Complex Class II Bulk-Fill Resin Composite Restoration: Cuspal Deflection and Effect of Water Storage on Microleakage: A Laboratory Study

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Abstract:

Objective: Objective: To evaluate cuspal deflection and microleakage of complex class II cavities filled with bulk fill and incremental resin composite. Also, asses effect of water storage on microleakage. **Materials and methods:** 120 maxillary premolars were collected, prepared into standardized (MOD) cavities, then teeth were divided as the following:- Forty tooth of the 120 prepared teeth were randomly assigned for cuspal deflection test which were randomly divided into four groups (n=10) according to restorative materials used (Filtek z350,Filtek bulk fill, Fill-up bulk fill , Beautifil bulk fill). The remaining 80 tooth were used for microleakage test, randomly divided into four groups (n=20) according to the previous mentioned used restorative materials. **Results:** For the cuspal deflection test, A statistically significant difference was found between bulk-fill and incremental-fill composite. Concerning microleakage results, no statistical significant difference was found between all groups investigated immediately or after water storage. **Conclusion:** Bulk fill resin composites had reduced cuspal deflection than incremental composite with no difference in microleakage recorded.

Introduction:

The use of direct posterior composite resin restorations has been widely increased in dental practice due to the high patient's demands for tooth colored restorations. It also has advantages such as single visit and short application time, aesthetics, ability to protect dental tissues during preparation, and being cheaper when compared to indirect methods.[1]

Although resin composite has good physical properties, polymerization shrinkage still a significant disadvantage.[2] This shrinkage can result in marginal microleakage that permits passage of bacteria, fluids, molecules, or ions leading to postoperative sensitivity, secondary caires, pulpal inflammation and pain.[3] Also, may creates internal stresses that draw cavity walls together, lowering the intercuspal distance (cuspal deflection) leading to occlusion points shift, postoperative discomfort, and tooth fractures in some circumstances.[4]

Recently, bulk fill composite has been introduced that allow the use of thicker increments up to 4 mm due to both developments in photo initiator dynamics and their increased translucency, which allows additional light penetration and a deeper depth of cure, also using dual curing composite, which it's chemical curing start from center and shrink toward the center as opposed to light curing materials, which shrink toward the light source, away from the cavity walls.[5]

Cuspal deflection may lead to micro-crack propagation, enamel cracks, crazing, ultimate reduction of the restored tooth fracture strength, and, even cusp fracture in extreme circumstances.[6]

Microleakage is a major factor influencing the restoration longevity. It is clinically undetectable space between restoration and the cavity wall which allow passage of bacteria, liquid, molecule and ions that finally lead to restoration failure.[7]

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This laboratory study was aimed to evaluate and compare cuspal deflection and microleakage of new bulk-fill resin composite materials.

Null hypotheses

Materials and Methods:

Materials:

Three bulk-fill resin composites; Filtek Bulk-Fill/Single Bond Universal, Beautifill Bulk-Fill/Beauti Bond Universal, dual cured bulk fill resin composite system (Fill Up!/One Coat 7 Universal adhesive) and an incremental-fill nanohybrid resin composite; Filtek Z350 XT/Single Bond Universal.

Methods:

Teeth selection:

120 freshly extracted human maxillary first premolar teeth were collected from the oral surgery clinic in Faculty of Dentistry, Mansoura University, after approval from the research ethics committee of Mansoura University# (A08030320).

Specimen preparation:

Teeth were placed vertically using chemically cured acrylic resin (Acroston, Egypt) to make it easier to handle the specimen and keep it stable throughout lab tests.

Cavity preparation

Standardized mesio-occluso-distal (MOD) cavities were prepared. The dimensions of cavity were 4mm depth, while width was one-third the intercuspal distance. The buccal and lingual walls were prepared parallel to each other, with a 90-degree cavosurface angle and rounded internal line angle of the cavity without beveling. The proximal boxes were one third the buccolingual distance and gingival seat of box with 1mm axial walls depth and height.

Teeth grouping:

Forty tooth of the 120 prepared teeth were randomly assigned for cuspal deflection test which were randomly divided into four groups (n=10) according to restorative

materials used. The remaining 80 tooth were used for microleakage test, randomly divided into four groups (n=20) according to the used restorative material.

Restorative Procedures:

Composite was applied as single layer with the use of cleansed, unsticky gold plated instrument then light cure was applied for 20 Sec for all groups except filtek z350 group in which composite was applied incrementally in oblique manner till complete filling of the cavities. Each increment was light cured from the occlusal aspect for 20 seconds and also for fill-up group that has chemical setting in 3seconds then, application of light curing for 7 Seconds.

Cuspal deflection test:

A digital micrometer was used to obtain three inter-cuspal readings between two fixed reference points per tooth before composite application and also after 5 min from its application. The cuspal deflection values are represented by the discrepancies between the mean of the before and after readings.

Microleakage test:

Teeth of immediate group were immersed in 2% basic fuchsin dye and left undisturbed in dark place for 24h. The crown of each tooth was sectioned in mesio-distal direction into two halves, examined by stereomicroscope (Olympus SZ30, Stereo Zoom Microscope) at 25x magnification.

While for the delayed group teeth were stored in distilled water for six months at room temperature then immersed in dye, sectioned and examined in the same manner for immediate group.

Results:

Cuspal deflection test:

There was statistically significant cuspal deflection difference between groups after 5 min from composite application (p=0.001) shown on (Table 1)

Microleakage test:

Kruskal Wallis Test showed no significant difference between the main four groups regarding microleakage scored either immediately after composite restoration (p=0.595) shown in (Table 2) or after 6 months water storage following composite restoration (p=0.510) shown in (Table 3).

Wilcoxon signed rank test showed there was no statistically significant difference between all tested groups when comparing microleakage scores immediately after composite restoration and after 6 months water storage from composite restoration.

Spearman correlation showed no significant relationship between cuspal deflection after 5 min from composite restoration and microleakage immediately & after 6 month water storage for each tested material

Table (1): Cuspal deflection values among studied groups

Cuspal deflection	Filtek bulk fill group (n=10)	Fill-up bulk fill group (n=10)	Beautifil bulk fill group (n=10)	Filtek z350 group (n=10)	ANOVA test (p value)
Mean ± SD Min-Max	0.006±0.001 0.004-0.009	0.004±0.002 0.001-0.008	0.006±0.002 0.004-0.009	0.009±0.002 0.007-0.013	F=10.56 P≤0.001*
P1 value	-	0.185	0.318	≤0.001*	
P2 value	-	-	0.024*	≤0.001*	
P3 value	-	-	-	0.004*	

*F: ANOVA test, *significant p ≤0.05, In-between groups comparison were tested by post hoc LSD test P1: comparison between Filtek bulk fill group and other groups*
P2: comparison between Fill-up bulk fill group and other groups P3: comparison between Beautifil bulk fill group and other groups

Table (2): Immediate microleakage scores after composite restoration

Micro leakage scores	Filtek bulk fill group (n=10)	Fill-up bulk fill group (n=10)	Beautifil bulk fill group (n=10)	Filtek z350xt group (n=10)	Kruskil wallis test (p value)
Median (Min-Max)	1 (0-3)	1 (0-4)	1.5 (0-4)	2 (0-4)	KW=1.89 P=0.595
P1 value	-	0.585	0.532	0.188	
P2 value	-	-	0.907	0.394	
P3 value	-	-	-	0.463	

KW: Kruskil wallis test, In-between groups comparison were tested by Mann Whitney test P1: Compare Filtek bulk fill group vs other grouping.
P2: Compare Fill-up bulk fill group vs other grouping. P3: Compare Beautifil bulk fill group vs other grouping

Table (3): Microleakage scores after 6 months water storage

Micro leakage scores	Filtek bulk fill group (n=10)	Fill-up bulk fill group (n=10)	Beautifil bulk fill group (n=10)	Filtek z350 group (n=10)	Kruskil wallis test (p value)
Median (Min-Max)	2.5 (0-4)	2.5 (0-4)	3 (1-4)	3.5 (1-4)	KW=2.31 P=0.510
P1 value	-	0.727	0.531	0.159	
P2 value	-	-	0.814	0.304	
P3 value	-	-	-	0.323	

KW: Kruskil wallis test, In-between groups comparison were tested by Mann Whitney test P1: Comparison between Filtek bulk fill group and other groups
P2: Comparison between Fill-up bulk fill group and other groups P3: Comparison between Beautifil bulk fill group and other groups

Discussion:

The result of this study showed that all groups displayed cuspal deflection (an inward deflection) following completion of restoration.

Fill-up composite which is a dual cure bulk fill composite showed the first least mean cuspal deflection of the four tested groups with no significant difference between groups this may be related to decrease polymerization shrinkage stresses of dual cure composite due to its slow manner of polymerization reaction which start chemically.[7] Filtek bulk fill posterior restorative showed the second least mean cuspal deflection of the four tested groups with no significant difference between groups. These result may be due to incorporation of two novel methacrylate monomers in Filtek™ Bulk Fill Posterior Restorative that, in combination act to lower polymerization stress.[8] Beautifil Bulk Fill showed the highest cuspal deflection among other bulk fill types tested in the current study, that agree with study higher presented by Jlekh et al. This could be because other bulk fill composites materials investigated in this work contain polymerization modulators with a large molecular weight.[9]

The outcome of microleakage test of the current study showed no significant difference in microleakage result between all tested groups. This could be related to insignificant difference in polymerization shrinkage between tested materials despite the difference in the packing techniques and curing times. This is supported by Elshazly et al. Christoph Bourauel et al. who found insignificant difference in marginal leakage scores for the bulk resin composite compared to the conventional one.[10]

Long term storage of tested groups in distilled water for 6-months resulted in insignificant decrease in microleakage between the tested resin composites This agree with Behery et al.[11] who found that there was no significant difference between bulk fill and conventional resin composite when evaluating marginal seal after storage for six months. This also supported by Santos et al. who proved that 6 months of water storage does not cause significant bonding degradation for both the silorane and methacrylate restorative systems.[12]

Conclusion:

Within the limitations of the current investigation, the following conclusions can be drawn:

- Bulk fill resin composites, investigated in this study, decreased cuspal deflection than incrementally applied resin composite.
- None of the tested restorative system yielded gap free restoration.

Aging of bulk fill or incremental resin composite restorations for six months doesn't affect microleakage.

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