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ORIGINAL RESEARCH

Evaluation of Effectiveness of Two Different Endodontic Retreatment Systems in Removal of Gutta-percha: An *in vitro* Study

[1]PK Thaju Raj, [2]Durga P Mudrakola, [3]Deepak Baby, [4]Rajeev K Govindankutty, [5]Dilu Davis, [6]Thenasseri P Sasikumar, [7]Kranti KR Ealla

ABSTRACT

Aim: To determine the effectiveness of two different endodontic retreatment systems for the removal of laterally compacted gutta-percha (GP).

Materials and methods: Sixty-three freshly extracted human maxillary central incisors were used for the study. The teeth were instrumented with K-flex files and obturated using lateral condensation technique with GP and AH Plus sealer. The teeth were divided into three retreatment groups, each group consisting of 21 teeth. Group I: D-RaCe desobturation files (D-RaCe); group II: ProTaper Universal retreatment files (PTUR); group III: Hedstrom files (H-file). After removal of GP, the teeth were split longitudinally and divided into three equal parts: Cervical, middle, and apical third. The middle and apical thirds of all root halves were examined using scanning electron microscope (SEM). The total surface area covered by the residual debris was evaluated using Motic Image plus 2.0 software. Statistical analysis was done by one-way analysis of variance (ANOVA) test with a p-value ≤0.05 used to determine significance and Tukey's multiple *post hoc* tests used for comparison between the groups, and 't' test was done for comparison between the thirds within the same group.

Results: The PTUR retreatment files showed overall better performance compared with D-RaCe files and H-files. The PTUR files performed better at middle third compared with others. The PTUR files and D-RaCe files performed equally at apical third better than H-files.

Conclusion: ProTaper retreatment files are better compared with D-RaCe files and H-files for the retreatment of the previously endodontically treated teeth.

Clinical significance: Highest efficacy for the removal of GP was shown by ProTaper Universal System followed by D-RaCe and H-file.

Keywords: D-RaCe, Gutta-percha, H-files, ProTaper retreatment files, Scanning electron microscope.

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[1,3-5]Department of Conservative and Endodontics, P.S.M. College of Dental Science & Research, Thrissur, Kerala, India

[2]Department of Periodontics, Dental Center, AIMST University Kedah, Malaysia

[6]Department of Prosthodontics, Educare Institute of Dental Sciences, Malappuram, Kerala, India

[7]Department of Oral and Maxillofacial Pathology, MNR Dental College & Hospital, Sangareddy, Telangana, India

Corresponding Author: Kranti KR Ealla, Department of Oral and Maxillofacial Pathology, MNR Dental College & Hospital Sangareddy, Telangana, India, Phone: +919849409070, e-mail: drekkr@yahoo.co.in

INTRODUCTION

Endodontics has been the flag-bearer of dentistry since very long time. There has been a tremendous improvement in the field of endodontics in the recent past, which did not slow down the pace yet. This included better diagnosis of periapical lesions and improving the prognosis of the endodontically treated teeth. But then, there have been incidences of root canal failures, though minimal, which did not fade away.

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.

Removal of GP can be accomplished by various methods, that include H-files, GP solvent, Gates-Glidden (GG) drills, heated pluggers, ultrasonic technique, and

lasers.[1,2] Recently introduced specifically designed nickel–titanium (NiTi) retreatment rotary files have proven to be efficient and require less time when compared with hand instrumentation.[3-5]

As the technique is difficult to implement, using appropriate materials combined with the correct sequences of steps is required for the removal of root canal fillings. Assuming that they can be prebent, it was suggested by some authors to combine rotary systems and manual instruments to complete the removal procedure for getting a better result in the removal of root canal fillings.[6]

D-RaCe has been introduced which is especially designed for retreatment procedures. It consists of two retreatment files, namely DR1 and DR2, whereas PTUR consists of three files: D1, D2, and D3. Some studies have shown the efficacy of PTUR in comparison with Mtwo, D-RaCe, and Profile.[7-9] However, few other studies[3,10] comparing PTUR and D-RaCe have shown the latter to be more efficient and hence, a need to do a study.

The SEM analysis generally enhances the inspection of surface remnants on the root canal wall, in comparison with stereomicroscope.[11] So, the aim of this study was to determine the efficiency of PTUR, D-RaCe, and H-file in the removal of GP from root canal walls and to determine and compare the cleanliness of the canal wall in the middle and apical portions using SEM.

MATERIALS AND METHODS

Sixty-three freshly extracted, intact human maxillary central incisors with single canal and with fully developed apices were taken for the study. Access opening was made on each tooth and the working length (WL) was established 1 mm short of root apex with No. 15 stainless steel K-Flex file. The crowns were sectioned horizontally such that WL was standardized to 15 mm. The canals were prepared using step-back technique. Canal instrumentation was done using K-Flex files with a master apical file size of 30, and canals were flared up to International Organization for Standardization (ISO) No. 60 file by reducing 1 mm from each successive instrument. The canals were irrigated with 2 mL of 3% sodium hypochlorite between the instrumentation. After the canal preparation, the final sequence of irrigation was done with 5 mL of 17% ethylenediaminetetraacetic acid and 5 mL of saline.

Canal obturation was done by cold lateral compaction technique with standardized GP cones with AH Plus sealer. The obturation was assessed radiographically to confirm the homogeneous filling. All teeth were stored in an incubator at a temperature of 37°C and 100% humidity for 10 days to mimic clinical conditions and to allow complete setting of the sealer. After this period, the removal of the temporary fillings was done and the teeth were divided randomly into three retreatment groups.

Group I: (n = 21) D-RaCe, group II: (n = 21) PTUR, and group III: (n = 21) H file.

To standardize the study, the coronal third of 5 mm of GP of all the samples was removed by using GG drills #1, and #2.

Group I: D-RaCe (FKG Dentaire): Two types of D-RaCe retreatment instruments were used in the procedure, namely DR1 with size 30 at the cervical third and the beginning of middle third, and DR2 with size 20 at the WL. The instruments were used according to the manufacturer's instructions. Irrigation was performed all along the procedure. #25 and #30 stainless steel hand K-files were used in final instrumentation.

Group II: PTUR: Crown-down technique was followed to remove the root canal fillings. The instruments used were as follows: D1 (size 30, 0.09 taper) for the cervical third, D2 (size 25, 0.08 taper) for the middle third, and D3 (size 20, 0.07 taper) for the apical third, until the WL was reached. This was followed by using #25 and #30 stainless steel hand K-files for final instrumentation. Irrigation was done all along the procedure.

Group III: H files (Mani): A drop of GP solvent (RC solve) was introduced into the canal for 2 minutes to soften the GP, and then the obturating material was removed with H-files of sizes 20, 25, and 30 in a circumferential quarter turn push-and-pull motion until WL was achieved. This was followed by using #25 and #30 stainless steel hand K-files for final instrumentation. Irrigation was done all along the procedure.

The preparations were considered finished when the uniform WL was reached. New instruments were used for all the procedures and were discarded as soon as the procedures were done. Buccal and palatal surfaces were grooved longitudinally with uniform dimensions. These grooves were used to cut the teeth with chisels in an equal dimension. The total time of the procedures was recorded individually. The teeth were divided into three parts: Apical, medial, and coronal. Grooves were made on the teeth to identify these parts. All the teeth were prepared by the same person to maintain the uniformity in the specimen.

Preparation for SEM Evaluation

The specimen were dehydrated at 37°C for 7 days and sputtered with gold. The middle and apical thirds of all root halves were examined using a SEM at 20 kV and at a standard magnification of 1000×. One image was made at the position of each groove prepared on the root surface for avoiding operator bias. The total surface area covered by the residual debris in the SEM images of middle and

the apical third was evaluated using Motic Image plus 2.0 software. Debris-free area was calculated by subtracting the total debris area from the total surface area (13,537 sqμm). Percentage of debris-free area was calculated by a mean score of the group divided by total surface area multiplied by 100. Statistical analysis was done using one-way ANOVA test with a p-value ≤0.05, which was used to determine significance, and Tukey's multiple *post hoc* tests for comparison between the groups and "t" test for comparison between the middle and apical third within the same group. Statistical software tools, namely SAS 9.2 and Statistical Package for the Social Sciences 15.0 version, were used for the analysis of the data.

RESULTS

It could be seen that the NiTi files used in the procedures were functionally superior to the hand files. Though the procedures of the retreatment were good, the remnants of old fillings were visible in all the groups, when the middle and apical parts were taken together. Descriptive analyses of three techniques showing the mean and standard deviation (SD) values for middle and apical third and the sum of them are presented in Table 1 and the p-values in Table 2.

In the middle third of the retreatment technique, group II obtained better results than group I (p = 0.0001) and group III (p = 0.0002). In the apical third, groups I and II obtained better results than group III (p = 0.0071 and p = 0.0078 respectively). There was no statistical difference between the D-RaCe and PTUR at apical third. In all groups, middle third showed cleaner root canals than apical third (p = 0.0454 in group I, p = 0.0000 in groups II and III) (Table 3). Rotary instruments required less time than hand instruments to remove the GP as given in Table 3. In between the rotary systems, PTUR was faster than D-RaCe.

Table 1: Percentage of debris-free area in three groups (groups I, II, and III) at middle and apical third

Groups and sections	*N*	*Mean ± SD*
Group I middle third	21	56.55 ± 9.86
Group I apical third	21	49.37 ± 2.38
Sum of middle and apical third		52.96 ± 9.55
Group II middle third	21	74.62 ± 9.20
Group II apical third	21	49.25 ± 7.92
Sum of middle and apical third		61.94 ± 8.58
Group III middle third	21	57.74 ± 2.76
Group III apical third	21	39.22 ± 2.26
Sum of middle and apical third		48.48 ± 9.76

*p < 0.05

Table 2: Pairwise comparison of three groups in middle and apical third of the root canal by Tukey's multiple *post hoc* procedures

Groups	*Middle third*	*Apical third*
Groups I and II	0.0001*	0.9993
Groups I and III	0.9423	0.0071*
Groups II and III	0.0002	0.0078*

*p < 0.05

Table 3: Mean and SD of time required for the removal of the filling material in groups I, II, and III

Group	*Mean ± SD*	*p-value (between the groups)*
I	4.30 ± 0.49	0.0484* (groups I and II)
II	3.93 ± 0.46	0.0001* (groups II and III)
III	4.87 ± 0.23	0.0015* (groups I and III)

*p < 0.05

DISCUSSION

Endodontic retreatment is always the first choice to save the tooth when infected again after the root canal treatment, though it is time-consuming. Advances in the endodontic field led to the use of NiTi rotary instruments, which are not only effective in root canal shaping but also proved to be efficient and require less time in removing GP/sealer during endodontic retreatment.[10]

D-RaCe retreatment files have two retreatment instruments, DR1 and DR2, and were designed with alternating cutting edges and triangular cross-section similar to the Race file. The first instrument DR1 has an active working tip to facilitate initial penetration of the filling material. DR1 (size 30, 0.10 taper, 1000 rpm) has a cutting tip to facilitate initial penetration of the filling material and is capable of coronal third cleaning. DR2 instrument (size 25, 0.04 taper, 600 rpm) has a noncutting tip and was used with light apical pressure until the WL was reached and was used for removing filling material from apical two-third of the root canal. The space for dentin removal on the back of the blades is deep and provides sufficient space for the exit of dentinal debris, contributing to the superior removal of filling material. DR1 and DR2 were designed with alternating cutting edges as well as a triangular cross-section.[12,13]

The PTUR system is integrated with three retreatment files D1, D2, and D3 and two new ProTaper finishing files, F4 and F5. There is more cutting action present in this type rather than planning action due to the presence of active cutting tip and negative cutting angles. These files remove large amounts of GP in spirals around the instruments. There is a reduced incidence of ledging and perforation during the removal of GP material due to the presence of nonactive tips in D2 and D3.

Traditionally, H-files have been used to remove the obturating material. They are made of stainless steel and can cut better than NiTi instruments in push-and-pull motion. Due to their positive rake angle, they cut only in one motion that is the withdrawal stroke facilitating GP removal.

The use of H-files alone results in better cleanliness compared with hand instrumentation with solvent,[14] but it is a tedious and time-consuming operation, especially in narrow and curved canals or when the filling material is well condensed.[15] Hence, in this study, solvent was used with H-file.

Race NiTi file 30(6%) in group I and finishing files of ProTaper finishing file namely F2 (25, 8%) and F3 (30, 9%) in group II were used to standardize the size of the teeth at #30. This makes the assessment easy.

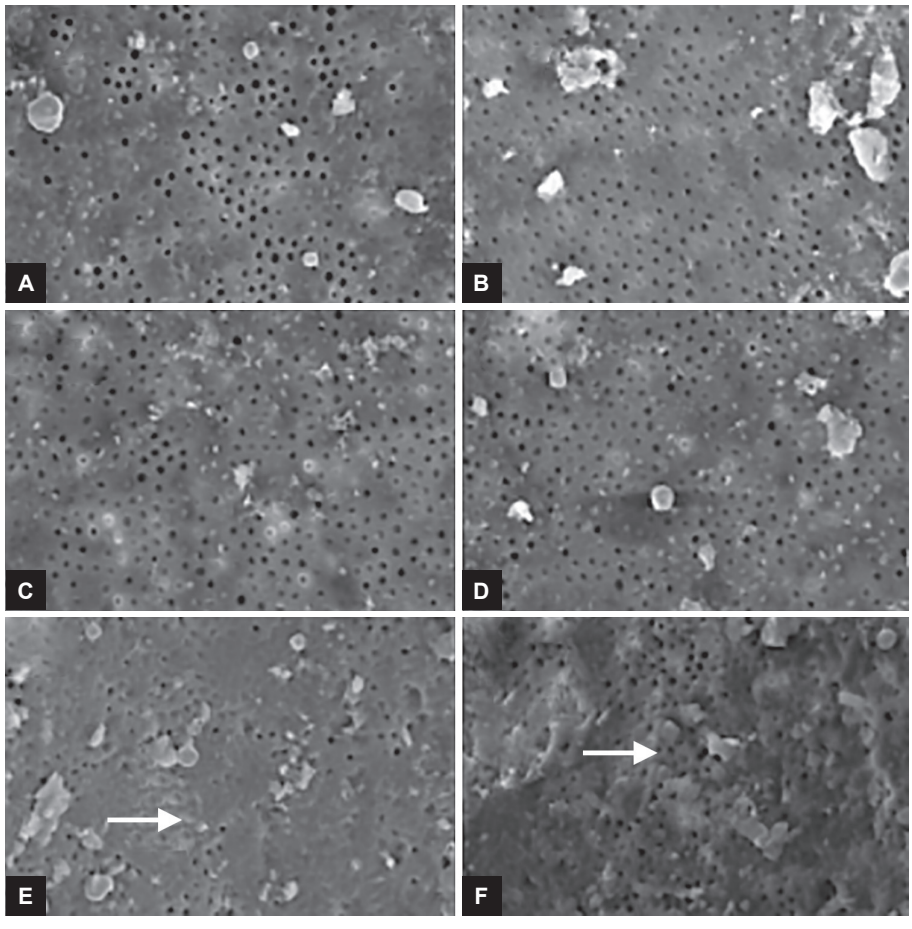
The coronal third assessment was not done, as it was prepared with GG drills to standardize all the three groups. After the removal of filling material, the teeth were spilt longitudinally into two equal halves and were assessed under SEM for the remaining debris. Operator bias was limited by grooves in the root surface prepared 2 and 6 mm from the anatomical apex specifying the area for investigation.

As revealed under SEM examination, it was impossible to completely remove all traces of GP/sealer from root canals with any of the retreatment files, which is consistent with previous studies.[16,17] No instrument has a 100% contact with the walls of root canals. This may result in the presence of debris in the root canal. It may be due to the presence of residual paste within the irregularities or cul-de-sacs of the root canal system. The presence of debris also could be because of better adhesion of resin-based sealers to dentin walls, which makes their removal from root canals with rotary instruments and also H-file more difficult. According to a study,[18] AH26 was associated with the largest amount of remnant cement on the root canal walls when compared with other sealers. The manufacturer of the PTUR contraindicates its use in root canals filled with resin-based sealers, which might help explain the presence of more filling debris.[19]

In all the groups, the residual filling material was found to be more in apical third than the middle third. This is evident in Figures 1B, D, and F. This may be due to the accumulation of more debris apically regardless of the protocol used.[20]

D-RaCe and H-files were less effective compared with PTUR retreatment files while performing in the middle third, which is in agreement with other studies.[4-6] The efficacy of D-RaCe and H-Files was comparable to each other. In the case of H-files, the space created by GG drills at coronal third facilitated the removal of the remaining GP by serving as a reservoir for the solvent and improving the access for further instrumentation.

In the present study, in the apical third region, D-RaCe and PTUR showed similar efficacy (Fig. 1). The reason for



Figs 1A to F: (A, B) Group I (D-Race) middle and apical third respectively. (C, D) Group II (PTUR) middle and apical third respectively. (E, F) Group III (H-file) middle and apical third respectively

this may be attributed to the fact that in group I, D-RaCe (DR1-30, 10% and DR2-25, 4%) followed by RaCe NiTi files (30, 4%) was used and in group II, the PTUR (D1-30, 9% and D2-25, 8%) followed by ProTaper finishing files (F2-25, 8%, and F3-30, 9%) was used, all of which possess greater taper. This ensured that there would be more contact between the rotary instruments and the canal walls, whereas the H-files used were ISO sizes 20 to 30 of only 2% taper due to which it might have resulted in less contact. It could be noted from this study that the hand instruments took longer time compared with rotary NiTi retreatment files, and are in accordance with most previously published studies.[4,8,15] Both the time required for retreatment and the safety of the instruments appeared to be influenced by the active tip and cutting edges of rotary NiTi retreatment instruments. Plasticization of GP during rotary instrumentation[15] may result in lower resistance to the action of the subsequent instrumentation and easier penetration and removal of the softened filling material.[21]

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.[22] Sticking to the strict observation of the manufacturer's instructions, discarding the NiTi instruments after five uses might have also affected this position.

CONCLUSION

It could be concluded that the PTUR files were the most effective for the removal of filling material from the middle third of the root canals compared with H-files and D-RaCe files. However, in the apical third of the same teeth, H-files lagged behind the PTUR files and D-RaCe files which performed very well. Though it could be concluded with this study that PTUR files were superior compared with D-RaCe files and H-files, it all boils down to the fact that it is completely based on the perception and discretion of the dentists who use them and make them work efficiently according to them.

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