ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at: www.ijdsir.com

Volume – 6, Issue – 2, March - 2023, Page No. : 161 - 171

Comparative evaluation of remaining obturating material volume and root dentin thickness following use of three different rotary nickel titanium retreatment files - An in vitro study.

[1]Snowyel Jesu Jenson Michael Chelladurai, Post Graduate Student**,** Department of Conservative Dentistry & Endodontics Sree Mookambika Institute of Dental Sciences Kulasekharam - 629161Tamil Nadu India.

[2]Vijay Mathai, Professor, Department of Conservative Dentistry & Endodontics, Sree Mookambika Institute of Dental Sciences Kulasekharam – 629161 Tamil Nadu India.

[3]Rajesh Sasidharan Nair, Professor, Head of the Department of Conservative Dentistry & Endodontics Sree Mookambika Institute of Dental Sciences Kulasekharam – 629161 Tamil Nadu India.

[4]Jeya Balaji mano Christiane Angelo, Professor, Department of Conservative Dentistry & Endodontics, Sree Mookambika Institute of Dental Sciences, Kulasekharam – 629161 Tamil Nadu India.

[5]Sarah Renjelina Christopher, Reader, Department of Conservative Dentistry & Endodontics Sree Mookambika Institute of Dental Sciences Kulasekharam – 629161 Tamil Nadu India

[6]Swathi Vasantha Sudersanan, Senior Lecturer, Department of Conservative Dentistry & Endodontics Sree Mookambika Institute of Dental Sciences Kulasekharam – 629161 Tamil Nadu India.

Corresponding Author: Vijay Mathai, Professor, Department of Conservative Dentistry & Endodontics, Sree Mookambika Institute of Dental Sciences Kulasekharam – 629161 Tamil Nadu India.

Citation of this Article: Snowyel Jesu Jenson Michael Chelladurai, Vijay Mathai, Rajesh Sasidharan Nair, Jeya Balaji mano Christiane Angelo, Sarah Renjelina Christopher, Swathi Vasantha Sudersanan, "Comparative evaluation of remaining obturating material volume and root dentin thickness following use of three different rotary nickel titanium retreatment files - An in vitro study", IJDSIR- March - 2023, Volume – 6, Issue - 2, P. No. 161 – 171.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Aim: To evaluate the remaining obturating material volume and remaining root dentin thickness following the use of three different rotary nickel titanium retreatment files, namely, Protaper Universal, Edge File XR, Neo Endo retreatment files using CBCT.

Objectives: To compare and evaluate the obturating material volume and root dentin thickness before and after retreatment procedure using CBCT.

Materials and methods: Thirty freshly extracted mandibular premolars were decoronated and bio mechanical preparation was performed with Hero shaper gold rotary files. The canals were obturated using lateral compaction technique with 2% gutta-percha and Seal

apex sealer. The teeth were randomly divided into 3 groups of 10 teeth each and CBCT images were obtained. All the canals were retreated with either Protaper universal, Edge File XR or Neo Endo retreatment files. Percentage of remaining gutta percha volume and the remaining root dentin thickness for the apical, middle, and coronal third of the root was determined after retreatment procedures using CBCT. Statistical analysis was performed using one-way ANOVA (post hoc) followed by Scheffe's test**.**

Results: Protaper universal and neo-Endo retreatment files removed least amount of obturating material in the apical third when compared with middle third and coronal third region of the root. Protaper universal and Neo Endo retreatment files removed more amount of root dentin in coronal third region. Edge File XR retreatment files did not touch the root dentin in coronal, middle and apical third region.

Conclusion: Protaper Universal retreatment file system was more efficient in removing gutta-percha in com parison to neo-Endo retreatment files followed by Edge File XR retreatment files. Edge File XR retreatment files was more efficient in preserving the root dentin in com parison to neo Endo retreatment files followed by Protaper retreatment files.

Keywords: Cone Beam Computed Tomography, Remaining Obturation material volume, Root Dentin Thickness, Retreatment files.

Introduction

Endodontic failures occur because of persistence of bacteria within the root canal system which is the result of improper cleaning and shaping, incomplete obturation, procedural errors or the lack of sufficient fluid-tight seal thus enabling the survival of micro-organisms inside the dentinal tubules. [1]

Conventional or non-surgical endodontic retreatment is the first option for infected root canal treated teeth. The main goal of retreatment is to remove contents and establish clean root canal system free of infection. The removal of root filling material includes the use of hand instruments with or without heat, the use of gutta-percha solvents, use of the NiTi rotary instruments and/or ultra sonic instruments. The use of NiTi rotary in stru mentation in removing obturation material from the root canal system has been shown to be more effective than hand files. It has the advantage of removing gutta-percha and simultaneously shaping the root canals. [2]

Cleaning and shaping of the root canal should remove all the tissue debris and at the same time preserve root dentin thickness during instrumentation. Fracture susceptibility of endodontically re-treated teeth may be more due to an increase in the amount of root dentin removal. [3]

Protaper universal retreatment files are manufactured using M-wire technology and consists of three files which are used for removal of gutta-percha from the coronal, middle and apical portion of the root canals.

Edge File XR retreatment files are manufactured from the Fire Wire TM brand of annealed, heat-treated NiTi alloy and consists of four files which are used for removal of gutta-percha from the coronal, middle and apical portion of the root canals.

Neo Endo retreatment files have a parallelogram cross-section, with a positive rake angle and consists of three files which are used for removal of gutta-percha from the coronal, middle and apical portion of the root canals.

Cone-beam computed tomography (CBCT) is a technology which can be used for the three-dimensional (3D) quantitative volume analysis of remaining gutta percha volume and remaining root dentin thickness

following retreatment with more accurate measurements. [4]

The purpose of this study was to evaluate the remaining gutta percha volume and remaining root dentin thickness following the use of three rotary NiTi retreatment files systems, namely, Protaper universal, Edge File XR and Neo Endo using CBCT. The null hypothesis was that the use of all the three different retreatment file systems would result in the same amount of remaining obturating material volume and same amount of remaining root dentin thickness.

Materials and Methods

Procedure

Thirty freshly extracted mandibular premolars with single canal and fully formed apices that had been extracted for orthodontic reasons were used in this study. The teeth were stored in saline at 4°C until use. The teeth were decoronated with diamond disc to a standardized length of 16 mm. Roots were embedded into putty index which were simulated in mandibular arch form. All teeth were scanned by cone beam computed tomography (CBCT) machine (Planmeca Promax 3D Max, Helsinki, Finland) to determine the root canal morphology.

A number 15 K-file (Mani, New Delhi, India), 25 mm in length was placed into the canal until it was visible at the apical foramen, and the working length (WL) was established 1 mm short of this length.

The canals were prepared with Hero Shaper Gold NiTi rotary files (Micro Mega, Besancon, France) -20/04, 25/04, 30/04, 20/06,25/06,30/06 up to working length using Tri Auto ZX 2 end motor (J Morita, Tokyo, Japan) according to manufacturer's recommendation. Files were passively followed into the canal to the working length and were withdrawn immediately with minimal apical pressure. Hero Shaper Gold files were used at a Speed of 300 Rpm and a Torque of 1.2 Ncm. Canals were irrigated with 3 ml of a 5.25% sodium hypochlorite solution (Septodont, Lancaster, England) in all the groups. Glyde (Dentsply Maillefer, Ballaigues, Switzerland) was used as a lubricant during instrumentation. Following root canal instru mentation,1 ml of 17% ethylene diamine tetra-acetic acid (META BIOMED, Cheongju-si, Korea) was used for 1 min followed by a final flush with normal saline. The canals were dried with absorbent paper points (Dia Dent, Burnaby, BC, Canada) in between each file change.

The root canals were obturated with 2% taper and size 30 master cone (Dia Dent, Burnaby, BC, Canada) coated using Seal apex sealer (Sybron- Kerr, Romulus, MI, USA) and placed into the root canal to the working length and obturation completed using cold lateral condensation technique until the spreader could not penetrate the canals more than 2 mm.

The excess gutta-percha in the coronal portion was removed with a heated plugger and the root canal openings of all specimens were sealed with temporary filling material Cavit (Diadent, Burnaby, BC, Canada).

At this stage primary CBCT images were taken and percentage of gutta percha filled volume and root dentin thickness was assessed. The samples were stored at 37°C and 100% relative humidity for the complete setting of the sealer. The samples were randomly assigned into three groups of ten samples each according to the retreatment procedures.

- Group I (n=10) – Canals instrumented using Protaper Universal Retreatment Files (Dentsply Maillefer, Ballaigues, Switzerland) according to manufacturer's recommendations.
- Group II (n=10) – Canals instrumented using Edge File XR Retreatment Files (Edge Endo, New Mexico, USA) according to manufacturer's recommendations.

- Group III (n=10) - Canals instrumented using Neo Endo retreatment files (Orikam Healthcare, Gurugram, Haryana, India) according to manufacturer's recommend dations.

Temporary restoration was removed in all three groups. Size no. 2 Gates-Glidden drill (Mani, New Delhi, India) was used to remove 2 mm of obturating material from the cervical portion of all samples. Three drops of gutta-percha solvent RC Solve (Prime Dental Products, Thane, Maharashtra, India) was used for 2 min in each canal to soften the obturating material and facilitate easy initial penetration of retreatment files namely, Protaper, Edge File XR, neo-Endo. All the rotary NiTi retreatment files were used according to the manufacturer's recommend dations using Tri Auto ZX 2 end motor (J Morita, Tokyo, Japan).

After retreatment, canals were irrigated with 3 ml of 5.25% sodium hypochlorite solution (Septodont, Lan caster, England) in all the groups. Following this one ml of 17% ethylene diamine tetra-acetic acid was used for 1 min and a final flush with normal saline was done. The canals were dried with absorbent paper points (Diadent, Burnaby, BC, Canada) in between each file change.

Complete retreatment was considered achieved once the working length was reached with the last file in each retreatment file system and when the instrument was not covered by any obturation material. The removal of obturation material was evaluated by post-treatment CBCT images.

Using CBCT percentage of remaining gutta percha volume in the root canal walls and the remaining root dentin thickness for the apical, middle and coronal third of the root was evaluated.

Cone-beam computed Tomography procedures and evaluation

CBCT images were taken before and after retreatment and evaluated by Planmeca ProMax 3D software (60 KHZ, 5 mA, 13.5 sec) in axial, coronal, and sagittal planes. CBCT cross-sections were 90 μm thick, and interslice distance was 1 mm for axial and coronal planes and 90 μm for sagittal plane. In this way, the entire root was viewed in the apical one-third, middle one-third, and coronal one third. The remaining obturating material volume (%) in the canal and the remaining root dentin thickness of the canal was calculated using the measurement mode of CBCT.

The remaining obturating material volume (%) was calculated by the formula.

Volume percentage of remaining obturating material = Volume of remaining obturating material in canal after retreatment/ Total volume of obturating material in canal before retreatment x 100

The remaining root dentin thickness was calculated by the formula

RDT (Remaining root dentin thickness) = $D_1 – D_2$

Where D_1 = Root dentin thickness before retreatment

D_2 = Remaining root dentin thickness after retreatment

Statistical analysis

Data was entered in Microsoft Excel 2010. The data was expressed with Mean and Standard Deviation. The values obtained were statistical analyzed using computer software statistical package for social sciences (SPSS) version 20.0 (SPSS Inc., Chicago, USA). One way ANOVA (post hoc) followed by Scheffe's test was applied to find the statistical significance between the groups. P value less than 0.05 ($P<0.05$) was considered to be statistically significant at 95% confidence interval.

Results

With respect to removal efficiency of the obturating material in the coronal third of the root, it was observed

that Protaper universal retreatment files (Group I) and Neo Endo retreatment files (Group III) had the highest mean removal efficiency (0.00 ± 0.00) than the Edge File XR retreatment files (Group II) (10.50 ± 4.76). P value (P<0.05) is significant when compared Group I with other groups and Group II with other groups.

With respect to removal efficiency of the obturating material in the middle third of the root, it was observed that Protaper universal retreatment files (Group I) had the highest mean removal efficiency (0.00 ± 0.00) than the Neo Endo retreatment files (Group III) (29.11 ± 16.29) followed by Edge File XR retreatment files (Group II) (5.19 ± 7.20). P value (P<0.05) is significant when compared Group I with other groups and Group II with other groups.

With respect to removal efficiency of the obturating material in the apical third of the root, it was observed that Protaper universal retreatment files (Group I) had the highest mean removal efficiency (18.26 ± 7.26) than the Neo Endo retreatment files (Group III) (29.61 ± 15.58) followed by Edge File XR retreatment files (Group II) (58.32 ± 13.30). P value (P<0.05) is significant when compared Group I with other groups and Group II with other groups (Table I).

Table 1: Mean coronal, middle and apical third values of different groups

Observation	Group-I (mean ± SD)	Group-II (mean ± SD)	Group-III (mean ± SD)
Coronal third total volume of obturating material in canal before retreatment	0.0179±0.0003	0.0165±0.002	0.0185±0.003
Coronal third volume of remaining obturating material after retreatment	0.00±0.00	0.0017±0.001	0.00±0.00
Coronal third volume of percentage of remaining obturating material	0.00±0.00	10.50±4.76	0.00±0.00
Middle third total volume of obturating material in canal before retreatment	0.0135±0.002	0.0134±0.001	0.0129±0.005
Middle third volume of remaining obturating material after retreatment	0.00±0.00	0.0040±0.002	0.0008±0.001
Middle third volume of percentage of remaining obturating material	0.00±0.00	29.11±16.29	5.19±7.20
Apical third total volume of obturating material in canal before retreatment	0.0095±0.002	0.0095±0.002	0.0102±0.002
Apical third volume of remaining obturating material after retreatment	0.003±0.001	0.0058±0.0027	0.0018±0.0009
Apical third volume of percentage of remaining obturating material	18.26±7.26	58.32±13.30	29.61±15.58

(P<0.05 significant compared group-I with other groups), (P<0.05 significant compared group-II with other groups)

With respect to amount of root dentin removal in the coronal third of the root, it was observed that Protaper universal retreatment files (Group I) (-0.5061±0.19) was better than the Neo Endo retreatment files (Group III) (-0.3862±0.24) followed by Edge File XR retreatment files (Group II) (0.1309±0.09). P value (P<0.05) is significant when compared Group I with other groups and Group II with other groups.

In all the groups root dentin removal was not observed in the middle third region of the root. P value (P<0.05) is significant when compared Group I with other groups and Group II with other groups.

In all the groups root dentin removal was not observed in the apical third region. P value (P<0.05) is significant when compared Group I with other groups and Group II with other groups (Table II).

Table 2: Mean coronal, middle and apical third RDT values of different groups

Groups	Coronal third RDT (mean ± SD)	Middle third RDT (mean ± SD)	Apical third RDT (mean ± SD)
Group-I	-0.5061±0.19	0.0675±0.06	0.3410±0.24
Group-II	0.1309±0.09	0.1825±0.10	0.3905±0.16
Group-III	-0.3862±0.24	0.1755±0.08	0.3353±0.22

(P<0.05 significant compared group-I with other groups)

(P<0.05 significant compared group-II with other groups)

Discussion

According to this study it was found that the use of Edge File XR retreatment files resulted in more percentage of remaining gutta-percha volume in the root canal walls followed by neo-Endo and Protaper Universal retreatment files in the apical, middle and coronal third of the root region. The use of Edge File XR retreatment files resulted in more amount of remaining root dentin thickness in the apical, middle and coronal third of the root region followed by neo-Endo and Protaper universal retreatment files. Hence the null hypothesis that the use of all the three different retreatment file systems will result in the same amount of obturating material volume in the root canal walls and same amount of remaining root dentin thickness was rejected.

The degree of anatomical variances that are often present in human teeth was one of the variables which was hardest to control in this study. Variations in the initial root canal morphology have a significant impact on the alterations that develop following root canal preparation, and consequently, after retreatment procedures. The length of the root canal filling was standardised, and only teeth with straight canals were chosen in an effort to reduce these factors. Due to their simplicity of handling, single-rooted human teeth were used in this study. For the purpose of approximating the amount of filling material, the root length was set at 16mm and accordingly teeth decoronation was done. This is consistent with study carried out by Marfisi K et al. [5] and Lincoin et al. [6]

Radiology and digital imaging, dividing teeth longitudinally, stereo microscopy, image analysis software or scoring systems, and operating microscopes are just a few of the procedures used to evaluate any residual root canal filling material. These techniques only produce a 2-D representation of 3-D structures. By employing CBCT imaging with the same settings and parameters as the initial scan, the evaluation of filling material left overs was carried out. Cubic millimetres were evaluated by a single observer who was unaware of the participants group affiliation. By dividing the volume of filling material covered after retreatment by the total filling material and multiplying by 100, the mean volume percentage values of the residual filling material were computed. This is consistent with the studies carried out by Baranwal HC et al. [7], Sagare SV et al. [8] and Pawar AM et al. [9] So in this study, cone-beam computed tomography (CBCT) was used that offers three-dimensional (3D) quantitative volume analysis of the remaining gutta percha volume and root dentin thickness. It enables a three-dimensional examination of the root canal both before and after obturation. Cone beam computed tomography (CBCT) scanning is easy, effective, and sensitive enough to analyse small portions

of remaining root canal obturating materials on the root canal wall. It provides a 3D evaluation of the root canal system.[5] When compared to medical computed Tomography, CBCT has a lower radiation dose, eliminates the drawbacks of two-dimensional imaging, and gives clinicians the ability to make more precise decisions and create more precise treatment regimens. Slice thickness, field of view, and voxel size are three crucial CBCT variables. The ideal voxel size would be 0.2mm because it would result in faster scanning and less radiation exposure for the patient. The noise and resolution both rise as voxel size decreases. Sharper images are those with lower voxel sizes. The employed voxel size for suspected root fractures should be 0.2mm. The voxel size for measuring internal root resorption should be 0.16mm. Voxel size of 0.125mm is used to measure the depth of proximal carious lesions. A more accurate voxel size is 0.2mm than 0.4mm. Voxel size is significant for image quality and directly relates to the field of vision, amperage, voltage, scanning, and reconstruction times. This study employed voxels with a size of 0.2mm. [10]

In this study, Protaper universal retreatment files and the neo-Endo retreatment files system entirely removed the gutta-percha in the coronal third region of the root. This may be due to the fact that initial root canal preparation was done with Hero Shaper Gold files system of size 30 and 6% taper. But the size and taper of the Protaper retreatment files and neo-Endo retreatment files used to prepare coronal third region are larger (Protaper D1 of size 30 and 9% taper, neo Endo N1 of size 30 and 9% taper) than those used for initial root canal preparation. Hence both the file systems entirely removed the gutta-percha in the coronal third region of the root. Hegde V *et al.* in their study found that the obturating material from the coronal aspect of the root canal region was completely removed with Protaper universal retreatment files when the root canal was obturated with gutta-percha and AH plus sealer. This was because of its convex triangular cross-section, constantly changing helical angle and pitch over its 14 mm cutting blades.[11]

Both the Protaper and neo-Endo retreatment file systems left some amount of obturating materials in middle third of the root region. This may be due to the fact that the size and taper of the Protaper retreatment files and neo-Endo retreatment files used to prepared middle third region are smaller (Protaper D2 of size 25, 8% taper, neo Endo N2 of size 25, 8% taper) than those used for initial root canal preparation (Size 30 and 6% taper). Hence both the file systems left some of obturating materials in the middle third of root region. Hegde V *et al.* in their study found that the removal of obturating materials from the middle and apical third of the root region using Protaper universal retreatment files was unsatisfactory when gutta-percha used with AH plus sealer. This was due to higher compaction and penetration of obturating material into the dentinal tubule in the middle and apical thirds of the root canal system, resulting in more residual debris.[11]

Least amount of obturating material was removed with both Protaper and neo-Endo retreatment files systems in the apical third when compared with middle third and coronal third region of the root. This may be due to the fact that the apical diameter of both the retreatment files system (Protaper D3 of size 20, 7% taper, neo–Endo N3 of size 20, 7% taper) are smaller than the initial root canal preparation files (Size 30, 6% taper). Hence least amount of obturating material was removed with both files systems in the apical third when compared with middle third and coronal third region of the root. A study by Sane SV et al. also demonstrated that Protaper universal retreatment files did not completely remove the

gutta-percha in apical third of the root region.[12] Turker SA *et al.* in their study found that the D3 instrument was manufactured to reach the working length but may not allow for a complete removal of gutta-percha. This was in accordance with this study.[13]

In this study, Edge File XR retreatment files system did not entirely remove the gutta-percha in the root region's coronal, middle, and apical third. This may be due to the fact that in this study initial root canal preparation was done with size 30 with 6% taper. Size and taper of the Edge File XR retreatment files prepared for coronal third, middle third and apical third region used in this study are lower (R1 size 25 and 12% taper, R2 size 25 and 8% taper, R3 size 25 and 6% taper, R4 size 25 and 4% taper) than those used for initial root canal preparation (size 30 and 6% taper) and hence the lower size and taper files did not remove the gutta-percha. Ozlek E et al. in their study found that Edge File XR system, which was created for the removal of root canal filling material, had a result comparable to the Protaper universal retreatment files system. As a result, the Protaper universal retreatment files system can be replaced with Edge File XR to remove the root canal filling material. This was in contrary to this study. They stated that the superior performance of Edge File XR files is attributed to its metal alloy which increases the efficiency and physical properties of the file.[14] Contrary to this study, Ankita *et al* observed that Edge File XR instrument were superior to Protaper universal files in removing gutta-percha as the Edge File XR instruments were made of the annealed heat treated NiTi alloy brand named Firewire TM which provides incredible flexibility and durability.[15]

In this study, it is observed that Protaper Universal retreatment file was more efficient in gutta-percha removal in comparison to neo-Endo retreatment files followed by Edge File XR retreatment files. Protaper universal retreatment files cutting efficiency may be attributed to their design. D1, D2, and D3 having progressive taper and lengths. Their cross section is triangular and convex. The gutta percha has a tendency to be pulled into the flutes and guided toward the canal orifice by the Protaper universal retreatment files. Additionally, these engine-driven files generate frictional heat that may cause gutta percha to plasticize and make removal easier.[16] Superior performance of gutta-percha removal by Protaper universal retreatment files may also be attributed to its progressive taper and length.[10] Muraleedhar et al. in his study stated that effectiveness of Protaper universal retreatment files was attributed to its convex triangular cross-section which renders it a larger internal area for removal of filling material.[17] Sane *et al.* in his study stated that Protaper universal retreatment system is capable of removing large amounts of filling material due to its negative cutting angle and lack of radial guide which excerts a cutting action instead of a smoothing action on the gutta-percha.[18] neo Endo retreatment files was found to be almost efficient as Protaper Universal retreatment files in removing gutta-percha. The efficiency can be attributed to parallelogram cross section, limiting the engagement zone and positive rake angle. Also, it has an active cutting tip which helps in easy initial penetration. In this study, residual gutta percha left after retreatment with the Protaper universal retreatment files was significantly less than the neo-Endo retreatment files. Muraleedhar AV et al. concluded in their study that neo-Endo files showed maximum efficacy followed by Protaper universal retreatment files in removing gutta-percha. They stated that the cross section of the neo-Endo retreatment files was parallelogram, with a positive rake angle which limited contact between the file and the

dentin to one or two spots. This decreased the binding and made sure that there is little or no screwing in, thus, enhancing the safety and cutting efficiency. The extra space around the instrument ensured improved debris removal. The results were contrary to this study.[17]

In this study, Protaper and neo-Endo retreatment files removed more root dentin from the coronal third region of the root. Both retreatment file systems failed to instrument the root dentin in the middle and apical third root regions. This may be due to the fact that Protaper universal retreatment files (D1 size 30 and 9% taper, D2 size 25 and 8% taper, and D3 size 20 and 7% taper) and neo-Endo retreatment files (N1 size 30 and 9% taper, N2 size 25 and 8% taper, and N3 size 20 and 7% taper) had large taper (D1 size 30 and 9% taper) than the initial root canal preparation files system. Protaper universal retreatment files (D1 size 30 and 9% taper, D2 size 25 and 8% taper, and D3 size 20 and 7% taper) and neo-Endo retreatment files (N1 size 30 and 9% taper, N2 size 25 and 8% taper, and N3 size 20 and 7% taper) had smaller taper (D2 size 25 and 8% taper, and D3 size 20 and 7% taper, N2 size 25 and 8% taper, and N3 size 20 and 7% taper) than the initial root canal preparation files system. Sartaj *et al* in his study stated that taper of the Protaper universal retreatment files could be a contributing factor in the generation of dentinal defects because of increased stress on the canal walls caused by the tapered files. Increased taper may cause more removal of tooth structure leading to more defects.[2] Das M *et al.* in their study found that the Edge File XR group has higher radicular dentine thickness when compared to the M Two files and Protaper Universal groups. This was in accordance with this study.[19]

In this study, Edge File XR retreatment files system did not instrument the root dentin in the coronal, middle, and apical thirds of the root region. In this study root dentin removal was not observed in coronal third, middle third and apical third region because the taper size for Edge File XR retreatment file system was smaller (size 25 and 12% taper, size 25 and 8% taper, size 25 and 6% taper, size 25 and 4% taper) than the initial root canal preparation (Size 30 and 6% taper). Das et al. in their study compared the Edge File XR group of files to the Protaper Universal group and found that the Edge File XR group showed less root dentin defects. This was in accordance to this study. [19]

In this study, Edge File XR retreatment files preserved more root dentin than neo-Endo retreatment files, which were followed by Protaper retreatment files. This may be due to the fact that Edge File XR retreatment files size and taper (R1 (25/12%), R2 (25/8%), R3 (25/6%), and R4 (25/4%)) were smaller than the initial root canal preparation (size 30 and 6% taper). In the case of Protaper retreatment files (Size 30,9% taper, size 25,8% taper, size 20,7% taper) and neo-Endo retreatment files (N1 (#30/9%), N2 (#25/8%), and N3 (#20/7%)), these retreatment files were bigger than the Edge File XR retreatment files. Hence the Edge File XR retreatment files did not instrument the root dentin when compared to neo-Endo followed by Protaper universal retreatment files systems.

A limitation of this study is that all the parameters have only been evaluated using the mandibular first premolar with straight roots and single oval canals. This present study does not investigate the impact of the root canal's curvature which also affects remaining root dentin thickness. Only single-rooted teeth were taken into consideration and furthermore *in vitro* studies do not accurately mimic *in vivo* conditions. Since the goal of the study is to evaluate the effectiveness of retreatment files, extra instruments are not being employed to remove gutta-percha. To improve the removal of gutta-

percha during endodontic retreatment, additional measures are advised, such as supplemental instrumentation with a combination of rotary and manual approaches. CBCT evaluation is also a limitation of this study. For a comprehensive analysis of the root canal system, micro-CT would be a more accurate and exact method. If the study had been conducted on actual patients, it would have more practical applications.

Conclusion

Within the limitation of this in vitro study, it may be stated that

1. Protaper universal retreatment files and neo-Endo retreatment files systems completely removed the gutta-percha in coronal third region of the root. Both the file systems left some amount of obturating materials in middle third. Least amount of obturating material was removed with both files systems in the apical third when compared with middle third and coronal third region of the root.
2. Edge File XR retreatment files system did not completely remove the gutta-percha in coronal third, middle third and apical third of the root region. Gutta-percha removal was more in the coronal third followed by middle third and then apical third region of the root.
3. Protaper Universal retreatment file system was more efficient in removing gutta-percha in comparison to neo-Endo retreatment files followed by Edge File XR retreatment files.
4. Protaper and neo-Endo retreatment files removed more amount of root dentin at the coronal third region of the root. Both the retreatment files system did not instrument the root dentin at the middle and apical third root region.
5. Edge File XR retreatment files system did not instrument the root dentin at the coronal third, middle third and apical third of root region.
6. Edge File XR retreatment files was more efficient in preserving the root dentin in comparison to neo Endo retreatment files followed by Protaper retreatment files.

References

1. Johann JE, Martos J, Silveira LM, Pino FA. Use of organic solvents in endodontics: A review. Clin Pesq Odontol. 2006; 2:393–99.
2. Sartaj M, Sangra A, Farooq R, Rashid A, Ahmad F. Evaluation of dentinal changes following retreatment by rotary NiTi retreatment files: An ex vivo stereo micro scopic analysis. Int J Appl Dent Sci.2017; 3:94–7.
3. Harandi A, Mohammad pours Maleki F, Moudi E, Ehsani M, Khafri S. CBCT assessment of root dentine removal by gates-glidden drills and two engine-driven root preparation systems. Iran Endod J. 2017; 12:29–33.
4. Hovland EJ, Dumsha TC. Leakage evaluation in vitro of the root canal sealer cement Seal apex. Int Endod J. 1985 ;18(3):179-82.
5. Marfisi K, Mercade M, Plotino G, Duran-Sindreu F, Bueno R, Roig M. Efficacy of three different rotary files to remove gutta-percha and Resilon from root canals. Int Endod J. 2010; 43:1022-28.
6. Keshav V, Passi S, Monga P, Mahajan P. Effectiveness of hand and rotary instruments in retreatment of teeth filled with resin-based filling material: An in vitro study. Endodontology. 2016; 28 (2): 132.
7. Baranwal HC, Mittal N, Garg R, Yadav J, Rani P. Comparative evaluation of retreat ability of bio ceramic sealer (Bio Root RCS) and epoxy resin (AH Plus) sealer with two different retreatment files: An in vitro study. J Conserv Dent. 2021;24(1):88.
8. Sagare SV, Chandra P, Kaur T, Ganorkar O, Khade A, Mehta SD. A comparative study of the efficacy of Wave One and Neo Endo retreatment file system for the

removal of gutta percha from the root canal. J. Pharm. Bio allied Sci 2021;13(Suppl 2): S1682.

9. Pawar AM, Thakur B, Metzger Z, Kfir A, Pawar M. The efficacy of the Self-Adjusting File versus Wave One in removal of root filling residue that remains in oval canals after the use of Protaper retreatment files: A cone-beam computed Tomo graphy study. J Conserv Dent. 2016 ;19 (1): 72.

10. Madhu K, Karade P, Chopade R, Jadhav Y, Chodankar K, Alane U. CBCT Evaluation of Gutta-Percha Removal Using Protaper and M two Retreatment Files, Wave One, and Hedstrom Files: An ex vivo Study. Frontiers in Dentistry. 2021.

11. Hegde V, Murkey L. Evaluation of residual root canal filling material after retreatment of canals filled with hydrophilic and hydrophobic obturating system: An in vitro scanning electron micro scopy study. Endo don to logy. 2017;29(1):47.

12. Antony JM, Kudva AR, Shetty HK, Kini S, Gowri S. Comparative Efficacy of Three Different Retreatment Rotary Instrument Systems for Removal of Gutta-Percha from Root Canals: A Comparative in vitro Study. Indian J Public Health Res Dev 2019;10(4).

13. Türker SA, Uzunoğlu E, Sağlam BC. Evaluation of the amount of apically extruded debris during retreatment of root canals filled by different obturation techniques. Niger. J. Clin. Pract. 2015;18(6):802-06.

14. Ozlek E, Gunduz H. Effectiveness of different rotary file systems in removing the root canal filling material: A micro-computed tomography study. J Dent Res Dent Clin Dent Prospects 2021;15(4):273.

15. Ankita, Khetarpal A, Ahlawat M Comparison of efficacy of Three Ni-Ti Retreatment Instruments in Removal of Gutta-Percha from root canal- An in vitro Study. IOSR-JDMS 2021; 20: 49-56.

16. Gu L.-S, J-Q Ling, X. Wei & X-Y Huang. Efficacy of Protaper Universal Rotary Retreatment system for Gutta Percha Removal from Root Canals. Int Endod J. 2008;41(4):288-95.

17. 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. J. Evol. Med. Dent. Sci 2021; 10 (14): 1025-30.

18. Sane SV, Kokate SR, Pawar AM, Malus are PC, Bala subramaniam K. The efficacy of three different file systems in removal of root filling residue that remains in oval root canal after the use of Protaper retreatment files: An in vitro cone-beam computed tomography study. Am J Hum Biol 2021;11(1):84.

19. Das M, Shivakumar S, Das A, Mailankote S, Naik S, Sathydevi P. Assessment of root dentin defect during retreatment procedure using various NiTi hand and rotary retreatment files: An In vitro study. J. Pharm. Bio allied Sci 2022;14(5):573.