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Comparative Evaluation Of Push-Out Bond Strength And Type Of Failure Between Bulk Fill And Conventional Composite With And Without Pressure Change - An In Vitro Study

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I. Aim-

The aim of the present study was to compare the push out bond strength and type of failure between bulk fill and conventional composite with and without pressure change.

For this in-vitro study, 40 caries free molars were obtained from the Department of Oral and Maxillofacial Surgery, Shri J.N. Kapoor D.A.V. (c) Dental College an Hospital, Yamunanagar. Soft tissues and hard aggregations were removed by scaling with ultrasonic scaler. The teeth were stored in distilled water till further use. All the molars were flattened on their occlusal surface to create an occlusal plain perpendicular to the axial axis. Class I cavities with depth 4mm and diameter 5mm were prepared on the occlusal surface of molars with the help of an airotor.

In order to compare the bond strength the teeth were randomly divided into 2 groups namely Group I and Group II of 20 teeth each

Group I was subdivided into two subgroups of 10 each and restored.

This group was not be subjected to pressure change.

Group Ia (n=10) - Restored with Tetric –N- Ceramic Bulk Fill

Group Ib (n=10) - Restored with Tetric N-Ceram Incremental

Group II was also subdivided in two sub groups of 10 teeth and restored. This group was subjected to pressure change.

Group IIa (n=10) - Restored with Tetric –N- Ceram Bulk Fill

Group IIb (n=10) - Restored with Tetric N-Ceram Incremental

All the specimen were prepared at room temperature (21^{o}C) and a relative humidity of 50-60%; they were then stored for 24hours in distilled water at 37^{0}C in an oven, maintaining an intra-pulpal pressure of 15mm/Hg.

All the samples in Group IIa and Group IIb were subjected to pressure change by placing them in a pressure chamber. Compressed air was introduced into the pressure pot at a rate of 1 atmosphere/min, allowing the maximum pressure to be reached in 3 min. The samples in the pressure chamber were subjected to 3 atmospheres pressure for 3 min and then decompressed over a 3 min period. The 15 cycles were repeated one after the other. **The samples in Group Ia and Group Ib were not be subjected to pressure change.**

Each specimen was sectioned perpendicular to the long axis using a diamond blade which is water cooled The occlusal slice, corresponding to occlusal enamel, was cut and discarded, and 1 mm slices of superficial and deep dentin will be marked and kept humid until their assessment with the push out test.

To assess the bond strength of restoration, the specimens were placed within a centralizing ring to ensure a centered application of the load, resting on another ring, with a central holes slightly larger than the restoration diameter. The load will be applied on the apical-coronal direction using punch tip, which passed through a guide cylinder to ensure a centered load application. The test was performed under a Universal testing machine.

Fractured slices will be carefully removed and observed under an stereomicroscope at 20x to categorize the type of failure as follows:

Type I: Adhesive failure between resin composite and dentin.

Type II: Cohesive resin fracture.

Type III: Mixed fracture: pressure of fragments of dentinal tissue or resin composite adhered to the interface.

Type IV: Cohesive dentin fracture .

In the present study the push-out bond strength was found to be more when incremental technique was used as compared to bulk fill technique in both groups i.e. with and without pressure change. The maximum push out bond strength was observed in **Group IV** (Incremental with pressure change) with **125.56Mpa** and the minimum in **Group I** (bulk fill without pressure change) with **70.10Mpa**.

The possible explanation may be due to the lower degree of conversion which plays a very important role in the polymerization. It causes an increase in the amount of released unreacted monomer, leading to less biocompatible restorations. Inadequate polymerization might lead to marginal microleakage, discoloration, and decreased bonding strength. In addition, uncured functional groups can acts as plasticized, producing restorations with inferior, mechanical properties. Adequate polymerization all over composite resin restorations is one of the main important factors influencing their clinical success. The degree of conversion is an important tool to estimate the physical, mechanical and biological properties of composite resin restorations. Higher degree of polymerization is an essential factor for obtaining superior physical and mechanical properties.

When the push-out bond strength was compared in Tetric-N-Ceram Incremental group, the push-out bond strength was more in with **Group IIb** i.e. Tetric-N-Ceram Incremental with pressure change than as compared to **Group Ib** i.e. Tetric-N-Ceram Incremental without pressure change.

In the present study where the samples were subjected to pressure chamber in Group II and Group IV, the push-out bond strength was **87.11Mpa** in **Group II** and **125.56Mpa** in **Group IV**. The increase in bond strength may be because of the greater degree of conversion of incremental as compared to bulk fill as discussed earlier.

However, when compared between groups with pressure change (Group II and Group IV) and without pressure change (Group I and group III), the push out bond strength was more in groups subjected to pressure change **(87.11Mpa** in **Group II** and **125.56Mpa** in **Group IV)** as compared to group not subjected to pressure change (group I with 70.10Mpa and Group III with 102.28).

The increase in the push-out bond strength in the group subjected to pressure change may be because of increase in the degree of conversion and remaining monomer. As discussed earlier, adhesive with higher degree of conversion demonstrated greater microshear bond strength value.

When comparing the type of failure, the maximum failure were of Type III i.e. mixed fracture: (fragments of dentinal tissue or composite adhered to the interface) and minimum failure was of Type IV, i.e. cohesive type of failure of the restoration.

When comparing with and without pressure change in bulk fill group and incremental group, the maximum failure were observed with Type III (mixed fracture) failure and the minimum was Type IV (cohesive dentine fracture). Similarly in incremental with and without pressure change maximum failure was Type III and minimum was Type I and Type IV.

When comparing pressure Group II and Group IV i.e. bulk fill and incremental with pressure change, the maximum failure in Group II was Type III with 60% and minimum was Type IV and Type II with 0%, where as Group IV the maximum failure was Type II 40% followed by Type I,III,IV 20% each.

The mixed type of failure could be because of proper adaptation of the materials to cavity walls without void formation owing to its fluctuating viscosity combined with low shrinkage and contraction stress upon curing of composite. Moreover, studies showed that low contraction stress reduced the possibility of the composite pulling away from the tooth surface during polymerization with subsequently low cuspal deflection.

Cohesive type of failure as observed in various groups except Group II may be due to the incorporation of voids or contamination between composite layers. Voids developed from resin porosity contain oxygen and form polymerization inhibiting zone resulting in bond failures between increments.