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# MARGINAL ADAPTATION OF SELF ADHESIVE BULK-FILL RESIN COMPOSITE VS CONVENTIONAL RESIN COMPOSITE AND RESIN MODIFIED GLASS- IONOMER: A COMPARATIVE STUDY

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## *ABSTRACT*

**Objective:** To compare the marginal adaptation of teeth restored with three types of materials (self-adhesive bulkfill resin Composite, conventional resin-composite, and resin-modified glass ionomer restorations).

**Materials and methods:** Three different restorative materials; Self-adhesive bulk-fill hybrid resin composite (surefil one, dentsplay sirona, Konstanz,Germany), Resin modified glass ionomer (fuji,, GC ,corp, Tokyo, Japan) and Resin-based composite (Filtek Z250, 3M ESPE), were used in this study. A total of 36 premolars were classified into three groups (n= 12) according to the restorative system used. The samples after being kept for a day in distilled water, were thermocycled for 500 cycles (5-55 °C) with dwell period for 15 seconds, and then the specimens were examined using a Scanning electron microscope. All test data were tabulated, and Statistical analysis was performed using SPSS software by one way ANOVA test (p value <0.05).

**Results**: one-way ANOVA test was used to determine the effect of study variables (materials) and their interaction on the marginal adaptation values ($p < 0.05$), which revealed that none of the study variables had a significant effect on the marginal adaptation results ($p > 0.05$).

**Conclusion:** Within the limitations of this study, Self-adhesive bulk fill (surefil one) and RMGIC (fuji) showed multiple gaps in their interface with cavity walls especially at gingival margin. But conventional resin-based composite (filtek Z250) performed better in marginal adaptation test in all thirds of the class II cavity with no significant difference.

**KEYWORDS:** Resin composites, Dental marginal adaptation, self adhesive bulk fill, Thermal cycles.

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## INTRODUCTION

Currently, resin composites have become the preferred material for the majority of dental professionals and patients when esthetic restorations are intended.[17] However, volumetric shrinkage and fracture continue to be regarded as the main issues with their use.[8] Polymerization shrinkage induces contraction stress at the interface between the composite resin and cavity walls, leading to gap formation and secondary caries.

To minimize the clinical effects of shrinkage during polymerization, incremental filling techniques are usually preferred to obtain an effective marginal seal.[19] It has been suggested that polymerization shrinkage can be compensated for by incremental techniques of resin composites.[13] Although incremental technique may be important for adequate light penetration, it has some disadvantages such as the possibility of trapping voids between layers and the time required to place the restoration.

The bulk application technique is simpler, it reduces the number of clinical steps, making the work easier and faster.[5] Several bulk-fill resin composites have been developed and introduced to the dental profession, in an attempt to reduce the polymerization shrinkage stress buildup and its adverse effects. These materials can be placed in a 4 mm bulk placement, Because of their strong reactivity to light curing and decreased polymerization stress.[6]

Adhesive bonding to tooth structure is an essential part of today's restorative dentistry, so restoration's biomechanical and aesthetic quality results are improved.[11] Dentinal tubules and restoration margins would be sealed by an efficient bonding to the tooth structure, avoiding microleakage and its detrimental effects on the pulp, recurrent tooth decay, and marginal discoloration.

A new class of self-adhesive resin composites that are attached to dentin and tooth enamel without the need of an additional adhesive has been created[3], which reduced the time and blood or saliva contamination to the restoration. Clinicians can now fill 4- to 5-mm deep boxes in posterior teeth in bulk by bulk-filling the cavities.[20] Acidic groups can be added to the structural monomers to modify them and provide sufficient adhesion. Furthermore, a radically polymerizable modified polyacid system (MOPOS) is included in the innovative self-adhesive Bulkfill resin composite hybrid, which copolymerizes to enhance strength.

Glass-ionomer cement (GIC) is a true example of a self-adhesive bulk-fill material that is Widely used in certain cases. The glass ionomer cement modification by the addition of resins was created to decrease the setting time, enhancing mechanical properties, and lessening the material's sensitivity to early fluid contamination when compared to GICs. The hybrid substance was given the term resin-modified glass ionomer cement (RM-GIC).

Gaps may result in material degradation and marginal infiltration on the restorations' edges.[4] Because that gap creation and internal defects will negatively impact the resin composite's mechanical qualities and the restoration's age. As a result, using resin composites and dental adhesives correctly should ideally result in restorations with a perfect seal that are devoid of voids and porosities.[2]

Currently, few studies are available on evaluating the marginal adaptation of the Self-Adhesive Bulk-fill Resin Composite. Accordingly, this study aimed to investigate the effect of using Self Adhesive Bulk-fill Resin Composite compared to Conventional Resin Composite and Resin Modified Glass- ionomer on marginal adaptation. This was designed to test the null hypothesis that no significant difference in marginal adaptation of the teeth restored with these three materials.

## MATERIALS AND METHODS

### Materials

Three different restorative materials; self-adhesive bulk-fill hybrid resin composite (surefil one, Dentsply Sirona, Konstanz, Germany), Resin modified glass ionomer (fuji, GC, corp, Tokyo, Japan), and Conventional Resin-based composite (Filtek Z250, 3M ESPE) with All Bond Universal adhesive (Bisco) were used in this study. Manufacturing, composition, and descriptions of these materials are presented in **(Table 1)**. All materials were used and manipulated according to manufacturers' instructions.

### Sample size calculation for experiment:

Sample size calculation was based on marginal adaptation between 3 different materials self-adhesive bulk fill resin composite, resin based composite & resin modified glass inomer retrieved from previous research (Behery et al., 2016). The sample size was calculated according to G*Power software version 3.1.9.6. depend on effect size=0.32; $\alpha$= 0.05; $\beta$=0.10; Power= 1- $\beta$= 0.90, three equal groups then the total sample was 12 at least.

### Methods

The total number of 36 premolars collected from the Oral Surgery Department**,** according to the guidelines of ethics were classified into three groups according to the restorative system used to conduct the marginal adaptation test, digital calipers were used to measure all chosen teeth, which had an approximate size of crown. The teeth selected had a maximum buccolingual width ranging from 8.5 to 9mm and had identical occlusal anatomy.

TABLE (1) Materials used in the study

| Material | Type | Manufacturer | Composition | Batch number |
|---|---|---|---|---|
| Surefil one | Self-adhesive bulk fill resin composite (hybrid) | Dentsplay sirona, Konstanz, Germany | MOPOS, BADEP, acrylic acid, water, reactive glass filler,non-reactive glass filler, initiator, stabilizer | 2205000565 |
| Fuji II LC capsule | self-adhesive resin-modified glass ionomer (RMGI) | GC Corp., Tokyo, Japan. | Powder: 100% strontium fluoroalumino silicate glass, Liquid: 35% HEMA, 25% distilled water,24% polyacrylic acid, 6% tartaric acid and 0.10% camphorquinone. | 2202181 |
| Filtek Z250 | Adhesive restorative material (Conventional nanohybrid resin composite restoration) | 3M ESPE | BIS-GMA, UDMA, and Bis-EMA (Bisphenol A polyethylene glycol diether dimethacrylate). This light-cured resin is filled with 60% (volume) silica/ zirconia. | 9582030 |
| All Bond Universal adhesive | Light-cured dental adhesive | Bisco, Bisco, Inc.1100W Irving Park Road, Schaumburg, IL 60193 USA | BisGMA, Ethanol, 2-Hydroxyethyl Methacrylate, 10-MDP | 2200003898 |

Abbreviations: MOPOS: Modified polyacids, BADEP: Bifunctional acrylate, BIS-GMA: GMA (Bisphenol A diglycidyl ether dimethacrylate), UDMA (urethane dimethacrylate),10-MDP:10-Methacryloyloxydecyl Dihydrogen Phosphate.

### Teeth classification

The selected teeth were randomly divided into 3 main groups according to the type of restorative material used, Group 1: For self-adhesive bulk-fill resin composite (surefil one) (n=12). Group 2: For resin-based composite (filtek Z250, 3M) (n=12). Group 3: For resin-modified glass ionomer (fuji, Gc) (n=12).

### Specimen preparation

A standardized mesio-occluso-distal (MOD) cavity was prepared in all teeth using a straight fissure carbide bur. The dimensions of the prepared cavities were 3mm bucco-palatally, as determined by measuring with a periodontal probe, and 4mm in depth extending from the pulpal floor to the occlusal Cavo surface edge, based on the radiograph and using a mark on the used carbide instrument at 4mm from the tip to prevent the depth of cavity from exceeding 4mm, which was confirmed by the periodontal probe. To decrease the variation in preparation, the MOD cavities were made without proximal boxes. The gingival walls of all cavities were placed above the cementoenamel junction (CEJ) of the proximal area, and the buccal and lingual walls were prepared in parallel to each other.

### Restorative techniques

Matrix Application: For all groups, cavities were surrounded with a Tofflemire matrix band and retainer (SS white, Lakewood, USA). No.1 ivory matrix retainer with rubber stop on its tip was used for more adaptation of the other band on the mesial and distal cavity margins, Group 1, Teeth that were restored using (Surefil One), To activate the capsule, fully depress its plunger and then place it in a capsule mixer for 10 seconds. Subsequently, the capsule was inserted into the delivery gun, expelled into the cavity, and then light-cured for 20 seconds.

Group 2, The teeth restored with resin composite (Filtek Z250) received selective etching of the enamel margin by 37% phosphoric acid gel. The etchant gel was rinsed off with water then blot dryness was done. The Bond Universal adhesive (Bisco) was applied to the cavity walls and floor. Then, it was cured for 10 seconds using an LED light curing unit, the composite was used to build the proximal walls of the cavity with a thickness of 1mm. It was then cured for 20 sec, to convert the mesio-occluso distal cavity into a Class I cavity. The cavities were filled using an incremental approach, where oblique increments of around 2 mm were used and then cured for 20 sec for each increment.

Group 3 consisted of teeth that were restored using (Fuji LC capsules). The encapsulated ionomers were subjected to mechanical manipulation using an amalgamator for 10 seconds, the capsule was inserted into the delivery gun and squeezed out into the bottom of the cavity, then light curing for 20 sec. Then all restored teeth were finished and polished.

### Marginal adaptation assessment

Each group's samples were stored for a full day in distilled water and thermocycling for 500 cycles (5-55 °C) with a dwell period of 15 seconds which corresponds to 12 months of clinical service (Patel et al., 2018)[18].

### Evaluation of marginal adaptation

The samples were allowed to air-dry at room temperature before being mounted on copper stubs and then coated with gold pallidum by (SPI Module-Sputter Carbon/Gold coater, EDEN instruments, Japan). An overall proximal view of the restoration/gingival margin interface was examined using a Scanning electron microscope (JSM-6510LV, JEOL Ltd., Tokyo, Japan). Each section of the restoration/gingival dentin interface was examined and measured using image analysis software at a magnification of x200. Segments of noticeable gaps have been calculated and examined. Software for image analysis was used to examine the images. SEM photograph of the tested samples was used for the gap evaluation. The ratio of the gap length to the total margin length for the cervical and proximal margins was used to calculate the degree of marginal gaps, and then converted to a percentage, for cervical and proximal margins shown in (figure 1). The optimal ratio between the length of the margin and the total length is referred to as a continuous margin. Imperfect margins are measured in micrometers (μm) and can be classified as either continuous (without gaps) or discontinuous (with gaps).

### Statistical analysis:

Data analysis was performed by SPSS software, version 25 (SPSS Inc., PASW statistics for Windows version 25 Chicago: SPSS Inc). A one-way ANOVA test was used to evaluate the impact of study materials and their interaction on the marginal adaptation values. The results' significance was assessed at the ($p \leq 0.05$) level.

## RESULTS

A one-way ANOVA test was used to determine the effect of study Variables(materials) and their interaction on the marginal adaptation values (at $p < 0.05$), which revealed that none of the study variables had a significant effect on the marginal adaptation results ($p > 0.05$). (table 2)

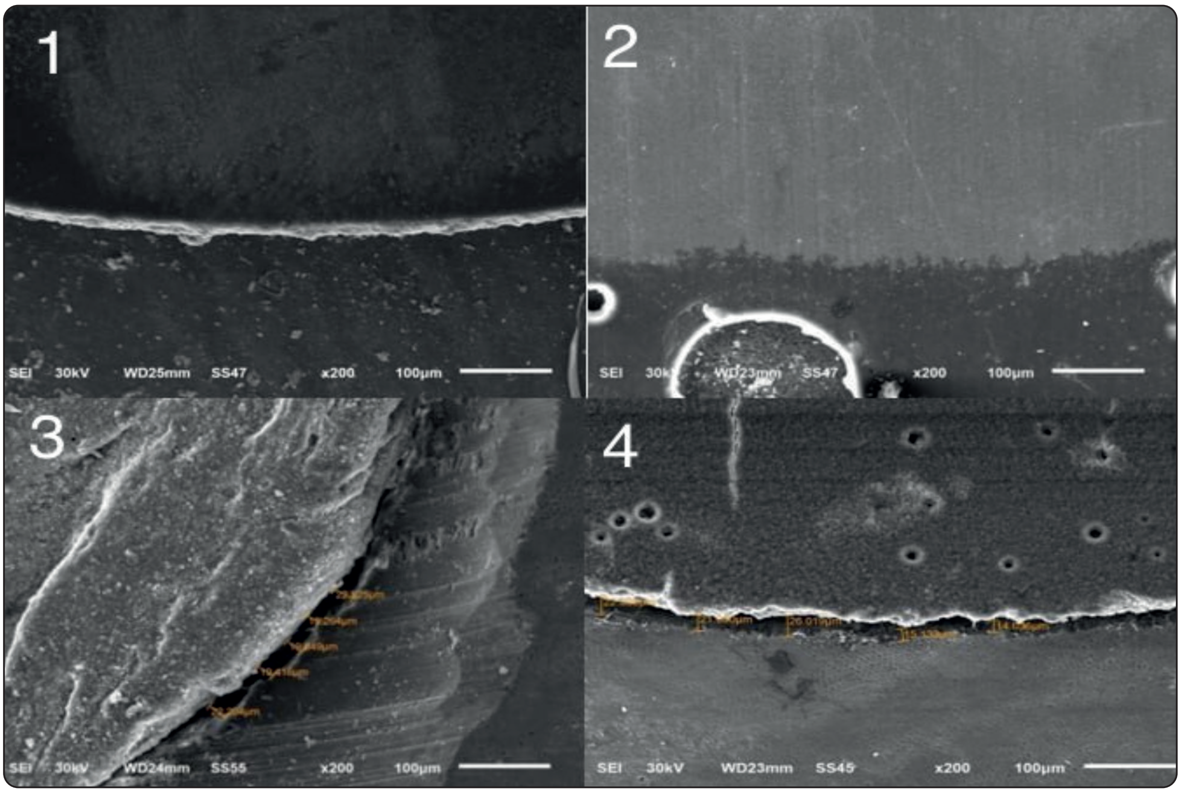


Fig. (1) Showed (1,2) SEM micrograph of a restoration (Filtek Z250) with no gap formation, (3) SEM micrograph of a restoration (Surefil one) with gap formation, (4) SEM micrograph of a restoration (RMGI) (Fuji) with gap formation, in (magnification ×200). (SEM, scanning electron microscopy).

TABLE (2) A one-way ANOVA test for marginal adaptation test, ($p>0.05$).

| | **Surefil one** | **Fuji** | **Filtek Z250** | **Test of significance** | **Within group significance** |
|---|---|---|---|---|---|
| **Marginal adaptation** | 25.96±11.23 | 21.97±3.38 | 36.03±4.76 | F=2.03<br>P=0.226 | P1=0.555<br>P2=0.212<br>P3=0.103 |

## DISCUSSION

Direct restoration of multi-surface extensive cavity preparation is generally a challenging clinical practice. Large restorations require the placement of several 2 mm layers of resin composite, this creates hazards such as the addition of voids, contamination, and layer-to-layer bond failure[15]. The restoration tooth complex's overall structural integrity has been improved to increase the restoration's longevity. This becomes possible via materials that were released onto the market under the name bulk-fill resin composites, they are intended to be placed in bulk increments of 4 mm thickness, therefore reducing the possibility of caries and reducing the amount of time needed for laying techniques.

Microleakage at the gingival margin of proximal boxes is one of the negative characteristics of Class II resin composite restorations[9], this corresponds with a less strong cementum dentin substrate for bonding at the gingival edges due to the absence of enamel[9]. When resin-based composite restorations are positioned in deep interproximal boxes, the orientation of the dentinal tubules may harm the level of hybridization and consequently promote leaking[9].

In this study, thermocycling was utilized to simulate bond deterioration over time as a result of temperature variations in the oral cavity, as well as to forecast and replicate the influence of the mouth cavity, 500 thermal cycles of 5°C to 55°C were performed on all of the teeth, along with a dwell period[12,18]. This clinically represents one year of clinical service.

Based on the findings of this study, the null hypothesis regarding marginal adaptation was accepted. As none of the study materials had a significant diffrence on the marginal adaptation results ($p > 0.05$). When comparing the different techniques, the results showed that the bulk fill technique recorded gingival and proximal gaps. The increase in width of the marginal gap in the bulk fill technique groups than the incremental. Teeth restored with Filtek Z250 resin composite exhibited the smallest marginal gaps, while Surefil one resin composite demonstrated moderate marginal adaptation. On the other hand, RMGI had the lowest marginal integrity values, as this may be connected to the fact that the resin composite has a high filler load that enhances the hygroscopic expansion of the resin composite, which is the main explanation for increased space[10]. Because of this region's polymerization shrinkage toward the light source and its poorer link with the dentin, gaps between the cavity margin and the resin composite material are more prone to appear.[12] Filtek Z250 has round-shaped filler particles, which decrease shrinkage.

It has been shown that when an adhesive restoration is used, marginal integrity values give a better description of the quality of the marginal adaptation. This is in accordance with Abdelwahed et al[1] (2022) which was accepted with this study. Opposite to our results, Oskoee *et al*.[16] and Kreitzer *et al*.[14] reported that bulk-fill resin composite resins had fewer gaps compared to conventional resin composites.

The utilization of the Bond, the high proportion of %CM found in the enamel of Filtek Z250 may be attributed to the use of a universal adhesive method combined with selective enamel etching. This is supported by the observation of 100% continuous margins in the enamel. Enamel etching using 37% phosphoric acid enhances the adhesive bond strength of this substrate

Surefil one has a remark as it difficultly adapts to cavity walls so making microlekage. This could have a negative impact on how well the material adapts to cavity walls, particularly the gingival edge, and stop neutralizing air bubbles that can accidentally be created during injection. The waiting period (about 6 minutes) before the matrix band was removed to enable full polymerization of the deeper layers was another remarkable observation.

Surefil One employed dual polymerization, which could potentially result in a higher shrinkage stress in cavities with a high C-factor as compared to self-curing techniques. The restorative material contracts as a result of this shrinking, and the margin becomes maladapted, which leads to microleakage.

RMGI had the lowest marginal integrity values. Czarnecka et al.[7], stated that the stickiness of RMGI, which was also employed in this investigation, made it difficult for the material to properly condense in small parts, which could have led to decreased marginal sealing. Despite the low resin content of the RMGI used, the presence of a resin-rich layer at the gingival/RMGI dentin boundaries in this study can be explained by the previous observation. It is hypothesized that the occlusal compression of the RMGI against the gingival floor results in the accumulation of resin in this area of the cavity. The bond strength of such materials was, however, significantly lower when compared to a conventional resin composite bonded with a universal adhesive.

## CONCLUSION

Self-adhesive bulk fill (surefil one) and RMGIC (fuji) showed multiple gaps in their interface with cavity walls, especially at the gingival margin. However conventional resin-based composite (filtek Z250) performed better in the marginal adaptation test in all thirds of the class II cavity with no significant difference.

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