

# Evaluation of Mean Gutta Percha Removal with Protaper Gold and Wave One Gold Files with Orange Oil from Root Canal Spaces: *In-Vitro* Study

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## ABSTRACT

**Introduction:** The adequate removal of microorganism, infected or necrotic pulp tissues and gaining access to apical foramen during endodontic treatment requires complete removal of obturation material. The study was conducted to evaluate effectiveness of Protaper gold and Wave one gold with use of orange oil in removing obturation material from root canals.

**Methods:** Thirty-two extracted, single rooted teeth with straight canals were cleaned, prepared, obturated and then divided in two groups (n=16) based on the file to be used for removal of root filling: Group 1: Protaper gold; Group 2: Waveone gold. 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.

**Results:** All teeth showed some residual obturation material within the canal. Amount of root filling remaining was significantly reduced in waveone gold group ( $2.9\pm 1.7\text{mm}$ ) compared to the protaper gold group ( $4.6\pm 1.4\text{mm}$ ) (p- value 0.007).

**Conclusion:** The mean gutta percha removal from root canals when using Wave one gold files was significantly better compared to use of Protaper gold files. Wave one files also showed minimal extrusion and took less time for gutta percha removal from root canal spaces.

**Keywords:** Gutta Percha; Waveone Gold; Protaper Gold; Orange Oil

## Introduction

Success of endodontic retreatment is achieved by adequate re-cleaning and re-shaping of root canal space and gaining access to apical foramen of root canal by removing existing filling material to provide conditions required for success of final obturation [1,2]. Non-surgical root canal retreatment is preferable as is least invasive with a high success rate. First essential step for retreatment is removal of 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,

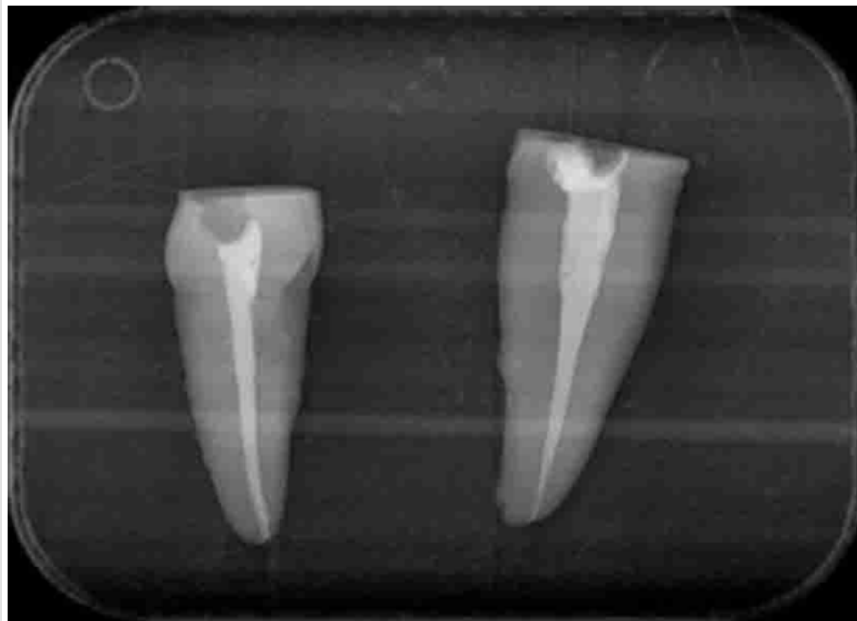
and xylene, but none meet ideal solvent requirements. Historically chloroform has been the solvent of choice, but its cytotoxicity to peri-apical tissues, and the potential to be carcinogenic and hepatotoxic has led to testing of new substances. Eucalyptus and orange oil have been tested for dissolving gutta percha 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 al [7] in their study concluded that as an effective alternative to chloroform, orange oil can be used [7]. This study was conducted to evaluate effectiveness of Protaper gold and Wave one gold files with use of orange oil to remove existing obturation material from root canal spaces during retreatment so that prognosis of retreatment cases can be improved.

## Methodology

This study has been reported according to Preferred Reporting Items for Laboratory Studies in Endodontology (PRILE) 2021 guidelines. The study was carried out at **xxxx** University, ethical approval from the Ethical review board of **XXXXXXXXXX** University was taken before commencement of the study (ref no: JSMU/IRB/2023/807). Thirty-two extracted human teeth, with single, straight canals, were selected from the tooth bank maintained at the Oral Surgery Department at **xxxx** University, Karachi from December 2023- May 2024. As the teeth were extracted for caries, periodontal or orthodontic reasons, and not specifically for this study. Teeth were selected after evaluating them by 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 from study. Thymol solution 0.2% was used for storage of selected teeth until in use. All crowns were removed using diamond rotary cutting instrument (Mani, Tochigi, Japan) leaving 16 mm root length. After preparing access cavities using diamond bur

in high-speed hand piece, canals were located. SX ProTaper Universal rotary system file was used for preflaring along with Gates Glidden burs (Dentsply Maillefer). ProTaper universal S1, S2, F1 and F2 files were used for apical preparation. 2ml of 2.5% sodium hypochlorite (NaOCl) was used for irrigation after each instrument change followed by 17% EDTA. Canals were then dried using paper points and obturated with F2 guttapercha 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 as shown in Figure 1. After 4 weeks, temporary seal was removed and teeth divided into 2 groups based on the file system used to remove obturation material using random alternate allocation as:

- Group A →16 teeth→ Protaper gold with orange oil,
- Group B →16 teeth → Wave one gold with orange oil.



**Figure 1:** Post-obturation radiograph to assess obturation quality.

In teeth assigned to Group A, orange oil was placed on orifice of canal and for coronal gutta-percha removal Gates Glidden drills were used sequentially. Re-instrumentation of canals was done by Protaper gold files (S1,S2,F1,F2) for removal of gutta-percha remaining in root canal spaces using a maximum of 2 ml of orange oil. In the teeth assigned to Group B, orange oil was placed on orifice of canal and coronal gutta-percha was removed with Gates Glidden drills used

sequentially. The canals were re-instrumented using Wave one gold small (20/.07), and primary (25/.07) files to remove gutta percha using a maximum of 2 ml of solvent was used. For all teeth during gutta percha removal, 5 ml of NaOCl and 5 ml of distilled water was 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 principal investigator. Post-operative peri-apical radiographs were then taken to assess remaining gutta percha in canals. Length of remaining gutta percha was calculated in millimeters using ACETON, SOPRO, FRANCE radiographic imaging software. The variables that were recorded and examined were; length of remaining gutta-percha in root canal (mm), extrusion of gutta percha through apex (yes/no) and time taken for gutta percha removal (minutes). All endodontic procedures were carried out by principal investigator to minimize incidence of inter-operator variability.

### Statistical Analysis

Data was analyzed by SPSS version 23. Shapiro-wilk test was applied to assess data normality. Mean  $\pm$  SD was calculated for gutta percha remnants. Qualitative variables such as tooth type and extrusion of gutta percha were presented as frequency and percentage. Difference in gutta percha extrusion between the groups was evaluated by chi-square test. Comparison between both groups for remaining gutta percha was evaluated using independent sample t-test.  $p \leq 0.05$  was considered as statistically significant.

### Results

Shapiro-Wilk test was applied on quantitative outcome variable

to assess the normality of data. As the  $p$ -value was  $>0.05$ , it was determined that data was normally distributed. According to tooth type, there were 20(62.5%) central incisors, 8(25%) lateral incisors and 4(12.5%) canines in the study. All teeth examined had residual filling material within root canal spaces (Figure 2). Mean remaining gutta percha in our study was  $3.8 \pm 1.8$ mm. The amount of obturation material remaining in both groups is shown in Table 1 & Figure 2 illustrates the postoperative radiograph, shows the remaining gutta percha in two experimental groups. There was a statistically significant difference among the two study groups ( $p$ -value 0.007). The operative time required for gutta-percha removal was  $2.2 \pm 0.9$  minutes. In Protaper gold group, mean time was  $2.9 \pm 0.8$  minutes and  $1.6 \pm 0.7$  minutes in the Wave One gold group. The difference between mean times of both groups was statistically significant ( $p$ -0.000). Out of 32 teeth, 12 teeth had extruded gutta percha from the root apex at end of the procedure. In Group 1 (Protaper gold) 11(68%) teeth had extrusion, while only 01(6.3%) tooth in Group 2 (Wave One gold) had extruded gutta percha. The results are shown in Table 2. When accounting for intra-operative errors in either group such as no signs of instrument separation, or plastic deformation were observed. Additionally, no iatrogenic errors, i.e. ledges, perforations, and blockages were recorded.

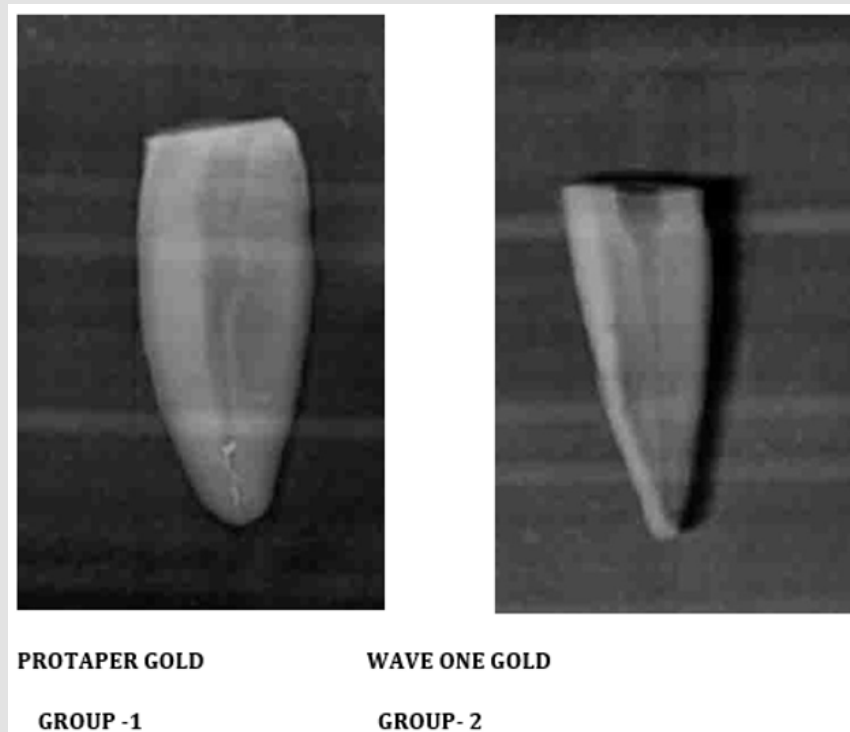


Figure 2: Postoperative radiograph, shows the remaining gutta percha in two experimental groups.

**Table 1:** Comparison of remaining gutta percha (mm) in the two experimental groups.

Groups	Mean $\pm$ S.D (mm)	p-value*
Protaper Gold (n=16)	4.6 $\pm$ 1.4	0.007
Wave One Gold (n=16)	2.9 $\pm$ 1.7	

Note: Independent sample t-test applied.  $p < 0.05$ -considered statistically significant.

n- number of teeth.

**Table 2:** Comparison of extrusion of gutta percha in the two experimental groups.

Extrusion	GROUPS		p-value*
	Protaper Gold n (%)	Waveone Gold n (%)	
YES	11 (68)	1(6.3)	0.000
NO	5 (3.1)	15(9.3)	
TOTAL	16	16	

Note: Chi Square test was applied.  $p < 0.05$ - considered statistically significant.

n (%) - number of teeth.

## 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 presence of microorganisms is persistent in cleaned and sealed canal spaces, post-treatment disease typically re-emerges [8]. Various mechanical instrumentation, along with solvent use have been ineffective for complete eradication of existing root canal filling. 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 root canal system [9,10]. Various researches have previously been aimed to compare effectiveness of traditional endodontic hand files with rotary NiTi files and various retreatment systems to remove GP. Complete cleaning of root canal can be challenging as suggested by prior research [11-13]. On basis of existing research, no current techniques can completely remove old filling materials from root canal spaces [14].

In this study, teeth were decoronated at cemento-enamel junction leaving 16 mm of roots, so that all specimen were standardized. The single operator performed all procedures to minimize operator dependency, and standardizing all the measurement protocols. Ac-

ording to manufacturer's instructions Ni-Ti rotary files were used at low torque in a low-speed electric motor to minimize risk of file separation and enhance tactile feedback. In a study by Abuelqomsan MA, [15] the remaining gutta percha in apical third of ProTaper Universal Retreatment rotary group was significantly higher (1.91 $\pm$ 0.43) compared to the reciprocating file systems used i.e Reciproc and Race files. Similar to the study by Abuelqomsan, our study also concluded that waveone gold files that use a reciprocating motion (2.9 $\pm$ 1.7mm) showed significantly less remaining gutta percha in root canals as compared to protaper gold files 4.6 $\pm$ 1.4mm, ( $p$ -value  $< 0.05$ ). Martins, et al. [3] have reported that Protaper Next system was an effective system to remove obturation material. In literature, no previous studies have been done comparing the use of Waveone gold and Protaper gold file systems to remove gutta percha. Results of our study reported waveone gold files were more efficient than protaper gold in removing gutta percha in less time and with minimum extrusion. These results may be explained due its reciprocating motion that results in easy removal of filling material and enhanced efficiency. Several solvents that have been recommended for removal of gutta-percha, include 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 cytotoxic [8] than eucalyptol and chloroform and has good biocompatibility with human tissues [11].

Muller GG [16] concluded that Endosolv R did not have any beneficial effects when removing gutta percha, where as a study by Saglam BC [17] concluded that chloroform did not reveal any favorable outcome, rather it made gutta percha 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 nonsignificant when removing MTA Fillapex ( $p=0.213$ ) [18]. Our study focused primarily on single rooted tooth with fully formed apices. In future, studies can be carried out on multirouted tooth using various different file system and a wide range of gutta percha removing solvents [19,20]. 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 gutta percha removal, suggesting the need for more advanced imaging techniques including Cone Beam Computed Tomography in future to provide a more comprehensive analysis of obturation material removal from root canal spaces. Inability of both groups (ProTaper gold and waveone gold systems) to completely remove gutta percha from root canal system emphasizes need for combining mechanical instruments with proper irrigation techniques to achieve effective removal from root canal spaces. However, this combined approach could ultimately enhance the clinical success outcome of re-endodontic procedures.

## Conclusion

The study concluded that gutta percha removal from root canal spaces when using Wave one gold files was significantly better compared to Protaper gold files. Therefore, WaveOne gold files may be recommended for use in re-endodontic cases to predictably remove the root canal filling.

## Source of Funding

This research did not receive any grant from funding agencies.

## Conflict of Interest

Authors have no conflict of interest to declare.

## Ethical Approval

Obtained from Institutional Review Board of XXXX University (ref no: JSMU/IRB/2023/807).

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