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# To Determine the Impact of Two Different Intra-Orifice Barrier Materials on Resistance of Fracture of Endodontically Treated Teeth

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**Abstract:-**

- ***Background:***

**Vertical root fracture and crown root fracture are a major clinical issues that may occur due to excessive widening of canals, use of irrigants, and medicaments. It is one of the most frequent cause for the extraction of root-filled teeth. Therefore, in addition to complete sealing of the cavity, an intraorifice barrier could be placed to strengthen the remaining tooth structure.**

- ***Aim:***

**The aim of the study is to assess the impact of two alternative intra-orifice barrier materials on the resistance of fracture of endodontically treated teeth.**

***Materials and Methodology:***

**45 extracted single-rooted human mandibular premolars, decoronated to equal dimension, prepared to be obturated with gutta-percha. The placement of different intraorifice barrier materials, was done by removing coronal 3-mm of gutta percha, except for the control group. Based on the intraorifice barrier material used, the specimens were divided into three groups (n = 15).**

**Group I: Control**
**Group II: Resin modified GIC**
**Group III: Composite**

**Universal testing machine was used to record the fracture resistance of the specimens.**

- ***Results:***

**Better resistance to fracture was seen with flowable nanohybrid composite and control group presented the least values.**

- ***Conclusion:***

**An intraorifice barrier can be used for reinforcement of the teeth that have undergone endodontic therapy, making it a successful therapeutic approach.**

## I. INTRODUCTION

Dentistry has undergone significant changes with time in the field of endodontics. A significant advancement today is the ability to retain the teeth in function, that would have been extracted decades ago. (1)

Unrestored teeth that have had endodontic treatment are more vulnerable to coronal leakage and fracture, leading to failure of root canal therapy. According to a number of clinical investigations, 11%–13% of extracted teeth with endodontic treatment exhibit vertical root fractures. (2)

The cleaning and shaping procedure results in transient contacts between instruments and the radicular dentin producing dentinal stresses like craze lines and micro cracks. (3) The usage of various kinds of intracanal irrigants

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and medicaments as an adjunct to chemo mechanical preparation remodels the structure of dentinal collagen and precipitates into fatigue, crack propagation and becomes susceptible to vertical root fracture. [4]

Reinforcement of the remaining tooth structure should be the primary intension of endodontic therapy. [5] Bender and Freedman also noted a rise in the frequency of vertical root fractures in teeth that had undergone endodontic treatment. [6]

**Roghanizad and Jones** were the foremost to introduce the concept of intraorifice barrier to prevent coronal micro leakage. [7] Immediately after removing the coronal section of the gutta percha and sealer, additional material is inserted into the canal orifices as part of the procedure. [7]

The root is reinforced using materials with elastic moduli that are comparable to dentin, i.e. 14–16 gigapascals, and the stress concentrations at the dentin–material interface are kept at their lowest. [8]

The use of instruments with greater taper widens the coronal third of the root canal which necessitates the reinforcement of this weakened part of tooth. Coronal seal is improved by using dental materials having bonding ability to dentin enhancing the fracture resistance and decreasing the fracture incidence. [9]

- *Aims and Objectives*

The purpose of this study is to examine and assess the fracture resistance of roots obturated with gutta-percha employing flowable hybrid composite and light cure glass ionomer cement as intraorifice barriers.

## II. MATERIAL AND METHODS

- *Selection of sample*

Human single rooted mandibular premolars extracted for orthodontic purpose were collected from Department of Oral and Maxillofacial surgery, CSMSS Dental College, Chh. Sambhajhinagar, India.

- *Inclusion Criteria:* Forty-five recently extracted mandibular premolars were collected based on their macroscopically comparable size and straight roots, which were shortened to 14mm from the coronal aspect.

- *Exclusion Criteria:* Teeth associated with fracture, craze lines, curved roots, developmental anomalies.

- *Preparation of sample*

On the root surface of 45 selected specimens, soft tissue and calculus were mechanically removed. To standardize the specimens, the teeth were reduced to 14mm from the coronal aspect (Figure 1). Following that, a stereomicroscope was used to check all specimens for presence of cracks. A size 10 K type file was inserted into the canal until the apical foramen was visible. A millimeter short of this length was chosen as the working length.

Fig 1 Prepared Samples for the Investigation.

- *Canal Preparation*

The instrumentation for the root canals was carried out using 0.06 taper Hero shaper rotary files, RC Prep lubricant, and 2ml of 5.25% sodium hypochlorite irrigation in between each file (Figure 2). A final irrigation of 5ml 17% EDTA and 5ml 2.5% NaOCl was used in the root canals, and then the canals were flushed with distilled water to prevent the prolonged effect of EDTA and NaOCl. After that, paper points were used to dry the canals.

Fig 2 Instrumentation of the Canal Done with Hero Shaper Rotary File

- *Canal Obturation*

The manufacturer's recommendations were followed while mixing AH plus sealer. Obturation was carried out using 0.06 taper single gutta percha cones after coating the sealer to the canals.

- *Intra Orifice Barrier Placement*

With the exception of the control group specimens, all other group specimens had the coronal 3mm of the root filling removed using a hot plugger and verified with William's periodontal probe. According to the intraorifice barrier material used, the obturated specimens were categorized into the following groups:

- *Group 1 (No Barrier – Control)*

This group did not remove the gutta percha or insert an intraorifice barrier.

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- *Group 2 (Resin Modified GIC)*

On a paper pad, the prescribed quantity of powder and liquid was poured in a 3:1 ratio, and the powder was divided into two equal portions. Agate spatula was used to combine the first portion into the liquid before adding the second portion to the leftover liquid. The canal orifice was filled with mixed glass ionomer cement, which was then cured for 20 seconds.

- *Group 3 (Composite)*

The root canal orifices were etched with 37% phosphoric acid for 15 seconds prior to the restoration with composite. The surface was then cleaned with water, and any excess water was syringed out with air.

Surface was coated with a bonding agent, which was then cured for 10 seconds. The flowable nano hybrid composite was then placed and allowed to cure for 20 seconds.

➢ *Mounting and testing of the specimen*

The specimen was mounted in self curing acrylic resin and it was ensured that the apical root tip was along the long axis.3mm of each root was left exposed above the acrylic resin.

Universal testing machine was used for mounting the specimen and maintaining a cross head speed of 1mm/min, a compressive force was applied upto the point where the specimen was fractured. (Figure 3)

Newton values were used to measure the magnitude of forces which led to fracture of each root specimen.

Fig 3 Universal Testing Machine for the Investigation.

Fig 4 Prepared Sample Placed Under the UTM During Testing.

Fig 5 Prepared Sample after Testing Under UTM

## III. RESULTS

Mean strength of Group 1 was 234.60 + 57.710 and Group 2 was 470.47+46.698 and Group 3 was 501.93+46.332 respectively. Mean of group 1 is least which is followed by group 2 and 3. The post hoc test indicate that the difference in the mean fracture resistance between group 1 – group 2 and group 1 – group 3 is significant. While group 2 and group 3 does not differ in the mean fracture resistance. Group 3 is having better fracture resistance than the other groups and group 1 has worst fracture resistance amongst all the groups. Results are shown in tables and graphs.

➢ *Descritpive Statistics for Fracture Resistance between the Groups*

| | Mean | Std. Deviation | Std. Error | 95% Confidence Interval for Mean | | Minimum | Maximum |
|---|---|---|---|---|---|---|---|
| | | | | Lower Bound | Upper Bound | | |
| Control | 234.60 | 57.710 | 14.901 | 202.64 | 266.56 | 112 | 350 |
| Resin Modified GIC | 470.47 | 46.698 | 12.057 | 444.61 | 496.33 | 400 | 570 |
| Composite | 501.93 | 46.332 | 11.963 | 476.28 | 527.59 | 400 | 564 |

Fig 6 Descritpive Statistics for Fracture Resistance between the Groups

➢ *Fracture Resistance Values in Newton*

| Group 1 ( CONTROL ) | Group 2 ( Resin modified GIC) | Group 3 ( Composite ) |
|---|---|---|
| 350 | 450 | 450 |
| 350 | 500 | 400 |
| 245 | 416 | 453 |
| 234 | 495 | 539 |
| 228 | 500 | 545 |
| 190 | 490 | 540 |
| 200 | 530 | 482 |
| 215 | 420 | 512 |
| 230 | 456 | 550 |
| 225 | 476 | 530 |
| 112 | 426 | 564 |
| 208 | 400 | 486 |
| 250 | 488 | 525 |
| 234 | 440 | 490 |
| 248 | 570 | 463 |

Fig 7 Fracture Resistance Values in Newton

➢ *Comparison of Fracture Resistance between the Groups (ANOVA Test)*

| | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|
| Between Groups | 640451.7 | 2.0 | 320225.9 | 125.5 | .000 |
| Within Groups | 107208.3 | 42.0 | 2552.6 | | |
| Total | 747660.0 | 44.0 | | | |

Fig 8 Comparison of Fracture Resistance between the Groups (ANOVA Test)

➢ *Multiple Comparison between the Groups*

| Group I | Group J | Mean Difference (I-J) | Std. Error | Sig. | 95% Confidence Interval | |
|---|---|---|---|---|---|---|
| | | | | | Lower Bound | Upper Bound |
| Control | Resin Modified GIC | -235.867* | 18.448 | .000 | -273.10 | -198.64 |
| | Composite | -267.333* | 18.448 | .000 | -304.56 | -230.10 |
| Resin Modified GIC | Control | 235.867* | 18.448 | .000 | 198.64 | 273.10 |
| | Composite | -31.467 | 18.448 | .095 | -68.70 | 5.76 |
| Composite | Control | 267.333* | 18.448 | .000 | 230.10 | 304.56 |
| | Resin Modified GIC | 31.467 | 18.448 | .095 | -5.76 | 68.70 |

Fig 9 Multiple Comparison between the Groups

The post hoc test indicate that the difference in mean fracture resistance between Control - Resin modified GIC and Control - Composite is significant. While the Resin modified GIC and Composite do not differ in mean fracture resistance

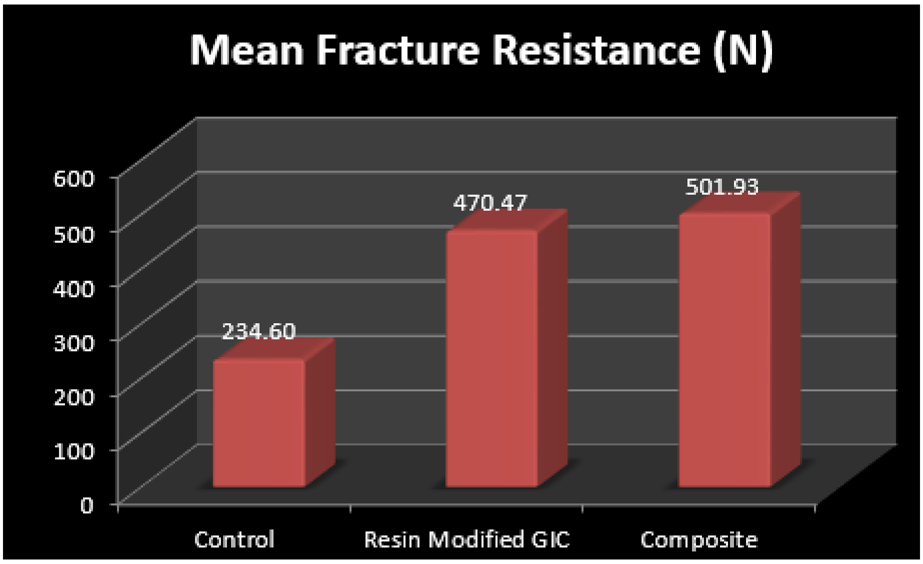

Fig 10 Mean Fracture Resistance

## IV. DISCUSSION

Due to their influence on the prognosis of non-vital teeth, procedures performed following endodontic therapy has acquired prominence. Dietschi et al. found that the amount of coronal tissue lost due to caries or a restorative procedure directly correlated with the susceptibility of endodontically treated teeth to fracture. (10) The ability to resist occlusal forces is linked to the amount of remaining tooth structure. (11) Therefore, it is crucial to offer a restoration after finishing a root canal therapy to prevent tooth fracture. The amount of tissue lost and its location (12,13), the size and duration of the load (11), the kind of tooth, the direction of the load, and the slope of the cuspal inclines (12,14) are a few other variables that might affect the fracture resistance of teeth. Apical periodontal health was found to be more dependent on coronal restoration than on the technical quality of endodontic treatment after assessing the link between the quality of both coronal restoration and root canal filling using radiographs of endodontically treated teeth (15). Prior studies have supported the significance of perfect restoration for periapical health. (16-19)

During the transfer of stresses from coronal to apical portion of the tooth, cementoenamel junction has proven to be the most important anatomical landmark. The pericervical dentin which lies near the alveolar crest, extending approximately 4mm coronal and 4mm apical to the crestal bone is a critical zone to transfer stresses and provide resistance to fracturing (20). According to Zandbiglari et al., obturation with AH + sealer did not increase fracture resistance and that roots were notably weakened when using higher taper instruments. (21) The placement of intraorifice barrier at the cervical portion of tooth compensates for the loss of dentin owing to the coronal flaring and leads to root strengthening. Thus in the present study the intraorifice barrier were placed in a thickness of 3mm to compensate for the loss of pericervical dentin. The stress concentration at the dentin-material interface is reduced with materials with a modulus of elasticity bearing similarity to that of dentin (14-16 Gpa) at the cervical region, the restorative material is flexed thereby generating lesser tension at the tooth restoration interface. Hence, the stresses get uniformly distributed along the tooth restoration interface when it is under occlusal loading. (5,22)

Past intraorifice barriers have included bonded amalgam, mineral trioxide aggregate, cement with calcium enrichment, resin-modified glass ionomer cement, flowable composite, etc. Bonded amalgam, MTA, and calcium-enriched mixed cement have strong sealing capacities but have not been used in this investigation due to their poor physical qualities. (23)

Late in the 1980s, light cure glass ionomer cement was introduced, and it includes certain methacrylate elements that are typical of resin composites. Two processes, a photochemical polymerization of water-soluble monomers and methacrylate groups, and the acid-base reaction shared by all glass ionomers, are responsible for the setting reaction. (24) According to Tselnik et al., it demonstrated improved performance as a satisfactory coronal seal for a period of 90 days (25) which is attributable to its higher performance, explained by the ability to absorb water, which causes setting expansion and, as a consequence, a better seal. Pre-treatment of dentin is not required while using the resin modified glass ionomer cement and fluoride release is also one of the useful property. (26)

Flowable resin-based composites are typically made with filler loadings that are less than 60% by volume, which changes the viscosity of the material. (27) The adhesive properties of composite enable it to bind to the cusps. Due to bonding their flexion decreases thereby leading to reinforcement of the tooth. Composites because of their low elastic modulus, transfer stress of compression onto adjoining tooth structure, hence buttressing weakened tooth structure. (28) The compressive strength of flowable composite resin is 230 MPa, whereas its elastic modulus is 5.3 GPa, which is considerably less than that of natural dentin. (27) They are asserted to provide increased elasticity, easier insertion, and higher flow in addition to better internal cavity wall adaptability. [29]

The control group exhibited the least fracture resistance in which the intraorifice barrier was not placed after obturation. This is in accordance to various studies [5,30] in which it was concluded that the fracture vulnerability of endodontically treated teeth is increased in the absence of an intraorifice barrier material.

Forces are transmitted uniformly when they are applied parallel to the long axis of the tooth. Hence, in the present study the force application was done in vertical orientation at a constant speed on the Universal testing machine. [1] The high numerical values of resistance observed with both resin modified glass ionomer and composite are attributed to their superior adhesion to dentinal tissue.

## V. LIMITATIONS

Because the findings of the study cannot be applied in clinical condition, this study has limitations. The effect of sealer on the adhesion of restorations to the root canal walls was not taken into account. Sealing ability of an intraorifice barrier needs to be taken under consideration. For the outcomes of this study to be exactly correlated to clinical success, more research is required.

## VI. CONCLUSION

The highest fracture resistance was provided by the NHC, followed by LC GIC and least by the control group. Keeping in mind the limitation of this study it can be concluded that intraorifice barrier can be considered as feasible and practicable modality to reinforce the endodontically treated teeth and reduce the postoperative root fractures. Due to reasonable superior fracture resistance NHC and LC GIC can be utilized as intraorifice barriers. Further research employing varied and newer types of materials and other parameters, in conjugation with clinical testings are required to validate the results from this in vitro study.

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