Original Article

Estimation of the Gingival Microleakage of Two Composite Resins with Three Insertion Techniques for Class V Restorations (In-vitro Comparative Study)

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Abstract

Objective: Evaluating the marginal microleakage of two different composite resins with three different restorative techniques in class V cavities with the cervical margins within the cementoenamel junction.

Methods: Sixty standardized box-shaped class V cavities of 2×2×3 mm (depth, length, width) prepared on the buccal and lingual surfaces of 30 freshly extracted healthy human premolars. The teeth randomly divided into two equal groups: group A (Filtek™ Z250 XT) and group B (Beautifil™ II LS giomer). Then each group is subdivided into 3 equal subgroups: group I (bulk technique-10 cavities), group II (split horizontal technique-10 cavities) and group III (vertical technique-10 cavities) and filled according to the manufacturer's instructions. The samples were subjected to thermocycling (5°C ±2°C & 55°C ±2°C with a 30 seconds dwell time) and immersed in 2% buffered Methylene blue solution at 37°C for 24 hours. The restorations were sectioned longitudinally in buccolingual direction through the centers of the restoration. Then evaluated for microleakage using a stereomicroscope at 10x magnification and scored as 0, 1, 2, and 3. Non-parametric Mann-Whitney and Kruskal-Wallis tests were used and p value ≤ 0.05 considered statistically significant.

Results: Split increment horizontal layering technique showed statistically significant lower microleakage than vertical layering and bulk technique. While giomer showed less microleakage than Z250 but statistically not significant.

Conclusions: The use of split horizontal technique and giomer composite offers better and less marginal microleakage in class V restorations.

Keywords: *Microleakage, Cl V cavity, Giomer, Nano-hybrid composite, Layering technique.*

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Introduction

The ideal dental restoration is one of the concerns in conservative dentistry nowadays, some cavities need special care like class V, one of the major problems is the difficulty to seal the cavity completely, which lead to microleakage[1]. Microleakage most commonly happens when the gingival margin of any restoration placed below cementoenamel junction because bonding to dentin is less than enamel due to its complex pattern and lower mineral content, also due to lack of adaptation which may occur partly due to polymerization contraction and extreme temperatures in the oral cavity[2]. Efforts to overcome these problems directed towards improving treatment techniques and developing new materials[3].

Although, the most used technique in restoring class V cavities is bulk technique by filling the cavity in a single-step without the need for layering[4], layering techniques may have some advantages such as the use of a small volume of material, lower cavity configuration factor and minimal contact with the opposing cavity walls during polymerization. Nowadays many types of restorative materials have been used to restore class V cavities. Therefore, choosing a low shrinkage composite resin material may play a critical role in the clinical success of the restoration. Giomer is a fluoride-releasing, resin-based dental adhesive material that encompasses a surface pre-reacted Glass Ionomer (S-PRG) fillers. Giomers have advantages such as low volumetric shrinkage and shrinkage stress, which used in areas where the dentin bonding agent does not have high strength such as class V restorations[5]. The aim of the current study to evaluate the marginal microleakage of two different composite resins with three different restorative techniques in class V cavities with the cervical margins within the cementoenamel junction.

Materials and methods

A total of thirty freshly extracted healthy human upper and lower premolars extracted from young male and female patients for the orthodontic purpose were used. The teeth were cleaned from debris using rotating rubber cup with polishing pumice to remove soft tissue remnant.

The teeth were stored in 10% formalin at 37°C for 14 days following extraction to avoid microbial contamination and transferred to distilled water during the study to prevent dehydration. A standardized box-shaped class V cavity of 2×2×3 mm (depth, length, width) and the gingival margins on the cemeto-enamel junction. The outline of the cavity drawn on the tooth surface with a mechanical pencil using a matrix band with a pre-cut hole as shown in Figure 1-A, which was fixed on the tooth with a retainer so that the margins did not pass the mesial and distal line angles. These dimensions were checked by a digital vernier; the depth of the cavity was calibrated using a pre-marked periodontal probe[6]. A flat end fissure diamond bur (No. 010) in a high-speed handpiece with water coolant mounted on a dental surveyor was used to prepare the cavities as shown in Figure 1-B; the bur changed after every 5 preparations and the entire experiments performed by the same operator.

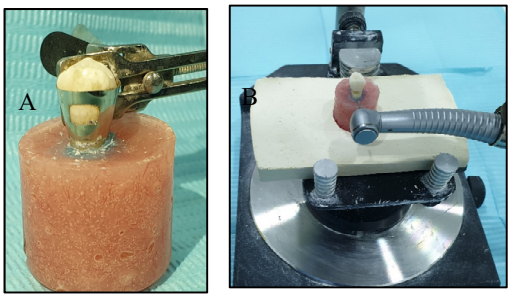

Figure 1: (A) Band with a pre-cut hole to determine the cavity outline on the tooth, (B) Cavity preparation using a dental surveyor.

After cavity preparation, the teeth were randomly divided into two groups (15 teeth) in each group based on the restorative material as Group A (n=30 cavities)- nanohybrid Filtek™ Z250 XT composite and Group B (n=30 cavities)- Beautifil™ II LS giomer. Each group was separated further into three subgroups depending on insertion technique used for restoration.

All cavities (enamel and dentin) were etched with 36% phosphoric acid gel by weight for 15 seconds and rinsed with water spray for 10 seconds followed by a gentle blotting using a cotton pellet according to the manufacturer's instruction. Adper™ single bond 2 adhesive was applied to the etched tooth surface with a gentle rubbing for 15 seconds, gently dried for 5 seconds and cured for 10 seconds according to the manufacturer instruction, same light curing unit used for all groups, which is (Light emitting diode LED) with a continuous photo-curing method, using a light source with an irradiance of 1200 mW/cm^2 with light curing time of 20 seconds for Filtek Z250 and 10 seconds for giomer. After the teeth were restored, they were finished using fine finishing bur and polished with polishing burs (Diatech Dental AG) and Sof-Lex discs (3M Dental Products).

Placement technique

Subgroup 1, Bulk placement technique

the composite was inserted in one step to fill the cavity, then light cured.

Subgroup 2, split increment horizontal layering technique

A flat 1 mm thickness composite resin increment was inserted to the axial wall of the cavity. Prior to light curing, 2 diagonal cuts were made in this increment using a plastic filling instrument with a blunt blade to split it into four triangular-shaped flat portions so that each piece contacted only one cavity wall and part of the floor. The resulting portions were light cured. Then each diagonal cut was filled separately with the composite and light cured[7]. Following this, the remaining part of the cavity filled in one step, and a celluloid strip band was applied to obtain adequate adaptation of the restorative material then light cured.

Subgroup 3, vertical layering technique

A 2 mm thickness occlusocervical increment was placed in vertical pattern starting from the mesial wall, and light cured from behind the wall. Then carried to the distal wall in the same technique. Finally, the middle part filled, and light cured.

The samples were subjected to thermocycling (5°C ±2°C & 55°C ±2°C with a 30 seconds dwell time) Then the apices of the samples were closed with chemical cured acrylic and tooth surfaces were isolated with two layers of nail varnish except for 1 mm around the restoration. The specimens were immersed in 2% buffered methylene blue solution at 37°C for 24 hours. The teeth were sectioned longitudinally in the buccolingual direction through the centers of the restorations with low-speed water cooled diamond disc using dental surveyor for standardization, creating two sections. 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 as shown in Figure 2.

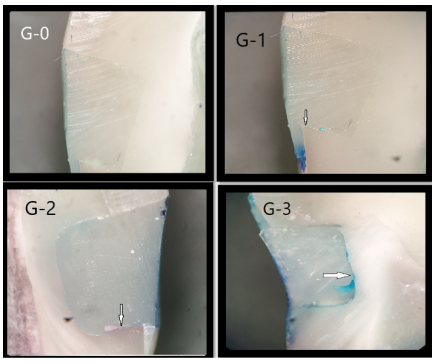

Figure 2: Dye penetration scores along the cervical walls.

Grade 0 : No dye penetration, grade 1: penetration involving half of the cavity depth, grade 2: penetration involving more than half cavity depth, grade 3: penetration involving the axial wall[8].

Statistical analysis

Cervical gingival microleakage scores were statistically analyzed using non-parametric Mann-Whitney and Kruskal-Wallis tests and p-value of ≤0.05 were considered to be significant.

Results

The descriptive statistics for the mean value and median value of the cervical microleakage of group A filled with Filtek™ Z250 XT composite are shown in Table 1 and Figure 3. From the Table, it was shown that group A2 Split Increment horizontal layering technique (SIHL) showed the least mean value which was (0.6 ± 0.5) while group A3 vertical layering technique (VL) showed the highest mean value which was (2.7 ± 0.7) and group A1 bulk technique showed a mean value (2.2 ± 0.9) which was higher than group A2 and less than group A3 as illustrated in Figure 3

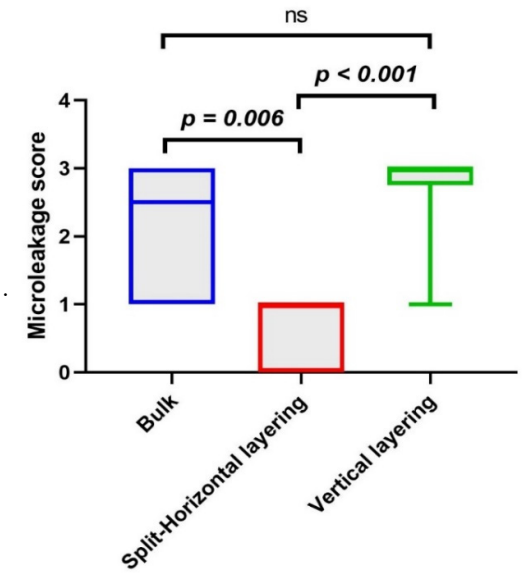

Figure 3: Boxplot of microleakage score of Z250 Composite according to the insertion technique.

Table 1: Comparison between the mean values and median (IQR) of cervical microleakage among the three groups which filled with Filtek™ Z250 XT composite.

	Group A1 Bulk	Group A2 Split Increment Horizontal layering	Group A3 Vertical layering	p-value
Mean ± SD	2.2 ± 0.9	0.6 ± 0.5	2.7 ± 0.7	<0.001
Median (IQR)	2.5 (1.0-3.0)	1.0 (0-1.0)	3.0 (2.75-3.0)	
IQR: interquartile range, SD: standard deviation				

For group B restored with Beautifil™ II LS Giomer composite, the results are illustrated in Table 2. From the Table 2, it was shown that group B2 SIHL technique showed the least microleakage mean value (1.1 ± 1.1), which was significantly lower than group B3 VL technique (2.1 ± 0.7) and lower than group B1 bulk technique (1.5 ± 0.07) but not significant as shown in Figure 4.

Regarding the two types of composites used, Giomer composite showed relatively lower microleakage than Filtek Z250 when we used the same insertion technique. However, the difference was statistically not significant as shown in Table 3.

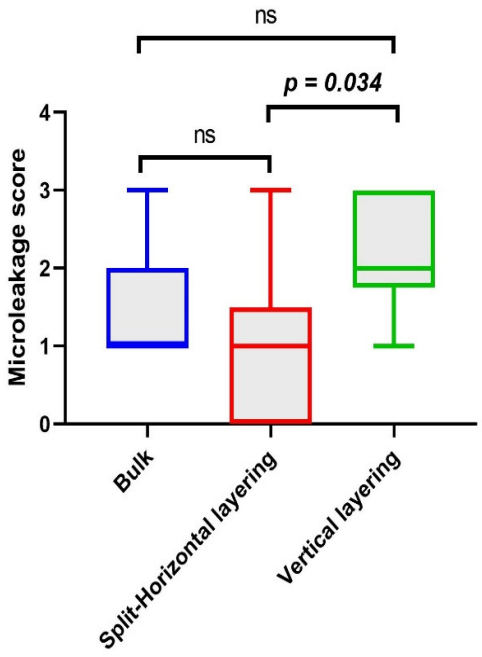

Figure 4: Boxplot of microleakage score of Giomer composite according to the insertion Technique.

Table 2: Comparison between the mean values and median (IQR) of cervical microleakage among the three groups which filled with Beautifil™ II LS Giomer Composite according to the insertion techniques.

	Group B1 Bulk	Group B2 Split Increment Horizontal layering	Group B3 Vertical layering	p-value
Mean ± SD	1.5 ± 0.07	1.1 ± 1.1	2.1 ± 0.7	0.039
Median (IQR)	1.0 (1.0 – 2.0)	1.0 (0 – 1.5)	2.0 (2.0 – 3.0)	
IQR: interquartile range, SD: standard deviation				

Table 3: Comparison among the two groups (Filtek Z250 and Giomer composite) using the three insertion techniques.

	Group A – Filtek Z250			Group B - Giomer			
Insertion Technique	Number	Mean ± SD	Median (IQR)	Number	Mean ± SD	Median (IQR)	P Value
Bulk	10	2.2 ± 1.5	2.5 (1.0 – 3.0)	10	1.5 ± 0.7	1.0 (1.0 – 2.0)	0.121
SIHL	10	0.6 ± 0.5	1.0 (0 – 1.0)	10	1.1 ± 1.1	1.0 (0 – 1.5)	0.487
VL	10	2.7 ± 0.7	3.0 (2.75-3.0)	10	2.1 ± 0.7	2.0 (1.75-3.0)	0.064
IQR: interquartile range, SD: standard deviation							

Discussion

One of the main reasons for failure of composites is interfacial defects, which develop as a result of long time thermal and mechanical stresses developed due to polymerization shrinkage, and physical and chemical properties of the material. The class V lesion presents serious problems with any restorative material because these materials should bond to the enamel and dentin/cementum. Dentin is less favorable substrate than enamel for resin bonding, because the enamel substrate is homogenous so, adherence to the enamel is expected to be better than dentin. Also, the C factor of class V restoration is 5 which corresponds to the ratio between the number of bonded to unbonded surfaces, which is responsible for the internal bond disruption and marginal gaps around the restorations. For this reason, Class V cavities were selected in this study[9].

Different materials have been used to restore such cavities, but resin composites still represent the most used for this type of lesions because of good esthetic and capability of establishing a bond to enamel and dentin[10].

Insertion technique is a very critical step in reducing microleakage of class V cavities. Incremental techniques are one of the most common methods which were used in order to minimize the curing shrinkage, by lowering the C factor[11]. On the other hand, bulk technique performs a direct composite restoration with minimum troubles and in a reasonable time[12].

The most popular test method employed to obtain a preliminary idea about the quality of a new material or combination of materials and different restorative techniques is microleakage test. Dye penetration method was used to detect microleakage because it is simple, inexpensive and does not require the use of complex laboratory equipment.

According to the result obtained from this study it shows that in both composite materials, the SIHL technique offer superior results in terms of microleakage compared to the other insertion techniques. The cause could be the ability of a composite resin restoration to relieve the stresses generated from the polymerization shrinkage is related to the C-factor of such restoration[13]. In the SIHL technique relief of such stresses was achieved by two diagonal cuts to split each flat increment into four triangular-shaped portions before light curing. This would reduce the C-factor from the ratio of five, obtained when one increment connects the cavity floor with the four surrounding walls, to an approximate ratio of 0.5 when each triangular-shaped portion of the split increment was bonded to only one surrounding cavity wall and one fourth of the floor. The free, unbonded composite surfaces created by the two diagonal cuts would convert the restricted shrinkage occurring on the cavity walls prior to splitting to unrestricted shrinkage. This serves as a reservoir for flow or plastic deformation in the initial stage of polymerization[14].

The bulk placement technique showed more microleakage when compared to the SIHL technique. This might be related to the bulk filling technique with a single composite increment can lead to high C- factor, which increase the shrinkage stress[15]. The vertical layering technique showed the highest gingival microleakage scores among the insertion techniques used, this might be due to that this technique frequently exhibited almost no adhesion of the restorative material to the cavity floor, this may have contributed to the fact that a tight adaptation with a plugger can be achieved more easily in a horizontal than a strictly vertical way, potentially leading to voids within the stressed interface[16].

The result of this study come in accordance with the result of the study done by Al-Zahawi et al.[17], which involved 80 class II cavities, filled using SIHL, VL and bulk technique, they found that gingival microleakage was less and better in SIHL than bulk and VL technique, which was in agreement with current study. In a study done Hassan[18] in Saudi Arabia the author concluded that SIHL was better than other incremental technique, it results in minimizing the detrimental effects of polymerization shrinkage stresses at the cavity walls and adhesive interface by the reducing the C-factor ratio from 5.0 to 0.5, which was in agreement with the present study findings.

On the other hand, the results of this study doesn't come in accordance with a study done by Duarte et al.[19], who evaluated the marginal microleakage in enamel and dentin/cementum walls in preparations with a high C-factor, they found no significant difference in term of microleakage when they use horizontal incremental placement technique, oblique incremental technique, and bulk technique. This controversy may be explained by more thermocycling times of the samples (1000 thermal cycles), a different dye used in their study (50 weight % silver nitrate) and different restorative materials used compared to the current study.

Regarding the two types of composites used in this study, Beautifil™ II LS Giomer showed relatively better microleakage resistant than Filtek Z250 when using the

layering technique. Giomer exhibits low volumetric shrinkage of less than 1% and low resultant shrinkage stress due to the novel SRS (Steric Repulsion Structured) molecule which is designed to minimize polymerization shrinkage through molecular steric repulsion resulting in a sturdy and stable restoration microstructure, the balance of the multi-filler phase and innovative SRS monomer also creates a none stick, moderately firm, sculptable paste that is easy to adapt, without any slump which may reduce the handling associated problems. Also, the bioactive S-PRG Fillers incorporated in giomer exhibit acid-neutralizing ability to maintain an acid neutral and fluoride rich environment, as claimed by the manufacturer these might be the reasons for this result[20]. However, there is no study has been performed using giomer and Filtek Z250 restorative materials to compare microleakage in class V restorations.

Within the limitation of this study as all in vitro studies is that the number of samples is limited, and it is difficult to reproduce accurate clinical conditions as it is not possible to directly mimic the oral conditions.

Conclusions

The use of split increment horizontal layering technique in class V restorations significantly reduce gingival marginal microleakage. Also, Giomer composite offer better and less gingival marginal microleakage in class V but statistically was not significant with Filtek Z250 XT.

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