ORIGINAL ARTICLE

THE COMPARATIVE EFFICACY OF THE PROTAPER UNIVERSAL RETREATMENT AND RECIPROC SYSTEMS IN THE REMOVAL OF GUTTA-PERCHA FROM ROOT CANALS

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ABSTRACT

Objective. The aim of the present study was to compare the efficacy of ProTaper Universal Retreatment (Dentsply Maillefer) and Reciproc 25/.08 (VDW GmbH) files in the removal of gutta-percha (GP) from root canals obturated with two different techniques: lateral compaction (LC) and continuous wave of condensation (CWC).

Material and Methods. Sixteen extracted human teeth (8 monoradicular and 8 pluriradicular) were divided into two equal groups of 8 teeth with a total of 16 root canals each, and obturated either with LC or with CWC after complete cleaning-shaping. Digital X-Rays to confirm the quality of the root canal fillings were taken. Groups were then randomly divided into two subgroups and retreated either with ProTaper Universal for Retreatment (PTUR) (Dentsply Maillefer) or with Reciproc 25/.08 (R25) (VDW). Time for gutta-percha removal was recorded, and scores were attributed to each root canal third, by evaluating the remaining material on the canal walls on digital periapical X-Rays, in order to compare the two analysed systems.

Results. Best results for gutta-percha removal were obtained with R25 in the LC group for all root canal thirds. In the CWC group, R25 was better in the coronal and middle third, while in the apical third no significant differences were observed. The time measured to remove the filling material was significantly shorter for PTUR in CWC group comparative to R25. For LC, both systems recorded similar time.

Conclusions. Although neither of the two systems removed all the filling material, PTUR was faster as time, but R25 was better as efficiency.

Keywords: Nickel-Titanium instruments, retreatment, gutta-percha removal, rotation, reciprocation

INTRODUCTION

The success of endodontic retreatment is mainly dependent on several factors, including the removal of the existing filling material from the endodontic space, proper instrumentation, successful decontamination and proper irrigation of the root canal system, right to its apical terminus [1-3]. Both continuous rotation and reciprocation are nowadays used with nickel-titanium (NiTi) dedicated instruments in order to remove gutta-percha from root canals [4-6]. Therefore, several mechanical systems have been tested in comparative studies to find those who prove to be faster, better and safer regarding breakage risks or the avoidance of apical transportation or alteration of the original root canal anatomy during retreatment [7- 9].

The most widespreaded and effective endodontic filling material is represented by gutta-percha in association with a sealer used in various obturation techniques [10, 11]. Because of its properties of being biochemically inert, having the ability to threedimensionally seal the endodontic space, especially when thermoplasticized, and the possibility of easily being removed from the endodontic space during retreatment with/without the association of a solvent, gutta-percha is still considered the golden standard in root canal obturation [10, 11]. That's why, its removal from the root canal system has been thorougly studied and various hand or mechanical instruments have been clinically and experimentally used for this purpose [12, 13]. Different techniques of removing the filling material form the root canals were recommended, including the use of hand files, ultrasonic instruments, rotary files or laser [1, 2, 13]. Conventionally, removing gutta-percha using manual tools with/without solvent can be a time-consuming process [12, 15, 16]. Therefore, the use of rotary NiTi instruments in endodontic retreatment is widely recommended nowadays because of its increased speed and quality, with advantages for the patient and clinician also, in comparison with hand files.

The purpose of the present study was to evaluate and compare the quality of the endodontic retreatment performed by using two mechanical NiTi systems in the step of gutta-percha removal from in vitro treated root canals: a dedicated set for desobturation, the ProTaper Universal Retreatment files (Dentsply Maillefer, Ballaigues, Switzerland) (instruments D1-D3) and the Reciproc 25/.08 instrument (R25) (VDW GmbH Munchen, Germany), without using chemical solvents. The advantages and disadvantages of each system were highlighted and compared by evaluating on before/ after digital radiographs the quantity of the remaining material in each third of the corresponding retreated

root canal. Scores from 0-4 were attributed, depending on the quantity, length and radiopacity of the filling material observed after mechanical retreatment on X-rays on the canal walls. The time for gutta-percha removal was recorded for each analysed root canal and system, and compared. The influence of the obturation technique on the removal of the filling material was also analysed for each NiTi system.

MATERIAL AND METHODS

Sixteen recently extracted human maxillary and mandibular teeth (8 monoradicular teeth with one root canal and 8 pluriradicular with three root canals each) counting a total number of 32 root canals respectively were endodontically shaped-cleaned-filled and then retreated. Teeth were digitally radiographed immediately after the root canal filling and after gutta-percha removal, using a Planmeca ProX intraoral X-ray unit with a Planmeca ProSD digital intraoral sensor (Planmeca, Helsinki, Finland).

Phase 1. Endodontic treatment

All teeth were hand-negotiated with ISO K-files 08-20 (Kendo, VdW GmbH, Munchen, Germany) and shaped under constant irrigation with 5.25% sodium hypochlorite (NaClO) solution (Chloraxid, Cerkamed, Poland) and ethylenediaminetetraacetic acid (EDTA) 17% solution in alternation, with the ProTaper Next system (Dentsply Sirona, Ballaigues, Switzerland) connected to an endodontic motor X-Smart Plus Endomotor (Dentsply Sirona) in the sequence X1-X3, with a final apical size of 0.30 mm and a taper of 7% (30/.07). After shaping, teeth were divided into 2 groups, according to the obturation technique: 8 teeth (16 root canals) were obturated with the cold lateral condensation technique (LC) using ISO standardised gutta-percha points #30 and accessory points, in association with a sealer AdSeal (Meta Biomed, Colmar, PA, USA); 8 teeth (16 root canals) were obturated with ProTaper Next X3 gutta-percha points (Dentsply Sirona) and gutta-percha pellets for injection in association with the same sealer, in the continuous wave of condensation technique (CWC), using the System B Fill/Pack cordless system (Sybron Endo, Orange, CA, USA). To evaluate the density and length of the root canal fillings, all teeth were digitally radiographed with the Planmeca ProX intraoral X-ray unit with a Planmeca ProSD digital intraoral sensor (Planmeca, Helsinki, Finland) and an initial score of 5 was attributed to each third of each root canal (coronal, middle and apical), representing the highest value of radiopacity and the maximum amount of gutta-percha for each sample, meaning each third was well obturated.

Phase 2. Endodontic retreatment

In order to retreat all 32 root canals from the two groups, two NiTi systems were used in the removal of the filling material connected to the X-Smart Plus Endomotor (Dentsply Sirona), with the corresponding settings of the motor for each system (rotation or reciprocation): ProTaper Universal Retreatment (PTUR) files (Dentsply Maillefer, Ballaigues, Switzerland), a rotary NiTi system dedicated for retreatment, with the corresponding instruments: D1 (30/.09-16mm); D2 (25/.08-18mm); D3 (20/.07-20mm) - Group I and Reciproc 25 (VDW GmbH, Munchen, Germany) (R25/.08-25mm) - Group II, a NiTi instrument that works in reciprocating mode. Both systems were used according to the producers' indications [17, 18]. No chemical solvents were used is association with the mechanical removal, only irrigation with NaClO 5.25% was performed during retreatment and final irrigation with EDTA.

For each group, a total number of 8 teeth and 16 root canals were retreated, divided as following: Group I (ProTaper Universal Retreatment): 2 subgroups of 4 teeth (2 monoradicular and 2 pluriradicular) with 8 root canals each, depending on the obturation method: LC-Group IA and CWC-Group IB; Group II (Reciproc 25) also with 2 subgroups of 4 teeth (2 monoradicular and 2 pluriradicular) with 8 root canals each, LC-Group IIA and CWC-Group IIB. The distribution in Groups and NiTi rotary systems used, depending on the root canal filling method is represented in Table 1.

For Groups I A and B (PTUR), the instrumentation in retreatment for each root canal was done in a crown-down technique (from the coronal to the apical third), as recommended by the producer, using the D1, D2 and D3 instruments of the ProTaper Universal Retreament set (Dentsply Maillefer) at a rotational speed set at 500 rpm combined with lateral brushing motion as they advance in the root canal to be more efficient in gutta-percha removal.

For Groups II A and B (R25), the instrument Reciproc 25/.08 from the Reciproc System (VDW) was used in the reciprocating mode, also in a crown-down technique, by using small incremental pecking motions of 3-5 mm, until reaching the working length. Lateral outwards brushing was also used, especially in the coronal and middle third, in order to remove all the gutta-percha observed on the root canal walls.

Four sets of PTUR and 4 R25 instruments were used in the present study, each instrument/set in the retreatment of 4 canals.

For all the study groups, the complete removal of the filling material was aimed, the retreatment being considered completed by the operator when no gutta-percha was observed inside the root canal or on the instrument removed from it.

Radiological evaluation

All teeth were digitally radiographed after the retreatment and then the resulting images were analysed and compared for the quality of the retreatment done with the corresponding NiTi system. In order to evaluate on radiographs the amount of the remained gutta-percha

Group	Number of teeth	Number of root canals	Retreatment NiTi system	Obturation Technique	Solvent
IA	4	8	PTUR	LC	No
IB	4	8	PTUR	CWC	No
IIA	4	8	R25	LC	No
IIB	4	8	R25	CWC	No

Table 1.

Distribution of samples into groups according to the retreatment system and root canal filling method

on the root canal walls, the roots were divided into 3 equal parts, corresponding to each root-third (1/3): coronal, middle and apical. For each third, a score from 0 to 4 was attributed by one operator on the radiographic images, according to the size, shape, location and radiopacity of the persistent gutta-percha (GP) in the respective third, as follows (Fig. 1).

0. No visible traces of GP on the canal walls;
1. Fine traces of GP isolated on the canal walls;
2. Linear traces of GP on one side of the third's length;
3. Linear traces of GP on both sides of the third's length;
4. Intense radiopaque material obstructing the lumen of the canal.

After the radiographical evaluation, all the retreated monoradicular teeth were longitudinally sectioned in half by using diamond disks, and each half was observed and photographed under a dental operating microscope DOM Alltion (Alltion, Wuzhou, China) at a magnification of 0.6x, using a Canon EOS D60 camera (Canon, USA) mounted on the microscope, to verify the existence of the X-ray observed GP remained on the root canal walls (Fig. 2).

Time evaluation

Another parameter recorded during retreatment in order to make a comparison between the two used systems was the time (minutes and seconds) spent at desobturation for each root canal. Also, the total time for gutta-percha removal was calculated for each subgroup corresponding to the obturation method, and comparisons were made not only between systems, to conclude which system works faster, but also between subgroups, to observe if the method of root canal filling is/not influencing the total retreatment time.

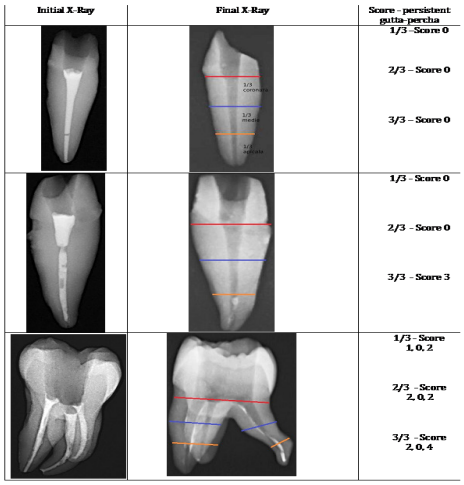

Figure. 1.

The scores assigned on radiographs to each third, according to the gutta-percha persistency on the root canal walls after retreatment in three of the samples (for the molar the scores are written from left to right for each canal)

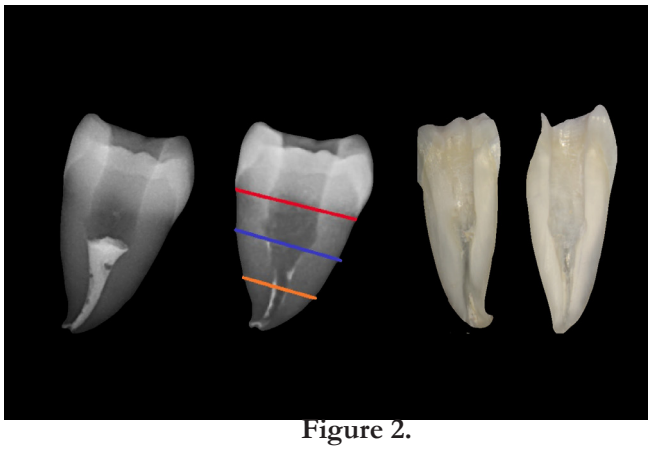

Figure 2.

Digital X-Ray of a sample before/after the retreatment and the corresponding half observed under the DOM

RESULTS

Radiological analysis

Comparing the scores assigned to each root canal third, in the lateral condensation group, R25 instrument (Group IIA) proved to be more efficient in removing gutta-percha from the apical third, in only one sample from 8 the highest score of 4 being achieved. For PTUR (Group IA), 4 of the 8 samples (50%) registered a score of 4 in the apical third, thus proving that Reciproc 25 was more efficient.

For the middle third, 4 samples form 8 of Group IA had a score of 2, and one a score of 4, comparative to 3 samples for Group IIA with a score of 2; R25 removed the filling material better. In the coronal third, also R25 proved to be more efficient (Fig. 3).

For the continuous wave of condensation group, R25 proved to be more efficient in removing gutta-percha from the coronal and middle third (Group IIB), while in the apical third no significant differences between the both systems have been observed (Fig.4).

At a comparison between the two groups depending on the root canals' obturation method, both systems were more efficient when the filling technique of the root canals was the continuous wave of condensation (Groups IB and IIB). It seems that when being laterally condensed (Groups IA and IIA), gutta-percha was more difficult to be removed, especially in the apical and middle part of the root canal. The distribution of scores on thirds for each group is represented separately for LC and CWC as diagrams in Figures 3 and 4.

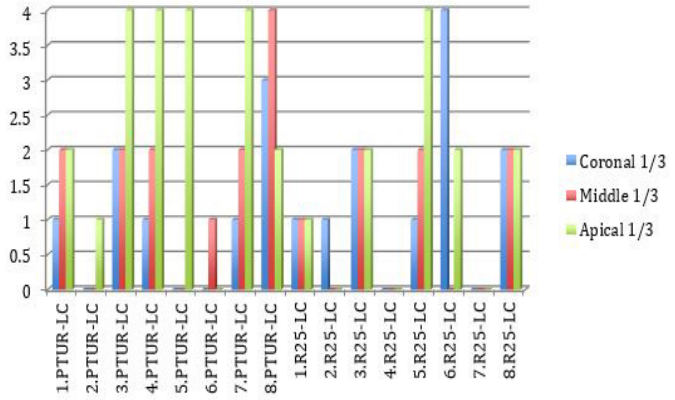

Figure 3.

The scores assigned to each root canal third after retreatment in each sample for PTUR and R25 (LC group)

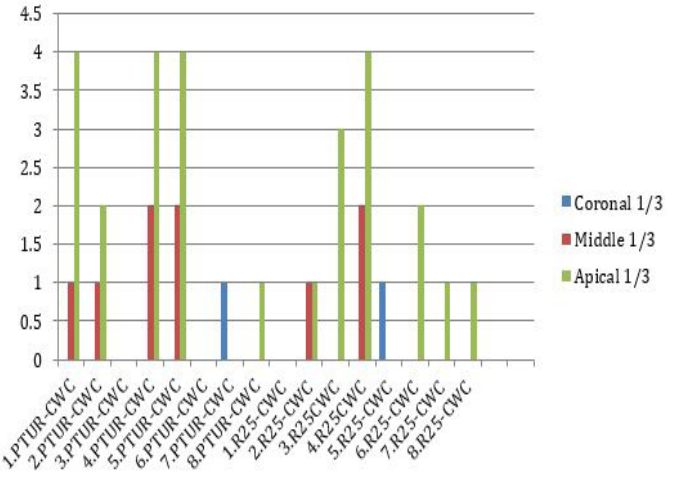

Figure 4.

The scores assigned to each root canal third after retreatment in each sample for PTUR and R25 (CWC group)

Time analysis

Comparing the required registered times for gutta-percha removal from the filled samples differences have been observed between the two systems and obturation technique (Table 2).

The lowest time for desobturation was attributed to the PTUR system in both condensation techniques. For this system, the total retreatment time was 26.45 min for the continuous wave of condensation group and 33.30 min for the lateral compaction.

For the Reciproc system, the results were different than for PTUR, showing that less time was consumed in the removal of gutta-percha from the 8 root canals filled with LC, a total time of 36.50 min being recorded, thus for the continuous wave, 51.20 min being necessary until the retreatment was considered finished by the operator.

Group	Retreatment NiTi system	Obturation Technique	Time Min	Time Max	Time Mean	Total Time
IA	PTUR	LC	3.50	4.25	4.11	33.30
IB	PTUR	CWC	3.10	3.25	3.18	26.45
IIA	R25	LC	3.45	5.10	4.36	36.50
IIB	R25	CWC	6.15	6.50	6.25	51.20

Table 2.

Time (minutes) recorded for retreatment in each group and obturation technique

Differences were also observed between the minimum recorded time in retreatment/root canal. For the PTUR, the fastest removal time was 3.10 min, and it was registered in the CWC group. This was the lowest value of retreatment time registered/root canal from all the 32 analysed samples. The maximum time for this group had also the lowest values in comparison with all the other study groups, being lower than the min values recorded in the other three 3 groups. For R25, instead, in the CWC group, the necessary time for gutta-percha removal was double, with registered time values between 6.15 and 6.50 min.

As for the LC group, R25 was faster as minimum recorded time/root canal than PTUR, but as a total retreatment time PTUR was better. Although, no significant differences were observed between these two systems when the obturation method was lateral compaction.

DISCUSSIONS

According to the present study, no mechanical system used for the removal of the filling material was 100% effective in the desobturation of gutta-percha from root canals, especially in the apical third. A possible explanation of the incomplete removal in this part of the canal is represented by the operators' more careful preparation in order to not over-enlarge the apical foramen or to irreversibly alter the original anatomy of the root canal. Also, most canals curvatures are being present in the apical part, that's why instruments have to be used more prudent, in order to avoid their separation during retreatment. The limitations of the technological part of the retreatment are not only represented by the type, size and taper of the instruments being used, but also by the complicated anatomy of the apical third (multiple curvatures, degree of curvature), which makes the retreatment of a root canal more difficult, especially in its last apical millimetres [1- 3]. That's why, in the present study, higher radiological scores (3-4) meaning more remaining gutta-percha left on the canal walls was observed in the apical third, especially in molars, where the root canal anatomy was more complicated, presenting curvatures. The avoidance of instrument breakage beyond these curvature and their careful use by the operator to reduce this risk were

probably a cause of observing more radiopaque material still present in the apical region after retreatment, for both of the used system.

Regarding the efficiency in retreatment based on the radiological scores of the remaining material on the canal walls, Reciproc 25 showed better results than the ProTaper Universal Retreatment set. This conclusion was also observed in other studies regarding the use of rotary versus reciprocating systems in the retreatment of gutta-percha [4, 5, 9]. These results may be explained due to the fact that the last instrument of the PTUR set, which is dedicated to the apical third, the D3, has a tip size of 0.20 mm and a taper of 7% [17]; thus being smaller than the size of the initial preparation, it cannot possible completely remove the gutta-percha from the apical part. In the present study, it was proved that an instrument with a bigger tip diameter (0.25 mm) and taper (8%), R25, was more efficient. Also, the cross-sectional shape of "S" of R25 and its reciprocating working mode [18] can also be the reasons for its better cutting action and removal during retreatment; although Reciproc is not a dedicated set of instruments for retreatment as Pro Taper Universal Retreatment, is being largely used in the clinical practice for this purpose. The most suitable procedure to be more effective in the retreatment with PTUR is to use other rotary instruments after the D3, in order to enlarge the apical part more and to remove better the condensed material in that area. Also, this procedure will create a better apical control zone. Another explanation of the better desobturation with R25 in the present study could be the represented by the longer retreatment time in the samples desobturated with Reciproc instruments, thus making the gutta-percha removal better.

However, as a time comparison between the two systems, the ProTaper Universal Retreatment system was almost two times faster in comparison with Reciproc 25 in the CWC group. For the LC group, the necessary retreatment time was almost the same for both systems, with insignificant shorter time for PTUR. Anyhow, both systems recorded a short retreatment time/canal, in concordance to other in vitro studies regarding mechanical retreatment of root canals, which proved that instrumentation with reciprocating or rotary NiTi files was faster than desobturation with hand files [12, 15, 16].

Even without the use of a solvent for gutta-percha, good results were obtained in the present study with both systems. This conclusion was also found in other studies, which showed that the use of solvents during retreatment could result in residue of a soft gutta-percha film that can infiltrate the dentinal tubules maintaining the presence of microorganism [19, 20].

According to the literature, the ProTaper Universal Retreament set has a higher incidence of fracture during retreatment in comparison with other systems [21]. Two ProTaper instruments were fractured in the present study, both in the apical part, and only one Reciproc file. This may be explained due to the smaller cross-section of the Reciproc instrument, its movement in the root canal or due to the NiTi alloy from its composition, resulting in a greater flexibility. Also, the reciprocation is considered a safer working motion for an instrument than full rotation; the instrument rotates alternatively counter-clockwise and clockwise with different amplitude, allowing it to be disengaged from the canal walls when being too stressed [18, 22].

CONCLUSIONS

Within the limitations of the present study, the following conclusions can be drawn:

1. No rotary/reciprocating NiTi instrument was able to completely remove the filling material from obturated root canals;

2. The most difficult anatomical part to be retreated was the apical third of the root canals, especially in pluriradicular teeth with curvatures;

3. The use of Reciproc 25 instrument allowed a better removal of the filling material than ProTaper Universal Retreatment, resulting in a better quality of the endodontic retreatment, although in a longer period of time.

REFERENCES

1. Ruddle CJ. Nonsurgical Endodontic Retreatment. In: Castelucci A, West JD. (Editors) Endodontics. Vol. 3, Florence, Il Tridente, 2009. p. 998-1070

2. Roda RS, Gettleman BH. Nonsurgical retreatment. In: Hargreaves K, Berman L. (Editors) Cohen's Pathways of the Pulp Expert Consult (11th Edition), St Louis, Elsevier, 2016, p. 324-386.

3. Ruddle CJ. Nonsurgical retreatment. J Endod. 2004;30(12):827-845.

4. Rios Mde A, Villela AM, Cunha RS, Vlasco RC, De Martin AS, Kato AS, Bueno CE. Efficacy of 2 reciprocating systems compared with a rotary retreatment system for gutta-percha removal. J Endod. 2014;40(4):543-6

5. Martinho FC, Freitas LF, Nascimento GG, Fernandes AM, Leite FR, Gomes AP, Camoes IC. Endodontic retreatment: clinical comparison of reciprocating systems versus rotary system in disinfecting root canals. Clin Oral Investig. 2015;19(6):1411-7.

6. Hulsmann M, Stotz S. Efficacy, cleaning ability and safety of different devices for GP removal in root canal retreatment. J Endod. 1997;30:227-33.

7. Das S, De Ida A, Das S, Nair V, Saha N, Chattopadhyay S. Comparative evaluation of three different rotary instrumentation systems for removal of gutta-percha from root canal during endodontic retreatment: An in vitro study. J Conserv Dent. 2017;20(5):311-316.

8. Hulsmann M, Bluhm V. Efficacy, cleaning ability and safety of different rotary NiTi instruments in root canal retreatment. Int Endod J. 2004;37:468-76.

9. Martins MP, Duarte MA, Cavenago BC, Kato AS, da Silveira Bueno CE. Effectiveness of the ProTaper Next and Reciproc Systems in Removing Root Canal Filling Material with Sonic or Ulstrasonic Irrigation: A Micro-computed Tomographic Study. J Endod. 2017;43(3):467-471.

10. AAE (American Association of Endodontists), Glossary of Endodontic Terms, 8th edition, 2012

11. Prakash R, Gopikrishna V, Kandaswamy D. Gutta-percha – An untold story. Endodontology. 2005;17(2):32- 36.

12. Mollo A, Botti G, Prinicipi Goldoni N, Randellini E, Paragliola R, Chazine M, Ounsi HF, Grandini S. Efficacy of two Ni-Ti systems and hand files for removing gutta-percha from root canals. Int Endod J. 2012;45(1):1-6.

13. Saad AY, Al-Hadlaq SM, Al-Katheeri NH. Efficacy of two rotary NiTi instruments in the removal of Gutta-Percha during root canal retreatment. J

J Endod. 2007;33(1):38-41.

14. Taşdemir T, Er K, Yildirim T, Celik D. Efficacy of three rotary NiTi instruments in removing gutta-percha from root canals. Int Endod J. 2008;41(3):191-6.

15. de Carvahlo Maciel AC, Zaccaro Scelza MF. Efficacy of automated versus hand instrumentation during root canal retreatment: an ex vivo study. Int Endod J. 2006;39:779-84

16. Schirrmeister JF, Wrbas KT, Scheider FH, Altenburger MJ, Hellwig E. Effectiveness of a hand file and three nickel-titanium rotary instruments for removing gutta-percha in curved root during retreatment. Oral surg oral Med Oral Pathol Oral Radiol Endod. 2006;101:542-7.

17.https://www.dentsplysirona.com/content/dam/dentsply/pim/manufacturer/Endodontics/Glide_Path__Shaping/Rotary__Reciprocating_Files/Shaping/ProTaper_Universal_Retreatment_Files/ProTaper-Universal-Retreatment-Files-rbfmtm6-en-1402205.

18. https://www.vdw-dental.com/en/products/detail/reciproc/

19. Horvath SD, Altenburger MJ, Naumann M, Wolkewitz M, Schirrmeister JF. Cleanliness of dentinal tubules following gutta-percha removal with and without solvents: a scanning electron microscopic study. Int Endod J. 2009;42:1032-8.

20. Kfir A, Tsesis I, Yakirevich E, Matalon S, Abramovitz I. The efficacy of five techniques for removing root filling material: microscopic versus radiographic evaluation. Int Endod J. 2012;45:35-41

21. Rödig T, Hausdörfer T, Konietschke F, Dullin C, Hahn W, Hülsmann M. Efficacy of D-Race and ProTaper Universal Retreatment NiTi instruments and hand files in removing gutta-percha from curved root canals – a micro-computed tomography study. Int Endod J. 2012;45(6):580-9.

22. Plotino G, Grande NM, Porciani PF. Deformation and fracture incidence of Reciproc instruments: a clinical evaluation. Int Endod J. 2015;48(2):199-