it has been shown that the use of flowable composite as a liner with packable composite with both application techniques used in this study (bulk and the increment) decreases the amount of dentinal microleakage and this may be contributed to that low viscosity composite liner may act as stress absorbing layer due to it's lower elastic modulus. This keeps polymerization shrinkage from pulling the material away from margins and the internal aspects of the preparation [10] and thus reduces leakage.

Flowable composite may improve the effectiveness of the dentin bonding agent in counteracting the polymerization stress at the restoration-dentin interface [11]. Actually flowable resins contain 20–25 % less filler than do non flowable material [12], and it is well known that the amount of filler present in a resin- based composite is the major factor in terms of polymerization contraction stress development, which ultimately will affect the marginal integrity of the restoration [13]. Increase viscosity and filler particles content require more force and increase the difficulty to adapt the resin composite to the cavity walls, stiffness of the material has been shown to be directly proportional to microleakage. The stiffness and inability to flow during the polymerization process might increase polymerization stresses which increase contraction and microleakage [5]. Packable composites have a difficult adaptation on the contact angle of the cavity preparation so a thin layer of flowable composite on the preparation

walls can improve the adaptation and seal of a packable composite [14]. This agrees with other studies which found an improvement in marginal sealing with the use of a flowable composite as the first increment in class II cavities [15, 16]. A reduction in the number of voids has also been demonstrated when a low-viscosity composite was used as a liner in class II cavities [17]. Fewer cervical voids were observed in packable composites with flowable liner [18] but this study disagree with a study done by Tredwin [19], where there data do not support the use of flowable resin composite linings in Class II resin composite restorations.

The effect of layering technique

In this study two groups received a composite restoration with a successive cusp build up technique , (group D and E) there is a statically high significant difference between them due to the presence of flowable composite not to the technique, because if comparing between (group D and B), (both of them has flowable composite but different technique), the mean value of microleakage for group D is 1.37 while the mean value for group B 1.36 they are too close and statically there is no significant difference between them, also for (group C and E),(both of them have no flowable composite but different placing technique),for C the mean value of microleakage is 1.75 and for group E is 1.79 they are too close from each other and statically there is no significant difference between these groups.

Several clinical techniques have been proposed to minimize the problem of polymerization shrinkage. One way to reduce the effect of contraction stress is the incremental layering of resin-based composites during placement to minimize bridging between cavity walls and to reduce shrinkage stresses through the sequential use of small volumes of material [6]. This benefit of the incremental technique for reducing polymerization shrinkage and leakage was not in agreement with the result of this study ,and our result come in agreement with other study by Gallo [20] who reported that, the bulk filling procedure have a similar leakage as incremental technique in Cl II cavity restored with packable resin composite. While David [21] stated that the leakage of packable posterior composite in bulk cured restoration scored slightly less than that in incremental layering technique and this come in agreement with Elsevier [22].

In summery, packable resin composite restoration whatever applied with different application techniques or restored with or without flowable composite scored higher microleakage than amalgam restoration, the use of flowable composite resin as a liner with packable composite resin decreases the amount of dentinal microleakage. Restorative technique of packable composite either with bulk build up technique, or incremental successive build up technique has no difference on the improvement of microleakge value.

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