Original Article

Comparative Evaluation of Three Different Intraorifice Barrier on Fracture Resistance of Endodontically Treated Teeth: An *In vitro* Study

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Abstract

Aims: The aim of this study is to evaluate the role of three different intraorifice barrier materials on resistance to fracture of obturated teeth with seal-apex sealer. **Subjects and Methods:** Eighty extracted human single-rooted mandibular premolars were decoronated to approximately similar dimension, and prepared and obturated with gutta-percha and seal-apex sealer. For the placement of different intraorifice barrier materials, the coronal 3-mm gutta-percha was removed except for the control group. The specimens were divided into four groups (n = twenty) on the basis of the intraorifice barrier material used. Group I: Mineral trioxide aggregate (MTA), Group II: Cention N, Group III: Nanohybrid composite, Group IV: Control, Fracture resistance of the specimens was tested. **Statistical Analysis Used:** It was done by the statistical software SPSS version 16.0. One-way ANOVA followed by Tukey's HSD test and independent t-test was used. **Results:** Fracture resistance of endodontically treated tooth was significantly affected by the type of intraorifice barrier used ($P < 0.001$). **Conclusions:** The use of nanohybrid composite significantly improved fracture resistance followed by cention N and MTA as compared to the control group.

Keywords: Cention N, endodontically treated teeth, fracture resistance, intraorifice barrier, mineral trioxide aggregate, nanohybrid composite

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Introduction

A vertical root fracture is a major clinical issue with unfavorable prognosis, that may occur due to excessive widening of canals, use of irrigants, and medicaments.[1] It is the second most common factor for the extraction of root-filled teeth.[2] Hence, in addition to complete sealing of the cavity, another major goal of endodontic therapy should be the reinforcement of the remaining tooth structure.

For reinforcement, placing the material having modulus of elasticity same as that of dentin (14–16 Gpa) at material-dentin interface, might be helpful.[3]

Such materials can be used as intraorifice barriers that will provide strength against the masticatory forces that tends to fracture roots.

Materials and Methods

Eighty-extracted human single-rooted mandibular premolars having single canal and approximately similar dimension were selected and stored in saline until use. Standardization of specimen was done by decoronating at 14 mm using diamond disc and water as a coolant. Woking length was calculated using a 10 k fie, and shaping of canal was done with ProTaper universal system till F2 using the crown-down technique. About 5.25% sodium hypochlorite (2 ml) was used for irrigation after every file changed, and final irrigation was done of 5 ml 17% ethylenediaminetetraacetic acid. Distilled water (10 ml) was used for final flushing of canals and allowed to dry with paper points. Canals were obturated with gutta-percha and seal-apex sealer. Incubation of specimens was done at 37°C for 8 h allowing complete setting of sealer.

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The procedure of placing intraorifice barrier: For the placement of intraorifice barriers, removal of coronal 3-mm gutta-percha was done from the obturated canal of all the specimens excluding the control group. Heated ball burnisher was used as an aid for removing gutta-percha. According to different intraorifice used, there was a random distribution of specimens into four groups consisting of 20 specimens each.

Group I (mineral trioxide aggregate)

Mineral trioxide aggregate (MTA) was mixed and placed into space prepared by removing gutta-percha using the MTA carrier. Setting of MTA was aided by moist cotton pellet and kept for 24 h.

Group II (cention-N)

Cention N powder and liquid were mixed accordingly and placed in the cavity. It was light-cured for 30 s.

Group III (nanohybrid composite)

After surface treatment of a cavity, nanohybrid composite was paced and cured for 40 s.

Group IV (control)

Gutta-percha was not removed for this group of specimens, and there was no placement of intraorifice barriers.

Following the placement of intraorifice barrier materials, incubation of specimens was done at 37°C, and humidity was maintained at 100% for 1 week that allowed complete setting of material.

Mounting and testing of specimens

Self-curing acrylic blocks were made to place a specimen vertically in it, keeping 3 mm of each specimen out of the block. Periodontal ligament simulation was performed using modeling wax. The fracture resistance was measured by mounting a specimen on the universal testing machine and applying compressive force at crosshead speed of 1 mm/min until the specimen fractured. The maximum force which fractured the specimen was measured in newton (N).

Statistical analysis

The statistical analysis was done by the statistical software SPSS version 16.0 (SPSS Inc., Chicago, US). The mean difference of fracture resistance between three groups was tested by one-way ANOVA followed by Tukey's HSD test and between two groups independent *t*-test was used.

Results

The highest fracture resistance is shown by nanohybrid composite when used as an intraorifice barrier followed by cention N, MTA and control group. The distribution mean ± standard deviation. of Fracture resistance of control, nanohybrid composite, Cention-N, and MTA groups are 699.58 ± 5.237, 969.97 ± 5.331, 873.51 ± 4.265, and 800.18 ± 5.228, respectively [Table 1]. The mean difference of fracture resistance between control, nanohybrid composite, Cention-N, and MTA group is highly significant, $P < 0.001$ [Table 2]. Table 2 shows the multiple comparison by Tukey' HSD test.

Table 1: The distribution mean±standard deviation of fracture resistance of control, nanohybrid composite, Cention-N, and mineral trioxide aggregate groups

Group	Sample number	Mean±SD	SE
Control	20	699.58±5.237	1.171
Nanohybrid composite	20	969.97±5.331	1.192
Cention-N	20	873.51±4.265	0.954
MTA	20	800.18±5.228	1.169

MTA: Mineral trioxide aggregate, SD: Standard deviation, SE: Standard error

Table 2: Multiple comparisons of mean of fracture resistance of four groups by the Tukey's HSD test

Group	Mean difference	SE	*P*
Control versus nanohybrid composite	270.383	1.592	<0.001*
Control versus Cention-N	173.926	1.592	<0.001*
Control versus MTA	100.593	1.592	<0.001*
Nanohybrid composite versus Cention-N	96.457	1.592	<0.001*
Cention-N versus MTA	73.332	1.592	<0.001*

*Highly significant. MTA: Mineral trioxide aggregate, SE: Standard error

Discussion

The morphology of root canal, remaining dentin thickness, size and shape of canal, and presence of curved roots are the factors influencing the fracture resistance of root canal-treated teeth.[4] Remaining dentin thickness is a key factor strengthening the roots against masticatory forces. Thus, decreasing fracture susceptibility.

However, other factors to be considered are straight-line access, effective irrigation and debris removal, canal obturation for successful endodontic treatment. Flaring of the coronal third of root canal helps to achieve all these parameters at the cost of reducing the remaining dentin thickness.

Rundquist and Versluis stated that during filling of root canal, there is a decrease in stresses in root as the taper increases, but the forces acting due to masticatory loading increases with increase in taper, i.e., at the level of cement-enamel junction.[5]

Therefore, the placement of intraorifice barrier at cervical portion of tooth compensates for loss of dentin due to coronal flaring and strengthens the root.

The intracoronal barrier concept was developed by Roghanizad and Jones to prevent coronal microleakage, and its favorable effect was documented in several studies.[6]

Nagas *et al*. showed that intraorifice barriers could also be used to provide resistance against forces that generate root fractures. The authors showed that the reinforcing effect was material-dependent.[7]

Gupta *et al*. concluded that RMGIC followed by FRC, nanohybrid composite, MTA when used as intraorifice barriers increased the fracture resistance of root canal-treated teeth significantly as compared to teeth without intraorifice barrier reinforcement.[8]

The materials used in the present study have been evaluated for increasing fracture resistance as intraorifice barriers for the following reasons:

MTA has the modulus of elasticity of 15.7 Gpa.[9] Studies have shown it can provide excellent seal against microleakage when placed as intracanal medicament.[10]

However, in terms of increasing fracture resistance by using as intraorifice barrier, it has shown the lowest values of all the groups excluding the control group. The result for this group was similar to a study conducted by Nagas *et al*. concluding MTA did not exhibit any reinforcing effect.[7]

It may be due to the lack of chemical bonding with tooth, high stiffness of material, and low-tensile strength.

Nanohybrid composite bond to the tooth structure micromechanically and thus provides good marginal seal, reinforcement of remaining tooth structure, and conservation of tooth structure.[11] It has high flexural strength also. It has the modulus of elasticity between 9 and 15 Gpa.[12] Aboobaker *et al*. also have reported flowable resin to be an effective intraorifice barrier with significantly high resistance.[13]

The addition of recently developed filler particles improves absorption and distribution of forces in uniform manner thus, improving fracture resistance and thereby prognosis.

Cention N has modulus of elasticity 13 Gpa. It also has patented isofiller which acts as shrinkage stress reliver thus, it helps to relives polymerization shrinkage.[14] It also bond to tooth structure micromechanically. Isofiller that leads to increased microhardness because filler particles are of nanoparticle size. It helps to withstand stresses and strains of the oral cavity. It can also be placed conservatively thus, reinforcing the remaining tooth structure.

Conclusion

Root reinforcement with the tested intraorifice barriers did not totally reduce the susceptibility of roots to fracture. However, within the limitations of this study, it might be concluded that the reinforcement of obturated roots with nanohybrid composite as intraorifice barriers can be regarded as a viable choice to reduce the occurrence of postendodontic root fractures.

Further laboratory research with different materials coupled with clinical trials is necessary to validate the results of this *in vitro* study.

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Conflicts of interest

There are no conflicts of interest.

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