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Comparison of efficacy of Three Ni-Ti Retreatment Instruments in Removal of Gutta-Percha from root canal- An In Vitro Study.

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Abstract
Aim: *This study Compares the efficacy of three Ni-Ti retreatment file systems and determines which retreatment file requires less time in removal of previous root filling material.*
Methodology*: Sixty single rooted anterior teeth were instrumented with K-files and filled using lateral compaction of gutta percha (GP) and AH plus sealer. The obturated specimens were randomly divide into 4 experimental groups of 15 specimens each. Removal of gutta-percha was performed with following devices and techniques: Pro Taper Universal Retreatment system (PTUR) files , R endo and EdgeEndo XR retreatment files and H-file respectively. Operating time to reach working length and to eliminate filling material was also recorded. Post-operatively Cone Beam Computed Tomography (CBCT) was used to assess the percentage of residual filling material in coronal, middle and apical third of root canal. The results were evaluated statistically using One Way Anova and Post Hoc Tukey tests.*
Results: *No system completely removed the root filling material from root canal walls. EdgeEndo XR took significantly less time for gutta-percha removal than R-Endo files and PTUR. EdgeEndo XR retreatment files removed the maximum amount of filling material gutta percha from apical, middle & coronal third.*
Conclusion*: Within the limitation of present study, it was found that EdgeEndo XR file (EdgeEndo, USA) system is the most efficient system followed by R-Endo, ProTaper & H-file.*
Keywords*: Ni-Ti instruments, CBCT, EdgeFileXR, PTUR files, R endo, H-files.*

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I. Introduction :

The success of root canal therapy depends upon proper working length determination, complete chemo-mechanical debridement and three dimensional obturation. The aim of retreatment is the complete removal of previously obturated root canals filling in order to regain access to apical foramen & achieve sufficient cleaning & re-shaping of the root canal system. Several techniques have been proposed to remove filling materials from root canal system including use of endodontic hand files with heat or chemical solvents, ultrasonic instruments, lasers, Gates Glidden burs, heated instrument, ultrasonic instruments, laser and use of adjunctive solvents. [(2)] When root canal therapy fails, treatment options include conventional retreatment, periradicular surgery, or extraction. The non-surgical approach is the treatment of choice when access to the root canal is feasible and it is the most conservative method.

Several techniques have been proposed to remove filling materials from root canal system including use of endodontic hand files with heat or chemical solvents, ultrasonic instruments, lasers, Gates Glidden burs, heated instrument, ultrasonic instruments, laser and use of adjunctive solvents. [(2)] Various NiTi rotary instruments in root canal retreatment decrease patient and operator fatigue. Conventionally, the removal of gutta-percha using hand files with or without solvent can be a tedious, time-consuming process especially when the root filling material is well compacted (de Oliveira et al. 2006). Therefore, the use of NiTi rotary instruments in root canal retreatment might decrease patient and operator fatigue (Tasdemiret al. 2008). Recently, EdgeFile XR retreatment nickel–titanium (NiTi) rotary files that are made of an annealed heat- treated Ni- Ti alloy brand named Fire- Wire TM, have been introduced to the market. The deformation and strength characteristics of metals and metal alloys could be changed with heat treatment. According to manufacturer Fire- WireTM Ni–Ti yields performance- enhancing durability that provides incredible flexibility, so that XR files will enhance and expedite the endodontic retreatment. The cyclic fatigue has been custom tested and found to be twice that of the other file systems. System includes four files - R1 (25/0.12), R2 (25/0.08), R3 (25/0.06), R4 (25/0.04) that are used in crown- down manner. All files have constant taper and parabolic cross section.

II. Materials and Methods

Selection of teeth: Sixty maxillary central and lateral incisors with mature root apices and single canal extracted for periodontal reasons were used. Teeth with root caries, cracks on the root surface, curved roots and extremely calcified canals were excluded. Soft tissue and calculus were removed mechanically from the root surface.

Initial root canal treatment:

Each tooth was decoronated at the cemento-enamel junction (CEJ) with a diamond disc to facilitate straight line access for instrumentation and obturation. Working length was determined by placing a size 15 K-file into the canal until it appeared at the apical foramen; this length was measured and the working length was set 0.5mm short of this distance. A circumferential "staging platform" was established near the canal orifice, ensuring a uniform working length (WL) of 16mm in each tooth.

Cleaning and shaping were performed using a modified step-back technique. Canal preparation was carried out by the sequential use of K-files (DentsplyMaillefer, Ballaigues, Switzerland) up to size 40 at working length; a step- back procedure in 1 mm increments to a file size 60 was then carried out. During instrumentation, all the canals were irrigated with 5.25% NaOCl, 17% EDTA and finally with saline. The canals were then dried with paper points and the obturation was done by cold lateral condensation. After, cavity sealed with cavit all teeth stored in an incubator at 37^0C with 100% humidity for 7 days to allow the complete setting of AH-Plus sealer.

Fig. 1. Armamentarium

1. 5.25% Sodium hypochlorite, 2. Normal Saline, 3. X Smart Endomotor, 4. Micro-motor, 5. Gates glidden Drills, 6. Gutta-percha, 7. Absorbent PaperPoints, 8. EdgeEndoXR retreatment file, 9. R-Endo Retreatment file, 10. ProTaper retreatment file, 11. K-files, 12. Plugger, 13. EndoBloc, 14. Round bur, 15. AH-Plus sealer, 16. Air Rotor, 17. EDTA, 18. Disposable syringe, 19. Irrigation needle, 20. Oralfil-G, 21. Diamond disc

Retreatment technique

The obturated specimens were randomly divide into 4 groups with each group containing 10 samples

Group I: ProTaper D (Dentsply Mallifer, Balligues, Switzerland) rotary retreatment files, D1 (size 30,0.09 taper) which is used to remove filling material from coronal portion of root canal. The D1 working tip facilitates initial penetration into the filling material. Whereas the middle and apical third of the canals were instrumented using ProTaper D2 (size 25, 0.08 taper) and ProTaper D3 files (size 20, 0.07 taper) respectively until the working length was reached

Group II: R-Endo (Micromega, Besancon, France) system consists of three instruments files R1(size 25, 0.08 taper), R2 (size 25, 0.06 taper), R3 (size 25, 0.04 taper). R1 will be used to one third and R2 used for two thirds of the working length. Finally R3 (size 25, 0.04 taper) used at the working length.

Group III: Edge File XR (Edge Endo, USA) retreatment file group. The following crown-down sequence was used: R2 (25, 0.08 taper) to R3 (25, 0.06 taper) then to R4 (25, 0.04 taper) using light medium pressure R4 is taken up to working length.

Group IV: Removal of root filling materials begun with the use of size 1-3 Gates Glidden drills in the coronal portion. The canals were re-instrumented with Hedstrom files (Mani, Inc. Japan) sizes (35, 25, 20) in a circumferential, quarter-turn, push-pull, filing motion to remove filling material until the working length was achieved. Files were wiped regularly using gauze to remove obturation material and debris.

Figure 8: Different Rotary Files Systems used for the removal of gutta percha

Fig. 9(a): Retreatment done with ProTaper D

Fig9 (b): Retreatment done with R Endo

Fig. 9(c): Retreatment done with EdgeEndo XR

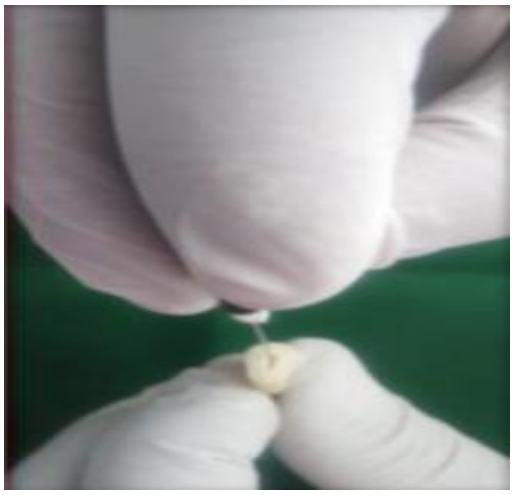

Fig. 9(d): Retreatment done with H-file

Assessment of Gutta Percha Removal Duration:
The total time required to remove the root filing was considered to be the time elapsed from the moment the instruments were first applied in the canal until reaching original working length. The stopwatch was stopped when instrument was removed from the canal and restarted when the preparation proceeded with another instrument.

Analysis of Root Filing Material:
Removing filing material on canal walls was evaluated through cone beam computed tomography CBCT (NewTom GiANO, Italy).

CBCT Evaluation:
Teeth were embedded in an acrylic resin block prepared for CBCT (NewTom GiANO, Italy) Scan. Acrylic block with four teeth were placed on the desk of CBCT device (60-90 KVp, 1-10 mA) for image acquisition. Image was analyzed using (NNT software, version 10.1). Axial, frontal, saggital sections were obtained after adjusting the appropriate parameters for scanning, with 0.1mm voxel resolution (8 cm FOV, 40 s for acquisition). The total area of the cervical, middle, and apical third was determined and the percentage of the area covered by filling debris.

$$\text{Area \% of remaining obturation material} = \frac{\text{Area of obturated material}}{\text{Area of canal wall}} \times 100$$

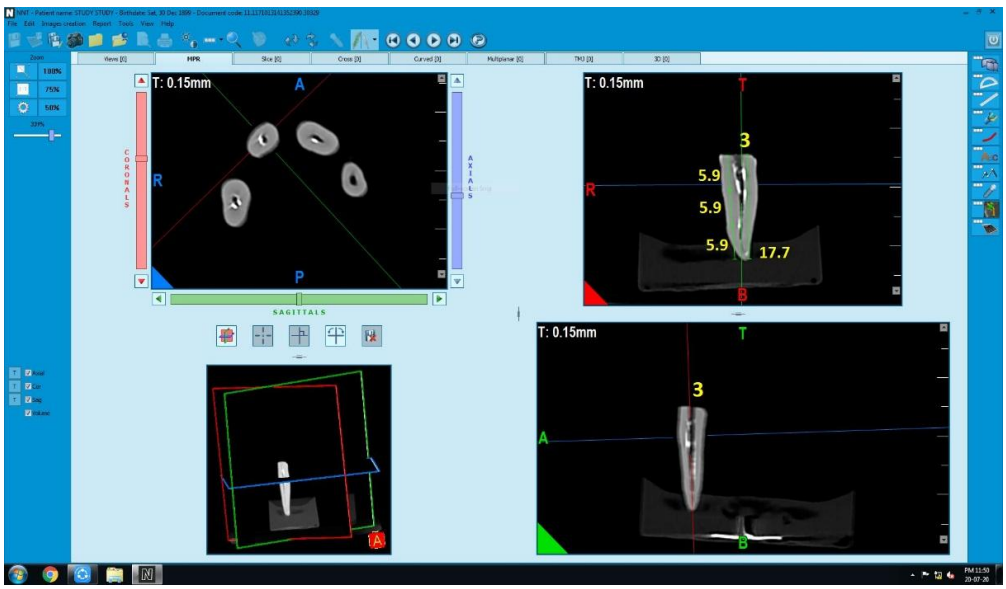

Figure a: CBCT evaluation of teeth in which gutta percha has been removed using ProTaper file system

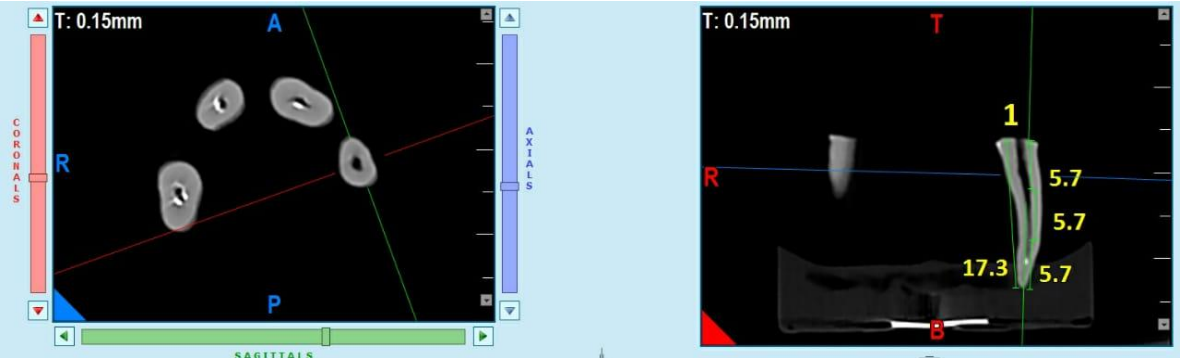

Figure 11b: CBCT evaluation of teeth in which gutta percha has been removed using R-Endo file system

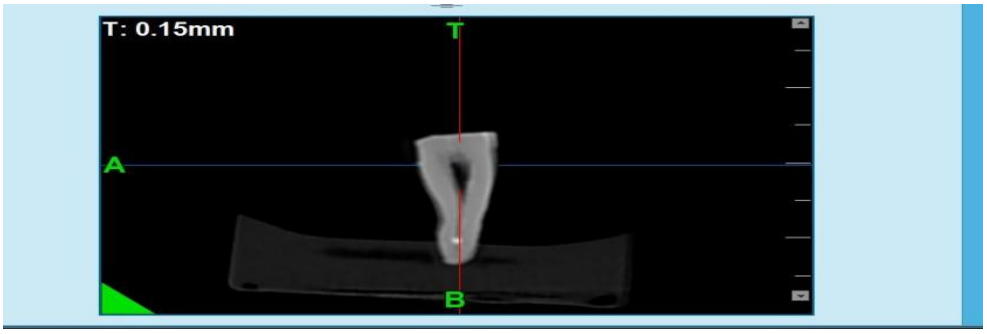

Figure 11c: CBCT evaluation of teeth in which gutta percha has been removed using EdgeEndo XR file system

III. Results

a) Remnants of material

In the apical third, area covered by remaining material was least for samples prepared with EdgeEndo XR retreatment file (EdgeEndo, USA). This was followed by R-Endo (Micro-Mega,Besancon,France) and then ProTaper D (Dentsply Malliefer, Ballaigues, Switzerland).In the Cervical and middle third, area of remaining material was found to be maximum with H-file (Mani, Inc.). This is followed by Pro-Taper (Dentsply Malliefer, Ballaigues, Switzerland) and then R-Endo (Micro-Mega, Besancon, France).

Table 1: Area fraction of root canal covered by GP remnants after retreatment

		Coronal		Middle		Apical	
S.No	**Group**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
1.	Group I (Protaper)	12.0333	1.51028	13.1267	1.47961	8.6000	.84600
2.	Group II (R-Endo)	9.1400	.95454	9.9867	1.75819	7.4667	1.20988
3.	Group III (Edgefile XR)	7.1000	1.44914	8.7800	.94506	3.5533	1.02041
4.	Group IV (H-File)	13.0600	1.29273	14.1600	1.20700	9.5400	.86255
	"F"	63.773		50.874		80.786	
	"S"	<0.001		0.001		0.001	

SD- Standard Deviation
F- Analysis of Variance (ANOVA)
P- Level of Significance

b) Operating time : The mean time taken for complete procedure was found to be minimum in group lll EdgeFile XR retreatment files in 110±8.237 seconds. Maximum time for that is 140±636 were required for reaching the working length using R-Endo file system.

	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
				Lower Bound	Upper Bound		
Group I (Protaper)	221	9.613	2.482	215.67	226.32	205.00	240.00
Group II (R-Endo)	248	11.45	2.956	241.65	254.34	227.00	265.00
Group III (Edge Endo)	202	10.21	2.638	196.34	207.65	185.00	218.00
Group IV (H-File)	300	10.07	2.600	294.42	305.57	284.00	319.00

Table 14: Mean & S.D of working time required for complete removal of gutta percha from root canal.

IV. Discussion

The main goal of retreatment is to remove all filling material in the root canal and regain access to the apical foramen, thereby enabling the insertion of new endodontic procedures and the subsequent restoration of health of the periapical tissues. The primary reason for the negative outcome following root canal treatment is the persistence of bacteria within the root canal system. Complete removal of root filling enables effective cleaning, shaping and filling of the root canal system.[32] Removal of obturation material is a very important factor in root canal retreatment because it allows chemo mechanical re-instrumentation and re-disinfection of the root canal system.[47]

An epidemiological study showed that the most endodontic clinical failures requiring nonsurgical retreatment, apical surgery or extraction were recognized within the first 3 yr. The success rate of endodontic retreatment ranges from 40 to 100% (Schirrmeister et al. 2006). In the present study, the teeth were decoronated to ensure standardization of specimens by eliminating some variables, such as anatomy of the dental crown and access to root canals thereby allowing more reliable comparison between the proposed retreatment techniques. In this study, the teeth were standardized to 16mm, so that varying length could not exert an influence on the results.). After adequate drying the canals with paper points, they were obturated with Gutta-percha and AH Plus sealer. AH Plus sealer is a thermoplastic, two-component paste, epoxy resin based root canal sealer, that contains adamantine based on epoxy-amine resin, which permits removal of the material when required, is used along with Gutta- percha for bonding to the canal walls. The root canals were filled using lateral compaction technique before their removal because this technique has been used in many similar studies (Schirrmeister et al. 2006, de Oliveira et al.2006, Tasdemir et al. 2008). Different methodologies have been reported to evaluate the amount of filling material remaining inside the canal after retreatment procedure. Other technique include splitting the teeth longitudinally and visualizing them using a stereomicroscope or by using images obtained with a camera and image analyser software.[3] For present study Cone Beam Computed Tomography (CBCT) scan has been used because it enables a three dimensional evaluation of the root canal system after removal of filling. The conventional use of hand instruments for removal of obturation material required more time and was tedious. Therefore rotary system was introduced for retreatment which are faster in removing the material from root canal system. More recently, ProTaper D (Dentsply maillefer, Ballaigues, Switzerland) and R Endo (Micro-Mega, Besancon, France) files and Edge File XR (Edge Endo, USA) were used for removal of gutta percha. These three rotary files were considered in this study for retreatment of root canal. Furthermore, the present investigation showed that that rotary NiTi instruments, the EdgeFile XR instrumentation was significantly more effective than ProTaper Universal, R-Endo and H-File group in terms of residual material. In the present study the better performance of EdgefileXR instruments may be because they are made of an annealed heat- treated Ni–Ti alloy brand named Fire- WireTM. The heat treated Fire-WireTM Ni-Ti yields performance enhancing durability (PED) that provides not only incredible flexibility, but according to the manufacturers it performs much better than other files in cyclic fatigue testing; a key indicator of file strength and durability. Maximum amount of time was taken by H-file (Mani, Inc.) followed by ProTaper, R-Endo, EdgeFile XR. In this study, cone beam computed tomography was used to outweigh the limitation of the methodologies previously applied in endodontic retreatment studies, such as displacement of the filling debris during cleavage and two-dimensional imaging on a three-dimensional structure in a non-invasive manner. CBCT results signifies that EdgeEndo XR removes maximum amount of gutta percha from the apical third of the canal. The present study shows the maximum amount of remaining filling material in the middle third of the root canal. The middle third shows greater compaction of obturating material. Moreover, greater sealer penetration into dentinal tubules at the middle third could be the reason for greater amount of remaining debris in the middle third. . All instruments left filling material inside the root canal

The comparison of GP (gutta percha) remnants at different levels among four groups using Bonferroni Method test showed that difference in different levels was found to be maximum between middle and apical levels (5.4) while it was minimum between coronal and middle levels (1.2). Clearly, further studies are needed to assess the efficacy, maintenance of original canal morphology and safety of NiTi rotary instruments during

retreatment with complicated root canal anatomy.

V. Conclusion

None of the retreatment systems were successful in removing all filling material inside the canal. With the limitations of this study, it was found that EdgeEndo XR file (EdgeEndo, USA) system is the most efficient system followed by R-Endo, ProTaper & H-file. Remnants of filling material were observed in all samples regardless of the group examined.

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