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Efficacy of rotary Ni-Ti retreatment systems in root canals filled with a new warm vertical compaction technique

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The aim of this study was to compare the efficacy of Mtwo, ProTaper retreatment files and Hedström files for the retreatment of root canals filled with BeeFill 2 in1 and cold lateral compaction techniques. 63 single-rooted human teeth were prepared with Mtwo rotary files to size 35/.04 and assigned into three groups (n=21/group). (1) BeeFill 2 in1/2Seal, (2) BeeFill 2 in1/AH26 and (3) laterally-compacted gutta-percha/AH26. The specimens were subgrouped according to the file system used to remove root fillings (n=7/subgroup): 1. Mtwo retreatment file, 2. ProTaper retreatment file, 3. Hedström file. Roots were split longitudinally and photographed. The time required for removal of root canal fillings and the areas of residual root filling materials were compared statistically (p<0.05). The maximum amount of remnant was observed in the Mtwo group for removal of BeeFill 2 in1/AH26. ProTaper retreatment files required less time to remove root filling material than Mtwo retreatment files and Hedström files (p<0.05). Among the tested removal systems, ProTaper retreatment files may offer the best efficiency-speed combination.

Keywords: Obturation techniques, Retreatment, Rotary files

INTRODUCTION

The main objective of endodontic treatment is to clean, shape and obturate the all portals of the root canal system, three-dimensionally to prevent reinfections[1]. Although success rates are varying between 86% and 98%[2], endodontic therapy may happen and result in failures by a number of biological and technical factors such as untreated canals[3], perforations[4], inadequately filled canals[5], coronal leakage[6]. These factors cause persistency of bacteria within the root canal system and as a result the microorganisms or their by-products may induce an inflammatory response within the periapical tissues causing periradicular lesions. When periapical disease is formed, the options for treatment are non-surgical retreatment, surgical procedures or extraction of tooth[2]. Among those, nonsurgical root canal retreatment, an attempt to re-establish periapical tissues after inadequate treatment or re-infection of an obturated root canal system, has become a routine procedure in dentistry because of etiological factors[7].

One of the basic properties of the ideal root canal filling technique and material is that it should be removable whenever necessary for retreatment purposes[8]. Gutta-percha is the well-known core material used for obturation. Major advantages of this material are its plasticity, ease of manipulation, radiopacity and ease of removal from the root canals. To properly remove the gutta-percha obturating material, many techniques and materials have been used in root canal-treated teeth. These include K-files or H-files, heat-carrying instruments, chemical solvents, ultrasonic instruments, engine driven rotary files such as Gates Glidden drill, GPX gutta-percha remover, NiTi rotary instruments, retreatment files (R-Endo, ProTaper and Mtwo retreatment files) heat carrier tips, ultrasonic files and lasers[2,9-11].

The ProTaper retreatment file system (Dentsply-Maillefer, Ballaigues, Switzerland) includes three retreatment instruments which are various tapers and diameters at the tip (D1, D2, D3). D1 has a cutting tip to facilitate initial penetration into the filling material. D2 and D3 both have non-cutting tips and are used to remove material from the middle and apical thirds, respectively. Mtwo retreatment file system (VDW, Munich, Germany) consist of two instruments with active cutting tip: R1 and R2. These instruments are characterized by two cutting edges.

Warm vertical compaction technique is introduced by Schilder[12] as an approach of filling the radicular space in three dimensions. Plasticized gutta-percha can be filled into irregularities and accessory canals with this method, thus replicating the intricacies of the root canal system[12,13]. BeeFill 2 in1 (VDW, Munich, Germany) is a recently introduced warm vertical compaction system that includes down-pack and backfilling equipments in one unit. The manufacturers claim that its efficacy in removal when is required, however scientific data on the removable properties of BeeFill 2 in1 is still lacking.

Consequently, the aim of this study is to compare the effectiveness and working time of Mtwo retreatment file, ProTaper retreatment file and Hedström files used for removal of root canal filled with BeeFill 2 in1 comparing with lateral compaction technique.

MATERIALS AND METHODS

In this study, after ethics committee approval, the freshly extracted single-rooted human teeth with mature apices were used. Soft tissue and calculus were removed

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from teeth. Canal curvatures according to Schneider method[14] were measured on periapical radiographs, and 63 canals with curvatures ranging less than 10 degrees were included. Then, the teeth were decoronated at the cementoeamel junction to make the length of each root approximately 15 mm. The working length of each canal was established by placing a size 15 K file (VDW Antaeos, Munich, Germany) into the root canal until it was seen at the apical foramen and subtracting 1 mm from this length.

Preparation of the root canal and obturation

All canals were prepared using Mtwo rotary instrument (VDW, Munich, Germany) in an endodontic motor (VDW Silver, Munich, Germany) according to the manufacturer's instructions. Six instruments were used: Mtwo 10/.04, Mtwo 15/.05, Mtwo 20/.06, Mtwo 25/.06, Mtwo 30/.05, and Mtwo 35/.04. RC Prep (Premier, Pennsylvania, USA) was used as a lubricant. Before the use of each instrument, root canals were irrigated with 2 mL freshly-prepared 2.5% sodium hypochlorite (NaOCl) solution. When instrumentation of the root canal was complete, the smear layer was removed through application of 5 mL of 17% EDTA and 5 mL 5.25% NaOCl, respectively. To finalize the irrigation, 10 mL saline solution was rinsed as final irrigation. The canals were then dried with paper points (Spident, Incheon, Korea).

As seen in Table 1, the prepared canals were randomly divided into three groups consisting of 21 specimens: Group 1 consist of samples obturated with BeeFill 2 in1 using 2 seal sealer (2 seal, VDW, Munich, Germany), Group 2 samples are obturated with BeeFill 2 in1 using AH 26 sealer (Dentsply Detrey, Konstanz, Germany), Group 3 samples are obturated with lateral compaction technique with AH 26 sealer.

In groups 1 and 2, a size 35/.04 tapered Mtwo gutta-percha (VDW, Munich, Germany) was fitted with 0.5 mm short of the working length with tug-back. The canal walls were thinly coated with a sealer. The trimmed gutta-percha cone was also coated with a sealer and then it was placed into the canal 0.5 mm short of the working length. The BeeFill™ (VDW, Munich, Germany) down-pack device was used for obturation of apical part in the root canal system. This device was preset to 180 degree during apical compaction of the gutta-percha. ISO 40/.03 hot plugger was applied, searing the points off approximately 3 to 4 mm from the apex. The remainder of the canal was filled with BeeFill™ backfill device as recommended by the manufacturer.

In group 3, a size 35 standardized master gutta-percha cone (Diadent, Seoul, Korea) fitted into the root canal at the working length was checked for tug-back. Then AH-26 sealer was applied into the root canal. Lateral compaction was applied by using accessory gutta-percha cones of size 20. Accessory gutta-percha cones (Diadent, Seoul, Korea) were put until finger spreader size 25 (VDW Antaeos, Munich, Germany) penetrated into the coronal by one third of the root canal space. After obturation, excess gutta-percha was removed using a hot plugger.

The teeth were radiographed in the buccolingual and mesiodistal directions to confirm the adequacy of root canal filling and then stored in 100% humidity at 37°C for one week.

Retreatment techniques

The size 2 and 3 Gates-Glidden (GG) drills were used to remove the coronal 3 mm of all root canal filling materials. The filled root canals from all groups were re-treated by using three different removal techniques (n=7) as follows groups;

Hedström group: # 15, 20, 25, 30, 35, 40 Hedström files (VDW, Antaeos, Munich, Germany), were used until they reached the working length in a circumferential

Table 1 The percentage of residual filling materials (Mean±Standard Deviation)

Obturation Technique/Sealer	Retreatment File	n	Canal Level			Total
			Apical	Middle	Coronal	
BeeFill 2 in1/2Seal	Hand	7	0.051±0.024[a]	0.034±0.024	0.028±0.012	0.114±0.024
	MTwo	7	0.045±0.017[a]	0.035±0.018	0.037±0.017	0.118±0.035
	ProTaper	7	0.060±0.046	0.024±0.007	0.042±0.028	0.127±0.060
BeeFill 2 in1/AH 26	Hand	7	0.197±0.160	0.044±0.030	0.027±0.024	0.269±0.169
	MTwo	7	0.135±0.057	0.096±0.063*[a]	0.110±0.071*[a]	0.341±0.149
	ProTaper	7	0.072±0.058	0.031±0.027	0.023±0.020	0.127±0.070
Lateral Compaction/AH 26	Hand	7	0.158±0.080[†]	0.038±0.029	0.033±022	0.230±0.092
	MTwo	7	0.104±0.053[†]	0.014±0.008*	0.02±0.010	0.146±0.069
	ProTaper	7	0.050±0.038*	0.025±0.018	0.03±0.027	0.108±0.066

* In the same row, the statistically difference group according to used retreatment file (p<0.05).
[a] In the same row, the statistically difference group according to obturation techniques (p<0.05).
[†] In the same column, the statistically difference group according to canal level (p<0.05).

quarter-turn push-pull filing motion to remove all the filling materials and clean the canal walls.

ProTaper group: Root canal fillings were instrumented with ProTaper retreatment files in an endodontic motor (X-Smart, Dentsplay, Maillefer, Switzerland), with a constant speed of 500 rpm according to the manufacturer's instructions. D1, D2, and D3 were sequentially used in a crown-down sequence to reach the working length. Root canal retreatment was completed with ProTaper rotary files based on the following sequence: F4 (#40), F3 (#30, 0.09–0.05 taper), F2 (#25, 0.08–0.055 taper), and F1 (#20, 0.07–0.055 taper) files were used with crown-down technique until the working length was reached. Finishing files size 2 and 3 were re-used again to the working length with a brushing circumferential motion to complete gutta-percha removal.

Mtwo group: The root canal fillings were removed to the working length using Mtwo R25/.05 and Mtwo R15/0.05 retreatment instruments in a brushing action. Then Mtwo rotary files were used in a circumferential motion at working length with in the following sequence: Mtwo 10/.04, Mtwo 15/.05, Mtwo 20/.06, Mtwo 25/.06, Mtwo 30/.05, Mtwo 35/.04, and Mtwo 40/.04 with an endodontic motor (VDW Silver, Munich, Germany). The torque and speed were selected for each file based on the manufacturer's suggestions.

During retreatment, all root canals were irrigated with the change of each instrument using 2 mL of 2.5% NaOCl. After irrigating with 5 mL of 17% EDTA solution, a final rinse with 5 mL of saline solution was applied. For standardization purposes, there was only one operator preparing the samples and conducting the experiments.

Evaluation of remaining filling materials

Retreatment was completed when the last file reached the working length, until no filling materials covering the instrument remained.

1. Time for retreatment

The time required for retreatment from entering the canal with the first GG bur until the completion of the re-instrumentation was recorded with a stopwatch.

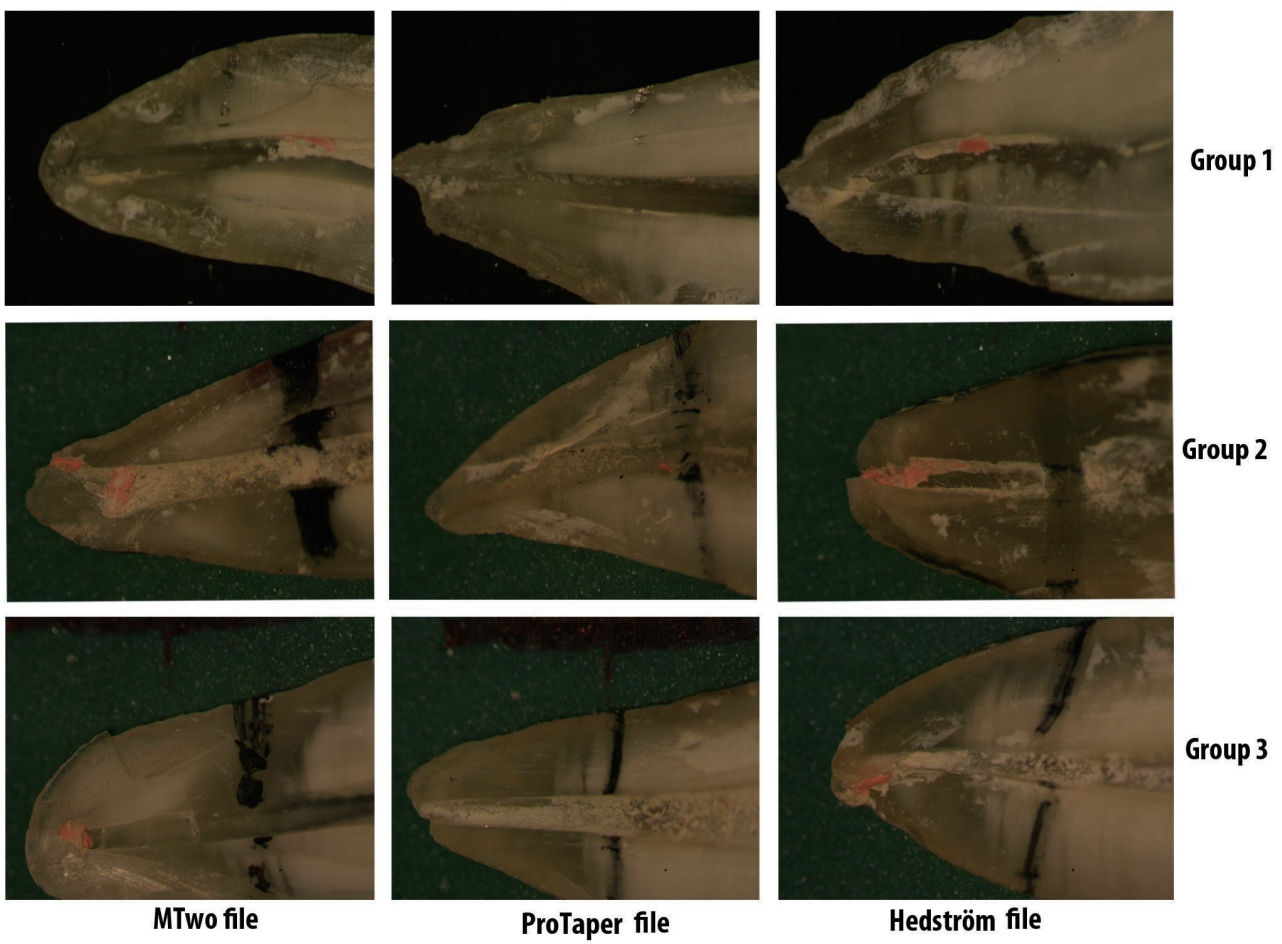

Fig. 1 Apical photomicrographs of representative specimens, demonstrating the extent of residual root fillings (32×, original magnification).

2. Canal Wall Cleanliness

The roots were split longitudinally, then each half was examined using operation microscope (Carl Zeiss OPMI PROergo, Oberkochen, Germany) at 8.16 and 32× magnifications (Fig. 1). They were photographed with a digital camera. The pictures were analyzed using an image analysis program (COMEF 4,3; OEG Messtechnik, Frankfurt, Germany) to determine the areas of remaining obturation material.

Statistical analysis

The area of residual root filling material measured and the time required for root canal removal were statistically evaluated using Kruskal-Wallis and Friedman tests. The level of significance in all tests was set at $p<0.05$.

RESULTS

The percentages of filling material remaining in the canal (Mean±Standard deviation) are shown in Table 1. In the all obturation techniques, there was a statistically significant difference among the removal techniques regarding the time required to remove the filling material ($p<0,05$) (Fig. 2). Both the groups with samples filled with BeeFill 2 in1 and the lateral compaction technique, the retreatment time for ProTaper was significantly shorter than Mtwo and Hedström file ($p<0.05$). On the other hand, Hedström files took the most time among all removal techniques ($p<0.05$).

When the amounts of the remaining material in apical, middle and coronal parts were compared among

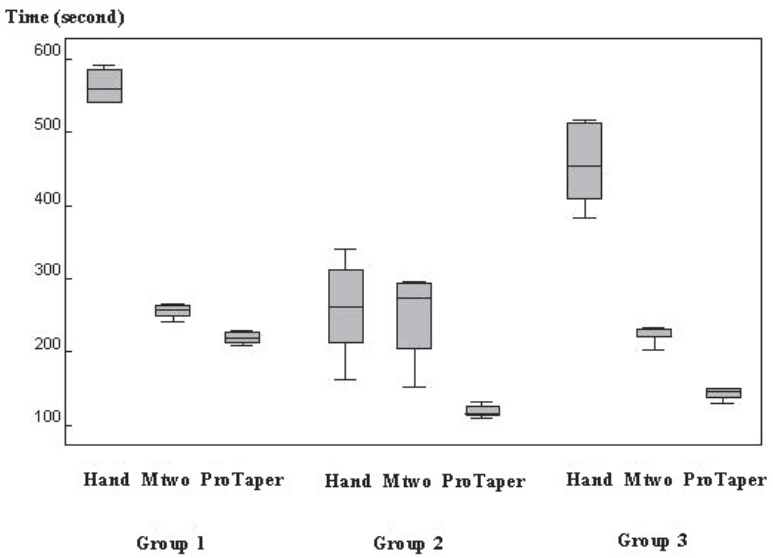

Fig. 2 Time required (seconds) to remove the filling material.

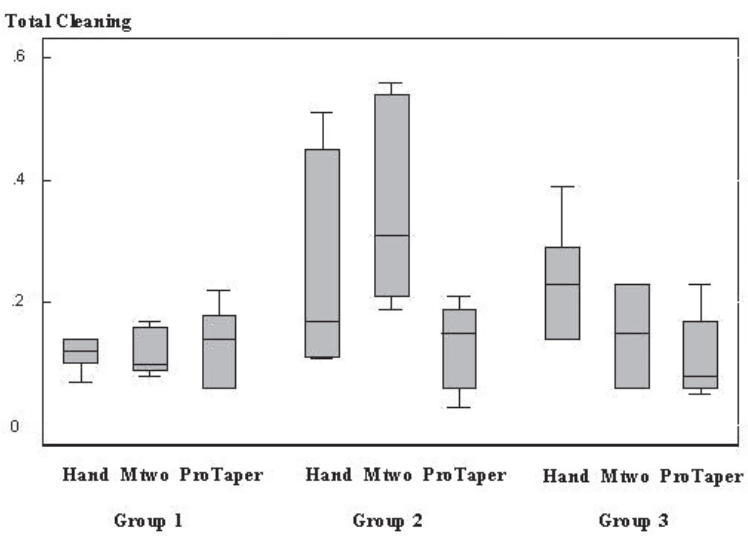

Fig. 3 Percentage of filling material remaining in the canal.

all groups, the most remaining material was found in apical parts (p=0.004). In all groups, the remaining materials left inside the root canal both of the rotary and the Hedström file (Fig. 3). When the amounts of remaining materials are compared, no difference was found between the BeeFill 2 in1/2 seal group and the lateral compaction group. The biggest percentage of remaining material was observed in the group BeeFill 2 in1/AH26 with Mtwo retreatment file (p=0.020).

When the removal techniques are compared, BeeFill 2 in1/2 seal showed the least amount of remaining material with Hedström files (p=0.014) while BeeFill 2 in1/AH26 showed biggest amount of remaining material when Mtwo retreatment files were used for removal (p=0.003). There was no statistically significant difference in terms of remaining material among all filling techniques when ProTaper retreatment files were used for removal.

DISCUSSION

In this comparative study, the removal effects of two different rotary instruments and hand file were evaluated in root canals filled with BeeFill 2 in1 which is a new warm vertical compaction technique with two different sealers. This new obturation technique was compared with lateral compaction technique which was used in many retreatment studies[15-18].

In the previous studies, the amount of filling material remained in the root canal wall after the retreatment were evaluated using radiography[19,20], computed tomography[21,22], and operational microscope[23]. It was reported that evaluation with operational microscope was an effective method in determining the amount of filling residue[19]. In this study, the teeth were longitudinally divided into two parts and the views obtained by the operational microscope were evaluated using scoring[20]. Each piece of the roots was evaluated based on four different views; apical, middle, coronal, and the whole root canal.

The manufacturer of the BeeFill 2 in1 system recommends the use of 2 seal sealer which is a resin based sealer. In this study, it is used two different resin based sealers with BeeFill 2 in1 system, 2 seal and AH 26 sealer which is accepted as the golden standard in the literature of endodontics. When the roots filled with BeeFill 2 in1/2 Seal was examined considering the total amount of remaining root canal filling material, there was no statistically difference found between the removal techniques. On the other hand, the most remaining material was seen in group BeeFill 2 in1/AH26 with Mtwo retreatment file. Although both of the sealers contain resin based, the difference between the results may be attributed to void formation in the body of the filling while using the plugger and the shrinkage of the heated gutta-percha obtained with the BeeFill 2 in1.

In the literature, there are comparative studies relating to the amount of filling residue in the root canal after retreatment[11,16-18]. It was reported that the removal techniques were not different each other in terms of their removability, and all instruments left remnants of filling material and debris on the root canal walls[24-26]. However, rotary instrumentation has been shown to be more effective than Hedström files in removing gutta-percha from root canal[16,24]. Saad *et al.*[24] showed the two rotary instruments, the ProTaper and K3, to be significantly more effective in removing gutta-percha from root canal compared to Hedström files. Similar results were obtained by the present study that demonstrated the efficacy of ProTaper compared with Hedström file. Whereas the findings of the present study showed the worst result were obtained using Mtwo for removal of the filling material.

When the time consumed for the removal of the used filling material, similar results were obtained in groups sealed with 2 seal and AH 26 sealer. The shortest time was recorded in ProTaper retreatment file groups used for removing of the filling materials. On the other hand, regardless of the filling technique and material, the maximum time consumed for removal of filling materials was obtained by Hedström file in all groups. A possible explanation could be that Mtwo and ProTaper retreatment file was used in rotational motion, whereas Hedström file in the all groups was used in push-pull filing action. It is believed that the rotary motion of ProTaper retreatment file plasticizes the gutta-percha thus it is easier to remove the material. Furthermore, specific flute design of this file tends to pull gutta-percha into the file flutes[27]. Similar to, some of the previous studies indicated that the rotary files required less time for retreatment compared to Hedström files[9,16,28]. According to Hülsmann & Bluhm, ProTaper retreatment file frequently removed large amounts of gutta-percha in spirals around the instruments, whereas Hedström file mainly removed the gutta-percha in small increments that did not adhere to the instruments[16]. It may be one of the answers to the question of why a lot of time was consumed with the Hedström file.

The coronal part of the each root canal was prepared by GG to make an easier removal of root canal filling. In some of the studies, the solvents have been used with the instruments to remove of root canal filling[16,27]. Hülsmann & Bluhm[16] indicated that no significant difference between removing gutta-percha with and without solvent regarding time required for retreatment using rotary and Hedström files. According to Wilcox, the use of Hedström file without a solvent is more time consuming than other techniques[29]. On the other hand, some studies reported that the removal of the filling material by using solvents was difficult because the fine layer of softened gutta-percha was formed and adhered to the root canal walls[27,30]. In the light of these studies, no solvent was used, in the present study.

There are many factors that influence successful retreatment such as root canal morphology, root canal filling materials, removal techniques considering the total amount of remaining root canal filling material. Schirrmeister *et al.*[31] demonstrated that the Hedström file showed higher means of remaining gutta-percha and sealer than RaCe instruments in a study on retreatment

of straight canals filled with laterally compaction technique. In another study using curved canals, there was no significant difference between Hedström and RaCe[32]. Consequently, they have concluded that the areas of remaining material did not depend on the removal techniques[33] and root canal morphology. The present study was performed on the canals with curvatures ranging less than 10 degrees. Therefore, further studies are necessary to evaluate the efficiancy of ProTaper retreatment files in curved canals.

CONCLUSION

Under the experimental conditions of this study, the tested rotary instruments are faster than the hand instrument to remove the used filling materials in straight canals and ProTaper retreatment files may offer the best efficiency speed combination.

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