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Current Protocols for Endodontic Retreatment: A Review

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Abstract

Introduction: Endodontic retraction is a procedure performed on a tooth that received an earlier attempt at a definitive treatment that resulted in a condition requiring additional new endodontic treatment to achieve a successful outcome. The main cause of treatment failure is insufficient cleaning and inadequate obturation.

Objective: To evaluate, through a literature review, the endodontic retreatments with rotary and mechanical files, which is the best efficacy.

Methods: Experimental and clinical studies were included (case reports, retrospective, prospective and randomized trials) with qualitative and quantitative analysis. The words were included "Endodontic Retreatments" and "Endodontic Treatments".

Conclusion: With recent technological advances in the area of endodontics, behind the literary reviews we can affirm that the system of instrumentation of the root canals with rotating files maintains the quality of the root preparation.

Keywords: Endodontic retreatments; Endodontic treatments; Clinical research

Introduction

Endodontic retraction is a procedure performed on a tooth that received an earlier attempt at definitive treatment that resulted in a condition requiring additional new endodontic treatment to achieve a successful outcome [1,2]. The main cause of treatment failure is insufficient cleaning and inadequate obturation, according to Abou-Rass [3]. Endodontic failure is due to the lack of biological-technical-scientific base. Many general practitioners venture in the area and the rate of failure within this group is quite high about 98.0% according to Leonardo [4]. A condition for successful endodontic retreatment is the proper cleaning of root canals, so special attention should be paid to the technique used to remove the obturator material [5-7], the most used being cements, pastes and gutta cones-percha [8]. In retreatment we have to reach the actual working length and completely remove the obturator material, clean the root canal and the final obturation.

Several techniques are described in endodontic retreatment for the removal of gutta-percha including rotary instruments, manuals, solvents and their associations [9,10]. The aim of the present study was to evaluate, through a literature review, the endodontic retreatments with rotary and mechanical files, which is the best efficacy.

Methodology

Experimental and clinical studies were included (case reports, retrospective, prospective and randomized trials) with qualitative and/or quantitative analysis. Initially, the key words were determined by searching the DeCS tool (Descriptors in Pubmed, Health Sciences, BIREME base) and later verified and validated by MeSh system (Medical Subject Headings, the US National Library of Medicine) in order to achieve consistent search (Figure 1).

Mesh terms

The words were included "Endodontic Retreatments" and "Endodontic Treatments". The literature search was conducted through online databases: Pubmed, Periodicos.com and Google Scholar. It was stipulated deadline, and the related search covering all available literature on virtual libraries.

Series of articles and eligibility

A total of 76 articles were found involving endodontic retreatments. Initially, it was held the exclusion existing title and duplications in accordance with the interest described this work. After this process, the summaries were evaluated, and a new exclusion was held. A total of 32 articles were evaluated in full, and 31 were included and discussed in this study, according to Table 1.

Literature Review

Bramante and Betti [11-13], evaluated the Quantec system for the removal of gutta percha. In the experiment, the authors used 30 instrumented and obturated central incisors divided into 3 randomized groups of 10 each. The gutta-percha removal was done using the Quantec rotary system and 16:1 contra-angle reduction and electric motor, varying the speed within each group: group 1 with 350 rpm, group 2, 700 rpm and group 3 - 1500 rpm, evaluating the time taken to reach the working length, time for gutta-percha removal, total time, apical extrusion of material during removal and fracture number of instruments. After removal of the material the teeth were radiographed, and the root canal wall cleaned.

Then, the teeth were splined longitudinally, sectioned and the cleaning of the walls of the root canal evaluated visually, scanned using scanner and the measured residues. They noted that the 1500 rpm group was significantly faster than the other groups and that the amount of material extruded apically was not significantly different between the groups. In the cleaning of the middle third it is possible

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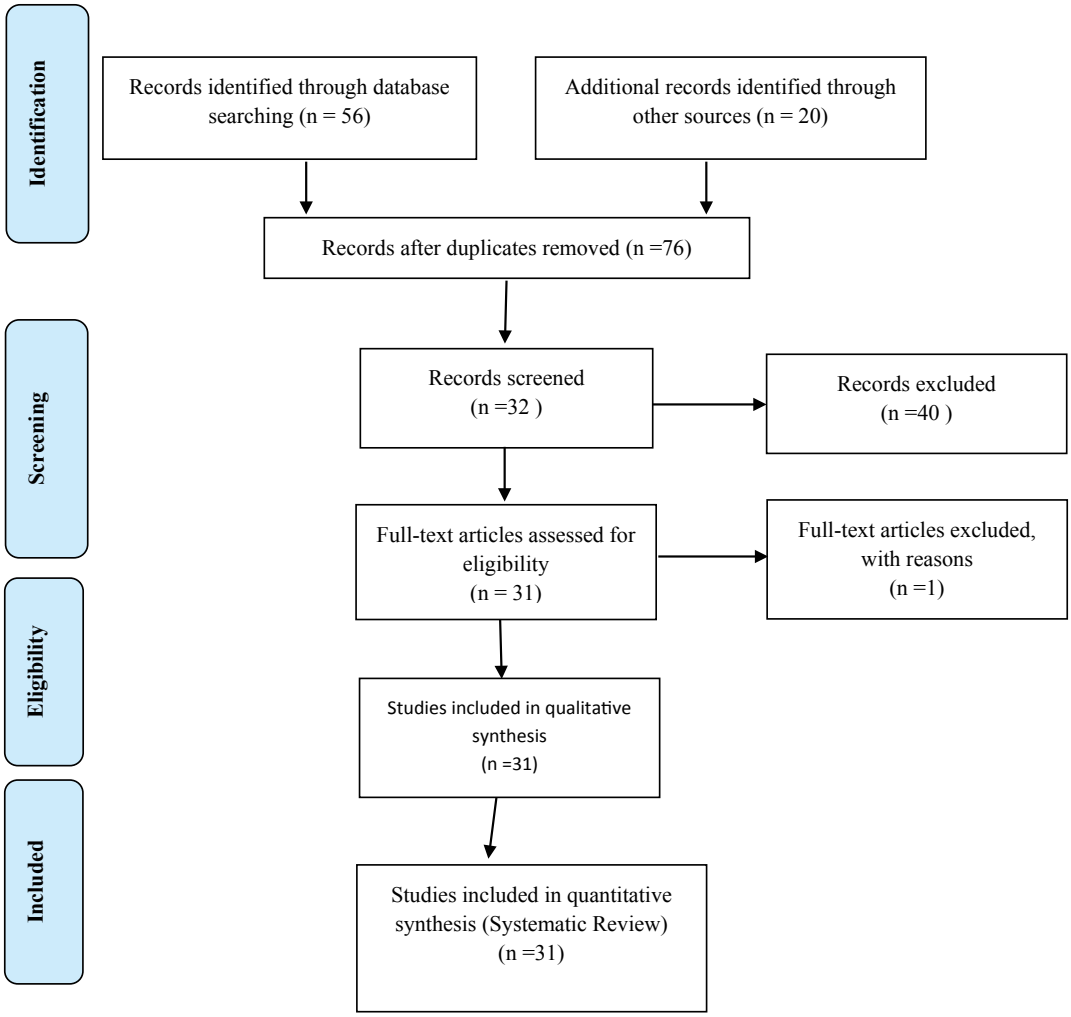

Figure 1: Flow-chart representing the series of articles and their eligibility criteria.

to notice radiographically great difference between the 14 groups, in this, the group with 350 rpm had the highest amount of debris. Group 1 resulted in 6 fractured instruments. In group 2; Four fractured instruments and in group 3 only one fractured instrument. They concluded that cleansing and the presence of debris were equivalent between groups, but the use of 1500 rpm provided greater agility with fewer numbers of fractured instruments.

In 2001, Ferreira et al. [14,15] tested the efficiency of gutta - percha removal using the ProFile System. They selected 48 teeth of humans with radicular canals with curvature between 25 and 45 which were instrumented by the standardized method with Do = 30 and conicity .04 and were filled with vertical condensation of gutta-percha. They compared the removal of the obturator material between the techniques with flexofile K files with chloroform; H-type file with chloroform; ProFile .04 with chloroform and ProFile .04. They measured the technique execution time and the presence of remaining debris. The roots were divided into apical, middle and cervical thirds and measured on a scale of 0 (without debris) to 3 (> 50.0% walls with debris) and observed radiographically. The results of presence of remaining debris in the root canals instrumented with K + file chloroform; ProFile + chloroform was lower and not significantly different between the 3 levels of roots examined; While Hedeström and ProFile + chloroform did not show significantly different results in the apical portion. In general, cervical cleansing was superior when compared to the apical third. The results indicated that the ProFile system and manual files + chloroform present similar cleaning, but that with ProFile there was 15 greater time savings in the execution of the disobturation when compared to manual files.

In the year 2001, Betti and Bramante [13] compared the Quantec rotary system with manual instruments for the removal of gutta-percha. In this, they used 20 upper central incisors of human with single canal and straight, enlarged and obturated that were divided randomly into 2 groups of 10 elements each. In group 1 they used the Quantec SC system and in group 2 the manual files associated with solvent. They evaluated the following factors: time to reach working length, time to remove gutta-percha, total time spent, apical extrusion of material during removal and number of fractured instruments.

After radiographs, the teeth were splined, cut longitudinally and the root canal cleaning was visually evaluated, and the respective radiographs were digitized, and the residual debris evaluated. They verified the cervical, middle, apical thirds as well as for the root canal as a whole. They found that the removal time was significantly lower

Studies	Study Type	Year	References
A comparison of the relative efficacies of four hand and rotary instrumentation techniques during endodontic retreatment	Prospective longitudinal	2000	[1]
Endodontics at the crossroads	Review	1996	[2]
Evaluation and clinical management of previous endodontic therapy	Retrospective longitudinal	1982	[3]
Endodontia: tratamento de canais radiculares: pricípios técnicos e biológicos	Review	2005	[4]
Effectiveness of the Canal Finder and hand instrumentation in removal of gutta-percha root fillings during root canal retreatment	Prospective longitudinal	1996	[5]
Effectiveness of ProFile .04 taper rotary instruments in endodontic retreatment	Experimental study	2000	[6]
Comparative study of six rotary nickel-titanium system and hand instrumentation for root canal preparation	Controlled study	2005	[7]
Extended cyclic fatigue life of F2 ProTaper instruments used in reciprocating movement	Prospective longitudinal	2010	[8]
Influence of rotational speed, torque and operator's proficiency on ProFile failures	Review	2001	[9]
Canal preparation using only one Ni-Ti rotary instrument: preliminary observations	Review	2008	[10]
Eficiência das limas ProFile taper. 04 séries 29 no retratamento endodôntico dos canais radiculares curvos	Experimental study	2003	[11]
By passing gutta-percha root filings with and automated device	Clinical trial	1990	[12]
Quantec SC rotatory instruments versus hand files for gutta-percha removal in root canal retreatment	Controlled study	2000	[13]
The efficacy of gutta-percha removal using profiles	Prospective longitudinal	2001	[14]
Microbiologic analysis of teeth with failed endodonic treatment and the outcome of conservative re-treatment	Prospective longitudinal	1998	[15]
Efficacy of different rotary instruments for gutta-percha removal in root canal retreatment	Prospective longitudinal	2006	[16]
Efficacy of three rotary NiTi instruments in removing gutta-percha from root canals	Prospective longitudinal	2008	[17]
Efficacy of Protaper Universal rotary retreatment system for gutta-percha removal from root canals	Prospective longitudinal	2007	[18]
Avaliação radiografica da eficiencia de diferentes intrumentos rotatorios no tratamento endodôntico RSBO	Prospective longitudinal	2008	[19]
Cyclic fatigue of Reciproc and WaveOne reciprocating instruments	Review	2012	[20]
Effectiveness of two nickeltitanium rotary instruments and a hand file for removing gutta-percha in severely curved root canals during retreatment: an ex vivo study	Controlled study	2007	[21]
Evaluation of single-use rotary nickel-titanium instruments	Review	2003	[22]
Comparison of defects in ProFile and ProTaper systems after clinical use	Controlled study	2006	[23]
Canal preparation with only one reciprocating instrument without prior hand filing: a new concept	Review	2011	[24]
Critical analysis of the balanced force technique in endodontics	Review	1994	[25]
Comparison of cyclic fatigue resistance of novel nickel-titanium rotary instruments	Controlled study	2014	[26]
Resistance to Flexural Fatigue of Reciproc R25 Files under Continuous Rotation and Reciprocation Movement	Review	2012	[27]
Canal Shaping with WaveOne Primary Reciprocating Files and ProTaper System: A Comparative Study	Review	2012	[28]
Clockwise or counter clock wise	Review	1984	[29]
Pain prevalence and severity before, during, and after root canal treatment: a systematic review	Systematic Review	2011	[30]
Current challenges and concepts in the preparation of root canal systems: a review	Review	2004	[31]

Table 1: General data of the main studies that were listed in the present study.

when using Quantec with SC files, whereas the material extravasated apically was not significantly different between the groups. The visual and radiographic evaluations of the root canal walls revealed that the manual instruments associated with the solvents performed better cleaning than the mechanical system in the cervical third and in the root canal as a whole and that although the Quantec system with SC files takes less time for the removal Of the obturator material, manual files with concomitant use of solvent cleanse the root canal more efficiently.

Schirrmeister et al. [16] evaluated the effectiveness of gutta-percha removal in curved channels in retreatments using manual technique, FlexMaster, Protaper and Race observed that the manual and FlexMaster techniques denote larger areas of obturation remnants and that the system Race showed better results than Protaper for cleaning ability, although it was slower and presented the lowest risk of fractures.

Tasdemir et al. [17] evaluated the efficiency of three different rotary instruments in the removal of the obturator material and concluded that the Protaper system presented the lowest averages of material remaining in the walls of the root canals. However, the instruments used were F1, F2 and F3 and not those intended for retreatment.

Gu et al. [18] in studying the Protaper Universal-Retraction system concluded that all the techniques tested left between 10.0% and 17.0% of the surface of the channels covered by the obturator material. In the middle and apical thirds, the specimens from the Protaper group for retreatment had the lowest percentage of remnant.

The benefits of using a "single use" file system in reciprocating movement are: shorter working time; Lower learning curve; Reduction in the number of instruments required for root canaling; Simplicity (reduction of the number of steps to prepare the channel), and safety regarding instrument fracture and errors during the procedure [19]. Such "one-time" instruments are fabricated from a new metal alloy called M-Wire®, which provides greater flexibility and resistance to cyclic fatigue than traditional nickel-titanium alloys. Reciprocating movement relieves stress on the instrument and consequently reduces

the risk of fracture of the instrument caused by cyclic fatigue, which is caused by the tension and compression of the instrument against the walls of the channel [19]. According to the author, it is an extremely simple technique. Only direct access to the channel system is necessary without the use of Gates Glidden type drills or any other preparation of the channel inlet orifice.

De Deus et al. [8] have shown that the movement used to actuate the instrument is one of the most important factors in the determination of resistance to cyclic fatigue. In their study, using ProTaper® F2 instruments, which were divided into two groups, A and B, group A in reciprocating kinematics and group B in continuous rotation. The instruments presented resistance to superior cyclical fatigue when driven in reciprocal motion, when compared to the same instruments driven in continuous rotation.

Further, the same authors above performed a quantitative evaluation of dentinal tissue extruded by the apical foramen during instrumentation of the canal system. The work was performed on extracted teeth. For the control group, they used manually instrumented teeth with Flexofile® type files which were pre-extended with Gattes Gliden type drills. The study was performed comparing the conventional instrumentation of the ProTaper® (rotary) system and the instrumentation with a single file ProTaper® F2 in reciprocal movement. It was concluded that there is no significant difference in the amount of extruded dental tissue between the two instrumentation methods

Plotinus et al. [20] submitted the two types of instruments, which were divided into four groups of 12, to the different instrumentation programs (Reciproc All and WaveOne All) of the Silver.Reciproc® engine, thus confirming that the Reciproc® R25 instrument has greater Cutting efficiency than WaveOne Primary instruments, and even greater efficiency when activated in its respective instrumentation program (Reciproc All).

Garcia Jr. et al. [19] compared *in vitro* the efficiency of gutta-percha removal of the root canals by means of different rotary instruments: ProFile, ProTaper, GT, K3 and Hero. The ProFile, ProTaper and GT systems obtained the best results, with no statistical difference between them.

Gergi and Sabbagh [21] evaluated the effectiveness of Hedströen, ProTaper and R-Endo manual files in the removal of gutta-percha from severely curved root canals. They noted that all instruments left material inside the root canal and that the ProTaper and R-Endo systems are unsuitable for complete removal of sealing material. In contrast, other studies have demonstrated the effectiveness of rotational systems in endodontic retreatment, but never producing completely obturator-free root canals.

Plotinus et al. [20], examined the cyclic fatigue strength of Reciproc and WaveOne instruments through simulated root canals. Two groups of fifteen NiTi instruments with an identical size of 25.0 mm were arranged, group A being composed of Reciproc R25 and group B of WaveOne Primary. All instruments were inspected and the defective discarded. Cyclic fatigue tests were performed on an artificial stainless-steel channel made by reproducing the size and conicity of the instruments. The simulated root canal had an angle of 60º of curvature and 5 mm of radius of curvature. The center of the curvature was 5.0 mm from the tip of the instrument and the curved segment of the canal approximately 5.0 mm in length. The Reciproc and WaveOne instruments were activated using each of their pre-specific program (Reciproc ALL and WaveOne ALL). All instruments were rotated until the occurrence of fracture, fracture time and fractured tip length recorded and recorded.

Still in the same work, time to fracture was recorded visually using a stopwatch and associated to the nearest whole number. The average length of the fractured fragment was evaluated for the correct positioning of the tested instrument within the curvature of the canal, with the presence of similar induced stresses. A longer fracture time is caused by greater resistance to cyclic fatigue. As a consequence, there was a statistically significant difference between the instruments. Reciproc R25 were associated with a significant increase in mean fracture time when compared to WaveOne Primary instruments. As a result, Reciproc instruments were associated with a significantly higher cyclic fatigue resistance than WaveOne instruments [20].

Further, it is well known that cyclic fatigue is influenced by the dimensions of the instruments, by the alloy and/or manufacturing process, which were similar in this study. Thus, a possible difference between the two instruments tested may be in relation to the oscillatory and rotational movement, which is not clearly revealed by the manufacturers. According to the manufacturer, Reciproc instruments are used in ten cycles of reciprocity per second, equivalent to about 300 rpm, while no information is available for WaveOne instruments. Another possible explanation of the different results obtained in the present study may be related to the different cross-sectional design of the instruments tested. Therefore, Reciproc and WaveOne single-use reduces, but does not eliminate the risk of accumulation of metal fatigue and failure.

Imura et al. [1] conducted a study to evaluate the effectiveness of the Channel Finder and manual instrumentation in the removal of gutta-percha during channel retreatment. Sixty teeth were used and divided into three groups. In Group I the teeth were re-instrumented manually with K-type files number 15 to 50 (two sizes higher than the preparation of the channels). In Group II, the re-instrumentation was performed with Channel Finder with files of diameter 15 to 50. In Group III - the channel was re-instrumented with K-type files, with the modified reduction technique in conjunction with the Channel Finder system. Chloroform was used as solvent and 0.5% sodium hypochlorite as the irrigating solution.

As a control of re-instrumentation, a radiograph of each tooth was performed. If the radiograph had any evidence of a plugging material, the tooth was cleaned again until the radiographic examination revealed no radiopaque material in the canal [22,23]. The following were evaluated: time for retreatment; Extrusion of sealing material apically; Cleaning the walls of the channels. The teeth were divided longitudinally and photographed. The total areas of the root canal and the debris area were traced and analyzed with a computerized image analysis system [1]. The ratio of the remaining obturator material and the root surface was obtained, and the statistical analysis was performed. The results showed that all the techniques employed left residues inside the root canal. The comparative test showed that the manual technique was significantly better than the others in the removal of the obturator material. All techniques caused extrusion of plug material without statistical significance. The hybrid technique required less time to remove the sealing material. The Channel Finder alone was not superior to manual instrumentation [1].

Yared [24] introduced a new concept of channel preparation with only one motor-driven NiTi instrument, without the prior use of manual instrumentation. The new Reciproc® reciprocating single file system includes three instruments (R25, R40 and R50), an electric

motor (VDW Silver Reciproc), absorbent paper tips and gutta-percha cones. Only one Reciproc® instrument is used to prepare the channel depending on the initial channel size.

The instruments are made with NiTi M-Wire alloys, which offer greater flexibility and resistance to cyclic fatigue when compared to the conventional NiTi 26 alloy. It has an "S" shaped cross-section. The three instruments have regressive conicity: At R25, the tip diameter is 0.25 mm and the taper 8% up to 3 mm from the tip; In R40 the tip diameter is 0.40 mm and the conicity is 6% up to 3 mm from the tip and at the R50, the tip diameter is 0.50 mm and the taper is 5.0% to 3.0 mm from the tip. The instruments are used in 10 cycles per second of reciprocating motion, at approximately 300 rpm. The angles of hourly and anti-clockwise movement are different [24].

The selection of the Reciproc® instrument is based on the preoperative radiographic analysis. When the channel is partially or completely invisible on the radiograph, the R25 should be selected. In other cases, when the radiograph shows the canal clearly to the apex and the canal is considered medium or wide, a file #30 should be inserted, possibly at the working length. If the channel is considered wide, one should use the R50, but if file #30 does not passively enter, one should opt for a file #20 for passive insertion, and then the channel will be considered medium, opting for the R40. In case, file #20 does not passively enter, the channel is considered attrésico, and one should opt for file R25. In the reciprocating movement, the hourly and counterclockwise angles determine the amplitude of the right and left rotation movement. The Reciproc® instrument should be inserted into the channel with small pivoting movements without removing the instrument completely from the channel and the amplitude of the movements should not exceed 3.0 to 4.0 mm [24].

A small pressure should be applied. After this insertion, the instrument should be removed for cleaning the channel, and a file #10 should be used to check the patency in 2/3 of the CT. Abundant irrigation should be performed. Preliminary studies have demonstrated the ability to centralize these instruments, even in severely curved channels. They are considered to be fracture-safe because of the reciprocating movement to the right and left, which allows the instruments not to reach the fracture angle in both torsion and block fractures. Working time is four times faster when compared to rotating NiTi preparations. With the use of the system, there is a lower incidence of complications, such as apical deviation, rungs and channel block when compared to traditional rotational techniques, and elimination of cross-contamination between patients, since the instrument is discarded after use [25].

Capar et al. [26] compared the resistance to cyclic fatigue of new endodontic instruments - ProTaper® Next X2 (M-Wire), OneShape® (conventional NiTi), Revo-S® Shaping Universal and HyFlex® 25/0.6 NiTi with controlled memory) with the Revo-S® instruments. Four groups of 20 NiTi instruments were tested on steel channels with a 3 mm radius and a 60° bend angle. The HyFlex® files had the greatest fatigue resistance and Revo-S® had the least resistance between the groups ($p<0.001$).

In 2003, Valois and Costa [11] conducted a study to evaluate *in vitro* the efficiency of the ProFile Taper.04 series 29 system in the treatment of curved root canals. For this purpose, 62 mandibular first molar teeth with mesial roots presented curvature between 25° and 30° were selected. The root canals were instrumented from the anatomical diameter to file #35 and filled by the lateral condensation technique using Sealer 26 as a sealant cement. Then, the teeth were randomly distributed in 6 groups with 20 root canals each: GI - conventional technique + solvent; GII - conventional technique + solvent + ultrasound; GIII - ProFile + solvent: GIV - ProFile + solvent + ultrasound; GV - ProFile; 18 GVI - ProFile + Ultrasound. Four specimens were used as controls. The following factors were evaluated: time spent, presence of extruded material via the apical foramen, cleaning of the root canal walls and safety of the instruments used. The data were submitted to ANOVA and Tuckey tests. The authors concluded that the use of ProFile files replaces the need for solvent during retreatment of curved channels. However, these instruments should be used with caution.

Berutti et al. [27] compared channel curvature and axis modulation after instrumentation with WaveOne Primer for rotational and rotary nickel-titanium rotary ProTaper, essential in determining the efficacy of all subsequent chemical disinfection and root canal filling procedures . Using ISO 15 training blocks, taper 0.02mm, all with slide guides previously created with PathFile 1,2,3 in the working length, two groups were created for modeling [27].

The first using the ProTaper sequence S1-S2-F1-F2, and the second making use of WaveOne Instrument ISO 25 and 0.08 mm conicity, both in the working length. Pre-and post-instrumentation digital images were overlaid and processed by a two-dimensional (2D) photographic method for analysis of the radius curvature (CRR) ratio, which, when closer to the value of 100, Caused by the instrumentation, and the relative error of the axis (rae), the smaller, less the shape of the channel was modified by instrumentation, representing the modification of the channel curvature. The results showed that the instrument factor was extremely significant for both CRR and rae parameters, with reduction of the channel modification when the NiTi WaveOne single instrument system is used, in order to preserve channel integrity and location and apical anatomy, Preparation for proper filling. These results may be particularly significant where the thickness of dentin is lower [27].

Gavini et al. [28] evaluated the flexural fatigue strength of the 25 mm reciproc nickel-titanium instrument 25 mm and taper of 0.08 mm made of super-elastic NiTi M-Wire which presents greater flexibility (close to 300-800%) and greater fatigue resistance Cyclic than conventional NiTi wire using continuous rotation and/or oscillatory and rotational motion.

Discussion

Two groups were created according to the applied kinematics of continuous rotation (RC group) and oscillatory and rotational movement, described as reciprocal (MR group). The instruments were submitted to dynamic test devices driven by an electric motor with 300 rpm speed, allowing the biceps movements, with 2.0 mm in each direction, through a block of tempered metal simulating the instrumentation of a root canal with 40º of Curvature and 5 mm radius [26-28].

Further, the electric motor was standardized to perform continuous rotation at a speed of 300 rpm and the oscillatory and rotational movement, characterized by rotation counterclockwise and clockwise, with a difference of 120° between the two, performing ten cycles of oscillatory movement and Per second, equivalent to 300 rpm. The fracture of the instrument was detected by the sensor of the device and the surface examined by scanning electron microscope. The time was marked in seconds and subsequently converted into number of cycles for fracture. The instruments moved by oscillatory and rotational motion reached significantly greater numbers of cycles before the fracture (mean 1787.78 cycles) when compared to the same types of instruments driven by continuous rotation.

MEV images showed fatigue striations that characterize the occurrence of fatigue failure and result in concavities/spherical dimples representative of a ductile fracture. Micro voids and fissures were also found [28]. Therefore, the kinematics of the movement of NiTi instruments influenced significantly the cyclic fatigue of the Reciproc R25 instrument, when the number of fracture cycles and the time in seconds were almost double in the MR group compared to the RC group. The oscillatory and rotational movement, proposed by Yared, improves the resistance to flexural fatigue in a nickel-titanium instrument compared to the continuous rotation movement, because the anti-clockwise rotation is greater than the hourly rotation (disengagement), resulting in a Screw compression effect, with reduction of compression forces favorable to the occurrence of elastic deformation, and of torsional fracture by locking of its tip [21,22, 29-31].

Conclusion

With recent technological advances in the area of endodontics, behind the literary reviews we can affirm that the system of instrumentation of the root canals with rotating files maintains the quality of the root preparation and, at the same time, decreases the amount of files needed to obtain a Channel, which would consequently reduce operative time and also considerably reduce the risk of twist fracture within the root canal than with files.

Conflict of Interests

There is no conflict of interest between authors.

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