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Incidence of apical crack formation and propagation during removal of root canal filling materials with ProTaper Universal retreatment and R-Endo retreatment instruments: An in-vitro study.

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Abstract

Objectives: To determine the incidence of crack formation and propagation in apical root dentin during retreatment procedures performed using ProTaper Universal Retreatment and R-Endo Retreatment file systems.

Materials and Methods: Thirty extracted maxillary central incisors were selected. 1mm from the apex of each tooth was ground and polished perpendicular to the long axis of the tooth. Samples were obturated and then divided into 3 groups. Group I control: (n=10) obturated teeth served as the negative control group where no retreatment procedure was performed. Group II ProTaper Universal retreatment (PTUR): (n=10) retreatment procedure was performed using ProTaper Universal retreatment rotary files. Group III R-Endo: (n=10) retreatment procedure was performed using R-Endo retreatment rotary files. Digital images of the apical root surfaces were recorded before preparation, after preparation, after obturation and after filling removal using a stereomicroscope at 10X magnification. The images were then inspected for the presence of any new apical cracks and crack propagation. Data was analyzed using one way ANOVA and Unpaired 't' test.

Results: Both experimental groups showed crack initiation and propagation after retreatment. The ProTaper

retreatment group caused greater crack initiation and propagation (0.823) than the R-Endo group (0.677).

Conclusions: Within the limitation of this in vitro study, both the experimental groups showed crack formation and propagation in apical dentin after retreatment procedure. **Keywords:** microcracks, apical dentine, retreatment,

ProTaper Universal retreatment, R-Endo.

Introduction

Failures are the pillars of success. Endodontic failures are no exception. When root canal therapy fails, treatment options include conventional (orthograde) retreatment, periradicular surgery, or extraction.^[1,2] The main goal of orthograde retreatment is regaining access to the apical foramen by complete removal of root canal filling material thus facilitating sufficient cleaning and shaping of the complete root canal system and final obturation.^[3] Several techniques can be used to remove the root canal filling material which includes use of stainless steel hand files,^[4,5] Gates Gliden drills, nickel-titanium (NiTi) rotary ultrasonic instruments. instruments, heat-bearing instruments,^[6-8] lasers,^[9] and use of adjunctive solvents. Nickel-titanium (NiTi) rotary systems are used in root canal retreatment because they provide easier and faster preparation than manual instrumentation. Although the canal preparation time is shorter using rotary systems,

they generate more stress on the dentin wall, which leads to cracked lines and microcrack formation.^[10]

No previous studies compared apical crack formation and propagation during retreatment procedures using ProTaper Universal retreatment (PTUR) and R-Endo retreatment files. Therefore, the purpose of this in vitro study was to evaluate the incidence of crack initiation and propagation in apical dentin after retreatment procedures performed using PTUR (Dentsply Maillefer, Ballaigues, Switzerland) and R-Endo (Micro Mega, Besanco, France) retreatment file systems. The null hypothesis was that there would be no significant difference in dentinal microcracks among these systems.

Materials and Methods

Tooth Selection and Preparation

All procedures were executed by a single operator.

30 freshly extracted human maxillary central incisor teeth were selected. The root surface of each tooth was then observed under a stereomicroscope (Magnüs, New Delhi, India) at 10X magnification for evidence of fracture lines, open apices, or anatomic irregularities and teeth with any of these characteristics were discarded. Teeth were stored in distilled water throughout the study.

All the teeth were decoronated at CEJ maintaining a standard root length of 16mm. These teeth were then embedded in a tube filled with self-curing acrylic resin, the apical 4 mm of the root was exposed to allow intra operative image recordings. 1mm apical root segments were ground perpendicular to the tooth axis using waterproof 320-grit silicon carbide abrasive paper. The ground apical surface was polished using waterproof 1,000-grit and 1,200-grit silicon carbide abrasive paper to obtain a finely polished surface to ensure that high-quality images could be obtained. Baseline images for all the samples were captured using a digital camera attached to a stereomicroscope.

A size 10 K-file (Dentsply Maillefer, Ballaigues, Switzerland) was placed into the roots until the tip could be seen from the apex. The working length (WL) was set as 1mm short of this length. A glide path was created to size 20 K-file, canals were then enlarged up to size F3 at working length using Protaper Universal NiTi rotary instruments. During the root canal preparation, each of the samples was irrigated with 2 mL of 2.5% sodium hypochlorite (NaOCl) (Vishal Dentocare Pvt. Ltd., Gujarat, India). For the final irrigation, 2 mL of 17% ethylenediaminetetraacetic acid (EDTA) (Prime Dental Products Pvt. Ltd., Maharashtra, India) for 1 minute, followed by 2 mL of 2.5% NaOCl. After preparation, images of the apical portions of the roots were taken, and crack initiation was checked. Sample showing evidence of a crack was evenly distributed to the experimental groups as described below.

Group I- Control group

Group II- PTUR group

Group III- R-Endo retreatment group

Root canal obturation

The canals were dried using paper points and obturated using gutta-percha and AH Plus root canal sealer (Dentsply DeTrey, Konstanz, Germany) upto the Working length. Radiographs were then taken from the buccolingual and mesiodistal directions to ensure quality of the obturation. Temporary filling material (Cavit-G, 3M ESPE) was used for sealing the coronal orifice.

Following obturation, the specimens were then stored at 37°C in 100% humidity for 14 days to allow complete setting of the sealer. Images of the apical surfaces of the obturated root canals were captured using a digital camera attached to a stereomicroscope.

Experimental Groups and Retreatment Procedures

Group I Control (n=10): 10 samples after obturation were stored as the negative control and no retreatment procedure was performed.

Group II ProTaper Universal Retreatment (n = 10): 10 samples were used. The canal filling material was removed by using the ProTaper Universal retreatment instruments (Dentsply Maillefer, Ballaigues, Switzerland). The retreatment instruments were used at a constant speed of 500 rpm for D1 and 400 rpm for D2 and D3, with a torque of 3 Ncm. The instruments were used according to the manufacturer's instructions: D1 (30/.09) worked in the coronal third, D2 (25/.08) in the middle third, and D3 (20/.07) throughout the entire WL.

Group III R-Endo Retreatment (n = 10): 10 samples were used. The canal filling material was removed by using the R-Endo retreatment instruments (Micro Mega, Besanco, France). Rm and Re files were used to remove first 2-3mm of the filling. The retreatment instruments were used at a constant speed of 500 rpm for R1 and 400 rpm for R2 and R3, with a torque of 3 Ncm. The instruments were used according to the manufacturer's instructions: R1 (25/.08) worked in the coronal third, R2 (25/.06) in the middle third, and R3 (25/.04) throughout the entire WL. All rotary NiTi instruments were used with a torque and speed controlled motor Canal Pro CL2 (Coltene/Whaledent, Altstätten, Switzerland). In all experimental groups, 0.2 mL RC solve (Prime Dental Products Pvt. Ltd., Maharashtra, India) was used to soften the gutta-percha at the root canal orifice. During retreatment, the root canals were irrigated with 1 mL 2.5% NaOCl. Retreatment was judged complete when no guttapercha or sealer was detected on the instrument surfaces or on the dentinal walls. Images were taken after retreatment procedure.

Stereomicroscopic examination

Each specimen in the experimental groups had 4 images taken (baseline, after preparation, after filling and after retreatment). The images were captured by a digital camera attached to a stereomicroscope. Each image was compared with the preceding image, and any visible crack line on the apical surface that was not present in the preceding image was noted. In each group, the number of cracks was recorded. Data was collected and analyzed with one way ANOVA test and Unpaired 't' test. The level of significance was set at p < 0.05.



Figure 1- crack initiation and propagation at different levels, group II showing more cracks at every level compared to group III

Results

Both the retreatment group showed crack formation [Figure 1]. ProTaper Universal retreatment group showed significantly more number of cracks at all the level then R-Endo retreatment group [Table 1 and 2].

Table1:Incidenceofapicalcrackformationandpropagation:

Groups	Baseline	BMP (Preparation)		Obtura	tion	Retreatment	
	Total	New	Total	New	Total	New	Total
Control	0	7	7	0	7	-	-
PTUR	0	8	8	0	8	9	17
R Endo	0	8	8	0	8	5	13 C

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	Groups	N	Mean	SD	t	df	p value	Inference
Baseline	PTUR	10	0.0	0.000^{a}	-	-	-	
	R Endo	10	0.0	0.000^{a}				
Bio-Mechanical	PTUR	10	0.9	0.568	0.45	18	0.001	
Preparation (BMP)	R Endo	10	0.8	0.422				Significant
Obturation	PTUR	10	0.9	0.568	0.45	18	0.001	
	R Endo	10	0.8	0.422				Significant
Retreatment	PTUR	10	1.7	0.823	1.09	18	0.004	
	R Endo	10	1.3	0.677				Significant

Table 2: Unpaired 't' test (Independent sample t test)

Discussion

The persistence of bacterial colonies within the complexity of the root canal system leads to apical pathology in endodontically treated teeth.^[11] Nonsurgical management is the treatment of choice for managing such endodontic failures.^[12] The primary objective of retreatment is to remove old root canal filling materials, uncover the remnants of necrotic tissue and bacteria, reinstrumentation, disinfection of the canal and obturation of the canal.^[13]

The present study consisted of extracted maxillary central incisors as they have single root and root canal with less deviated apical foramen. Adorno *et al* reported that a deviated apical foramen might be a factor in initiation of cracks. ^[14] Teeth were decoronated to maintain constant length in all specimens. Although it does not reflect the clinical situation but it facilitates canal access, thus providing more reliable comparison.^[15] The apical 1mm of the root segments were grounded and polished, the presence of apical delta ramification in apical 1mm of root may mimic crack and affect the interpretation of result, it also eliminate potential damage caused to dentin by sectioning process and helps in clearly accessing crack

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initiation and propagation.^[16,17] Baseline images for all the samples were captured using a digital camera attached to a stereomicroscope.

Initial canal preparation was performed with ProTaper Universal Ni-Ti rotary instrument up to size F3 in all groups. The image after initial preparation showed crack formation in the apical dentin.^[18] This may be due to greater apical taper 30/0.09% of F3 and number of rotation in the canal that are necessary to complete a preparation.^[10,19] Obturation was done by using single cone technique matching the master apical file. The images taken after obturation did not show any crack initiation or propagation may be because single cone technique applies minimal pressure compared to compaction techniques.^[20]

It was claimed that the taper and file design could be contributing factor in generation of cracks because of increased stress on canal walls caused by tapered files.^[10,21,22] This is in synchrony with results of our study, which shows that PTUR D3 have greater taper 20/0.07% and convex triangular cross-section whereas R-Endo R3 is 25/0.04% tapered and have equally spaced triangular file design.^[23] Despite simulating clinical condition, the dry

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condition of the teeth during experimental procedures might also have influenced the results.

Conclusion

- Within the limitations of the present study, it can be concluded that NiTi rotary retreatment files causes crack initiation and propagation in the apical root dentin.
- 2. Taper of the file can influence crack initiation and propagation.

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