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EFFICACY OF THREE DIFFERENT ROTARY NI-TI INSTRUMENTS IN REMOVING GUTTA PERCHA DURING ROOT CANAL RETREATMENT (IN VITRO STUDY)

Ibrahim Abdel Halim Mohamed Abo El Magd*, Shady Ali Hussein **
and Tarek Mostafa AbdelAziz ***

ABSTRACT

of three rotary Ni-Ti retreatment systems in root canal retreatment. Remaining obturating material on canal walls, time required for retreatment process, number of fractured files, amount of debris extrusion was evaluated. The total number of sample was 60 canals in 30 mesial root of lower mandibular first molar type III and was randomly divided into 3 groups of 20 canals according to retreatment system used. In Group (I), Group (II), Group (III) retreatment was done using Protaper universal retreatment files Fanta AF retreatment files and M3 Pro gold retreatment files respectively. Fanta and M3 progold retreatment file systems has higher efficiency in removal of obturating material than Protaper retreatment file system with statistically significant difference. Protaper retreatment file system was faster than Fanta and M3 progold retreatment file with significant difference. 3 protaper, 2 Fanta, 5 M3 progold files were broken. Fanta showed the highest amount of debris extrusion with significant difference. Under the circumstances of this study, it can be concluded that fanta and M3 progold file has higher efficiency in removal of obturating material, protaper faster in retreatment, different root section affects amount of remaining root filling material, M3 progold file system has more broken files, fanta extrude more debris than protaper and M3 progold.

Keywords Different Rotary Ni-Ti Instruments, Obturating Material , Root Canal Retreatment

INTRODUCTION

Failure might occur in case of persistence of bacteria in the root canal system because of insufficient cleaning, inadequate obturation, or when there is coronal leakage1 . If root canal therapy fails, treatment options include conventional retreatment (orthograde filling), apical surgery, or extraction. Whenever possible, the conventional retreatment

* BDSc, Faculty of Dentistry, Ain Shams University
** Associate Professor of Endodontics, Faculty of Dentistry, Ain Shams University
*** Lecturer of Endodontics, Faculty of Dentistry, Ain Shams University

is preferred as it is the most conservative method. Although conservative retreatment may pose a significant challenge to clinicians making it stressful and time consuming procedure, especially in curved canals [1].

The main goal of retreatment is to regain access to the apical foramen by removing the root canal filling material completely, because remnants may shield and protect persistent bacteria involved in post-treatment disease maintaining inflammatory process and symptoms [2] . Removal of much as possible of obturation material allows chemicomechanical re instrumentation and redisinfection of the root canal system [3] . However, none of the techniques evaluated to date could completely remove remnants of gutta-percha and/or sealer from the root canal.

Several studies have evaluated the efficacy of different engine-driven nickel-titanium (Ni-Ti) file systems in the removal of root canal filling materials, whereby these systems promised reduced working time [1,4,7,9]. Against this background, this study is aiming to further investigate the applicability of Ni-Ti rotary instruments in the removal conventional root canal filling material.

Therefore, the study aimed to evaluate of the efficiency of three rotary Nickel-Titanium systems in the removal of root canal filling material regarding the terms of: determination of the amount of remaining obturation material on dentinal walls, measuring the time required for retreatment, number of file fractured during procedure and debris extrusion during retreatment.

MATERIALS AND METHODS

We used manual file #10 Manni (DENTSPLY, Maillefer, Ballaigues, Suisse) for patency and tooth length determination, rotary F1 (#20 taper 7%) Protaper file, sodium hypochlorite 2.5%, 17% ethylene-diamine-tetra-acetic acid (EDTA) solution and plastic syringe with 27 gauge needle for canal preparation and cleaning, Paper points size 20, guttapercha size 20, Speader size 25, Flame, condensor, epoxy resin sealer (Ad seal) from Metabiomed for obturation.

Protaper universal retreatment system (DENTSPLY, Maillefer which includes 3 files (D1, D2, D3) (30/9, 25/8, 20/7) respectivly, FANTA AF retreatment system (FANTA Dental, Shanghai, China) which includes 3 files (RTR1, RTR2, RTR3) (20/7, 25/8, 30/9) respectivly, M3 pro gold retreatment system: (UNITED Dental, Shanghai, China) which includes 3 files (M3RT1, M3RT2, M3RT3) (20/7, 25/8, 30/9) respectively was used.

Epindorph tubes for debris collection, rotary motor (Endogold woodpecker) for root canal preparation and retreatment, stopwatch for evaluating time of retreatment, fissure surgical bur and wheel stone for tooth separation and decoronation, Diamond disc and chisel for root splitting, stereomicroscope with digital camera for evaluation of remaining obturating material were used in our study.

Regarding sample selection, Mesio-buccal and mesio-lingual canals of Thirty extracted human permanent mandibular first molar teeth (60 canals) were used in this study. The teeth were confirmed to be type III. The working length (WL) was established 1 mm short of that length. The mesial root was separated from distal root by fissure surgical bur then decoronated using a high-speed wheel stone with water coolant, and the length was standardized at 15mm for all samples [4].

All samples were sixty canals in thirty mesial roots of lower mandibular first molar type III (n=60) and were randomly divided into three groups of twenty canals (n=20) according to retreatment system used. All samples were prepared and instrumented using crown down technique by protaper universal F1 (#20 taper 7%) according to manufacturer instruction's (speed from 300 rpm and torque 2.6 Ncm). apical patency was checked using a size #15 K-file then apical stop was checked by k-file #20, and the canals were irrigated with 2

ml of 2.5% sodium hypochlorite (NaOCl) using a 27-gauge needle and a plastic syringe.

An Eppendorf tube was used as a collecting container for any debris or irrigants extruded during instrumentation. These tubes were preweighted to 10^{-5} precision of milligrams by using microbalance using 3 consecutive measurements for each tube and then mean value was recorded. The rubber stopper was fitted securely in mouth of the flask with tip of root inside the Eppendorf tube and below its orifice. A 30-G needle was inserted into the rubber stopper to balance internal and external pressures allowing debris extrusion. The receptor tubes were then stored in an incubator at 37°C for 10 days to evaporate the moisture. The weight of dry extruded debris was calculated by subtracting the weight of the empty tube from the weight of the tube containing debris. 3 consecutive measurements were done, and the mean measurement for each tube was considered to be its weight [5].

Removal of obturation material was done by step down technique with the sequence of retreatment kit. In all samples, no gutta percha solvent was used. Gentle apical pressure was combined with a brushing action against the lateral walls, according to the manufacturer's instructions. After finishing retreatment of all samples, eppendorph tubes were then stored in incubator to evaporate the moisture to weigh the dry debris. The roots were then splitted by diamond disc and chisel to measure the remaining gutta percha under stereomicroscope.

All samples were splitted longitudinally using chisel into mesial and distal halves. The half of the root that had the largest area of remaining obturation material was selected for scanning using stereomicroscope and analysed at coronal, middle and apical portions, using a fixed magnification of x50. Images were captured using a digital camera fitted on the microscope, and then transferred to desktop and saved as JPEG format. ImageJ software was used to analyze the obtained images by measuring the percentage of area covered by remaining obturation material with no attempt to distinguish between residual filling material and sealer [6].

The total time of retrieval process was recorded using stopwatch (in minutes) including the time required to reach the working length from the first instrument used and until no obturation material can be distinguished on the last used file. Time taken for the change of files, irrigation was excluded. The number of fractured instruments were recorded. In case of fracture another sample was added to the group and a new file was used. File was evaluated by its length shorter than normal with loss of canal patency and the working length of canals in the could not be reached. Any file had been broken was discarded.

RESULTS

Two-way analysis of variance, one way analysis of variance (ANOVA) and t-student tests were done. $P \leq 0.05$ was considered as the level of significance. Regarding amount of filling material on canal walls Protaper showed the highest remaining gutta percha (44.76 ±13.48) followed by M3 progold while Fanta showed the lowest remaining gutta percha (26.38 ±9.94). There was a statistically significant difference between Protaper and the other two files. While there was no statistically significant difference between Fanta and M3 progold (table 1).

TABLE (1): Mean ± standard deviation (SD) of remaining GP (%) for different retreatment rotary systems

	Coronal	Middle	Apical
Protaper	37.87 ±11.78 [a]	49.20 ±14.27 [a]	47.21 ±12.02 [a]
Fanta	23.8 ±6.6 [b]	29.52 ±9.88 [b]	26.22 ±12.07 [b]
M3 progold	19.32 ±11.27 [b]	30.07 ±14.67 [b]	31.62 ±11.24 [b]
P-Value	<0.001	<0.001	<0.001

P> 0.05 = non significant (NS); P < 0.05 = significant (S); P < 0.001 = highly significant (HS)

Means that don't share the same letter are significantly different.

Endodontic treatment is fairly predictable in nature with reported success rates up to 86– 98%. Nonsurgical endodontic retreatment of previously obturated root canals is the initial treatment of choice for the management of endodontic failures. Necrotic tissue or bacteria, covered by remaining gutta-percha or sealer, might be responsible for periapical inflammation or pain. Thus, the maximum quantity of obturation material should be removed to allow chemomechanical re instrumentation and re disinfection of the root canal system [7].

In the current study, the retreatment procedure was considered complete when there was no evident filling material on the last retreatment instrument used. However, all the canals had remnants of the filling material on the canal walls, as shown in other studies [8]. Our results indicate that the absence of filling material on the instruments is not a valid criterion for demonstrating complete removal of filling material from the canal walls, as found in the results of a study by Schirrmeister and others [9].

Due to limited availability of micro-CT scan, in current study the amount of remaining filling material was evaluated by longitudinal cleavage followed by quantitative analysis. Three different aspects of the tooth were evaluated: the coronal, middle, and apical thirds in one half of a split root specimen. Root sections were imaged by stereomicroscope followed by analysis using ImageJ software [10]. It was reported that this method was effective in determining the amount of filling residue and minimized subjectivity in the scoring method based on a scale [11].

Regarding removal of gutta percha it is supposed that there is some features that impact the removal of gutta percha such as Taper, cross section and Metallurgy either it is austenite or martensite. The taper can be either progressive or uniform taper. In this study there were three files one with progressive taper which was protaper universal retreatment system and two files with uniform Taper which was Fanta and M3 pro gold. regarding cross section there were two files which were Protaper universal retreatment system and M3 progold with the same cross section which was convex triangle and one with rhomboid shaped cross section which was Fanta retreatment system. regarding metallurgy there was one austenitic file which was Protaper universal retreatment system, and two files have a mixture of martensite and austenite at room temperature which were Fanta and M3 progold retreatment systems which show some elasticity.

Regarding removal of gutta percha in Coronal part, unpredictably, protaper showed the highest remaining gutta percha followed by Fanta while M3 progold showed the lowest remaining gutta percha, despite that protaper universal retreatment files and M3 progold retreatment files has the same cross section. The null hypothesis stated that the file with progressive taper will have large diameter at coronal area which will remove and clean the coronal portion more efficiently but, in our study, M3 progold remove more gutta-percha than protaper with statistically significant difference. This may be due to the high rotating speed used with protaper which may made thermoplasticization of gutta percha making it more adherent to the canal walls.

Regarding removal of gutta percha in Middle part and apical part, Protaper showed the highest remaining gutta percha followed by M3 progold while Fanta showed the lowest remaining gutta percha. Fanta removed much more gutta percha in middle and apical thirds may be due to its difference in cross section which is rhomboidal shaped. Fanta may show some elastic property, and this may facilitate more engangment to the apical portion without transportations or procedural errors. The protaper universal retreatment file has the highest remaining gutta percha may be due to its progressive taper which may has smaller apical diameter making it in less contact with the walls in apical area. There was no statistically significant difference in the

amount of remaining gutta percha in Fanta and M3 progold groups this may be because they share the same property of uniform taper, and they have a mixture of martensite and austinite form in room temperature. Regardless of the file type the middle and apical portion showed the most remaining gutta-percha on walls, and this is in full agreement with **Fenoul et al.,** [12] who concluded that Filling material was left in all techniques inside the root canal and mainly in the apical third. No single technique allowed complete removal of debris from the canal walls this agreed with **Saad et. al** [13] , **Gu et. Al** [14] where they stated that all techniques left debris on walls.

Regarding time of removal of gutta-percha, it is supposed that there is some features that impact the penetrability of the file which will affect the time of removal of gutta-percha such as helical angle, rake angle, geometric design and metallurgy of the file. This may clarify why Protaper universal retreatment file has the fastest time to remove gutta-percha as it has a convex triangular cross section with a neutral rake angle and regarding helical angle it progressively increases along the file [15]. Both the geometric design and manufacturing process (heat treatment) of instruments may affect the flexibility and the reaction forces as well as the screw-in effect. Protaper is made of conventional NiTi alloy and has a triangular cross-sectional area designed to cut root dentin with three-point symmetrical contacts. PTU also has a progressive taper compared with M3 progold retreatment file. These characteristics increase its rigidity and may produce a higher screw-in effect. This clarify the reason why protaper universal retreatment file is faster than M3 progold despite the same cross section which is convex triangle. our results in complete agreement with **Bramante et al.,** [16] and **Takahashi et al.,** [17] **DINCER** [18] who stated that protaper requires less time to remove gutta-percha, but our results contradicted by **Marfisi et al.,** [19] who stated that protaper requires more time to remove gutta percha.

Regarding fracture incidence Several variables, such as instrument size, taper, crosssectional design, and manufacturing techniques, affect the clinical performance of endodontic files and their resistance to fracture by torsion and/or cyclic fatigue. Factors influencing the fatigue resistance include file design, cross-sectional geometry and diameters of core, tip size, and taper of the tested file [20]. A higher percentage of martensitic structure in the instrument may significantly influence the cyclic fatigue lifespan. In addition, the manufacturing process and machining may influence the instrument's fatigue lifespan by inducing external or internal defects. Manufacturing process may serve as nucleating sites for the micro-voids and crack propagation at grain boundaries and surfaces leading to instrument fractures during clinical use. The high density of surface defects facilitates the crack nucleation stage, and the fatigue failure is largely a crack propagation process [21]. In our study 5 M3 progold files fractured with incidence 25% which is the most fractured files followed by 3 protaper files fractured with incidence 15% while 2 fanta files fractured with incidence 10% which is the least fractured files. This may be due to the manufacturing process.

Results presented here are consistent with other apical extrusion studies and reinforce the fact that it is impossible to prepare a root canal system chemomechanically without any extrusion of debris13. However, most of these studies evaluated the amount of apical debris in a semiquantitative form with the use of the scoring system. It would not be sensitive enough to detect the tiny differences among various techniques and thus tends to provide an overoptimistic evaluation of apical extrusion. In contrast, studies measuring the amount of debris with the aid of microbalance accurate to ten thousandths' digit did find out the difference [22]. Our results demonstrated that, with only few exceptions, the amount of apically extruded materials for each sample was below 0.01 g, and significant differences were found among groups.

Fanta showed the highest amount of debris extruded which may be due to its cross section regarding shape which has less clearance spaces. This removed more amount of dentin causing debris accumulation and extrusion apically. M3 progold came second while Protaper showed the least amount of debris extruded and this is in acceptance with **Vikram** [6], this might be due to its smallest apical diameter, which allowed clearance of debris coronally and prevented debris accumulation at apical area. The Protaper retreatment files are designed in such a way that although there are three points of contact with the root canal dentinal wall, there is ample space between the instrument and the walls to accommodate the fragmented debris [23]. Protaper and M3 progold showed no statistically significant difference in between. On the other hand Fanta was statistically significant from the other two groups.

CONCLUSION

Under the circumstances of this study, it can be concluded that fanta and M3 progold file has higher efficiency in removal of root canal filling material than Protaper file, protaper faster in retreatment than Fanta and M3 progold, different root section affects amount of remaining root filling material, M3 progold file system has more broken files than 2 other groups, fanta extrude more debris than protaper and M3 progold.

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