

The Efficacy of D-Race and Different NiTi rotary Instruments in the Removal of Root Canal Filling Materials

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Abstract

Although endodontic treatment has high success rate, but endodontic treatment can fail. Several methods were tried to remove root filling material. The aim of this study is to evaluate the efficacy of D-Race retreatment file with different NiTi rotary instruments (RECIPROC blue (RB), ProTaper NEXT (PTN), ProTaper Gold (PTG)) in the removal of root canal filling materials.

Sixty mandibular premolar teeth with straight canal were selected. Teeth were instrumented with PTN in sequence (X1-X4) then obturated by using single cone with GuttaFlow 2 obturation material. The teeth were divided into four groups for retreatment: D-RaCe, D-RaCe+ RB, D-RaCe+ PTN, D-RaCe+ PTG. The specimens were sectioned longitudinally and inspected by digital Stereomicroscope at 12.5X magnification. Statistical analysis was performed by Kruskal-Wallis test ($P>0.05$).

A non-significant difference was found between groups (I, II, III, IV) at all levels (Apical, Middle, Coronal) ($P>0.05$). In each group a non-significant difference between levels was found ($P>0.05$).

The highest remnant was found at the coronal level of group I (9.83 %), while the lowest remnant was found at coronal level of both groups III&IV (0%).

Although shaping instruments with different motions and designs were used, the additional use of shaping instruments (RECIPROC blue, ProTaper Next, ProTaper Gold) with D-RaCe system didn't enhance root filling material removal significantly.

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Introduction

Endodontic treatment has high success rate when it is done in correct manner including thorough debridement and perfectly done obturation.¹ Root canal system can be obturated by cold method or by warm obturation; both types of obturation have high success rate with favorable outcome,² but there are several factors that may cause endodontic failure including: poor coronal seal, inadequate root filling and persistent bacteria.³ The presence of bacteria inside dentinal tubules is responsible for post endodontic treatment failure.⁴ Endodontic retreatment both surgical and non-surgical has ability to allow periapical healing.¹ During non-surgical endodontic retreatment; gutta percha is

removed allowing mechano-chemical disinfection of root canal system by exposure of dentinal tubules and allowing periapical healing.⁵ The amount of remaining filling material is important as the remnant of material may prevent adequate disinfection.⁶

Different techniques have been used to remove gutta percha from root canal, hand instrument and rotary nickel titanium (NiTi) files were used in endodontic retreatment.^{7, 8} Special rotary instruments with different motions were developed to remove gutta percha including D-Race file (FKG Dentaire, La Chaux-de-Fonds, Switzerland) and ProTaper Universal Retreatment file (DentsplySirona Endodontics, Ballaigues, Switzerland).⁹

Recently shaping instruments either reciprocating or rotary instruments were used to remove gutta percha. RECIPROC blue (VDW, Munich, Germany) file is used for removal of obturating material, these files initially were used for root canal cleaning and shaping due to its high fracture resistance and safety.¹⁰ ProTaper

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Next and ProTaper Gold (DentsplySirona, Ballaigues, Switzerland) are another shaping instruments used in continuous rotation, ProTaper Next was used in crown-down technique to remove gutta percha and found similar ability of removal in comparison with ProTaper Universal Retreatment and better than manual technique.¹¹ Few studies are available about using combination of retreatment and shaping instruments for retreatment;¹² this study was conducted to evaluate the efficacy of D-Race retreatment file alone and with different NiTi instruments (RB, PTN, PTG) in the removal of root canal filling material.

Materials and methods

Sample preparation

Sixty of permanent mandibular first premolar teeth were chosen. Teeth after extraction were cleaned by Cumine (Pakistan). The disinfection of the teeth was done by immersion in 3% of sodium hypochlorite (NaOCl) then stored in 0.1% thymol solution until use.

Teeth were selected with these criteria: single straight canal and fully formed apex were selected. The teeth were measured and decoronated at length 14 mm using separating disk 22*04 (Komet, Lemgo, Germany).

Root canal instrumentation and obturation:

PTN system was used according to manufacturer instruction using X-smart™ Plus (DENTSPLY MAILLEFER, Ballaigues, Switzerland). PTN instrument was used at 300Rpm and 2.0Ncm, the instruments (X1-X4) were used in brush and follow manner.

During canal preparation 1ml of 2.5% NaOCl (CERKAMED, Stalowa Wola, Poland) irrigation was used between instruments, then 1ml of EDTA (Produits Dentaires, Vevy, Switzerland) was used for 1 min followed by 1 ml of 2.5% NaOCl and final irrigation of 5ml distilled water to remove the irrigants. After instrumentation all roots were obturated by single cone technique using gutta percha X4 (DENTSPLY MAILLEFER, Ballaigues, Switzerland) and GuttaFlow 2 (Coltène/Whaledent, Langenau, Germany). The samples were radiographed (mesio-distally & Bucco-lingually) to ensure the quality of

obturation, then the samples were stored in the incubator (Memmert, Schwabach, Germany) at 100% humidity and 37°C for 14 days to ensure complete setting of sealer

Retreatment procedure

The specimens were divided into four groups: D-RaCe, D-RaCe+ RB, D-RaCe+ PTN, D-RaCe+ PTG.

Group I (D-RaCe system):

D-Race system was used according to manufacturer's instruction using X-smart™ Plus. The endomotor was set at (1000 Rpm and 1.5 Ncm) for DR1 and (600 Rpm and 1 Ncm) for DR2 DR1 was used to remove root filling material at coronal third then irrigation was done by 4ml of 2.5% NaOCl, DR2 was used at speed (600 RPM) to remove filling material at middle and apical third of canal.

Group II (D-RaCe+ RB):

D-Race system was used similar to group I, then RB (R40.06) was used according to manufacturer's instruction. The file was moved in apical direction in reciprocating motion using a slow in-out pecking motion of 3mm amplitude plus brushing motion toward walls, after 3 pecking motion the instrument was removed and cleaned and irrigation was done by 2.5% NaOCl.

Group III (D-RaCe+ PTN):

D-Race system was used similar to group I, PTN file X4 was used according to manufacturer's instruction. The instrument was used in follow and brush manner till full working length, the canals were irrigated every four motions with 2.5% NaOCl.

Group IV (D-RaCe+ PTG):

D-Race system was used similar to group I, PTG file F4 (40.06) was used according to manufacturer's instruction. The instrument was used in follow and brush motions and every four motions the file was removed and irrigation was done by 2.5% NaOCl till the file reached full working length. Final irrigation for each group

was achieved by using 2 ml of 17% EDTA for 1min, and then 2 ml of 2.5% NaOCl.

Total irrigation for each specimen was 10 ml of 2.5% NaOCl. Each instrument was used for three canals then it was discarded. The retreatment procedure for all groups was considered complete when no root filling material was detected on files.

Splitting and scanning of specimens under Stereomicroscope:

Marker was used to draw longitudinal lines parallel to long axis of the tooth along the buccal and lingual surface of the root, then longitudinal sectioning was done. The longitudinal section of each root with ≤ 180 of canal circumference was chosen, while the section >180 of canal circumference may interfere with total canal visualization during photography; therefore it was discarded.

The chosen part of the split root was placed over millimeter gridding paper for measurement. Afterward the specimen was scanned and photographed at magnification 12.5X using digital Stereomicroscope (Koolertron, Shenzhen, China). The images with no blurring were transferred to computer.

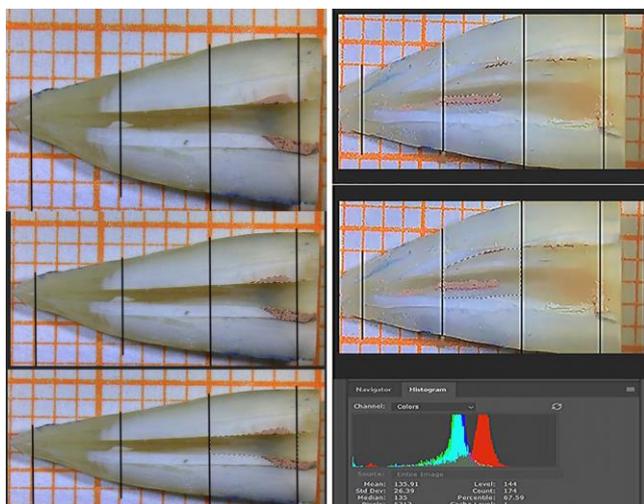


Figure 1. Calculation of pixels occupying the remnant area and pixels occupying the total third area by using Photoshop.

The images were imported into Adobe Photoshop CC 2018 (Adobe system incorporated, Seattle, USA), then the root canal area was divided into three levels: Beginning from apex; apical, middle and coronal level. The software

tool (magnetic lasso tool) was used to trace the remaining root filling material; the total number of pixels occupied by root filling material was calculated by histogram function of the program. The total area of each third was calculated separately by pixels occupied the area through the same function mentioned previously(Figure1).

The percentage of remaining root filling material was calculated according to following equation: Percentage of remaining root filling material = $A/B \times 100$

Where A represents the pixels of remaining root filling material at each third; while B represents the total pixels of entire canal third.

Statistical analysis:

Statistical analysis was performed with SPSS Statistics V.24 (IBM, New York, US). Shapiro-Wilk test was done to assess normality of data, since the test showed non normal distributed data; Kruskal-Wallis test for non-parametric results was performed at the 95% confidence level ($P < 0.05$) to determine the presence of statistical difference between groups at each level and levels at each group. The flow chart that summarizes the methodology is shown in (Figure 2)

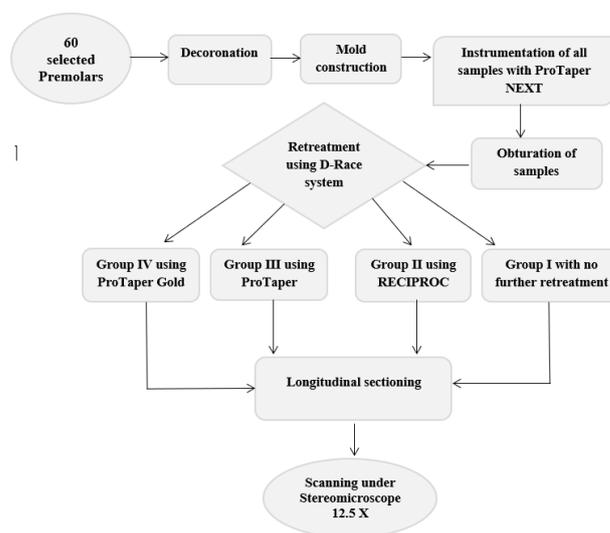


Figure 2. Flow chart summarizes the methodology.

Results

The results that showed the median of remnant of root filling material at different levels and different groups were represented in (Table 1) (Figure 3).

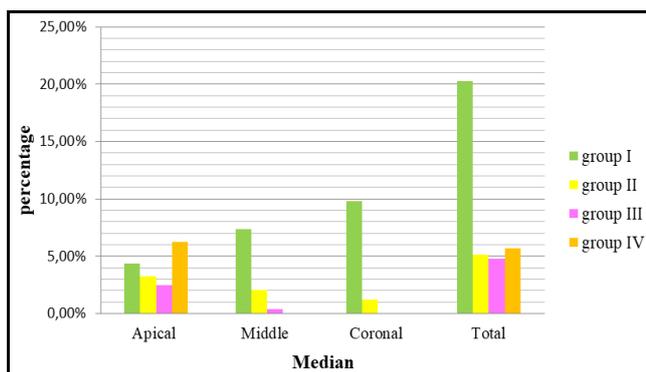


Figure 3. Bar chart represents median percentage of remnant of root filling material at different levels and groups.

Groups	Levels	n	Median	Min	Max
Group I D-RaCe system	Apical	15	4.35	.00	87.20
	Middle	15	7.37	.00	58.39
	coronal	15	9.83	.00	58.55
	Total	60	20.26	.00	44.28
Group II D-RaCe plus RECIPROC blue	Apical	15	3.28	.00	61.46
	Middle	15	2.06	.00	89.87
	coronal	15	1.22	.00	35.36
	Total	60	5.15	.00	48.72
Group III D-RaCe plus ProTaper NEXT	Apical	15	2.47	.00	42.75
	Middle	15	.36	.00	49.35
	coronal	15	.00	.00	60.71
	Total	60	4.76	.00	48.33
Group IV D-RaCe plus ProTaper Gold	Apical	15	6.22	.00	27.17
	Middle	15	.00	.00	30.14
	coronal	15	.00	.00	17.96
	Total	60	5.72	.00	15.11

Table 1. Descriptive statistics including median, minimum and maximum percentage of remnant of root filling material at different levels and groups.

The highest remnant was found in group I at coronal level (9.83%); while the lowest remnant was found at coronal level of both groups III&IV (.00 %).

Kruskal-Wallis test was done to detect statistical difference between groups at each level, between levels at each group and between total percentages of groups. The test showed non-significant difference between groups at

each level and between levels at each group ($P > 0.05$).

At levels (Middle, Coronal) the highest remnant was found at group I (7.37 %, 9.83 % respectively) except apical level which showed the highest remnant in group IV (6.22 %), although the difference between groups at different levels (Apical, Middle and coronal) was non-significant ($P = 0.930, 0.366$ and 0.099 respectively). The lowest remnant at all levels was found in Group III (2.47%, .36%, .00).

In group I the highest remnant was found coronally (9.83%); while the lowest remnant was found apically (4.35 %); although the difference is non-significant ($p = 0.720$). In groups II, III and IV the highest remnants were found apically (3.28 %, 2.47 % and 6.22 % respectively); while the lowest remnants in these groups (II, III and IV) were found coronally (1.22 %, .00 %, .00 %); although the difference between levels at groups (II, III and IV) was non-significant ($p = 0.764, 0.647$ and 0.136 respectively).

The highest total remnant was found in group I (20.26 %) followed by group IV (5.72 %) then group II (5.15 %) and the lowest was found in group III. Although the difference was non-significant ($P = 0.131$)

Discussion

To allow complete disinfection of root canal system during retreatment; all root filling material must be removed to allow exposure of dentinal tubules for disinfectant which results in providing favorable circumstances for periapical healing.¹³ Several methods were tried to remove root filling material including hand, rotary and reciprocating instruments.^{14,15,16}

Separating method was used because it was considered as gold standard method and when compared with radiographic method, the radiographic method showed poor accuracy in detection of remnant of root filling material.^{17,18} Other methods were excluded because the result may depend on operator choice which causes bias in the result like SEM method, Micro-CT imaging consumes more time reaching about 300 hours and more expensive than other methods.^{19,20}

The retreatment step was considered complete when no root filling material could be detected on instruments, although some of

studies added other methods to confirm no presence of root filling material like using dental operating microscope or using of irrigation as a marker for no presence of root filling material residue in irrigation, but the most important guide for completion of retreatment was considered the absence of material on instruments.^{21,22} Although the complete removal of root filling material is challenging as seen in several studies,^{23,24} complete removal of root filling material was done in segments and total canal area and this was in accordance with other studies.^{9,19}

At apical third a non-significant difference was found between groups (D-RaCe, D-RaCe+ RB, D-RaCe+ PTN, D-RaCe+ PTG). The cause of non-significant difference between groups at apical 1-5mm level may be related to two reasons: the first one is that most of root filling material was removed by D-RaCe system which may be related to the design of D-RaCe that has triangular cross section and alternating cutting edges for efficient removal of gutta percha,^{25,26} the second reason is that all of the instruments either have equal or smaller size than final size of primary treatment which may prevent reaching of instrument to challenging area. The lowest remnant apically in PTN group may be related to rectangular cross section with two points of contact and asymmetric movement that provides large room for debris removal.^{11,27}

At middle third the last group PTG has the least amount of remnant; this may be related to design of instrument which has triangle cross section with three point of contact which may enhance cutting efficiency,²⁸ the lowest remnants in the groups II, III and IV may be related to use of brushing motion which enhances cutting action.²⁹

At coronal third Both groups III&IV (D-RaCe+ ProTaper NEXT, D-RaCe+ ProTaper Gold) showed lowest remnant which may be related to design of ProTaper systems including triangular cross section for ProTaper Gold which enhances cutting efficiency,²⁸ while the ProTaper NEXT has rectangular cross section with offset motion.^{11,27} Both of systems were used in a brushing action which enhanced cutting efficiency.²⁹

In group I the cause of highest remnant in apical third may be related anatomy of canals which tends to be circular in the apical part and oval in the middle and coronal parts and the canals become larger when ascending

coronally.³⁰ For group II, III and IV (D-RaCe+ RECIPROC blue, D-RaCe+ ProTaper NEXT, D-RaCe+ ProTaper Gold) the least remnant was found at coronal third may be related the action of instruments in brushing motion which may enhance cleanliness.²⁹ For group III (D-RaCe+ ProTaper NEXT) the result showed an agreement with another study,¹¹ they found the highest remnant in apical part and lowest in the coronal part but with significant difference, this discrepancy may be related to use of instruments in retreatment procedure which have two sizes smaller than final size of primary treatment, as it was found that apical preparation of three instruments larger than final size didn't allow complete contact with all canal walls.

For total remnant of root canal filling material, a non-significant difference was found between rotary and reciprocating instruments, the results showed agreement with other studies.^{31,32} While some studies found that the reciprocating instruments are significantly more efficient than rotary instruments.^{33,34}

Conclusions

Although shaping instruments with different motions and designs were used, the additional use of shaping instruments (RECIPROC blue, ProTaper Next, ProTaper Gold) with D-RaCe system didn't enhance root filling material removal significantly.

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Declaration of Interest

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