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Original Research Article

XP Endo Finisher R Efficiency in Retreatment Cases

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Abstract: Complete removal of old filling material is essential for successful endodontic retreatment. While a variety of techniques—such as hand files, rotary NiTi instruments, ultrasonic devices, and lasers—are available, none are fully effective, particularly in anatomically complex oval-shaped canals. Supplementary instruments have been introduced to improve outcomes. This study evaluated the efficacy of the XP-Endo Finisher R (XPEF-R) in removing root canal filling material after retreatment with three different NiTi rotary systems: ProTaper Universal Retreatment (PTUR), ProTaper Next (PTN), and WaveOne Gold (WOG). A total of 36 extracted mandibular incisors with single, straight, oval-shaped canals were standardized and initially prepared using the XP Endo Shaper system. The canals were obturated with gutta-percha and AH Plus sealer using warm vertical compaction. Specimens were divided into three groups (n=12) and retreated with PTUR, PTN, or WOG. Micro-CT scans were used to measure the volume of residual filling material. Following this, all samples underwent supplementary instrumentation with XPEF-R. Statistical analysis was conducted using the Kruskal-Wallis nonparametric test. The greatest volume of material was removed from the full canal length, though differences among canal sections were not statistically significant. PTUR showed the most effective performance across all levels. While XPEF-R further reduced residual material, the reduction was not statistically significant ($p > 0.05$). The PTUR and XPEF-R combination yielded the best results, but not significantly better than the other groups. In conclusion, the combination of the XP-Endo Finisher R with other rotary Ni-Ti systems is effective for the retreatment of oval-shaped canals, with the ProTaper Universal Retreatment system being superior.

Keywords: XP Endo Finisher R, Protaper Universal Retreatment, Protaper Next, Waveone Gold, Oval-Shaped Canals, Micro-CT.

INTRODUCTION

The success rate of primary root canal therapy was reported to exceed 90% (Burns LE *et al*., 2022). The favorable prognosis and enhanced success rate depend on the quality of chemo-mechanical preparation and root canal obturation, in addition to the hermetic coronal seal (Al-Afifi NA, 2023).

Nonetheless, in certain instances, therapeutic failure and further disease may arise, usually related to residual microflora (Siqueira JF *et al.,* 2008; Nair PN, 2004). These findings are regarded as indications for nonsurgical orthograde endodontic retreatment (Patel B, 2016). Anatomical abnormalities and oval shape of the endodontic space can hinder the thorough cleaning and shaping of the root canals, and are considered a challenge for retreatment (Karova E *et al*., 2023).

Complete removal of the prior filling material, together with the meticulous shaping and cleaning of the root canal system, is of paramount importance for the secondary root canal therapy (Ruddle CJ, 2004). Various procedures and techniques have been suggested for removing the root filling material, including stainless steel hand files with or without solvents, Nickel-Titanium (NiTi) rotary instruments, ultrasonic and sonic

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devices, and lasers (Rossi-Fedele G *et al*., 2017). Engine-driven rotary systems provide superior efficiency and are less time-consuming compared to hand instruments, rendering them ideal for root canal retreatment (Somma F *et al*., 2008).

Nowadays, both NiTi systems specifically designed for retreatment and those induced for primary root canal treatment are used to remove filling materials from root canal walls. (Rios MdeA *et al.,* 2014; Silva EJ *et al*., 2015; Nevares G *et al.,* 2016; Jorgensen B *et al*., 2017).

The ProTaper Universal Retreatment system (Dentsply Sirona Endodontics) is among the most widely used (Ma J *et al.,* 2012; Sairaman S *et al*., 2024). Additionally, systems originally intended for primary shaping, were also presented for the removal of root canal filling (de Souza PF *et al.,* 2015). ProTaper Next, have been evaluated for retreatment due to their efficient cleaning and debris removal capabilities. Some researchers evaluated their effectiveness for root canal retreatment in comparison to alternative NiTi rotary systems (Ozyurek T *et al*., 2017; Azim AA *et al.,* 2018; Bis BM *et al*., 2021).

Reciprocating systems, like WaveOne Gold (*Dentsply Sirona, Ballaigues, Switzerland*) have also gained popularity in retreatment (Madarati AA *et al*., 2018; Al-Zaka IM *et al*., 2022) for their improved resistance to fracture and fatigue, attributed to heat-treated NiTi alloy and innovative file design (Gavini G *et al*., 2012; Adıgüzel M *et al.,* 2017).

Despite the variety of retreatment methodologies, none of the suggested techniques or instruments effectively eliminate all filling material from the root canal walls (Rossi-Fedele G *et al.,* 2017). Many engine-driven NiTi systems create a circular preparation in the center of the canal (Peters OA *et al.,* 2001; Pérez AR *et al.,* 2018), leaving substantial regions of the dentin walls untouched in oval canals (Velozo C *et al.,* 2021). Various supplementary methods were suggested to enhance the removal of filling remnants (Siqueira Junior JF *et al.,* 2018; Karova E *et al.,* 2023). The XP Endo Finisher R (*FKG Dentaire in La Chaux de Fonds, Switzerland*) is a file designed for endodontic retreatment purposes. It is a non-tapered instrument, composed of a highly flexible NiTi wire with an ISO size of 30.00. The distinct "spoon-like" shape enables cleaning of canal walls, hence improves the extraction of filling remnants, when used after instrumentation with other NiTi rotary instruments (Tsenova-Ilieva I *et al.,* 2022; Tsenova-Ilieva I *et al.,* 2023; Alkahtany SM *et al.,* 2024).

This study aims to assess the effectiveness of the XP Endo Finisher R when used following three different NiTi systems – one specifically designed for retreatment and two intended for primary endodontic treatment. The null hypothesis was that the XP Endo Finisher R improves the cleaning of the root canal walls significantly.

MATERIALS AND METHODS

Sample Selection

This study received ethical approval from the Ethics Committee of the Medical University of Sofia (Protocol No. 16/19.12.2023). A total of 36 extracted mandibular incisors were selected for the present research. Inclusion criteria required each tooth to possess a single, straight root canal (<5° curvature) with an oval cross-sectional shape, and to be free of root resorption or carious lesions. To confirm these criteria, all samples underwent double-sided radiographic evaluation in both bucco-lingual and mesio-distal projections. Throughout the study period, the specimens were stored in individual Eppendorf tubes (*FL Medical, Padova, Italy*) containing 0.9% saline solution.

Sample Preparation

The root surfaces of the samples were cleaned of calculus and soft tissues using ultrasound, polishing discs, brushes, and polishing paste prior to root canal shaping. All samples were sectioned 16 mm from the apex under proper cooling to ensure uniform sample length. K-file ISO 10 was used to measure the working length of each tooth (*Dentsply Sirona, Ballaigues, Switzerland*). After insertion into the root canal, the file tip was extended beyond the root foramen, and working length was set 1 mm short of this measurement. K-files ISO 10 and ISO 15 (*Dentsply Sirona, Ballaigues, Switzerland*) were used to create a smooth glide path. The XP Endo Shaper system (*FKG Dentaire SA, La Chaux-de-Fonds, Switzerland*) and the X Smart Plus endodontic motor (*Dentsply Maillefer*) were used to prepare all of the samples, in accordance with the manufacturer's guidelines. Each instrument was used for the instrumentation of three canals. Throughout the canal shaping procedure, irrigation was primarily carried out with 2% sodium hypochlorite (NaOCl) (*CHLORAXID 2%, Cerkamed, Stalowa Wola, Poland*). A final rinse involved the use of both 2% NaOCl and 17% EDTA (*Cerkamed, Stalowa Wola, Poland*).

Root Canal Filling

The entire working length of the root canals was filled with a pre-adjusted gutta-percha master cone ISO 30/.04, sectioned at the orifice level, and covered with a thin layer of AH Plus sealer (*Dentsply Sirona Endodontics, Ballaigues, Switzerland*). The canals were obturated using a warm vertical compaction technique consisting of two phases: the downpack, where a heated plugger applied apical pressure to compact the gutta-percha, followed by the backfill, in which the coronal portion of the canal was filled up to the orifice using the Elements™ Free Cordless Obturation System (*SybronEndo/Kerr Endodontics, Orange, CA*). To guarantee full setting of the sealer, all samples were temporarily sealed with Citodur Hard (*DoriDent, Wien,*

Austria) and kept in a 100% humidity environment for a month (Ørstavik D *et al*., 2001).

The quality of obturation was assessed using both conventional radiography and micro-computed tomography (micro-CT) scanning. The micro-CT was conducted utilizing a Nikon XT H 225 (*Nikon Metrology, Tring, UK*) with the following parameters: 100 kV voltage, 125 µA current, 500 ms exposure time, 1 frame per projection, and 2880 projections. An aluminium filter with a thickness of 1.0 mm was employed to enhance the picture quality. The segmentation of the axial scans of the samples into 5mm, 10mm, and full length was executed using specialized software (*VG Studio MAX version 2.2; Volume Graphics, Heidelberg, Germany*). The volume of the filling material for all three levels was quantified utilizing Image J software (*Fiji software v.1.54f; Rasband W.S., National Institutes of Health, Bethesda, Maryland, USA*). The measurements were performed in cubic millimeters (mm^3).

Retreatment Procedure

All 36 samples were subsequently randomized into three groups (n=12), based on the retreatment system employed.

PTUR Group: The samples were retreated by utilizing the three files the ProTaper Universal Retreatment system – D1 (30.09), D2 (25.08), and D3 (20.07), at speed of 500 rpm and torque of 2.5 Ncm.

PTN Group:

The roots were retreated with the rotary ProTaper Next system (PTN). The retreatment protocol comprised the subsequent sequence: X3 (30/.06) for the coronal third of the root canal and X2 (25/.06) to full working length, both operated at 300 rpm and 2 Ncm torque.

WOG Group: The specimens were retreated by WOG Primary file (25.07), operated in "RECIPROCATING" mode.

All retreatments were performed using the X-Smart Plus endodontic motor with manufacturer-recommended settings. Solvents were omitted in all retreatment techniques. The main irrigant utilized during instrumentation was 2% sodium hypochlorite. A single file was limited to the treatment of three root canals. The technique was deemed complete once the canal walls and file flutes were free of any remaining filling material.

Following the retreatment processes, a subsequent micro-CT analysis of the residual volume of filling material was conducted. The extracted filling material was quantified as a percentage of the initial filling volume.

Supplemented Instrumentation

The samples from the three groups underwent further processing using the XP Endo Finisher R system (XPEF-R), operated at 1000 rpm and a torque of 1 Ncm. Subsequent to cooling, the file was passively inserted into the root canal. The preparation was performed using gentle reciprocating motions with an amplitude of 7–8 mm for 30 seconds, ensuring the file was in contact with the dentinal wall of the root canal.

A third micro-CT scan and volumetric analysis were conducted. The extracted material was measured as a percentage of the remaining volume following the initial retreatment procedures.

Statistical Analysis

The results were statistically analyzed using IBM SPSS Statistics 23.0 software (*International Business Machines Corporation, New York, NY, USA*). Means and standard deviations were computed for all groups and canal levels. Due to non-normal data distribution, a nonparametric Kruskal-Wallis test was performed to compare the variables, with a significance level established at $p < 0.05$. The volume of the extracted material was quantified as a percentage.

RESULTS

The volume of canal filling material was quantified using micro-CT scanning along the entire canal length, as well as at 10 mm and 5 mm distances from the apex. Three micro-CT scans were conducted: subsequent to canal obturation and following first and additional retreatment procedures. The amount of material removed after using PTUR, PTN, and WOG systems was compared to the initial filling volume measured after root canal obturation.

Complete cleaning of the canal walls was not achieved with any of the retreatment methods (Table 1 and Table 2). Table 1 depicts the percentage of retrieved filling material following the first retreatment. The results across the groups did not exhibit statistical significance. Nonetheless, the PTUR system demonstrated greater efficacy than the other two methods across all canal levels.

Table 1: Amount of removed root canal filling (%) at different canal levels using the three tested systems

Level	Retreatment system	N	% of removed root canal filling material after retereatment			
			Min %	Max %	Mean±SD %	p-value
5	PTUR	12	59.29	98.68	84.19±11.700	0.357
	PTN	12	27.20	97.47	75.25±21.768	
	WOG	12	8.24	99.31	70.71±24.933	
10	PTUR	12	78.14	99.10	93.02±5.586	0.257

Level	Retreatment system	N	% of removed root canal filling material after retereatment			
			Min %	Max %	Mean±SD %	p-value
	PTN	12	58.84	98.71	87.40±12.264	
	WOG	12	1.29	99.41	78.30±28.760	
Full	PTUR	12	89.74	99.51	96.37±2.953	0.181
	PTN	12	78.23	99.41	93.82±6.569	
	WOG	12	67.45	99.71	88.22±11.124	

Kruskal Wallis test $\chi 2(2) = 3.416$, $p = 0.181$,

Table 2 illustrates the percentage of removed obturation after the supplementary shaping with XPEF-R in all experimental groups. The results showed that the combination of PTUR and XPEF-R achieved the highest removal rates at all three tested levels (93.32%, 95.16%, and 97.34%), although the differences compared to the other groups were not statistically significant.

Table 2: Amount of removed root canal filling (%) at different canal levels using XP Endo Finisher R combined with PTUR, PTN and WOG

Level	Initial retreatment system	N	% of removed root canal filling material after the combined use of XPEF-R with PTUR, PTN and WOG			
			Min %	Max %	Mean±SD %	p-value
5mm	**PTUR**	12	75.34	100.00	93.32±8.17	0.681
	PTN	12	49.12	100.00	85.52±17.01	
	WOG	12	8.24	100.00	82.41±26.24	
10mm	**PTUR**	12	83.45	99.54	95.16±4.72	0.842
	PTN	12	73.19	100.00	92.71±8.62	
	WOG	12	20.65	99.93	83.48±25.69	
Full	**PTUR**	12	89.92	99.72	97.34±2.83	0.860
	PTN	12	86.77	100.00	96.31±4.35	
	WOG	12	70.42	99.94	92.47±9.97	

Kruskal Wallis test $\chi 2(2) = 0.302$, $p = 0.860$,

DISCUSSION

The thorough removal of the previous filling material during secondary endodontic treatment is crucial for the tooth's future prognosis (Wrbas KT *et al.,* 2025). Currently, numerous strategies for the removal of root canal filling materials have been documented in the literature (Mohd Isa MN *et al.,* 2023). Regardless of the diverse methodologies and protocols employed, none have been shown to entirely eliminate filling residues from canal walls, particularly in oval-shaped root canals (Ma J *et al*., 2012; Karova E *et al*., 2023).

The current study assessed the initial and residual filling volumes using micro-CT. This method is the most frequently employed for assessing the efficacy of the evaluated retreatment strategies, owing to its non-invasiveness and exceptional precision (Delai D *et al.,* 2019). A limitation of the methodology was the difficulty encountered during segmentation, as the algorithms struggled to reliably differentiate between gutta-percha and sealer residues within the root canals.

The sealer employed in this study was AH-Plus epoxy sealer, regarded as the "gold standard" among sealers due to its physical properties (Vinola SM *et al.,* 2024). However, the infiltration of the sealer into the dentinal tubules, along with its long-term stability and solubility, may compromise retreatment procedures (Tsenova-Ilieva I *et al.,* 2023).

This study aimed to evaluate three different NiTi rotary systems for the retreatment of oval-shaped canals: one developed specifically for secondary retreatment and two intended for primary endodontic treatment, each employing different operative motions. To our knowledge, there are no articles that compare the efficacy of PTUR, PTN, and WOG systems in the retreatment of oval-shaped canals. The current results indicate no statistically significant difference in the performance of the retreatment system compared to the other two systems, aligning with earlier studies (Ozyurek T *et al.,* 2017; Azevedo MAD *et al.,* 2020). Our findings also demonstrated that reciprocating systems can be efficiently utilized in retreatment cases. These results correspond to those of other researchers (Rios MdeA *et al.,* 2014; Cecagno FL *et al*., 2024). Although the three evaluated systems demonstrated comparable efficacy, the retreatment system exhibited marginally superior performance relative to the other two. This could be related to its particular design (Zongova-Adem SE *et al.,* 2024).

The supplementary technique with the XPEF-R enhanced canal cleaning, however not to a considerable degree. Consequently, the null hypothesis was rejected. Despite the supplementary treatment, complete removal of the filling was not achieved. However, XPEF-R demonstrated higher performance compared to other

methods used in the retreatment of oval-shaped canals, irrespective of the obturation technique or sealer utilized (Aksel H *et al.,* 2019; De-Deus G *et al*., 2019; Kapasi K *et al*., 2020; Eid BM *et al*., 2021; Karova E *et al.,* 2022; Agarwal D *et al*., 2024). The current investigation indicated that the combination of PTUR and XPEF-R enhanced the removal of fillings in oval-shaped canals.

All retreatment procedures were conducted by a single experienced operator, who was blinded to the group distribution. Solvents were not employed in the canal shaping process, since they could adversely affect the retrieval of the filling (Tsenova-Ilieva I *et al*., 2023).

The decoronation of the samples can be regarded as a certain limitation in the current study, as the shape of the endodontic cavity can influence the performance of the files (Tsenova-Ilieva I *et al.,* 2023).

CONSLUSIONS

Considering the limitations of the present investigation, it can be concluded that the combination of the XP-Endo Finisher R with other rotary Ni-Ti systems is effective for the retreatment of oval-shaped canals, with the ProTaper Universal Retreatment system being superior.

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