

Comparative evaluation of gutta-percha removal efficiency of Protaper gold and Waveone gold systems using orange oil: An In-vitro study

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Abstract

Objective: To evaluate and compare the effectiveness of two advanced rotary endodontic file systems using orange oil in removing obturation material from root canals.

Method: The experimental in-vitro study was conducted at the Department of Operative Dentistry and Endodontics, Sindh Institute of Oral Health Sciences, Jinnah Sindh Medical University, Karachi, from December 7, 2023, to May 31, 2024, and comprised extracted, single-rooted teeth with straight canals that were cleaned, prepared, obturated and then randomised into ProTaper Gold Group A and WaveOne Gold group B. Variables examined and recorded were length of remaining gutta-percha in canal (mm), gutta-percha extrusion through apex (yes/no) and time taken for gutta-percha removal. Data was analysed using SPSS 23.

Results: Of the 32 teeth, 16(50%) were in each of the two groups. All the 32(100%) teeth showed some residual obturation material within the canal. The amount of root filling remaining was significantly reduced in Group B compared to Group A ($p=0.007$).

Conclusion: The mean gutta percha removal from root canals when using WaveOne Gold files was significantly better compared to the use of ProTaper Gold files. WaveOne Gold files also showed minimal extrusion, and took less time for gutta percha removal from root canal spaces.

Key Words: Gutta percha removal, WaveOne Gold, ProTaper Gold, Orange oil, Endodontic retreatment.

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Introduction

Success in endodontic retreatment is achieved by adequate re-cleaning and re-shaping of the root canal space, and gaining access to the apical foramen of root canal by removing existing filling material to provide conditions required for the success of final obturation.^{1,2} Non-surgical root canal retreatment is preferable as it is least invasive with a high success rate. The first essential step for retreatment is removal of the remaining obturation material from root canal spaces as they can cause microorganisms to multiply and settle.³ Gates Glidden drills and manual files were used conventionally for this, but have lost their popularity due to the need for solvents. Various types of solvents have been used in re-endodontic treatment to soften gutta-percha (GP). These include chloroform, eucalyptol, tetrachloroethylene, orange oil and xylene, but none of them meets the ideal solvent requirements. Historically, chloroform has been the solvent of choice, but its cytotoxicity to periapical tissues, and the potential to be carcinogenic and

hepatotoxic have lead to testing of new substances. Eucalyptus and orange oil have been tested for dissolving GP and sealer as they have minimum reported deleterious effects.⁴ In recent times, orange oil has been used as it is biocompatible to the periapical tissues, and has minimal harmful effects.^{5,6} Rehman et al⁷ concluded that, as an effective alternative to chloroform, orange oil can be used.⁷

The use of hand files for the retreatment procedure of root canals with or without solvent is time-consuming. A rotary file system is effective in the removal of remnants from the root canal, but one major advantage of using rotary instruments for GP removal is their fast action.⁸ According to a study, none of the tested file systems (Mtwo, ProTaper and WaveOne) completely removed the filling material. Mtwo retreatment files showed the greatest efficacy, but failed to achieve complete GP removal.⁹

The current study was conducted to evaluate the effectiveness of two advanced rotary endodontic file systems using orange oil in removing obturation material from root canals.

Materials and Methods

The experimental in-vitro study was conducted at the Department of Operative Dentistry and Endodontics,

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Sindh Institute of Oral Health Sciences, Jinnah Sindh Medical University (JSMU), Karachi, from December 7, 2023, to May 31, 2024. The study followed the Preferred Reporting Items for Laboratory Studies in Endodontology (PRILE)¹⁰ 2021 guidelines. After approval from the institutional ethics review board, the sample size was calculated using OpenEpi¹¹ calculator on the basis of an earlier study¹ while keeping the power of test at 80% and confidence level at 95%. The sample comprised extracted human teeth, with single, straight canals that included centrals, laterals and canines that were selected from the tooth bank maintained at the JSMU Oral Surgery Department. As the teeth had been extracted for caries, periodontal or orthodontic reasons, and not specifically for the current study, the teeth were selected after evaluating them on the basis of digital apical radiographs (PSPIX2, ACTEON, SOPRO, France) taken in mesiodistal direction with #2 sensor (ACTEON, SOPRO, France) if they had a single, fully formed root with straight and single canal. Teeth having resorption, calcification, dilacerations and root caries were excluded.

Thymol solution 0.2% was used for the storage of the selected teeth until in use. All the crowns were removed using diamond rotary cutting instrument (Mani, Tochigi, Japan) leaving 16mm root length. After preparing access cavities using diamond bur in high-speed handpiece, the canals were located. SX ProTaper Universal rotary system file (ProTaper, Dentsply Maillefer) was used for preflaring along with Gates Glidden burs (Dentsply Maillefer). ProTaper Universal S1, S2, F1 and F2 files (ProTaper, Dentsply Maillefer) were used for apical preparation. The study used 2ml of 2.5% sodium hypochlorite (NaOCl) for irrigation after each instrument change, followed by 17% ethylenediaminetetraacetic acid (EDTA). Canals were then dried using paper points, and obturated with F2 GP points (ProTaper, Dentsply Maillefer) and sealer (Kerr-Sealapex) along with accessory cones (Dentsply Maillefer). The GP points were seared off using heat and touch level with the coronal surface of the sectioned tooth. To ensure that adequate obturation of root canal was done, periapical radiograph was taken, followed by storage of teeth in distilled water for four weeks to ensure complete setting of sealer. After four weeks, the temporary seal was removed, and the teeth were divided into two groups based on the file system used to remove obturation material. The teeth were randomised using two opaque, sealed envelopes containing inserts of Group A or Group B in them. The dental assistant was asked to pick and choose one of the envelopes. The envelope was opened before root canal re-treatment to determine the group. The file systems were different in ProTaper Gold Group A and WaveOne Gold group B, while all other steps of

endodontic treatment remained the same in both the groups and were carried out by the principal investigator.

In Group A, orange oil was placed on the orifice of the canal, and for coronal GP removal, the drills were used sequentially. Re-instrumentation of canals was done by ProTaper Gold files (S1, S2, F1, F2) (Dentsply Maillefer) for the removal of GP remaining in root canal spaces, using a maximum of 2ml of orange oil. In Group B, orange oil was placed on the orifice of the canal, and coronal GP was removed with the drills used sequentially. The canals were re-instrumented using WaveOne Gold small (20/.07) and primary (25/.07) (Dentsply Maillefer) files to remove GP using a maximum of 2ml of solvent. For all teeth during GP removal, 5ml of NaOCl and 5ml of distilled water were used between filing for canal irrigation and debris removal, until no obturation material was visible on the files. The extruded material through apical foramen during the procedure was assessed visually by the principal investigator. Postoperative peri-apical radiographs were then taken to assess the remaining GP in canals. The length of the remaining GP was calculated in millimeters using a radiographic imaging software (ACETON, SOPRO, France). The variables that were recorded and examined were the length of the remaining GP in root canal (mm), extrusion of GP through apex (yes/no), and time taken for GP removal (minutes). All endodontic procedures were carried out by the principal investigator to minimise inter-operator variability.

Data was analysed using SPSS 23. The Shapiro-Wilk test was applied to assess data normality. Mean $\pm$ standard deviation were calculated for GP remnants. Qualitative variables, such as tooth type and extrusion of GP, were presented as frequencies and percentages. Difference in GP extrusion between the groups was evaluated with chi-square test. Comparison between the groups for remaining GP was evaluated using independent sample t-test. $P \leq 0.05$ was considered statistically significant.

Results

Of the 32 teeth, 16(50%) were in each of the two groups. There were 20(62.5%) central incisors, 8(25%) lateral incisors and 4(12.5%) canines.

All the 32(100%) teeth showed some residual obturation material within the canal spaces (Figure 1). Mean remaining GP was 3.8 ± 1.8 mm. The amount of obturation material remaining in the canals, and the operative time required for GP removal were significantly different between the groups (Table 1).

In Group A, 11(68.7%) teeth had extrusion, while 1(6.3%) tooth had it in Group B (Table 2).

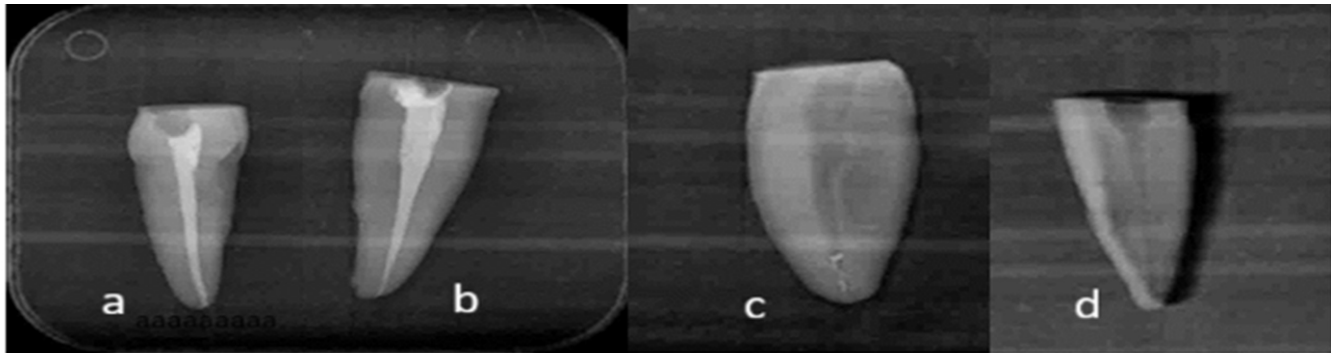


Figure: Post-obturation radiograph showing the quality of obturation in ProTaper Gold (a) and WaveOne Gold (b) groups, and the remaining gutta-percha ProTaper Gold (c) and WaveOne Gold (d) groups.

Table-1: Comparison of remaining gutta-percha and time taken for its removal in the two experimental groups.

Groups	Mean $\pm$ S.D (mm)	p-value
ProTaper Gold (n=16)	4.6 $\pm$ 1.4	0.007
WaveOne Gold (n=16)	2.9 $\pm$ 1.7	
	Mean $\pm$ S.D (minutes)	
ProTaper Gold (n=16)	2.9 $\pm$ 0.8	0.000
WaveOne Gold (n=16)	1.6 $\pm$ 0.7	

Table-2: Extrusion of gutta percha in the two experimental groups.

Extrusion	GROUPS		p-value
	ProTaper Gold n (%)	WaveOne Gold n (%)	
Yes	11 (68.7)	1(6.3)	0.000
No	5 (31.3)	15(93.7)	
Total	16 (100)	16 (100)	

No signs of instrument separation or plastic deformation were observed, and no iatrogenic errors were recorded during the study.

Discussion

Complete removal of obturation material and thereby all microorganisms and necrotic tissue from within the root canal system is the main objective of nonsurgical endodontic retreatment.¹

Inadequate biomechanical preparation, obturation and definitive restoration of endodontically treated teeth can result in post-treatment disease. If the presence of microorganisms is persistent in cleaned and sealed canal spaces, post-treatment disease typically re-emerges.¹²⁻¹⁵ Various mechanical instrumentation, along with solvent use, have been found ineffective in complete eradication of root canal fillings. When compared for removal of GP and sealer from root canal spaces, engine-driven systems are significantly more effective than manual instrumentation, and lead to less apical extrusion. Studies

have shown that combining chemo-mechanical techniques further improves removal of debris and smear layers, resulting in cleanliness of the root canal system.^{16,17}

Complete cleaning of root canal can be challenging.¹⁸⁻²⁰ On the basis of existing research, no current techniques can completely remove old filling materials from root canal spaces.²¹

In a study²² the remaining GP in the apical third of ProTaper Universal Retreatment rotary group was significantly higher (1.91 $\pm$ 0.43) compared to the other file systems. In the current study, WaveOne Gold files using a reciprocating motion showed significantly less remaining GP in the root canals (2.9 $\pm$ 1.7mm) than the ProTaper Gold files (4.6 $\pm$ 1.4mm) ($p < 0.05$). While Martins et al.³ reported that Protaper Next was an effective system to remove obturation material, no previous study, to our knowledge, has compared the use of WaveOne Gold and ProTaper Gold file systems to remove GP. The results suggested that WaveOne Gold files were more efficient than ProTaper Gold in removing GP in less time and with minimum extrusion. The finding may be explained by its reciprocating motion that results in easy removal of filling material and enhanced efficiency.

Several solvents that have been recommended for GP removal, including orange oil, halothane, xylene and tetrachloroethylene. Xylol and chloroform are seldom used because of their risks of cytotoxicity. In the present study, orange oil was used as it is less cytotoxic⁸ than eucalyptol and chloroform, and has good biocompatibility with human tissues.¹⁵ A study²³ concluded that Endosolv R did not have any beneficial effect when removing GP, whereas another study²⁴ concluded that chloroform did not reveal any favourable outcome, rather it made GP removal more difficult. Orange oil demonstrated significantly greater dissolution

of AH Plus sealer ($p=0.022$) and Roekoseal ($p=0.004$) after 10 minutes. However, the difference was not significant when removing MTA (mineral trioxide aggregate) Fillapex ($p=0.213$).¹⁴

The current study has limitations as it focussed primarily on single-rooted tooth with fully formed apices. Studies should be carried out on multi-rooted tooth using different file system and a wide range of GP removing solvents. Also, the in-vitro design, even though controlled, may not fully replicate clinical conditions, potentially affecting the applicability of the results in real-world scenarios. While radiographs provide objective measurements, they might not capture all details of GP removal, suggesting the need for more advanced imaging techniques, including cone beam computed tomography (CBCT), in future studies to provide a more comprehensive analysis of obturation material removal from root canal spaces.

The inability of both ProTaper Gold and WaveOne Gold systems to completely remove GP from root canal system emphasises the need for combining mechanical instruments with proper irrigation techniques to achieve effective removal from root canal spaces. This combined approach could ultimately enhance the clinical success outcome of re-endodontic procedures.

Conclusion

GP removal from root canal spaces when using WaveOne Gold files was significantly better compared to ProTaper Gold files.

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AUTHORS' CONTRIBUTIONS:

SP: Data analysis, acquisition, interpretation, concept, design, drafting and agreement to be accountable for all aspects of the work.

SYAA: Concept, data analysis, acquisition, drafting and agreement to

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MML: Data analysis, discussion, drafting, revision and final approval.

SA: Data interpretation, drafting and agreement to be accountable for all aspects of the work.