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RESEARCH ARTICLE

TO COMPARE THE EFFECT OF DIFFERENT INTRAORIFICE BARRIERS ON THE FRACTURE RESISTANCE OF ENDODONTICALLY TREATED ROOTS OBTURATED WITH GUTTA PERCHA: AN IN VITRO STUDY

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ABSTRACT

Aim: To compare the effect of different intraorifice barrier materials Ever X Posterior , Cention N, Resin-Modified Glass Ionomer Cement (RMGIC) on the fracture resistance of roots obturated with GuttaPercha and AH Plus sealer.

Objective:

1.To evaluate fracture resistance of Ever X Posterior as intraorifice barrier.
2.To evaluate fracture resistance of Cention N as intraorifice barrier.
3.To evaluate fracture resistance of RMGIC as intraorifice barrier.

Materials and Methods: Forty mandibular premolars were decoronated to a standardized length, and prepared and obturated with gutta-percha and AH Plus sealer. The coronal 3-mm gutta-percha was removed and filled with different materials, except for control specimens. The specimens (40) were divided into four groups (n = 10) on the basis of the intraorifice barrier material used. Group 1: Ever X Posterior, Group 2: RMGIC, Group 3: Cention N, Group 4: No barrier (control). Fracture resistance of the specimens was tested.

Results: The mean force required for vertical fracture to occur in all 4 groups can be arranged in following manner:

Ever X Posterior >Cention N > RMGIC> Control.

Conclusions: Ever X Posterior and Cention N significantly increase the fracture resistance of endodontically treated teeth.

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INTRODUCTION

Endodontically treated teeth are more susceptible to fracture than vital teeth because of excessive loss of tooth tissue, dehydration of the dentin, and pressure during obturation procedures. Previous clinical studies have shown that 11-13% of extracted teeth with endodontic treatment are associated with vertical root fractures, rendering it the second most frequent identifiable reason for loss of root-filled teeth.(1,2) The strength of an endodontically treated tooth is directly related to the amount of remaining sound tooth structure. Caries removal, access preparation, canal instrumentation, use of irrigants and medicaments, excessive widening of root canals and preparation for the final restoration all lead to loss of tooth structure, structurally weakening the tooth. The most catastrophic result of this is tooth or root fracture.(3,4) With the recent advancements in adhesive technology and stronger adhesive materials, it is now possible to use composite materials that are bonded directly to the tooth structure and strengthen it.(5) In order to reduce polymerisation shrinkage, use of laboratory-prepared indirect resin restorations that adhere to the tooth structure is recommended. They can provide a favorable reinforcement for extensively damaged teeth.(6) Considering that root canal treatment is necessary, it would be advantageous if the radicular canal obturation, in addition to providing an adequate seal, could decrease the

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root fracture susceptibility through an adhesive filling material. However the adhesive potential of guttapercha to root dentin is far from satisfactory,(7,1) Roghanizad and Jones suggested placing a coronal seal in the orifice of the root canal immediately after root canal therapy can prevent coronal microleakage(8) Through the use of restorative materials with elastic moduli similar to the dentin or the materials that can be bonded to dentin or the materials that have good flexural strength it might be logical to assume that intraorifice barriers can also provide stiffness against forces that generate root fractures. So the objective of this study was to evaluate the effect of three different intraorifice barrier materials Ever X Posterior, Resin-Modified Glass Ionomer Cement (RMGIC), Cention N on the fracture resistance of roots obturated with gutta-percha and AH Plus sealer.

Inclusion Criteria

- Teeth extracted for periodontal and orthodontic reasons.
- Permanent teeth with intact and developed apices.
- No previous endodontic treatment.
- Single rooted premolars with single canal.

Exclusion Criteria

- Premolars with resorption.
- Premolars with calcification.
- Premolars with open apices.
- Premolars with previous root canal treatment.
- Premolars with fracture.
- Premolars with curved roots.
- Premolars with more than 1 canal.

MATERIALS AND METHODS

Forty freshly extracted mandibular premolars from patients for orthodontic or periodontal purposes were collected for the study. Ethical clearance was obtained by the Institution Ethical Committee. A total of 40 extracted human single rooted mandibular premolars with single canal and less than 10° curvature with approximately same dimension were selected and stored in 1% chloramine-T (Himedia Labs, Mumbai, India) solution for 12 h followed by storage in distilled water until use. All the teeth were examined under a stereomicroscope at 10X magnification to ensure the absence of preexisting fractures. Specimens were decoronated with diamond disc and water as a coolant to a standardized length of 14 mm. Instrumentation and obturation of root canal system After determination of the working length, root canals were instrumented with rotary ProTaper universal system (DentsplyMaillefer, Ballaigues, Switzerland) in a sequential manner till F3 using crown down technique (as per manufacturer' instructions). During instrumentation, canals were irrigated with 2 mL of 5.25% sodium hypochlorite after each change of file and final rinse of 5 mL 17% ethylenediaminetetraacetic acid (EDTA). Finally, canals were flushed with 10 mL of distilled water and dried with paper points. Obturation was performed using corresponding gutta-percha (Dentsply Maillefer, Ballaigues, Switzerland) and AH Plus Sealer (De Trey-Dentsply, Konstanz, Germany). Excess gutta-percha protruding out of the root canal was seared off with a hot burnisher. The samples were then stored in an incubator, at 37°C for 8 h to allow complete set of the sealer. Placement of intraorifice barrier except for control specimens, coronal 3 mm of root canal obturation was meticulously removed with the aid of a customized spoon excavator (API Ashoosons, Mehrauli, New Delhi), heated red hot on a Bunsen burner and later on with alcohol (70%)-moistened microbrushes to remove sealer remnants.
The specimens were randomly divided into four groups with respect to the intraorifice barrier material used over root canal obturation. Each group consisted of 10 specimens.

Group I: (n = 10) : Ever X Posterior was according to the manufacturer's recommendation and placed incrementally with gun into prepared coronal space and condensed with the help of condenser.
Group II: (n = 10) After mixing according to the manufacturer's instructions, RMGIC was placed into the cavity using plastic carrier instrument and condensed.
Group III: (n = 10): After dentin conditioning with 37% phosphoric acid for 15s, the preparation was rinsed with distilled water for 10s, and excess moisture was removed with moist cotton. A thin layer of bonding agent was applied with applicator tips and light-cured for 10 s. Cention N was placed in the prepared space. Light-curing was performed for 40 s.
Group IV: (n = 10):
The coronal 3 mm of gutta-percha was not removed
After placement of the intraorifice barrier materials, all the specimens were stored at 37°C and 100% humidity for 1 week in an incubator to allow the materials to set completely. Mounting and testing of specimens: The apical root end of each tooth was aligned vertically along their long axis in self-curing acrylic filled in 10 × 10 × 20 mm dimension (length × breadth × height) stainless steel blocks, leaving 3 mm of each root exposed. Periodontal ligament (PDL) simulation was performed using light body elastomeric impression materials .The specimens were mounted on a universal testing machine and a compressive force was applied at a crosshead speed of 1 mm/min until fracture occurred. The force necessary to fracture each specimen as displayed on the monitor was recorded in newton (N).

RESULTS

The mean force required for vertical fracture to occur in all 4 groups can be arranged in following manner:

Ever X Posterior >Cention N > RMGIC> Control

Statistical Analysis

Statistical analysis was done by using descriptive and inferential statistics using one way ANOVA and Multiple comparison: Tukey test and software used in the analysis were SPSS 22.0 version and EPI-INFO 7.0 version and $p<0.05$ is considered as level of significance. Mean fracture resistance in control group was 307.70±109.17, in Ever X posterior it was 801±202.13,in Cention N group it was 734.10±170.54 and in RMGIC group it was 491.60±79.18.

Comparison of fracture resistance in four groups

Descriptive Statistics

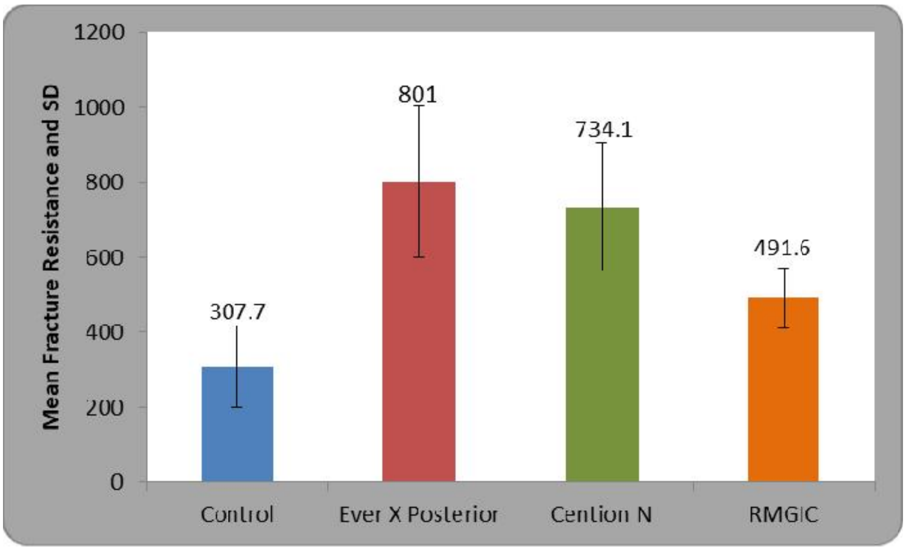
Group	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Control	10	307.70	109.17	34.52	229.60	385.79	162.50	451.00
Ever X Posterior	10	801.00	202.13	63.91	656.40	945.59	473.00	991.00
Cention N	10	734.10	170.54	53.93	612.09	856.10	585.00	1052.00
RMGIC	10	491.60	79.18	25.03	434.95	548.24	362.00	584.00

One way ANOVA

Source of variation	Sum of Squares	df	Mean Square	F	p-value
Between Groups	1544978.20	3	514992.73	23.37	0.0001,S
Within Groups	793191.90	36	22033.10		
Total	2338170.10	39			

Multiple comparison:Tukey Test

Group		Mean Difference (I-J)	Std. Error	p-value	95% Confidence Interval	
					Lower Bound	Upper Bound
Control	Ever X Posterior	-493.30	66.38	0.0001,S	-672.08	-314.51
	Cention N	-426.40	66.38	0.0001,S	-605.18	-247.61
	RMGIC	-183.90	66.38	0.042,S	-362.68	-5.11
Ever X Posterior	Cention N	66.90	66.38	0.746,NS	-111.88	245.68
	RMGIC	309.40	66.38	0.0001,S	130.61	488.18
Cention N	RMGIC	242.50	66.380	0.004,S	63.71	421.28



By using one way ANOVA statistically significant variation was found in mean fracture resistance in samples of four groups (F=23.37,p=0.0001).

On comparing mean fracture resistance in four groups statistically significant difference was found between

1. Control And Ever X Posterior Group (P=0.0001),
2. Control And Cention N Group (P=0.0001),
3. Control And RMGIC group (p=-0.042),
4. Ever X posterior And RMGIC group(p=0.0001) and
5. Cention N And RMGIC group (p=0.004),

However Ever X posterior and Cention N group it shows NO statistically significant difference (p=0.746).

DISCUSSION

A fracture is a complete or incomplete break in a material resulting from the application of too much force. Fracture resistance is an key property directly associated to cracking. Fracture resistance is the inbuilt property of a material by virtue of which it resists plastic deformation under a particular load. It determines its ability to exhibit resistance to occlusal forces produced both in function and parafunction (9,10) Endodontically treated teeth are susceptible to fracture and is intrinsic to root canal morphology, dentin thickness, canal shape and size and curvature of external root. Enlargement of coronal third of root canal space is considered important to support root canal length measurement, debris removal, effective irrigation and canal obturation. Use of rotary instruments during preparation of root canal space by cutting the dentin to gain straight line access weakens the root structure. Dessication and dehydration of dentin are also few causes that may predispose to the weakening of tooth. The ability to predictably restore a root-filled tooth to its original strength and fracture resistance is a matter of concern and various efforts are made to achieve the same. Placement of intraorifice barrier i.e removal of coronal 3mm of guttapercha and sealer and placement of restorative material is found to improve fracture resistance of endodontically treated teeth. So, the present study evaluated the reinforcing ability of 3 materials Ever X Posterior, Cention N, RMGIC used as intraorifice barriers.

Result in this study has shown that the presence of intraorifice barriers strengthen the fracture resistance of endodontically treated teeth as compared to endodontically treated teeth without intraorifice barriers. Ever X Posterior >Cention N > RMGIC> Control Ever X posterior(GC Tokyo Japan) is a short fibre reinforced composite has gained attention recently as restorative material and is recommended to be used in high stress bearing area.The manufacturers claim that this material prevents or arrests crack propagation. This may be attributed to short glass fibre fillers composed of barium glass and silanated E glass fibres (10-12). It is also claimed that it provide isotropic reinforcement effect in multiple directions instead of 1 or 2 directions. No comparative study has been uptil made using this material as intraorifice barrier. So this material was included in this study to check the fracture resistance of endodontically treated teeth with other materials. The fibre length of 1-2mm and diameter of 16 um wide which is more than the critical length fibre. It is claimed that individual fibre act as crack stopper or crack arrest barrier. Because of this critical length and multiple direction of fibres, Ever X Posterior showed highest fracture resistance amongst all.(13-15). Resin modified GIC (RMGIC) was introduced in the late 1980, and it is composed of some methacrylate components common in resin composites. It showed superior performance as an acceptable coronal seal over 90 d reported by Tselnik *et al*., due to the superior performance of RMGIC explained by water sorption by the material, resulting in setting expansion and consequently a better seal is achieved.

RMGIC requires no pre-treatment of dentin and can adhere to it and another useful property of RMGIC is the release of fluoride (16,17) RMGIC have high flexural strength and modulus of elasticity. Also modulus of elasticity value (14-16 GPA) is similar to dentin, material can withstand large amount of stress before transmitting the load to the root (1,2). This explains that in this study RMGIC showed significant difference in fracture resistance as compared to control group. This result is in conjunction with previous studies done by Gupta *et al*. (2016) and Nagas *et al* (2010). However Ever X Posterior and Cention N were not included in their studies. Ever X Posterior have glass fiber fillers while cention N have patented filler content which further increases the strength so were included in this study. Cention N (Ivoclar Vivadent) - The new filling material that belongs to the materials group of Alkasites that offers tooth-coloured esthetics together with high flexural strength.

Cention N contains organic monomer in the liquid consisting of four different dimethacrylates a combination of UDMA, DCP and PEG-400 DMA which interconnect during polymerization reaction. UDMA is the main component of the monomer matrix. The stronger mechanical properties may be credited to its higher viscosity and lack of hydroxyl side groups which are hydrophobic in nature hence reveal lower water absorption. DCP has a cyclic aliphatic structure which allows enhancement of strength. Cention N higher strength values may be because of dense polymer network and degree of polymerization (9,10). The powder of the material consists of barium aluminium silicate glass filler, ytterbium trifluoride, Isofiller (Tetric N-Ceram technology), calcium barium aluminium fluorosilicate glass filler and calcium fluorosilicate an alkaline glass filler. The fillers particle size ranges between 0.1 m and 35 m. These fillers are responsible for imparting adequate strength to withstand the stresses and strains of the oral cavity and to achieve acceptable clinical longevity. The Isofiller is a patented filler functionalized by silanes and it is bonded to other filler particles. This enhances the bond between the organic monomer matrix and the inorganic filler& keeps shrinkage stress to a minimum. (18-20).

This might be the reason that in this study Cention N showed no significant difference in fracture resistance as compared to Ever X Posterior group. The use of intraorifice barriers for root reinforcement did not totally eliminate the susceptibility for root fracture. However, within the limitations of this study, it might be concluded that the reinforcement of obturated roots with Ever X Posterior and Cention n as intraorifice barriers can be considered as a viable choice to reduce the occurrence of postendodontic root fractures. However further studies are needed with more different materials and parameters for clinical day to day practice.

Conclusion

Within the limitations of this study, the following conclusions can be drawn

- Endodontically treated roots with an intraorifice barrier are more resistant to fracture compared with those without one.
- Fracture resistance of roots was significantly affected by the type of intraorifice barriers.
- Ever X Posterior and Cention N significantly increase the fracture resistance of endodontically treated teeth.
- Ever X Posterior yeilded the highest fracture resistance followed by Cention N and RMGIC.

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