



COMPARATIVE EVALUATION OF THREE RE-TREATMENT ROTARY FILE SYSTEMS (PROTAPER UNIVERSAL, NEOENDO RETREATMENT FILE AND D-PERFECT'S RETREATY KIT) FOR REMOVAL OF GUTTA PERCHA AND BIO-CERAMIC SEALER ALONG WITH ULTRASONIC AND SONIC IRRIGATION DEVICES USING CONE BEAM COMPUTED TOMOGRAPHY: AN IN-VITRO STUDY

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ABSTRACT

Background: Effective removal of root canal filling materials is essential for successful endodontic retreatment. Various rotary retreatment file systems and irrigation activation techniques have been developed to improve the removal of gutta-percha and sealers. This in vitro study compared the efficacy of ProTaper Universal, Neoendo, and D-perfects Retreaty kit, used in conjunction with ultrasonic and sonic irrigation devices, for removing gutta-percha and root canal sealer. **Methods and Material:** A total of 30 healthy human mandibular premolars extracted due to orthodontic therapy was selected. Distilled water was used to sterilize the teeth before they were preserved in Thymol Solution. The canals were widened and coronal access was done and till F3 ProTaper universal File system could be used. For the obturation, we utilized gutta-percha cones and Safe endo bio-ceramic sealer. Teeth are separated into three groups (n=30); Group 1: ProTaper Universal file, Sub-Group 1 A: Passive Ultrasonic Irrigation, Sub-group 1 B: Sonic irrigation; Group 2: Neoendo retreatment file, Sub-Group 2 A: Passive Ultrasonic Irrigation, Sub-group 2 B: Sonic irrigation; Group 3: D-Perfect's Retreaty Kit, Sub-Group 3 A: Passive Ultrasonic Irrigation, Sub-group 3 B: Sonic irrigation. All samples were cone-beam computed tomography (CBCT) recorded. **Results:** No statistical significance was found in the amount of residual filling material, difference in passive ultrasonic and sonic irrigation within any of these three Re-treatment File Systems ($p < 0.5$). However, D-Perfect's Retreaty Kit showed the lowest mean values for residual filling material in both coronal and sagittal sections, indicating better performance overall, although not statistically significant. ProTaper performed better than NeoEndo but slightly below the D-Perfect's Retreaty Kit. **Conclusions:** From the findings of this in-vitro study, the following conclusion can be drawn: none of these three Re-treatment file systems were able to completely remove gutta-percha and Bio-ceramic sealer from root canals of mandibular premolar.

KEYWORDS : Retreatment, Irrigation, Bio-ceramic Sealer.

INTRODUCTION

Non-surgical root canal retreatment, often the first treatment option for failed previous root canal treatments, is a predictable procedure with a high success rate.[1] The main contributing factors to root canal treatment failure includes incomplete cleaning and disinfection of the root canal system, inadequate obturation, missed canal and inappropriate or delayed coronal restoration. Thus, the primary goal of root canal retreatment is thorough cleaning and, in some cases, reshaping of the root canal system.[2]

Methodology and Methods:

It's an in-vitro study design, where a total of 30 healthy human mandibular premolars extracted due to orthodontic therapy was selected which is shown in the Figure [1]



Fig.1 Presents in vitro study comprised of thirty extracted mandibular first premolars with single straight roots.

There are inclusion criteria were freshly extracted human mandibular premolars, the teeth free from any previous restorations and the teeth extracted for therapeutic reasons.

Exclusion criteria were the teeth with caries, the teeth with history of endodontic treatment and the teeth with any

developmental defects and the teeth with visible cracks under 10x magnification.

Procedure:

Root canal treatment on the tooth sample was done using ProTaper universal File System and obturated using Safe Endo bioceramic sealer. They were stored in distilled water and kept 48 hrs for incubation in incubator before re-treatment procedure.

Retreatment technique

The samples were divided into three groups (Total n=30) and their sub-groups based on retreatment file system which are:

GROUP 1-PROTAPER RETREATMENT FILE SYSTEM

The D1 Pro-Taper file was used to remove the filling material from the cervical third of the root canal material, followed by the D2 Pro-Taper file was used in the middle thirds of the root canal and lastly the D3 ProTaper file was used with light apical pressure until the working length was reached and no further filling material could be removed.

GROUP 2-NEOENDO RETREATMENT FILE SYSTEM

The N1 Retreatment file was used to remove the filling material from the cervical third of the root canal material, followed by N2 Retreatment file used in the middle thirds of the root canal and lastly the N3 Retreatment file was used with light apical pressure until the working length was reached and no further filling material could be removed.

GROUP 3- D-PERFECT'S RETREATY KIT

This Re-treatment file system consists of five files which are

named as BULL Y, SKINN Y, SHAP Y1, SHAP Y2 and SHAP Y3. BULL Y (#25/.07) removes coronal thirds of root filling material followed by SKINN Y (#25/.04) that removes middle and apical thirds of root filling material, then 10K File was used with passive pressure to attain apical patency. SHAP Y1(#20/.05), SHAP Y2(#25/.05) and SHAP Y3(#30/.05) was used to re-shape the root canal for re-obturation. Passive Ultra-sonic Irrigation System and Sonic Irrigation Systems Passive Ultrasonic Irrigation (Ultra-X Orikam Healthcare) used for 15s for 3 cycles on subgroup 1A, 2A & 3A teeth sample and Sonic Irrigation (Woodpecker) used for 15s for 3 cycles on subgroup 1B, 2B & 3B teeth sample.

CBCT Evaluation

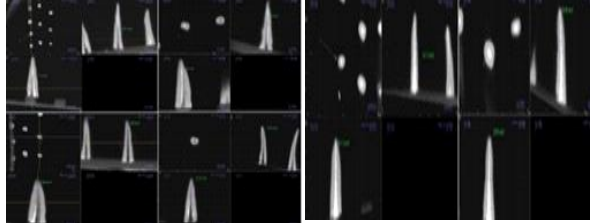


Figure [2]. Pre-operative and post-operative Images of obturated extracted mandibular premolar

The surface area of the canal and the residual filling material were calculated on the coronal and sagittal sections, and the percentage of the remaining filling material on the canal walls shown on Figure [2] was calculated with the following equation

(AREA PERCENTAGE OF REMAINING FILLING MATERIALS). APRFM represents area percentage of the remaining filling material. A grading system was used to score the amount of residual filling material in the coronal, middle and apical portion of each canal as, no or slight presence (0-25%) of debris on the dentinal surface, some (25-50%) debris on the dentinal surface, moderate (50-75%) amount of debris on the dentinal surface, heavy presence (>75%) of debris on the dentinal surface, no attempt was made to distinguish between the filling material and sealer remnants. Next, the coronal, middle and apical thirds of each tooth were evaluated on axial sections.

Statistical analysis

Post-retreatment CBCT was recorded for all samples. A one-way analysis of variance (ANOVA) + turkey post hoc test for intergroup and the intragroup using student unpaired t-test were utilized for statistical analysis to compare the different experimental groups.

RESULTS

No statistically significant difference was observed in inter-group comparison in the amount of residual filling material among the three file systems (ProTaper Universal, NeoEndo Retreatment, and D-Perfect's Retreat Kit) with Passive Ultrasonic Irrigation System shown in Table 1 & 2 and with Sonic Irrigation System in either coronal or sagittal sections (p-values > 0.05 in all comparisons) shown in Table 3 & 4. Likewise, no significant difference was found between Passive Ultrasonic Irrigation and Sonic Irrigation within any of the three file systems shown in table 5, 6 & 7. D-Perfect's Retreat Kit showed the lowest mean values for residual filling material in both coronal and sagittal sections, indicating better performance overall, although not statistically significant. NeoEndo Retreatment files showed the highest mean residual values. ProTaper performed better than NeoEndo but slightly below the D-Perfect's Retreat Kit.

Table 1. Comparison of residual filling material in ProTaper Retreatment with Neoendo Retreatment along with Passive Ultrasonic Irrigation system in the coronal and sagittal sections (mean $\pm$ standard deviation)

Section	D-PERFECT [®] S retreaty kit (3A)	ProTaper (1A)	Mean difference	95% CI of difference	T-value	P(two-tailed)
Coronal	36.76 $\pm$ 8.6	40.54 $\pm$ 14.2	3.78	-7.2-14.8	0.72	0.48
Sagittal	40.28 $\pm$ 10.2	41.56 $\pm$ 7.1	1.28	-6.9-9.5	0.32	0.75
Section	D-PERFECT [®] S retreaty kit (3A)	Neoendo (2A)	Mean difference	95% CI of difference	T-value	P(two-tailed)
Coronal	36.76 $\pm$ 8.6	47.94 $\pm$ 17.9	11.18	-2.03-24.38	1.78	0.09
Sagittal	40.28 $\pm$ 10.2	43.76 $\pm$ 6.34	3.48	-4.48-11.44	0.92	0.37

Table 2. Comparison of residual filling material (mm³) in D-Perfects Retreaty kit with ProTaper and Neoendo retreatment with Passive Ultrasonic Irrigation system in the coronal and sagittal sections (mean $\pm$ standard deviation).

Section	ProTaper (1B)	Neoendo (2B)	Mean difference	95% CI of difference	T-value	P (two-tailed)
Coronal	28.36 $\pm$ 10.9	32.48 $\pm$ 1.6	4.12	-4.95 - 13.19	0.92	0.36
Sagittal	31.87 $\pm$ 7.8	35.24 $\pm$ 8.5	3.37	-3.72 - 10.46	1.01	0.32

Table 3. Comparison of residual filling material in ProTaper Retreatment with Neoendo Retreatment along with Sonic Irrigation system in the coronal and sagittal sections (mean $\pm$ standard deviation).

Section	D-PERFECT [®] S retreaty kit (3B)	ProTaper (1B)	Mean difference	95% CI of difference	T-value	P(two-tailed)
Coronal	25.84 $\pm$ 9.4	28.36 $\pm$ 10.9	2.52	-5.84-10.88	0.64	0.53
Sagittal	29.12 $\pm$ 7.2	31.87 $\pm$ 7.8	2.75	-3.56 - 9.06	0.89	0.38
Section	D-PERFECT [®] S retreaty kit (3B)	Neoendo (2B)	Mean difference	95% CI of difference	T-value	P(two-tailed)
Coronal	25.84 $\pm$ 9.4	32.48 $\pm$ 11.6	6.64	-2.48 - 15.76	1.52	0.14
Sagittal	29.12 $\pm$ 7.2	35.24 $\pm$ 8.5	6.12	-0.92 - 13.16	1.87	0.07

Table 4. Comparison of residual filling material in D-Perfects Retreaty kit with ProTaper and Neoendo retreatment with Sonic Irrigation System in the coronal and sagittal sections (mean $\pm$ standard deviation).

Section	ProTaper (1A)	Neoendo (2A)	Mean difference	95% CI of difference	T-value	P (two-tailed)
Coronal	40.54 $\pm$ 4.2	47.94 $\pm$ 17.9	7.40	-7.77-22.58	1.02	0.32
Sagittal	41.56 $\pm$ 7.1	43.76 $\pm$ 6.34	2.20	-8.55-4.15	0.73	0.47

Table 5. Intra-group Comparison of residual filling material in ProTaper along with Passive Irrigation system and Sonic Irrigation system in the coronal and sagittal sections (mean $\pm$ standard deviation).

Section	NEOEN DO (2A)	NEOEN DO (2B)	Mean Difference	95% CI of difference	t-value	P (two-tailed)
Coronal	47.94 $\pm$ 17.9	32.48 $\pm$ 11.6	15.46	-3.18 - 34.10	1.78	0.09

Sagittal	43.76 ± 6.34	35.24 ± 8.50	8.52	-1.42 – 18.46	1.92	0.07
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Table 6. Intra-group Comparison of residual filling material in Neoendo along with Passive Ultrasonic Irrigation system and Sonic irrigation system in the coronal and sagittal sections (mean ± standard deviation).

Section	ProTaper (1A)	ProTaper (1B)	Mean Difference	95% CI of difference	T-value	P (two-tailed)
Coronal	40.54 ± 14.2	28.36 ± 10.9	12.18	-2.86 – 27.22	1.74	0.10
Sagittal	41.56 ± 7.1	31.87 ± 7.8	9.69	-1.18 – 20.56	1.85	0.08

Table 7. Intra-group Comparison of residual filling material in D-Perfects Retreaty along with Passive Ultrasonic Irrigation system and Sonic irrigation system in the coronal and sagittal sections (mean ± standard deviation).

Section	D-PERFECTS RETREATY (3A)	D-PERFECTS RETREATY (3B)	Mean Difference	95% CI of difference	t-value	P (two-tailed)
Coronal	36.76 ± 8.6	25.84 ± 9.4	10.92	-1.76 – 23.60	1.96	0.07
Sagittal	40.28 ± 10.2	29.12 ± 7.2	11.16	-0.84 – 23.16	2.01	0.06

DISCUSSION

Retreatment is common in endodontics. The success of endodontic retreatment in clinical aspect seems to depend on whether alterations in the natural course of the root canals were caused by previous root canal treatment.[3] Some authors related their outcomes to microbiological problems to dis-criminate root canal retreatment. The clinical rate of success of retreatment has been estimated to vary between 50% and 90%. The ultimate goal of nonsurgical root canal retreatment is to re-establish healthy periapical tissues.[4]

For gutta-percha removal various techniques have been used such as manual endodontic hand devices [5,6], Gates Glidden Drills and ultrasonics [7], lasers, heat-carrying instruments, nickel-titanium (NiTi) rotary instruments and with the adjunctive use of solvents.[8]

Sagare et al found that both systems which is WaveOne and NeoEndo retreatment system failed to completely remove gutta-percha. WaveOne was significantly more effective than the NeoEndo retreatment system.[9] Calcium silicate-based root canal sealers, commonly referred to as bioceramic sealers, are capable of setting in the presence of moisture and are widely used in various endodontic procedures.[10] These materials are preferred because of their antibacterial properties, biocompatibility, sealing ability, and favourable physicochemical characteristics, making them particularly suitable for several clinical endodontic applications. In recent years, increasing attention has been directed toward the retreatability of calcium silicate-based materials, an important factor that is often underestimated during the initial selection of endodontic sealers.[11] Alouda et al found both of its bioceramic materials demonstrated different mineral depositions onto their surfaces after 24 hours, 1 month, and 4 months, and showed mineral depositions into dentinal tubules at 4 months. Retreatment was faster in achieving the apex for group Ceraseal group compared to ProTaper Universal System ($p < 0.001$), while no difference was found between both systems among the AH plus Bioceramic groups.[12]

To facilitate the removal of obturating materials, several manufacturers have introduced nickel-titanium retreatment file systems. The ProTaper Universal Retreatment system

(PUR; Dentsply Sirona) is a commonly used multi-file system comprising three files with convex triangular cross-sections. The D1, D2, and D3 files are specifically designed for removal of filling materials from the coronal, middle, and apical thirds of the canal, respectively.[13]

Neoendo retreatment files (Orikam Healthcare, India) are manufactured using proprietary heat-treatment and micro-grinding technologies that reduce the engagement zone during instrumentation. These files possess controlled memory, a parallelogram cross-sectional design, and a positive cutting tip, which collectively help minimize ledge formation and reduce the risk of file separation during retreatment.[14]

D-Perfect's Retreaty Kit developed by Shenzhen Perfect Medical Instruments consists of five files. The initial two files, Bull-Y and Skinn-Y, are intended for removal of previous obturation materials and negotiation of the canal to the apex, whereas the remaining three files are used to complete the canal shaping procedure.[12]

To improve the effectiveness of retreatment procedures, various irrigation and irrigant activation systems have been introduced as adjuncts to conventional cleaning and shaping techniques. Among these, passive ultrasonic irrigation (PUI) has gained considerable attention because of its superior ability to enhance canal debridement. PUI operates through the transmission of ultrasonic to the irrigating solution, producing acoustic streaming and cavitation effects that facilitate disruption and removal of debris, smear layer, organic tissue remnants, and intracanal medicaments from inaccessible areas of the root canal system.[15]

Another widely used irrigant activation system is the sonic irrigation system, such as the Endo Activator. This system utilizes a flexible noncutting polymer tip activated by sonic vibration to agitate the irrigating solution within the canal. Sonic activation generates hydrodynamic agitation, acoustic streaming, and enhanced irrigant penetration, thereby improving disruption of residual filling materials and smear layer.[16]

Limitations of our study that it was done in-vitro using less number of extracted teeth and having straight oval root canals. Since root curvature plays a crucial role in affecting the efficacy of irrigating system, the findings of the present study cannot be applied directly to teeth having curved root canals.

CONCLUSION

None of the re-treatment systems were able to completely remove gutta-percha and sealer from the root canals. D-Perfect's Retreaty Kit demonstrated higher efficacy in removing filling materials, possibly due to its specialized file designs and use of multiple alloy types.

ProTaper Universal showed better cutting efficiency than NeoEndo due to its alloy and taper design. The type of irrigation activation device (ultrasonic vs. sonic) did not significantly impact the cleaning efficacy. Further in vivo studies are necessary to evaluate clinical performance, including post-treatment pain and long-term prognosis.

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