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Fracture Incidence of Reciproc Instruments in Endodontic Treatment Provided by Graduate Students - A Retrospective Study

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Abstract

Aim: Evaluate the fracture incidence of Reciproc R25 instruments after clinical use by graduate students.

Methodology: An evaluation was conducted of 2,356 case records of endodontic treatment provided by graduate students over a period of 24 months. Included in the analysis were 1,958 treatments performed using the Reciproc R25 file on premolars and molars, following the manufacturer's instructions. Dental pulp status was not taken into account. The cases of fractures were evaluated and recorded.

Results: There were 12 fractures (0.61%), 4 of which occurred 16 mm from the instrument tip (0.20%) and 8 of which occurred approximately 5 mm from the instrument tip (0.41%). Of this total, 25% occurred in pre-molars and 75% in molars.

Conclusion: There was a low incidence of fractures during instrumentation of root canals with Reciproc R25 files in premolars and molars by graduate students.

Keywords: Instrument fracture, Nickel-titanium, Reciprocating motion, Separation incidence, Reciproc

Introduction

One of the most disagreeable complications that can occur during root canal cleaning and shaping is the fracture of instruments within the canal system. In some situations, removal of the fragment can be technically difficult. On the other hand, non-removal can eventually hinder and even preclude correct cleaning and shaping of canals, consequently increasing the probability of failure [1].

Introduction of Nickel-titaniun (NiTi) instruments in the preparation of root canals has resulted in greater efficiency and in treatments completed in less time [2-6].

New instruments have been introduced in the market, with improved designs and mechanical properties, using electric motors with rotational or reciprocating motion. Thanks to these advances, curved and constricted canals, which have always been a challenge in endodontics, can now be prepared more quickly and safely [7].

Studies have shown that reciprocating motion is associated with more favorable mechanical behavior of NiTi instruments than continuous rotation, resulting in less torsional fatigue on the instrument [8-18].

Despite all the technological advances in both rotary and reciprocating instruments and techniques, unexpected fractures of instruments may occur, especially when these techniques are applied by less experienced operators [19,20]. The influence of operator experience on the rate of instrument fracture has been reported in previous articles, primarily when NiTi instruments in continuous rotation are used [21-24].

Some studies have compared NiTi rotary and reciprocating instruments with regard to the incidence of fractures in laboratory tests. The majority of these studies have shown that the type of motion is one of the factors related to a lower incidence of fractures. Three recent clinical studies showed a low incidence of fractures when two different single-file systems were applied with reciprocating motion by professionals trained in endodontics [25-27].

The aim of the present retrospective observational clinical study was to evaluate the incidence of fractures of Reciproc R25 files (VDW, Munich, Germany) used by graduate

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students to prepare root canals in the period from December 2012 to November 2014.

Methodology

A total of 2,356 case records of endodontic treatment retrieved from the files of the graduate program in endodontics of the Health Specialties Center of the Ingá Higher Education Unit (CESA/UNINGÁ), Salvador, BA, Brazil, was evaluated. Graduate students provided the treatment from December 2012 to November 2014 (24 months). Endodontic interventions with the Reciproc R25 instrument (VDW, Munich, Germany) for a single use in premolars or molars were included in the analysis treatments using R40 and R50 files. The chi-squared test (degree of freedom 1, alpha = 0.01 and test power = 0.95) was used to determine the sample size, resulting in a total of 726 specimens. The 1,958 teeth obtained from the case records that met the inclusion criteria were therefore considered sufficient. Dental pulp status (vital or non-vital) was not considered as inclusion or exclusion criteria. Treatments on anterior teeth and endodontic retreatments were excluded. The teeth used in the study are presented in Table 1.

The endodontic treatment protocol adopted in the graduate course is described below. Coronal access cavities were made with drills and ultrasonic inserts. The root canals were prepared with Reciproc files following the manufacturer's instructions. Exploration of the canals was made with a stainless steel # 10 K-type file (VDW). The Reciproc file (VDW), coupled with a Silver Reciproc endodontic motor (VDW) operating in the Reciproc. All mode, and was used with 3 in-and-out motions, until reaching 2/3 of the canal length, as preliminarily determined in the initial radiograph. The files were cleaned with gauze between applications of each of the 3 motions. Canal length determination was then conducted with files of a diameter closer to the initial diameter of the stainless steel K-type file (VDW) and with a Romiapex A15 foramen locator (Romidan, Kiryat Ono, Israel). The working length considered was the total length of the canal. Once the working length was established, the remaining preparation was made with the Reciproc R25 files using 3 penetrating motions and 1 removal of the file from the inside of the canal following the manufacturer's instructions. During the entire instrumentation process, the canals were constantly irrigated after each instrument change with 2.5% sodium hypochlorite. For aminal patency was maintained with a stainless steel #10 K-type file (VDW).

After the preparation was completed, 3 alternated passive ultrasonic irrigations were made with 2.5% sodium hypochlorite and 17% EDTA, in 3 cycles of 20 s each. The canals were then dried and filled in the same session, and the cases of fractures were evaluated and recorded.

Results

Out of a total of 1,958 teeth treated with R25 files, there were 12 fractures (0.61%), 4 of which occurred approximately 16 mm from the instrument tip (0.20%) – 1 fracture in superior premolar (bucal canal) and 3 in superior molars (MB); and 8 of which occurred approximately 5 mm from the instrument tip (0.41%) -3 fractures in superior premolars (bucal root), 3 fractures in superior molars (1 - MB and 2 - ML) and 2 fractures in inferior molars (1- MB and 1 - ML). Of the total fractures, 25% occurred in premolars and 75%, in molars.

	Premolars	Molars
Maxillary	557	413
Mandibular	376	612

Table 1: Teeth used in the study.

Discussion

Despite the constant development of NiTi files, with modifications not only in relation to design and metal characteristics, but also in relation to rotation motion, the risk of fracture of these instruments is still a concern for professionals. It is often impossible to predict this type of occurrence, because, in most situations, there are no signs to warn the clinician of the occurrence of instrument fatigue [28].

In some cases, removal of the separated fragment is not possible, precluding correct cleaning and shaping of the root canal system. Although the permanence of a fragment within the canal does not necessarily result in failure, it certainly increases the probability that the endodontic treatment will be unsuccessful [1,29,30]. In this study, the protocol adopted for root canal preparation was based on manufacturer recommendations, for the purpose of standardizing the procedure performed by the different operators.

Only mandibular molars and premolars instrumented with Reciproc R25 files were included. The anatomical characteristics of these teeth, mainly the curvature angles and radii, render endodontic treatment more complex, thus increasing the importance of conducting clinical studies on the behavior of NiTi instruments in relation to the possibility of fracture in these teeth [25,26]. In a study involving 4,865 cases treated by residents Iqbal, et al. (2006) observed that there was a higher percentage of fractures in rotary instruments than in manual instruments (1.68% versus 0.25%), and that the vast majority of cases of fractures occurred in molars (55.5% in mandibular molars and 33.3% in maxillary molars). Similar observations were reported previously in studies by [31-34]. These authors also reported a higher percentage of fractures in molars than in other teeth.

Prior clinical studies assessed the influence of operator training on the rate of instrument fractures when manual and motor-driven files were used (Table 2) [35-42]. The present retrospective clinical study showed a small percentage of fractures (0.61%) for Reciproc R25 instruments during preparation of molars and premolars by graduate students. In the majority of these studies, the percentage was higher than that observed in the present study. This observation could be related to use of rotary and manual instruments. Notwithstanding this observation, strict comparisons between the results of the different studies are difficult, owing to methodological differences. Some authors made no distinction in relation to the different types of teeth [23,26,27,30-33,43,44]. Used only posterior teeth with severe curvatures [45]. Again, some authors, as in the present study, assessed the total number of teeth, whereas others evaluated the total number of canals treated [26].

The percentage of fractures observed in the present study was similar to that found by [25-27]. A similarity worth noting between the present study and that of Plotino, et al. (2015) was the occurrence of cases of fractures approximately 16 mm from the working tip. Possible explanations include inadequate access, manufacturing defects and the instrument design itself [27].

It is interesting to note that, in the studies by [25,26] treatment

	Fractures (%)	Deformations (%)	Instruments	Teeth	Operator
Ramirez- Salomon et al. (1997)	3.7		Rotary (Lightspeed)	Mandibular and maxillary first molars	Specialists
Parashos et al. (2004)	5	12	Rotary (FlexMaster, GT,Orifice Shapers, ProFiles,ProTaper, Quantec,Quantec Flare, Hero)	**	Specialists
Alapati et al. (2005)	11.3	16	Rotary (Protaper, Profile,Profile GT)	**	Graduate students
Cheung et al. (2005)	22,9	1.06	Rotary (Protaper S1)	All	Specialists
DiFiore et al. (2006)	1,9		Rotary (ProFile, ProTaper, GTRotary, K3Endo)	All	Graduate students
Iqbal et al. (2006)	0.25 and 1.68 (manual and rotary)		Manual and rotary	All	Graduate students
Knowles et al. (2006)	1.3		Rotary (Lightspeed)	Molars and premolars (treatments and retreatments)	Graduate students
Wolcott et al. (2006)	2.4		Rotary (Protaper)	All	Specialists
Tzanetakis et al. (2008)	0.55 and 1.33 (manual and rotary)		Manual and rotary	All	Graduate students
Ehrhardt et al. (2012)	1.98	28.78	Rotary (Mtwo)	Posterior teeth	Specialists
Inan & Gonulol (2009)	16.02	9.78	Rotary (Mtwo)	**	Specialists
Shen et al. (2009) a	5	3	Rotary (ProTaper, ProTaper manual, K3)	**	Specialists
Shen et al. (2009) b	0.3	1	Rotary (Profile)	**	Undergraduate students
Shen et al. (2009) c	6.28		Rotary (Race)	**	Specialists
Wu et al. (2011)	2.6		Rotary (Protaper Universal)	Maxillary and mandibular molars	Specialists
Ungerechts et al. (2014)	1		Manual	All	Undergraduate students
Cunha et al. (2014)	0.42		Reciprocating (Wave One)	Posterior teeth	Specialists
Plotino et al. (2015)	0.47		Reciprocating (Reciproc)	All	Specialists
Shen et al. (2015)	0.18	8.4	Rotary (Vortex and Vortex Blue)	All	Graduate students
Shen et al. -2016	0.5	9.6	Reciprocating (Wave One)	All	4 specialists and 1 graduate student

**Included teeth not specified

Table 2: Incidence of fractures and deformations of NiTi instruments reported in previous studies based on tooth type and operator experience.

was provided by experienced professionals (endodontics specialists), whereas in the present study and that of [27], the teeth were treated by graduate students. This may indicate that the reciprocating technique has a short learning curve, as also reported by [46]. This observation contrasts with the results of previous studies in which continuous rotation instruments were used, and in which operator experience was a determining factor in preparation quality and in NiTi instrument fracture or deformation [19,20-22,24].

Another factor that may explain the good results observed in the present study is related to the superior physical and mechanical properties of the Instruments manufactured with the M-Wire alloy, as observed by several authors using different methodologies [14,16,19-24,47-52].

The results obtained by the present study show a low rate of fractures of Reciproc instruments in posterior teeth treated by graduate students.

Conclusion

Based on the results of this retrospective clinical study, a low incidence of fractures was observed during instrumentation of root canals with Reciproc R25 files in premolars and molars by graduate students.

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