Original Research Paper

Volume - 12 | Issue - 06 | June - 2022 | PRINT ISSN No. 2249 - 555X | DOI : 10.36106/ijar

Clinical Research

A COMPARATIVE ASESSMENT OF FRACTURE RESISTANCE OF ENDODONTICALLY TREATED TEETH USING FOUR DIFFERENT INTRAORIFICE BARRIER : AN IN VITRO STUDY

Yogesh Sahu	Professor, Department of Conservative Dentistry & Endodontics, Maitri College of Dentistry and Research Centre, Anjora, Durg
Manjunath Malur*	Professor & HOD, Department of Conservative Dentistry & Endodontics, Maitri College of Dentistry and Research Centre, Anjora, Durg*Corresponding Author
Kalyan V Lad	PG student, Department of Conservative Dentistry & Endodontics, Maitri College of Dentistry and Research Centre, Anjora, Durg
Ankita Singh	Reader, Department of Conservative Dentistry & Endodontics, Maitri College of Dentistry and Research Centre, Anjora, Durg
Praveen Mishra	Reader, Department of Conservative Dentistry & Endodontics, Maitri College of Dentistry and Research Centre, Anjora, Durg
Shruti Sharma	Senior Lecturer, Department of Conservative Dentistry & Endodontics, Maitri College of Dentistry and Research Centre, Anjora, Durg

ABSTRACT **AIM :** The aim of this invitro study is to investigate and compare root reinforcement potential of endodontically treated teeth using four different intraorifice barriers. **MATERIALS AND METHODS :** Twenty five extracted single – rooted mandibular premolars were decoronated to a standardised length and instrumentated with Dentsply Protaper Gold rotary system and obturated with corresponding gutta-percha cones and AH Plus sealer. The samples were randomly divided into five groups (n= 5) on the basis of intraorifice barrier material used. Group 1 : No Barrier (control) , Group 2 : Endocem Zr , Group 3 : MTA , Group 4 : Cention, Group 5 : Conventional Glass Ionomer Cement (GIC). Except for the control group specimens , coronal 3 mm gutta percha was removed and replaced using various intraorifice materials in respective groups. Fracture resistance test was applied using a universal testing machine. **STATISTICAL ANALYSIS USED :** Data were analysed using One way analysis of variance test and Post hoc Tukey's test **RESULTS :** Fracture resistance was significantly higher in experimental groups (restored with intraorifice barrier) than control group (no intraorifice barrier placed). According to the result of present study Endocem Zr demonstrated significantly highest mean fracture resistance while Control group demonstrated the least and the difference between their mean fracture resistance was statistically significant . There was no statistically significant difference among other experimental groups. **CONCLUSION :** Within the limitations of present in vitro study, the placement of an intra- orifice barrier can be regarded as beneficial for reinforcement of an endodontically treated teeth.

KEYWORDS : Intraorifice barrier , AH Plus sealer , Endocem Zr , MTA , Cention , Conventional Glass Ionomer Cement (GIC)

INTRODUCTION :

The primary objective of root canal therapy is to make root canal system free of all the microbial infection to obtain a three dimensional fluid impervious obturation along the root canal from coronal intraorifice to apical constriction.[1] However, endodontically treated tooth are more susceptible to fracture than vital teeth due to many iatrogenic and noniatrogenic factors some of which include wide canal taper,occlusal stresses,dehydration of dentinal tubules and reduced mechanical properties contributing to fatigue induced root fracture.[2]

During instrumentation numerous transient contacts occur between instruments and canal walls that create stress concentrations in dentin that induce dentinal defects or craze lines and microcracks.[1]Applying the concept of "extension for prevention" facilitates treatment procedures but removes valuable dentin at the cervical region, leaving tooth structure biomechanically compromised after endodontic treatment.[3]These teeth are brittle in the cervical region and need reinforcement.[8]Irrigants and medicaments used during biomechanical preparation alter collagen structure which contributes to the alteration of mechanical properties of dentin,thus precipitating fatigue crack propagation and hence increasing the susceptibility to vertical root fracture.[2]

Current root canal filling material such as resilon and gutta percha which have low modulus of elasticity as compared to dentin.[2] Restoring with the material having modulus of elasticity as same as that of dentin (14–16 Gpa) at material-dentin interface can provide stiffness against forces that generate root fractures.[4]As reasons for tooth weakening are multifactorial reinforcement of both remaining coronal & radicular tooth structure is important to protect them against fracture.[1]

Thus there is need for different material to overcome the shortcomings of current endodontic root canal filling material to reinforce roots that is known as intra-orifice barriers.[2]

Intra orifice barrier apart from enhancing probability success of endodontic treatment may also augment periodontal therapy as intra pulpal infection is known to contribute in worsening of periodontal health by promoting marginal bone loss and pocket formation.[5]

The ideal intraorifice barrier has not been identified yet or, perhaps, not even developed.

Wolf et al. proposed the following criteria for the ideal intraorifice barrier:
(i) easily placed by the specialist
(ii) bonds to tooth structure (retentiveness)
(iii) effectively seals against coronal microleakage
(iv) easily distinguished from natural tooth structure
(v) does not interfere with the final restoration of the access preparation.

Intraorifice barriers are usually used before bleaching for coronal sealing and cervical resorption due to penetration of bleaching agents from dentinal tubules to periodontal tissues. Therefore it is necessary to prevent penetration of bleaching agents from pulp chamber into root canal and cervical periodontal tissues .[7]Conventionally, few materials like GIC, RMGIC, composites have been evaluated for their use as intracoronal barriers, but not many studies have reported Endocem Zr as a barrier material.[6]

Endocem Zr (Maruchi, Wonju,Korea), which is a zirconium oxide-containing white MTA-like material. These materials are claimed to set within 4 min according to the manufacturer.[3] Its advantages are fast setting time (4 min), biocompatibility, osteogenecity and minimal tooth discoloration.

Thus the present study is designed to evaluate fracture resistance of endodontically treated teeth using Endocem – Zr, MTA, Cention and conventional GIC as intra-orifice barriers.[1]

MATERIAL METHODS :

SPECIMEN COLLECTION

Freshly extracted twenty five single rooted mandibular premolars with almost similar dimensions were selected. Clinical and radiographic evaluation was done to exclude teeth with crack lines, internal or external resorption, curved roots, calcifications or multiple canals.[1]

SPECIMEN PREPARATION

Soft tissues & calculus were mechanically removed by ultrasonic scaler and samples were stored in saline at room temperature[4] The teeth were decoronated to 14mm with mandrel and disc under copious water cooling.[7]

CANAL PREPARATION

A #10 K- file (Mani , Japan) was inserted and advanced until it was visualized at the apical foramina.

The root canals were instrumented with hand files upto # 20 K file (Mani Japan) 1mm short of apex followed by Rotary Protaper Gold system (Dentsply Maillefer, Ballaigues, Switzerland) in a sequential manner with endomotor (E-Connect Pro, Orikam Healthcare India Pvt. Ltd, India) using crown-down technique, as per manufacture's instructions.[10]

Irrigation was performed using 5ml of 5% sodium hypochlorite in between each instrumentation followed by final irrigation with 5ml of 17% ethylenediaminetetraacetic acid after which the canals were rinsed with 10 ml of distilled water and subsequently dried with sterile paper points.[2]

CANAL OBTURATION

The canals were obturated using corresponding sized F3 gutta percha (Dentsply Maillefer, Ballaigues, Switzerland) and AH Plus sealer.The excess gutta percha was sealed off with heated instrument and burnished till the level of orifice.[p] Specimens were then stored in an incubator at 37ºC and 100% relative humidity to allow complete set of the sealer.

PLACEMENT OF INTRAORIFICE BARRIERS

The coronal 3mm of the root canal obturation was removed from all samples using a heated plugger. p Obturated specimens were divided with respect to intraorifice barrier material placed over the root canal filling and were randomly divided into five experimental groups.[2]

GROUP 1 : NO BARRIER (control group)
(n= 5) In this group , there was no removal of gutta–percha and no placement of intra-orifice barrier.

GROUP 2 : ENDOCEM Zr
(n = 5)

GROUP 3 : MTA
(n = 5)

GROUP 4 : CENTION N
(n = 5)

GROUP 5 : CONVENTIONAL GLASS IONOMER CEMENT (GIC)
(n = 5)

After placing respective intraorifice barrier materials as per manufacture's instructions, all the specimens were stored at 100% relative humidity 1 week to allow the materials to set completely.[1]

The apical root ends were mounted along their long axis in self-curing acrylic blocks, leaving coronal 9 mm of each root exposed.[2]

FRACTURE RESISTANCE TEST

The fracture resistance test was performed using universal testing machine . A custom stainless steel loading fixture tip was centered over canal opening over intra-orifice barrier material and a compressive force was applied at a crosshead speed of 1mm/min until the fracture occurred. The forces necessary to fracture each root segment was recorded in Newtons (N).

RESULTS :

Results were statistically analysed using SPSS version 21. Overall group comparison of fracture resistance was made using one way analysis ANOVA. Intergroup comparison was made using Post hoc pairwise comparison using Tukey's test. The level of statistical significance was set at 0.05. The mean fracture resistance of control group **was** 153.76 ±30.28,in Endocem Zr Group it was 290.90± 74.82,in MTA group it was 258.40 ±52.48,in Cention N it was 216.20±96.85 & In conventional GIC it was 159.00±42.91.

Table 1 : Mean Fracture resistance values among different study Groups

.N.	Study group	Mean Fracture resistance in Newtons (Mean ± S.D.)
1.	Group I	153.76 ±30.28
2.	Group II	290.90± 74.82
3.	Group III	258.40 ±52.48
4.	Group IV	216.20±96.85
5.	Group V	159.00±42.91

Table 2 : Comparison of Mean Fracture Resistance among different study Groups on applying ANOVA test

Groups Comparison		Mean Difference	P value	95% Confidence Interval	
				Lower Bound	Upper Bound
Group I	Group II	-137.14000	.022(S)	-258.3053	-15.9747
	Group III	-104.64000	.112(NS)	-225.8053	16.5253
	Group IV	-62.44000	.549(NS)	-183.6053	58.7253
	Group V	-5.24000	1.000(NS)	-126.4053	115.9253
Group II	Group I	137.14000	.022(S)	15.9747	258.3053
	Group III	32.50000	.927(NS)	-88.6653	153.6653
	Group IV	74.70000	.377(NS)	-46.4653	195.8653
	Group V	131.90000	.029(S)	10.7347	253.0653
Group III	Group I	104.64000	.112(NS)	-16.5253	225.8053
	Group II	-32.50000	.927(NS)	-153.6653	88.6653
	Group IV	42.20000	.833(NS)	-78.9653	163.3653
	Group V	99.40000	.142(NS)	-21.7653	220.5653
Group IV	Group I	62.44000	.549(NS)	-58.7253	183.6053
	Group II	-74.70000	.377(NS)	-195.8653	46.4653
	Group III	-42.20000	.833(NS)	-163.3653	78.9653
	Group V	57.20000	.627(NS)	-63.9653	178.3653
Group V	Group I	5.24000	1.000(NS)	-115.9253	126.4053
	Group II	-131.90000	.029(S)	-253.0653	-10.7347
	Group III	-99.40000	.142(NS)	-220.5653	21.7653
	Group IV	-57.20000	.627(NS)	-178.3653	63.9653

Table 3: Pairwise Comparison of fracture resistance after applying Post Hoc (Tukey) test

S.N.	Study group	Mean Score in mm(in Newtons) (Mean ± S.D.)	F value	p value
1.	Group I	153.76 ±30.28	4.43	0.010 (p <0.05) Statistically Significant
2.	Group II	290.90± 74.82		
3.	Group III	258.40 ±52.48		
4.	Group IV	216.20±96.85		
5.	Group V	159.00±42.91		

Discussion

A fracture is a complete or incomplete interuption in a material which develops from the implementation of too much force. Fracture resistance is the integral property of a material by virtue of which it resists plastic deformation under a specific load. It dictates its ability to exhibit resistance to occlusal forces produced both in function and parafunction.6 Much more of the Attention has been given to procedures administrated after completion of endodontic treatment in addition as their impact on the prognosis of non-vital teeth.Decreased fracture resistance 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 tend for securing sufficient remaining dentin.[1]

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. 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.[7]

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.8 Nagas et al. showed that intraorifice barriers could also be used to provide resistance against forces that generate root fractures & showed that the reinforcing effect was material-dependent (Mithali Jain). So, the present study evaluated the reinforcing ability of 4 materials EndocemZR,MTA, Cention N,GIC used as intraorifice barriers.

S.aboobaker etal concluded that presence of intraorifice barriers leads to greater fracture resistance.Tetric N Flow & Fuji GC LC GIC can be used as intraorifice barrier with good fracture resistance in obturated roots.

M.jain etal compared MTA,Cention & Nanohybrid Composite as Intraorifice barrier and concluded that use of nanohybrid composite significantly improved fracture resistance followed by cention N and MTA as compared to the control group.

E.Yasa Etal used Fibre reinforced composite,Nanohybrid composite,Bulk fill composite,MTA & Biodentine as intraorifice barrier Material and concluded that use of MTA as an introrifice barrier did not significantly increase the fracture Resistance of endodontically treated roots compared to the control group.

ENDOCEM-Zr (MARUCHI, Wonju, Korea) is a white, fast-setting, pozzolan-based MTA, with excellent properties of minimal discolouration and calcification. It mainly consists of oxides of calcium, silicon aluminum, magnesium and iron along with zirconium oxide radio-opacifiers. Also study conducted by S.Hang kong etal concluded that,the newly introduced ENDOCEM Zr which contain zirconium oxide, exhibited less discoloration compared to Grey MTA,which contain bismuth oxide(S.hang kong).8Additionally Endocem ZR which contains Pozzolon Particles,helps in easy manipulation and quick setting of the cement.Pozzolon is a siliceous material finely divided into pozzolon particles which increases the area of surface contact of mixing liquid.This increases the reactivity of calcium silicate particles with water resulting in formation of compound with cementitious properties(i.e, calcium hydroxide and calcium silicate hydrate phases). Further calcium hydroxide reacts with oxides of pozzolon known as pozzolonic reaction which is similar to an acid-base reaction leading to the gradual reduction in the free calcium hydroxide particles which has detrimental effects on the durability & mechanical strength of the material. Simultaneously there is formation of additional calcium silicate hydrate & aluminate particles which are more stable & increase the strength of the cement.(Silva). This explains that in this study Endocem ZR showed difference in fracture resistance as compared to MTA.10
Cention N is a urethane dimethacrylate-based, self-curing powder & liquid restorative with optional additional light curing. Its powder contains various glass fillers, initiators, pigments and liquid contains dimethacrylates and initiators. Cention N has modulus of elasticity 13 Gpa,which is close to normal dentin.Cention N also includes isofiller (Tetric N-Ceram technology), which are nanoparticle size,which acts as shrinkage stress reliver.This isofiller particles increases the microhardness of cement after setting.This distinctive use of cross-linking methacrylate monomers & self cure initiator,it shows strong polymer network density. Kanwalpreet Kaur. This might be the reason that in this study Cention N showed no significant difference in fracture resistance as compared to Endocem ZR group & MTA Group.[11]

GICs, contrastingly, are principally made up of alumina, silica, and polyacrylic acid and self-curing materials. These are commonly presented as an aqueous solution of polymeric acid and a finely divided glass powder, which are mixed by an appropriate method to form a viscous paste that sets rapidly.13 They show an interfacial ion-exchange layer with the tooth, and this is responsible for the high durability of their adhesion to the tooth surface. GIC is a solitary restorative materials that depend fundamentally on a chemical bond to tooth structure. They establish an ionic bond to hydroxyapatite at dentin surface and also gain mechanical retention from microporosities in the hydroxyapatite.12 GICs establish inferior initial bond strength to dentin than resins, (3–7 Mpa). The present study showed a statistically significant difference between fracture resistance of GIC Type IX and Endocem ZR.(Kanwalpreet Kaur Bhullar1)

The use of intraorifice barriers for root reinforcement did not completly rule out the susceptibility for root fracture. However, within the limitations of this study, it might be concluded that the reinforcement of obturated roots with Endocem ZR,MTA and Cention N as intraorifice barriers can be considered as a viable choice to reduce the occurrence of postendodontic root fractures.

CONCLUSION
Within the limitations of this study, it can be concluded that:

- Endodontically treated roots with an intraorifice barrier are more resistant to fracture as compared to those without one.
- Endocem ZR,MTA and Cention N significantly increase the fracture resistance of endodontically treated teeth.
- Endocem ZR showed the highest mean fracture resistance followed by MTA >Cention N >GIC.

REFERENCES

1. C Parul, Garg Ashima, M Rakesh, K Hemanshi. A comparative evaluation of fracture resistance of endodontically treated teeth tooth using four different intraorifice barriers : An vitro study. J conserve Dent 2019;22:420-4
2. Randow K, Glantz PO. On cantilever loading of vital and non-vital teeth. An experimental clinical study. Acta Odontol Scand 1986;44:271-7.
3. Howe CA, McKendry DJ. Effect of endodontic access preparation on resistance to crown-root fracture. J Am Dent Assoc 1990;121:712-5.
4. Gutmann JL. The dentin-root complex: anatomic and biologic considerations in restoring endodontically treated teeth. J Prosthet Dent 1992;67:458-67.
5. Reeh ES, Messer HH, Douglas WH. Reduction in tooth stiffness as a result of endodontic and restorative procedures. J Endod 1989;15:512-6.
6. Re GJ, Norling BK, Draheim RN. Fracture resistance of lower molars with varying faciocclusolingual amalgam restorations. J Prosthet Dent 1982;47:518-21.
7. Larson TD, Douglas WH, Geistfeld RE. Effect of prepared cavities on the strength of teeth. Oper Dent 1981;6:2-5.
8. Stankiewicz NR, Wilson PR. The ferrule effect: a literature review. Int Endod J 2002;35:575-81.
9. Jotkowitz A, Samet N. Rethinking ferrule--a new approach to an old dilemma. Br Dent J 2010;209:25-33.
10. Fernandes AS, Dessai GS. Factors affecting the fracture resistance of post-core reconstructed teeth: a review. Int J Prosthodont 2001;14:355-63.
11. 11.Naumann M, Blankenstein F, Kiessling S, Dietrich T. Risk factors for failure of glass fiber reinforced composite post restorations: a prospective observational clinical study. Eur J Oral Sci 2005;113:519-24.
12. Vire DE. Failure of endodontically treated teeth: Classification and evaluation. J Endod 1991;17:338-4