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Original article

RETREATMENT OF TEETH FILLED WITH SINGLE CONE TECHNIQUE AND MTA BASED SEALER – COMPARISON OF THE EFFECTIVENESS OF DIFFERENT RETREATMENT TECHNIQUES (IN VITRO STUDY)

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ABSTRACT

Purpose: The **aim** of the presented in vitro study was to compare the effectiveness of three different retreatment techniques in the removal of MTA-based sealer and taper matched single gutta-percha cone from the root canal.

Material and methods: Extracted single rooted human teeth were used (n=33). Roots were enlarged using ProTaper Universal files up to size F2. They were filled with central cone technique and MTA-based sealer. Specimens were divided into three groups (n=11), according to the retreatment method: Gr1 – retreated using ProTaper Universal Retreatment files; Gr2 – hand instruments (H files); Gr3 – ultrasonic tips. For determining the effectiveness of the removal of the filling material specimens were scanned with CT and then observed under microscope under 16x magnification.

Results: Best removal of the filling material for the coronal and middle part was achieved with the hand instruments. The ultrasonic tips presented best in the apical part.

Conclusions: Complete removal of filling material was not achieved in any part of the root canal. Worst results were achieved with the machine rotary files. We would recommend the combined use of machine files with either hand files or ultrasonic tips for achieving better results.

Keywords: single cone technique, MTA based sealer, retreatment techniques,

INTRODUCTION:

The effectiveness and long-term results of endodontic treatment have been studied a lot, and the reported success rates are widely varying [1, 2]. Failure reasons might be endodontic, periodontal or prosthetic. The outcome depends on the diagnosis, preoperative condition of the patient and the tooth, the standard of the endodontic treatment, endodntic tooth restoration [3]. In cases of failure, there are two options – nonsurgical orthograde or surgical retrograde retreatment. Nonsurgical endodontic retreatment procedures are usually the first choice, especially when inadequacy of the endodontic treatment is established. They have a significant chance for success if the guidelines for case selection are followed and the adequate technologies, precise techniques and good materials are used [4]. The main goals of the non-surgical retreatment are the removal of the root filling, correction of present mistakes, establishment of root canal patency, thorough cleaning of the canal system and adequate filling [5].

There are a vast variety of sealers and obturation techniques that might be applied during endodontic treatment. In the last decade, with the widespread of rotary nickel-titanium instruments, allowing to create a root canal space with comparatively standard geometry, the filling of the root canals with single cone technique with taper matched gutta-percha points has started to be applied in the everyday practice [6,7], due to the fact that its easier to be applied, faster and the risk of fracture of the root canal during the filling procedure is reduced, cause no pressure is applied unlike the case with the lateral compaction technique.

Recently a new generation of sealers has started to be applied in the endodontic practice – the mineral trioxide aggregate (MTA)-based sealers. The MTA in their composition allows the formation of new tissue, including cement, they are biocompatible, expand during polymerization and can form chemical bonding with the hydroxyapatite, which provides good sealing of the root canal, not allowing penetration of tissue fluids and/or bacterial recontamination [8]. Another important property of sealers is their easy removal from the root canal system, if necessary [9]. Concerning this property of the MTA-based sealers, the data present in the literature is controversial. According to some authors, calcium-based silicate

sealers are harder and more resilient compared to other sealers and the time needed for their removal is longer and more remnants of the material are found [10, 11, 12]. Other authors have found that the retreatment time needed is less and the residual material is comparable [13, 14].

The **aim** of the presented study was to compare the time needed and the effectiveness of three different retreatment techniques in the removal of MTA-based sealer and taper matched single gutta-percha cone from the root canal.

MATERIAL AND METHODS

Thirty-three extracted human teeth were selected for the study. They were single-rooted, single-canal, with straight root canals and completely formed apices. External root surface was cleaned from soft tissue and calculus, using ultrasonic scaler and stored in 0.5% NaOCl solution. The crowns were removed using a diamond disk to obtain 15mm root samples. A K-file size 15 was used to determine the working length (one mm shorter than the length till the apical foramen). The canals were enlarged using ProTaper Universal files (Dentsply Maillefer, Bellaigues, Switzerland) up to size F2, according to the manufacturer's instructions. Three milliliters 5.25% NaOCl was used for irrigation during the enlargement. Paper points (Dentsply Maillefer, Bellaigues, Switzerland) were used to dry the prepared canals. All samples (n=33) were filled with single cone gutta-percha (#F2 Dentsply Maillefer, Bellaigues, Switzerland) and bioceramic based sealer (MTA Fillapex, Angelus, Londrine, PR, Brazil). Access cavities were sealed with temporary filling material (MD-Temp, Meta Biomed Co Ltd, South Korea). The quality of the fillings was checked with postoperative radiographs. Teeth were stored in 100% humidity for 3 weeks.

Samples were divided into three groups (n=11), according to the retreatment method. Group one (G1) was retreated using ProTaper Universal Retreatment files (Dentsply Maillefer, Bellaigues, Switzerland) (PTUR). Gates Glidden #3 was used to remove the gutta-percha in the coronal 2 mm. Then solvent (orange oil) was applied. D1, D2 and D3 instruments were used consequently in a crown down manner until working length was reached and no filling material was noticed on the file.

The teeth in Group two (G2) were retreated using hand instruments (H files (Dentsply Maillefer, Bellaigues, Switzerland) (HF). Gates Glidden #3 was used to create space for the placement of orange oil in the coronal 2mm of the canal. Files were used mainly with brushing movements. The canal was accepted as ready when full working length was reached, and no filling material was seen on the file.

Group three (G3) was retreated using ultrasonic tips (EMS, Switzerland # 20] (UST). Three milliliters of 5.25% NaOCl were used for irrigation during the removal of the filling material and 2 ml. for a final flush. Working length and smoothness of the retreated canals was checked with a K-file #25 (Dentsply Maillefer, Bellaigues, Switzerland). The canals were dried with paper points. Retreatment time was measured with a chronometer. The time for the final irrigation and drying afterwards was not included.

Specimens were numbered and scanned with computed tomography. The exposure conditions were the following: rotation time – 1.0, scan type – 1.0 sec, field of view (FOV) 26/16 sm, thick speed 0.625, 100 kV/250 mA tube voltage. Specimens were divided into three equal parts – coronal, middle and apical. The following scale was used to determine the residual filling material: score 0 – no presence of residual filling material; score 1 – less than 1/3 of the wall is covered with filling material; score 2 – 1/3 to 2/3 of the wall is covered with filling material; score 3 – more than 2/3 is covered; score 4 –residual filling material is present along the whole wall.

Root canals were grooved longitudinally and then split into halves. The two halves were observed under a microscope (Leica M320, Germany) under x16 magnification and images were made. The amount of residual material was evaluated, using the above-mentioned scale. The results, achieved with the CT and the microscope evaluation were compared.

SPSS software (Version 17) was used to analyse the data. Quantitative variables were presented as mean ($\overline{X}$) and standard deviation (SD) whilst qualitative ones as numbers and percentages. The differences among the groups were determined using analysis of variance (ANOVA). Kruskal-Wallis test for comparison of more than 2 groups and Mann-Whitney for comparison of 2 groups were used for the evaluation of the remaining root filling material.

RESULTS

The average time needed for the retreatment with the different techniques was 3.6864 min. There was no statistically significant difference between the groups (table 1).

Residual filling material was observed in all groups. Only in 9.09 % of the cases, gutta-percha was present. Gutta-percha remnants were found only in the apical part. In all the rest there was only sealer left.

Hand and ultrasonic instruments cleaned better the coronal part of the root canal (63.6% and 54.5% of the samples were without any sealer, compared to 13.6% for the hand, ultrasonic and machine instruments respectively) (fig. 1), the difference being statistically significant ($p<0.001$ for the HF and $p=0.001$ for the ultrasound) (table 3).

Best removal of the filling material was achieved in the middle part of the root canal (fig.2). Complete absence of residual filling material was observed in 36.4%, 86.4% and 45.5% of the samples prepared with the machine, hand and ultrasonic instruments (table 2). Statistically, a significant difference was observed only between the hand and machine instruments ($p=0.002$). Worst results were achieved in the removal of the filling material from the apical part of the root canal (fig.3). Best cleaning in this region was achieved with the ultrasonic tips, although the difference with the hand files was not significant (table 3). Their median was lower, compared with the machine files.

Table 1. Comparative analysis of the retreatment time for the studied groups

Groups	n	X	SD	P
G1	11	3.94	0.46	0.134
G3	11	3.77	0.81	
G5	11	3.35	0.76	

Table 2: Samples with different scores in the different regions of the root canal

Presence of residual filling material		PTUR		HF		UST	
		n	%	n	%	n	%
M coronal	Absence of residual filling material	3	13,6	14	63,6	12	54,5
	Residual filling material covering less than 1/3 of the wall	9	40,9	7	31,8	8	36,4
	Residual filling material covering 1/3 to 2/3 of the wall	6	27,3	0	0,0	2	9,1
	Residual filling material covering more than 2/3 of the wall	3	13,6	1	4,5	0	0,0
	Whole wall covered with residual filling material	1	4,5	0	0,0	0	0,0
M middle	Absence of residual filling material	8	36,4	19	86,4	10	45,5
	Residual filling material covering less than 1/3 of the wall	10	45,5	1	4,5	9	40,9
	Residual filling material covering 1/3 to 2/3 of the wall	2	9,1	2	9,1	3	13,6
	Residual filling material covering more than 2/3 of the wall	2	9,1	0	0,0	0	0,0
	Whole wall covered with residual filling material	0	0,0	0	0,0	0	0,0
M apical	Absence of residual filling material	6	27,3	9	40,9	11	50,0
	Residual filling material covering less than 1/3 of the wall	3	13,6	9	40,9	9	40,9
	Residual filling material covering 1/3 to 2/3 of the wall	6	27,3	0	0,0	1	4,5
	Residual filling material covering more than 2/3 of the wall	7	31,8	3	13,6	1	4,5
	Whole wall covered with residual filling material	0	0,0	1	4,5	0	0,0

Table 3. Difference in the effectiveness of cleaning of teeth filled with central cone technique in the different parts of the root canal with different techniques.

Part of the root canal	*p* overall	*p* machine/ hand	*p* machine/ ultrasonic tips	*p* hand/ ultrasonic tips
Coronal	<0.001	<0.001	0.001	0.517
Middle	0.005	0.002	0.476	0.010
Apical	0.023	0.088	0.006	0.390

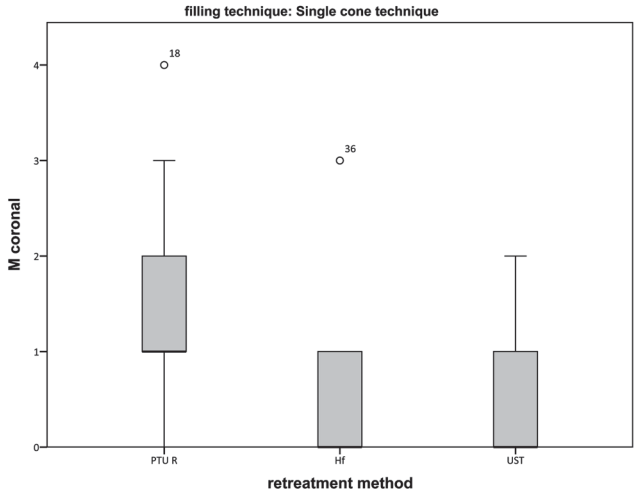


Fig. 1. Plots of the residual filling material in the coronal part

Fig. 2. Plots of the residual filling material in the middle part

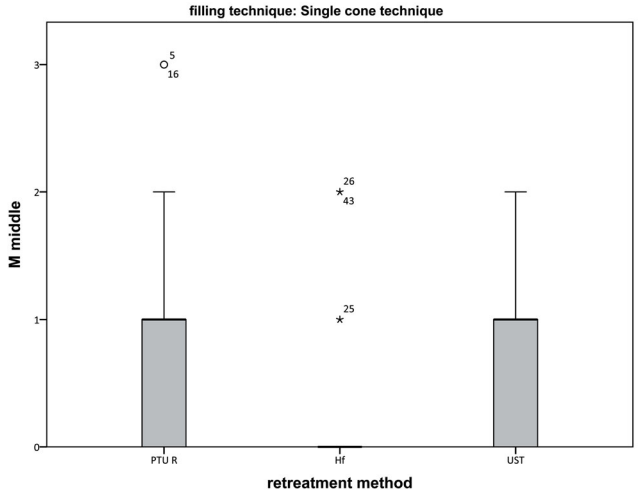
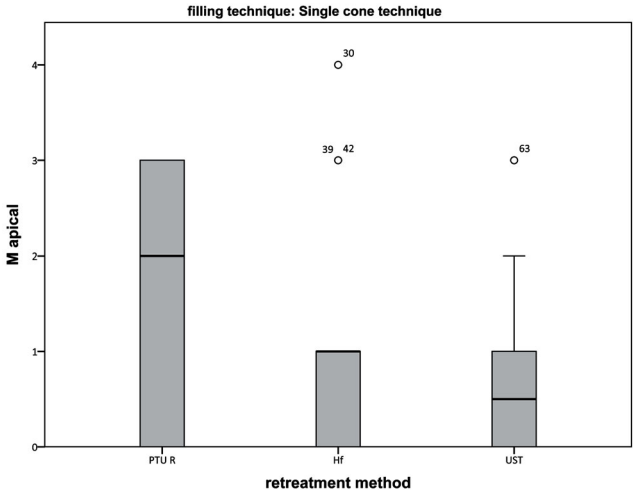


Fig. 3. Plots of the residual filling material in the apical part



DISCUSSION:

It is accepted that the removal of filling material with hand instruments is a slow, time-consuming procedure [15]. Retreatment NiTi systems were created with the idea, that they might make the retreatment procedure faster. There are several studies that confirm the fact [11, 16]. The average time for the retreatment with hand and rotary instruments in our study was 3.77 min and 3.94 min. respectively. The longer time required for the retreatment procedure with PTUR system might be explained with the fact that we have included the time needed for the change of the machine instruments, while in the other studies it was excluded. The retreatment time with the ultrasonic instruments was done for the shortest time (mean 3.35 min.). This correlates with the results of other authors [17]. This might be contributed to the plasticization of the gutta-percha and the de-bonding of the sealer due to the heat and vibrations generated by the ultrasonic tip.

Worst removal of the sealer in the coronal part was achieved with the machine rotary files, the difference with the hand and ultrasonic instruments being statistically significant ($p <$ and $= 0.001$ respectively). Machine instruments do not always fit well into the canal, especially in cases with oval shaped ones. Their taper corresponds to the taper of the pre-calibrated gutta-percha points, so they remove them easily, but the sealer seems to be a problem. Despite of the brushing movements that we have applied all around the walls, still, the areas with sealer were significantly more. Other authors have achieved similar results [18]. The good results with the ultrasound might be explained with its specific action - ultrasonic activation generates a high movement of fluid in a circular action around the vibrating instrument inside the canal space, which leads to better cleaning and dissolving. Its cavitation effect also helps for its efficiency [19].

The middle part of the root canal was best cleaned. The anatomy of this part of the root canal is not that complex as the coronal and the apical one, which could explain the good results. Pro-Taper Universal Retreatment files achieved better results than in the other parts, and their cleaning capacity was comparable to that of the ultrasonic files.

Most remnants of filling material were left in the apical part of the root canal. In this part, the canal is not that wide, and there are ramifications of the main canal, which makes the removal of the filling material more difficult. Best results in this region were achieved with the ultrasonic tips, which are most probably due to the activation of the solution of NaOCl, which facilitates the removal of the sealer [19]. Worst was the retreatment with the PTUR system. Other authors have had similar results [18]. A possible explanation of the results, specifically in this region, might be the fact that the size of the tip of D3 file is smaller than the size of the tip of F2 file that was used for the enlargement of the canal.

CONCLUSION:

None of the tested retreatment techniques succeeded to remove all filling material. Worst results were achieved with the machine rotary files. Hand instrumentation performed best. We would recommend the combined use of machine files with either hand files or ultrasonic tips for achieving better results.

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