



ISSN Print: 2394-7489
ISSN Online: 2394-7497
IJADS 2020; 6(4): 242-246
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www.oraljournal.com
Received: 05-09-2020
Accepted: 13-10-2020

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Efficacy of various rotary retreatment instruments for gutta percha removal: An *in vitro* study

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DOI: <https://doi.org/10.22271/oral.2020.v6.i4d.1073>

Abstract

Background: Failure of endodontic treatment may necessitate retreatment by removing gutta percha from root canals. The present study evaluated the efficiency of retreating gutta-percha obturated root canals with protaper universal retreatment files, endo retreatment files, nrt gpr retreatment files and h files, while using the sealers, ah plus and zinc oxide euginol for obturation.

Materials and Methods: Intact single rooted 120 mandibular premolars were decoronated to obtain a standardized root length of 15 mm. Canals were obturated using thermoplasticized gutta percha (GP) with either AH Plus or Endofill as sealer.

The roots were randomly divided into 8 groups, with 15 teeth in each group, and gutta percha removal was done using H files, (PTUR Protaper universal retreatment), R Endo and NRT GPR (Nickel titanium gutta percha remover), for studying their efficiency in terms of total operating time and GP remnants left in the canal by using Confocal Raman Microscope.

Results: The order of efficiency in terms of time and gutta percha (GP) removal was PTUR > R-Endo > NRT GPR > H-files. The difference in GP removal was not statistically significant but the time taken for removal was statistically significant.

The use of AH Plus sealer showed more remnants than Endofill sealer and the file system followed the same order of efficiency, but the difference was not statistically significant.

Conclusion: The rotary retreatment system proved to be more efficient than hand files for gutta percha removal.

Keywords: Retreatment, rotary instruments, root canal sealers, gutta percha, microscope

1. Introduction

Endodontic retreatment is defined as a procedure performed on a tooth that has received prior attempted definitive treatment resulting in a condition requiring further endodontic treatment to achieve successful results [1]. Although root canal treatments have a high success rate when properly conducted, there are chances for failures to occur. Persistent apical periodontitis or post treatment disease is an inflammatory disorder of periradicular tissues caused by persistent microbial infection within the root canal system of the affected tooth [2].

Among various other factors, endodontic failures, or otherwise called as post treatment disease, can be attributed to inadequacies in cleaning, shaping and obturation, iatrogenic events, or reinfection of the root canal system when the coronal seal is lost after completion of root canal treatment [3]. It can also be due to the complex anatomical structure of root canal system which impede proper cleaning and shaping.

The removal of gutta –percha using hand files with or without solvent can be tedious and time consuming process [4]. With the advent of rotary NiTi instruments, the time taken for retreatment has come down and this may decrease patient and operator fatigue [5]. They have desirable properties like high resistance against corrosion, super elasticity and shape memory. The latter two properties attributes to the atomic arrangement that is different from conventional alloys such as stainless steel [6].

Nickel titanium alloys were first developed for the US navy by the Naval Ordnance laboratory. The first NiTi file was introduced to the market in 1991. The rotary NiTi instruments have been proposed for the removal of filling materials from root canal walls as

they provide a more predictable and consistent outcome. This study attempts to compare the efficiency of a newly introduced retreatment file system NRT GPR with PTUR, R-Endo and H-files in terms of GP removal and time taken for it, while using the sealers Endofill and A H Plus.

2. Materials and methods

One hundred and twenty mandibular single-rooted premolar teeth; freshly extracted for orthodontic purposes and stored in 10% formalin, with fully formed apex were used for the study.

2.1 Study Design: Invitro experimental study

2.2 Sample size: One hundred and twenty mandibular single-rooted premolar teeth

2.3 Inclusion criteria: Single rooted mandibular premolar with minimal damage.

2.4 Exclusion criteria: Teeth with root caries, previous root canal treatment, fractured tooth, cracked tooth and tooth with immature apex were excluded from this study.

2.5 Procedure methodology

The teeth were decoronated with a diamond disk to obtain a standardized root length of 15 mm. Access opening was made in all specimens. A 10-K file was placed into the canal until it was visible at the apical foramen and the working length was established at 1mm short of that length. Cleaning and shaping was performed using Protaper Universal NiTi rotary instruments. Canals were enlarged up to F2 at working length. During instrumentation all canals were irrigated between each instrument change with 2.5mL of 5.25% NaOCl. A final flush was performed with 5mL of 17% EDTA for 30 seconds followed by a rinse with 5mL of saline. The specimens were divided into 8 groups of 15 teeth each. After drying the canals with paper points the obturation was carried out by thermoplastisized gutta percha obturation technique. Groups 1, 2, 3 and 4 were obturated with gutta-percha and AH Plus and groups 5, 6, 7 and 8 were obturated with gutta-percha and Endofill sealer. The access cavities were sealed with temporary restorative material for 2 weeks

2.5.1 Endodontic retreatment

Groups 1 and 5: The retreatment was carried out with Protaper universal retreatment files. The D1 Protaper file was used to remove the filling material from the cervical third of the root canal and 0.1mL of RC solve was deposited for 1 minute into the reservoir created. A D2 Protaper file was used in the coronal two thirds of the root canal. The D3 Protaper file was used with light apical pulses of pressure until the working length was reached.

Groups 2 and 6: The retreatment was carried out with R-Endo retreatment files. First Rm hand file (K-File) was used with 1/4 turn pressure directed towards the apex to create a pathway; thus, allowing the centering and the alignment of the next instrument. Re NiT irotary file was used 1 to 3 mm beyond the pulp chamber floor with circumferential filing. Again, 0.1mL of RC solve was deposited into the reservoir created for 1 minute. R1 NiTi rotary file was used to penetrate from the coronal third to the beginning of the middle third through repeated apically directed pushing actions. R2 NiTi rotary file was used from the middle third to the beginning of the apical third. R3 NiTi rotary file was used at the working

length with circumferential filing action.

Groups 3 and 7: The retreatment was carried out with NRT GPR files. Coronal gutta-percha was removed with GG drill, followed by deposition of RC solve for 1 minute. Retreatment was performed using 2S (size 50, 18 mm length, 0.04 taper) and 4N (size 30, 21 mm length, 0.04 taper) instruments against the canal walls in a crown down fashion until working length was reached.

Groups 4 and 8: The retreatment was carried out with Hedstroem files. Filling material was removed from the coronal portion of canal with GG drill size 2 and 3. Thereafter 0.1ml of RC solve was placed in the canal for 1 minute. Hedstroem files of size 35, 30, 25 were used to remove root fillings in circumferential quarter turn push-pull motion until working length was reached.

2.6 Evaluation of total operating time

In all the groups retreatment was done until no further filling material could be removed. All the rotary retreatment systems were used in endodontic micromotor (COLTENE) at 300rpm in crown down manner. The time taken for the retreatment procedure was calculated using a stop watch. The total operating time was calculated as the sum of time taken for the initial removal of GP until the working length was reached and for complete GP removal, excluding the time taken for the change of instruments, irrigation and radiographs.

2.7 Evaluation of GP remnants

A post treatment radiograph was taken to evaluate the thoroughness of GP removal. The roots were grooved longitudinally in buccolingual direction with a diamond disk and split into two halves with a chisel. The sectioned specimens were observed under Confocal Raman Microscope at 40x magnification and images were captured. The images were transferred to Image J image analyzing software and canal area and amount of debris present were calculated.

The percentage of GP remnants (A) was calculated using the following equation: $A = (\text{area of the remnants} \times 100) / \text{area of the root canal}$. The results were analyzed using the SPSS 15 software package.

2.8 Statistical analysis

For the overall comparison of the four files within each of the sealer, ONE WAY ANOVA was used and for the two files comparisons in each of the sealer, TUKEY POST HOC method was used. This was done for both the sealers. Statistical analysis of operating time between each group was done by KRUSKAR – WALLIS TEST.

3. Result

- Maximum amount of GP remnants was associated with AH Plus sealer than Endofill sealer, but the difference was not statistically significant.
- Among the various rotary retreatment systems, PTUR left behind least remnants, followed by R Endo, NRT GPR and then H –file system, but the difference were not statistically significant
- Total operating time, for GP removal was more with AH Plus sealer than Endofill sealer, and was statistically significant.
- PTUR took least time for GP removal, followed by R Endo and NRT GPR, H files took the most time for removal, and the difference were statistically significant.

Table 1: Intergroup comparison of GP remnants (in %)

Sl No:	Group	Mean	Median	SD	Minimum	Maximum
1	AH PLUS-NRT GPR	44.5746358240	46.0498809800	9.35595968144	25.10032654	58.93427531
2	AH PLUS-PTUR	43.2061513267	44.5180257200	6.39770804280	31.12398783	51.74700419
3	AH PLUS-R ENDO	43.8467492007	45.5829620400	6.99339562869	30.40898641	55.89510600
4	AH PLUS-H FILE	45.8530765100	49.2745717400	7.76993554637	25.24897257	52.98614502
5	ENDOFILL-NRT GPR	44.9993048773	47.7256774900	8.04299239240	27.05942790	56.65550232
6	ENDOFILL-H FILE	45.5615403920	49.1586049400	9.03930911628	29.23393250	55.72713216
7	ENDOFILL-PTUR	40.9029388433	39.3054962200	7.23849918582	26.74789429	50.70927938
8	ENDOFILL-R ENDO	42.8695170093	44.0012613900	3.38067258283	36.98997498	47.47937520

% of GP remnants were calculated using the formula, A = area of remnants/ area of root canal x 100

Table 2: Intergroup comparison with NRT GPR files

	Group	N	Mean (%)	Std. Deviation	Std. Error Mean	P value =0.622
Percent Area	AH PLUS-NRT GPR	15	44.574636	9.3559597	2.4156984	
	ENDOFILL-NRT GPR	1	44.999305	8.0429924	2.0766917	

Table 3: Intergroup comparison with PTURfiles

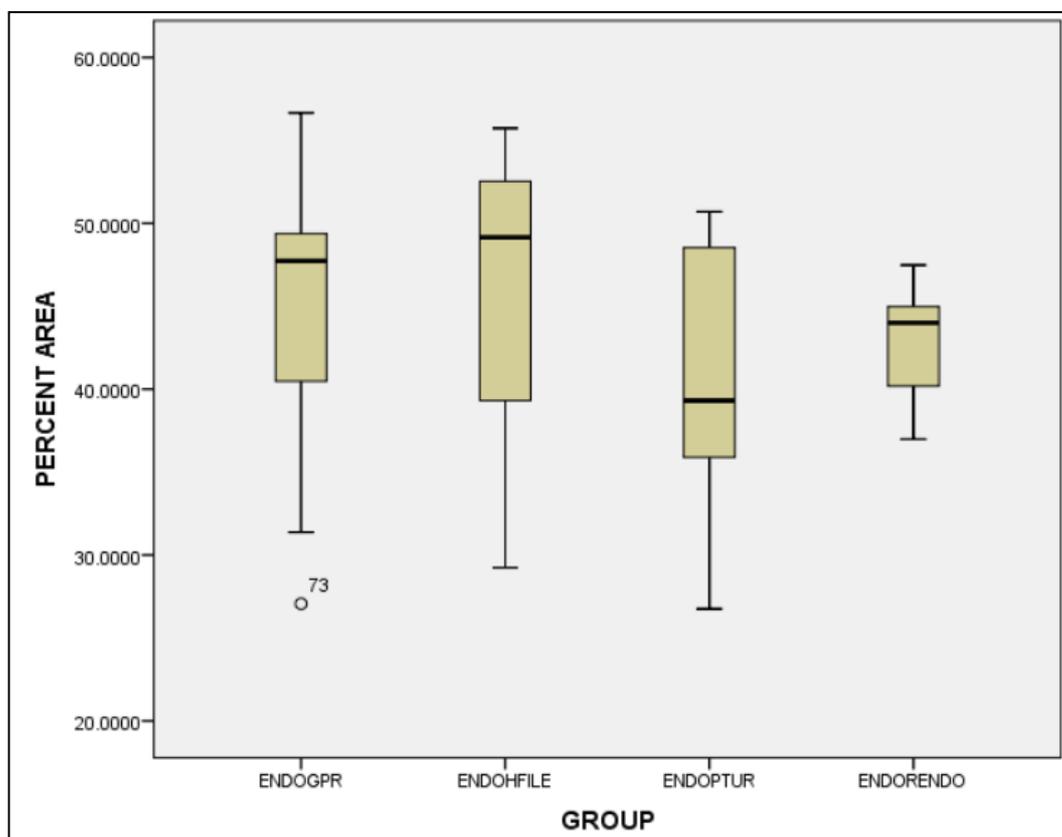
	Group	N	Mean (%)	Std. Deviation	Std. Error Mean	P value =0.454
Percent Area	AH PLUS-PTUR	15	43.206151	6.3977080	1.6518811	
	ENDOFILL-PTUR	15	40.902939	7.2384992	1.8689725	

Table 4: Inter group comparison with H files

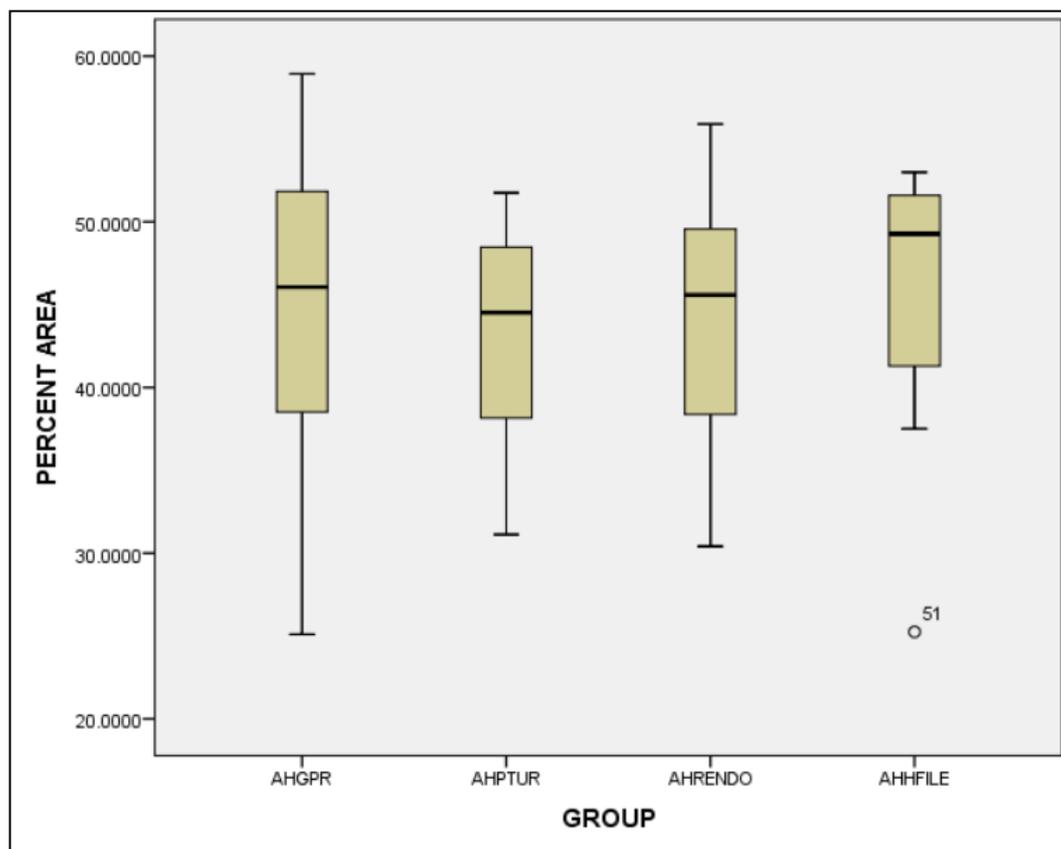
	GROUP	N	Mean (%)	Std. Deviation	Std. Error Mean	P value = 0.396
Percent Area	AH PLUS-H FILE	15	45.853077	7.7699355	2.0061887	
	ENDOFILL-H FILE	15	45.561540	9.0393091	2.3339396	

Table 5: Intergroup comparison with R-endofiles

	Group	N	Mean (%)	Std. Deviation	Std. Error Mean	P value = 0.06
Percent Area	AH PLUS- R ENDO	15	43.846749	6.9933956	1.8056870	
	ENDOFILL-R ENDO	15	42.869517	3.3806726	.8728859	



Graph 1: Percent area of remnants in endofill sealer groups



Graph 2: Percent area of remnants in AH plus sealer groups

4. Discussion

The incidence of post treatment disease, although small, translates into a large number of cases where further treatment is needed. When encountered with such a situation, the clinician must determine the etiology of the persistent pathosis and devise a rationale strategy for further treatment. One of the major differences between primary endodontic therapy and retreatment of persistent apical periodontitis is the necessity to remove the existing filling materials from the root canals.

In our study the sectioned specimens were viewed under Confocal Raman microscopy as it has proven to be extremely popular analytical technique with the set of unique advantages such as great spatial resolution, clear image quality, outstanding chemical differentiation, ability to perform 3D mapping of bulk samples and no preparation of the sample required in the study of M. Minsky Scanning in 1988 [7]. The obturation was done using thermoplastisized injectable gutta percha technique, as it is proved to be superior in obturation quality than the lateral compaction technique. There are various studies in literature proving the same [8, 9]. The difficulty encountered with thermoplastisized technique was the brittleness of the set material. This made it difficult to remove the resultant gutta percha mass from the root canal, and this was consistent with other studies [10, 11].

A new gutta percha remover, NRT GPR manufactured by Mani Inc., Japan was used in this study. The proposed advantage of this system is that it is fracture resistant around the tip part since there is no concentration of stresses due to non-cutting tip. If they do fracture, N3 and N4 will fracture at the neck, and is easy to extract from the canal. However, an important drawback of these instruments is limited cutting efficacy compared to other retreatment systems available currently. In addition, its minimum tip size being #30, does not penetrate into apical gutta percha where the apical part is

prepared to sizes lesser than #30 [12].

In the present study the better performance of ProTaper Universal retreatment instruments may be due to their specific flute design. The file not only cut gutta-percha but also the superficial layer of dentin during root filling removal. Other features are progressive tapers of D1, D2, D3 files which make it possible to shape specific sections of a root canal with one file and variable tip diameter which allow the files specific cutting action in defined area of the canal, without stressing the instrument in other section. The flute design and rotary motion cut the large amount of gutta-percha in spiral around the instrument and direct it towards the orifices.

The manufacturer of R-Endo instruments claims that instrument is designed especially for retreatment and are machined into a round blank and they have a triangular cross-section with three equally spaced cutting edges; the instrument has neither radial land nor an active tip. This system has sufficient rigidity to remove material from the root canal. The present study indicate that R-Endo system, left almost similar amount of filling material in the canal walls compared with ProTaper rotary system. Tasdemir *et al.* [5] reported that ProTaper, R-Endo and manual instrumentation groups have similar effectiveness in removing filling material in straight root canals.

In the present study, all types of rotary NiTi instruments were significantly faster than hand files in removing gutta-percha, while ProTaper instrument systems required significantly less time for retreatment than R-Endo and NRT GPR instruments. Thus the total operating time taken for GP removal was in the order PTUR < R-Endo < NRT GPR < H-files.

In the present study, sealers used for obturation are AH Plus and Endofill sealer. AH Plus is a two paste system which is an epoxy resin-based endodontic sealer with low solubility and disintegration, adequate radiopacity, adhesion to the root dentine, antimicrobial activity and adequate biological

properties. The Endofill is a zinc oxide eugenol based sealer and has more solubility^[13].

AH Plus has greater adhesion to root dentin than Endofill as it is an epoxy resin-based sealer. It has better penetration into the micro-irregularities because of its creep capacity and long setting time, which increases the mechanical interlocking between sealer and root dentin^[14]. AH Plus presented lower solubility, probably due to the presence of HEMA in its composition and the higher solubility was presented by endofill due to the continuous loss of eugenol from the sealer matrix. This justifies the presence of more areas of remnants in samples obturated with AH Plus than that of the Endofill even though the difference was not statistically significant.

In the present study, all types of rotary NiTi instruments were significantly faster than hand files in removing gutta-percha, while ProTaper instrument systems required significantly less time for retreatment than R-Endo and NRT GPR instruments. Thus the total operating time taken for GP removal was in the order PTUR < R-Endo < NRT GPR < H-files.

5. Conclusions

Rotary retreatment systems were more efficient in terms of time and GP removal than the manual technique. Among these techniques, PTUR system was most efficient whereas the manual use of H file was least efficient. However, since all the techniques showed remnants of GP on the canal walls, additional measures such as combination of manual rotary techniques and further instrumentation than the recommended would be beneficial for complete GP removal during endodontic retreatment procedures.

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