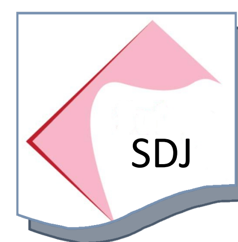
Evaluation of microleakage in the gingival margin of class II resin composite restoration when using three placement techniques (An in vitro study)



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Abstract

Objective: To evaluate and compare the effect of bulk and layering composite filling techniques on the gingival microleakage in class II cavity.

Materials and methods: Standardized 60 class II cavities were prepared in the proximal surfaces of thirty extracted non caries permanent molars and randomly were divided into two main groups A and B each composed of 30 cavities, for group (A) the gingival floor on mesial side was prepared one mm above the CEJ and for group (B) one mm below the CEJ, then each main group was subdivided into three subgroups (n=10 cavities) according to the composite placement technique: 1) bulk, 2) horizontal, 3) oblique. The specimens were immersed in a solution of 2% methylene blue dye for 24 hours. The microleakage scores (0 to 3) were obtained from the cervical surface and the cervical microleakage was analyzed with a stereomicroscope.

Results: The gingival dye penetration increased when the gingival floor was below the CEJ. The microleakage is increased with bulk followed by horizontal and oblique.

Conclusion: This study predicts that the oblique layering composite filling technique of class II is betters then the other techniques when the gingival floor is above and below the CEJ.

Keywords: *Gingival dye microleakage, Nano-hybrid resin based composite, bulk placement techniques, incremental placement techniques.*

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Introduction

Posterior composite restorations have been shown to produce higher failure rates due to secondary caries, which can be directly linked to marginal integrity [1,2]. This is the result of composite resin polymerization shrinkage, which may be responsible for the formation of a gap between composite resin and the cavity walls, and it may be filled with oral fluids and bacteria [3]. Other adverse consequences of polymerization shrinkage stresses include coronal deformation resulting in postoperative sensitivity, propagation of existing enamel microcracks, and micro cracks of composite resin due to cohesive failure [4]. Several efforts have been made to decrease these polymerization shrinkage stresses and were directed toward improving composite resin formulation, curing methods and restorative placement techniques [5]. Although the mechanical properties and abrasion resistance of resin-based composites have improved considerably over the years, the placement technique of posterior resin-based restoration remains very technique sensitive and regarded as a major factor of influence for clinical performance of class II composite resins fillings [6,7].

Different composite placement techniques have been recommended (bulk technique and layering technique). Using bulk technique,a high internal stresses may be generated in the material and loss of marginal integrity can occur [7]. Layering or incremental techniques, in contrast to bulk packing methods, have decreased marginal gaps [8]. Furthermore, layering techniques has been advocated for use in large composite restorations to decrease the overall contraction by reducing the bulk of material cured at one time [9]. Layering composite filling techniques also reportedly enhances complete polymerization by reducing the required depth of cure and enhance esthetic results from the multi-layering of color and also improve marginal seal [10].These techniques include the horizontal (Gingivo-occlusal layering), the wedge-shaped oblique layering, the successive cusp buildup technique, the split-increment horizontal placement technique, vertical (facio-lingual layering) and centripetal placement [5,11].

In this study we investigated the influence of horizontal and oblique techniques on gingival microleakage in class II composite filling compared with bulk technique. The horizontal

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layering technique is the traditional way to fill the cavity, the thickness of each increment of resin composite is not more than 2 mm. Each increment shall be fully polymerized before the next one is inserted into the cavity [12], while in oblique layering technique; wedge-shaped composite increments are placed and polymerized only from the occlusal surface [13].

Materials and methods

Thirty extracted non caries human permanent molars were selected; the teeth were scaled to remove any calculus and polished with pumice to remove plaque and debris.Then all the selected teeth were kept in distilled water at 4°C for 24 h. Two sound extracted molars were embedded in dental stone to the level of 3 mm below the cementoenamel junction (CEJ) and the test specimen was embedded between these two teeth (Fig. 1.a). Sixty Class II MO/DO cavity preparations were made on each side of the teeth using a straight fissured diamond bur (No.010) in a high-speed handpiece and copious amounts of water. The teeth were divided into two main groups as shown in (Fig.2): (Group A), (n=30 cavities); the gingival floor on mesial side was prepared one mm above the CEJ; and (Group B), (n=60cavities); the gingival floor on distal side was prepared one mm below the CEJ. No bevels were placed at any of the cavosurface margins.

All the cavities were etched then a light-curing, single-component bonding agent for enamel and dentin was applied (Tetric N-Bond, Ivoclar, Vivadent) (Fig. 1. d) and cured for 40 seconds as per manufacturer's instructions. After the preparations were completed, each main group was subdivided into three subgroups (n=10

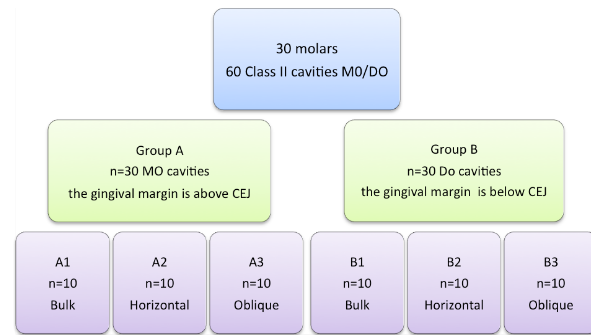
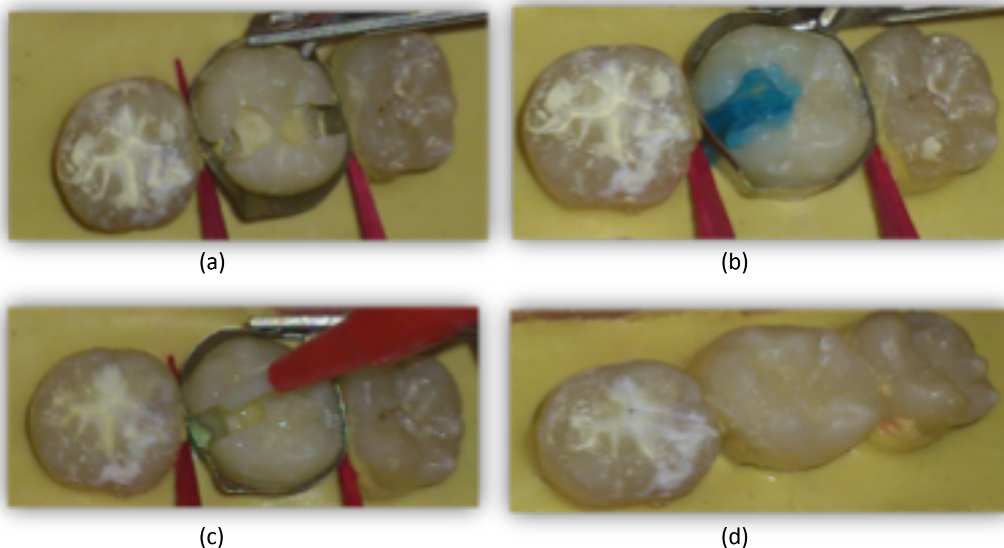


Figure 2. The division of the study groups.

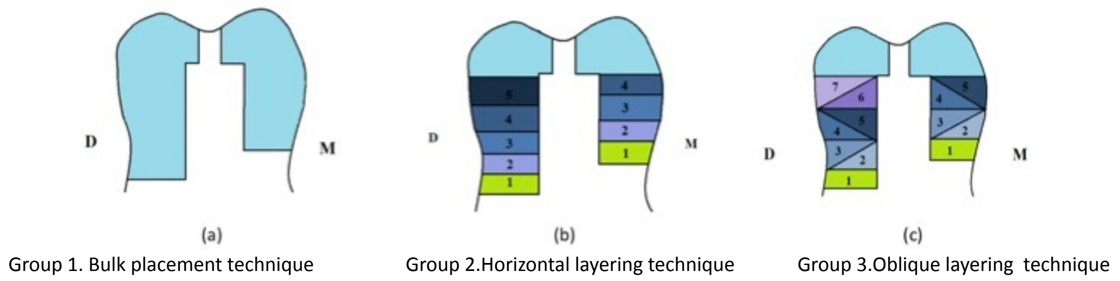
cavities) as shown in (Fig. 2), then a tofflemire universal matrix retainer is positioned from the buccal surface of the test molar (Fig. 1-b). The tofflemire band was contoured and firmly wedged to closely adapt the matrix to the gingival margin of the preparation and to achieve a degree of tooth separation in order to compensate the matrix width. Then the teeth in all groups were restored with a Nano-hybrid resin based composite (Tetric N-Ceram, Ivoclar, Vivadent). The manufacturer instruction was followed; the light curing was done using Cool Blue TM LED (Milestone Scientific, Livingston, NJ, USA) with a light intensity of (400 mW/cm 2). The composite restorations were placed in each group according to the techniques shown in (Fig.3).

After removal of the metal band, all the specimens were stored in distilled water at 37°C for 24 hours; the restored teeth were subjected to artificial aging by thermocycling. All the specimens were immersed alternatively in water baths at 5 °C and 55 °C for 1500 cycles with a dwell time 30 seconds and a transfer time of 15 seconds. In order to prevent dye penetration into



(a) (b) (c) (d)

Figure 1. (a) shows the embedding test specimen between two molars in dental stone, (b) illustrates the acid itching procedure, (c) displays the bonding procedure, (d) shows the tooth at the end of the filling procedure.



Group 1. Bulk placement technique | Group 2.Horizontal layering technique | Group 3.Oblique layering technique

Figure 3. Placement techniques of the composite resin according to the groups.

Figure 4. The two halves of the sample after being sectioned mesio-distally through the center.

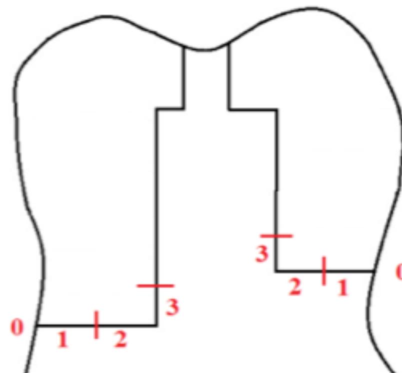
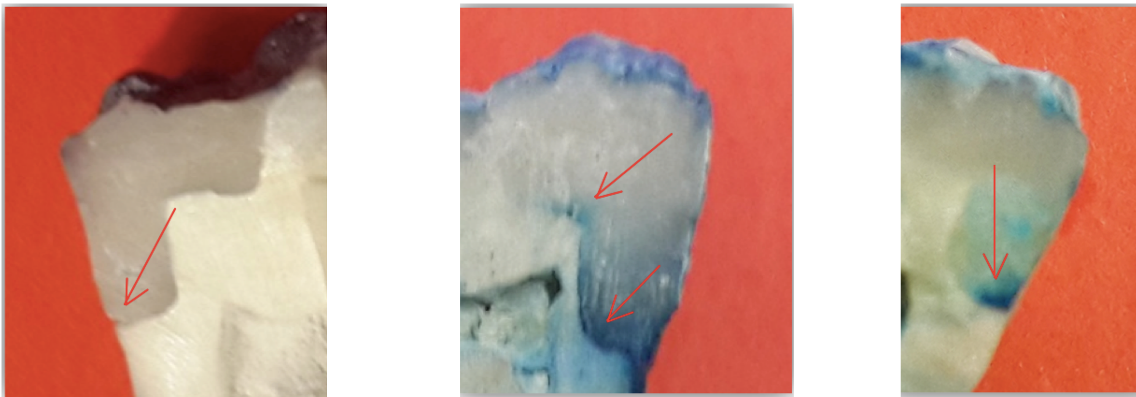


Figure 5. The point selected to scores of the dye penetration, when the gingival floor is above and below the CEJ.



Group A3 | Group B1 | Group B2

Figure6. Samples of the specimens, the red arrow shows the gingival dye pentration; Groups; A3 (score 0),B1 (score 3) and B2 (score 2)

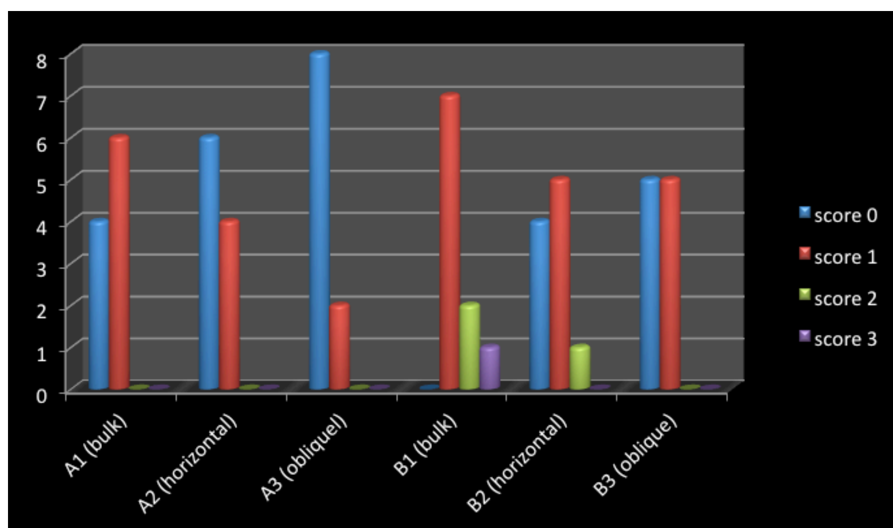


Figure 7. The gingival microleakage scores above (A) and below (B) CEJ of the groups

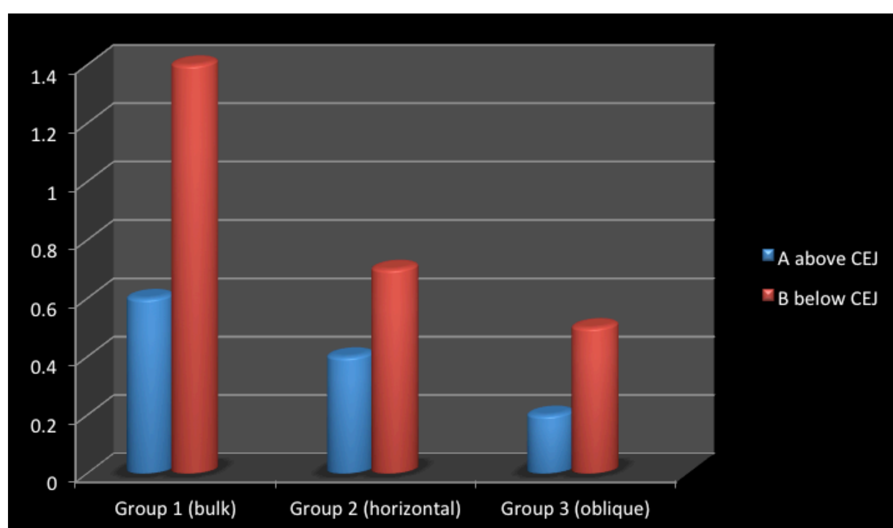


Figure 8. Mean of the gingival microleakage scores above (A) and below (B) CEJ of the three placement technique groups

Table 1. The gingival microleakage scores above (A) and (B) The CEJ of all the groups

	Groups	**SCORES**			
		0	**1**	**2**	**3**
Above CEJ	A1 (bulk)	4	6	0	0
	A2 (horizontal)	6	4	0	0
	A3 (oblique)	8	2	0	0
Below CEJ	B1(bulk)	0	7	2	1
	B2(horizontal)	4	5	1	0
	B3 (oblique)	5	5	0	0

Table 2. Mean and standard deviation values of the gingival microleakage Scores above (A) and (B) the CEJ of all the groups (N10)

Groups		Mean	St. deviation	Variance
Group A (Above CEJ)	A1	0.6	± 0.516	0.267
	A2	0.4	± 0.516	0.267
	A3	0.2	± 0.422	0.178
Group B (Below CEJ)	B1	1.4	± 0.699	0.489
	B2	0.7	± 0.675	0.456
	B3	0.5	± 0.527	0.278

Table 3. student t-test to compare the gingival microleakage between the three placement technique

Groups		Mean differences	Paired differences			95% confidence interval of the difference		df	Sig.
			Std. deviation	St. Error mean	t-test	upper	lower		
Group A (Above CEJ)	A1-A2	0.2	0.516	0.163	0.866	0.685	0.285	18	0.398 NS
	A1-A3	0.4	0.516	0.163	1.897	0.843	0.043	18	0.074 NS
	A2-A3	0.2	0.516	0.163	0.949	0.643	0.243	18	0.355 NS
Group B (Below CEJ)	B1-B2	0.7	0.699	0.221	2.278	1.346	0.054	18	0.035 S
	B1-B3	0.9	0.699	0.221	3.25	1.482	0.318	18	0.004 HS
	B2-B4	0.2	0.675	0.213	0.739	0.769	0.369	18	0.470 NS

Table 4. student t-test to compare the gingival microleakage above (A) and Below (B) CEJ between the placement technique groups

Groups	Mean differences	Paired differences			95% confidence interval of the difference		df	Sig.
		Std. deviation	St. Error mean	t-test	upper	lower		
A1-B1	0.8	0.516	0.163	2.91	0.223	1.377	18	0.009 HS
A2- B2	0.3	0.516	0.163	1.116	0.265	0.865	18	0.27 NS
A3- B3	0.3	0.422	0.133	1.406	0.148	0.748	18	0.177 NS

the dentinal tubules and lateral canals, the apices were sealed with sticky wax then the teeth surface were isolated with two layers of nail varnish except for one mm around the restoration, The specimens were immersed in a solution of 2% methylene blue dye for 24 hours at 37°C. The sticky wax was removed following the dye exposure. Then after the nail varnish was removed, the specimens were sectioned through the center of the restoration mesio-distally with diamond disk (Fig.4). The cervical microleakage was analyzed and recorded with a stereomicroscope at 10X magnification for the degree for dye penetration along the cervical walls as shows in (Fig.5) using the following score;

0= no dye penetration, 1= dye penetration extending into 1/2 of the cervical wall, 2= dye penetration into more than 1/2 or a complete extension of the cervical wall, 3= dye penetration into cervical and along the axial walls. The data

were statistically analyzed using the SPSS21 (Statistical Package for the Social Sciences-Version 21.O) for Windows XP. Analysis of variance (ANOVA) test and Student t-test were used.

Results

Figure (6) shows samples of microscopic dye penetration picture of the above and below CEJ at the gingival floor position. Table (1) and figure (7) shows the scores of the gingival dye penetration of the three groups which is more when the gingival floor is below the CEJ in comparison to the gingival floor above the CEJ.Table (2) and Figure (8) shows the mean of the gingival dye penetration scores in all groups.

The results show that in a group (A) there was no significant difference between bulk, horizontal and oblique layering filling techniques ($p>0.05$). In group (B) results showed that there was a significant difference between bulk and horizontal ($p<0.05$) and highly significant between bulk and oblique techniques ($p<0.01$). Whereas the relation between horizontal and oblique techniques was no significant ($p>0.05$) as shown in table (3). The results in Table (4) shown that there was highly significant ($p<0.01$) in bulk filling techniques between group A and B, however there was no significant difference ($p>0.05$) in horizontal and oblique layering filling between group A and B.

Discussion

The purpose of the microleakage test is to get information about the sealing ability of the restoration-adhesive complex [14].Methylene blue dye having a molecule size of 1.2 nm 2 is commonly used to show the dye penetration through the micrograph spaces [15]. In this study we used extracted teeth,because using of acid etching and bonding procedure with composite filling material, which requires the presence of enamel rods and dentinal tubules, as the acid itching acts on them , which are absent in acrylic teeth. Highly filled nanohybrid composites show less free linear shrinkage values than microhybrid composites, because of their lower monomer and higher filler content [16]. This type of composite filling materials was used in this study to standardize the procedure.

The result of this study regarding the gingival floor position, it showed that the gingival microleakage scores are more when the gingival floor is below the CEJ. The factor that leads to this outcome is the bond strength to the enamel is usually higher than the bond strength to the dentin. Dentin is a less favorable bonding substrate due to its heterogenous structure [6]. However, enamel is a highly mineralized tissue than dentin [17]. The results of this study are consistent with these studies; Eakle WS et al, 1990 [18], Bogra P et al, 2012 [19], Joseph A et al, 2013 [20].

Regarding the filling techniques the result showed that the bulk placement technique was more gingival microleakage than the two layering technique horizontal and oblique. This might be related to the bulk filling techniques with a single composite increment can lead to high C- factor, which increase the shrinkage stress [21].The C factor (configuration) is the ratio between the bonded and free surfaces of the cavity. High (C factor) can cause adhesion breakdown between the restorative system and the cavity wall [22].While there is a lower cavity (C factor) when using layering technique due to the large free surface permitting resin to flow during polymerization. Other cause within incremental technique, there is minimal contact with the cavity walls during polymerization [23], as the larger volume of composite to be polymerized, the more will be the polymerization shrinkage [7].Each increment is compensated by the next, and the consequence of polymerization shrinkage is less damaging since only the volume reduction of the last layer can damage the bond surface [24]. The result of our study is agree with the following studies; Abbas Get al, 2003 [25], PoskusLT et al, 2004 [26], Santhosh L et al, 2008 [27], Andrian Set al, 2009 [28],Ozel E and Soyman M, 2009 (29) Moezyzadeh M et al, 2009 [30] and Nadig RR et al, 2012 [31].

Analysis the results between the two layering techniques oblique and horizontal, the oblique technique showed less gingival microleakage than the horizontal technique. This may be in the oblique layering technique, the composite filling and light curing of 1.5-mm diagonal cuts width in each increment were performed; so, one diagonal cut was completely filled and light cured, followed by filling and curing of one-half of the second diagonal cut at a time. This sequence would prevent composite resin from connecting two opposing cavity walls at the same time, thereby minimizing the development of the detrimental polymerization shrinkage stresses on adhesive interfaces at cavity walls and margins [32].The above explanation could be responsible for reduced gingival microleakage scores of oblique technique as compare to the horizontal technique. In horizontal layering technique, Spreafico RC et al , 2000 [33] showed that the horizontal technique have poor gingival marginal sealing power, as the polymerization shrinkage "pulls" the material away from the cavity wall, and therefore the cavity C factor will be increased. This study agrees with Eakle WS et al, 1990 [34] and Andrian Set al, 2009 [28] who showed

that the oblique layering filling technique is less microleakage score than horizontal filling technique group.

Conclusion

According to this in vitro-study, it concluded that in class II restorations, the gingival microleakage is more when the gingival floor is below the CEJ,so in class II cavity preparation, we should attempt to put the gingival floor above the CEJ,and it is increased with bulk technique when compared with the two layering technique. The oblique layering technique is preferable way of composite filling than the horizontal in class II cavity preparation.

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