ISSN: 2350-0743

www.ijramr.com

International Journal of Recent Advances in Multidisciplinary Research

Vol. 02, Issue 09, pp.0727-0731, September, 2015

REVIEW ARTICLE

EFFECT OF TWO DIFFERENT COMPOSITES ON GINGIVAL MICROLEAKAGE OF CLASS II RESTORATION USING FOUR DIFFERENT PLACEMENT TECHNIQUES (AN IN VITRO STUDY)

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ARTICLE INFO

Article History:
Received 21st June 2015
Received in revised form
10th July, 2015
Accepted 08th August, 2015
Published online 30th September, 2015

Keywords:
Microleakage,
Nanohybrid resin,
Microhybrid resin,
Bulk placement techniques.

ABSTRACT

Objective: To determine the effect of two different composite resins by using different filling techniques through measuring the gingival microleakage in class II cavity.
Materials and methods: Standardized 80 class II cavities were prepared in the proximal surfaces of forty extracted non caries permanent molars and randomly were divided into two main groups (A and B) 40 cavities for each group. In group A the Nanohybrid resin based composite was used and for group B, Microhybrid resin based composite was used, then each main group was subdivided into four subgroups (n=10 cavities) according to the composite placement technique: 1) bulk, 2) vertical, 3) split horizontal and 4) centripetal. The specimens were immersed in a solution 2% methylene blue dye for 24hours. The microleakage scores (0 to 3) were obtained from the cervical surface and the cervical microleakage was analyzed with a stereomicroscope.
Results: The gingival microleakage is less in nanohybrid group than in microhybrid, in both groups the worst result is in bulk technique followed by vertical, split horizontal and/or centripetal techniques.
Conclusion: This study predicts that the Nanohybrid resin based composite is better than Microhybrid resin based composite for posterior class II restoration. Also centripetal and split horizontal are better than vertical layering and bulk techniques.

INTRODUCTION

The use of direct resin based composite materials has become an active part of contemporary Operative Dentistry. The esthetic appearance associated with conservative cavity preparations and the constantly improved properties has made these materials the main choice for all classes of restorations (Roulet *et al.*, 2001). However, resin composites in common with the majority of dental materials; undergo deterioration and degradation in the intraoral environment (Finer and Santerre, 2004). Microleakage is one of most frequently encountered problems, especially at the gingival margin of class II restoration (Ozel *et al.*, 2009 and Agrawal *et al.*, 2012). This may lead to postoperative sensitivity, recurrent caries, marginal deterioration, pulp injury and enamel fracture (Sajjan, 2010). The microleakage 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 (Deliperi *et al.*, 2004) Several efforts have been made to decrease these polymerization shrinkage stresses and were directed toward

- Improving composite resin formulation
- Curing methods
- Restorative placement techniques (Hassan *et al.*, 2010).

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Several new composite materials have been developed with modifications in filler technology, filler distribution, filler loading, and alterations in the matrices (Manhart *et al*., 2002). The basic formula is higher the filler content, lower is the resin content which causes less shrinkage. In the quest for a higher filler load, several new materials like microhybrid, packable composites and more recently, nanocomposites have been introduced.

Microhybrids have been popular in restorative dentistry. They involve tightly clustered spheres of the same size with gaps being filled with smaller-sized spheres. These materials exhibit reduced polymerization shrinkage and offer improved strength, but at the cost of esthetic quality. However, the latest innovations make use of nanotechnology that has become the most popular discipline in science and technology in the restorative dentistry (Mitra *et al*., 2003). Nanocomposites consist of two fillers: (a) nano particles that allow high polish ability and (b) nanoclusters that allow higher filler loading, thereby, exhibiting higher strength than microhybrids. While regarding the placement technique of posterior composite restoration, different 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 (Yap *et al*., 2000). The layering techniques include the horizontal (Gingivoocclusal layering), the wedge-shaped oblique layering, the successive cusp buildup technique, the split horizontal placement technique, vertical (facio-lingual layering) and centripetal placement (Duarte *et al*., 2008).

In this study, we compared the gingival microleakage of nanohybride and microhybride composite resins when four different techniques (bulk technique, vertical facio-lingual layering, split horizontal and centripetal placement) were used in the posterior class II cavity.

MATERIALS AND METHODS

Forty 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 room temperature for 24 h. After that 80 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 gingival floor was prepared 1mm below the CEJ. Following that the teeth were divided into two main groups as shown in (Fig.1): Group A (n=40 cavities); Nanohybrid resin based composite (Tetric N-Ceram, Ivoclar, Vivadent), and Group B (n=40cavities); Microhybrid resin based composite.

was done using Cool Blue TM LED (Milestone Scientific, Livingston, NJ, USA) with a light intensity of (400 mW/cm 2).

Placement Techniques

Subgroup 1: bulk placement technique; the composite was inserted in one step to fill the cavity (Fig.3.a), and light curing for 120 seconds.

Subgroup 2: vertical facio-lingual layering placement technique: a vertical first layer of the composite was inserted vertically in the cavity toward the facial proximal wall and were then cured for 40 seconds, and next, the second layers were vertically placed on the opposite proximal wall on the lingual side, and finally the remaining lingual cavity was filled vertically with the resin composite which was inserted onto gingival floors, each layer was cured for 40 seconds (Fig. 3.b)

Subgroup 3: split horizontal placement technique: The first layer of the composite thickness of (1 mm) was applied toward the metallic matrix up to half of the occluso-gingival height contacting the proximal box and being curing for 40 seconds

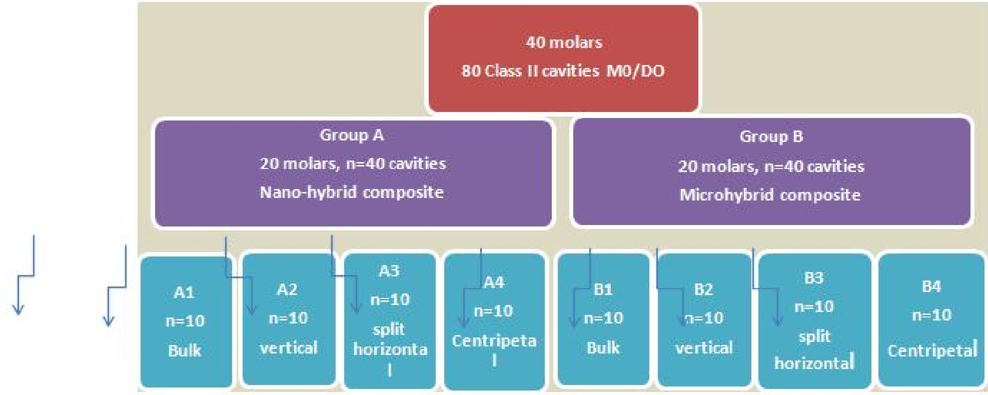

Figure1. The division of the groups

Figure 2. The 80 class II cavities were prepared in the proximal surfaces of extracted non caries permanent molars

No bevels were placed at any of the cavosurface margins. A tofflemire universal matrix retainer is positioned from the buccal surface of the test molar. For group A; the cavities were etched and bonding using a single-component bonding agent for enamel and dentin (Tetric N-Bond,Ivoclar, Vivadent) and cured for 40 seconds as per manufacturer's instructions. For group B; the cavities were etched and bonding using a single-component bonding agent for enamel and dentin (Compobond, Promedica) and cured for 40 seconds as per manufacturer's instructions. Then each main group was subdivided into four subgroups (n=10 cavities) as shown in (Fig. 1). Light curing

and the second layer was applied over the previous layer of contacting cavosurface margin of the proximal box and cured for 40 seconds to form marginal ridge of the class I cavity, the first layer of resin composite thickness of (2mm) was placed horizontally and split it to form two triangular shaped flat portions by cutting this layer diagonally and cured for 40 seconds, in this way, each portion of split increment contacted half of the gingival wall and only of two of the surrounding cavity walls during curing instead of opposing each other. The diagonal cut space was filled with composite and light-cured for 40 seconds from the occlusal direction. Similarly, the second horizontal increment was placed till cavosurface margin and light-cured (Fig.3.c).

Subgroup 4: centripetal placement technique: the marginal ridge was formed as in split horizontal placement techniques, the resulting class I was built up with subsequent increments (2mm thick) which were applied horizontally toward the occlusal area of the cavity until the proximal box was filled, each increment being curing for 40 seconds (Fig.3.d).

Evaluation of gingival microleakage

After removal of the metallic band, all the specimens were stored in distilled water at room temperature for 24 hours, the restored teeth were subjected to artificial ageing by thermocycling, for this reason 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.

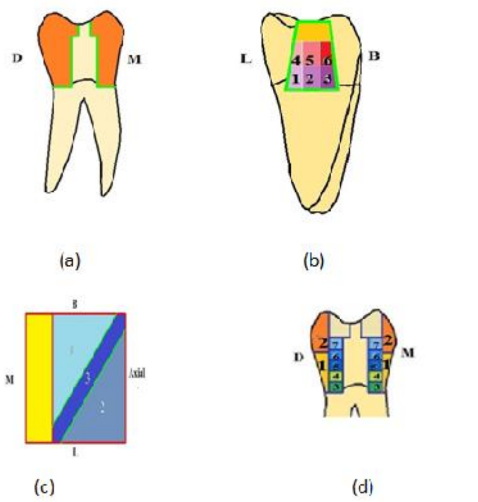

Figure3. Placement techniques of the composite resin for both groups. a.Subgroup 1.Bulk placement technique (buccal side), b. Subgroup 2.Vertical layering technique (proximal side), c. Subgroup 3.Splithorizontal layering technique (occlusal side) and d.Subgroup 4. Centripetal layering technique (buccal side)

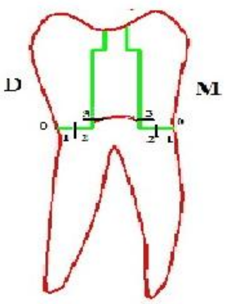

Figure4.The scores of the dye penetration for the gingival microleakage when the gingival floor is bellow the CEJ in mesial and distal side

Then tooth surfaces were isolated with two layers of nail varnish except for 1mm around the restoration, The specimens were immersed in a solution of 2% methylene blue dye for 24 hours at room temperature, after the nail varnish was removed, the specimens were sectioned through the center of the restoration mesio-distally with diamond disk. Finally the cervical microleakage was analyzed with a stereomicroscope at 10X magnification which scored for the degree of dye penetration along the cervical walls using the following score (Fig.4): 0= no dye penetration, 1= dye penetration extending into 1/2 of the cervical wall, 2= dye penetration into more than 1/2 or complete extension of the cervical wall, 3= dye penetration into cervical and axial walls toward the pulp.

Table1. Mean and standard deviation values of the gingival microleakage scores for group (A) and (B) when (n=10) for each subgroup

Groups		Mean & SD	Variance
	A1	1.40 ± 0.699	0.489
Group A	A2	1.30 ± 0.483	0.233
Nanohybrid	A3	0.30 ± 0.483	0.233
Composite)	A4	0.40 ± 0.516	0.267
	B1	2.3 ±0.823	0.678
Group B	B2	1.6 ± 0.516	0.267
Micro hybrid	B3	0.4 ± 0.516	0.267
Composite)	B4	0.3 ± 0.483	0.233

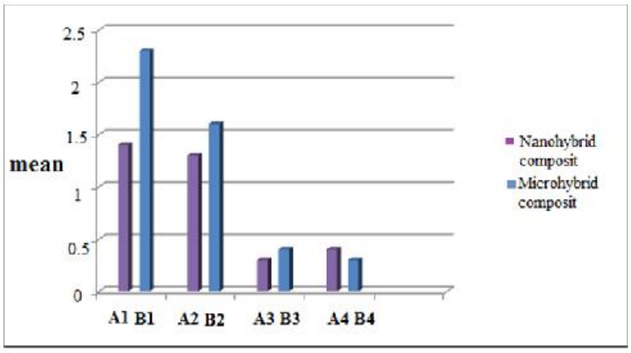

Figure 6. Mean of the gingival microleakage scores of group A (Nanohybrid resin based composite) and group B (Microhybrid resin based composite) for all the placement technique subgroups (A1 and B1:bulk , A2 and B2: vertical layering, A3 and B3: split horizontal finally A4 and B4: centripetal) technique

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 (5) shows samples of the specimens for the gingival dye microleakage under stereomicroscope scored from (0 to3).

Table 2. Student t-test comparing the gingival microleakage in (groupA) between the placement technique subgroups

Groups	Mean differences	Paired differences		df	Sig.
		SD	t-test		
A1-A2	0.1	0.699	0.372	18	0.714 NS*
A1-A3	1.1	0.699	4.093	18	0.001 HS**
A1-A4	1	0.699	3.638	18	0.002 HS
A2-A3	1.0	0.483	4.629	18	<0.001 HS
A2-A4	0.9	0.483	4.025	18	0.001 HS
A3-A4	0.10	0.483	0.440	18	0.660 NS

Table 3. student t-test comparing the gingival microleakage in (group B) between the placement technique subgroups

Groups	Mean differences	Paired differences		df	Sig.
		SD	t-test		
B1-B2	0.700	0.823 0.516	2.278	18	0.350 NS
B1-B3	1.900	0.823 0.516	6.183	18	<0.001 HS
B1-B4	2.000	0.823 0.483	6.626	18	<0.001 HS
B2-B3	1.200	0.516 0.516	5.196	18	<0.001 HS
B2-B4	1.300	0.516 0.483	5.814	18	<0.001 HS
B3-B4	0.100	0.516 0.483	0.447	18	0.660 NS

Table 4. student t-test comparing the mean of gingival microleakage between group A and B in each placement technique subgroups

Groups	Mean & SD	Sig.
B1-A1	2.30 ± 0.823 1.40 ± 0.699	.017 S***
B2-A2	1.60 ± 0.516 1.30 ± 0.483	.196 NS
B3-A3	40 ± 0.516 .60 ± 0.966	.571 NS
B4-A4	30 ± 0.483 80 ± 1.033	.182 NS

*non significant at (p>0.05),
**highly significant at (p<0.01),
***significant at (p<0.05)

The results as shown in Table1 and figure 6 predict that the least microleakage of Nanohybrid resin based composite occurred in split horizontal followed by centripetal, vertical layering and bulk technique, but for group B when using Micohybrid composite resin the least microleakage occurred in centripetal followed by split horizontal vertical layering and bulk technique as shown in Figure (6). The result showed that in group A and B there was no significant difference of gingival microleakage between the bulk and vertical layering techniques also between split horizontal and centripetal techniques at ($p>0.05$), however, there was a highly significant difference between bulk technique and vertical layering technique with split horizontal and centripetal techniques at ($p<0.01$) as shown in Table (2) and (3). While the results in a Table (4) showed that there was a significant difference between group A and B when using a bulk technique at ($p<0.05$), however, there was no significant difference between group A and B when using vertical layering, spl it horizontal and centrepital techniques.

DISCUSSION

The marginal seal is one of the most important factors for a successful restoration. The restoration of cavities having margins partly or totally located in the dentin is an unresolved problem with composite resin restorations (Yazici *et al*., 2003). Since bonding to enamel is a relatively simple process, without major technical requirements or difficulties. While bonding to dentin, on the other hand, presents a much greater challenge due to the heterogenous nature of dentin (Bala, *et al*., 2003), so that for the purpose of standardization all class II cavities were prepared 1mm below the CEJ on human teeth. Also, in order to simulate the results of this in vitro microleakage study to be close to clinical reality and to simulate oral conditions, all the specimens were thermocycled (Crim, *et al*., 1981 and Eick *et al*., 1997).

One of the most important clinical drawbacks of the resin composite restorative materials is their marginal microleakage (Antonson *et al*., 2012), which occurs as a result of polymerization shrinkage, fatigue-cycling and thermal changes in the oral environment (Kubo, *et al*., 2001) . The Microleakage is an important property used to assess the success of restorative material, which described as the chemically undetectable passage of bacteria, fluids, molecules or ions between the cavity walls and the restorative materials (Roberson *et al*., 2006). Dye penetration is an established in vitro method for investigating marginal leakage along tooth-restoration interfaces and is generally assessed after cutting the teeth in the longitudinal direction (Kusgoz *et al*., 2011).Various tracer dyes are available for microleakage studies; Methylene blue is one of the most common tracers and can be used at different concentrations (Heintze *et al*., 2008 and Fabianelli *et al*., 2010). So that Methylene blue was used for investigating marginal leakage in this study.

The marginal microleakage is due to polymerization shrinkage, one approach to minimize the effects of this shrinkage is the insertion of resin composite in increments (Gallo *et al*., 2000). Morever, in this study vertical layering, split horizontal and centeripital techniques beside the bulk technique were used, it was observed that all the incremental techniques showed less microleakage score in comparison to bulk placement technique, also among the incremental techniques, split horizontal technique showed least microleakage scores in group A. This was in line with the study done by Hassan *et al*, (2005) and Duarte *et al*, 2008. This might be due to the fact that split horizontal technique had smaller increment size, along with the lower configuration factor (C-factor), would relieve most of the shrinkage stresses by means of flow of the free surfaces, rather than at the bonded interfaces, which otherwise would increase cuspal deformation (Feilzer *et al*., 1990). When C-factor mean 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 (Sezp *et al*., 2001).

In this study centripetal technique achieved better marginal adaptation and less microleakage than vertical layering and bulk techniques in both studied groups, because the amount of composite required to build up the proximal wall in centripetal technique was minimal compared to that for the other two techniques this is in agreement with the findings of Szep *et al*, (2001). However the vertical layering technique showed the highest gingival microleakage scores among the incremental techniques this might be due to that this technique frequently exhibited almost no adhesion of the restorative material to the cavity floor, because a tight adaptation with a blogger can be achieved more easily in a horizontal than a strictly vertical way, potentially this will lead to voids within the stressed interface (Nikolaenko *et al*., 2004). Beside that the bulk placement technique showed greatest microleakage when compared to all other groups. 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 (Moosavi *et al*., 2012).

Regading the two types of composites used in this study, Nanohybride resin based composite showed less gingival microleakage than Microhybrid resin based composite, however the difference was not significant in each technique except for bulk technique($p<0.05$), this is might be due to better physical properties of Nanohybride resin based composite than Microhybrid resin based composite as Takahashi *et al*, (2011) showed in their study that the Nanohybride resin based composite had slightly better physical properties than Microhybrid resin based composite even it was not significant. This might be due to the fact that Nanofilled composites present similar mechanical and physical properties to those of Microhybrid composites, but when it comes to polish and gloss retention they perform significantly better (Mitra *et al*., 2003).

Conclusion

According to this in vitro study, it can be concluded that in class II restorations, the gingival microleakage is more when using Microhibrid resin based composite in bulk technique, so it can be decided that Nanohybrid resin based composite is better for class II restorations, specially in bulk technique, however both resin based composite can be used with good success in centripital, split horizontal and vertical incremental techniques.

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