Original Article

Evaluation of Rotary Retreatment File System for Removal of Gutta-Percha: A Volumetric Analysis – An *Ex Vivo* Study

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Abstract

Aim: The aim of the study was to evaluate rotary retreatment file system for removal of Gutta-percha through volumetric analysis using cone-beam computed tomography (CBCT) imaging modality with three groups, that is, Neoniti EDM, Re-Endo, and R-Endo rotary file systems. **Materials and Methods:** Sixty extracted permanent human mandibular premolar teeth were chosen and disinfected according to CDC guidelines on infection control in dental health-care setting 2003. Teeth were decoronated using diamond disk to achieve standardized working length. Initial root canal treatment was done using manual step back technique and obturated with Gutta-percha and AH Plus sealer. Pre-operative CBCT volumetric analysis was done of the obturated canals. Teeth were randomly divided in three groups ($n = 20$), that is, group (a) Neoniti Neolix, (b) Re-Endo and Group, and (c) R-Endo file systems. Retreatment was done using the files according to manufacturer's instruction. Residual volume of Gutta-percha was analyzed using CBCT. **Results:** Re-Endo files left less residual volume followed by R-Endo and Neoniti Rotary file systems ($P < 0.5$). **Conclusion:** Within the limitations of this study, it was reported that rotary instruments do not completely remove root canal filling material and may require the combined use of conventional hand instrumentation which was corroborated with other studies.

Keywords: CBCT, Volumetric Analysis, Retreatment, Rotary Retreatment Files

Introduction

Persistent micro-organism within root canal is one of the known causes of persistent apical periodontitis in root filled teeth. Unsuccessful root canal treatments occurs due to various factors such as persistent bacteria, inadequate filling of the canals, overextensions of root canal filling materials, improper coronal seal, untreated canals, iatrogenic procedural errors, and complications of instrumentations.[1]

The aim of the retreatment is to recover access to the apical foramen through the complete removal of filling material to achieve sufficient cleaning of root canal system which provides adequate conditions for final obturation.[2]

There are various techniques for removal of root canal filling material such as hand H-files or rotary NiTi files with or without heat, Gutta-percha solvents, ultrasonic activation, and laser irradiation.[3,4] The remnants of the infected root canal filling materials could compromise the effectiveness of cleaning and disinfecting using mechanical and chemical methods.[3]

There are few studies which have used three-dimensional analyzing technique to check the efficacies of rotary file systems in non-surgical endodontic retreatment procedures. The aim of the study is to evaluate the rotary retreatment system in removal of Gutta-percha by analyzing the volume of residual volume of root canal filling material using three-dimensional imaging modality, that is, cone-beam computed tomography (CBCT).

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Materials and Methods

Sample preparation

Sixty freshly extracted human mandibular premolars were collected. They were prepared according to CDC guidelines of infection control in dental health-care setting 2003. Only the teeth with intact and mature root apices were included in the study.

Roots were standardized by decoronating them to be 16 mm in length. Working length determination done followed by biomechanical preparation till #35 K file as master apical file. Step back preparation was done till #50 K file. Standardized

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irrigation protocol was used.[5] Root canals were obturated using lateral compaction technique, using #35.02 GP Mastercone with AH Plus sealer with additional accessory cones. Coronal access was sealed with a temporary filling material. The adequacy of the root canal filling was confirmed by radiographs. The roots was then randomly distributed into three groups of 20 specimens each (n = 20) to receive retreatment. Three-dimensional reconstruction of CBCT scans was done to evaluate the volume of Gutta-percha in canal. Area of interest was selected in every slice and volume of Gutta-percha was calculated in volume calculation tool which was done.

For the retreatment procedure, the sample specimens were divided into three groups: (n = 20 each group)

- Group 1: Neoniti EDM rotary file system (Neolix, Châtres-la-Forêt, France)
- Group 2: Re-Endo rotary file system (Endostar, Poldent. Warsaw, Poland.)
- Group 3: R-Endo (Micro-Mega, Besancon, France)

During the filling removal, irrigation was done using 2.5% NaOCl and 17% EDTA and normal saline. The root canals in all the groups were instrumented until no evidence of filling material on the instrument.

The CBCT images after removal of obturating material were recorded and analyzed.

Comparison parameters were as follows:

The CBCT images after removal of obturating material were recorded and analyzed. The volume percentage of residual filling material on canal walls was calculated with the following equation:

Volume % of remaining filling material = Volume of remaining filling material/Total volume of material in canal before removing × 100

Statistical analysis

The data obtained were subjected to statistical analysis using the Statistical Package for the Social Sciences (Version 23; Chicago Inc., IL, USA).

Variables were compared using mean values and standard deviation. The mean for different readings between the groups was compared using one-way analysis of variance, and the intercomparison between each group was done using Tukey's *post hoc* analysis. $P < 0.05$ was considered to be statistically significant.

Results

No significant difference was noted between the groups when checked for total volume of material in canal before removing at $P = 0.154$, as shown in Table 1.

When compared for the volume of remaining filling material between the file system, a significant difference was noted at $P = 0.038$. Re-Endo File was found most effective in removing Gutta-percha with a mean residual volume of Gutta-percha of 7.2712 + 5.16114 followed by R-Endo and Re-Endo system with a mean of 8.7950 + 5.57349 and 11.4992 + 4.64862, respectively, as shown in Table 2.

When compared independently between groups, *post hoc* analysis showed no significant difference between any of the file system for total volume of material in canal before removing, as shown in Table 3.

On comparing for the volume of remaining filling material between groups, a significant difference was noted between Neoniti versus Re-Endo at $P = 0.031$, also having a highest mean difference of 4.22800. No significant difference was noted between Neoniti versus R-Endo and Re-Endo versus R-Endo file system (Table 4).

Table 1: Comparative evaluation of total volume of material in canal before removing between groups

Groups	*n*	Mean	SD	Standard Error
Neo – NiTi	20	30.5440	5.50869	1.23178
Re – Endo	20	34.1440	4.32364	0.96679
R-Endo	20	32.8980	7.39081	1.65263
ANOVA Statistic			1.935	
Df			2	
P-value			0.154 (NS)	

*Significant, NS: Not significant

Table 2: Comparative evaluation of volume of remaining filling material between groups

Groups	*n*	Mean	SD	Standard error
Neoniti	20	11.4992	4.64862	1.03946
Re-Endo	20	7.2712	5.16114	1.15407
R-Endo	20	8.7950	5.57349	1.24627
ANOVA statistic			3.469	
Df			2	
P-value			0.038*	

*Significant, NS: Not significant

Table 3: *Post hoc* analysis of total volume of material in canal before removing between groups

Pair	Mean difference (I-J)	Standard error	Significance
Neoniti versus Re-Endo	−3.60000	1.85888	0.138 (NS)
Neoniti versus Re-Endo	−2.35400	1.85888	0.420 (NS)
Re-Endo versus R-Endo	1.24600	1.85888	0.782 (NS)

*Significant; NS: Not significant

Table 4: *Post hoc* analysis between volumes of remaining filling material between groups

Pair	Mean difference (I-J)	Standard error	Significance
Neoniti versus Re-Endo	4.22800	1.62594	0.031*
Neoniti versus Re-Endo	2.70420	1.62594	0.228 (NS)
Re-Endo versus Re-Rndo	−1.52380	1.62594	0.619 (NS)

*Significant, NS; Not significant

When comparing for volume percentage of remaining filling material between the file systems, a significant difference of $P = 0.001$ was noted with Neoniti having the highest mean of 39.2665 + 20.36137 followed by R-Endo and Re-Endo, as shown in Table 5.

Post hoc evaluation for volume percentage of remaining filling material showed a significant difference of $P = 0.001$ for Neoniti versus Re-Endo file system with a mean difference of 18.27345 which was also greatest between groups. A mean difference of 14.18283 was seen between Neoniti versus R-Endo file system which was significant at $P = 0.016$. Re-Endo versus R-Endo exhibited no significant difference, as shown in Table 6.

Discussion

Various rotary NiTi file systems are available in the market, but very few are efficient for Gutta-percha removal. The study of Gokturk *et al.* observed that, root filling material can be removed faster with rotary instruments than manual instrumentation. This probably occurred since the rotary movement might have produced frictional heat to further soften the Gutta-percha, making it easier to remove and thus requiring less time.[4]

Neoniti (Neolix, Châtres-la-Forêt, France) is a fifth generation rotary file system with non-homogeneous rectangular cross-section and multiple taper in a single instrument. It consists of one C1 and three A1 with different tip sizes (#20, #25 and #40) files. According to manufacturer, this file has special abrasive properties for faster preparation and higher flexibility due to heat treatment process delivered to the file. It is manufactured using a newly developed wire cut electrical discharge machining process.[5]

Re-Endo (Endostar, Poland) file system is an exclusively made file system for retreatment purpose. File no. 1 and 2 have square cross-section similar to K-Files with four cutting edges and good elasticity while no. 3 and no. 4 files which provide positive rake angle with two cutting edges distributed symmetrically, increased pitch length and more cross-sectional space for enhanced cutting and allowing the debris to move coronally. They also present with great cutting ability, a non-cutting tip and good elasticity. Apically extruded debris has been found less comparatively with protaper retreatment files.[6]

R-Endo Retreatment: It consists of four instruments: (Re, R1, R2 and R3). Re is used in initial bulk removal of filing material with 0.12% taper and 15 mm length. R1 is used in coronal third with 0.08% taper 15 mm length. R2 is used in middle third with 0.06% taper and 19 mm. R3 is used in apical third with 0.04% taper and 23 mm length. The files have an inactive tip, no radial land, and a triangular cross-section with three equally spaced cutting edges.[7]

In this study, CBCT analysis was done and the volume percentage of remaining filling material was calculated as it was done in a study by Prasad *et al*. 2018.[8] CBCT was choice of investigation as it could be effectively replicated for *in vivo* studies due to its advantages such as no gross destruction of sample for calculation, accurate, three-dimensional analysis, and low dosage of radiation compared to conventional three-dimensional imaging modalities.[9]

According to our study, there was significant difference in volume percentage of remaining filling material between Neolix NeoNiti compared with Re-Endo and R-Endo file system.

Within the limitations of this study, Re-Endo System had least residual volume of Gutta-percha but there was no significant difference noted between Re-Endo and R-Endo file systems.

Efficacy of Re-Endo file system has been attributed due to its S-Shaped cross-section design which provides positive rake angle with two cutting edges distributed symmetrically, increased pitch length and more cross-sectional space for enhanced cutting and allowing the debris move apically. This was correlated with the study by Jena *et al*., where Re-Endo File system performed better.[6]

In a study by Sharma *et al.,* R-Endo file system performed better than the PTUR, Mtwo followed by GPR and Neoniti Neolix rotary files. The efficiency of R-Endo system has been due to its active tip and cutting blades. The instrument design for each third of root cleaning is also a factor influencing its efficiency.[7]

The active tip and cutting blades of Re-Endo and R-Endo file systems positively influenced the cutting efficiency compared to Neoniti Neolix files. The increasing pitch length might have influenced removal of debris coronally in Re-Endo file system which left the least residual volume of Gutta-percha in canals.

As per Madarati *et al*., the use of these instruments is gaining popularity due to their specific benefits, such as the solvent-free removal of Gutta-percha, easier penetration of root canal

Table 5: Comparative evaluation of volume percentage of remaining filling material

Groups	*n*	Mean	SD	Standard error
Neo – NiTi	20	39.2665	20.36137	4.55294
Re-Endo	20	20.9931	14.09562	3.15188
R-Endo	20	25.0837	10.99558	2.45869
ANOVA statistic			7.516	
Df			2	
P-value			0.001*	

*Significant, NS: Not significant

Table 6: *Post hoc* analysis of volume percentage of remaining filling material

Pair	Mean difference (I-J)	Standard error	Significance
Neoniti versus Re-Endo	18.27345*	4.94697	0.001*
Neoniti versus Re-Endo	14.18283*	4.94697	0.016*
Re-Endo versus R-Endo	−4.09062	4.94697	0.688(NS)

*Significant, NS: Not significant

filling materials plasticized by friction heat, faster removal of root canal fillings, and reduced chance of filling extrusion.[10]

Conclusion

The popularity of NiTi-Rotary instruments among general practitioners and endodontists has significantly increased due to the emergence of modified and improved rotary systems, faster preparation, and extensive marketing by the manufacturing companies and workshops.

However, in the present study, it was reported that neither of the files removed completely the filling material from the canal which corroborated with other studies as well. Hence, it is suggested to use a combination of conventional hand instrumentation circumferentially around the canal to completely remove the filling material.

References

1. Tabassum S, Khan FR. Failure of endodontic treatment: The usual suspects. Eur J Dent 2016;10:144-7.
2. Do Nascimento Menezes C, Carneiro VF, Do Vale MS. Removal of obturation material in endodontic retreatment: A literature review. RSBO 2019;16:109-16.
3. Jiang S, Zou T, Li D, Chang JW, Huang X, Zhang C. Effectiveness of sonic, ultrasonic, and photon-induced photoacoustic streaming activation of NaOCl on filling material removal following retreatment in oval canal anatomy. Photomed Laser Surg 2016;34:3-10.
4. Gokturk H, Yucel AC, Sisman A. Effectiveness of four rotary retreatment instruments during root canal retreatment. Cumhuriyet Dent J 2015;18:25-36.
5. Fatima K, Nair R, Khasnis S, Vallabhaneni S, Patil JD. Efficacy of rotary and reciprocating single-file systems on different access outlines for gutta-percha removal in retreatment: An *in vitro* study. J Conserv Dent 2018;21:354-8.
6. Jena A, Shashirekha G, Barai S, Mahaprasad A. Comparison of apically extruded debris after retreatment procedure with ProTaper and Endostar retreatment file system. J Clin Diagn Res 2018;12:ZC31-4.
7. Sharma R, Garg AK, Hans MK, Paul R. Effectiveness of various rotary file systems for removing gutta percha during retreatment using stereomicroscope-an *in vitro* study. Univ J Dent Sci 2018;4:61-8.
8. Prasad A, Nair RS, Angelo JM, Mathai V, Vineet RV, Christopher SR. A comparative evaluation of retrievability of Guttapercha, Resilon and CPoints for retreatment, using two different rotary retrieval systems-an *ex vivo* study. Saudi Endod J 2018;8:87-92.
9. Yilmaz F, Sonmez G, Kamburoglu K, Koc C, Ocak M, Celik HH. Accuracy of CBCT images in the volumetric assessment of residual root canal filling material: Effect of voxel size. Niger J Clin Pract 2019;22:1091-8.
10. Madarati AA, Sammani AM, Zafar MS, Bani-Younes H, Ahmed HM. Usage of NiTi rotary instruments for root canal retreatment procedures: Experience and practice of dental practitioners and endodontists. Endo 2016;10:213-23.