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Evaluation Of Fracture Resistance Of Premolars Restored With Different Restorative Technique With Decoupling In Class II Composites Restorations

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***Abstract**:*

Background and aim : *To analyse the outcome of decoupling technique by comparing and evaluating the fracture resistance in Class II (Mesio-occluso-distal [MOD]) composite restoration .*

Methods and materials : *The present study was conducted using 60 extracted premolars, 10 for each group of restorative material and technique. Class II (MOD) cavities were prepared maintaining uniform dimensions and samples were divided into six groups randomly (*n *= 10 each)*

Group 1 (positive control) – Intact teeth ,

Group 2 (negative control)- Premolar teeth with unfilled MOD cavity.

Group 3 - Teeth restored with Universal Restorative Composite (3MFiltek Z350) by incremental layering technique without decoupling.

Group 4- Teeth restored with Universal Restorative Composite (3MFiltek Z350) after decoupling with flowable composite (3MFiltek Z350 XT) for 5 minutes.

Group 5- composite layering technique using Universal Restorative Composite (3MFiltek Z350) after decoupling with glass fibre (Interlig,Angelus) for 5 minutes.

Group 6 – Teeth restored with Bulk Fill Composite (tetric bulk flow) after decoupling with glass fiber (Interlig Angelus) for 5 minutes.

Results : *Decoupling technique significantly increased the fracture resistance. The highest fracture resistance was shown by Group 1- 1569.30N followed by Group 6 - 1421.30N. group 5 1395.80N , group 4- 1141.04N and 3- 981.92N . Group-2 showed the least mean fracture resistance of 845.50 N .*

Conclusion : *Decoupling with fibre in composite restorations significantly increased the fracture resistance among both the groups restored with composite layering technique and bulk fill technique. Decoupled class 2 restoration showed higher fracture resistance when compared to class 2 restorations without decoupling.*

Clinical significance: *This study confirms that decoupling with flowable composites or fiber reinforced composites reduces the adverse effects of polymerization shrinkage. This technique can be integrated into routine clinical practice to enhance the longevity , greater marginal adaptation and reduce the polymerization shrinkage stress , potentially reducing the failure rates of composite restorations .*

Keywords: *decoupling technique, polymerization shrinkage, fibre reinforced composites. class 2 composite restoration*

Introduction

Dental composites are extensively used in restorative procedures owing to their advantageous properties such as conservative approach, commendable strength and pleasing aesthetics yet they have the highest failure rates . This is due to the intrinsic property of composites that is polymerization shrinkage.(1)To minimize polymerization shrinkage innovative methods like decoupling technique , layering techniques , use of diverse curing modes have been implemented . (2) Failure to address polymerization shrinkage may result in post operative complications like sensitivity , pain , discolouration and poor marginal integrity .

As per the decoupling procedure, it is recommended to maintain the first increments to a minimum thickness of less than 2mm for a specific duration of 5 to 30 minutes in order to decrease the stress of polymerization on the forming dentine bond of the hybrid layer.(3) Before the hybrid layer is fully developed and strong, the coupling of deep dentine to enamel or superficial dentine cannot occur due to its small thickness. Decoupling is a procedure that neutralizes the bondability hierarchy. According to the hierarchy of bondability, when a comoposite is polymerized, it contracts towards the mineralized and dry walls and expands away from the organic and wet ones. (3)

Therefore, the purpose of this study is to compare and evaluate the fracture resistance of class 2 composite restorations restored using decoupling technique.

Materials and methods

The present study was conducted using 60 extracted premolars(n=10) .Teeth were stored in normal saline solution and were used within 2 weeks after extraction. .Freshly extracted premolar teeth were included in study. Premolar teeth with carious lesion, restoration, severe attrition, erosion, fractures, cracks and with developmental defects were excluded from the study.

Figure : 1 – Materials used for the study .

Tooth preparation

The width of the MOD cavity was half of the intercuspal length and one-third of the mesiodistal length, and it was formed on every tooth except for the positive control group (group 1). Four millimeters from the central pit was the norm for the cavity depth. One millimeter above the cemento-enamel junction marked the cervical boundaries of the proximal box cavities for every specimen. in conjunction with a water-cooled, high-speed handpiece and a straight fissure diamond point bur (FG 109 009, Horico, Germany).

Figure : 2 – Class 2 MOD cavity preparation on premolar .

Restorative procedure

All the prepared teeth were randomly divided into 6 groups, 10 specimen in each group (n =10) .Before restorative procedures, each specimen was mounted with teeth on either side for the stability and seating of the metal matrix bands (Palodent V3 sectional matrix system, Dentsply) to build up the proximal walls. After 20 seconds of acid etching using 37% phosphoric acid (Prime etching gel), a 10-second washing with water, and then air drying, all of the cavities were finished. The specimens were bonded using 3M ESPE Triple Bond Universal Adhesive according to the manufacturer's directions and then cured for 20 seconds under an Ivoclar Bluephase Curing Light, an LED curing light. Next, each sample was returned to its original group.

Group 1 (positive control) – Intact teeth

Group 2 (negative control)- Premolar teeth with unfilled MOD cavity.

Group 3 - Teeth restored with Universal Restorative Composite (3MFiltek Z350) by incremental layering technique without decoupling.

Group 4- Teeth restored with Universal Restorative Composite (3MFiltek Z350) after decoupling with flowable composite (3MFiltek Z350 XT) for 5 minutes.

Group 5- Teeth restored with composite layering technique using Universal Restorative Composite (3MFiltek Z350) after decoupling with polyethylene fibre (Interlig,Angelus) for 5 minutes.

Group 6 – Teeth restored with Bulk Fill Composite (tetric bulk flow) after decoupling with polyethylene fiber (Interlig Angelus) for 5 minutes.

Restorative groups

Groups	Method
Group 1 (positive control)	**Intact teeth**
Group 2 (negative control)	**MOD cavity (Unrestored)**
Group 3	**Class 2 composite restoration**
Group 4	**Class 2 composite restoration with decoupling**
Group 5	**Decoupling with fibre using composite layering technique in class 2 restoration**
Group 6	**Decoupling with fibre using bulk fill technique in class 2 restoration.**

FRACTURE RESISTANCE

The samples were tested for their resistance to fracture at an oblique angle of 45 degrees using a Universal Testing Machine. The reconstructed teeth's buccal cusps, where the enamel and composite filling meet, were subjected to a compressive force at a crosshead speed of 0.5 mm/min until a fracture was seen. After recording the maximum load in kilograms, the fracture resistance was converted to Newtons.

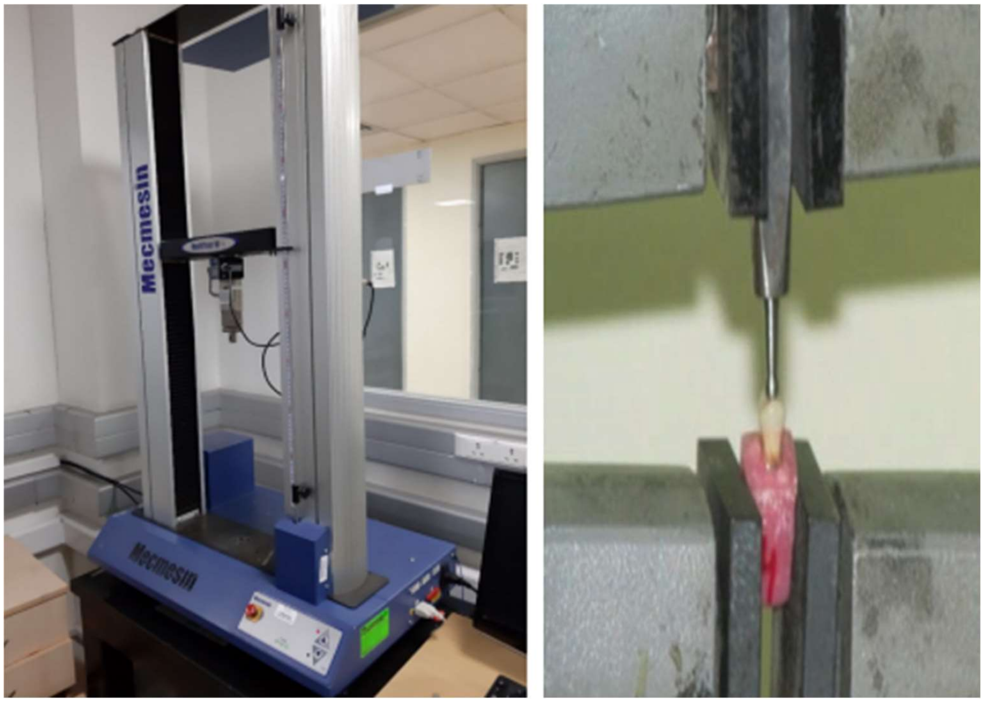


Figure : 3 – Universal testing machine used for testing Fracture Resistance .

Statistical analysis

Mean (± standard deviation) was calculated for each group. A one-way analysis of variance and Tukey's post hoc honestly significant difference test were used to analyse the data at a 95% significance level.

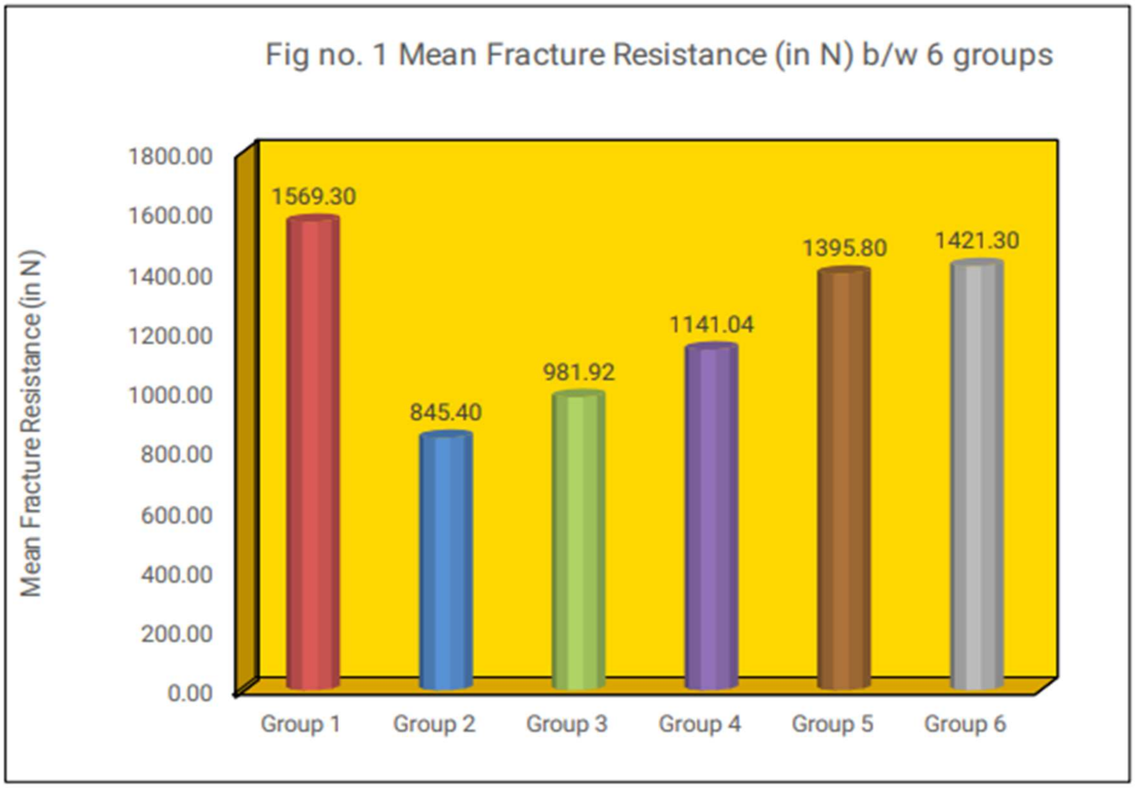
Results

The test result showed the mean Fracture resistance for Group 1 was 1569.30 ± 155.85, Group 2 was 845.40 ± 46.61, Group 3 was 981.92 ± 59.11, Group 4 was 1141.04 ± 75.90, Group 5 was 1395.80 ± 51.89 and Group 6 was 1421.30 ± 37.73. The difference in the mean fracture resistance between 6 groups was statistically significant at p<0.001

Comparison of mean Fracture Resistance (in N) b/w 6 groups using One-way ANOVA Test						
Groups	N	Mean	SD	Mi	Max	p-value
Group 1	10	1569.30	155.85	1271	1711	<0.001*
Group 2	10	845.40	46.61	779	904	
Group 3	10	981.92	59.11	898	1069	
Group 4	10	1141.04	75.90	1016	1274	
Group 5	10	1395.80	51.89	1348	1490	
Group 6	10	1421.30	37.73	1365	1481	

* - Statistically Significant

Note: Group 1 – Intact teeth group; Group 2 – Decoupled Class 2 group, Group 3 – MOD cavity group, Group 4 – Decoupled with fibre Incremental group, Group 5 – Normal Class 2 group & Group 6 - Decoupled with fibre bulk fill group



Graph: 1 - Depicting mean fracture resistance and standard deviation of specimens

Discussion

According to the decoupling method, the hybrid layer's forming dentin bond should be subjected to as little polymerization shrinkage stress as possible for at least five to thirty minutes by maintaining initial increments of no more than two millimeters in thickness. The connection of deep dentin to enamel or superficial dentin cannot occur until the hybrid layer is almost fully developed and strong enough, which is prevented by its minimum thickness. (3) . In this current study decoupling technique was carried out for 5 mins which ultimately showed significant increase in mean fracture resistances.

Premolars were specifically chosen for investigation due to their heightened vulnerability to cusp fractures attributable to unfavourable anatomical features such as shape, crown-root ratio and volume. (7) Among the experimental groups intact teeth (positive control) demonstrated the highest mean fracture resistance values while unrestored teeth (negative control) exhibited the lowest.This observation is consistent with prior research findings , which suggest that the absence of restoration correlates with diminished fracture resistance . (8,9) The proposed mechanism underlying this phenomenon involves the application of load onto unrestored teeth generating a wedging effect between the buccal and palatal cusps.(2) This phenomenon ultimately compromises fracture resistance and increases the likelihood of more catastrophic tooth fracture.

The dentin connection achieves 90% of its potential strength within 5 minutes, according to a research conducted by Lu et al. in 2004. Before performing a direct restoration, it is important to provide the dentin bond at least 5 minutes to grow in a stress-free environment. This will give the hybrid layer enough time to mature. (4)

This may explain why, compared to regular class 2 restorations, those that were decoupled from flowable composite for 5 minutes exhibited greater fracture resistance. Fracture resistance was much greater in the groups who underwent restoration using the fiber insert approach compared to the other methods. The reason for this is the efficient transmission of stress from the polymer matrix to the fibers.

In addition to preventing cracks from spreading, the fibers maintain the surface composite layer. (10)

The restoration/adhesive interface's stress dynamics are altered by interlig fiber. (6)

When fibers are used to replace a portion of the composite, the total volumetric contraction and shrinkage stress are reduced.

A splinting effect is exerted on the proximal walls by the buccal-lingual fiber orientation, which is perpendicular to the direction of the applied force, to avoid cusp separation when subjected to occlusal pressure. (10)

The nanocomposites, whether put incrementally or in bulk, exhibited high values for fracture resistance. Five, there was no discernible difference between the two sets of data ($P > 0.05$). Both nanocomposites include nanomer and nanocluster filler particles, which is why this happens. (12)

Nanoclusters are loosely bonded agglomerates of nano-sized particles (zirconia/silica), whereas nanomers are distinct nanoagglomerated particles (20 nm-75 nm) in size. (13) This synergy increases filler loading by decreasing the interstitial gap between the filler particles. Their increased resistance to fracture is evidence of this. (11, 13)

CONCLUSION

- Results from this research show that both the composite layering method and bulk fill technique groups showed a substantial improvement in fracture resistance after decoupling with fiber in composite restorations.
- Decoupled class 2 restoration showed higher fracture resistance when compared to class 2 restorations without decoupling.
- The group with intact teeth (the positive control) had the greatest mean fracture resistance, whereas the group with mod cavity unrestored teeth (the negative control) exhibited the lowest.

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