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ORIGINAL ARTICLE

A Comparative Analysis of Efficacy of Retreating the Root Canal using Rotary Files, in Rotational Motion or Reciprocative Adaptive Motion and Reciprocating Single File System: An *In Vitro* Study

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ABSTRACT

Aim: This experiment was planned, to understand and analyze the efficacy of retreatment with the PTUR files with rotational motion and adaptive motion technology and a single reciprocating file system (Reciproc R50); in an *in vitro* setup.

Materials and methods: Fifty-four extracted lower 1st molars were equally distributed in three groups of 18 specimens, respectively. Access cavity was prepared, and working length was measured in the mesiobuccal canal with a No.10 K-file. Canal preparation was done using ProTaper Universal files SX-F2. Irrigation was done using 2.5% NaOCl and 17% Ethylenediaminetetraacetic (EDTA) solution. Obturation was done using ProTaper F2 GP cones with AH Plus sealer by using System-B warm vertical compaction method. Group I–Retreatment with PTUR files D1-D3 in rotary motion; Group II–Retreatment with PTUR files D1-D3 in adaptive motion; Group III–Retreatment with reciproc R50 file in the reciprocating motion. The time taken for retreatment of the canal in each sample in each group was noted. The teeth were sectioned longitudinally and were observed under the stereo microscope at 8X magnification. The remaining amount of filling material was calculated on the images as a percentage. Statistics were analyzed using one way analysis of variance (ANNOVA) and Tukey post-hoc test.

Results: In the coronal third, the Reciproc R50 file was the most efficient in removing the filling from the canal followed by the ProTaper retreatment files in adaptive motion and then the ProTaper retreatment files in rotary motion with a significant difference according to statistics, between all three groups.

In middle one-third and apical one-third, ProTaper retreatment files in adaptive motion were the most effective in removing root canal filling followed by the reciproc R50 file and then the ProTaper retreatment files in rotary motion with a significant difference between all the three groups. The reciproc R50 files in reciprocating motion took significantly less preparation time compared to the other two groups.

Conclusion: The ProTaper retreatment files with adaptive motion showed the least amount of remaining filling material in the middle and apical one-third of the root canal. The reciproc R50 file with reciprocating motion showed the least amount of residual filling material in the coronal one-third of the root canal. The ProTaper retreatment files with adaptive motion prepared the root canal most rapidly among the three groups.

Keywords: Adaptive motion, Reciprocating motion, Retreatment, Rotary motion, Stereomicroscope.

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INTRODUCTION

According to the American Association of Endodontics (AAE), the triad of endodontics consisting of biomechanical preparation, complete microbial control and complete three-dimensional obturation of canal space remains the cornerstone of endodontic therapy.[1] A study called "Washington Study" was conducted by Ingle depicting the endodontic failures, namely, 60% failures occur due to incomplete obturation of root canals whereas 40% failures occur due to root perforation, constant trauma, broken instruments, unfilled root canals, grossly overfilled or overextended root canals and other minor causes including inadvertent removal of silver points.[2] Endodontic retreatment is defined as a process of removing root canal filling from the tooth, followed by cleaning, shaping and obturating the canals according to the AAE.[3]

The primary aim of retreatment is to treat the infection by removing the root canal filling material and removing debris and microorganisms in association with apical periodontitis. Retreatment is opted because of its conservative approach to facilitate a sufficient amount of cleaning, preparation of the root canal system and obturation.[4]

The ProTaper retreatment files have progressive increasing taper, a curved triangle shape cross section and also modified tip. They consist of three instruments namely: D1, D2, D3 with tip diameter and taper of size 30,0.09; 25,0.08 and 20,0.07 respectively. D1 has an active tip that aids in

facilitating the path of the next file. The non-active tips of D2 and D3 reduce the possibility of lodging, stripping and perforation during removal of material.[5]

A new nickel titanium (NiTi) file system has been launched called the twisted file (TF) Adaptive, a system with its endodontic motor (elements motor, sybron endo) that uses a combination of motions.[6] TF™ instruments are manufactured by raw NiTi wire in the austenite crystalline structure phase and changing it into a different phase of crystalline structure (R-phase) by a process of heating and cooling.[7,8] The TF™ Adaptive technique has been propagated to maximize the advantages of reciprocation while reducing its disadvantages.[9] The movement of the file depends on the level of stress in the canal that the file faces.

When stress levels in the canal are low, the file rotates 600° clockwise and stops and then resumes again in the clockwise direction. In cases where the stress on the file is high, the movement changes to reciprocating motion. This reciprocation movement may be changed up to 370° clockwise and 50° counterclockwise depending on the file.[6,10] The angle of reciprocation has a lot of influence on both, clinical and experimental manifestations of NiTi instruments.[11]

Yared initiated the concept of reciprocation with new Ni-Ti instruments that were based on the concept of "balanced force" technique, and it was proven to be effective in the biomechanical preparation of the canal using one instrument.[12] Furthermore, the"M-wire" alloy increases the cyclic fatigue resistance and flexible behavior of reciprocating instruments.[13] Reports have shown that Reciproc R50 has been used for root canal retreatment. Capar et al. in 2014 reported that reciproc system had increased cutting ability than few of the rotary nickel-titanium files.[14]

Capar et al. analyzed the efficacy of rotary files with rotational or reciprocating adaptive motion in removing root canal filling from lower molars and found enhanced results with adaptive motion. However, very few studies have evaluated the use of this kinematic motion in retreatment.[10]

Hence, the purpose of this *in vitro* study was to compare and evaluate the efficiency of root canal retreatment using ProTaper retreatment files in rotary motion, reciprocating adaptive motion and a single reciprocating file system.

MATERIALS AND METHODS

Specimen Preparation

A total of 54 extracted lower molars were collected. The teeth were placed in 0.5% chloramine liquid solution for 2 days for purpose of disinfection (Fig 1) and then kept in distilled water.

Fig. 1: Specimen storage

Root Canal Treatment

Access was made with an airotor hand piece and a No. 206 tapered diamond point. The working length of MB canal was established using size 10K-file, 1 mm was reduced from the obtained measurement. Glide path was made with size 15K–file; RC-Prep was used in canal preparation and irrigation was done with 2 mL of 2.5% NaOCl solution. Root canal treatment was done with rotary ProTaper files (S_x-F_2)–dentsply. After the use of each instrument, each canal was irrigated with 10 mL of 17% EDTA and 10 mL of 2.5% sodium hypochlorite and dried with paper points. ProTaper F2 Gutta Percha cone (dentsply) was coated with AH plus sealer (dentsply) and then placed into the canal up to working length. Down packing was done with fine medium system B plugger (sybron endo). At apical 1/3rd, Buchananplugger (sybron Endo) was used. Backfill was done with the extruder handpiece-elements system (Fig 2).

Storage

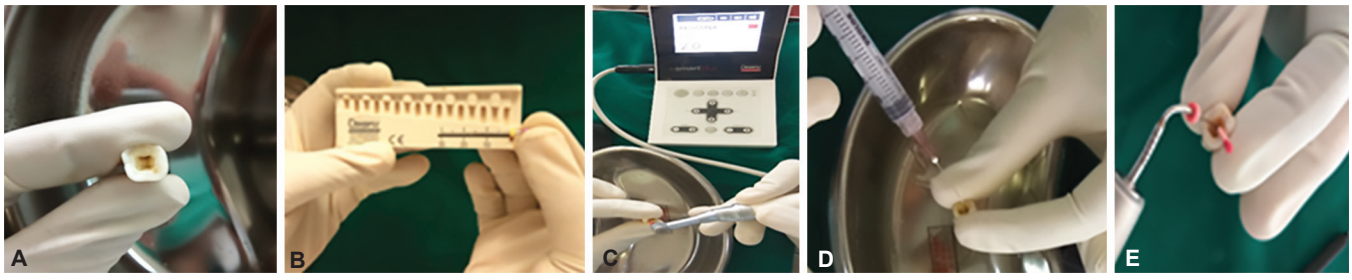
After completion, teeth were preserved at 37°C with a 100% humid conditions for 7 days to allow the sealer to set as much as possible in an incubator (Fig. 3).

Retreatment

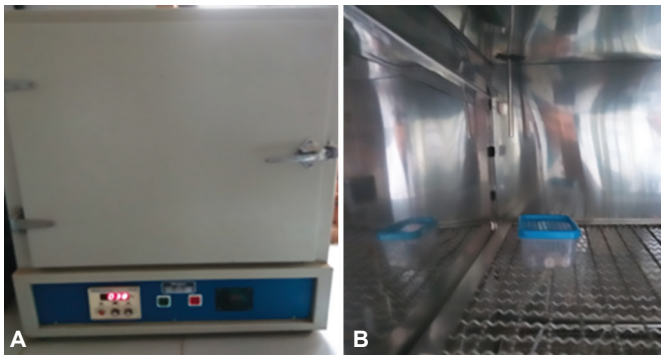
The main group of 54 teeth were distributed into three subgroups of 18 teeth respectively; namely group I, group II, group III.

Group I: n=18–Rotary Motion

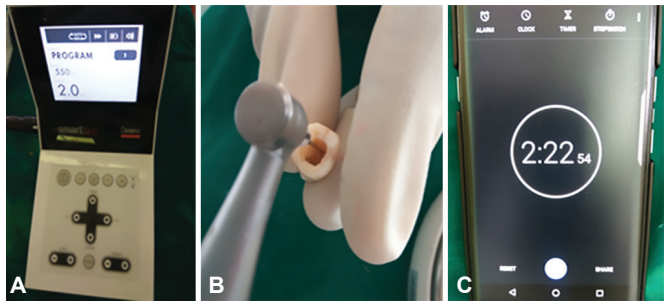
ProTaper D_1-D_3 files were used in a crown-down manner with X-smart plus motor, dentsply according to manufacturer's instructions. The final preparation was done with F3, file at 250 rpm and 200gcm^{-1} torque with brushing circumferential motion. F4 and F5 were used for final preparation at same torque as F3 (Fig. 4).



Figs 2A to E: A schematic representation of root canal treatment (A) Access preparation; (B) Working length measurement; (C) Biomechanical preparation; (D) Irrigation; (E) Obturation



Figs 3A and B: (A) Incubator; (B) Specimen storage inside the incubator



Figs 4A to C: Retreatment with ProTaper retreatment files using rotary motion (Group I)

Group II: n=18–Adaptive Motion

ProTaper universal D_1-D_3 files were used with TF Adaptive technique of elements motor (sybron endo) in the exact same way as group I, adaptive motion (AM) i.e., 600° clockwise/0° counterclockwise to 370° clockwise/50° counterclockwise is used. ProTaper F3, F4 and F5 files were used for the final apical preparation in the same manner as group I (Fig 5).

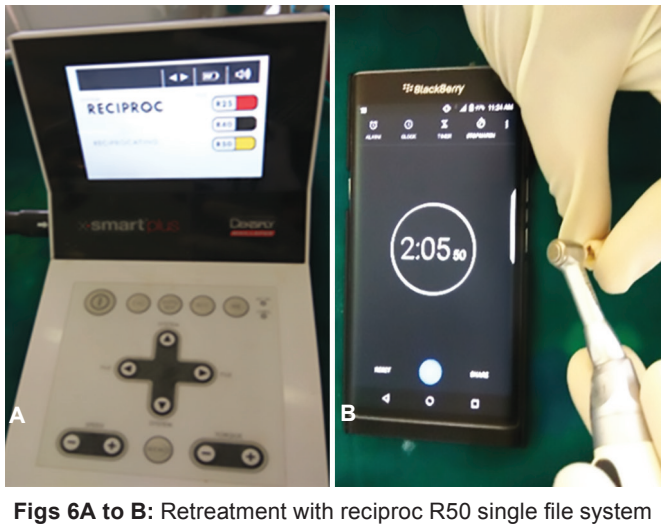
Group III: n=18–Single Reciprocating File–Reciproc 50 (ReM)

Reciproc 50 single file system(Vdw Dental) was used in reciprocmotion with X-smart plus, Dentsply. The instrument was introduced into root canal in 3 in and out movements with an amplitude of approx 3 mm. The apical pressure was given with gentle movements against canal walls. As the file moved into the canal it was removed and cleaned with clean gauze piece. The procedure was repeated until instrument reached 0.5 mm beyond original working length. The reciproc instrument is designed for single use. It was used only once and then discarded. In each of the three groups, when working length was achieved and no filling material could be viewed on last instrument used, retreatment was considered to be finished (Fig 6).

Assessment of Gutta-percha Removal

All teeth were markedbuccolingually using stainless steel disc and then sliced longitudinally. Digital images

Figs 5A to B: Retreatment with ProTaper retreatment files using adaptive motion (Group II)



Figs 6A to B: Retreatment with reciproc R50 single file system using reciprocating motion (Group III)

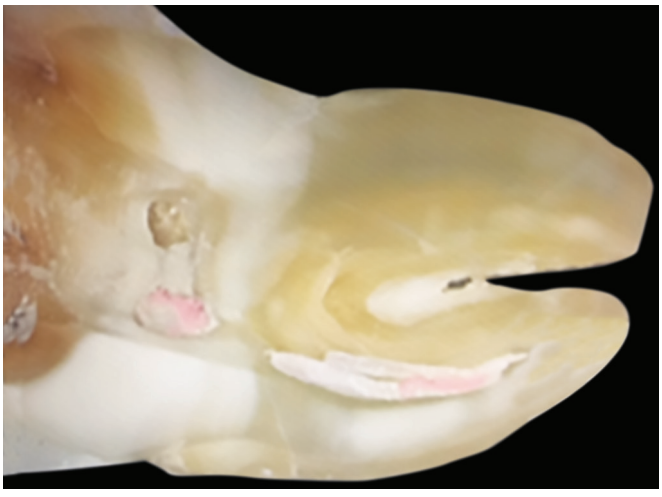


Fig 7: Specimen image analyzed using the stereomicroscope

at 8X magnification were assessed from both slices for residual root filling material in the coronal, middle third and apical third using a stereomicroscope (Fig 7).

The ratio of the area of canal walls covered by remnant gutta-percha as well as a sealer and the total area of the root canal was calculated and denoted as a percentage. The average distribution of gutta-percha between and also among thethree groups was also measured.

Scoring criteria[15] for assessing remnant filling material was:

- None to little presence 0 to 25% of residual filling covering the dentinal surface
- Presence of 25 to 50% of residual filling on the surface
- Presence of 50 to 75% of residual filling
- Complete or almost complete surface covered with residual filling 75 to 100%

Statistical Analysis

The data were analyzed using ANNOVA and repeated measures ANOVA test to assess the difference between the three groups. The Tukey post hoc test and Bonferroni post hoc test was applied to compare all the groups at 95% confidence level.

Table 1: Comparison of the amount of residual Gutta-percha between the study groups

	Study groups	*N*	*Mean*	*SD*	*ANOVA*	
					F	*p-value*
Coronal	Group 1	18	1.08	0.30	83.07	<0.001*
	Group 2	18	0.27	0.17		
	Group 3	18	0.24	0.17		
Middle	Group 1	18	1.31	0.16	152.55	<0.001*
	Group 2	18	0.33	0.18		
	Group 3	18	0.61	0.18		
Apical	Group 1	18	1.57	0.22	251.64	<0.001*
	Group 2	18	0.44	0.13		
	Group 3	18	0.49	0.15		

*p <0.05 statistically significant, p >0.05 Nonsignificant, NS

RESULTS

Comparison of the amount of residual Gutta-percha between the study groups is shown in Table 1.

In the coronal third, the Reciproc R50 file was the most efficient in removing canal filling material followed by the ProTaper universal retreatment files in adaptive motion and then the ProTaper retreatment files in rotary motion with a statistically significant difference among all the three groups.

Group III >Group II > Group I–Coronal Third

In the middle third and apical one-third, the ProTaper retreatment files in adaptive motion were the most effective in removing root canal filling followed by the Reciproc R50 file and then the ProTaper retreatment files in rotary motion with statistically significant difference between all the three groups.

Group II > Group III > Group I–Middle third and Apical third

Comparison of preparation time between the study groups is depicted in Table 2. The Reciproc R50 files in reciprocating motion took significantly less preparation time compared to the other two groups.

Group II >Group III >Group I

DISCUSSION

Non-surgical retreatment is necessary because of failure of root canal treatment due to the following reasons; improper diagnosis, inadequate isolation, inadequate access cavity preparation, insufficient cleaning and shaping, apical extrusion of necrotic debris, improper or over obturation, instrument separation within the canal, perforation or ledge formation, constant trauma, missed canals and loss of coronal or apical seal. Whatever the etiology may be, the additive result of all causes is leakage.[16]

The present *in vitro* study showed that ProTaper retreatment files used with adaptive motion showed best results in the retreatment of middle one-third and apical third of canal because it promoted both cuttings off the root canal filling material and displacement of the filling material in the coronal direction, simultaneously. Capar et al.[10] conducted a study in which they concluded that ProTaper Retreatment files used in adaptive motion are the most efficient in removing root canal obturating material when compared with rotary motion. The reason

Table 2: Comparison of preparation time between the study groups

Study groups	*N*	*Mean*	*SD*	*ANOVA*	
				F	*p-value*
Group 1	15	2.93	0.47	30.674	<0.001*
Group 2	15	1.73	0.48		
Group 3	15	1.98	0.38		

*p <0.05 statistically significant, p >0.05 Nonsignificant, NS

for this is the cutting of the root filling material in rotary motion and disengagement of the filling from the canals via the reciprocating motion.

Reciproc R50 file in reciprocating motion showed the best results in the coronal one-third for retreatment. The reciprocating motion has shown better results when compared with rotary motion because reciprocating systems bring about a wider motion in the counterclockwise angle and a shorter motion in the clockwise direction, keeping the file more balanced towards the center in the canal.[17]

This property of better canal centering along with remarkable taper of these files that is 0.05 (5% taper) creates a larger area of contact between instrument and gutta-percha, allowing root canal filling removal that is more effective than that produced in continuous rotation. Zuolo et al.[17] conducted a study which they concluded that reciprocating motion is better than a rotary motion for removing root canal filling material because the reciprocating motion has a greater contact area with gutta-percha along with marked taper of the Reciproc R50 file which allows for more root filling removal as compared to rotary motion.

ProTaper retreatment files used in rotary motion showed the maximum amount of residual gutta-percha in coronal, middle as well as apical one-third and was also the slowest method for retreatment of root canal when compared with adaptive motion and reciprocating motion. This is attributed to the fact that rotary motion makes a smaller contact angle with the gutta-percha and since there is the only clockwise movement of the file, only cutting action takes place, and there is less coronal dislodgement of the root canal filling material.

Capar et al.[10] conducted a study in which they concluded that ProTaper Retreatment files used in rotary motion are inferior in removing root canal filling material when compared with adaptive motion because of the clockwise movement of the file in which only cutting action takes place and there is less coronal dislodgement of canal filling material. Zuolo et al.[17] conducted a study which concluded that rotary motion is inferior than the reciprocating motion for removing root canal filling material. This is attributed to the fact that the triangular cross-section of the rotary file, use of conventional NiTi rotary instruments and smaller cutting angle formed with the gutta-percha as compared to reciprocating file; reduces the efficiency of the rotary files.

Based on the results of this study, none of the techniques were able to eliminate the root canal filling material. The results were obtained in an *in vitro* setup, hence, long-term clinical trials are necessary to understand the performance of rotary motion, reciproc motion and adaptive motion in a clinical situation for the retreatment of the root canal.

CONCLUSION

In the view of the limits of this *in vitro* study, the following conclusions can be made:

The ProTaper retreatment files used in adaptive motion removed root canal filling material most efficiently in middle third and apical one-third, because of the simultaneous cutting and displacement action of adaptive motion.

Reciproc R50 in reciprocating motion showed the best results in the coronal third when compared with adaptive and rotary motion in the retreatment of root canal because of the 'screwing-in effect' seen with reciprocating files.

The ProTaper universal retreatment files in adaptive motion because of the cutting and displacing action took the least time for completing the retreatment procedure.

Further studies and advancements in techniques are required in this field to evaluate the success of various motion kinematics for the purpose of retreatment of the root canal.

REFERENCES

1. Cohen S, Hargreaves K. Pathways of the Pulp 9th ed. Mosby, St.Louis, Mo,2006.
2. Ingle JI, Beveridge EE, Glick DH, Weichman JA. Endodontic success &failure: The Washington Study in J.I Ingle, L.K Bakland (Eds) Endodontics, 4th ed. Williams & Wilkins, Baltimore:1994:21-45.
3. American Association of Endodontists. Glossary of Endodontic Terms. 8th ed. AAE, Chicago; 2012.
4. Saad AY, Al-Hadlaq SM, Al-Katheeri NH. Efficacy of two rotary NiTi the removal of Gutta-percha during root canal treatment. J Endod 2007;33(1):38-41.
5. Gu L-S, Ling J-Q, Huang X-Y. Efficacy of ProTaper Universal rotary retreatment system for gutta-percha removal from root canals. IntEndod J 2008;41:288-295
6. Gambarini G, Testarelli L, De Luca M, Milana V, Plotino G, Grande NM, et al. The influence of three different instrumentation techniques on the incidence of postoperative pain after endodontic treatment. Ann Stomatol (Rome) 2013;4: 152-155.
7. Gambarini G, Grande NM, Plotino G, Somma F, Garala M, De Luca M, et al. Fatigue resistance of engine driven rotary nickel-titanium instruments produced by newer manufacturing methods. J Endod 2008;34:1003-1005.
8. Bhagabati N, Yadav S, Talwar S. An invitro cyclic fatigue analysis of different endodontic nickel-titanium rotary instruments. J Endod 2012;38(4):515-518.
9. Gambarini G, Rubini AG, Al Sudani D, Gergi R, Culla A, De Angelis F, et al. Influence of Different Angles of Reciprocation on the Cyclic Fatigue of Nickel-Titanium Endodontic Instruments. J Endod 2012;38(10):1408-1411.

10. Capar ID, Arslan H, Ertas H, Gok T, Saygili G. Effectiveness of ProTaperUniversal retreatment instruments used with rotary or reciprocating adaptive motion in the removal of root canal filling material. IntEndod J 2015;48:79-83.
11. Gambarini G, Glassman G. TF Adaptive: A novel approach to Nickel-Titanium Instrumentation. " Rotary when you want it, Reciprocation when you need it." Oral Health Dent J, May 2013;22:30.
12. Yared G. Canal preparation using only one Ni-Ti rotary instrument: preliminary observations. Int Endod J 2008;41: 339-344.
13. Shen Y, Zhou HM, Zheng YF, Peng B, Haapasalo M. Current challenges and concepts of the thermomechanical treatment of nickel-titanium instruments. J Endod 2013;39: 163-172.
14. Capar ID, Ertas H, Ok E, Arslan H, Ertas ET. Comparative study of different novel nickel-titanium rotary instruments for root canal preparation in severely curved root canals. J Endod 2014;40(6):852-856.
15. Somma F, Cammarota G, Plotino G, Grande NM, Pameijer CH. The effectiveness of manual and mechanical instrumentation for the retreatment of three different root canal materials. J Endod 2008;34:466-469.
16. Southard DW. Immediate core build up of endodontically treated teeth:the rest of the seal. PractPeriodontAesthet Dent 1999;11(4):519-526.
17. Zuolo AS, Mello JEJo, Cunha RS, ZuoloML, Bueno CES. Efficacy of reciprocating and rotary techniques for removing filling material during root canal retreatment. IntEndod J 2013;46:947-953.