

**Efficacy of different methods for removing root canal filling material in retreatment under stereomicroscope - An in-vitro study**

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**Abstract**

**Introduction:** Endodontic retreatment is primarily indicated to eliminate or reduce microbial content of failed endodontically treated tooth. Conventionally, the removal of GP using hand files with or without solvents can be tedious & time-consuming process. Therefore, various nickel titanium instruments have been introduced for the effective retrieval of gutta percha.

**Objectives:** The aim of this invitro study was to evaluate and compare the effective removal of filling material from the root canal, using various endodontic file systems.

**Material and Methods:** The study was conducted on 40 human extracted mandibular premolars. Access cavity preparation of samples was done and working length was established with 15 K-file. Bio-mechanical preparation was done up to size 40 K-file and obturation

was done using gutta-percha and zinc-oxide eugenol sealer. After 15 days storage, samples were decoronated and subjected to removal of obturated material by four instruments: Endo star RE- Endo retreatment files, ERE (Poldent Co. Ltd, Warsaw, Poland), Protaper universal retreatment rotary system (Dentsply), Neo-Endo retreatment files: Orikam and H-files (MANI), grouped as 1,2,3, and 4 respectively. Only 2mm of obturated material from the coronal part was removed using no.3 GG Drill, and retreatment was performed. The retreatment procedure was said to be complete when no visible debris was observed on instrument flutes. The samples were split into two halves using diamond disc buccolingually in vertical direction and was examined under stereomicroscope, photographed and assessed using AUTOCAD software and percentage of remaining filling material in coronal, middle, apical thirds of canal was calculated in mm<sup>2</sup>. The data was statistically analysed with ANOVA test through SPSS software to compare means of different groups and Post Hoc test was used for comparing data between group variables.

**Results:** None of the protocols succeeded in complete removal of the filling material from any root canal during retreatment. The specimens retreated with the Endo star RE- Endo retreatment files left least amount of filling material inside the root canals followed by Protaper universal retreatment system then Neo-Endo retreatment files and H-files.

**Conclusion:** None of the techniques investigated provided complete removal of filling material from the root canals. Application of the Endo star RE Endo Rotary System showed least percentage of area covered by filling material when compared to the Protaper universal retreatment system followed by Neo-Endo retreatment system and Hedstrom files.

**Keywords:** Retreatment, H-files, Rotary retreatment files, Stereomicroscope.

## Introduction

Endodontic retreatment is primarily indicated to eliminate or reduce microbial content of failed endodontically treated tooth. Non-surgical retreatment is the most conservative attempt to re-establish healthy periapical tissues.<sup>1</sup> The main goal of retreatment is to regain access to the apex of the tooth by removal of filling material, followed by effective cleaning, shaping and re-filling.<sup>2</sup> The retreatment procedure is mostly similar to the initial RCT procedure, with the greatest difference being the removal procedure for the root canal filling material during retreatment.<sup>3</sup>

Gutta percha, in combination with root canal sealers, can be removed by the use of hand instruments alone or in combination with rotary instruments with or without solvents.<sup>1</sup> Several techniques have been proposed to remove filling materials from the root canal system, including the use of endodontic hand files (K-files and H-files), nickel-titanium (NiTi) rotary instruments, Gates Glidden drills, heat, ultrasonic instruments, laser and use of adjunctive solvents like chloroform, eucalyptol, xylene, orange oil.<sup>4</sup>

H-Files were traditionally used for root canal retreatment.<sup>5</sup> Conventionally, the removal of GP using hand files with or without solvents can be tedious & time-consuming process.<sup>1</sup> Currently, the popularity of NiTi rotary file systems has increased because of their superiority over stainless steel files.<sup>3</sup> The rotary technique is considered to be fast and safe for removal of well-condensed obturation, even in curved canals. Thus NiTi files are widely used in root canal preparation and retreatment procedures.<sup>6</sup> The Protaper universal retreatment files are characterised by progressively increasing tapers, a convex triangular cross section and a

modified guiding tip. They consist of three instruments (D1, D2, D3) with various tapers and diameters at the tip (size 30, 0.09 taper, size 25, 0.08 taper, size 20, 0.07 taper). D1 file has an active tip that aids in facilitating penetration of subsequent files.<sup>7</sup>

A new system has been proposed for GP removal from root canals, the Endo star Re Endo retreatment files, ERE (Poldent Co. Ltd, Warsaw, Poland), contains 4 instruments, with tapers from 04,06,08,12 respectively and size 30.<sup>8</sup>

Neo Endo Retreatment File system introduced by Orikam. It comes as N1 - For Coronal one-third N2 - For Middle one-third N3 - For Apical one-third. N1 and N2 comes in 16mm and 18mm and N3 comes in 22mm and 25mm. The file is used in circumferential filing motion. The N1, N2, N3 files remove gutta percha from coronal one-third, middle one-third and apical one-third respectively.<sup>8</sup> The purpose of this study was to compare the efficacy of three different rotary systems, Protaper Universal retreatment files, Endo star Re Endo and Neo-endo retreatment files with that of H files for gutta percha removal during retreatment.

## Materials and methods

### Sample selection

Forty freshly extracted, straight single-rooted mandibular premolars with relatively similar dimensions and morphology were used in this in-vitro study which were collected from the Department of Oral and Maxillofacial Surgery of Desh Bhagat Dental College and Hospital, Mandi Gobindgarh. External surface of teeth were cleaned to remove debris and soft tissue remnants and were stored in normal saline solution until required. Teeth with the presence of a single canal were included. Teeth with previous root caries, cracks, curved canals, internal resorption or calcification were excluded.

### Initial Endodontic Treatment

After access cavity preparation, apical patency was confirmed and working length was established 1mm shorter than the length at which a size 15 K-file was visualized at the apical foramen. Root canals were prepared using step back technique and enlarged upto size 40 K-file. During instrumentation, all the canals were irrigated with 1% sodium hypochlorite using 27-gauge needle. Last irrigation of all the canals were done with normal saline. The root canals of all the samples were dried with paper points and obturated with gutta-percha and zinc oxide eugenol as sealer using lateral compaction technique. Teeth were stored at 37 degrees centigrade for 15 days to allow the sealer to set completely.

### Endodontic Retreatment

Specimens were randomly divided into four experimental groups with 10 teeth each. The teeth were decoronated at the cemento-enamel junction using a diamond disk accompanied with a water coolant to standardize a root of 15mm in length. The removal of filling material from the canals was performed along with irrigation of 1% sodium hypochlorite after each instrument change. On withdrawal, the files were cleansed of any obturating material before being reintroduced in the root canal. When no traces of gutta percha were found on the surface of the instrument or in the irrigating solution, retreatment was considered complete.

Specimens in each group were retreated as follows:

#### Group 1: Endo star Re Endo Retreatment files

The kit contains 4 instruments designed to work with the crown-down technique. The Re-Endo file of number 1 (taper 0.12/size 30) was used to remove the filling material from the coronal 1/3rd of the root canal. File number 2 (taper 0.08/size 30) was used to remove the

filling material from the middle 1/3rd of the root canal. File number 3 (taper 0.06/size 30) and file number 4 (taper 0.04/size 30) was used for the apical part of the root canal, to remove the filling material from the canal as specified by the manufacturer.

#### Group 2: Protaper Universal Rotary Files

One of the most sought-after retreatment file is the Protaper Universal rotary retreatment file system. It includes three instruments with different sizes and tapers. All the three Protaper Universal system retreatment files were used in crown down technique sequentially, until working length was reached. D1 Protaper file (0.09 taper, size 30) was used to remove the filling material from the coronal third of the root canal. D2 Protaper file (0.08 taper, size 25) was used in the coronal two thirds of the root canal. The D3 Protaper file (0.07 taper, size 20) was used with light apical pressure in the apical part of the root canal. Preparation of root canal was completed when the D3 instrument reached the working length (WL).

#### Group 3: Neo Endo Retreatment Files

Neo Endo retreatment files were used in a sequential manner using a light apical pressure with crown down technique as per the manufacturer's instruction. It includes three instruments with different sizes and tapers. Neo Endo retreatment files N1 (0.09 taper, size 30), N2 (0.08 taper, size 25) and N3 (0.07 taper, size 20) were used to remove the filling material from the coronal, middle and apical one third of the root canal respectively until the working length was reached and no further filling material was removed.

#### Group 4: H-FILES

Gutta percha was removed from the coronal portion of the canal by using GG drill size 3. The re-instrumentation of the canal was carried out with H files sizes 15-40 in circumferential quarter-turn push-pull

filing motion to remove gutta-percha from the canal. H files are the most commonly used files available in the market for removing filling material from the root canals which was the reason behind its selection.

The retreatment procedure was said to be complete when no visible debris was observed on the instrument flutes. The samples were then split into two halves using diamond disc buccolingually in vertical direction and examined under stereomicroscope at 10x magnification, photographed and assessed using AUTOCAD software and percentage of remaining filling material in coronal, middle, apical thirds of canal wall were calculated in mm<sup>2</sup>.

#### Evaluation

The amount of remaining filling material was evaluated. The roots were grooved and split longitudinally in buccolingual direction, after which the coronal, middle and apical thirds of the specimens were examined under stereomicroscope 10X magnification. The specimens were photographed with a camera which was attached to stereomicroscope after which the images were evaluated using AUTOCAD software using a formula.

The percentage of volume of remaining filling material on canal walls was calculated with the following equation:

$$\text{Volume \% of remaining filling material} = \frac{\text{Volume of remaining filling material}}{\text{Volume of original filling material}} \times 100 \%$$

#### Statistical analysis

The data obtained was analyzed with descriptive statistics, ANOVA (Analysis of Variance)-one way and Scheffé's post hoc test was applied for intergroup comparison of gutta percha remnants. SPSS (Statistical Package for Social Sciences) software was used to perform statistical analysis.

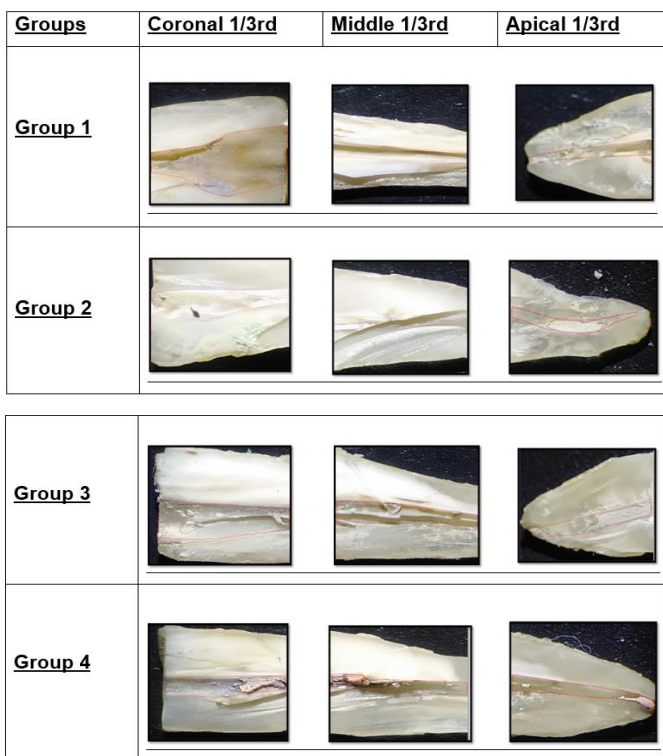


Fig 1: Assessment of Residual Gutta Percha examined under stereomicroscope

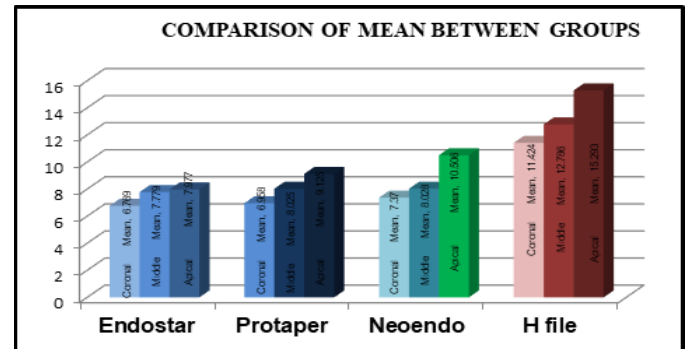
## Results

Amongst the manual and rotary retreatment systems evaluated, remnants of filling material were observed in all the groups, i.e., none of the protocols succeeded in complete removal of the filling material from any root canal during retreatment. The specimens retreated with the Endo star RE- Endo retreatment files left least amount of filling material inside the root canals followed by Protaper universal retreatment system then Neo-Endo retreatment files and H-files (Table 1, Graph 1).

Group	Coronal Mean $\pm$ SD	Middle Mean $\pm$ SD	Apical Mean $\pm$ SD	Total Mean $\pm$ SD
Endo star	6.76 $\pm$ 0.33	7.77 $\pm$ 0.56	7.97 $\pm$ 0.62	7.46 $\pm$ 0.51
Protaper	6.95 $\pm$ 0.40	8.02 $\pm$ 0.58	9.12 $\pm$ 0.54	7.68 $\pm$ 0.37
Neo	7.37 $\pm$	8.02 $\pm$	10.5 $\pm$	7.87 $\pm$

Endo	0.54	0.42	1.14	0.38
H file	11.42 $\pm$ 0.85	12.78 $\pm$ 0.88	15.29 $\pm$ 0.68	13.17 $\pm$ 0.51

Table 1: Comparison of the mean percentages of total root canal filling material remaining in the coronal, middle, apical and entire tooth among the four groups.



Graph 1: Comparison of the mean percentages of total root canal filling material remaining in the coronal, middle, apical 1/3rd among all the four groups.

## Discussion

There are multiple reasons for the failure of root canal which include insufficient cleaning which results in persistence of bacteria leading to infection, inadequate obturation, overextension of the GP points, and improper seal. This resulted in the increase in research in the endodontic retreatment, which is gaining light currently by the removal of old GP.<sup>9</sup>

In 1986, late Dr Herbert Schilder quoted the term “RETREATODONTICS” and said that the future of endodontics lies in the “Retreatment of Endodontic Failures”. When root canal therapy fails, treatment options include conventional retreatment, periradicular surgery or extraction. Whenever possible, the retreatment option is preferred because it is the most conservative method to solve the problem.<sup>10</sup>

We chose to work with mandibular premolars because they are flattened mesiodistally and have a greater buccolingual dimension, making it harder for endodontic instruments to touch all of dentinal walls. The anatomy



of the root canal system and the quality of the initial root filling are important factors that need to be considered during retreatment procedures.<sup>11</sup> The use of solvent as an aid in removing the filling mass is somewhat controversial. A solvent can facilitate penetration of the instrument into the filled canal, but its use may result in the formation thin and hard to remove layer of filling material adhered to the dentinal walls. We have not used any solvent in this study because owing to the risk of extrusion into the periapical region.<sup>12</sup>

Overall, rotary instruments which were used in this study were more effective than stainless steel H-files in the removal of the residual root canal filling material. H-files have a positive rake angle that facilitate gutta percha removal on withdrawal strokes. Compared to rotary files, hand files are more rigid and stiffer and their use till the working length can lead to procedural complications like ledge, transportation and perforation of the canals. Khalilak Z et al. in their study reported that Protaper universal retreatment files showed better efficacy than H files in removal of gutta percha. This is because Protaper files D1, D2, D3 (9 %, 8 %, 7 % taper respectively) have larger cross section compared to 2 % tapered H-files thus, removing more filling material.<sup>13</sup>

In this study, the Neo-Endo retreatment files proved to be less effective in removing root canal filling material from the root canal during retreatment than the other two rotary retreatment file systems used. Neo-endo retreatment files has a niti metallurgy design featuring parallelogram cross section, positive cutting edge with micro-grinding manufacturing technology.<sup>14</sup>

The superiority of Protaper Universal retreatment files over Neo-endo retreatment files in removing filling material from root canals is attributed to the three progressive tapers and length design of D1, D2 and D3 files with the retreatment series having a convex

triangular cross section, However, D1 has a working tip that facilitates its initial penetration into filling materials.<sup>15</sup> While Neo-endo retreatment files has a NiTi metallurgy design featuring parallelogram cross section, positive cutting edge with micro-grinding manufacturing technology. Although, statistically insignificant difference was seen between both the retreatment file systems due to presence of similarities in the size and taper of both system, i.e, the Protaper Universal retreatment files exhibit tapers and diameters at the tip, which are D1 (size 30, 0.09 taper), D2 (size 25, 0.08 taper) and D3 (size 20, 0.07 taper). While as per manufacturer's recommendation Neo-endo retreatment files has N1- (size 30, 0.09 taper), N2- (size 25, 0.08 taper) and N3-(size 20, 0.07 taper) respectively.

The findings of the present investigation showed that the reason behind most effective result of Endo star RE Endo Rotary System than Protaper Universal retreatment files is on the basis of the design of the file system. In Endo star RE Endo Rotary System the file no. 1, file no. 2 has square cross-section similar to K-files with four cutting edges and good elasticity while No. 3 and No. 4 have S-cross-section with cutting taper/tip diameter of 0.06/30 and 0.04/30 respectively. This may be attributed to S-cross section design of No. 3 and No. 4 files which provides positive rake angle with two cutting edges distributed symmetrically, increased pitch length and more cross-sectional space for enhanced cutting and allowing the debris to move coronally.<sup>2</sup> The depth of the space designed for dentine removal is increased behind the blades, which provides the large space for dentine removal and leads to more efficient gutta-percha removal.<sup>16</sup> They present with great cutting ability, a non-cutting tip and very good elasticity.<sup>17</sup>

While the cross-sectional design of the Protaper Universal retreatment files favours removal of large

amounts of gutta-percha in spirals around the instruments, the same cross-sectional design and the high-centering ability prevent it from contacting all the walls of the root canals, thereby deterring complete removal of filling material from the root canals.<sup>18</sup>

Statistically non-significant difference was noted in the amount of residual filling material in the coronal, middle and apical 1/3rd of the root canal walls among the three rotary files systems used in this study. But Endo star RE Endo Rotary System showed slightly better removal of residual filling material in the apical one-third than other two rotary systems used. This may be attributed to S-cross section design of No. 4 file of Endo star RE Endo Rotary System with cutting taper of 0.04 whereas Protaper universal retreatment system and Neo-endo retreatment files were having cutting taper of D3 file and N3 file, ie, 0.07 and 0.07 respectively.

The results showed that the use of NiTi rotary files that are specifically designed for retreatment of root canal fillings appeared to be safe in retreatment procedures. Sticking to the strict observation of the manufacturer's instructions, discarding the NiTi instruments after five uses might have also affected this position.<sup>19</sup>

Under the experimental conditions of the present study, all techniques proved helpful for removal of endodontic filling material. The rotary NiTi instruments were significantly more effective than manual H-files in removing gutta-percha during retreatment but there was no significant difference between the three rotary instruments. From the results of the present study, we can conclude that the design of retreatment files could have an effect on its cleaning ability.

### Conclusion

Within the parameters of this study, the following conclusions may be drawn:

1. All four instruments proved to be helpful and safe devices for gutta percha removal in nonsurgical endodontic retreatment.
2. None of the techniques investigated provided complete removal of filling material from the root canals.
3. Application of the Endo star RE Endo Rotary System showed least percentage of area covered by filling material when compared to the Protaper Universal retreatment system followed by Neo-endo retreatment system and Hedstrom files.

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