(International Print/Online Journal)

SJIF IMPACT FACTOR: 4.617
PUBMED-National Library of Medicine ID-101739732

ISSN (Print): 2209-2870
ISSN (Online): 2209-2862

International Journal of Medical Science and Current Research (IJMSCR)
Available online at: www.ijmscr.com
Volume 2, Issue 5, Page No: 112-116
September-October 2019

IJMSCR

Evaluation of Fracture Resistance of Endodontically Treated Teeth Restored With Nanohybrid Composite Using Incremental and Bulk Fill Placement Techniques-An In Vitro Study

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Type of Publication: Original Research Paper
Conflicts of Interest: Nil

ABSTRACT

Aims:
To evaluate the fracture resistance of endodontically treated teeth restored with conventional incremental and new bulk fill placement technique of nanohybrid composites in mesio-occlusal-distal cavities.

Methods and Material:
Sixty extracted human maxillary premolars were selected. Twenty intact teeth served as positive controls(Group A). Endodontic therapy was done in remaining 40 teeth.MOD cavities were prepared in all the teeth with standardised dimensions and were randomly divided into two groups (Group B-bulk placement of nanohybrid composite, Group C-Incremental placement of nanohybrid composite). Restorations were done for both the groups. Fracture resistance was measured by Instron universal testing machine.

Statistical analysis used:
One- way anova test and Tukey's post hoc test.

Results:
Highest fracture resistance was shown by intact teeth group(822.92±399.2 N).There was no statistically significant difference seen in between the incrementally placed and bulk fill nanohybrid composites(P>0.05).

Conclusion:
High-viscosity bulk-fill nanocomposite displayed fracture resistance values similar to incrementally placed nanocomposite in endodontically treated teeth.

Keywords: Bulk fill; fracture resistance; mesio-occlusal-distal cavity; nanohybrid, root filled teeth.

INTRODUCTION

One of the criteria for successful root canal treatment is the restoration of root canal-treated teeth with a permanent, definitive post endodontic restoration as these teeth are considered more susceptible to fracture. Fracture of root canal treated teeth occurs due to the loss of dentin after the endodontic procedures and also due to the removal of important anatomic structures such as cusps, ridges, and the arched roof of the pulp chamber. Final restoration of root canal treated teeth reestablishes aesthetics and functions, preserves the remaining tooth structure, and prevents microleakage.[1-4]

Vale experiment has proved that fracture resistance of a tooth reduces when the marginal ridges are involved in cavity preparation and intercuspal distance is increased.[5] The advent of adhesive resin technology has had a significant role in improving fracture resistance of tooth as the resin bonds to the tooth surface and reinforces the tooth structure.[6] Nanohybrid composites are considered to be the gold standard among tooth colored restorations.[7]

Amongst the various placement techniques for composites in the prepared cavity, the incremental layering technique is commonly recommended. However the recent advanced bulk fill composites

can be placed in a single increment of upto 4 mm thickness reducing the clinical time spent on a restoration compared with conventional incremental placement of composite resin and also reduction in polymerization shrinkage.[6,8]

The aim of this study was therefore to evaluate the fracture resistance of endodontically treated teeth restored with long practiced incremental placement technique and new bulk fill technique of the nanohybrid composites.

MATERIALS AND METHODS:

Sixty extracted human maxillary premolar teeth which were approximately the same size and were free of caries, restorations, fracture or any anatomical variations were included in the study. All the soft tissues and debris on the teeth were removed using an ultrasonic scaler and the teeth were stored in saline at room temperature. The teeth were randomly divided into three experimental groups of 20 teeth each and then subjected to the following procedures.

- Group A :Normal intact teeth (n=20)
- Group B: Bulk placement of nanohybrid composite resin (Tetric N ceram Bulk fill,Ivoclar)
- Group C: Incremental placement of nanohybrid composite resin (Tetric N-ceram,Ivoclar)

Root canal treatment and MOD cavitiy restoration for group B and group C**:**

In 40 teeth standard endodontic access cavities were prepared using round bur (BR-45) with airotor hand piece. The root canals were instrumented 1mm short of the apical foramen with K-files (Mani,Inc, Tochigi, Japan) up to an apical size of 35 using the step back technique. By using the Gate Glidden drill of sizes #1, #2, #3, the coronal third of the root canals were flared. Normal saline was used as an irrigating solution and then obturated with Gutta percha (SPI Dental Mfg. Inc., Inchon, Korea) and Zinc Oxide Eugenol sealer using lateral condensation technique.And the orifices were restored with glass ionomer cement.

Mesio-Occlusal-Distal (MOD) cavities were prepared in all the specimens using an airotor handpiece with a No. 245 straight bur so that the buccolingual width of the occlusal isthmus were 1/3rd the width of intercuspal distance. Dimension of the MOD cavities were standardized by keeping the pulpal depth of 2±0.2mm, buccal and lingual wall thickness of 2.5 ±0.2mm from the height of contour of each surfaces and the gingival cavosurface margin were kept 1.5mm coronal to the cement enamel junction. Subsequently the teeth were then divided into group B and group C. A universal tofflemire matrix band and retainer were applied before each restorative procedure.

Group B: Bulk placement of nanohybrid composite resin (tetric n ceram,ivoclar)

Cavities were etched using 37% phosphoric acid for 15 seconds and then rinsed and dried. Then single bond universal adhesive (3M ESPE) was applied and light cured. Then the cavities were filled with a single increment of bulk fill composite (Ivoclar) and light cured from buccal, lingual and occlusal direction each of 20 seconds.

Group C: Incremental placement of nanohybrid composite resin (tetric n-ceram,ivoclar)

The same procedures of etching and bonding in group B were done and then light cured. Then the proximal boxes were restored first using horizontal and oblique increments of 2 mm thickness each and then occlusal component was restored using two oblique increment and then light cured for 20 sec from the occlusal direction.

After removing the matrix band from the tooth specimen all the 40 teeth restored with composite were once again light cured for 20 sec from buccal and lingual aspect of the preparations. After 15 minutes, the restorations were finished and polished using (shofu) composite polishing kit. The specimens were then stored in an incubator at 37ºC for 3 days. To stimulate the periodontal ligament and alveolar bone,the root surface of each tooth specimen were wrapped with aluminum foil and mounted in a block of cold cure acrylic resin up to 1.5mm apical to cementoenamel junction.

Mechanical Test:

The mounted teeth were placed on the lower holder of the Instron universal testing machine. The upper part of the machine holds the metal intender of round tip with a diameter of 5 mm. The tip was placed in the inclines of the buccal and lingual cusps and

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subjected to slowly increasing force of 1mm/min vertically down the long axis of the tooth until the tooth fractured. The force required to fracture each tooth was recorded in Newtons (N).

Statistical analysis:

Mean(± standard deviation) was calculated for each group. Data was carried out using anova test and Tukeys post hoc honestly significant difference test at a 95% significance level.

RESULTS:

The results of the current study are summarized in the table 2. Normal intact tooth (822.92±399.2N) and group C (630. 85 ±143.8N) showed the highest and the lowest values of fracture resistance respectively. No significant difference in fracture resistance were observed between group B (752.11±135.4*N*) and group C (630.85±143.8N).

DISCUSSION:

Root canal treatment is deemed incomplete until the permanent restoration is in place.[7] Numerous studies have been conducted to determine the ideal method to restore endodontically treated teeth as these teeth have decreased fracture resistance due to the loss of tooth structure during endodontic access cavity preparation procedures.[1]

Different restorative materials have been suggested for restoration of root canal treated teeth. Silver amalgam and Composite resins are the most commonly used materials to restore the access cavity. Composite restorations are recommended as they adhere to enamel and dentin and also reinforce the remaining tooth structure.[9] Endodontic procedures have only a small effect on tooth rigidity, resulting in reduction of relative tooth rigidity by 5% which is contributed entirely by the loss of tooth structure due to access cavity preparation. When caries extend to the marginal ridge, there is an increase in loss of tooth rigidity. The loss of one marginal ridge results in 46% loss in tooth rigidity and the preparation of MOD cavities, that involves both the marginal ridge, result in 63% loss in tooth rigidity.[10]

In the present study, maxillary premolars were used, because studies have shown that these tooth are more prone to fracture.[11-13]

Incremental layering technique has been the standard method for placement of composite resins. This technique of composite placement also influences the value of cavity configuration factor (C-factor) and the extent of the polymerization shrinkage. When composite resin is placed in the prepared cavity using incremental placement technique, polymerization shrinkage occurs in each increment. Shrinkage of this single thin layer of composite resin generates less tensile force and also the C –factor is significantly lower, which further reduces the stress due to the polymerization shrinkage , resulting in better marginal sealing and decreasing the risk for development of secondary caries.[14,15]

Time saving restorative materials is an ongoing demand for posterior applications. The bulk fill composites were introduced for this reason. They are utilized to hasten the restoration process by enabling upto 4-5 mm thickness of increment to be cured in a single step. High-viscosity bulk-fill resin composites with higher filler fraction presented polymerization contraction values closer to the conventional resin composite. An increase in the filler content can, to a certain extent, reduce the polymerization contraction due to the decrease in the monomer content in relation to the filler-to-monomer ratio. The bulk fill composite used in this present study is Tetric N ceram bulk fill composite. Besides having a regular camphorquinone/amine initiator system,the Tetric N ceram bulk fill composite has an 'Initiator booster'(Ivocerin) that is able to polymerize the material to 4-5mm depth.[16]

In the present study high fracture resistance was displayed by both the incremental and the bulk fill placement technique of nanohybrid composites. Statistically no significant difference (P>0.05) were observed between these two groups.

Versluis et al [17] questioned the reduction of polymerization shrinkage stress by incremental filling technique of composite resins. They revealed that there are higher polymerization shrinkage stresses at the restoration-enamel interface during the incremental filling technique than the bulk filling of the cavity. Following this result, many authors have reported minimal differences in the overall outcomes of composite placed in both the technique. [16,18,19]

Bulk fill composite technique appears to be better in terms of time that is required to prepare the

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restoration. This technique may be able to substitute the time consuming incremental filling technique. However various factors such as oral temperature, occlusion, magnitude, speed and direction of forces are different in the oral cavity of each individual and this may affect resistance of restored tooth. Hence long term clinical studies are required for bulk fill composite to replace the gold standard incremental placement technique of composite restorations.

CONCLUSION:

Within the limitation of this *in vitro* study, it can be concluded that high-viscosity bulk-fill nanocomposite displayed fracture resistance values similar to incrementally placed nanocomposite in endodontically treated teeth.

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Table 1:Composition of the composites used		
	TETRIC N-CERAM BULKFILL (IVOCLAR)	TETRIC N-CERAM INCREMENTAL (IVOCLAR)
organic matrix	Dimethacrylates (20-21 Wt %)	Dimethacrylates (17–18 Wt %).
Fillers	barium glass, ytterbium trifluoride, mixed oxide and copolymers (79-81 wt %).	barium glass, ytterbium trifluoride, mixed oxide and copolymers (82-83 wt %).
Fillers weight %	76–77%	75–76%
Fillers volume %	53–54%	53–55%.
Initiators	Ivocerin	Camphorquinone

TABLE 2 : MEAN AND STANDARD DEVIATION		
GROUPS	**N**	**MEAN ± SD**
A	20	822.92±399.2N
B	20	752.11±135.4*N*
C	20	630.85±143.8N

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