# Evaluation of Cuspal Deflection of Fiber Reinforcing Composite Application Techniques Using Measuroscope

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***Abstract:***

**Objective:** To evaluate cuspal deflection of mesio-occluso-distal (MOD) cavities restored with short fiber-reinforced composite. **Materials and Methods:** Two different commercially available composite resin restorations; short fiber-reinforced (ever X Posterior GC, Tokyo Japan) and conventional micro-hybrid (G-aenial universal resin composite GC, Tokyo Japan) resin composite restorative material bonded with a universal adhesive (G-Premio BOND GC, Tokyo Japan) were used in the current study. A total of 40 sound maxillary human premolars were selected for the cuspal deflection test and received standardized MOD cavity preparations suitable for each test. The sample was divided into four groups; Group A: conventional microhybrid resin composite (conv.), Group B: short fiber-reinforced composite (SFRCs), Group C: short fiber-reinforced composite laminated with conventional microhybrid resin composite (SFRCs+conv.), Group D: short fiber-reinforced composite "cut off" then laminated with conventional microhybrid resin composite. Measuroscope was used to evaluate the cuspal deflection. For the cuspal deflection test, the collected data from each test were tabulated, coded and then statistically analyzed. One-way ANOVA followed by a post-hoc Tukey test was used for multiple comparisons. The level of significance was set at $P < 0.05$. **Results:** Both Group A (conv.) and Group C (SFRCs+conv.) showed insignificant differences in cuspal deflection values, in comparison with groups B ( SFRCS) and D (Cut off) ($p > 0.05$). There were significant differences in cuspal deflection between Group A (conv.) and group c (SFRCs+conv.) ($p < 0.05$). There were43 significant differences in cuspal deflection between groups, B( SFRCS) and group D (Cut off) ($p < 0.05$). **Conclusions:** Conventional resin composites exhibit higher cuspal deflection values than those containing short fibers. Laminating conventional resin composite to SFRCS, as per the manufacturer's instructions, increases cuspal deflection values more than SFRCS. The cut-off technique seems to have a positive effect on the cuspal deflection value.

## Introduction:

More than 260 million direct dental resin composite restorations are placed to restore caries defects every year. It is estimated that 2.3 billion people suffer from caries of permanent teeth. Direct dental resin composites can bond to hard tooth structures by using adhesive systems and hence obtain more preservation of tooth structure compared to amalgam restorations.[1]

However, some disadvantages including polymerization shrinkage and weak mechanical properties, challenge the longevity of direct resin composite resin restorations. Polymerization shrinkage induces contraction stresses which may lead to inward cuspal movement. If the bond strength is higher than the polymerization contraction stresses, the stresses will transfer to the cusps, resulting in cuspal deflection. On the other hand, at sites where these stresses are higher than the bond strength between the restorations and dental substrate, a micro-gap will form. These gaps might increase the probability of post-operative sensitivity and occurrence of recurrent caries. [2]

Cuspal deflection is known as the linear movement of tooth cusps due to the interaction between polymerization shrinkage stresses of resin composite, the adhesive interface, and compliance of the cavity wall of the tooth. There are many methods to measure cuspal deflection, including non-contact methods [photography, measuroscope, laser-scanning, and three-dimensional micro-computed tomography] and contact methods [strain gauge, interferometers, and linear variable differential transformers]. The novelty of these techniques can measure changes due to cuspal deflection up to 50 mm with high accuracy. For example the use of measuroscope which is a light microscope with 1 micrometer accuracy. [3]

Many studies introduced some strategies to overcome/minimize the adverse effects of polymerization contraction stresses. One of the most popular methods is using incremental techniques in the placement of resin composite restorations. However, this restoration placement technique seems to be more time consuming and it might lead to the incorporation of large voids between restoration increments. Resin composite materials have been developed to overcome polymerization shrinkage, and associated stresses and reduce chairside time as well as tooth structure, such as bulk-fill resin composite and fiber-reinforced resin composite (FRCs). The incorporation of stress relievers

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or fibers within the resin composite ingredients might increase the depth of cure and enhance mechanical properties. [4]

The integration of E-glass fibers into the resin composite material is important for fiber-reinforced composites (FRCs). The fibers act as stress relievers because they do not shrink. Also, the placement of these fibers improves the mechanical properties. However, the uniformity of distribution of these long fibers may impair the mechanical, and physical properties. Accordingly, randomly oriented short fiber-reinforced composites (SFRC) were developed to solve this dilemma. Moreover, several studies utilized E-glass SFRCs in lengths ranging between (1-3mm). The short fibers have a length equal to or greater than the critical fiber length. [5]

Short fiber–reinforced composite (SFRC) was introduced as a dentin-replacing material (bulk base) to support the remaining tooth structure and improve the durability of the final biomimetic resin composite restoration. Furthermore, this type of FRC substructure and thickness of the veneering resin composite also play a significant role in overall polymerization shrinkage and fracture resistance. SFRC-based resin composite restorations showed higher fracture resistance than other tested restorations. The outcome of several research studies revealed that SFRC showing promising results. This was attributed to its relatively low-polymerization shrinkage compared to conventional resin composite. [6]

Aim of this study was to evaluate the cuspal deflection of mesio-occluso-distal (MOD) cavities restored with short fiber-reinforced composite restorations (SFRC) and conventional microhybrid resin composite restorations using measuroscope. The null-hypothesizes of this study was that there is no significant difference in the magnitude of cuspal deflection in MOD cavities restored with conventional microhybrid resin composite and short-fiber-reinforced composite restoration systems.

## Materials and Methods:

Two commercially available composite resin restorations were utilized in the current study, (i) conventional microhybrid resin composite restorations (G-aenial universal resin composite GC, Tokyo Japan and (ii)) short fiber-reinforced composite restorations (ever X Posterior GC, Tokyo Japan). Also, a universal adhesive (G-Premio BOND GC, Tokyo Japan), 37% phosphoric acid etch, and 10% orthophosphoric acid solution. All the materials were used according to the manufacturer's instructions.

Forty freshly extracted maxillary premolars free from caries were collected from Oral Surgery Department in the Faculty of Dentistry, Mansoura University for orthodontic purposes from patients ranging in age from15 to 30 years old and with the agreement of every patient. These procedures were approved according to the guidelines of the Faculty of Dentistry Ethical Committee, Mansoura University, No: A03070519. Teeth were cleaned from adherent debris using a hand scaler, rubber cup, pumice, and a low-speed handpiece.

Specimens were ultrasonically cleaned by an ultrasonic cleaner (Blazer, Farmingdale, NY, USA) in distilled water. Teeth were disinfected for one day in a 5% chloramines solution and then, were stored in deionized water (DI) in an incubator at 37°C until use. The DI water was changed periodically every 5 days to avoid dehydration of the teeth. For the cuspal deflection test, all selected teeth were measured using an electronic digital caliper (Flower & NSK, Japan). The selected premolars had approximately the same crown size; with average bucco-palatal intercuspal distance ranging from 8.35 to 8.95mm. All selected teeth had nearly the same occlusal anatomy.[7]

Study design: For the cuspal deflection test, a total number of forty Teeth (n=40) were divided into four equal groups according to restorative technique (n=10); GroupA: conventional microhybrid resin composite, Group B: short fiber-reinforced composite, Group C: short fiber-reinforced composite laminated with conventional microhybrid resin composite, Group D: short fiber-reinforced composite "cut off" then laminated with conventional microhybrid resin composite.

Mounting of teeth: All selected teeth were fixed into a specially designed cube-shaped mold filled with chemically cured acrylic resin. The specially designed cubic mold had $2cm^3$ dimensions. The chemically cured acrylic resin extended 2 mm cervical to the cementoenamel junction simulating the position of the tooth in the alveolar bone and preventing the crown from being reinforced by the base. This mold provided stability to the specimen which reflects on the accuracy of laboratory tests.[8]

Specimen preparation: Standardized 'slot' mesio-occluso-distal (MOD) cavities without steps were prepared on the teeth to weaken teeth structures and favor cuspal deflection. The cavities were prepared using straight fissure carbide burs (KR 314 018; Komet, Brasseler, Lemgo, Germany 6836) at high speed with air/water coolant to produce a nearly standardized cavity width of 3 mm bucco-palatally and depth of 4 mm from the enamel cavosurface margin. Cavity dimensions were measured using a digital caliper. The cavities were prepared as slot shape MOD preparation so that the pulpal floor, mesial, and distal corresponding gingival walls were at the same level (there was no step going from the pulpal floor to the gingival wall) to reduce preparation variation. The gingival floor was located above CEJ. Cavo-surface margins were prepared without bevels.[9]

**Assessment of cuspal deflection using measurescope:** Nikon Measuroscope(10x) (Nikon Measurescope UM-2, Nikon, Tokyo, Japan) was used to evaluate the cuspal deflection Figure 1.

Table 1. Materials used in the study

| Materials | The main composition of restorative materials | Type | Manufacturer | Batch no. |
|---|---|---|---|---|
| **everX Posterior (Universal)** | Bis-GMA, PMMA, TEGDMA, Short E-glass fiber filler, Barium glass 74.2 wt%, 53.6 vol% | short fiber-reinforced composite | GC, Tokyo Japan | 13312271 |
| **G-ænial universal resin composite** | UDMA and DMA comonomer Inorganic Filler silica, Prepolymerized Filler( 17 mm 400 nm Strontium Glaslanthanoid fluoride100 nm ) | Micro hybrid resin composite | GC, Tokyo Japan | 180274A |
| **G-Premio BOND** | 4-MET, MDP, methacrylate monomer, aceton, water, initiator, and silica | Universal adhesive | GC, Tokyo Japan | 180094 |
| **Abbreviations: Bis-GMA: bisphenol A glycidyl dimethacrylate , PMMA: poly methyl methacrylate, UDMA: urethane dimethacrylate, TEGDMA: triethylene glycol di methacrylate, MDP: methacryloyloxydecyl dihydrogen phosphate, HEMA: hydroxyethyl methacrylate, DMA: dimethacrylate, 4-MET: 4-methacryloxy ethyltrimellitate anhydride** | | | | |


**Figure. 1 The Nikon-10 Measurescope (Nikon Measurescope UM-2, Nikon, Tokyo, Japan) components showed (a) the specimen, (b) the observation table, (c) the eyepiece, (d) Major adjustment, (e) Two digital fine adjustment tool, (f) Digital readout unit, (g) right angles metal stand, (h)reset button.**

This Measuroscope has two axes digital counter which can measure inter-cuspal distance in microns. Two occlusal marks were drawn on the buccal and palatal cusps tips by permanent super fine 0.4 mm marker with high color stability (Stablio Olphen universal, Heroldsberg, Germany). The acrylic cubic mold was placed on a measuroscope observation table and a custom-made standardized right-angle metal stand was used to maintain the position of the acrylic cubic mold for eachspecimen during the repeated measurements Figure 1-g. After switching on the power of the measurescope and the attached digital readout unit, Figure 1-f, the specimen on the measuroscope observation, Table.

Figure1-b, is observed through the eyepiece Figure 1-c, and adjusted using the major adjustment tool, Figure 1-d until the two occlusal cuspal marks could be recognized. The two fine adjustment tools are used to move the measuroscope observation table on vertical and horizontal axis till the target focusing tool of the eyepiece was centered on the buccal identification occlusal mark Figure 1-e. After that the reset button Figure 1-h, the digital readout unit was activated to

reset the initial reading (pre-measuring 'zero' point). Then the fine adjustment tools were reused to center the measuroscope target focusing tool of the eyepiece to the palatal identification occlusal mark. The distance between buccal and palatal identification occlusal marks was displayed automatically on the attached digital readout unit ,Figure 1-f and recorded as pre-restoration measurements.

Restorative procedures: "Group A" conventional microhybrid resin composite group:

The restorative procedure was performed according to the manufacturer's instructions. A total-etch technique was used by applying 37% phosphoric acid gel directly from the syringe to the freshly cut enamel first for 15 sec, then applied to all exposed dentin for 15 sec. The etchant gel was rinsed off with a water stream for 30 sec to obtain a clean and contamination-free field. Gentle air dryness was applied then dentin was re-wetted using small moist sponges to avoid the collapse of exposed collagen fibers. The universal adhesive was applied to the cavity walls and floor with a disposable mico-brush and rubbed in for 20sec and lightly air dried for 3-5sec from 1cm distance, then light cured for 10sec using LED light curing unit (Elipar, 3M ESPE, USA)with light irradiance of 800 mW/cm2. After the application of the No. 8 ivory matrix band and retainer for each prepared tooth, a conventional microhybrid resin composite was placed in an incremental technique. The first and second increments were placed and gently adapted to the cavity floor by a clean non-stick titanium coated applicator (DuraFlex double paddle #38T, NourDent, USA) and cured for 20sec from occlusal aspect for each increment. The third layer was used to complete the building of the proximal walls and reshape the buccal and palatal cusps then cured for another 20sec for each cusp. After removal of the matrix band and retainer, additional light curing was applied from buccal, palatal, mesial, and distal 20sec for each surface. Excess material was removed using scalpel blades. Polishing procedures were performed immediately using Sof-lex discs (3M ESPE, ST. Paul, MN, USA) in the recommended order (coarse, medium, fine, and superfine) to produce a smooth surface.

"Group B" short fiber-reinforced composite application: Etching and bonding were applied as mentioned before in group A. After placement of the matrix band and retainer, the short fiber-reinforced composite was placed, in group A, using the incremental technique to restore the MOD cavity. The restorative procedure was done as mentioned before according to the manufacturer's instructions. The same previously mentioned finishing and polishing steps were performed.

"Group C" short fiber-reinforced composite laminated with a conventional microhybrid resin composite: Etching and bonding were applied as mentioned before in group A. After placement of the matrix band and retainer, the 3mm depth of the cavity was restored using the layering technique as in group A by fiber-reinforced composite (each increment was placed in thickness 1mm ), and the last occlusal 1mm laminate of cavity was restored with conventional microhybrid resin composite using clean nonstick titanium coated applicator. The restorative procedure was done as mentioned before according to the manufacturer's instructions. Finishing and polishing were done as mentioned before.

"Group D" short fiber-reinforced composite cut-off laminated with conventional microhybrid resin composite: Etching and bonding were applied as mentioned before in group A. After placement of the matrix band and retainer, the short fiber-reinforced composite was placed as mentioned, in group A, using the incremental technique which restore all cavity depth till reach the full occlusal surface. Then a cut-off of 1mm from the occlusal surface using straight fissure diamond carbide burs (KR 314 018; Komet, Brasseler, Lemgo, Germany 6836) at low speed with air/water coolant.

The depth of 1mm was measured using a digital caliper. Then Etching and bonding were applied again and finally, the last occlusal 1mm of the cavity was restored with a conventional microhybrid resin composite using clean nonstick titanium coated applicator. The occlusal surfaces of restorations were carved to simulate the normal tooth surface. Finishing and polishing were done as mentioned before.After 15 minutes the cubic mold was refixed under measurescope and the inter-cuspal distance between the measurescope and the inter-cuspal distance between the previous occlusal marks on buccal and palatal cusps tips was remeasured in microns and the readings were recorded as post-restoration measurements as mentioned before. The difference between pre-restoration measurements and post-restoration measurements was considered a cuspal deflection value.[10]

Statistical analysis: All the collected data from each test were tabulated, and subjected to statistical analysis using the IBM SPSS (Statistical Package for social science) software package version 26. For all groups, the Kolmogorov-Smirnov test was conducted to check the data for normal distribution. In the statistical comparison between the different groups, the significance of difference was tested using one-way ANOVA (analysis of variance) used to compare more than two groups of numerical (parametric) data followed by post-hoc Tukey test.

## Results:

**Cuspal deflection test:** The outcome of this test revealed that cuspal deflection data followed a normal distribution pattern.

The one-way ANOVA outcome showed that the restoration technique has a significant effect on cuspal deflection values ($p<0.05$). Post Hoc multiple comparison tests revealed that the cuspal deflection values were significantly higher in (Conventional group) and in (SFRCS+Conv. group) ($p<0.05$). Conversely, both (SFRCS and Cut_off groups) showed significantly lower cuspal deflection value, Table 2&3.

Table 2.Comparison of cuspal deflection between different groups (Mean±SD)

| Groups | N | Mean±SD (mm) |
|---|---|---|
| A (Conv) | 10 | .0142±.0024 [b] |
| B (SFRCs) | 10 | .0075±.0009 [a] |
| C (SFRCs+Conv) | 10 | .0127±.0008 [b] |
| D (SFRCs+Cut-off) | 10 | .0074±.0013 [a] |

**Data expressed as mean±SD**
**SD: standard deviation, P:Probability, *:significance <0.05**
**test used: One-way ANOVA test followed by post-hoc tukey**
**Different letters indicate a significant difference in means**

Mean cuspal deflection in all groups shows that there was a significant difference among groups. Both group A (conv) and group c (SFRCs+conv) showed insignificant difference in cuspal deflection than group B (SFRCS) and group D (cut-off) ($p > 0.05$). There were significant differences in cuspal deflection between group B (SFRCS) and D (cut-off) ($p < 0.05$). There were significant differences in cuspal deflection between group A (conv) and C (SFRCs+conv) ($p < 0.05$). (Tables 2&3)

## Discussion:

Resin composite restorations were developed over the years since 1950. These development cycles improved the mechanical and esthetic properties. Polymerization shrinkage was considered one of the main problems facing developers. The contraction stresses are reflected clinically on cusp deflection. Measuring cuspal deflection is very important for many authors to study the effect of different resin composite restorations and techniques on tooth structures. [11]

Adding short fibers to resin composite was thought as one of the strategies to decrease polymerization shrinkage and its contraction stresses. During this experiment, SFRCs composite materials were used as they were in the market. As a consequence, limited data were available for these SFRCs. In addition, it was assumed that SFRCs could reduce polymerization shrinkage than do conventional resin composite restorations consequently reducing cuspal deflection. The current *in vitro* study was held to evaluate the impact of short fibers on cuspal deflection and so its reflection on polymerization shrinkage in comparison with conventional composite.[12]

Maxillary premolar teeth were selected in this study because they have approximately equal two-cusp regarding similarity in occlusal anatomy and height. As a consequence this facilitated marking reference points' on buccal and palatal cusp tips. This allowed easy and more reproducible measurements of cuspal movement before and after resin composite restoration. The teeth were pre- measured using digital caliber. The average of bucco-palatal width between selected premolars not exceed 5% to minimize the effect of size difference between the selected premolars as much as possible.[8]

To weaken the remaining tooth structure, standardized big MOD cavities were prepared. It was found that the degree of cuspal deflection is proportional to the loss of tooth structure. Also standardized large MOD cavities need more restorative material and this would increase the effect of magnitude of polymerization shrinkage and consequently more cuspal movement. The MOD cavities were prepared as pulpal floor and both mesial and distal gingival floors were at the same level without any proximal box steps. As a consequence the variation in the preparation decreased in the selected teeth.[13]

In this study, measuroscope was used to measure cuspal movement. This method was preferred because it has the advantage of determining tooth deformation by measuring intercuspal distance without contacting the teeth or applying any physical stresses on them. Measuroscope accuracy reaches up to 0.001-mm so it was accurate and reliable method. The Nikon-10 Measurescope has the advantage of producing readings with a resolution, up to 1 micron, in both horizontal and vertical directions through two fine digital micrometers, which are connected to an observation table. In addition, it is simple and available in comparison with other methods. A modified microscope stage and special designed standardized right angles metal stand to maintain position of acrylic cubic mold for each specimen during the repeated measurements. Other measuring methods such as strain gauge and LVDTs are contacted or even bonded to the surfaces or structures undergoing deformation.[14]

Permanent super fine 0.4mm marker was used to determine reference point to provide stability of marks through repeated measurements. The inter cuspal distances readings were measured after tooth preparation, as it was found that, there were no significant differences in cuspal deflection when the initial measurements were recorded before or after cavity preparation. Although most of the polymerization shrinkage occurs within the first 5 minutes, the second readings were measured after 15 minutes.
Cuspal deflection was much slower and took longer time than polymerization shrinkage of resin composite because of the remaining free radicals, and double bonds in resin based composite kept on react. In addition to that some cusp relaxation or cusp recover occurred after 15 minutes so best reading result obtained after this period.[15]

Table 3. Comparison of cuspal deflection between different groups

| | | A (Conv) (N=10) | B (SFRCs) (N=10) | C (SFRCs+Conv) (N=10) | D (SFRCs+Cut_off) (N=10) | P |
|---|---|---|---|---|---|---|
| **cuspal deflection** | **Mean±SD** | 0.0142±0.0024 | 0.0075±0.0010 | 0.0127±0.0008 | 0.0074±0.0013 | <0.001* |
| | **Post-hoc** | | P1=<0.001* | P1=0.13<br>P2=<0.001* | P1=<0.001*<br>P2=0.99<br>P3=<0.001* | |

**Data expressed as mean±SD**
**SD: standard deviation P:Probability *:significance <0.05**
**Test used: One-way ANOVA test followed by post-hoc Tukey**
**P1: significance relative to A (conv)**
**P2: significance relative to B (SFRCs)**
**P3: significance relative to C (SFRCs+conv)**

Based on the findings of this study, the null hypothesis regarding cuspal deflection was rejected. As there was statically significant differences among the means of cuspal deflection values between the tested groups (p > 0.05). Both group B (SFRCS) and group D(cut_off) gave lowest result in the means of cuspal deflection values. Group A (Conventional group) gave the highest result in the means of cuspal deflection values (0.0142±.0024 mm). Group C (SFRCS + Conventional) gave intermediate result (0.0127±.0008 mm). Group B( SFRCs)(0 .0075±.0009 mm) and group D (Cut_off) (0.0074±.0013 mm) groups showed significantly lower in means of cuspal deflection values and so lower polymerization shrinkage than group A (conventional) and group C (SFRC+ conventional) groups.

For group B (SFRCs), the shrinkage strain showed low in all direction of multi directional discontinuous fibers. Resin composite had multi directional discontinuous short fiber as seen in ,Figures 2,3,4. During polymerization, resin composite cannot shrink along the length of the fibers. However the polymer matrix between the fibers is able to shrink. This was in agreement with the outcome of the study by Garoushi et al. who compared the polymerization shrinkage of various commercial posterior composite resins, including bulk-fill and SFRC resins. They concluded that SFRC had the lowest shrinkage strain (.17%). They found that the properties of anisotropic materials vary depending on the orientation of reinforcing fibers, and shrinkage is not uniform in all directions. The polymerization shrinkage is controlled according to the direction of the fibers. Improvement in result of means of cuspal deflection values may be due to the presence of glass fibers in filler content which more transparent than other filler content. These glass fibers can scatter light to deeper areas.[16]

Also this finding was in agreement with who reported that The volumetric shrinkage of SFRC was much smaller (1.15 percent) than that of the other bulk-fill and traditional PFC resins examined (range: 1.3-2.4 percent ). As a result, employing short E-glass fibers with a semi-IPN-resin matrix may be one of the causes behind SFRC's lower volumetric shrinkage. They also stated that the inclusion of short fibers in the composite resin improves microcracking resistance while lowering shrinkage stress. Bocalon et al. concluded that replacing a small fraction of filler particles with glass fiber fillers considerably reduced post-gel shrinkage in the range of 30-72 %, confirming the findings of the prior research. This is owing to good fiber-to-semi-IPN-resin matrix bonding.[4]

On the other hand, in another study conducted by Miletic et al. reported that The volumetric shrinkage of SFRC was comparable to or lower than that of tested conventional PFC resins, and glass fiber fillers had no effect on SFRC shrinkage behavior in the measuring setup used. They concluded that a higher polymerization stress value could be expected for its high TEGDMA content. Also the higher filler content including fibers would increase reactivity of these monomers cause high conversion level and consequently may lead to high shrinkage.[17]

This finding was in agreement with the outcome of the study by Fronza et al. who investigated one conventional and four bulk-fill composites were for degree of conversion (DC) and polymerization shrinkage stress (PS). They found that the polymerization shrinkage stress of the bulk-fill resin composites they tested was less than that of SFRCS. The bulk-fill resin composite, on the other hand, has a different resin matrix and contains more filler. Moreover, this was relatively small areas of internal gap formation along the axial wall of SFRC restorations. Shrinkage could be occurred through this internal gap between tooth surface and fibers.[18]

Group D (cut-off group), showed the least cuspal deflection value among groups (0.0074±.0013mm). The cut-back 1mm of SFRCs from occlusal surface gave some sort of stress relaxation on cusps. Furthermore, the short-fibers might reduce the cuspal defection, as they were not able to shrink during polymerization shrinkage. The magnitude of cusp deflection is affected by many factors as amount of restoration and thickness of layer of restoration. As a consequence, the small increment of conventional resin composite after stress relaxation did not give great effect on cuspal deflection value after stress release due to cut-back.[19] Group C (SFRC+conventional) showed intermediate cuspal deflection value (0.0127±.0008 mm). The polymerization shrinkage is due to the monomer systems in matrix in all resin composite and alter in filler not give the great change. This is in agreement with Al Sunbul et al. who investigated the shrinkage stress of 18 commercially available composite resins. Polymerization shrinkage stress values ranged from 3.94 to 10.45 MPa, with SFRC having a value of 5.16 MPa, which was comparable to or lower than several other composite resins. [20]

Group A (conventional group) showed the highest cuspal deflection value (0.0142±.0024mm). Volumetric polymerization shrinkage is mainly determined by composition of the material, such as the type and amount of the resin matrix used, the initiation system and filler loading. Resin matrix such as UDMA and DMA comonomer used in conventional composite leads to elevated shrinkage stress values and therefore cuspal deflection value. In general the volumetric shrinkage of the used conventional resin composite is within the average of the microhybrid resin composites. This was agreed by Al Sunbul et al. who evaluate the effect of different composition of different resin composite including microhybrid and SFRCS on polymerization shrinkage stresses. They found that conventional microhybrid resin composite had more polymerization stresses than other tested bulk-fill resin composite including SFRCS. [21]

On the other hand Mahdi et al. who compared polymerization shrinkage of five composite resins. They found that resin composites had a polymerization shrinkage similar to each other. They consumed that addition of great amounts of fillers to decrease the resin volume is not an efficient approach to decrease the polymerization shrinkage and stress. Thus, chemical modification is another adopted approach to slow down the polymerization rate and to decrease the polymerization shrinkage stress.

The matrix consists of a mixture of urethane dimethacrylate (UDMA) and dimethacrylate co-monomers without bis-GMA. Bisphenol A glycidyl dimethacrylate(bis-GMA) which was present in the composition of bulk-fill restorative materials including (SFRCS), had a high reactivity and results in a higher conversion of double bonds and consequently a higher shrinkage.[22]

## Conclusions:

Within the limitations of the current study, the following conclusions can be drawn:Conventional resin composite exhibits higher cuspal deflection values than those short Fiber -reinforced composite. Laminating conventional resin composite to SFRCS increases cuspal deflection values than SFRCS. The cut off technique seems to have the lowest cuspal deflection values.

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