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# Comparative Evaluation of Fracture Resistance of Endodontically Treated Teeth Restored with three Different Materials

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## Introduction

Restoration of endodontically treated teeth is one of the major challenges faced in the field of operative dentistry. In endodontically treated tooth, most part of the tooth structure is lost because of dental caries, conventional access cavity preparation and biomechanical preparation during root canal therapy. They become very weak and brittle and also more prone to fracture compared to vital teeth.(1) Particularly, extensive cavity design with the combination of access cavity may result in additional weakening of the treated tooth when subjected to chewing forces, occlusal habits and temperature changes. It may lead to fracture unless coronal restorations complementary to root canal treatment are supported by strong dental tissues (2). Restoration of root canal-treated teeth with a permanent, definitive, postendodontic restoration is a final step for successful root canal treatment.(3) To prevent the failure of root canal treatment, a simple, quick, high strength, direct and cost effective restorative procedure may be desirable. (4)

Tooth-colored restorations are in demand for the present generation due to many advantages they offer over the metallic restorations. Majority of metallic restorations are now being replaced by high strength tooth coloured restorations. (5)

Tetric N Ceram (Ivoclar) is a nanohybrid composite based on Nano-optimized technology. Nano additive have been incorporated in a targeted fashion. Its Nano optimized filler technology is responsible for the material's unique chameleon effect. It is suggested for universal use of all anterior and posterior restorations. (6) Ceram xSphereTEC

One (DENTSPLY) is a nanoceramic light cured radiopaque composite with prepolymerized fillers. It has newer filler technology containing granulated spherical fillers in combination with an optimized resin matrix system and it is suggested for all direct and indirect anterior and posterior restorations.(7) GC gold label HYBRID has an advanced Glass Hybrid technology. It has been created from the synergistic combination of two types of FluoroAlumino-Silicate (FAS) glass with diverse particle size and reactivity, and two different types of polyacrylic acid. The end objective is a stronger and more aesthetic self adhesive posterior restorative material suggested for post endo restoration(8)

The present study aims to compare the fracture resistance of teeth offered by three different materials in endodontically treated maxillary premolars. The objective of the study is to compare the fracture resistance of badly mutilated, endodontically treated teeth restored with three different materials in MOD cavity of maxillary premolar teeth.

The null hypothesis proposed was there will be no difference in the fracture resistance of these three different materials.

## MATERIALS AND METHODS

### SAMPLE PREPARATION:

40 intact maxillary premolars with mature apices, intact enamel and dentin without any carious lesion, restorations or developmental disturbances were included in this study and teeth with open apices or resorption, caries, cracks, root fracture, hypoplastic teeth, previous restorations or with any anatomical variation were excluded from the study. Specimens were cleaned off calculus and periodontal tissue using an ultrasonic scaler. (9)

### MESIO-OCCLUSO-DISTAL (MOD) CAVITY PREPARATION

10 intact premolar teeth were used as positive control (Group 1). MOD cavities were prepared for the remaining 30 teeth using high-speed airotor hand piece with a straight fissure diamond point (SF-41; Mani Dia Burs). Dimensions of the MOD cavities were standardized by keeping the buccal and lingual wall thickness of 2.5 ± 0.2 mm from height of contour of each surface, the gingival cavosurface margin was kept 1.5 mm coronal to the cementoenamel junction and the gingival seat was kept as 1mm. Dimensions of the cavity were measured with the help of vernier caliper.(10)

### ACCESS CAVITY PREPARATION:

Endodontic access were gained for the 30 teeth using Endo Access Bur (Dentsply- 21mm) with an airotor handpiece. Canal patency was checked using 10 size k-file and the working length was measured 1 mm short of apex. Root canal preparation was done upto F2 ProTaper Gold files. After each file, canals were rinsed with 3% NaOCl. At the end of preparation, canals were dried with absorbent paper points. Root canal obturation was done with F2 Gutta percha points (Dentsply) and bioceramic sealer (Angelus Bio-C sealer). Excess gutta-percha was removed with a hot instrument.

### POST-ENDODONTIC TREATMENT PROCEDURE:

The teeth were then randomly divided into 3 experimental groups. The access cavities were restored with respective materials according to manufacturer's instruction.

GROUP 1 –Intact tooth

GROUP 2- MOD cavity restored with conventional nanohybrid resin composite (IvoclarTetric N-ceram)

GROUP 3- MOD cavity restored restored with nano ceramic composite (Ceram.XSphereTEC one,Dentsply)

GROUP 4- MOD cavity restored with hybrid glass Ionomer cement (GC gold label HYBRID)

The restorative procedures were carried out using Tofflemire matrix system for creating the proximal contours.

## THERMOCYCLING

Thermocycling of the samples were carried out 500 cycles at 5°C ± 2°C–55°C ± 2°C with 30 s dwell time and 5 s transfer time.The specimens were then stored in an incubator at 37°C for 24 h and mounted in a block of cold cure acrylic resin up to 1.5 mm apical to cementoenamel junction. A layer of light body elastomeric impression material was applied around the root surfaces to simulate the periodontal ligament.

## FRACTURE RESISTANCE TESTING

A compressive force at a strain rate of 1 mm/min was applied using universal testing machine (Instron) by a 1mm diameter sphere, which was placed parallel to the long axis of the tooth and centered over the teeth in such a way it just contacted the occlusal surface of the restoration.Forces necessary to fracture each tooth was measured in Newtons (N).

## STATISTICAL ANALYSIS

Results were subjected to one-way ANOVA for comparison between groups and Tukey's post hoc test for Intergroup multiple comparisons.

## RESULTS

Highest mean fracture resistance was observed with intact teeth (Group 1) followed by nanoceramic composite (Group 3), nanohybrid composite (Group 2) and hybrid glass ionomer cement (Group 4). One-way ANOVA test revealed statistically significant difference (P<0.0001) between all the groups. Tukey's post hoc test revealed that there was no significant difference between group 2 and 4. All the other groups showed statistically significant difference (P < 0.0001).

TABLE 1- REPRESENTS DISTRIBUTION OF MAXIMUM FORCE AMONG THE DIFFERENT GROUPS

| GROUP | SAMPLE SIZE | MEAN | SD | SE | MIN | MAX | P VALUE |
|---|---|---|---|---|---|---|---|
| 1 | 10 | 1912.44 | 260.69 | 82.43 | 1661.34 | 2162.14 | <0.001* |
| 2 | 10 | 663.49 | 73.73 | 23.31 | 551.98 | 772.38 | |
| 3 | 10 | 1111.93 | 189.20 | 59.83 | 940.09 | 1494.96 | |
| 4 | 10 | 569.31 | 66.80 | 21.12 | 487.22 | 672.38 | |
| TOTAL | 40 | 1064.29 | 661.49 | 88.77 | 3640.63 | 5101.86 | |

*P VALUE <0.05, ONE WAY ANOVA TEST

TABLE 3 POST HOC TEST FOR FORCE DISTRIBUTION

| GROUP(I) | GROUP (J) | MEAN DIFF (I-J) | SE | P VALUE | 95% CI | |
|---|---|---|---|---|---|---|
| | | | | | LOWER | UPPER |
| 1 | 2 | 1248.95 | 75.38 | <0.001* | 1045.91 | 1451.98 |
| 1 | 3 | 800.50 | 75.38 | <0.001* | 597.47 | 1003.53 |
| 1 | 4 | 1343.12 | 75.38 | <0.001* | 1140.09 | 1546.15 |
| 2 | 3 | -448.44 | 75.38 | <0.001* | -651.47 | -245.41 |
| 2 | 4 | 94.17 | 75.38 | 0.600 | -108.85 | 297.20 |
| 3 | 4 | 542.61 | 75.38 | <0.001* | 339.58 | 745.64 |

*P VALUE <0.05, TUKEY'S TEST

## DISCUSSION

Demand for having tooth-colored restorations has been increasing widely due to many advantages they offer over the metallic restorations. Majority of metallic restorations are now being replaced by high strength tooth coloured restorations. (11) Conventional composites are considered to be the gold standard as a posterior restoration due to their dense filler loading, excellent optical properties, and improved mechanical properties. However, still it undergoes polymerization shrinkage (1.6–7.1%) that creates contraction stresses which in turn may cause microleakage and subsequently restoration failure. (9) So this study aims to compare the fracture resistance of nanohybrid composite, nano ceramic composite and hybrid glass ionomer cement in endodontically treated maxillary premolars.

Maxillary premolars were chosen as they are more prone to fracture due to anatomical shape with steep cuspal inclines, leads to cuspal separation during mastication and greater incidence of fracture than mandibular premolars. MOD cavities were prepared in the teeth as these are considered to be the worst in terms of fracture resistance. (12)

Thermocycling of the samples were done as it simulates in vitro, thermal changes that occur in the oral cavity. (13)

A layer of light body elastomeric impression material, polyvinyl siloxane, was applied around the root surfaces before mounting of specimens in acrylic block to simulate the periodontal ligament. Then they were embedded in cold cure acrylic resin up to 1.5 mm apical to cementoenamel junction. This was performed to simulate the bone level. (14)

Results of our study showed statistical significance and higher fracture resistance was exhibited by intact teeth. Nanoceramic composite showed an acceptable fracture resistance after intact teeth (1890.93 N). This is because ceram.xSphereTEC one is based on the advanced granulated filler technology. It hasmicroscaled, well-defined sphericals superstructures, comprising of submicron glass. Microstructured surface of a SphereTEC filler (d3.50 ~ 15 μm) is obtained via spray-granulation process from submicron glass fillers. SphereTEC spherical prepolymerised fillers provides a ball-bearing effect that enables excellent adaptation and sculptability. (7)

It also showed the higher mean fracture resistance when compared to other experimental groups due to the formation of a continuum between tooth surface, adhesive and restorative material, which is accomplished by the demineralization and penetration of resin in enamel and the formation of a unique body between restoration and tooth structure. (7)

## CONCLUSION

Within the limitations of this study, maximum fracture resistance is shown by the Nanoceramic composite after intact teeth. Hence, it can be concluded that Nanoceramic composite is the preferred material for restoring endodontically treated teeth with extensive cavities.

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