

Comparative Evaluation of Three Different Flowable Intra-Orifice Barriers on the Fracture Resistance of Endodontically Treated Roots Obturated With Gutta Percha- An Invitro Study

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Abstract

Introduction

Root canal therapy has provided dentistry with the ability to preserve the teeth which would have been extracted years before. Root canal treated teeth are more prone to fracture than vital teeth because of excessive loss of tooth tissue, dehydration of the dentin, and loss of proprioception. The major goal of root canal therapy should be to reinforce the remaining tooth structure. Studies have found out that use of intracoronal barriers can prevent coronal microleakage and can also provide strength against forces that generate root fractures.¹

The retention of an adhesive restorative material is based on micromechanical retention or chemical bonding, it does

not require macro-retentive components, minimal invasive preparation with maximal conservation of dentinal tissue can be realized. Coronal reinforcement of the tooth has been demonstrated through bonded restorations.

Thus, there is a need for different materials and/or techniques to overcome the shortcomings of current endodontic filling materials to reinforce the roots.² Through the use of restorative materials with elastic moduli similar to the dentin, it might be logical to assume that Intra-orifice barriers can also provide stiffness against forces that generate root fractures.³

An Intra-orifice barrier is an efficient alternative to decrease coronal leakage in endodontically treated teeth, and thus helps in hermetic coronal seal.⁴ Different materials such as amalgam, Cavit, glass ionomer cement,

composite resin, Mineral Trioxide Aggregate (MTA), and Intermediate Restorative Material (IRM) are used for this purpose.^{5,6,7}

SureFil SDR flow (SDR; Dentsply Caulk, Milford, DE, USA), one of the bulk-fill composite resins recently introduced to the market, is a silorane-based nano- and micro-hybrid composite with low viscosity; its shrinkage stress is lower than conventional fluids.⁸ Bulk fill flowable resin composites are used in association with conventional composites for aesthetic restorations in posterior teeth, having lower polymerization stress, better flow with easy placement, an excellent adaptation to the cavity walls and low modulus of elasticity, which can reduce the stress generated on the cavity walls.⁹

Multi Core which is a dual cure composite resins have gained attention recently as restorative materials and are recommended to be used in high stress bearing areas. Multi Core is a fluoride containing radio-opaque composite.¹⁰

RMGIs were produced by adding methacrylate to polyacrylic acid. Some of them are light-cured, which is supplementary to the basic acid-base reaction.¹¹ It has a modulus of elasticity similar to that of the dentin, which is about 14-16 GPa.¹²

Very few studies have assessed the reinforcing effect of intraorifice barriers placed over root canal fillings. Hence in this study the fracture resistance of different intraorifice barriers were assessed on obturated roots.

Aim

To compare the effects of different materials used as intraorifice barriers on the fracture resistance of endodontically treated roots obturated with gutta-percha and AH plus sealer.

Materials and Methodology

1. Selection of Specimens

60 single rooted mandibular premolars were collected which were extracted for orthodontic and periodontal reasons from the Department of oral and maxillofacial surgery Sri Hasanamba Dental college and hospital, Hassan.

Inclusion Criteria: 60 freshly extracted mandibular premolars selected on the basis of their macroscopically similar size and straight roots.

Exclusion Criteria: Teeth with fracture, craze lines and curved roots. All specimens were examined under stereomicroscope in 15 x magnifications to rule out cracks/fractures.

2. Specimen Preparation

Soft tissue & calculus were mechanically removed from the root surface of 60 selected specimens. Teeth were decoronated at CEJ. Size 10k file inserted until visible in apex and 1mm was reduced from this Length.

3. Canal Preparation

Canals were prepared upto F3 Size using flexer file with irrigation of 2ml 5.25% NaOCL after each change of file and 5 ml 17 % EDTA for 5 min. After which the canals flushed with distilled water to avoid the prolonged effect of EDTA and NaOCl.

4. Canal Obturation

The root canal of each tooth was dried with paper points. Root canals were coated with AH plus sealer and obturated with guttapercha cones of 0.06 taper 30 iso size single cones.

Then the samples were stored in incubator at 37 degree celsius, 100% humidity for 8 hours for complete set of sealer.



Fig 1- Decoronation Of Samples At CEJ

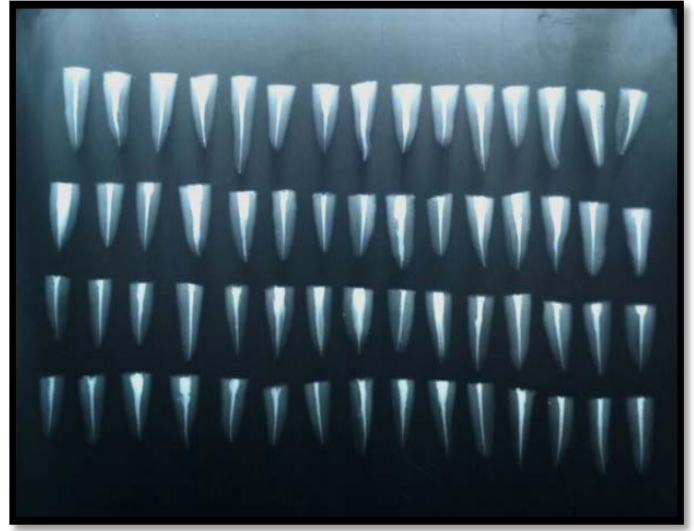


Fig 4- Radiograph Of Obturated Samples



Fig 2- Decoronated Samples

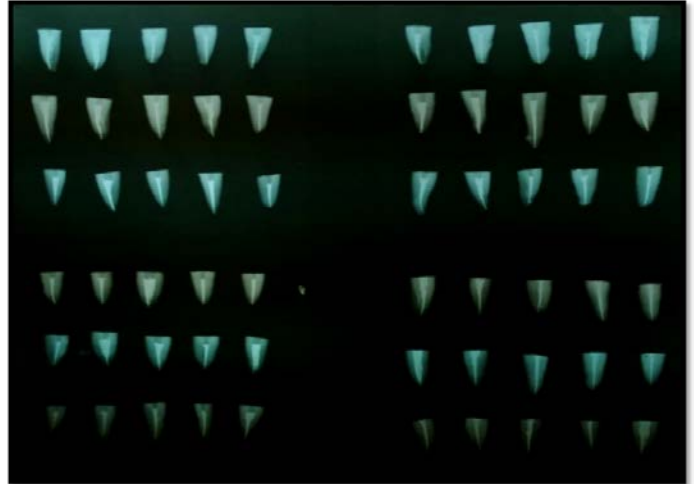


Fig 5- Radiograph Showing Space For Intraorifice Barriers



Fig 3- Obturated Samples



Fig 6- Placement of Rmgic



Fig 7- Placement of Multicore

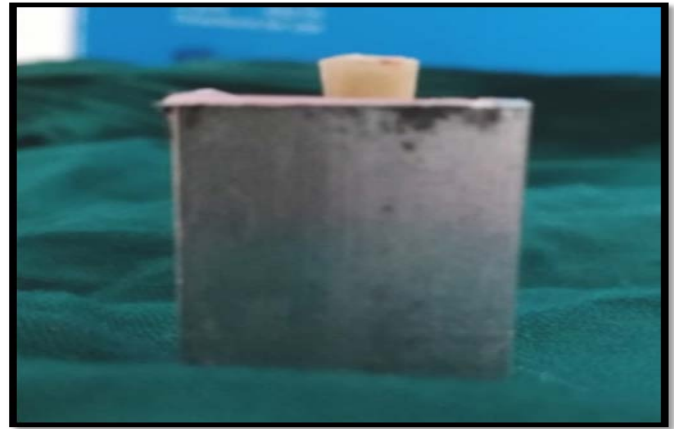


Fig 10 –Samples Mounted In Acrylic in Aluminium Blocks - GP 4-CONTROL



Fig 8- Placement of SDR Bulk Fill

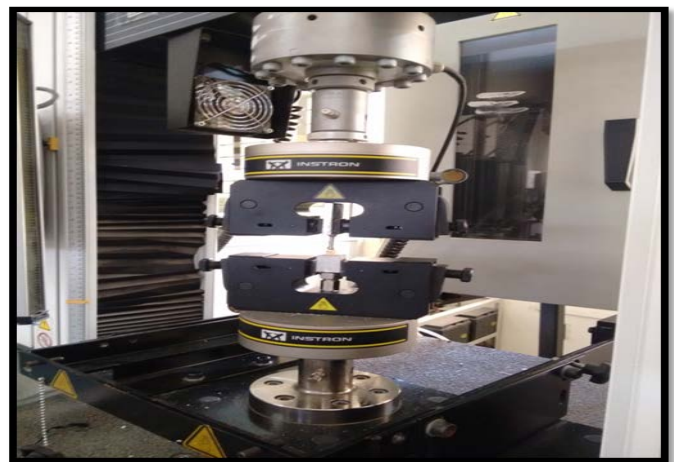


Fig 11 –Fracture Resistance Testing In Universal Testing Machine(Instron)

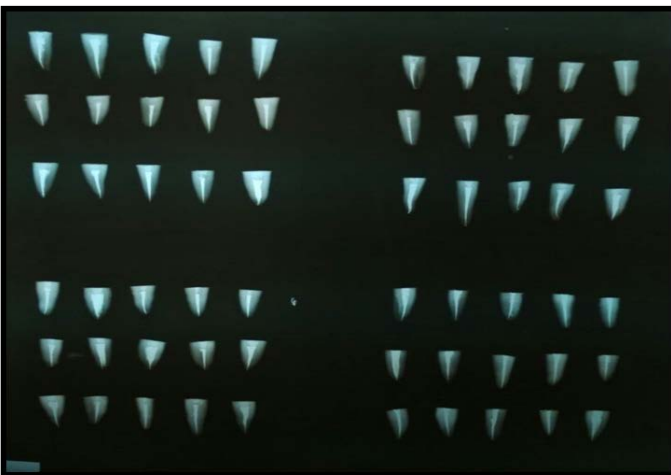


Fig 9- Radiograph Showing Intraorifice Barriers In Place

4. Grouping Of Samples- 60 samples were divided into four groups of 15 samples each.

GROUP 1- RMGIC (Resin modified glass ionomer cement) (Vitremer, 3M ESPE, USA) (N=15).

GROUP 2- Multicore flow (Ivoclar vivadent)(N=15)

GROUP 3-SDR bulk fill flow(Dentsply) (N=15)

GROUP 4: No barrier (CONTROL) (N=15)

5. Placement of Intra Orifice Barriers

Except for control group (GROUP 4) specimens the coronal 3 mm of root fillings of all other group specimens removed with the aid of heated finger plugger and verified with the help of william's periodontal probe. Obturated specimens divided with respect to the intra orifice barrier

material placed over the root canal fillings into the following groups.

GROUP 1- RMGIC (Resin modified glass ionomer cement) (Vitremar, 3M ESPE, USA) (N=15).

After mixing according to the manufacturer's instructions, the material was syringed into the cavity using a 2ml syringe (DISPO VAN) and condensed using plastic instrument (Manipal) and light-cured for 40s.

GROUP 2- Multicore flow (N=15), was syringed into the intraorifice and condensed using plastic instrument (manipal) and ISO size 15 finger plugger (Mani) and light cured for 40 sec.

GROUP 3-SDR bulk fill flow (N=15), was syringed into the intra orifice according to the manufacturer's instructions and light cured.

GROUP 4: No barrier (Control) (N=15)

In this group, there were no removal of gutta-percha and no placement of intra-orifice barriers.

Fracture Resistance Testing In Universal Testing Machine

Specimens were mounted on a universal testing machine (instron) and a compressive force was applied at cross head speed of 1mm/min until fracture occurred.

The force necessary to fracture each specimen in Newton (N) was recorded.

Statistical Analysis

The results obtained were tabulated and subjected to One Way ANOVA and Unpaired t-Test, using Statistical Package for Social Sciences (SPSS, V 20.0) package with significance value (p) kept at <0.05.

Results

The mean peak failure load for Group I, Group 2, Group 3 and group 4 along with Standard deviation values was

Table 2: Inter Group Comparison Between Each Showing No Statistical Difference.

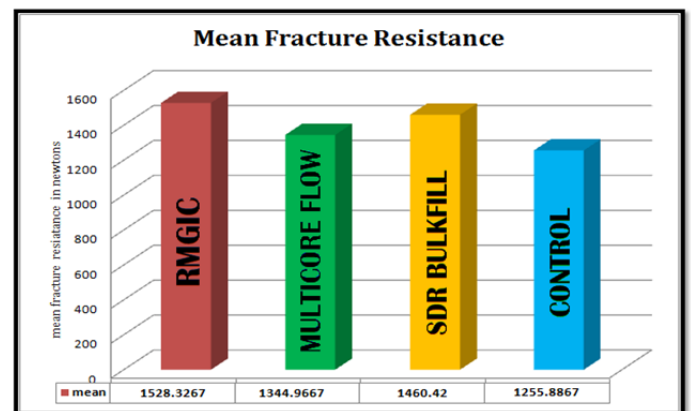
(1528.32 +/- 584), (1344.96 +/- 409.76), (1460.42 +/- 456.15), (1255.88 +/- 348.93) respectively (table 1). The results showed that Group 4 samples which was the control group fractured at the lowest load (1255.88 +/- 348.93) applied, while Group 1 samples restored with RMGIC fractured at the highest load (1039.90 +/- 15.94N) followed by Group 2 (multicore flow) and group 3 (SDR bulk fill flow). To compare the mean failure loads difference among the groups, one-way ANOVA [Table 1] and unpaired t test at 95% level of significance was employed [Table 2]. Intergroup comparison was done using unpaired t test (table 2) and the results shows that, there is no statistically significant (p < 0.05) difference among the groups.

TABLE 1: Mean difference in fracture resistance by one way ANOVA

Rmgic > Sdr Bulk Fill > Multicore Flow > Control

ONEWAY ANOVA							
FRACTURE RESISTANCE							
	N	Mean	Std. Deviation	Std. Error	F	Df	P
RMGIC	15	1528.32	584.00	150.79	1.046	59	0.379
MULTICORE	15	1344.96	409.76	105.80			
SDR	15	1460.42	456.15	117.77			
CONTROL	15	1255.88	348.93	90.09			

Figure 12



Unpaired T- Test					
	Group	N	Mean	Std. Deviation	P
Fracture Resistance	Rmgic	15	1528.3267	584.00820	0.328
	Multicore Flow	15	1344.9667	409.76319	
	Rmgic	15	1528.3267	584.00820	0.725
	Sdr Bulk Fill	15	1460.4200	456.15598	
	Rmgic	15	1528.3267	584.00820	0.132
	Control	15	1255.8867	348.93008	
	Multicore Flow	15	1344.9667	409.76319	0.472
	SDR Bulk Fill	15	1460.4200	456.15598	
	Multicore Flow	15	1344.9667	409.76319	0.527
	Control	15	1255.8867	348.93008	
	Sdr Bulk Fill	15	1460.4200	456.15598	0.179
	Control	15	1255.8867	348.93008	

Discussion

Susceptibility to fracture of endodontically treated teeth is intrinsic to the root canal morphology, dentin thickness, canal shape, and size and curvature of the external root, thus special attention should be given for preserving sufficient amount of remaining dentin.¹³

However, enlargement of the coronal third of the root canal space is considered important to support root canal length measurement, debris removal, effective irrigation, and canal obturation. Extensive use of rotary instruments during preparation of the root canal space by cutting the dentin to gain straight lines access weakens the root structure.

Desiccation and dehydration of the dentin are also a few of the causes that may predispose to the weakening of tooth. Rundquist *et al.* (2006) stated that with increasing taper, root stresses decreased during root filling but tended to increase for masticatory loading, resulting fracture originating in the cervical portion.¹⁴

Growing attention has been given to procedures carried out after completion of endodontic treatment as well as their impact on the prognosis of non-vital teeth.¹⁵ According to Dietschi *et al.*, the tooth strength is reduced in proportion to coronal tissue lost due to either carious lesions or restorative procedures.¹⁶

There is a connecting link between the amount of remaining tooth structure and its ability to resist occlusal forces.¹⁷ Hence, it's very important to provide a restoration after completion of root canal treatment for avoiding fracture of tooth. Several other factors also affect the fracture resistance of teeth are: amount of tissue lost and its location^{18,19}, magnitude and duration of load¹⁷, tooth type, direction of applied load and slope of the cuspal inclines.^{18,20}

To reinforce endodontically treated tooth, stress concentrations at the dentin-material interface should preferably be minimized by using materials with a modulus of elasticity similar to that of the dentin (14-16 GPa).²¹

In the present study, gutta-percha combined with the tested endodontic sealer (AH Plus) was not able to increase the root fracture resistance significantly in all the groups including the control group. Zandbiglari *et al.* (2006) also observed that roots get significantly weakened with the use of greater taper instruments and obturation with AH Plus sealer was not able to increase the fracture resistance.²²

Based on this context, the present study evaluated the reinforcing ability of postendodontic materials like RMGIC, multicore flow, and SDR bulk fill flow. The presence of intraorifice barriers increases the fracture resistance of endodontically treated teeth as compared to endodontically treated teeth without intraorifice barriers. The fracture strength values of the test groups revealed that fracture resistance of the roots was positively affected by the type of intraorifice barrier used.

The results of this study are in accordance with study by Gupta A *et al* 2016³ in which RMGIC showed the maximum fracture resistance. RMGIC has high flexural strength and modulus of elasticity (10-14 GPa) close to the dentin and thus, the material can withstand a large

amount of stress before transmitting the load to the root.²³ All these properties might have resulted in RMGIC being the most fracture-resistant material tested in the present study.

Aboobaker *et al.* (2015) also have reported RMGIC and flowable resin to be an effective intraorifice barrier with significantly high resistance.²

RMGIC chemically bonds with the dentinal surface, rendering more strength at the dentin cement interface.²⁴ Superior performance of RMGIC is explained also by the water sorption by the material, resulting in setting expansion and a better seal.¹¹

The high Fracture resistance in SDR compared to multicore flow may be due to compositions of each material. The polymerization stress had been reduced in SDR by 50% or more compared to conventional resin composites.²⁵ Presence of "polymerization modulator" which is included chemically in the polymerizable resin may have reduced the polymerization stresses.²⁶ SDR has good internal adaptation in high c-factor cavities with its self levelling property.²⁷

Multicore Flow is resin-based composite which is dual-curing, containing fluoride fillers. Multicore has filler loading of only 46 % by volume compared to 68% in SDR which may account for reduced fracture resistance.²⁸

In this study, the presence of intra orifice barriers strengthen the fracture resistance of endodontically treated teeth as compared to endodontically treated teeth without intra orifice barriers. After RCT, the teeth will fracture because of loss of vitality and moisture content, but with the help of intra orifice barriers fracture resistance of teeth can be extended without the presence of full coverage restorations. Intra orifice barriers not only provide fracture resistance but also coronal sealing, thereby boosting the outcome of endodontic treatment.²

Root reinforcement with the tested intraorifice barriers did not totally reduce the susceptibility of roots to fracture. Further laboratory research with different materials coupled with clinical trials is necessary to validate the results of this *in vitro* study.

Conclusion

Endodontically treated roots with an intraorifice barrier are more resistant to fracture compared with those without ones. Fracture resistance of roots was significantly affected by the type of intraorifice barrier.

Within the limitations of this study, it might be concluded that the reinforcement of obturated roots with, RMGIC, SDR or Multicore Flow, as intraorifice barriers can be regarded as a viable choice to reduce the occurrence of postendodontic root fractures.

However, more studies with simultaneous testing of both microleakage and mode of failures are needed including more materials and parameters.

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