

**Efficacy of four newer NiTi RE-treatment file systems-A stereomicroscopic study**

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**Abstract**

**Background:** The primary goals of endodontic re-treatment remain the same as the goals of the initial treatment: elimination of bacteria and prevention of further bacterial contamination by means of well obturated canals and coronal seal. Various rotary nickel titanium instruments have been introduced for the effective retrieval of gutta percha. Compared to the conventional or traditional methods using hand instruments, rotary instrumentation is much faster and less tedious for the operator. This study compares and evaluates the efficacy of four rotary file systems for

removing gutta-percha and sealer from root canal with the use of solvents.

**Methodology**

90 extracted single rooted permanent premolars were cleaned, prepared and obturated using gutta percha and AH Plus sealer using lateral compaction technique. Samples were randomly divided into five groups of 18 specimens each. Group 1 was instrumented with Hedstrom hand Files (H-Files). Group 2 with Neo-endo retreatment files, Group 3 with MANI GPR retreatment file system, Group 4 with Micromega R-Endo retreatment files and group 5 with pro taper universal

retreatment files (PTUR). The samples then sectioned longitudinally and observed under a stereomicroscope. Digital images were taken and analysed using digital image analysing software (image Pro V10). The data was statistically analysed using Kruskal Wallis for multiple group comparison and Mann Whitney for inter group comparisons. Intra group comparisons was done by Wilcoxon sign rank test. Probability value ( $p < 0.05$ ) was considered statistically significant.

### **Results**

On evaluation of total percentage of residual material, Neo-endo files showed maximum efficacy followed by PTUR, R-Endo, MANI-GPR and H files. The time needed for retreatment was also less for the Neo-endo retreatment files compared to the other retreatment files.

### **Conclusion**

Gutta percha and sealer removal using Neo-endo retreatment files were faster and more efficient compared to Protaper universal retreatment file system, MANI-GPR, R Endo and H files. None of the instruments were able to remove the filling material completely.

**Keywords:** Endodontic Retreatment, AH Plus sealer, Protaper Universal Retreatment Files, R-Endo micromega Retreatment Files, Neo Endo Retreatment Files, MANI-GPR Retreatment Files, H Files.

### **Introduction**

Endodontic therapy is a treatment sequence designed to eliminate bacteria from the infected root canal, and to prevent decontaminated tooth from future microbial invasion.

The science of endodontics has established itself as the cornerstone of restorative dentistry in modern times. The high success rate of endodontic treatment can be attributed to the ever-increasing focus on material science and in creating a germ-free environment inside

the root canal. Needless to say, cleaning and shaping of the root canal is the prime factor in achieving a complete debridement.

There are several reasons attributed for the failure of endodontic treatment. Some of these reasons can be listed as iatrogenic, complex canal morphology, bacterial, residual infections, and poor hygiene. Any one of these or several together may lead to a persistent infection and ultimately results in failure of the endodontic therapy. All endodontic failures are directly associated with the presence of bacteria and their toxins inside the root canal system. A failed root canal warrants a reintervention by an endodontist. The procedure involves regaining access into the root canal, followed by removal of the root filling, cleaning and shaping, medication, reobturation of canal space and sealing of coronal orifice.

Endodontic retreatment as a term refers to treatment performed because the initial treatment was inadequate or the lesion failed to heal, resulting in a revisit.

Removal of gutta-percha using traditional hand files with or without solvents is time consuming, especially when the fillings are well condensed. One of the effective and efficient methods to remove GP is the use of rotary retreatment files. Rotary Nickel-titanium instruments are specifically designed to remove obturation materials. NiTi rotary systems have been suggested for removing gutta percha and sealer because of their safety, efficiency, and speed. Multiple systems and designs have been developed specifically for this purpose.

This study aims to compare and evaluate the efficacy of four rotary file systems for removing gutta-percha and sealer from root canal with the use of solvents.

The four rotary retreatment files used in this study includes Neo-endo retreatment files, Protaper

retreatment files, R-Endo Micromega files, Mani - GPR files and Hand files included in the study are H files.

## **Methodology**

### **Specimen preparation**

90 single rooted mandibular permanent premolars extracted for orthodontic purpose were collected and disinfected in 0.5% Chloramine-T for 1 hour and stored in saline (Baxter, India Pvt. Limited, Tamil Nadu, India.) till use. Diagnostic X-ray were taken to confirm the existence of a single straight canal, fully formed apex and no signs of internal resorption, calcification or previous endodontic therapy or caries, restoration or presence of dentin pins. Soft tissue and calculus were removed mechanically from the root surface. They were decoronated using a diamond disc to attain a 15-16mm. root length.

### **Root canal procedure**

In all groups working length were determined with size #15 K-file (Mani Dental. Inc., Japan), by inserting the file into the canal until the tip of the file is just visible at the apical foramen and reducing 1mm from this length from coronal reference point to the tip. In all teeth root canal treatment was initiated. Root canal cleaning and shaping was done in crown down technique using Protaper Ni-Ti rotary system (Dentsply, Maillefer, Switzerland). Patency of the canal was maintained throughout the procedure by passing #10 K-file (Mani Dental. Inc., Japan) approximately 1mm through the apex.

Cleaning and shaping of the canal was carried out using Protaper NiTi rotary system - Sx, S1, S2, F1, F2 (Dentsply, Maillefer, Switzerland). And the canals were enlarged up to F2-6% at working length. During instrumentation, all canals were irrigated between each instrument change with 5ml of 5.25% NaOCl). The smear layer was removed using 5ml of 17% EDTA for

one minute, followed by a final rinse of 2ml of 5.25% sodium hypochlorite and finally with 5ml saline following the irrigation protocol. The canals were then dried with paper points (Dentsply Maillefer, Switzerland) and the obturation was done by lateral condensation method.

All the groups were obturated with Gutta percha and AH Plus sealer using lateral condensation technique using accessory cone (Dentsply Maillefer, Switzerland) with the help of spreaders, and sealed using a heated instrument at the level of orifice of all canals. The teeth were radiographed to confirm the adequacy of the root filling. After placing a temporary restoration of Cavit (3M ESPE, Germany), each tooth stored in a humidior at 37°C for 3 weeks to allow the sealer to set completely.

### **Retreatment technique**

All temporary cements were removed by straight fissure bur. From each group first 2-3 mm of Gutta-percha were removed using no:2 Gates Glidden drill from the cervical part of the root. Retreatment by removal of obturation materials were initiated using the placement of 2 drops of GP solvent (carvene, - Prevest Denpro) for 2 min. Canals were constantly irrigated with 2.5ml of 5.25% NaOCl, 10ml of EDTA solution and 5ml of NaOCl alternately with the final irrigation of 5 ml of saline, according to the irrigation protocol, in between each file change.

The criteria for completion of retreatment is the presence of clean filings, no evidence of filling material on the flutes of files or paper point and smooth canal walls.

### **Specimens in each group were retreated as follows**

**Group 1: Hedstrom file group:** The H- files were used in a crown down manner to end at 30-15 were used in descending order to the working length using a circumferential filling motion. Once the working length

had been reached with a size 15 file, size 20, 25, and 30 were used at the working length.

**Group 2: Neo-endo Retreatment Files group:** Neo-endo retreatment files were used in a sequential manner using a light apical pressure at a constant speed of 350 rpm as per the manufacturer's instruction. Neo-endo retreatment files N1, N2 and N3 were used for the coronal, middle and apical one third respectively using crown down technique.

**Group 3: Mani -GPR retreatment file system:** 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.

**Group 4: R-Endo Retreatment Files:** R-Endo files were used in a gentle in and out motion at a constant speed of 300 rpm as per manufacturer's recommendation. The Rm stainless steel hand file was used with ¼ turn pressure to allow the alignment of the next instrument. The Re instrument was used to remove the first 2- 3 mm of the filling. R1 and R2 instruments were used to one-third and two-third of the estimated working length respectively. R3 was used at the working length with circumferential filing action.

**Group 5: Protaper Universal Retreatment Files (PTUR):** The root canals were instrumented in a crown down manner in a brushing motion. The rotational speed was set at 500 rpm as per manufacturer's recommendation. D1, D2 and D3 were used in a sequential manner for the coronal, middle and apical one third respectively to reach the established working length.

#### Analysis of remaining filling material using stereo microscope

The roots were grooved longitudinally in the buccolingual direction with a diamond disk and split into

halves with a diamond disk and chisel. The amount of remaining GP and sealer was evaluated in three segments; 1mm above the apex (apical), 8mm from the apex (middle), 2mm below the cemento-enamel junction (coronal). Then, the specimens were examined using a stereomicroscope at 10X magnification. After being photographed with a digital camera, the images were evaluated using digital image analysing software, Image Pro v10 (media cybernetics).

The percentage of residual filling material (A) was calculated using the following equation:  $A = (\text{Area of the residual filling material} \times 100) / \text{Area of the root canal wall}$ .

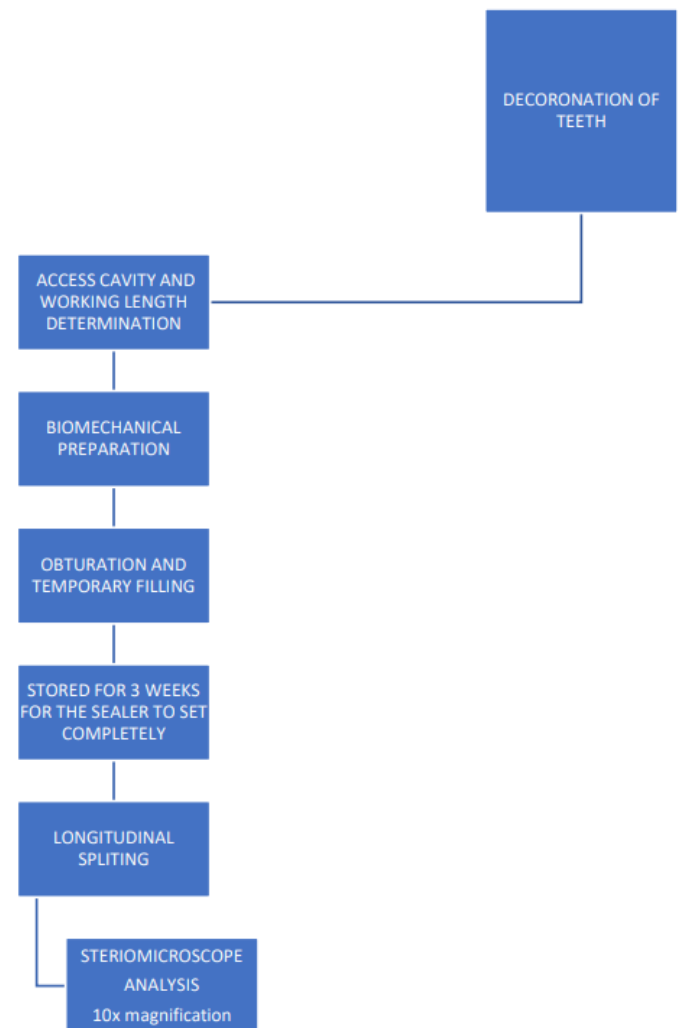


Fig 1: Work flow of the specimen preparation for stereo microscope.

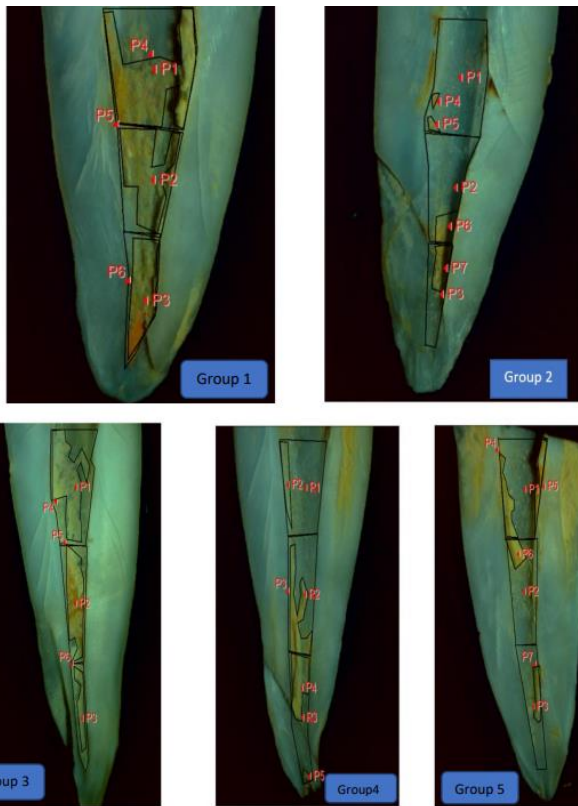


Fig 2: Assessment of Residual filling material Using Image Pro V 10 Software

**Results**

All statistical procedures were performed using Statistical Package for Social Sciences (SPSS) 20.0. Calculations for power (80%) of study was performed before commencement of the study. All quantitative variables were expressed in mean and standard Deviation. Qualitative variables were expressed in percentages. Normality was checked using Shapiro wilk test. Kruskal Wallis for multiple group comparison was made and Mann Whitney for inter group comparisons. Probability value ( $p < 0.05$ ) was considered statistically significant.

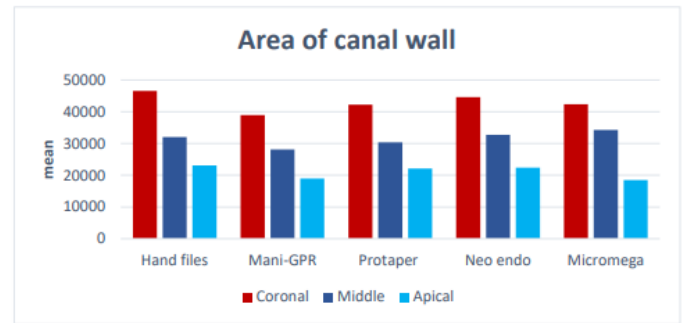
In the current study, remnants of filling material were observed in all the groups. On assessing the total percentage of residual material, Neo-endo files showed maximum efficacy followed by PTUR, MicromegaR-Endo, MANI-GPR and H files. The time taken for

retreatment was also less for Neo-endo retreatment files compared to the other retreatment files.

Table 1: Area of canal wall

	Coronal		Middle		Apical	
	Mean	SD	Mean	SD	Mean	SD
<b>Neo endo</b>	44639.2	7372.1	32748.0	5651.3	22399.0	2633.6
<b>Mani-GPR</b>	38974.4	4707.9	28101.3	7900.7	18965.8	6811.3
<b>Protaper</b>	42266.3	7882.5	30371.9	5380.4	22116.3	3994.3
<b>H files</b>	46599.8	12322.9	32062.7	4215.2	23124.9	5087.1
<b>Micromega R-Endo</b>	42369.1	5321.9	34268.2	6417.8	18514.0	4927.1

#Kruskal Wallis test



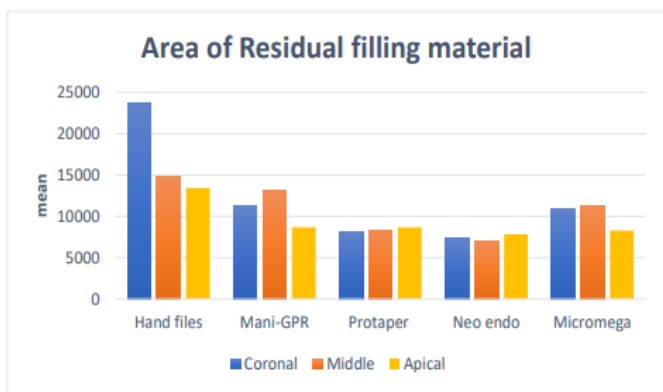
Graph 1

Table 1/ Graph 1: Shows the comparison of different endodontic file in area of canal wall. Coronally area of canal wall was highest in H files  $46599.8 \pm 12322.9$  followed by neo endo ( $44639.2$ ) > micromega R-Endo ( $42369.1$ ) > Protaper ( $42266.3$ ) > maniGPR ( $38974.4$ )

Table 2: Area of Residual filling material

	Coronal		Middle		Apical	
	Mean	SD	Mean	SD	Mean	SD
<b>Neo-endo</b>	7352.4	3535.8	7004.3	6398.1	7841.8	6898.1
<b>Mani-GPR</b>	11250.1	7715.1	13159.2	5218.6	8658.1	4224.9
<b>Protaper</b>	8167.1	5187.1	8368.8	4145.3	8670.8	4817.1
<b>H files</b>	23738.1	10620.2	14725.6	6997.2	13416.7	3405.5
<b>Micromega R-ENDO</b>	10902.7	7165.2	11316.3	8388.3	8281.3	3485.9
<b>P value</b>	<0.001**		0.002*		0.004*	

#Kruskal Wallis test;  $p < 0.05$  is statistically significant;  $** < 0.001$  is statistically highly significant.



Graph 2

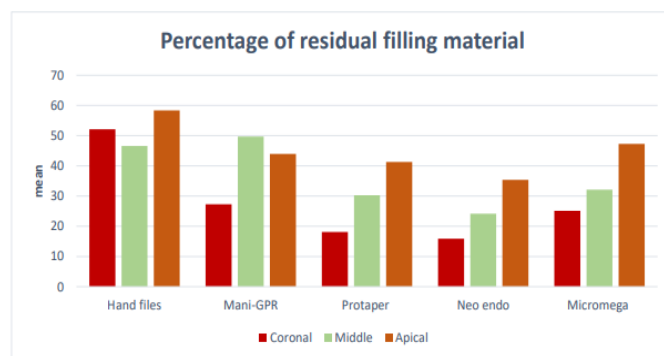
Table 2 /Graph 2: Depicts the comparison of the area of remnants remaining between different endodontic files. Coronally area of residual filling material was highest in hand files  $23738.1 \pm 10620.2$  followed by Mani-GPR (11250.1) > micromega R-Endo (10902.7) > Protaper (8167.1) > Neo-endo (7352.4) this difference was statistically highly significant ( $p < 0.001$ ).

There was a significant difference ( $p = 0.002$ ) of area of canal wall at middle third with hand files having highest value (14725.6) and Neo-endo the least (7004.3). Significant difference ( $p = 0.004$ ) was seen at apical third with H [hand] files having the highest value (13416.7) and Neo-endo the least (7841.8)

Table 3: Percentage of residual filling material.

	Coronal		Middle		Apical	
	Mean	SD	Mean	SD	Mean	SD
Neo endo	15.9	5.7	24.2	25.3	35.4	31.0
Mani-GPR	27.3	20.1	49.7	24.6	44.0	15.5
Protaper	18.1	12.3	30.3	17.2	41.3	24.1
H files	52.1	23.3	46.6	22.1	58.4	11.3
Micromega R-Endo	25.1	15.4	32.1	21.3	47.3	21.9
P value	<0.001**		0.003*		0.02*	

#Kruskal Wallis test; p value <0.05 is statistically significant; \*\* <0.001 is statistically highly significant.



Graph 3

Table 3/Graph 3 - Depicts the comparison of the percentage of residual filling material between different endodontic files. Coronally percentage of residual filling material was highest in hand files  $52.1 \pm 23.3$  followed by Mani-GPR (27.3) > micromega R-Endo (25.1) > Protaper (18.1) > Neo-endo. (15.9) this difference was statistically highly significant ( $p < 0.001$ ).

There was a significant difference ( $p = 0.003$ ) of percentage of residual filling material at middle third with Mani GPR having highest value (49.7) and Neo endo the least (24.2). Significant difference ( $p = 0.02$ ) was seen at apical third with hand files having the highest value (58.4) and Neo-endo the least (35.4).

### Discussion

Endodontic therapy is a sequence of treatment undertaken for the infected pulp of a tooth with or without periapical pathosis, which results in the elimination of infection and protection of the decontaminated tooth from future microbial invasion<sup>[1]</sup>

The success of endodontic treatment depends on the thorough debridement of the infected canal system and complete sealing of the canal space, thus preventing persistence of infection and/or reinfection of the pulp space. [1 based on the recent clinical evidence; a large number of retreatment cases are due to iatrogenic errors. Root canal treatment failures occur when the treatment falls short of the acceptable standards. It is usually associated with procedural errors in infected tooth. It

may be due to inadequate cleaning and shaping, or due to overfilling of root canals or inadequate coronal seal [2]

Various techniques are used for removal of root canal sealers and obturating material such as hand instruments like K-files or H-files, Gutta-percha solvent, Combination of paper points and gutta-percha solvent, Rotary instruments, Specialized rotary instruments designed for retreatment, Heat transfer devices, Soft tissue and ultrasonic devices. Rotary instruments have proved to be effective and time saving in removing the filling materials.<sup>[2]</sup>

Various methods have been used to assess efficiency of retreatment by identifying and measuring the remaining filling material in the root canal. Radiography and digitised images were used in the studies. Various other techniques like splitting of the teeth longitudinally and visualization with the help of stereomicroscopy and using digital camera and image analyser software -image proV10 also used in this study.

The retrievability of each obturating material from the canal walls were evaluated by measuring the percentage volume of residual root canal obturating material compared to the total volume of root canal after the obturating material is removed by five retrieval systems.

In this study gutta-percha was used along with an epoxy resin-based sealer (AH Plus, Dentsply), to achieve bonding to the canal walls. AH Plus sealer is a thermoplastic, two-component paste, that contains adamantine based on epoxy amine resin, which permits removal of the material when required and is used along with gutta-percha for bonding to the canal walls.<sup>[3,4]</sup>

Various methods have been used to remove gutta-percha from root canal which includes the use of K type or H type hand files along with solvents like chloroform, xylene, eucalyptol, halothane or orange solvents. Also rotary Gates-Glidden drills, heated pluggers and

ultrasonic tips can be used to remove gutta-percha from root canals.

Rotary retreatment file system plasticizes obturation materials by the heat produced by friction on rotation and the specific flute design tends to pull the gutta-percha in to the file flute making the removal of obturation material more efficient.<sup>[5,6,7]</sup> In this study rotary file systems compared are neo-endo, PTUR, R-Endo, and MANI-GPR files.

Xylene has been used in the present study as the gutta percha solvent. Xylene dissolves gutta percha slowly and allows better elimination of gutta percha rather than liquidized gutta percha.<sup>[8]</sup>

H-files have a positive rake angle that facilitate gutta percha removal on withdrawal strokes. But H files are prone to fracture easily because of flute design. 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.[9] Studies reported that Protaper universal retreatment files showed better efficacy than H files in removal of gutta percha.[10] 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.

Neo-endo Retreatment Files comes N1- 30/09 taper for Coronal One-third, N2- 25/08taper for Middle One-third, N3- 20/07taper for Apical One-third and using a light apical pressure at a constant speed of 350 rpm and 1.5NCm torque. N1 and N2 comes in 16mm and 18mm and N3 comes in 22mm and 25mm respectively. Neo-endo files are used with gentle touch, the files are never forced and always the recommended speed and torque setting is used. The file is used in circumferential filing motion. The files are always cleaned in between and inspected for any deformation. It is used until all the

gutta percha is removed from the canal. These file systems have a parallelogram cross section and a positive rake angle.<sup>[11]</sup>

MANI-GPR/Gutta Percha Removal files are a pack with which removing GP from any canal is done in just two simple steps even without GP solvents. MANI-GPR retreatment files systems are a set of 4 file-2SS & 2NiTi allow us to efficiently remove GP from a failed root canal, only by engaging with the GP and securing healthy dentine during procedure. MANI-GPR is equipped with thermally treated 5mm tip and shape memory effect, provides GPR files with increased flexibility and fatigue resistance.<sup>[12]</sup>

R-ENDO developed by Micro-Mega, R-ENDO is a total concept dedicated to retreatment. R-Endo (Micromega, Besancon, France) retreatment system, consists of three files such as R1, R2, and R3. R-ENDO comprises a stainless-steel Rm hand file used to break the hard layer of filling material and 4 NiTi instruments in continuous rotation for flaring (Re) and progressive shaping of the 3 root canal areas (R1, R2, R3).<sup>[13]</sup> The R1 file is used in the coronal 1/3 of the canal, R2 is used in the middle 1/3 of the canal, and R3 is used in the apical 1/3 of the canal. Perfectly adapted to the materials generally encountered during endodontic re-treatment such as Gutta Percha or filling pastes and combined with a simple and safe protocol, this single unique method is used to remove filling materials and to finish the root canal. No separate shaping step is required. R-ENDO files have been especially designed in terms of tapers, pitches and lengths for a progressive access to each zone of the canal space.<sup>[14]</sup>

Protaper Universal Retreatment Files (PTUR) was developed to overcome the drawback of Protaper rotary finishing files which when used for obturation material removal from canals were unable to penetrate Gutta-

percha and had higher incidence of fracture of 22.7% according to studies conducted by Betti and Ruddle.<sup>[15,16]</sup>

Protaper retreatment files have triangular cross section along with three progressive tapers and length enabling the file to cut not only guttapercha but also superficial layer of dentin during obturation material removal. D1 (size 30, 0.09 taper, 16mm length) was used for initial penetration and removal of coronal third of filling material, D2 (size 25, 0.08 taper, 18mm length) for middle third of root canal and D3 (size 20, 0.07 taper, 22mm length) to reach the working length.<sup>[30,31]</sup>

On evaluation of total percentage of residual material, Neo-endo files showed maximum efficacy followed by PTUR, R-Endo, MANI-GPR and H files. In the present study, all types of rotary NiTi instruments were significantly faster than hand files in removing guttapercha, while neo-endo instrument systems required significantly less time for retreatment than Protaper, R-Endo and NRT GPR instruments. Thus the total operating time taken for GP removal was in the order Neo-endo < R-Endo < NRT GPR < H-files.

The results of this study support the results of the previous studies that the retreatment techniques left some remnants within the root canal. Was Nik et al. in 2013 proved that use of rotary as well as hand instrumentation could not achieve a completely cleaner canal.[19] Karamifar K et al. [20] in their study reported that rotary instrumentation was more efficacious than hand instrumentation for gutta percha removal. In the current study, on assessing the total percentage of residual material, Neo-endo files showed maximum efficacy followed by PTUR, R-Endo, MANI-GPR and H files. The time taken for retreatment was also less for Neo-endo retreatment files compared to the other retreatment files.



The Neo-endo files have a parallelogram cross section and a positive rake angle. The parallelogram cross section limits the contact between the file and the dentin to only one or two points at any given cross section. This will subsequently reduce the binding and makes sure that there is little or no screwing in, thus, improving the safety and cutting efficiency.

The added space around the instrument ensures room for improved debris removal. Also it has an active cutting tip which helps in easy initial penetration. In the present study, residual gutta percha left after retreatment with the Neo-endo files was significantly less than the other four groups. This finding is in accordance with that reported by Antony JM et al. [11]

The study being an invitro one, there is associated limitations as the study could not be conducted under oral environmental conditions, and to conclude on the results we need clinical trials. The associated risk of instrument fracture in the root canals during removal of obturation material and the possibility of apical extrusion of debris could also be not neglected. The chances of vertical fracture of the tooth due to the development and propagation of micro cracks created during instrumentation also has to be considered. The obturation material in the root canals of teeth which need retreatment, in case of primary endodontic treatment failure, which hinders the further canal debridement and disinfection, must be removed from the root canals for providing an acceptable three dimensionally sealed obturation. Various factors affect the retrievability of this filling material.

**CONCLUSION** With in the limitations of this study it can be concluded that rotary retreatment systems effectively removed Gutta-percha better than hand files. Among the systems compared, neo-endo file system was the most efficient and H file the least efficient

concurring with the available literature. However no system could remove the GP remnants completely from the root canal walls. Furthur modifications in techniques and newer instrument designs may hold the key for complete removal of Gutta-Percha remnants from the root canal system.

### **References**

1. Carrotte P. Endodontics: Part 11 The modern concept of root canal treatment Brit Dent J 2004;197(4).
2. Muraleedhar AV, Satish SV, Patil AM, et al. Comparative evaluation of efficacy of three different rotary retreatment systems with manual instrumentation in removing gutta-percha from root canals - an in vitro study. J Evolution Med Dent Sci 2021;10(14):1025-1029, DOI: 10.14260/jemds/2021/219.
3. Marfisi K, Mercade M, Plotino G, Duran-Sindreu F, Bueno R & Roig M et al. Efficacy of three different rotary files to remove gutta-percha and Resilon from root canals. Int Endod J 2010;43: 1022 – 8.
4. Aliveni A. Evaluation of Gutta-Percha and Resilon Retreatment - an invitro study, Indian J of Dent Adv 2009;1(1):12 –5.
5. Gu LS, Ling JQ, Wei X, Huang XY. Efficacy of Protaper universal rotary retreatment system for gutta-percha removal from root canals. Int Endod J 2008; 41(4):288-95.
6. 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.
7. Hammad M, Qualtrough A, Silikas N. Three-dimensional evaluation of effectiveness of hand and rotary instrumentation for retreatment of canals filled with different materials. J Endod 2008;34(11):1370-3.
8. Cohen S. Cohens Pathways of pulp. 10th ed. Elsevier publication 2012.pp 348-88.

9. Khalilak Z, Vatan pour M, Dadresanfar B, et al. In vitro comparison of gutta-percha removal with H-file and Protaper with or without chloroform. *Iran Endod J* 2013;8(1):6-9.
10. Hassanloo A, Watson P, Finer Y, Friedman S. Retreatment efficacy of the Epiphany soft resin obturation system. *Int Endod J*. 2007;40(8):633-43.
11. Antony JM, Kudva AR, Shetty HK, et al. Comparative efficacy of three different retreatment rotary instrument systems for removal of guttapercha from root canals: a comparative in vitro study. *Indian J Public Health Res Dev* 2019;10(4):272-7.
12. Akhavan H, Bah rami Z, Moshari A, Sadighnia A, Haeri A, Ghannad S. The comparison of two rotary systems effect, Protaper and NRTGPR, on the amount of debris extrusion during root canal retreatment. *Ind J Fund App Life Sci*. 2015; 5:141-6.
13. Ashraf K, Noushad MC, Sebastian A, et al. Evaluation of efficacy of three different rotary systems in removal of gutta-percha from root canal during retreatment-an in vitro CBCT study. *Int J Recent Sci Res* 2019;10(6): 32925- 9.
14. Lalit P, Godara N, Varma KR. Evaluation of efficiency of three NiTi instruments in removing gutta-percha from root canal during retreatmentan in vitro study. *Endodontology* 2012; 3:4.
15. Betti L.V & Bramante C.M. Quantec SC rotary instruments versus hand files for gutta-percha removal in root canal retreatment. *Int Endod J*. 2001; 34:514-519.
16. Rajender Singh, ashu Gupta, Vishal Sharm. Efficacy of two NiTi retreatment systems and hand files in removing gutta-percha and sealer from root canals filled with three different types of sealers. *Dent J Adv studies*. 2015; 3:71-79.
17. Joseph M, Ahlawat J, Malhotra A, et al. In vitro evaluation of efficacy of different rotary instrument systems for gutta percha removal during root canal retreatment. *J Clin Exp Dent* 2016;8(4):355-60.
18. Das S, De Ida A, Das S, et al. Comparative evaluation of three different rotary instrumentation systems for removal of gutta-percha from root canal during endodontic retreatment: an in vitro study. *J Conserv Dent* 2017;20(5):311-6.
19. Was Nik P, Banga KS. Endodontic retreatment effectiveness of NiTi rotary instruments versus stainless steel hand files: an in vitro study. *Endodontol* 2013; 1:89-94.
20. Karamifar K, Mehrasa N, Paradis P, et al. Cleanliness of canal walls following gutta-percha removal with hand files, Race and Race plus XP Endo finisher instruments: a photographic in vitro analysis. *Iran Endod J* 2017;12(2):242-7.