ORIGINAL ARTICLE

Comparison of Hedstrom and Protaper Universal Retreatment Files for Root Canal Retreatment Using Two Different Solvent

Hassan Rasheed Khan[1], Saima Azam[2], Kiran Saba[3], Beenish Qureshi[4]

ABSTRACT

Objective: To compare the efficacy of Hedstrom files and ProTaper Universal Retreatment files in gutta-percha/sealer removal during root canal retreatment using chloroform and orange solvent.

Study Design: In-vitro Randomized Experimental Study.

Place and Duration of Study: Islamabad Dental Hospital in the department of Operative Dentistry and at the National University of Science and Technology Islamabad over a period of 8 months from 3 Jan 2022 to 31 Aug 2022.

Materials and Methods: Sixty mandibular premolars were prepared and then obturated. Specimens were randomly divided in four groups and the gutta percha was removed with Hedstorm files with chloroform (Group A), Hedstorm files with orange solvent (Group B), ProTaper Universal system with chloroform (Group C), ProTaper Universal system with orange solvent (Group D). Residual GP/sealer were outlined on digital radiographs using an AutoCAD software and recorded in millimeter square for coronal, middle and apical 1/3rd of root. Time taken for complete removal was recorded using a stop watch. The data was analyzed using SPSS version 22.0. One-way ANOVA with post-hoc analysis was used to compare the amount of residual GP/ sealer among the four groups and for the comparison of time taken to remove the root filling. Post-hoc Tukey's test was further applied for comparison amongst the groups. A *p* value of ≤ 0.05 was considered statistically significant.

Results: The mean endodontic retreatment time in groups A, B, C and D were 7.15 min, 7.44 min, 5.46 min and 5.38 min respectively. One-way ANOVA and post hoc analysis showed significant difference of group A and group B with group C and group D (p value<0.001). Comparison of the mean GP/sealer remnants using One-way ANOVA and post hoc analysis showed no significant difference between all the groups (p value=0.778).

Conclusion: ProTaper Universal retreatment files demonstrated faster results as compared to the hand instruments (Hedstrom files) in removing GP/sealer. All the techniques left some residual GP/sealer as seen on radiographs.

Keywords: *Endodontic sealer, Gutta percha, ProTaper retreatment files, Retreatment, Solvent*

Introduction

Scientific advancements in endodontics have managed to retain millions of teeth which could not be saved otherwise.[1] Despite improvements, in some cases root canal therapy may lead to an endodontic failure.[2,3] Persistent bacterial growth and recolonization of the root canals leads to the failure of endodontic treatment, requiring retreatment.[4] Gutta-percha and sealer are widely used as obturating material. For endodontic retreatment many techniques are employed to remove gutta-percha, which include mechanical methods like hand files, rotary instruments, the use of heat and ultrasonics.[5] Solvents soften gutta-percha which helps in its removal, thus their use is recommended during root canal retreatment.

Traditionally, retreatment employed Hedstrom files also with K type files in conjunction with various endodontic solvents.[6] Recently NiTi rotary systems have been introduced for retreatment. These systems provides appropriate tip diameter and taper which not only facilitates the penetration of the files

[1]*Department of Operative Dentistry*
Bashir Institute of Health Sciences, Islamabad
[2,3]*Department of Operative Dentistry*
Islamabad Medical and Dental College, Islamabad
[4]*Department of Operative Dentistry*
Hi-tech IMS, Taxilla

Correspondence:
Dr. Kiran Saba
Assistant Professor
Department of Operative Dentistry
Islamabad Medical and Dental College, Islamabad
E-mail: kiran.saba@iideas.edu.p

Received: July 10, 2025; Revised: December 25, 2025
Accepted: December 26, 2025

https://doi.org/10.57234/jiimc.december25.2638

in the obturating material but also its removal from the canal.[7] Gutta-percha dissolution is ensured by a meticulous retreatment instrumentation technique in conjunction with an efficient solvent like chloroform and xylene. Use of chloroform for retreatment has recently been debated due to its toxicity and carcinogenicity.[8] Xylene can be used clinically but it is also thought to be toxic to the tissues.[9]Therefore, use of various alternate solutions have been suggested, like orange solvent for softening of filling materials.[10]

Studies have been conducted to compare the gutta-percha dissolving ability of various solvents like eucalyptol and orange solvent. These essential oils have proved to be safer and biocompatible but the reported efficacy compared to chloroform is different in different studies.[11,9] Various studies have been published to compare efficacy of rotary instruments in removing root filling material to other traditional methods.[12,13] However, none of the retreatment options seem to assure completely debris free canal walls.

Endodontic retreatment is a crucial procedure that aims to salvage teeth that have failed due to previous endodontic treatment. The success of this procedure largely depends upon the efficiency of removal of GP/sealer. Since previous studies have reported mixed results in terms of efficacy of the newer techniques compared to traditional methods, the need for our study arises. The aim of this study was to compare manual Hedstrom files and ProTaper Universal system in terms of removal of gutta-percha/sealer during endodontic retreatment procedure employing two GP solvents and to explore a technique that is effective and quick during retreatment.

Materials and Methods

The current In-vitro experimental study was carried out at Islamabad Dental Hospital and National University of Science and Technology Islamabad over a period of 8 months from 3-01-22 to 31-08-22, after approval from the institutional review board(Letter Number IMDC/DS/IRB /044) the current). Total 60 mandibular premolars were selected for the study using World Health Organization sample size calculator.[14] A*p*value of 0.05 or less was considered significant at Confidence interval of 95% (with margin of error 5%). The sample was divided into 4 groups with 15 teeth in each group by simple randomization method (using Random number table method), **Group A**: Hedstrom Files with Chloroform, **Group B**: Hedstrom Files with Orange solvent (Henry Schein, USA), **Group C**: ProTaper Universal Retreatment files (Dentsply, USA) with Chloroform, **Group D**: ProTaper Universal Retreatment files with Orange solvent. Randomization was done to balance the known and unknown factors to eliminate bias. Mandibular pre-molars with one root, straight canal, fully formed apices were included in the study, while teeth with radiographic evidence of calcifications, intra canal obstructions, internal resorption, previous endodontic treatment and teeth with root caries were excluded. External surfaces of the sample teeth were washed and the buccal and mesial sides of the root were marked with one groove and two grooves respectively.

The teeth were decoronated using a highspeed handpiece (W&H, Austria) and tapering fissure (MANI ISO 198/018 TR-S13) bur at the Cemento-Enamel Junction (CEJ) to ensure specimen standardization and eliminate variables, such as coronal tooth anatomy and the shape of access cavities. The teeth were stored in 10% formalin (Avonchem, UK). All the experimental procedures were done by one operator to reduce variation and increase reliability.Orifices were enlarged using high-speed (W&H, Austria) and round diamond bur (MANI ISO 001/014 BR-41) with copious water spray. Working length was determined radiographically 0.5mm from the radiographic apex using paralleling technique. Step-back canal preparation technique was employed, while irrigatingwith 5mL of 3% sodium hypochlorite (NaOCl) (PD, Swiss). Apical patency was ensured using K-files in size 10 (mani K files) between each file. A size 40K file was used as master apical file (MAF). Canals were flushed again with 3% NaOCl at the completion of instrumentation. After drying with paper points (TopDent, USA), the canals were obturated with gutta-percha (TopDent, USA) and sealer (Sealapex, SybronEndo, USA) using cold lateral condensation technique. Gutta-percha was seared off using a heated condenser. To evaluate the root canal obturation, two radiographs were taken in bucco-lingual and mesiodistal direction. Root canal orifices were restored with glass ionomer cement (GIC) (Ketac Molar, 3M ESPE, Germany). The

teeth were stored for 30 days in an incubator at a temperature of 37°C to simulate oral environment and allow the sealer to set.

The teeth were randomly divided into 4 groups for endodontic retreatment. Following GIC removal, #2 and #3 Gates Glidden drills were used for coronal flaring to a depth of 2mm into the orifice. In group A chloroform 0.5 ml was injected in the canal using a syringe and immediately instrumented with H-files (Henry Schein, USA) using 25, 30, and 35 files in a circumferential quarter-turn push and pull motion to remove gutta-percha/ sealer from the canal. The same procedure was used in group B, but 0.5mL of orange solvent (Henry Schein, USA) was used. In group C, Torque and speed (1.5-2 N.cm and 300rpm respectively) for protaper universal retreatment files were adjusted according to the manufacturer's instructions. Chloroform (0.5mL) of was introduced in the canal and D1 file was used for first entry into the gutta-percha. The D2 file was used for removing gutta-percha at the mid third of the root. While D3 file was used for removal of apical root filling material. Procedure similar to Group C was followed in group D with 0.5mL of orange solvent instead of chloroform. During retreatment procedure, copious irrigation was done with 5mL of 3% of NaOCl. Complete preparation was achieved in all the groups with no gutta-percha/sealer residue on the retreatment instrument, the canal was smooth and the file reached the working length.

The residual root filling material was evaluated exposing digital periapical radiographs in two different directions (bucco-lingual and mesio-distal) at 90-degree angle. The root canal walls and the residual GP/sealer were outlined by AutoCAD operator in both radiographs for each tooth using AutoCAD software. (Figure 1). Area of the canal covered with residual GP and/or sealer was calculated in bucco-lingual and mesio-distal dimensions and expressed in mm2. A mean value was calculated for each tooth by adding the residual GP/sealer in bucco-lingual and mesio-distal area and dividing by 2. Each tooth was divided was further divided into 3 portions (coronal, mid, apical) for residual GP/sealer. GP removal process was timed using stopwatch. Time was taken from placement of first drop of GP solvent in root canal till the file reaches working length with no visible GP on it. The data was analyzed using SPSS version 22.0. One-way ANOVA with post hoc analysis was used to compare amount of residual GP/ sealer among the four groups and for the comparison of time taken to remove the root filling. Post-hoc Tukey's test was further applied for comparison among the groups.

Results

Two teeth were excluded from the study because of instrument separation (Group A and Group B). The comparison of the amount of residual root filling material showed no statistically significant difference among the groups (p value=0.778). (Table I)

When the coronal, middle and apical 1/3rd were compared, there was no statistically significant difference among the four groups, although there was overall greater amount of residual GP/sealer in the coronal 1/3rd.(Table I)

The mean endodontic retreatment time in group A, group B, group C and group D were 7.15 min, 7.44 min, 5.46 min and 5.38 min respectively, showing statistically significant difference amongst the groups (p value<0.001). Group D showed less time to remove gutta-percha from the root canal followed by group C, group A, and group B.(Table 2) Results of multiple comparisons are shown in the Table II.

The amount of residual root filling as seen on radiograph is shown in figure 1. The yellow outline indicates root canal wall, red horizontal lines divide the root into coronal middle apical 1/3rd and the red line surrounding the root canal wall represents the residual GP/ sealer.

Table I: Comparison of Residual Root Filling the Groups

Group	Coronal Mean± SD	Middle Mean± SD	Apical Mean± SD
A	0.019±0.035	0.015±0.022	0.014±0.035
B	0.009±0.015	0.007±0.013	0.016±0.033
C	0.021±0.0422	0.012±0.021	0.001±0.003
D	0.009±0.026	0.010±0.029	0.030±0.054
p value	0.601	0.794	0.207

Discussion

The current study revealed that all the techniques left residual GP/sealer in the canal. In terms of time taken to remove the GP/sealer, group D and C performed better compared to group A and B. Thorough removal of existing GP/Sealer during retreatment is crucial to expose the necrotic tissue or microbes that may have become a source of

https://doi.org/10.57234/jiimc.december25.2638

Table II : Multiple Comparisons of Retreatment Time In Minutes Among The Four Groups Using Post-Hoc Tukey's Test

(I) Groups of Teeth	(J) Groups of Teeth	Mean Difference (I- J)	Std. Error
A	B	-.28643	.17584
	C	1.69143*	.17289
	D	1.76876*	.17289
B	A	.28643	.17584
	C	1.97786*	.17289
	D	2.05519*	.17289
C	A	-1.69143*	.17289
	B	-1.97786*	.17289
	D	.07733	.16988
D	A	-1.76876*	.17289
	B	-2.05519*	.17289
	C	-.07733	.16988

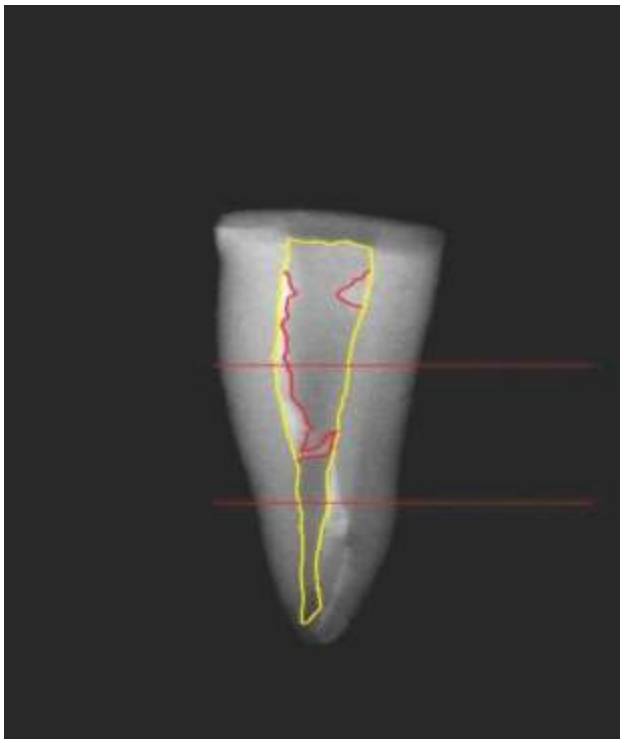

Figure 1 : Radiograph of Sample Tooth Showing Residual

infection resulting in failure of treatment. Retreatment with manual instruments is a time taking procedure particularly with well obturated canals. Therefore, the use of rotary nickel titanium instruments is considered to reduce patient and operator fatigue.[14]

Due to the difficulties met during the removal of the existing obturating material, numerous studies have been carried out to investigate new instruments for endodontic retreatment. Various techniques have been evolved for this purpose such as hand (K-files and H-files), rotary (Gates Glidden burs, Peeso reamers, and NiTi instruments), reciprocating (One Wave and Reciproc), heat-carrying instruments, chemical agents like solvents, ultrasonic device, and lasers.[15]

In this study ProTaper Files were compared with H-files and two different solvents for retreatment. ProTaper Universal Retreatment Instruments have a specific design of their flutes and their rotary motion has the tendency to pull the GP towards their flutes, therefore directing it coronally. Additionally, rotary motion of engine-driven files produces heat due to friction that plasticizes the GP making removal easy.[7,16]

Neither of the techniques advocated in current study completely removed gutta-percha/sealer as detected by the radiographs. This is in harmony with former studies,[17] where authors recommend that absolute removal of obturating material from the canals is difficult and traces are always left regardless of the technique used. Muraleedhar AV,[18] quantified the residual gutta-percha/sealer during retreatment using rotary and hand files (K-file and H -file). All the techniques left traces of GP/ sealer.

On the contrary, some studies concluded that ProTaper Universal retreatment instruments were efficient compared to manual instruments in retreatment. The reason is the differences in the methodology compared to the current study. Giuliani V et. al.,[19] reported ProTaper Universal retreatment files were quick and left significantly less residual GP compared to K- files. In our study, H-files were used which have better cutting efficiency and therefore removes GP/ sealer better compared to K files. Shivanand S et. al.,[20] in his study used a stereomicroscope to examine the cut sections of teeth, inferred that ProTaper instruments were efficient resulting in less residual GP. In the current study periapical radiograph was used to detect residual GP which cannot give a good image of 3-dimensional tooth structure leading to misinterpretation of results. This could be the reason of contrast with the study.

Rotary systems generate heat as a result of frictional movements. Excessive heat causes the “smearing” of root canal walls with the GP leading to incomplete removal. Moreover, sealer is usually brushed onto

the canal walls during the retreatment procedure, thereby making it difficult to remove because there is weak connection between sealer and GP.[21] Therefore, thorough canal cleaning and re-preparation is of utmost significance after GP and sealer removal.

In terms of residual GP/sealer in the coronal, middle and apical areas, there was no significant differences but overall increased GP/sealer were found in coronal 1/3rdfollowed by the middle and then apical 1/3rdin all groups. Jain A reported similar results in their study.[22] The lack of complete GP/sealer removal from the coronal 1/3rdcould be because of the fact that lateral condensation technique of obturation has tendency to entrap large amounts of sealer in the obturating material and creates a condensed mass in the coronal, middle rather than the apical part. This leads to in increased residual GP and sealer in these areas.[23]

The mean endodontic retreatment time showed statistically significant variation of group A and group B with group C and group D (p value<0.001). Group D was less time-consumingtechnique and group B was more time consuming. The result is in accordance with earlier studies demonstrating rotary NiTi instruments are less time consuming in retreatment compared to hand instruments. Similar results were found by other studies stating rotary files as more efficient than hand files.[24,18]

Chloroform is an effective solvent for dissolving gutta-percha. Although it is still commonly used in our region, the possible adverse effects associated with chloroform cannot be overlooked as it has been classified as a carcinogen and is toxic to the periapical tissues. Xylol, orange oil and thyme oil are proved to be better compared to other solvents.[25] In the present study, chloroform and orange solvent performed equally well with hand files and ProTaper Retreatment files.

Conclusion

All the techniques left some gutta percha/sealer as seen on periapical radiographs, but ProTaper retreatment files readily removed gutta percha/sealer removal compared to hand files. Orange solvent and chloroform are equally effective GP solvents.

The radiographic analysis showed some limitations as it gives only a two-dimensional information. Therefore advanced 3-dimensional evaluation strategies are recommended for better analysis. In vitro conditions cannot fully mimic vivo environment hence further research is required to authenticate the results.

Acknowledgement: None

Disclaimer: None

Conflict of interest: None

Funding Disclosure: The project was funded by Islamabad Medical and Dental College

REFERENCES

1. Khan FR, Ghafoor R, Umer F, Rahman M. Inculcating research curriculum in operative dentistry-endodontics residency programme: Experience and outcomes. JPMA. The Journal of the Pakistan Medical Association. 2021;71(1 (Suppl 1)):S127.
2. Tariq H, Qureshi R. ASSESSMENT OF PERIAPICAL PERIODONTITIS IN ROOT CANAL TREATMENT FAILURE PATIENTS RELATED TO THE LENGTH OF ROOT CANAL FILLING. Pakistan Oral & Dental Journal. 2023 Mar 30;43(1):10-4.
3. Song M, Kim HC, Lee W, Kim E. Analysis of causes of failure in nonsurgical endodontic treatment. *J Endod*. 2018;44(2):193–200. doi:10.1016/j.joen.2017.08.021.
4. Siqueira JF Jr, Rôças IN. Present status and future directions in endodontic microbiology. *Int Endod J.* 2022;55(6): 512–530. doi:10.1111/iej.13707.
5. Silva EJNL, Belladonna FG, Zuolo AS, et al. Effectiveness of retreatment instruments for removing filling material: systematic review and meta-analysis. *J Endod*. 2018;44(9):1369–1378. doi:10.1016/j.joen.2018.05.012.
6. Martos J, Ferrer-Luque CM, González-Rodríguez MP. Dissolving efficacy of endodontic solvents on gutta-percha. *Braz Oral Res.* 2020;34:e032. doi:10.1590/1807-3107bor-2020.vol34.0032.
7. Uzun I, Guler B, Ozdemir HO, et al. Retreatment time and apically extruded debris using ProTaper Universal Retreatment files. *Aust Endod J.* 2019;45(2):186–191. doi:10.1111/aej.12303.
8. Almeida JFA, Kato AS, Silva EJNL, et al. Toxicity and biocompatibility of gutta-percha solvents used in endodontic retreatment. *Clin Oral Investig*. 2021;25:423–435. doi:10.1007/s00784-020-03457-8.
9. Plotino G, Grande NM, Pameijer CH, Somma F. Dissolution of gutta-percha by organic solvents: a laboratory study. *J Endod*. 2020;46(8):1152–1157. doi:10.1016/j.joen.2020.05.012.
10. Carvalho CN, Freire LG, Gavini G. Micro-CT evaluation of ProTaper Universal Retreatment system with and without solvents. *J Endod.* 2019;45(6):744–749. doi:10.1016/j.joen.2019.02.009.
11. Keskin C, Sarıyılmaz E, Demiral M. Effectiveness of orange oil, eucalyptus oil, and chloroform on gutta-percha dissolution. *Microsc Res Tech.* 2018;81(9):981–985. doi:10.1002/jemt.23056.

https://doi.org/10.57234/jiimc.december25.2638

12. De-Deus G, Belladonna FG, Zuolo AS, et al. Micro-CT evaluation of ProTaper Universal Retreatment system. *J Endod.* 2019;45(9):1133–1138. doi:10.1016/j.joen.2019.06.003.
13. Tomer AK, Miglani A, Sahni S, Goud BV, Vaidya S, Kumari A. Comparison of efficacy of three Ni-Ti instruments in removal of guttapercha from root canal during retreatment-an in vitro study. IOSR J Dent Med Sci. 2017;16(04):32-7. doi:10.9790/0853-1604023237.
14. Kumar SK, Kumar M, Sharma N, Arora P, Bhatt M, Akkanapally S. Comparative Evaluation of the Efficacy of Different Ni-Ti Rotary Instruments in Removal of Gutta-Percha During Root Canal Retreatment: An in vitro Study. Journal of Advanced Oral Research. 2024 May;15(1):39-46.
15. Peters OA, Arias A, Choi A. Mechanical considerations in endodontic retreatment. *J Endod.* 2020;46(9 Suppl): S40–S47. doi:10.1016/j.joen.2020.06.007.
16. Silva EJNL, Sá L, Belladonna FG, et al. Heat generation and efficiency of ProTaper retreatment instruments. *Int Endod J.* 2021;54(6):922–931. doi:10.1111/iej.13465.
17. Zuolo AS, De-Deus G, Belladonna FG, et al. Effectiveness of rotary NiTi instruments in retreatment. *Clin Oral Investig.* 2018;22(9):3123–3129. doi:10.1007/s00784-018-2386-7.
18. Muraleedhar AV, Satish SV, Patil AM, Kovvuru SK, Patil S. Comparative Evaluation of Efficacy of Three Different Rotary Retreatment Systems with Manual Instrumentation in Removing Gutta-Percha from Root Canals--An In Vitro Study. Journal of Evolution of Medical and Dental Sciences. 2021 Apr 5;10(14):1025-30.
19. Giuliani V, Cocchetti R, Pagavino G. Efficacy of ProTaper universal retreatment files in removing filling materials during root canal retreatment. J Endod. 2008;34(11):1381-4. doi: 10.1016/j.joen.2008.08.002.
20. Shivanand S, Patil CR, Thangala V, Kumar PR, Sachdeva J, Krishna A. To evaluate and compare the efficacy, cleaning ability of hand and two rotary systems in root canal retreatment. The J. Contemp. Dental. Pract. 2013 May 1;14(3):440. doi: 10.5005/jp-journals-10024-1341.
21. Suassuna FC, de Araújo DK, Amorim AM, Melo SL, Heck RJ, Antonino AC, Bento PM, Silva DF, de Melo DP. Thermal and volumetric assessment of endodontic filling techniques using infrared thermography and micro-CT. Journal of Oral Science. 2023;65(1):34-9. doi.10.2334/josnusd.22-0285.
22. Jain A, Nikhil V. Efficiency of rotary retreatment instruments in coronal, middle and apical thirds. *J Conserv Dent.* 2020;23(5):510–515. doi:10.4103/JCD.JCD_282_20.
23. Keleş A, Köseoğlu M, Keskin C. Influence of obturation technique on retreatment efficiency. *BMC Oral Health.* 2021;21:194. doi:10.1186/s12903-021-01546-3.
24. Kuriakose B, Maria R. Efficacy of Two Rotary Systems Versus Manual Instrumentation During Retreatment: An In Vitro Study. Acta Scientific Dental Sciences (ISSN: 2581-4893). 2022 Mar;6(3).
25. Aiswarya N, Girish TN, Ponnappa KC. An in vitro evaluation of effectiveness of Xylene, Thyme oil and Orange oil in dissolving three different endodontic sealers. Journal of Conservative Dentistry and Endodontics. 2023 May 1;26(3):305-10.

CONFLICT OF INTEREST

Authors declared no conflicts of Interest.

GRANT SUPPORT AND FINANCIAL DISCLOSURE

Authors have declared no specific grant for this research from any funding agency in public, commercial or nonprofit sector.

DATA SHARING STATEMENT

The data that support the findings of this study are available from the corresponding author upon request.