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Comparitive Evaluation of the Fracture Resistance Of Three Different Bulkfill Composite Resins In Class Ii Mesio-Occlusal Distal Cavities: An In Vitro Study

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ABSTRACT

Background: Because to the anatomically vulnerable shape of premolars and the problem of micro leakage caused by composite restoration at the gingival margin of the proximal boxes, Class II MOD cavities in maxillary premolars present a challenge for the restoration material in terms of fracture resistance. To increase strength and resistance, as well as to reduce polymerization shrinkage and improve cure depth, bulk-fill composite was invented.

Aim: This study aims to evaluate and compare the fracture resistance of maxillary premolars with Class II mesio-occlusal distal (MOD) cavities restored with Aura bulkfill (SDI), Beautiful bulk (Shofu) and Tetric n ceran (Ivoclar) bulk fill composite systems.

Materials and Methods: Total of 30 intact upper premolars were divided into three groups of 10 each. Teeth were prepared in the form of class II MOD cavity and restored accordingly: group I restored with Aura bulkfill (SDI), group ii restored with Beautiful bulk (Shofu) and group iii restored with Tetric n ceran (Ivoclar) bulk fill composite systems. Fracture resistance test was done using Universal Testing Machine. Fracture resistance was measured in Newton (N).

Results: ANOVA test resulted no significant differences ($p > 0.05$) in all experimental groups. However, resin composite Tetric n ceran bulk-fill has a higher fracture resistance (498 N) compared to other groups, Aura bulk fill (423N) and Beautiful bulk (344N).

Conclusion: Among the experimental groups, Tetric n ceran bulkfill composite (Ivoclar) showed the highest fracture resistance.

Keywords: Bulk-fill composite, Fracture resistance, premolars.

INTRODUCTION

One of the largest problems in dentistry is restoring severely damaged teeth. On the molecular level, several studies and developments are taking place to the evolution of composites with improved properties by overcoming drawbacks including polymerization shrinkage, microleakage, water sorption, and method sensitivity.

A cavity that affects a tooth's mesial, occlusal, and distal surfaces is classified as a MOD class II cavity. With MOD class II composite resin restorations, microleakage near the gingival border of proximal boxes is one of the main issues. This has to do with the lack of enamel at gingival borders, which makes the cementum-dentine substrate for bonding less robust. Dentine's organic and humid makeup makes bonding challenging, which in turn compromises the restoration materials' ability to adapt.[1]The anatomical configuration of posterior teeth, especially maxillary premolars, makes them more prone to cuspal fractures when subjected to occlusal force during chewing. Maxillary premolars with class II MOD cavities present a unique challenge for the restoration material in terms of durability and fracture resistance. Thus, a restorative material for posterior teeth that can withstand breakage and withstand high occlusal pressure is required.[2]

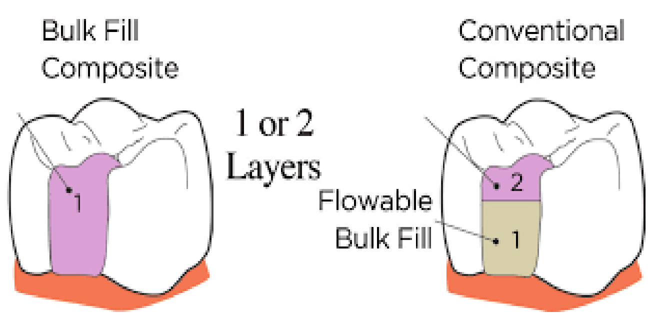
Dental composites face the well-known restoration difficulty of polymerization shrinkage. The contraction stress on cavity walls and the gap creation at the tooth restoration interface could be caused by the shrinking. The surrounding tooth structure would then distort as a result of this gap, resulting in microcracks that make the tooth more prone to fracture. 4 One approach for reducing polymerization shrinkage is the incremental placement technique. The two main limitations of this, particularly in large spaces, were the potential for trapping gaps between layers and the length of time required to place the restorative. For this reason, bulk-fill composite resin materials were developed since they speed up the healing process by minimising the number of clinical steps required.[3]

The clinical benefits of bulk-fill composites include low polymerization shrinkage, a high depth of curing (up to 4 mm), reduced porosity, uniform consistency, and reduced cost and time for the patient. 5 Particularly in a deep restoration, bulk-fill composites typically have a greater filler percentage and a modified initiator system to ensure better curing. Bulk-fill composites have also undergone a number of advancements to maximise their benefits, including the modification of the monomers, the use of specialised repair placement tools, and the addition of fibre includes reinforcement.[4]

Aura Bulk Fill (SDI) has low volumetric shrinkage, it delivers reduced stress to provide long-lasting restorations. It has also excellent flexural strength. Aura Bulk Fill resists major deformations without fracturing. Aura Bulk Fill resists the good amount forces of compression in the mouth.

Beautifil-Bulk is a light-cured, bioactive direct resin composite developed for faster, easier and simpler restoration with one single increment of up to 4mm. Deep cure, little polymerization shrinkage stress, perfect physical qualities with outstanding shade match, and all-around fluoride protection are provided by a special balance of resin with novel monomers and fillers.

Tetric N-Ceram Bulk Fill yields aesthetic outcomes that, in every way, can be compared to those of traditional composites. The proprietary photo-initiator Ivocerin is primarily responsible for achieving the 4 mm cure depth. The polymerization booster Ivocerin is resulting more reactive than traditional initiators. Even in deep cavities, it can be safely cured in brief polymerization periods.



MATERIALS &METHODS

30 upper first and second premolars served as study samples. Fresh, unaltered, individual human upper premolars that were free of cavities and had not had any restorations removed due to orthodontic treatment or mobility were the selection criteria.Excluded from the study were teeth having open apices, resorption, prior restorations, or any anatomical abnormality.

The 30 healthy upper premolars were scaled and kept in saline solution after cleaning. According to the type of restoration material used, samples were randomly split into three groups of 10 teeth each, and they were mounted on acrylic blocks for the preparation and restoration processes.

- Group I: Class II MOD cavity restored with Aura bulk fill (SDI)
- Group II: Class II MOD cavity restored with Beautifil bulk (Shofu)
- Group III: Class II MOD cavity restored with Tetric N Ceram (Ivoclar)

Fig 1 : Three bulkfill composites

With a high-speed water-cooled hand piece, standardised MOD cavities were created using a tungsten carbide straight fissure bur. The bur was replaced following each ten cavity preparations. The measurements were 2 mm± 0.2 mm for the pulpal width, 1.5 mm± 0.2 mm for the gingival width, and 2 mm ± 0.2 mm for the buccolingual width. The occlusal segment's lingual and facial walls were prepared parallel to one another, with the cavosurface angle set at 90 degrees.

Fig 2 : Cavity preparation mesial view Fig 3 : Cavity preparation occlusal view

With the use of a microbrush, the cavities were acid etched for 15 seconds before being rinsed with water and allowed to air dry. The tooth's structural moisture was preserved. The prepared cavity surfaces were then lightly air-dried and microbrushed with a bonding agent for 10 seconds. The polymerization process was carried out using an LED light curing equipment for 20 seconds.

The bulk-fill composite was then positioned at a thickness of 4 mm, measured with a probe, and allowed to cure for 20 seconds, depending on the group type.

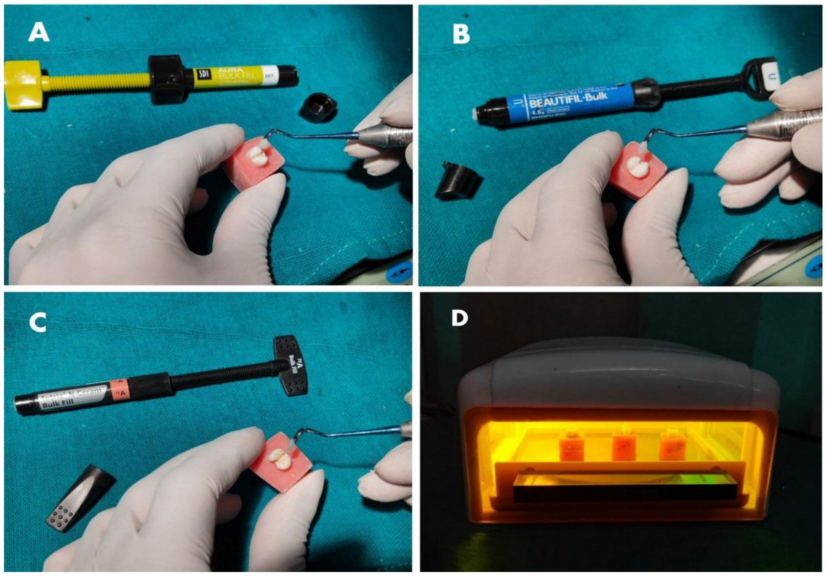


Fig 4 : Aura bulkfill placement (A), Beautifil bulk placement (B), Tetric N Ceram placement (C), Light curing (D)

Polishing and finalising

The specimens were polished with a silicone bur after being finished with a fine finishing diamond bur to eliminate extra composites.

Storage of Water and Thermocycling

All of the repaired specimens underwent 500 cycles of thermocycling at 5°C and 55°C with a dwell time of 20 seconds and a transfer time of 5 seconds after being placed in a container filled with saline solution for 24 hours.

Pressure test

Using an electronic system universal testing machine, the samples were put under a compressive force at a cross-head speed of 1 millimetre per minute. The tooth's core was drilled and a specially designed metal pin was inserted to apply compression loading. For each group, the mean of the force needed to cause fracture was computed in Newtons (N).

Fig 5: Pressure test

Analysis of Data

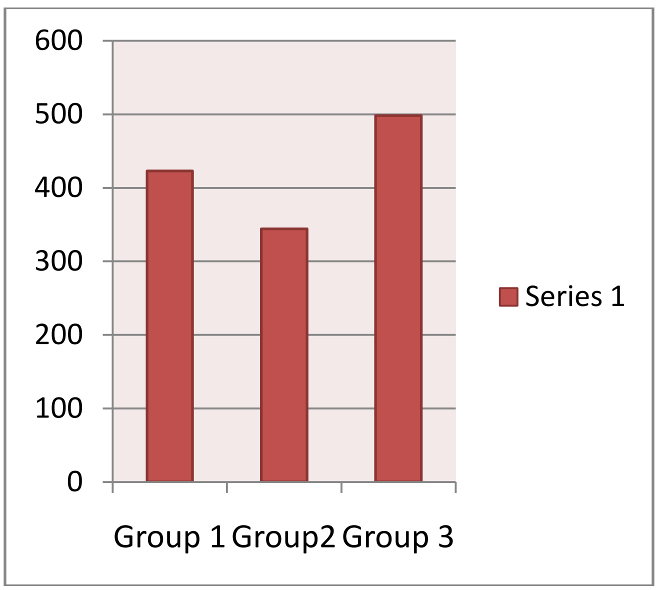
To determine whether there were any differences between groups, the data were statistically analysed using one-way ANOVA with a confidence level of 95% and a significance level of = 0.05.

RESULTS

The mean value of fracture resistance for Group III (Tetric N Ceram-Ivoclar) was 498 ± 64.41 N, followed by Group I (Aura bulk fill-SDI) at 423 ± 52.58 N and Group II (Beautifil bulk fill-Shofu) at 344 ± 66.89 N.

Table 1: The ANOVA results of mean value ± standard deviation of fracture resistance in groups I to III

Group	Fractureresistance (Newton) x ± SD	p value
I. Aura bulk fill (SDI)	423 ± 52.58	0.151
II. Beautifil bulk fill (SHOFU)	344 ± 66.89	0.151
III. Tetric N Ceram (Ivoclar)	498 ± 64.41	0.151



Graph 1: Mean value of the fracture resistance of bulk-fill composites

DISCUSSION

This study looked at the resistance to fracture of maxillary first premolars, which have a propensity for cusp separation during mastication due to their anatomical form. This type of tooth has inclines that are significantly higher than those in maxillary molars, which can cause a different pattern of fracture resistance for these teeth. Moreover, it has been noted that maxillary premolars experience more fractures than mandibular premolars.

The study showed that Tetric N Ceram bulk fill (Ivoclar) had the highest fracture resistance compared to other bulk-fill composites. A fracture is an entire or partial break in a material brought on by the use of excessive force. The prevention of the crackpropagation is directly correlated with fracture resistance. Cusps tend to be deflected by masticatory forces, although composites lessen the deformation of the cusps under masticatory pressure.[5]

Different composites' strengths may change because to variances in the chemical makeup of their matrix, filler content, filler size, and other factors. Hence, an increase in compressive strength and surface hardness is directly proportional to a reduction in size and an increase in filler volume.[6]The physical and handling characteristics of composites are improved by high filler loading, and novel adhesive materials not only seal the margin but also improve retention and durability characteristics of the repaired tooth. Current advances in nanofiller technology result in high filler loading, which raises compressive and flexural strengths. These fillers are nanometric and impregnated in nanoclusters.[7]

By regulating the shape and variety of the sampling teeth, Jefferson et al. conducted a fracture endurance research on premolars. With a microscope, the teeth were examined to confirm that the Samples were free of cracks and cavities. Cusp variation, premolar position, and size of the upper teeth were not controlled in our study. The risk of microcrack, which was previously possible, was not controlled because samples were not examined under a microscope.[8]

The highest fracture resistance value of Tetric N Ceram bulk fill (Ivoclar) in this study may be due to the combination of resin matrix, short e-glass fiber filler, and an organic filler in its composition. The short fiber composite resin has also proved to maintain the polymerization shrinkage stress by fiber orientation, and thus, reducing marginal microleakage. The ultra high density glass filler provides a high strength interface that can withstand high compressive forces.

Giomer (glass ionomer+ polymer) is the particle found in Beautifil-Bulk. This new particle has been introduced as a genuine glass ionomer and composite resin hybrid. The giomer has the advantages of each parent substance while whileminimising their individual drawbacks.The resin matrix of this particle incorporates filler particles made of surface-pre-reacted glass ionomer (S-PRG). The nanoparticles in the nanohybrid and nanofill, on the other hand, exhibited strong inter- or inter-material bonds due to their high surface free energies. This quality improves the mechanical and physical qualities.

Fahad recommended covering the root surface of the teeth with aluminium foil up to 2 mm below the cemento-enamel juncture to mimic the periodontal condition. in his study on fracture resistance on weak premolars.[9]Similar to this, Franca et al. measured the average thickness of the periodontal ligament by dipping the root surface into molten wax to a depth of 2 mm below the cementoenamel junction (CEJ).[10]

CONCLUSION

Within the limitations of this study, maximum fracture resistance is shown by the Tetric N Ceram bulk fill composite.

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