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EVALUATION OF THE EFFECTIVENESS OF REMOVING THE FILLING MATERIAL CARRIED OUT BY THE PROTAPER UNIVERSAL SYSTEM RETREATMENT ASSOCIATED WITH A PROTAPER UNIVERSAL F4 FILE AND THE RECIPROC SYSTEM, WITH AND WITHOUT THE AID OF THE OPERATING MICROSCOPE

Lucílio Marcos da Silva

Carlos Eduardo da Silveira Bueno

Rina Andréa Pelegrine

Alexandre Sigrist De Martin

Carlos Eduardo Fontana

Augusto Shoji Kato

Abstract: The maximum removal of filling material from the root canal system is essential for the success of endodontic reintervention to be achieved. The objective of this study was to compare the effectiveness of removing filling material from root canals between the ProTaper Universal Retreatment (PUR) system associated with the ProTaper Universal (PTU) F4 file, and the R40 file of the Reciproc system, with and without the use of a microscope (OM) as an auxiliary means. Sixty mandibular premolars with a single canal and straight roots were instrumented, filled and randomly divided into four experimental groups (n=15), according to the unfilling technique to be performed: PUR followed by the use of the PTU F4 file, Reciproc R40, PUR followed by the use of the PTU F4 file and OM help, Reciproc R40 with OM help. After unfilling, the teeth were longitudinally sectioned, photographed and analyzed, quantifying the percentage of residual filling material in each third of the root canal. The sequence of statistical tests used was: application of the Kruskal-Wallis Test, with significance level $p<0.05$, followed by application of the Mann-Whitney Test, adjusted by the Bonferroni Correction. The results showed that the Groups were statistically similar for the variables 'all canal', 'cervical third' and 'middle third' ($P > 0.05$). For the Variable 'apical third', the Group 'PUR + F4 with the aid of the microscope' was significantly better than the Group 'Reciproc with the aid of the microscope' ($P = 0.02$). It was concluded that the PUR + F4 systems and the R40 file of the Reciproc system were effectively similar in terms of their ability to remove filling material from the root canal system, regardless of whether or not the OM was used, differing only in the apical third, when associated with the use of OM, in which the PUR + F4 system was more effective.

Keywords: Retreatment. Reciprocal. ProTaper. Operating microscope.

INTRODUCTION

Endodontic therapy has undergone numerous changes in recent years, with the inclusion of new techniques, materials and clinical equipment that have contributed to improved results. However, failures still occur mainly due to the persistence of intraradicular infection, requiring endodontic reintervention.

Although endodontic therapy has a success rate of over 90% when properly conducted (Kim, Kratchman, 2006), failures can occur and these are often associated with incompletely cleaned and decontaminated canals (Mollo et al., 2012). Problems related to the anatomy of the canal (Torabinejad et al., 2009) and also microbial factors can explain failure rates of around 8% for treated canals (Masiero, Barletta, 2005).

Nair et al. (1990) evaluated, through electronic and optical microscopy, teeth with resistant periapical lesion, and concluded that endodontic failure is associated with the presence of microorganisms in the root canal system or the recolonization of the root canal space, resulting from coronal or apical microleakage.

In case of failure in endodontic treatment, the options for reintervention would be periradicular surgery, non-surgical retreatment and extraction (Özyürek, Demiryürek, 2016). According to Hülsmann (2004), among several treatment alternatives, non-surgical retreatment must be considered as the first choice.

One of the main problems during non-surgical endodontic retreatment is the difficulty in achieving complete removal of the filling material, however the removal of this filling material is a prerequisite, as this allows the subsequent cleaning and decontamination of the root canal, removing

the necrotic tissues or bacteria responsible for post-treatment disease (Barletta et al., 2007; Mollo et al., 2012).

Mechanical systems have been proposed as an alternative to manual instrumentation for gutta-percha removal (Masiero, Barletta, 2005). The use of rotary nickel-titanium systems in endodontic retreatment has been proposed due to their safety, efficiency, and speed in the removal of gutta-percha and root canal sealer (Saad et al., 2007; Tasdemir et al., 2008; Gu et al, 2008).

One of the systems idealized for endodontic retreatment is the ProTaper Universal Retreatment system (Dentsply), composed of 3 files used for the retreatment of root canals: D1, D2 and D3. ProTaper Universal Retreatment System files are designed to facilitate removal of filling material. Each file has different lengths, taper and apical diameter. The D1 file has an active tip to facilitate initial penetration of the canal filling material, has a length of 16 millimeters (mm), a tip of 0.30 mm, and a taper of 0.09%. The D2 file for removal of filling material in the middle third of the root has a length of 18 mm, a tip of 0.25 mm, and taper 0.08%. The D3 file for removal of obturator material from the apical third is 22 mm long, tip 0.20 mm, and taper 0.07%, and is used to reach the working length (Giuliani et al., 2008).

In 2008, Yared introduced the concept of a single file with clockwise and counterclockwise movement, with the advantages of being more cost-effective, eliminating the possibility of cross-contamination, and reducing instrument fatigue. Based on this concept, the Reciproc instrument appeared on the market, whose clinical sequence suggested by the manufacturer is a technique with a single instrument using one of its three files: R25 (with tip 25, and taper of 0.08% in the first 3 apical millimeters), R40 (with tip 40, and 0.06% taper in the first 3 apical millimeters), R50 (with tip 50, and 0.05% taper in the first 3 apical millimeters). The instruments are produced with nickel-titanium M-Wire (Plotino et al., 2012; Alves et al., 2012). Manufacturers claim that reciprocating motion reduces torsional stress by periodically reversing rotation by 150° counterclockwise rotation followed by 30° clockwise (Kim et al., 2012).

To verify the quality of removal of remnants of root canal obturator materials, radiographic examination is used, but its use is limited in the detection of small obturator fragments after the use of files for retreatment (Kfir et al., 2012). The use of magnification devices, such as the operating microscope, allows the detection of structures that are not identifiable with the naked eye (Fabbro, Taschieri, 2010), improving clinical performance in the execution of treatment procedures (Monea et al., 2015). It is expected that less filling material remains in the root canal after its removal in a reintervention with the aid of the operating microscope (Schirrmeister et al., 2006).

Although Reciproc files were initially designed and indicated for conventional endodontic treatment, research has evaluating its effectiveness in removing filling material from root canals in cases of retreatment (Zuolo et al., 2013; Rios et al., 2014; Fruchi et al., 2014; Crozeta et al., 2016; Özyürek, Demiryürek, 2016; Akbulut et al., 2016; Martins et al., 2017), thus, it becomes interesting to study and applicability of these instruments in the endodontic opening phase, comparing them with ProTaper Universal files specific for retreatment, as well as evaluating the efficiency removal of filling material with and without the aid of the operating microscope during the procedure.

The objective of this research was to compare the ability to remove filling material from the root canal system, by the ProTaper Universal Retreatment systems associated with a ProTaper F4 file, and Reciproc, with and

without the aid of the operating microscope.

The null hypothesis was that there would be no difference between the experimental systems with or without the use of the operating microscope.

MATERIALS AND METHODS

SELECTION OF TEETH

After approval by the research ethics committee (Opinion 428,345), the tooth bank of the São Leopoldo Mandic Dental Research Center – Campinas donated sixty human lower premolars, with complete rhizogenesis, without calcifications or resorptions, with a single canal, straight or with slight curvatures smaller than 5º when measured by the Schneider method. The teeth were examined, X-rayed in the mesiodistal direction, and measured to verify the necessary conditions for inclusion in the work (Figure 1).

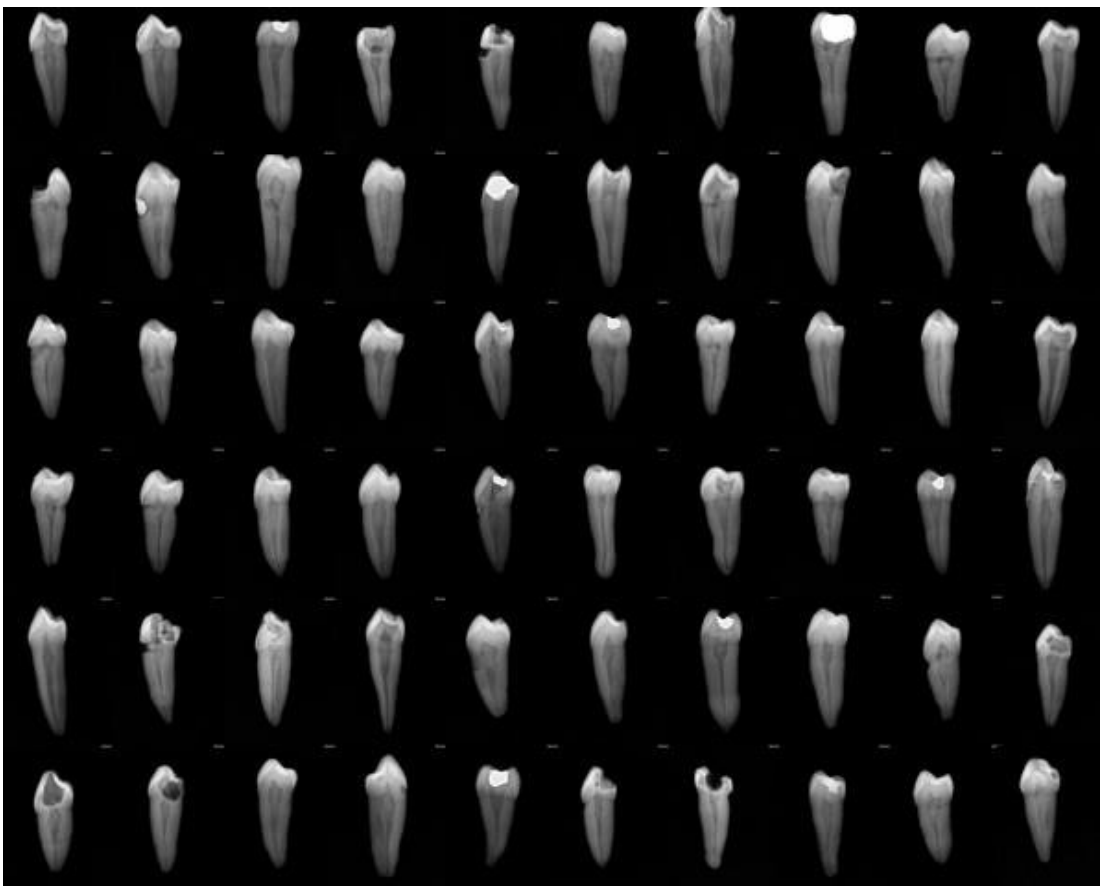

Figure 1 – initial radiographs of the samples taken in the mesiodistal direction (Kodak Sensor RVG 6100)

Source: Own authorship

The sample size was calculated using the PS-Power Sample Size Calculation program, in its version 3.0, in 14 sample elements in each Group, to reject the null hypothesis that the population means of both Groups are equal, with the power of 80% study. The Type I error associated with this null hypothesis test was 5%.

The teeth were kept in a 1% thymol solution for disinfection until use. Its external cleaning was carried out, being carefully scraped with periodontal curettes to remove any dirt on its surface. Then, the specimens were stored in saline at 100% humidity until handled.

TEETH PREPARATION

The teeth had part of their crowns removed by a diamond disc (Figure 2) so that all of them had a standardized length of 19 mm, measured using a digital caliper, considering 4 mm for crown sealing and 15 mm for the length of the root canal, divided into 3 thirds of 5 mm each. Teeth that did not have any of their coronal walls complete, were reconstructed with Charisma photoactivated resin, so that they could serve as a reservoir for irrigating solutions.

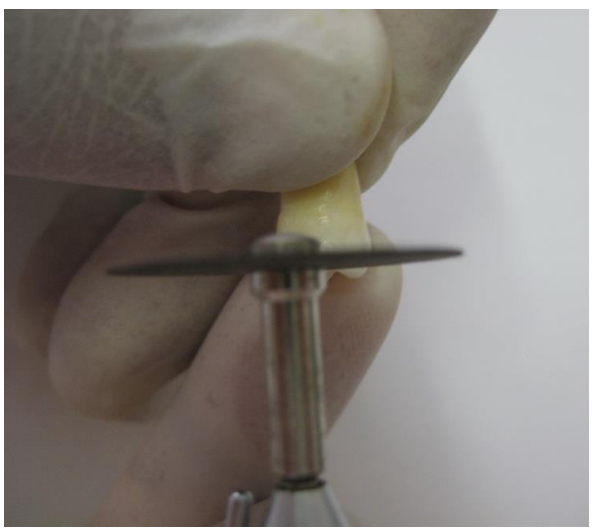

Figure 2 – Tooth cutting using a diamond disc

Source: Own authorship

After this procedure and access to the root canal system, a #10 K-file was introduced into the canal until it was visible at the apex with the aid of the operating microscope. From this measurement, 1 mm was subtracted to obtain the working length.

CANAL INSTRUMENTATION

Instrumentation of the canals was performed by a single operator in a step-back sequence, using Gates-Glidden reamers numbers 3 and 2 in the cervical third, and K-type manual files in the middle and apical thirds, up to a K-type file #30 in working length. At each instrument change, the canal was irrigated with 2 mL of 5.25% sodium hypochlorite, using a 5 mL disposable syringe attached to a 40-6 irrigation tip, and aspiration with a suction cannula. After canal instrumentation was completed, irrigation with 5 mL of 17% ethylenediaminetetraacetic acid (EDTA) was applied for 1 minute to remove the smear layer, followed by a final irrigation with 5 mL of 5.25% sodium hypochlorite. After the final irrigation, aspiration was performed with Capillary tips 0.014, and the canal was dried using absorbent paper tips.

FILLING OF CANALS

The canals were filled with Icone's gutta-percha cones and Pulp Canal Sealer, root canal sealer, using the lateral condensation technique, followed by vertical compression of the gutta-percha cones (Figure 3). This technique consists of selecting and adapting a main cone, followed by lateral condensation of this main cone using digital spacers and accessory gutta-percha cones, and subsequent cutting of the surplus by heating and vertical compression of the gutta-percha using a Shilder condenser number 4. After filling the canals, the teeth were sealed with Coltosol and stored at 100% humidity, in distilled water, at 37 degrees for 2 weeks to wait for complete

setting of the root canal sealer.

Figure 3 – Digital radiograph of one of the teeth filled (mesiodistal direction) and sealed (buccolingual direction)

Source: Own authorship

REMOVAL OF ROOT CANAL FILLING MATERIAL

The provisional cement was removed with a 1014 diamond spherical tip at high speed, and the 60 teeth were randomly divided by drawing lots into 4 groups of 15 teeth, according to the filling material removal technique used:

GR PUR + F4: Removal of filling material was performed with the ProTaper Universal Retreatment System, followed by the use of a ProTaper Universal F4 file. The technique used was the one recommended by the manufacturer: Removal of filling material in the middle and cervical thirds with the ProTaper retreatment instrument D1 09/30, middle third with D2 08/25 and apical third with D3 07/20, with movement of introduction and removal with traction against the walls of the canal, followed by the use of a ProTaper rotary file f4 40/06 with insertion and removal movement in the direction of the long axis of the tooth. The instruments were used with a VDW Silver rotary instrumentation electric motor with a constant speed of 500 revolutions per minute (rpm) and torque of 2 Newtons per centimeter (Ncm) for the ProTaper Universal Retreatment system, and a constant speed of 300 rpm with torque of 3 Ncm for the F4 file.

GR PUR + F4 + OM: The technique used was the same as described for the GR PUR, with subsequent examination with an operating microscope and its use as an auxiliary visual resource (with 8x magnification) to complement the removal of the obturator material by repeating the sequence unblocking technique.

GR REC: Removal of filling material was performed using the Reciproc System technique using an R40 40/06 instrument in the VDW Silver engine with reciprocating movement. It was performed with in and out movements removing the instrument with lateral pressure against the canal walls.

GR REC + OM: The technique used was the same as described for the GR REC, with subsequent examination with an operating microscope and its use as an auxiliary visual resource (with 8x magnification) to complement the removal of the obturator material through the repetition of the technical sequence of unfilling.

No type of solvent was used, and the procedure was considered complete when no gutta-percha or root canal sealer was detected on the surface of the instruments or inside the root canal. When observing remnants of filling material, the technique was repeated up to the maximum limit of 3 complete sequences in all Groups. The observation of the presence or not of remaining filling material was performed with the naked eye, or by the operating microscope, according to each study group, viewing through the coronal opening in the direction of the long axis of the tooth.

During re-instrumentation, irrigation with 2 mL of 5.25% sodium hypochlorite was used at each change of instruments, or at maximum 3 movements in and out of the

instrument. Final irrigation was performed with 5 mL of 17% EDTA, interspersed with 3 ultrasonic activations of 20 seconds each with an Irrisonic ultrasonic tip, inserted up to 1 mm short of the working length, and coupled to an Enac ultrasound device set at 10% of maximum power. Then, a new irrigation was performed with 5 mL of 5.25% sodium hypochlorite, interspersed with 3 ultrasonic activations of 20 seconds each.

EVALUATION OF RESIDUAL FILLING MATERIAL

To evaluate the residual filling material, two buccal and lingual grooves were made (Figure 4), taking care that these grooves did not reach the interior of the root canal (Figure 5). The teeth were split longitudinally (Figure 6) using an Ochsenbein chisel. In the samples in which there was loss of one of the parts, the other half was used for analysis, and in the samples in which there was no problem in the division into two halves, the one with the largest amount of remaining filling material was considered. Each half of the root was photographed using a Canon PowerShot SD1000 camera. Images were transferred to Digital Image Tool 2.0c image analysis software to measure areas of residual filling material and canal walls.

Figure 4 – Preparation of buccal and lingual grooves

Source: Own authorship

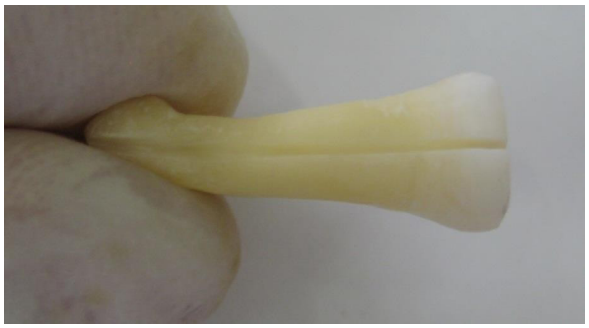

Figure 5 – Made grooves

Source: Own authorship

Figure 6 – teeth cleavage

Source: Own authorship

The teeth were divided for analysis into 3 thirds of 5 mm each in the root portion, measured from the apex of the root, disregarding the 4 mm corresponding to the crown seal (Figure 8). The analysis of the remaining filling material was performed by the researcher himself (with 20 years of clinical experience in dentistry, including 10 years of work as a specialist in Endodontics). The area of residual filling material in the entire root canal (total area) and also in each third (cervical, middle and apical) was measured (Figures 7 and 9). The percentage of residual filling material in the canal walls (A) was calculated using the following equations: A=(remnant area x 100)/root canal area, and A=(remaining area of the analyzed third of the canal x 100) /area of the analyzed canal third.

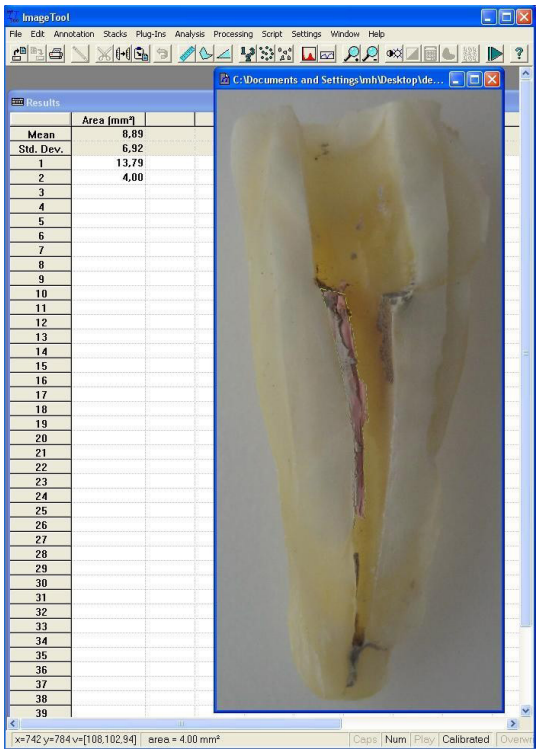

Figure 7 – Sectioned tooth ready for analysis

Source: Own authorship

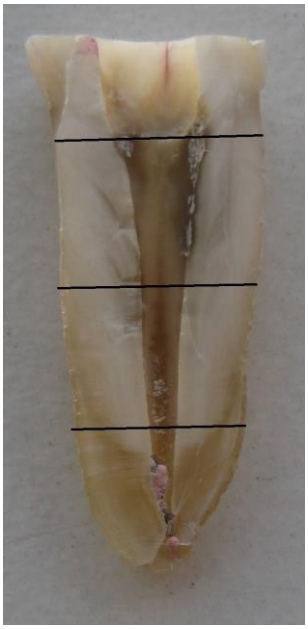

Figure 8 – Division of teeth into thirds

Source: Own authorship

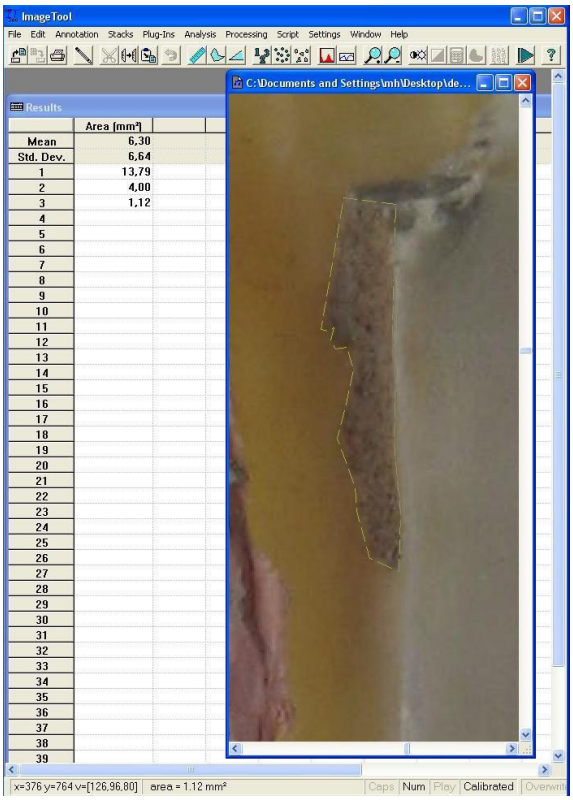

Figure 9 – Area demarcation of residual filling material

Source: Own authorship

Statistical analysis of the area of residual filling material was performed comparing the four groups studied (Figures 10, 11, 12 and 13) for the variables of interest (all canal, cervical third, middle third and apical third). The sequence of statistical tests used was: application of the Kruskal-Wallis Test, comparing, concomitantly, the four Groups with a significance level <0.05, and then application of the Mann-Whitney Test, adjusted by the Bonferroni Correction, in the third in which there was a statistically significant difference, to identify which Groups differed from each other, when compared pair by pair.

Figure 10 – Group PUR + F4 analyzed sample

Source: Own authorship

Figure 11 – Group PUR + F4 + OM analyzed sample

Source: Own authorship

Figure 12 – Group REC analyzed sample

Source: Own authorship

Figure 13 – Sample analyzed from Group REC + OM

Source: Own authorship

RESULTS

Through the application of the Kruskal-Wallis Test, a statistically significant difference was observed in the apical third of the root canals:

Variable	Group	n	Average	Standard deviation	Minimum	Maximum	Percentile 25	Percentile 50 (Median)	Percentile 75	Sig. (p)
ALL CANAL	REC	15	16,16	8,55	0,16	28,68	10,94	14,62	25,38	0,194
	REC + OM	15	14,39	10,96	3,69	43,56	6,72	10,89	20,04	
	PUR + F4	15	14,17	8,72	0,00	31,18	6,13	13,51	19,97	
	PUR + F4 + OM	15	10,46	9,01	2,18	32,85	5,04	6,81	11,69	
	Total	60	13,80	9,36	0,00	43,56	6,62	11,66	19,81	
CERVICAL THIRD	REC	15	14,04	9,80	0,00	36,77	4,04	14,36	18,95	0,347
	REC + OM	15	12,07	12,96	0,00	45,26	1,57	9,39	22,57	
	PUR + F4	15	14,22	11,45	0,00	41,46	3,72	14,76	22,64	
	PUR + F4 + OM	15	8,40	8,74	0,00	25,73	2,09	4,81	16,99	
	Total	60	12,18	10,84	0,00	45,26	3,02	10,11	18,69	
MIDDLE THIRD	REC	15	17,21	15,27	0,00	48,45	4,59	16,63	33,84	0,541
	REC + OM	15	13,74	13,17	0,00	39,65	4,27	7,92	21,23	
	PUR + F4	15	9,99	9,96	0,00	31,11	0,00	6,02	16,98	
	PUR + F4 + OM	15	14,16	15,31	0,00	56,51	4,10	8,63	23,20	
	Total	60	13,78	13,50	0,00	56,51	4,14	8,28	20,43	
APICAL THIRD	REC	15	20,13	15,77	0,00	46,41	7,08	17,36	36,09	0,020
	REC + OM	15	28,51	18,04	3,50	58,53	14,97	21,27	44,02	
	PUR + F4	15	20,75	17,08	0,00	52,39	5,38	19,64	40,88	
	PUR + F4 + OM	15	10,42	14,91	0,00	54,94	1,80	4,44	12,33	
	Total	60	19,95	17,32	0,00	58,53	4,47	16,89	34,79	

Caption: n: number of samples

Table 1 - Results of applying the Kruskal-Wallis Test

Source: Own authorship.

As this statistically significant difference was found in the apical third, the Mann-Whitney Test was applied, adjusted by the Bonferroni Correction, to identify which groups differed from the others, when compared pair by pair, obtaining the following results:

	Pair of Groups					
Variable	RECX REC + OM	RECX PUR + F4	RECX PUR + F4 + OM	REC + OMX PUR + F4	REC + OMX PUR + F4 + OM	PUR + F4X PUR + F4 + OM
apical third	0,152	0,917	0,071	0,254	0,003	0,051

(Bonferroni alpha = 0,008512)

Table 2 – Results of applying the Mann-Whitney Test, adjusted by Bonferroni correction

Source: Own authorship

The groups were statistically similar for the variables 'ALL CANAL', 'CERVICAL THIRD' and 'MEDIUM THIRD'; already, for the variable 'APICAL THIRD', the groups 'REC + OM' and 'PUR + F4 + OM' showed a statistically significant difference (Table 2), and in this third the use of the PUR + F4 + OM system showed better results.

The null hypothesis that there would be no difference between the experimental systems with or without the use of the operating microscope was rejected.

DISCUSSION

METHODOLOGY DISCUSSION

Several studies have evaluated the removal of filling material from root canals, comparing different techniques and systems, and aiming to define the best methodology for performing endodontic reintervention, since the failure of this type of treatment can be directly associated with the permanence of filling material. inside the canals. Comparisons were made between the effectiveness of manual and automated instrumentation (Hammad et al., 2008; Somma et al., 2008; Duarte et al., 2010; Mollo et al., 2012; Colaco, Pai, 2015), comparisons between the effectiveness of only different automated systems (Saad et al., 2007; Zanettini et al., 2008; Zuolo et al., 2013; Rios et al., 2014; Akbulut et al., 2016; Crozeta et al., 2016; Özyürek, Demiryürek, 2016), or evaluation of only one rotary system in isolation (Gu et al., 2008). Other works have sought to evaluate the effectiveness of the association with the use of solvents as a way to facilitate the removal of filling material (Wilcox, 1995; Takahashi et al., 2009; Singh et al., 2015).

In this work, we sought to compare the ProTaper Universal Retreatment and Reciproc systems, evaluating their effectiveness in removing gutta-percha from the interior of the root canal of lower premolars, as well as verifying the influence of the use of the operating microscope in aiding the removal. of this residual filling material. Unlike the analysis performed by Zuolo et al. (2013), Rios et al. (2014), Akbulut et al. (2016), Özyürek & Demiryürek (2016) and Crozeta et al. (2016), in the comparison between rotary and reciprocating systems, the evaluation of the benefits of using the operating microscope as an auxiliary means during the removal of filling material from the root canals was added in this work (Baldassari-Cruz, Wilcox, 1999; Mello Junior et al, 2009).

As a way of trying to standardize the samples, 60 mandibular premolars were selected that had only one root canal and straight root or with a slight curvature of less than 5º, measured using the Schneider Method (Bürklein, Schäfer, 2012), and the section of part of the coronal portion of the elements in order to standardize working limits, and the length of the teeth in 19 mm (Takahashi et al., 2009; Marques da Silva et al., 2012; Rios et al., 2014; Singh et al. al., 2015; Akbulut et al., 2016; Özyürek, Demiryürek, 2016).

The root canals were instrumented up to the diameter of a 30 kerr file (Gu et al., 2008; Marques da Silva et al., 2012), subsequently filled, sealed with temporary cement (Bramante et al., 2010; Marques da Silva et al., 2012) and stored at 100% humidity, in distilled water, at 37 degrees for 2 weeks to wait for the root canal sealer to set completely (Marques da Silva et al., 2012; Crozeta et al., 2016; Özyürek, Demiryürek, 2016).

When choosing the files for opening the canals, the completion of the opening and preparation was performed with a tip 40 instrument, which configures a greater magnification than the tip 30 instrument used at the end of the initial preparation of the samples, and in an attempt to approximate the final working diameters of the different systems used. In the GR PUR and GR PUR +

OM groups, desaturation was performed with the ProTaper Universal Retreatment system, following the technique recommended by the manufacturer using files D1, D2 and D3. As the D3 file has a tip 20, after the initial sequence of the 3 files of the PUR system, the F4 file of the ProTaper Universal system was used to finalize the preparation with tip 40 (Singh et al., 2015). The instruments were used with a VDW Silver rotary instrumentation electric motor (VDW, Munich, Germany) with insertion and removal movement with traction against the canal walls for the ProTaper Universal Retreatment system, and introduction and removal movement in the long direction tooth axis for the F4 file. In the GR REC and GR REC + OM groups, the filling material was removed with the Reciproc system using only one R40 instrument in the VDW Silver engine in reciprocating movement, performing in and out movements, exerting lateral pressure against the canal walls during instrument removal.

The ProTaper Universal Retreatment and ProTaper Universal instruments were used on up to 4 different teeth (Giuliani et al., 2008; Duarte et al., 2010; Bramante et al., 2010). Reciproc instruments are designed to be used and discarded after the first use to prevent the risk of cross-infection between patients. In this laboratory study, to match the number of uses of files from the other sequence, files from the Reciproc system were also used in up to 4 different teeth, similar to the number of uses of this system in the work of Bürklein & Schäfer (2012), who evaluated the extrusion of debris through instrumentation of root canals. Even with the reuse of instruments, fracture of any of the instruments used was not verified in this study.

Some studies have evaluated the use of the operating microscope during treatment or retreatment of root canals, comparing their influence on the final quality of endodontic therapy (Baldassari-Cruz, Wilcox, 1999; Mello Junior et al., 2009; Fabbro, Taschieri, 2010; Monea et al., 2009; Monea et al. al., 2015). In this work, the removal of filling material was considered complete when gutta-percha or root canal sealer was not detected on the surface of the instruments or inside the root canal (Zanettini et al., 2008; Takahashi et al., 2009; Marques da Silva et al., 2012; Rios et al., 2014; Fruchi et al., 2014). In the GR PUR + OM and GR REC + OM groups, after initial opening with the systems, an examination was performed with an operating microscope and its use as an auxiliary visual resource (with 8x magnification) to complement the removal of the filling material up to the maximum limit, previously stipulated for all groups, of 3 repetitions of the sequence.

After the canals were unfilled, the teeth were divided into two halves to analyze the remaining filling material (Wilcox, 1995; Saad et al. 2007; Takahashi et al., 2009; Marques da Silva et al., 2010; Zuolo et al, 2013; Rios et al., 2014; Singh et al., 2015; Özyürek, Demiryürek, 2016). Cleavage is a procedure that must be performed with as much care as possible, because even with the use of a thin disc, and avoiding invasion of the root canal space, during cleavage displacement of the remaining filling material may occur, partially altering the result of the work (Takahashi et al., 2009; Rios et al., 2014; Özyürek, Demiryürek, 2016). Some samples had one of their halves fragmented into more parts during cleavage in order to prevent their analysis from being carried out.

The analysis of the samples in this work to verify the effectiveness of the removal of the filling material was carried out through the section of the teeth, photography, demarcation and calculation of the area of the remaining filling material using a specific software. This type of methodology allowed a two-dimensional analysis of the remaining

material, contrary to evaluations carried out such as those by Fruchi et al. (2014), Crozeta et al. (2016), and Martins et al. (2017), in which, through analysis using microtomography, they were able to determine in three dimensions not the area, but the total volume of filling material remaining in the root canal. Although volume was not evaluated with the methodology used in this work, it is also an effective way of analyzing the remaining filling material, allowing a direct visualization of the root canal walls.

DISCUSSION OF RESULTS

Similar to the study by Baldassari-Cruz & Wilcox (1999), no significant difference was found in the analysis of the entire area of the canal between the groups of the same system evaluating the use or not of the microscope as an auxiliary resource in the removal of the filling material. In this study, between the two evaluated systems, no significant difference was found either in the analysis of the cervical and middle thirds, with the use of the operating microscope or not as an auxiliary resource in the removal of the filling material.

In the present study, although the operating microscope was used as an auxiliary resource in two groups, removal of filling material was limited to the use of only rotary files of the systems. The small difference observed is due to the fact that the gutta-percha can be better visualized in the wall of the canals, and the direction of the files against this residual material, promoting better removal of it. Even observing the presence of filling material adhered to the walls after the limit of attempts was exhausted, no other form of intervention was made in an attempt to improve the cleaning of the residual material. Better results could be obtained if associated with the use of the operating microscope, ultrasonic inserts were used to remove the residual material, as demonstrated by Mello Junior et al. (2009), who found a statistically significant difference comparing gutta-percha removal between two groups, with and without the use of an operating microscope and ultrasound as an auxiliary means.

The significant difference found in the apical third (P = 0.02) between the "REC + OM" and "PUR + F4 + OM" groups may be associated with the fact that two ProTaper files were used in the apical third in each sequence (D3 and F4, versus just R40 in the other group), and that perhaps because of the PTUR system featuring rotary instruments specifically designed to remove filling material, it was easier to direct against the walls, achieving better traction of the residual material. It was possible to observe in this work greater ease in removing gutta-percha using the ProTaper Universal Retreatment when compared to Reciproc files, perhaps due to the better traction observed, reducing the number of repetitions necessary in some samples, until the gutta-percha was no longer visible inside the canals. Gu et al. (2008) obtained results of greater efficiency with the ProTaper Universal Retreatment System for removing gutta-percha from the canals, when compared to the use of Gates-Glidden reamers associated with the ProTaper Universal System, and the use of manual kerr-type files. Özyürek & Demiryürek (2016) obtained faster desaturation speed with the ProTaper Universal Retreatment system, when compared to the Reciproc, Twisted File Adaptive and ProTaper Next systems.

Similar to this work, Rios et al. (2014) and Akbulut et al. (2016) did not observe a significant difference in the effectiveness of removing filling material from the canals between the ProTaper Universal Retreatment System and Reciproc, when analyzing the entire canal. Different from these results, Özyürek & Demiryürek (2016) observed that the Reciproc System left significantly

more residual material on the canal walls when compared to the ProTaper Universal Retreatment System, similar to the result obtained in this work in the removal of filling material from the apical third of the canals with the aid of the operating microscope.

Although there are differences in the results between several works carried out, in none of them any type of technique was totally efficient for the removal of all the gutta-percha present in the root canals, which according to Mollo et al. (2012) would compromise the complete cleaning and decontamination of the root canal. Considering that this removal of the greatest possible amount of remaining filling material allows a better disinfection of the root canal system, it would be interesting to carry out a future analysis of the entire volume of remaining material in these canals using microtomography, evaluating the use of the operating microscope as an auxiliary resource associated with the use of ultrasonic inserts, to explore the true potential of the results that can be obtained with the visual magnification allowed by this method.

The average amount of filling material remaining in the root canal after using files for root canal removal reflects the mechanical efficiency of each system in the results of endodontic reintervention. Although one of the goals during endodontic reintervention is the complete removal of all filling material, none of the techniques used in this study were able to completely remove gutta-percha from the root canals. This may have occurred, in part, due to the limitations established in this work.

CONCLUSIONS

The ProTaper Universal Retreatment systems followed by the use of the ProTaper Universal F4 file, and the Reciproc system behaved similarly in terms of the ability to remove filling material from the root canal system, regardless of whether or not the operating microscope was used, differing only in the apical third, when associated with the use of the operating microscope, in which the ProTaper Universal Retreatment system followed by the use of the ProTaper Universal F4 file was more effective.

The null hypothesis that there would be no difference between the experimental systems with or without the use of the operating microscope was rejected.

No system was able to completely remove all filling material adhered to the root canal walls.

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