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# EFFECT OF VENEERING LAYER THICKNESS ON CUSPAL DEFLECTION OF BI LAYERED FIBER REINFORCED RESIN COMPOSITE RESTORATIONS

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## *ABSTRACT*

**Objectives:** To evaluate the effect of veneering layer thickness on cuspal deflection of bi-layered fiber-reinforced resin composite restorations.

**Materials and methods:** Two different resin composite restoration systems Short flowable bulk-fill fiber reinforced resin composite (SFRC) (Ever x flow and Essentia universal) and Flowable bulk fill resin composite (FBF) (SDR Flow+ and Neo Spectra ST) were used in this study. 60 premolars were classified into two groups A and B (n= 30) according to the restorative system used. Each group was classified into three subgroups one, two, and three according to the veneering layer thickness (n=10) (0.5 / 1 / 1.5 mm). The specimens were fixed under ZEISS, Stereo zoom Microscope (50 x) was attached to the camera. Three measurements were taken for each specimen, before restoration/ within 5 and 15 minutes. All collected data were tabulated, and subjected to statistical analysis using SPSS software.

**Results:** A three-way ANOVA test was used to determine the effect of study variables (composite type, thickness, and time point) and their interaction on the cuspal deflection values (at $p < 0.05$), which revealed that none of the study variables had a significant effect on the cuspal deflection results ($p > 0.05$). Additionally, the interactions of all variables were not significant ($p<0.05$).

**Conclusion:** Within the limitations of this study, it is possible to conclude that neither the type of resin composite nor the veneering layer thickness affected the cuspal deflection result.

**KEYWORDS:** SFRC, FBF, polymerization shrinkage stresses, cusp deflection.

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## INTRODUCTION

Nowadays, dental resin composite has become the preferred material for both patients and dental practitioners, as it offers several advantages. However, the issues of volumetric shrinkage and fracture are still considered significant concerns with dental composites, as highlighted by previous research.[5, 25]

Polymerization shrinkage is one of the most critical limitation of light cured dental composites, such shrinkage induces contraction stress at the interface between the composite resin and cavity walls, leading to gap formation and secondary caries.[7] Recently introduced bulk-fill resin composite materials have been noted to exhibit lower levels of polymerization shrinkage stress compared to conventional resin-based composites.[6, 11, 15] This characteristic has been documented in several studies, reducing the occurrence of cuspal deflection.[31]

Additionally, these materials can be applied in a single 4-mm layer and still achieve sufficient light polymerization at the restoration's depth, streamlining the clinical process, this simplification also reduces the chances of air bubbles or contamination between layers. This makes these materials a more attractive option for dental practitioners.[8, 22]

The primary chemical composition of bulk-fill resin composite materials is similar to that of other methacrylate-based resin composites.[16] Some studies mention that the increased depth of cure of bulk-fill composite materials is regulated mainly by increasing the translucency of the material.[9,30] This translucency is achieved by reducing the concentration of fillers (filler content and translucency correlate linearly) or by minimizing the difference in the refractive indices of the resin matrix and the filler particles.[2, 21] In addition, the incorporation of a potent initiator system enhances the polymerization.[9]

(SFRC) have low polymerization shrinkage compared to (PFC).[27] Also they had the lowest shrinkage strain (.17%), this attributed to the short fiber fillers and plasticization of the polymer matrix. The anisotropic materials properties vary according to the orientation of reinforcing fibers, and shrinkage is not equal to all directions and the polymerization shrinkage is controlled in the direction of the fibers, therefore, during polymerization, the material is not able to shrink along the length of the fibers. It retains its original dimensions horizontally, but the polymer matrix between the fibers can shrink.[12]

Considering that, SFRC has already demonstrated superior mechanical properties when used in vivo and lower polymerization shrinkage compared to particulate-filled resin composites.[12, 13, 27] So, cuspal deflection test was performed since it is commonly used as an indirect means of assessing shrinkage stress.[3] the null hypothesis tested in the current study was that neither the type of flowable bulk fill nor the veneering layer thickness affected the cuspal deflection result.

## MATERIAL AND METHODS

### Material

Two different resin composite restoration systems which are Short flowable bulk-fill fiber reinforced resin composite (Ever x flow, GC corp, Tokyo, Japan and its veneering material, Essentia universal) and Flowable bulk fil resin composite (SDR Flow+, Dentsply Sirona, Konstanz, Germany and its veneering material, Neo Spectra ST) were used in this study. All materials were used and manipulated according to manufacturers' instructions.

### Methods

***Specimen grouping:***

A total number of 60 premolars were classified into two groups A and B (n= 30) according to the restorative system used. Each group was classified into three subgroups one, two, and three according to the veneering layer thickness (n=10) (0.5 / 1 / 1.5mm). To conduct the cuspal deflection test, digital calipers were used to measure all chosen teeth, which had similar crown sizes. The teeth selected had a maximum buccolingual width ranging from 8.5 to 9mm and had identical occlusal anatomy.

### *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 from the occlusal Cavo surface margin to the pulpal floor, 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.

### *Cuspal deflection assessment*

The acrylic cylindrical-shaped mold was fixed under ZEISS, Stereo zoom -Microscope Stemi 508 (50 x) attached to the camera (ZEISS Axiom 208 color). The measurement process started by switching on the power of the microscope and the attached camera then, we adjusted the focus of the microscope using the knob until the two occlusal cuspal marks were clearly recognized then the photo was captured by the attached camera on the computer using ZEISS, Microscope system. After that, the inter cuspal distance between the two occlusal marks was recorded on the captured photo in micron scale. Three measurements were taken for each specimen and the average was recorded; this is called pre-restoration measurement. Then three measurements within 5 and 15 minutes have been taken for each specimen and the average was recorded, this is called post-restoration measurements.

### Statistical analysis

The results of the test were organized into tables and analysed using statistical software, specifically IBM SPSS version 20. A three-way ANOVA test was used to evaluate the impact of study variables (composite type, thickness, and time point) and their interaction on the cuspal deflection values.

## RESULTS

The findings showed that the cuspal deflection values were not significantly influenced by any of the variables examined ($p>0.05$), and the interactions among all variables were also not significant ($p<0.05$), (Table 1, Fig1).

TABLE (1) Mean ± SD of cuspal deflection values (µm) of different thicknesses of both tested composite groups at different time points

| Thickness \ Type of composite | | everX Flow | SDR |
|---|---|---|---|
| **Sub.G1** | **5 min** | 49.46 ± 9.71 | 55.54 ± 8.03 |
| | **15 min** | 56.55 ± 9.8 | 56.23 ± 11.46 |
| **Sub.G2** | **5 min** | 42.54 ± 9.2 | 50.96 ± 11.5 |
| | **15 min** | 70.12 ± 10.54 | 46.27 ± 5.86 |
| **Sub.G3** | **5 min** | 45.6 ± 7.4 | 49.79 ± 7.04 |
| | **15 min** | 58.4 ± 11.72 | 45.39 ± 7.39 |

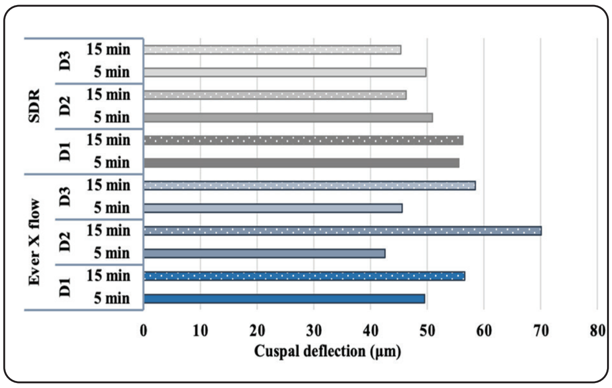


Fig. (1) Chart showing cuspal deflection means of all studied groups

## DISCUSSION

To enhance the durability of posterior restorations, efforts have been made to improve the overall structural integrity of the restoration tooth complex, aided in part by the fiber reinforcement of resin composites.[26] Additionally, the introduction of bulk fill composites to the market has further bolstered these efforts. The materials are formulated to be applied in larger increments of 4 mm thickness, which minimizes the possibility of voids and decreases the need for layering techniques, thereby saving time. The enhancements in depth-of-cure can be attributed to factors such as heightened translucency and the incorporation of supplementary photo-initiator systems, as evidenced by various studies.[4, 20, 23]

The use of fiber reinforcement has been introduced to conventional dental composites as a means of enhancing their physical and mechanical properties and increasing their resistance to fractures. The mechanism behind this enhancement is the transfer of stress from the matrix to the fibers, with the degree of stress transfer being dependent on the length and diameter of the fibers. Garoushi et al.[12] conducted a study to evaluate the effect of fiber reinforcement and discovered a significant enhancement in the physical properties of the material. Fiber-reinforced composites have also been proposed to decrease polymerization shrinkage, enhance toughness, and improve impact strength, ultimately resulting in better fracture resistance of restored teeth.[17]

The material under consideration is designed to function as a bulk-base material, with research showing encouraging mechanical properties, such as impeding and deflecting the propagation of cracks, when employed as a reinforcing base in extensive restorations.[3, 10, 28] Nevertheless, it is recommended to "cap" these base materials with a layer of traditional particulate filler composite.[12, 20] This is due to the fact that these materials exhibit lower wear resistance, surface roughness, and hardness than conventional particulate filler composite, which is typically used as a veneering material.[14, 29]

In this study, we used a biomimetic resin composite structure, which is an alternative bi-layered technique. This restoration technique involves the use of both flowable fiber-reinforced resin composite and particulate filler composite. Short fiber-reinforced resin composite materials are characterized by their unique fiber and polymer composition, which gives rise to a range of improved physical and mechanical properties.[18]

For this study, we used flowable bulk fill resin composite due to previous research indicating a correlation between polymerization shrinkage and weakening of the restoration. Studies have suggested that the use of bulk fill flow composites can reduce polymerization shrinkage in posterior teeth, thanks in part to their low elastic modulus, which acts as a flexible layer and may alleviate stresses within the cavity during polymerization. This may explain why the use of bulk fill flow composite helped to increase the fracture resistance of teeth with mesial occlusal distal cavity preparations.[1]

The results of this study led to the acceptance of the null hypothesis regarding cuspal deflection, as none of the study variables were found to have a significant effect on the observed cuspal deflection ($p>0.05$). Neither the type of composite nor the thickness of the veneering layer had a statistically significant impact on cuspal deflection. This lack of effect may be attributed to both resin composite restoration systems exhibiting low levels of polymerization shrinkage. While undergoing polymerization, the resin composite material reinforced with short fibers cannot contract along the length of the fibers, thus maintaining its original dimensions horizontally. However, the polymer matrix between the fibers can undergo shrinkage.[12]

In this study, a stress-reducing resin composite was utilized, which is a flowable bulk fill resin composite that contains stress-reducing technology, including a polymerization modulator integrated into its chemical composition. This modulator functions to slow down the material's polymerization rate and delay its transition to the gelation phase, thus prolonging the pre-gelation phase. During this time, the material can flow more effortlessly, resulting in a reduction in the level of shrinkage stress. Previous research by Rizzante et al. has demonstrated that shrinkage stress in stress-decreasing resin composites is lower than in other flowable resin composites.[24] Additionally, Kim et al. found that this material exhibited lower shrinkage stress and better adaptation ability than other flowable composites.[19]

## CONCLUSION

Neither the type of flowable bulk fill nor the veneering layer thickness affected the cuspal deflection result.

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