

Efficacy of Three Retreatment Systems Mtwo, Protaper-R, and R-Endo in Removing Gutta-Percha from Root Canal as Compared to Manual Instrumentation: An *In Vitro* Study

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Abstract:

Background: To investigate, the ability of three different rotary nickel titanium retreatment instruments and hand instrumentation to remove gutta-percha and sealer from the root canal.

Materials and Methods: 40 freshly extracted human single rooted teeth, each with one root canal, were selected. It was instrumented with K-files and filled using cold lateral compaction with gutta-percha and AH Plus sealer. The teeth were randomly divided into four groups of ten specimens each. Removal of gutta-percha was performed with the following devices and techniques: Protaper-R, R-Endo, Mtwo and Hedstrom files. The specimens were rendered transparent and the area of remaining filling material on the root canal wall was measured using a computer image analysis program. Statistical analysis was accomplished by Kruskal-Wallis and Mann-Whitney *U*-tests with Bonferroni correction for the analysis of residual root filling material and working time.

Result: Specimens retreated with the H-files left less filling material inside the root canals than the other groups, but significant difference was found between only H-file and R-Endo ($P < 0.05$). The retreatment time with the Protaper and Mtwo instruments was significantly shorter as compared to hand instrumentation and R-Endo.

Conclusion: Although H-File left significantly less gutta-percha and sealer in the root canal than other instrument groups, but it required more time in removal procedure. Complete removal of materials did not occur with any of the instrument systems investigated.

Key Words: Gutta-percha, H-files, Mtwo, Protaper R, R-Endo

Introduction

The goal of non-surgical retreatment is to remove the Gutta-percha and sealer from the root canals so as to access the apical foramen which is considered to be most crucial zone for cleaning as the necrotic tissue found in this area below the remaining filling material can cause periapical inflammation or pain.¹

Various techniques for removal of Gutta-percha from the root canal have been advocated. These may include use of manual or rotary technique with adjunct of heat or ultrasound.²

Recently, different companies have come up with newer NiTi rotary retreatment instruments like Protaper-R, Mtwo and R-Endo systems which claim to have superior efficacy in non-surgical retreatment procedure of Gutta-percha removal.

Thus, this study aims to investigate the efficacy of these three retreatment systems compared with conventional H-File method in removing Gutta-percha from the root canal.

Materials and Methods

Several (40) freshly extracted human single straight rooted teeth were selected. Each tooth was verified radiographically as having a single patent canal with curvature $<10^\circ$ (Schneider's method).³ Only root canal in which apical diameter was size 15 were selected. Teeth with calcified canals, severe curvatures and presence of more than one canal were discarded. The teeth were sectioned coronally such that each sample has a root length of 16 mm.

Access cavity preparations were done with high-speed diamond burs and #10 K-file was placed in the canal until it was seen at the apical foramen under $\times 3$ magnification. The working length was determined by subtracting 1 mm from this measurement. The root canal was prepared using K-files with the step-back technique. Apical constriction was enlarged until size 30 K-file. Then, step back preparation was done at a 5 mm coronal level until size 55 k-file. Coronal part of the canal was flared with

size 2 and 3 Gates-Glidden burs.⁴ A size 10 K-file was used during root canal preparation to maintain patency of the canal. After each instrument change, canal was copiously irrigated with 2 ml of 2.5% NaOCl (Avuechlor; Dent. Avenue, India). When instrumentation of the root canal was complete, 17% EDTA (Dentwash; Prime Dental, India) was applied for 1 min and the canal was flushed again with 2.5% NaOCl. The root canals were dried with paper points (Sureendo, Korea) to remove the moisture followed by obturation with laterally compacted Gutta-percha (Meta Dental Co. Ltd, Korea) and AH Plus sealer (Dentsply, Germany, Switzerland). The teeth were then analyzed in buccolingual and mesiodistal directions to confirm the adequacy of root filling with the help of radiographs. Regardless of tooth length, the extent of the root filing was uniformly limited to 14 mm from the apex so that the volume of the Gutta-percha filling was approximately equal for all teeth. Temporary filling material was then used to seal the access cavities which were stored at 37°C in 100% humidity for 2 weeks. The samples were randomly divided into four groups containing 10 specimens each.

As a standardized protocol for retreatment the coronal part of the root canal filling material was removed using Gates-Glidden burs sizes 2 and 3. A drop of orange wood oil (RC Solve, Prime dental, India) was introduced into the canal to soften the Gutta-percha with additional two or three drops added as and when required. The canals were then instrumented using different file systems until the working length was reached within between frequent irrigation of 2.5% NaOCl to flush out the debris. Thus, based on methodology four groups were formed:

Group I (Hand instrument)

Hand instrumentation was carried out with Hedstrom (VDW Antaeos, Munich, Germany) files (sizes 20-30) in a circumferential motion.

Group II (Mtwo Retreatment)

Mtwo retreatment instruments (R15/0.5% and R25/0.5%; VDW, Munich, Germany) were used in a single motion to reach the apex of the teeth at torque 0.931 N/cm² and speed 250-350 as recommended by manufacturer.

Group III (Protaper-R)

Protaper-R (Dentsply, Germany, Switzerland) instrument sequence with light apical pressure in a crown down manner was used. The sequence involved D1 (size 30, 0.09-0.05 taper) with an input motion to remove the Gutta-percha followed by D2 (size 25, 0.08-0.055 taper) and D3 (size 20, 0.07-0.055 taper) until the working length.

Group IV (R-Endo)

R-Endo retreatment files (Micromega, France) contained three files namely; R1 (size 25, 0.08 taper) to remove filling from coronal 1/3rd of canal, R2 (size 25, 0.06 taper) from middle two-third and R3 (size 25, 0.04 taper) from apical third of the canal.

Crown-down technique and push and retain circumferential motion was used for instrumentation procedure.

The recommended speed and torque were maintained throughout the procedure. The procedure was considered complete when working length was reached, flutes of the files were free from debris; canals were smooth and free of visible debris. Each instrument could re-treat only five root canals and then discarded.

Evaluation

The specimens were decalcified in 5% nitric acid for 3 days, rinsed for 4 h and dehydrated in increasing concentrations of ethyl alcohol (80% for 12 h, 90% for 1 h, and 100% for 3 h).⁵ The roots were then placed in clearing agent xylene which made them transparent after approximately 2-3 h (Figure 1). Specimens were photographed using a stereomicroscope with a digital camera at ×10 magnification, and the amount of Gutta-percha/sealer on the canal walls was measured as the percentage of the remaining filling material in the coronal, middle, and apical part of the teeth using image analyzer software (Pixcavator IA 4.3; Intelligent Perception Co., Germany) in the buccolingual and mesiodistal directions according to the technique described by Schirrmeister *et al.*, 2006 (Figure 2).^{1,6}

Statistical analysis

Statistical analysis for remaining root filling material and working time involved the use of Kruskal-Wallis, ANOVA, *post-hoc*-Tukeys HSD, and unpaired *t*-test.

Results

All instruments left filling material inside the root canal (Tables 1 and 2). Specimens retreated with the H-files left less filling material inside the root canals than the other groups, but significant difference was found between only H-file and R-Endo ($P < 0.05$). Values are expressed as a mean ± standard deviation.



Figure 1: Photographic image of cleared specimen, (a) Buccolingual view and (b) Mesiodistal view.

Table 1: Percentage of remaining filling material in each third of the root canal in the different groups.

Methods	Mean±SD					
	Mesiodistal (%)			Buccolingual (%)		
	Cervical	Middle	Apical	Cervical	Middle	Apical
Group I	5.743±2.41	3.914±1.59	7.27±2.94	7.06±2.55	4.68±2.45	6.46±2.12
Group II	5.315±2.12	4.192±2.03	9.60±5.16	7.27±5.85	5.66±1.90	9.27±2.89
Group III	9.31±3.67	8.12±3.20	9.85±3.14	6.29±1.67	7.45±2.90	10.31±3.82
Group IV	12.61±6.06	12.50±9.02	16.45±14.33	7.80±2.70	8.89±3.90	8.49±3.45

SD: Standard deviation

Table 2: The total percentage of remaining filling material and the time required to remove the filling material with each technique.

Method	Mesiodistal (%)	Buccolingual (%)	Time (s)
Group I	5.64±1.12	6.11±1.47	295±228.63
Group II	6.37±1.70	7.40±2.87	195±150.73
Group III	9.09±1.82	8.02±1.91	70.5±36.15
Group IV	13.65±9.22	8.39±1.97	241.6±45.06

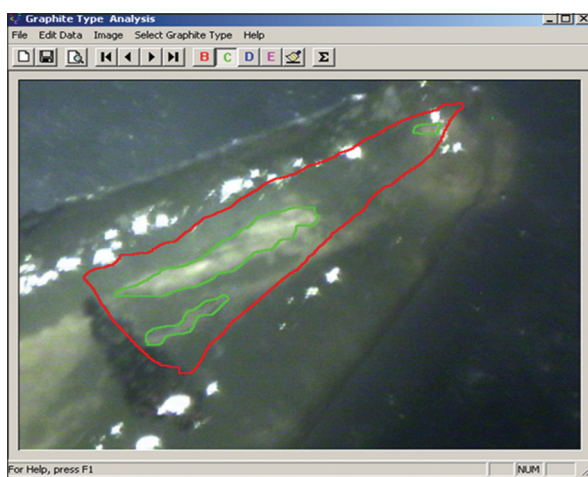


Figure 2: Analysis of remaining root filling material using image analyzing software (Pixcavator IA 4.3; Intelligent Perception Co. Germany).

Discussion

Conventionally, the removal of Gutta-percha using hand files with or without solvent can be a tedious, time-consuming process, especially when the root filling material is well condensed.⁷ Advent of NiTi instruments has improved the technique of Gutta-percha removal and have reduced the time required for doing this. To improve safety preparation and to prepare more appropriate shapes, retreatment instruments have been designed with non-cutting tips, radial lands, varying tapers and rake angles, and changing pitch lengths.

Different methods have been used to assess the cleaning of the root canals after retreatment. The most common method used was the longitudinal sectioning of the roots,^{8,9} radiographical assessment,^{10,11} teeth clearing technique⁶ and computed tomography scan.¹² Each of used techniques had its limitations. Schirmeister *et al.*, 2006 reported that residual material might be lost by splitting the roots longitudinally. Teeth clearing technique was found to be sensitive enough to detect the residues in root canal after retreatment.¹³

In the present study, orange wood oil was used as Gutta-percha solvent. Chloroform was not used during the instrumentation because of its carcinogenic potential although being more efficient in dissolving Gutta-percha than other chemicals.

This study involved the comparisons of the four methods used to evaluate the total percentage of remnant material as well as the percentage residuals at three different levels *viz.*; cervical, middle and apical as compared to previous studies which measured only total areas (Tasdemir *et al.*, 2008).

In overall comparison of the four groups, when viewed; mesiodistally; H-file was found to be best followed by Mtwo, ProTaper-R and then lastly R-Endo at 5% significance level for total percentage of remnant material. While at cervical and middle level, there is no significant difference in H-file and Mtwo. Overall ranking of the methods could be stated as H-file, Mtwo, Protaper-R, and R-Endo.

Similarly when viewed buccolingually, it was observed that there is significant difference between the mean percentage residual material of the groups when measured in total and at middle and apical level. However, there is no difference at the cervical level.

In general from both mesiodistal and buccolingual views, when mean percentage residual material are measured it was found that there is significant difference between the methods for total, cervical and middle level while for apical level there is no significant difference.

The retreatment time with the Protaper-R and Mtwo instruments was significantly shorter as compared to hand instrumentation and R-Endo. R-Endo was significantly slower than Mtwo and ProTaper-R; and faster than manual instrumentation, but the difference was not statistically significant.

In the present study, all retreatment techniques left filling material inside the canal. The results of this study were in accordance to studies carried out by other authors.^{2,9,14} These results demonstrated that the use of H-file instrumentation combined with Gutta-percha solvent was significantly more effective than R-Endo in terms of the residual material, whilst no statistical difference was found amongst the Protaper, Mtwo, and manual instrumentation groups.

Protaper-R has efficacy similar to hand instrumentation in apical third region and has shown better removal timings as compared to all groups. Thus, it can be a good clinical option for faster and effective removal of Gutta-percha.

No instrument fractures occurred during Gutta-percha removal. The low-torque hand piece increased tactile sensation, gave better control of rotary instrumentation, and also reduced the risk of instrument fracture.¹⁵ The speed of the rotary NiTi instruments was also adjusted according to the manufacturer's recommendation. In addition, using each set of instruments to prepare five root canals only, plus the use of orange oil as a solvent might be an additional reason for the lack of instrument fracture in this study.

Conclusions

Irrespective of the technique used all instrument groups showed incomplete removal of the Gutta-percha. Under the experimental conditions H-file left significantly less Gutta-percha and sealer than R-Endo, but the technique is time consuming and tedious requiring operator dexterity.

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