Use of Reciproc® and Wave One® reciprocating systems in endodontics: literature review

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ABSTRACT

Introduction: Preparation and cleaning of root canals may have their effectiveness affected by factors such as root canal system anatomy and intracanal infection. Root canal shaping is a complex stage of the treatment and requires prudence and caution to be implemented. Single-file reciprocating systems have been recently used in Endodontics for preparation of root canals. The use of such systems should be guided by their performance, taking the following variables into account: less extrusion of debris, better fracture resistance, better cleaning standards, less root canal deviation, and shorter treatment time. **Objective:** This study aimed at comparing Reciproc® and Wave One® reciprocating systems by means of a literature review, particularly taking the aforementioned variables into account. **Methods:** A literature search was conducted Pubmed, Medline, Lilacs and Scopus databases. A total of 5 years of publication were researched, and 25 out of 660 papers found were selected for having met the established criteria. **Results:** Regarding extrusion of debris via apical foramen, there were no differences between systems evaluated in the studies. Regarding cyclic fatigue resistance and preparation time, Reciproc® system stands out, whereas Wave One® system has greater resistance to torsional fracture. As for root canal deviation and cleaning standard, the systems showed no significant differences. **Conclusion:** According to the variables proposed in this paper, the reciprocating systems performed favorably when used in both endodontic treatment and retreatment.

Keywords: Endodontics. Dental instruments. Root canal preparation.

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Introduction

Biomechanical preparation of the root canal system (RCS) is accomplished by proper cleaning and shaping of these canals, which, in turn, are achieved by mechanical action of manual and engine-driven endodontic instruments, combined with the chemical action of irrigating solutions.[1]

Automated systems were introduced in Endodontics to perform correct shaping and cleaning of the RCS, even in complex anatomical conditions, as well as to reduce chair time, avoiding clinician and patient's fatigue.[2]

Reciproc® files can be as follows: R25 (tip 25 and taper 0.08), R40 (tip 40 and taper 0.06), and R50 (tip 50 and taper 0.05). Those instruments have an "S-shaped cross section, two sharp edges and blunt tips that reduce perforations along the canal. They operate in 150° counterclockwise cutting movement, followed by a 30° clockwise movement. Those tools are manufactured with M-wire technology, through which nickel-titanium alloy surface (M-Wire alloys, 56% - Ni and 44% - Ti) is thermally treated, thus resulting in greater flexibility to the instrument.

Wave One® files can be as follows: small (tip 21 and taper 0.06), primary (tip 25 and taper 0.08), and large (tip 40 and taper 0.08). They also present non-cutting blunt tips and M-Wire technology, in addition to the shape of the cross section being triangular with three cutting edges and shafts guided towards counterclockwise cutting movements. Cutting movement occurs in a 170° counterclockwise direction, followed by a 50° clockwise movement. A complete rotation is reached after three cycles.

The relevant role played by root canal preparation led to creation and improvement of techniques, tools and engines that allow greater accuracy and shorter clinical time, thus mitigating the risk of accidents, such as irregularities, deviations, perforations and instrument fractures.[3]

Nickel-titanium alloys (NiTi) are considered an important technological breakthrough because instruments made of NiTi have greater flexibility, better tissue-cutting capacity, and adequate resistance. This makes instruments cast out of such alloys very suitable for root canal instrumentation.[4]

Reciprocating systems were developed based on the single-instrument preparation concept, in which an F2 rotary file from the Universal Protaper system was coupled to an engine with reciprocating kinematics and speed control. The results of this study allowed improvement and development of systems applied to non-rotational kinematics. The first reciprocating systems developed were Reciproc® (VDW, Germany) and Wave One® (Dentsply, USA). The instruments were advocated to be used as single-file systems for preparing root canals. This would be allowed by the use of a new NiTi M-Wire alloy, which provided greater flexibility and fracture resistance than conventional NiTi instruments.[5]

The successful use of single-file reciprocating systems for root canal preparation has triggered some interest in the possibility of these systems being also used in endodontic retreatment. Root canal retreatment techniques involve removal of the material previously packed into the canal and canal subsequent preparation.[6]

Techniques and systems chosen for both endodontic treatment and retreatment should comply with the following proposed variables: produce less extrusion of debris via apical foramen, improve resistance to fracture, perform centralized preparation capable of removing contaminated dentin without deviating from the original path of the canal, and perform the work within the shortest time possible.[7]

This study aimed at comparing Reciproc® and WaveOne® reciprocating systems when applied in endodontic treatment and retreatment, by means of assessing the aforementioned variables, particularly due to their relevance to a better treatment prognosis.

Material and Methods

For this literature review, Pubmed, Medline, Lilacs and Scopus databases were used as research databases. Papers included in the literature review were selected from 2012 to 2016 (last five years) with the following keywords: Reciproc; Wave One; extrusion of debris; cyclic fatigue; torsional fatigue.

The search retrieved 660 papers, out of which 25 were selected, including clinical and laboratory research, published in Portuguese and English, and those assessing at least one of the following variables: extrusion of debris after endodontic treatment preparation and after removal of filling material in

endodontic retreatment; cyclic fracture resistance; torsional fracture resistance; cleaning standards; root canal deviation; and working time. Papers were distributed in tables organized by variable, covering the following: authors and year of publication; type of study and sample; system studied; and main results/conclusions.

Literature review

Analysis of selected papers in the present study was grouped into six tables that comprise the following variables.

Extrusion of apical debris (AD)

Every preparation technique employed in endodontic treatment or retreatment lead to extrusion of debris via apical foramen. Although systems have improved as to generate less extrusion of debris, none of the file systems currently available are capable of fully avoiding this inconvenience.[4]

Such inconvenience may lead to an inflammatory reaction, which can lead to postoperative pain and edema, characterizing a clinical condition known as flare-up.[8]

Cyclic fatigue fracture (CF)

All endodontic instruments may eventually fail. One of the possible failures that can occur is CF fracture. This fracture is induced by alternating cycles of tension and compression to which the alloy is subject when the instrument is rotated at the maximum curvature of the canal. CF fractures can be explained in three phases: the first phase starts with the initiation of cracks, where the microcracks arise and show a preferential growing path along crystal planes; the second phase is characterized by the propagation of cracks, which grow continuously, achieving the third phase in which the cracks reach a point in which remaining material is overloaded, thus resulting in an overload zone that eventually leads to total fracture of the material. CF of rotary tools is influenced by several factors, such as rotation speed, angle of root canal curvature, and clinician's skill.[9]

Torsional fracture (TF)

Fractures of endodontic instruments may also happen due to torsion. TF occurs when the tip of the instrument is engaged into the canal and stops rotating while the instrument body continues to rotate. The instrument exceeds the specific elastic threshold of the metal alloy and suffers plastic deformation followed by instrument fracture.[10]

Technological improvement in instrument manufacturing, such as cross-section design, as well as instrumentation protocols, have made these instruments to become increasingly resistant to torsional fractures.[11] In addition to those characteristics, electric engines with speed and torque control, besides a reverse rotational system, were developed to control the threshold of elastic deformation of these instruments more efficiently, thus preventing fractures from happening.[12]

Cleaning standards

Preparation in endodontic treatment and cleaning of root canals in retreatment always generate debris and other remaining types of material. No instrumentation technique is able to leave the RCS totally free from remaining material which can hamper the hermetic sealing of the canal in final filling.[6]

Although complete removal of RCS filling material is somewhat unattainable, removing as much gutta-percha and cement as possible seems to be essential to allow decontamination of RCS and favor successful endodontic retreatment.[13]

Root canal deviation

All root canal instruments and preparation techniques tend to deviate and change the original path of the canals. This fact is observed mainly in the case of curved canals. The development of NiTi instruments and recent thermally-treated NiTi alloys greatly improved flexibility of these instruments. That allowed better preservation of the initial conformation of the canal and, therefore, less apical transport events.[14]

Working time

The search for instruments and systems that allow quicker and safer preparations with less stress for both patients and clinicians has always been a major goal in the industry that develops technology applied to Endodontics. As a rule of thumb, rotary systems generally involve a number of instruments

to be used sequentially in order to shape the canal. The idea of preparing canals with one single instrument was the technological leap necessary for the development of engines that apply alternating reciprocating kinematics, as well as to devising instruments intended to be safely used to this end.[5]

Not too long elapsed until automated systems were also applied in endodontic retreatment with the purpose of reducing root canal cleaning time, if compared to techniques that used manual instruments. In addition to reducing material removal time, those systems also generated less stress to the clinician.[13]

Comparative analysis of papers shown in Tables 1 to 6 covers the variables selected in the present study and allows one to observe authors and year of publication, type of study, sample, comparison between reciprocating systems, in addition to main results and conclusions of studies.

Table 1. Comparative study between Reciproc®, Wave One® and other root canal rotatory instrumentation systems considering the variable extrusion of apical debris (AD).

Authors/Year	Study sample	Compared systems	Results / Conclusion
Silva et al.[19], 2015	Ex vivo laboratory / 60 instrumented mandibular premolars (MPM)	PTU, PT Next systems, Reciproc® and Wave One®	PTU produced more AD, no statistically significant differences were found among the other systems
Uzunoglu, Görduysus[17], 2014	Ex vivo laboratory / 40 instrumented MPM	Reciproc®, SAF	Reciproc® produced greater AD extrusion
Küçükyilmaz et al.[16], 2014	Ex vivo laboratory / 45 instrumented MPM	Reciproc® PTU and One Shape	Reciproc® produced greater AD extrusion
Nayak et al.[4], 2014	Ex vivo laboratory / 60 instrumented MPM	Reciproc®, Wave One® and One Shape	The two reciprocating systems produced more AD compared to One Shape
Silva et al.[6], 2014	Ex vivo laboratory / 45 retreated MPM canals	Reciproc®, Wave One® and PT retreatment	PT produced higher extrusion of AD, followed by Wave One® and Reciproc®

PTU = ProTaper Universal, PT = ProTaper.

Table 2. Comparative study between Reciproc®, Wave One® and other root canal rotatory instrumentation systems considering the variable cyclic fatigue (CF).

Authors/Year	Study / Sample	Compared systems	Results / Conclusion
Higuera et al.[21], 2015	In vitro laboratory / 45 Nickel-titanium files	Reciproc®, Wave One®, Twisted Adaptive File	Wave One® was less resistant to CF, but no statistically significant differences were found between Reciproc® and Twisted Adaptive File
De Deus et al.[14], 2014	In vitro laboratory / 68 files	Reciproc® and Wave One®	Reciproc® presented greater resistance to CF
Frota et al.[10], 2014	In vitro laboratory / 80 files	PTU, Reciproc®, Wave One® and Mtwo	Reciprocating files have greater resistance to CF
Pedulla et al.[26], 2014	In vitro laboratory / 270 files	Reciproc®, Wave One®, PT	Reciproc® presented with lower resistance to fracture after immersion in NaOCl from 45 seconds to 3 minutes
Plotino et al.[35], 2014	Clinical laboratory longitudinal / 1696 files used in endodontic treatment and retreatment	Reciproc®	Only R25 files fractured (0.47%): 0.29% used in treatment and 0.16% in retreatment
Lopes et al.[22], 2013	In vitro laboratory / 20 files	Reciproc® and Mtwo	Reciproc® presented greater resistance to CF
Pedulla et al.[23], 2013	In vitro laboratory / 90 files	Reciproc®, Wave One®	Reciproc® with greater resistance to CF after immersion in NaOCl
Gavini et al.[25], 2012	In vitro laboratory / 36 files	Reciproc® continuous and reciprocating rotation	Reciproc® presented with greater resistance to CF under reciprocating movement
Kim et al.[20], 2012	In vitro laboratory / 30 files	Reciproc®, Wave One® and PT	Reciproc® presented better resistance to CF
Plotino et al.[9], 2012	In vitro laboratory / 30 files	Reciproc® and Wave One®	Reciproc® presented better resistance to CF

Table 3. Comparative study between Reciproc®, Wave One® and other root canal rotatory instrumentation systems considering the variable torsional fatigue (TF).

Authors/Year	Study / Sample	Compared systems	Results / Conclusion
Frota et al.[10], 2014	In vitro laboratory / 80 instruments	PTU Reciproc®, Wave One®, Mtwo	Reciprocating files presented greater resistance to TF
Kim et al.[27], 2014	In vitro laboratory / 60 files	Reciproc®, Wave One®	There were no statistically significant differences
Kim et al.[20], 2012	In vitro laboratory / 30 files	Reciproc®, Wave One®, PT	Wave One® presented with better fracture resistance

Table 4. Comparative study between Reciproc®, Wave One® and other root canal rotatory instrumentation systems considering the variable cleaning standards.

Authors/Year	Study/Sample	Compared systems	Results / Conclusion
Carvalho et al.[28], 2015	Ex vivo laboratory / 25 instrumented mandibular molars mesial roots	Reciproc®, Wave One®	There were no statistically significant differences
De-Deus et al.[7], 2015	Ex vivo laboratory / 30 slightly curved instrumented mesial roots	Reciproc®, Wave One®	There were no statistically significant differences
Souza et al.[29], 2015	Ex vivo laboratory / 40 retreated single-rooted premolars	Reciproc® and PT Retreatment	There were no statistically significant differences
Rödig et al.[31], 2014	Ex vivo laboratory / 60 canals of retreated mandibular molars	Reciproc®, PT and Hedstroem Files	There were no statistically significant differences
Silva et al.[19], 2015	In vitro laboratory / 40 retreated premolars	PT and Wave One®	There were no statistically significant differences
Zuolo et al.[30], 2013	Ex vivo laboratory / 54 retreated central incisors	Gattes-Glidden, Mtwo and Reciproc®	There were no statistically significant differences

Table 5. Comparative study between Reciproc®, Wave One® and other root canal rotatory instrumentation systems particularly regarding root canal deviation.

Authors/Year	Study/Sample	Compared systems	Results / Conclusion
Moghadam et al.[33], 2014	Ex vivo laboratory / 40 mesiobuccal canals of molars	Reciproc® Twisted file	There were no statistically significant differences between systems
Vilas-Boas et al.[18], 2013	In vitro laboratory / 20 resin blocks	Reciproc®, used under continuous and reciprocating movement	There were no statistically significant differences in root canal deviation between the two types of movements

Table 6. Comparative study between Reciproc®, Wave One® and other root canal rotatory instrumentation systems considering the variable working time.

Authors/Year	Study/Sample	Compared systems	Results / Conclusion
Souza et al.[29], 2015	Ex vivo laboratory / 40 retreated single-rooted premolars	Reciproc® and PT Retreatment	Reciproc® was faster
Silva et al.[32], 2015	In vitro laboratory / 40 retreatment premolars	PT and Wave One®	Wave One® was faster in removing the filling material
Küçükyilmaz et al.[16], 2014	Ex vivo laboratory / 45 instrumented MPM	Reciproc®, PTU and One Shape	Reciproc® demanded shorter working time
Rodig et al.[31], 2014	Ex vivo laboratory / 60 retreated mandibular molars canals	Reciproc®, PT and Hedstrom Files	Reciproc® was faster
Vilas-Boas et al.[18], 2013	In vitro laboratory / 20 resin blocks	Reciproc®, used under continuous and reciprocating movement	Reciproc® was faster under continuous movement
Zuolo et al. [30], 2013	Ex vivo laboratory / 54 retreated central incisors	Gattes-Glidden, Mtwo and Reciproc®	Reciproc® was faster
Machado et al.[34], 2012	In vitro laboratory / 20 resin blocks	Reciproc® and Wave One®	Reciproc® was faster

Discussion

Extrusion of apical debris

Automated systems were developed to prepare root canals. However, they have also been used for removal of filling material in endodontic retreatment. In both situations, debris are invariably produced and extruded into the periapical region. Rotational systems have prreviously showed to have better results in terms of less extrusion of debris.[15] With the development of reciprocating systems, comparative studies have been carried out.

Studies by Nayak et al[4] and Küçükyilmaz et al[16] showed that the reciprocating systems evaluated caused more AD extrusion when compared to rotatory systems, especially One Shape® system. This fact can be explained by different cross-section designs along the file in this system, which greatly enhances its cutting ability. Those features tend to reduce the piston effect insofar as the file cuts along different cross-section configurations, favoring the outflow of debris to the cervical region, thus minimizing extrusion.

The study by Uzunoglu and Görduysus[17] compared Reciproc® reciprocating system to SAF (Self Adjusting File) rotatory system files. Results pointed out to higher AD extrusion provided by the reciprocating system in relation to SAF. The SAF system applies continuous rotation to the right. However, instrument design is very particular, with an irrigation system coupled to the file, which considerably enhances the cleaning of canals, thus allowing not only better material debridement, but also less AD extrusion after preparation.[7]

By and large, problems caused by extrusion of debris to the periapical region are most often related to postoperative pain. For this reason, studies have been carried out to evaluate reciprocating systems concerning this variable.[18]

Silva et al[19] compared two rotatory systems: ProTaper Universal and ProTaper System Next; and two reciprocating systems: Reciproc® and Wave One®, all of which are used for endodontic retreatment. Results showed no statistical difference between the reciprocating systems. However, both caused less extrusion than the rotatory systems. ProTaper Universal system showed the highest extrusion of debris during removal of gutta-percha from root canals. Those results corroborate the study by Silva et al[6] which used the Protaper Retreatment rotary system to remove packed material from the canal. Those findings can be explained by the fact that rotational kinematics does not allow clearance during cutting activity, which is a common feature to reciprocating systems. Continuous movement to the right transfers the responsibility of accommodating the remnants produced during removal to the escape area of the instrument. As for systems using reciprocating kinematics, they present counterclockwise and clockwise alternated rotation, which may favor changes in AD displacement direction generated by either material removal or dentin preparations.

Fracture by cyclic fatigue (CF)

Reciprocating systems were manufactured with NiTi M-Wire alloys, which provides them with greater flexibility and resistance to cyclic fatigue fracture. However, the need to further investigate the behavior of those instruments in cyclic fatigue fracture remains paramount as to analyze other possible variables which may influence the occurrence of such events.[9]

By analyzing rotatory systems in comparison to Mtwo system files, Reciproc® system also showed greater resistance to CF in the study by Lopes et al[12] The study by Kim et al[20] compared 30 instruments from three different systems, Wave One® and Universal ProTaper, and concluded that Reciproc® files were shown to be more resistant to CF.[20]

However, in the study by Higuera et al,[21] in which 45 files from Reciproc®, Wave One® and Twisted Adaptive File systems were compared, no significant differences were observed between systems, except for Wave One® which showed less resistance to cyclic fatigue.

Nevertheless, when Reciproc® and Wave One® reciprocating systems were compared to ProTaper Universal and Mtwo, in 80 rotatory instruments systems in the study by Frota et al[10], the reciprocating instruments exhibited higher CF resistance.

Reciproc® files, or from other reciprocating systems, were shown to be more resistant to CF fracture in several studies.[10,20-22] Three of those studies compared Reciproc® and Wave One® files, and showed that Reciproc® demonstrated greater resistance to cyclic fatigue. This may be related to its clockwise

unlocking movement kinematics and S-shaped cross-section design, which provides the system with greater flexibility.[9,23,24]

In the study by Gavini et al,[25] the authors tested Reciproc® reciprocating files in two kinematics: reciprocating and rotational. To this end, half the instruments were used under reciprocating movements, whereas the other half was used under continuous rotational movement. They concluded that Reciproc® files showed greater resistance to cyclic fatigue fracture when performing reciprocating movements, possibly explained by the file unlocking feature optimizing stress relieving capacity of the instrument during instrumentation.

The use of sodium hypochlorite solution as a root canal irrigating substance raises the question as to whether damage is caused to the metal structure of endodontic instruments. The study by Pedulla et al[23] proposed to evaluate such condition by analyzing Reciproc® and Wave One® files with regards to their resistance to CF fracture when immersed in 5% sodium hypochlorite solution. Reciproc® files were shown to have higher resistance. However, Pedulla et al[26] showed contrary results after assessing 270 instruments by means of different conditions and samples.

Plotino et al,[35] using 1696 Reciproc® files in endodontic treatment and retreatment, demonstrated a 0.47% fracture rate altogether, of which 0.29% happened during treatment, and 0.16% in retreatment. Although those results seem extremely encouraging, the study was not clear in distinguishing whether fractures were of either cyclical or torsional nature.

Torsional Fracture (TF)

Torsional resistance of an instrument varies according to its cross-section shape and area. Those features may vary depending on what shaft level of the instrument is being considered.[27]

Both clinician and the type of instrumentation are also key factors to avoid torsional stress during treatment. Various aspects can increase stress during this procedure, such as excessive pressure on the instrument and a large contact area between canal walls and instrument surface. Those factors lead to an increased risk of locking, which can subsequently lead to instrument fracture. This risk can be reduced by applying torque control and self-reversing features of endodontic engines, which will stop and reverse the direction of rotation before locking the instrument.[27]

Studies on torsional fracture show that the file systems greatly differ in this regard. The study by Kim et al[27] assessed Reciproc®, Wave One® and Universal ProTaper systems in relation to torsional fracture. A total of 30 files from those systems were used. Wave One® files showed greater resistance to torsional fracture when compared to the others. In general, reciprocating systems showed higher resistance to TF.[13] However, the study by Kim et al[27], also using 30 Reciproc® and 30 Wave One® files, compared instruments regarding their resistance to torsional fracture, but failed to find statistically significant differences.

Cleaning standards

It is long known that debris buildup can cause several problems, from poor adherence to filling material to reinfection and postoperative pain. RCS cleaning standard was assessed in 30 mandibular molars mesial canals with curvatures ranging from 10° and 20°, according to the Schneider method, after being prepared with Reciproc® and Wave One® reciprocating systems in a study by De-Deus et al.[7] Results showed that preparation carried out by both systems did not avoid debris buildup and compaction in the final millimeters of instrumented canal walls. There were no significant differences between the groups studied.

The study by Carvalho et al[28] found similar results when performing this experiment in curved mesial canals of 25 mandibular molars. However, besides the two reciprocating systems, Race files were also studied.

When assessing remaining material after unpacking endodontic retreatment, it was quite clear that no instruments or techniques were 100% effective in preventing material residues from attaching to root canal areas. In a retreatment study by Souza et al,[29] 40 mandibular premolars were unpacked by Reciproc® and ProTaper Retreatment systems, and no significant differences in cleaning standards between the two types of systems were found.

Zuolo et al[30] compared Reciproc®, Mtwo and Gates-Glidden drills, particularly regarding cleaning

in 54 central incisors subjected to endodontic retreatment. No statistically significant differences were observed. None of the instruments completely removed the filling material. Similar findings were achieved by the study by Rödig et al,[31] when a reciprocating system (ProTaper Retreatment) was compared to Hedstrom manual files in 60 mandibular molars subjected to endodontic retreatment. The study clearly demonstrated the impossibility of total removal of debris originated after unpacking root canals in endodontic retreatment.

Wave One® reciprocating system followed the results achieved by the other assessed systems. Silva et al[32] compared Wave One® with ProTaper Retreatment instruments in unpacking root canals of 40 premolars, and concluded that none of them completely removed the filling material off the root walls. Results make evident how similar the results regarding cleaning standards are.

Root canal deviation

The study by Vilas-Boas et al[18] tested R25 Reciproc® files in artificial curved canals under reciprocating kinematics and continuous rotation to the left. No statistical differences were found between the two types of movements vis-à-vis root canal deviation. This corroborates other studies comparing the same instruments used under different kinematics in relation to root canal deviation.

Moghadam et al[33] compared Reciproc® and Twisted File (TF) files regarding root canal deviation. Cone-Beam computed tomography (CBCT) was used to this end. Analysis used 40 mesial root canals from mandibular molars and mesiobuccal roots of maxillary molars with curvatures between 15° and 30° (Scheiner score). Results showed that both systems satisfactorily maintained the original path of the canals. This may be associated with the development of NiTi alloys present in those systems: NiTi M-Wire alloy in reciprocating systems and NiTi Phase-R alloy in TF files. After such changes, instruments became more flexible and with reduced tendency to cause displacement and transport during preparation.

It seems clear that more important than the kinematics applied to the instrument is the quality of the NiTi alloy. Proof of that is the aforementioned study in which the same instrument showed no statistically significant differences.[18]

Working time

The search for instruments and systems that allow the implementation of faster and safer preparations with less stress to both patient and clinician has been one of the main goals pursued by the endodontic industry. Rotatory systems generally comprise a number of instruments to be used sequentially for shaping the canal. The idea of preparing the canal with a single instrument was the technology breakthrough that allowed the development of alternated reciprocating-kinematics engines and instruments, which can be safely used in this way.[5]

A strategy applied in the study by Vilas-Boas et al[18] was the use of Reciproc® files in a counterclockwise continuous rotation and reciprocating movement. A shorter preparation time compared to the continuous rotational movement was evinced. This fact can be related to the great cutting power of Reciproc® file flutes in a counterclockwise direction, probably promoting a faster flaring of the canal.

Reciproc® and Wave One® reciprocating systems were pioneers in the single-instrument approach for root canal preparation using reciprocating kinematics.[20]

Some studies have demonstrated the superiority of Reciproc® system with regards to the time required to remove filling material from root canals in endodontic retreatment. In the study by Küçükyilmaz et al,[16] Reciproc® system was compared to ProTaper Universal and One Shape® instruments in unpacking 45 premolars. The study by Rodig et al[31] compared Reciproc® systems with ProTaper Retreatment and Headstrom Files in unpacking 60 mandibular molars, whereas Zuolo et al[30] compared Reciproc® system with Gattes-Gliden burs and Mtwo files in cleaning 54 central incisors.

Wave One® system was compared to ProTaper Retreatment in the study by Silva et al.[32] Wave One® system was superior to ProTaper Retreatment in cleaning 40 premolars.

There are several studies in the literature assessing Reciproc® system working time vis-à-vis other systems.[16,29-31,33] The study by Souza et al[29] corroborates this result by comparing Reciproc® and ProTaper Retreatment systems in endodontic retreatment of 40

premolars. Unpacking was performed within shorter working time with the aid of Reciproc® instruments. Machado et al[34] compared Reciproc® and Wave One® instruments using 20 artificial canals. Their results pointed out that Reciproc® system was the fastest.

Although the speed in preparation can be considered a great and valuable advantage, cleaning of the root canal system can be compromised. Although rapid root canal shaping may allow the cone to fit in, it will not guarantee decontamination, for not enough time will be allowed to ensure the antimicrobial effect of the irrigation solution. For this reason, irrigation techniques with ultrasonic activation have been improved in order to follow this new paradigm of simplicity and speed in preparation of root canals.

Conclusion

When evaluated for the variables proposed in this study, reciprocating systems – compared among themselves and with other systems - revealed positive results in relation to both endodontic treatment and retreatment. Reciproc® instruments were shown to have better performance in relation to the maintenance of root canal path, resistance to cyclic fatigue and shorter working time, while Wave One® instruments proved to be more resistant to torsional fracture. Both systems extrude debris at comparable rates and are unable to completely clean the RCS, features that are not significantly different if compared to other systems evaluated in the papers assessed by this study.

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