

# EVALUATION OF THE TIME REQUIRED FOR RETREATMENT WITH THREE ENDODONTIC SYSTEMS

## ЕВАЛУАЦИЈА НА ВРЕМЕТО ПОТРЕБНО ЗА РЕТРЕТМАН СО ТРИ ЕНДОДОНТСКИ СИСТЕМИ

Mircheska M.<sup>1</sup>, Popovska L.<sup>2</sup>

<sup>1</sup>Department of Dental Pathology, Faculty of Dentistry, European University, Skopje, Macedonia, <sup>2</sup>Department of Cariology and Endodontology, Faculty of Dental Medicine, "Ss. Cyril and Methodius" University, Skopje, North Macedonia

### Abstract

When endodontic treatment fails, retreatment consists of the complete removal of the root canal filling material for thorough cleaning and reobturation. Various techniques are available for the filling removal procedure with varying degrees of efficacy and a varying length of time to perform. **The aim** of this study was to compare the time required to carry out endodontic retreatment with three different endodontic systems (one manual-Hedstroem and two machine rotary nickel-titanium systems Pro Taper Retreatment and Pro Taper Gold). **Material and Methods:** Hundred and twenty extracted human teeth kept in vitro conditions were endodontically treated and retreatment was performed using three different endodontic systems. Samples were divided into 3 groups; A-retreatment with Hedstroem hand files, B-retreatment with Pro Taper Retreatment files and C-retreatment with Pro Taper Gold files. The time required to remove the filling materials was measured with a stopwatch. The data were analyzed using the ANOVA one-way test ( $\alpha = 0.05$ ). **Results:** The time required to remove the filling material was significantly shorter in group B, followed by group C, the slowest being group A ( $P < 0.05$ ). **Conclusions:** Pro Taper Retreatment System was the fastest method for removing root canal filling material.

**Key words:** retreatment, debris, manual instrumentation, NiTi instruments

### Апстракт

Кога ендодонтскиот третман ќе се покаже неуспешен, повторното лекување се состои од целосно отстранување на материјалот за полнење на коренскиот канал и реобурација. Постојат различни техники за ендодонтски ретретман, кои покажуваат различна ефикасност, како и различно време за нивна реализација. Времето потребно за ендодонтски ретретман е важен двигател за конечниот успех на оваа постапка. **Целта** на оваа студија беше да се спореди времето потребно за изведување на ендодонтски ретретман со три различни ендодонтски системи (еден рачен Hedstroem и два ротирачки никел-титаниумски системи Pro Taper Retreatment и Pro Taper Gold). **Материјал и методи:** Сто и дваесет екстрахирани човечки заби беа во in vitro услови ендодонтски третирани, додека ретретманот беше направен со користење на три различни ендодонтски системи. Примероците беа поделени во 3 групи; А- ретретман со Hedstroem рачни инструменти, В - ретретман со Pro Taper Retreatment машински инструменти и С- ретретман со Pro Taper Gold машински инструменти. Времето потребно за отстранување на материјалите за полнење беше мерено со стоперка. Податоците беа анализирани со помош на ANOVA one-way test ( $\alpha = 0,05$ ). **Резултати:** Времето потребно за отстранување на материјалот за полнење беше значително пократко за групата В, по што следи групата С, додека најспоро за групата А ( $P < 0,05$ ). **Заклучок:** Pro Taper Retreatment системот се покажа како најбрз метод за отстранување на материјалот за полнење од коренскиот канал. **Клучни зборови:** ретретман, дебрис, рачна инструментација, NiTi инструменти

### Introduction

Conventional endodontic retreatment is a therapy of choice for endodontic treated teeth in case the post-treatment disease requires an intervention<sup>1,2,3</sup>. The main goal of the retreatment is to access the apical foramen by completely removing the previous filling material and to perform additional cleaning and shaping of the root canal system<sup>4,5</sup>. Numerous techniques have been described for removing the filling of the root canal, including the use of hand or machine rotary files, heat, ultrasound or chemical solvents in different combinations<sup>6,7,8,9</sup>. Some rotating NiTi

systems are specially designed for the retreatment of the root canal system. Studies for clinical use and efficiency of rotary retreatment instruments have concluded that they are more appropriate in terms of the efficiency and speed of removing the filling material at endodontic retreatment versus hand instruments<sup>10</sup>.

In addition to the efficiency of the instruments and procedures used in retreatment, the total operating time is another factor conditioning the clinical efficiency of gutta-percha removal techniques. Total operating time is the time taken to reach the working length and ideally, to achieve complete removal of the obturation material<sup>11</sup>.

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The Pro Taper Gold system (Dentsply Maillefer, Ballaigues, Switzerland) was placed on the market in late 2016, as a revolutionary product in terms of its flexibility. According to the manufacturer the resistance to cyclic fractures of the instrument is increased up to 30%, due to the special metallurgical processing of the NiTi alloy. The files have a golden glow on the surface.

Since the number of studies examining the efficiency of this new product is relatively small, we hope that this study will provide new data about time required for retreatment with Pro Taper Gold files in correlation with hand Hedstroem files (commonly used for retreatment) and ProTaper Universal Retreatment files (specially designed for this procedure).

The purpose of this study was to compare the time required to remove filling material using three endodontic systems. The Null hypothesis is that there is no significant difference in time required for endodontic retreatment between these three different endodontic systems.

## Material and methods

The study investigated three endodontic systems of which one endodontic system was used for manual instrumentation of the root canal, and the other two endodontic systems were used for mechanical instrumentation. The sample included 120 extracted teeth. The teeth were extracted for other reasons, not for the purpose of our research, with the approval of the Ethics Committee of the Ss. Cyril and Methodius University in Skopje, Faculty of Dentistry-Skopje (Ethics number; 2018.82-1577/3). The samples included in the study were selected according to certain criteria: teeth with a present crown at the level of the pulp chamber, not previously endodontically treated teeth with fully formed apex and teeth with previously determined root canal patency to anatomic apical foramen. Our research was performed in *in vitro* conditions in order to evaluate the real efficiency of the three different endodontic systems by excluding the subjective patient factors. All samples were examined by only one operator in order to eliminate subjective factors that would result from subjectivity if there were multiple operators. Prior to the endodontic retreatment with the three examined endodontic systems, the specimens (extracted teeth) were previously prepared for the procedure.

### *Preparation of the specimens (root canal preparation and filling)*

Soft tissue, calculus and foreign bodies of the samples were removed with tap water and a metal brush and/or ultrasound. For disinfection and removal of the organic debris, the teeth were completely immersed in 2% sodium hypochlorite (Cerkamed, Stalowa Wola,

Poland) within 24 hours. They were washed with tap water and stored in a physiological solution (Dental Medical, Subotica, Serbia) until used. Standardization of the samples was made by decoronating them with a long conical burr (TF-11, ISO 173/014, MANI, Tochigi, Japan) and a water spray using an air hand piece (ET605C, KaVo, Biberach, Germany) with 280000 rpm speed. A long conical diamond burr (TF-11, ISO 173/014, MANI, Tochigi, Japan) was used only for opening the entrance to the canal, without expanding it. Hand K-file #15 (MANI, Tochigi, Japan) and 17% EDTA (DiaPrep Pro17%, DiaDent, Seoul, Korea) were used and irrigation was made with 3% H<sub>2</sub>O<sub>2</sub> (Alkaloid, Skopje, North Macedonia) and distilled water (Alkaloid, Skopje, North Macedonia). For each sample the root canal patency was established. The K-file #15 (MANI, Tochigi, Japan) was inserted until the tip of the instrument was visible at the apical foramen. The samples were divided in 3 groups according to retreatment systems. The groups were marked with A-hand Hedstroem files-H (MANI, Tochigi, Japan), B-machine Pro Taper Universal Retreatment files-PTR (Dentsply Maillefer, Ballaigues, Switzerland) and C-machine Pro Taper Gold files-PTG (Dentsply Maillefer, Ballaigues, Switzerland). The samples in each group were marked with numbers from 1 to 40 and 3 groups of 40 samples each were formed. Further, each of the samples was instrumented with the Step Back technique and the working length (WL) was recorded 1-mm short of the length of the patency file. The last file used was #30 K-file. After changing the instruments, samples were irrigated with 2 ml 3% H<sub>2</sub>O<sub>2</sub>. Final irrigation was with 5 ml 3% H<sub>2</sub>O<sub>2</sub>. Samples were obturated with root canal filling Endofil (Produits Dentaries, Vevey, Switzerland) and gutta-percha cone (MANI, Tochigi, Japan) and sealed with temporary coronal filling (Provis, Favodent, Karlsruhe, Germany). Samples were stored in distilled water (Alkaloid, Skopje, North Macedonia) during the entire study on room temperature (20-25°C).

### *Root canal retreatment*

Three weeks after, endodontic retreatment was performed (Crown down technique) with the corresponding investigated system (H; PTR; PRG) according to the manufactures instructions. The Hedstrom files are made up of a continuous sequence of cones. They are very sharp with a cutting tip. They were used in a push-pull fashion. Pro Taper Universal Retreatment files were used with speed of 500-700 rpm for gutta-percha removal and 300 rpm for paste fillers removal and torque set at 3 N-cm. Pro Taper Gold files were used with speed of 300 rpm and torque 5 N-cm for S1&Sx; 1.5 N-cm for S2&F1; 3 N-cm for F2, F3, F4, F5.

The retreatment with the appropriate endodontic system (H; PTR; PTG) was performed. During the canal instrumentation only distilled water was used for irrigation, because the aim of the research was to determine the efficiency of endodontic systems that derives from their characteristics, without the use of chemical agents. Irrigation protocol was: After every 3 insertions of each file, 2 ml distilled water was used with 27- gauge open-ended needle that was inserted into the canal as deeply as possible into the apical third of the root canal. Final irrigation was performed with 5 ml distilled water.

Complete removal of the obturation material was defined by the following criteria: when there was no evident filling material on the instrument.

#### *Time required for gutta-percha removal*

A stopwatch was used and the total time required to remove the gutta-percha cone and Endofil™ was considered to be the time lapsed from the moment the files were first inserted into the root canal until the files reached the WL. Using a stopwatch, the time duration from entering the root canal with file or engine driven instrument to the completion of the reinstrumentation was measured in seconds<sup>12,13,14,15</sup>.

#### *Statistical analysis*

The time required to remove the filling materials was expressed in seconds. The values obtained are shown

through their mean values and standard deviation. The minimum and maximum measured values are also displayed. A one-way analysis of the variance (ANOVA) for comparison between the three examined endodontic systems was performed as well as a post hoc test for comparison among the groups. The significance level was set in all cases at  $\alpha = 0.05$  (there is statistical significance for  $P < 0.05$ ). Statistica 10 (StatSoft, 2010) was used for data analysis.

## **Results**

Mean  $\pm$  SD, maximum and minimum values of the time required to remove filling material from root canals using the three different retreatment systems are shown in Table 1. The mean of the working time (seconds) for the retreatment was the highest for SiA and the lowest for SiB.

ANOVA one-way analysis showed a high significant difference between the three groups  $P = 0.000048$  (Table 2).

Table 2 shows that the F-value is greater than the F-critical value for the alpha level selected (0.05). Therefore, we reject the null hypothesis because at least one of the three samples has significantly different means.

To check which samples had different means we performed the post hoc test. There was a significant differ-

**Table 1.** Mean  $\pm$  SD, maximum and minimum values of the time required to remove filling material from root canals

System	Mean (sec)	SD (sec)	Median (sec)	Min (sec)	Max (sec)
Si A	711.175000	332.564386	627.500000	274.000000	1745.000000
Si B	449.200000	186.672509	437.000000	115.000000	929.000000
Si C	519.700000	240.870132	472.000000	128.000000	943.000000

**Table 2.** A one-way analysis of the variance (ANOVA) for comparison between the three examined endodontic systems ANOVA

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	1470184.35	2	735092.175	10.83865084	0.00004803503	3.073762904
Within Groups	7935100.575	117	67821.37244			
Total	9405284.925	119				

ence between the SiA vs. the SiB (0.000042) and the SiA vs. the SiC (0.004204) ( $P < 0.05$ ). This means that SiA obtained the highest time (711s) with statistically significant differences in relation to SiB and SiC. Between SiB (449s) and SiC (520s) there are not any statistically significant differences.

## Discussion

Removal of root canal filling material is a procedure of major importance in endodontic retreatment because, through the use of instruments and irrigating solutions, it constitutes an effective measure against the debris and microorganisms associated with apical periodontitis<sup>16,17</sup>.

Three different root canal retreatment systems were compared: one manual-Hedstroem and two machine rotary nickel-titanium systems Pro Taper Retreatment and Pro Taper Gold files to determine which was the fastest.

According to the results obtained, Pro Taper Retreatment files (SiB) removed filling material in a shorter time than Pro Taper Gold files (SiC) and Hedstroem hand files (SiA). Hedstroem hand files obtained the highest time in seconds, meaning SiA performed the retreatment the slowest.

Although endodontic retreatment is common in dental practice, some techniques and materials make the removal of the filling material difficult, leading to a search for faster, safer and more effective resources, which undoubtedly, result in success<sup>18,19,20</sup>. The most common filling material to be removed is gutta-percha<sup>21,22</sup>. For this purpose, either hand or rotary instruments, with or without solvents, can be used<sup>23,21,19,20</sup>.

Concerning to rotary instruments, Pro Taper Retreatment System has instruments with active point enabling the filling material removal without using solvents, eliminating the formation of a gutta-percha film on root canal walls, which could prevent the action of intra-canal medication on the root canal disinfection process during endodontic retreatment<sup>21</sup>. Our study showed the same results, Pro Taper Retreatment System performed the fastest in the retreatment procedure.

On the other hand, the Pro Taper Gold system, in spite of its improved elasticity, does not have any instruments with active point which, according to our results, lead to slower time for the retreatment than Pro Taper Retreatment files.

The results of the present study revealed that the rotary systems were faster than the manual system, findings that concur with previous studies<sup>12,24,25</sup>. These findings may be explained by the design of the rotary files (motion, flute design, different taper and active tip). In

addition, the softening or plasticization of the gutta-core is caused by the higher rotational speeds, which leads to easier removal of the obturation material<sup>26,27</sup>.

Takahashi et al.<sup>28</sup> compared manual files + Gates-Glidden drills with ProTaper Retreatment System, with or without the use of solvents, and had the same conclusions like us, that the rotary system without solvents was the fastest technique. Bramante et al.<sup>29</sup>, studying two rotary systems and comparing them with a manual technique, indicated that Protaper Retreatment System had the best performance, corroborating the findings of Vale et al.<sup>30</sup> that similar to our results.

Our study showed that the Pro Taper Gold System was slower than the ProTaper Retreatment System, dissipating its improved elasticity. The reason is the active tip of the ProTaper Retreatment files. Still, the design of these instruments is more effective in cleaning the root canals than hand instrument, because of the instrument rotation, which causes the plasticization of gutta-percha. This makes the removal of the filling material easier, because of the tendency of the gutta-percha to be pulled towards coronal direction<sup>31</sup>. The general analysis of the results regarding the retreatment time differed from most of the previous studies including our reporting that rotary instruments were faster in removing the filling material. Finally, it is noteworthy to mention that none of the procedures promoted the complete removal of the filling material, fact that has been identified by other studies<sup>30,32</sup>.

## Conclusion

The results of this in vitro study showed that the Pro Taper Retreatment System was the most rapid method for removing filling material in the retreatment of root canals, and the manual was the slowest one.

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