Fracture Incidence of WaveOne and Reciproc Files during Root Canal Preparation of up to 3 Posterior Teeth: A Prospective Clinical Study

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Abstract

Introduction: Reciprocating instruments were developed to improve and simplify the preparation of the root canal system by allowing greater centralization of the canal and requiring a shorter learning curve. Despite the risk of instrument separation, using a reciprocating instrument in more than 1 case is a relatively common clinical practice. The aim of this study was to evaluate the fracture resistance of Reciproc (R25; VDW, Munich, Germany) and WaveOne (Primary; Dentsply Maillefer, Ballaigues, Switzerland) instruments according to the number of uses during the preparation of root canals in up to 3 posterior teeth. **Methods:** A prospective clinical study was conducted by 3 experienced specialists who performed treatment of 358 posterior teeth (1130 canals) over a period of 12 months using 120 reciprocating instruments, 60 of which were Reciproc R25 and 60 were WaveOne Primary. The motion used during instrumentation followed the recommendations of the respective manufacturers. After each use, the instruments were observed under a dental operating microscope at 8× magnification. In the case of fracture or deformation, the instrument was discarded. **Results:** None of the instruments showed any signs of deformation, but 3 instruments fractured (0.26% of the number of canals and 0.84% of the number of teeth). All fractures occurred in mandibular molars (1 WaveOne Primary file during the third use and 2 Reciproc R25 files, 1 during the first use and the other during the third use). **Conclusions:** There was a low incidence of fracture when reciprocating files were used in up to 3 cases of endodontic treatment in posterior teeth. *(J Endod 2017;■:1–4)*

Key Words

Instrument fracture, posterior teeth, Reciproc, reciprocating movement, WaveOne

Significance

In this study, Reciproc and WaveOne files were used safely for up to 3 clinical cases of endodontic treatment in posterior teeth with a fracture rate comparable with that observed in studies on single-use reciprocating instruments.

The introduction of WaveOne (Dentsply Maillefer, Ballaigues, Switzerland) and Reciproc (VDW, Munich, Germany) systems in endodontic practice enabled preparation of root canals using the single-file concept (1). Single-file reciprocating systems are advantageous because they require a shorter learning curve, simplify the endodontic instrumentation process, and are more cost-effective compared with full-sequence rotary systems (2, 3). Furthermore, reciprocating motion has been proven to be safer both in respect to cyclic fatigue and torsion fracture (4). As a result, the life span of the instruments used with this motion has been proven to be longer (5).

The number of times an endodontic file can be used is a highly controversial topic in the related literature. According to the manufacturers, instruments must be disposed of after the first use, a recommendation confirmed by Kim et al (6). According to these authors, contraindications for the reuse of reciprocating instruments would be that instrument damage is cumulative and that there is no guarantee that the reciprocating motion programmed in the motor driving the instrument will maintain its action within the elastic range of the material.

However, it seems reasonable to assume that the wear suffered by an instrument when used in a tooth with only 1 canal is less than that observed when it is used in a tooth with 3 canals. Based on this reasoning, one could admit the possibility of using the same reciprocating instrument in more than 1 case, particularly in environments in which the high cost of instruments can hinder or preclude treatment altogether.

The thermal treatment of the NiTi alloy used in reciprocating instruments has been linked to a low incidence of fractures. Gambarini et al (7) showed that this treatment imparts enhanced flexibility and resistance to cyclic fatigue compared with instruments made of conventional NiTi alloy. Furthermore, in the kinematics of reciprocating systems, the instrument does not complete a full 360° turn continuously, thus reducing taper lock and the overall risk of torsion fracture (2, 4, 8–11).

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Another contraindication to reusing reciprocating instruments, according to the manufacturers, is the difficulty involved in guaranteeing their proper sterilization. However, this difficulty was not observed by Raju et al (12), who evaluated different methods of sterilization for endodontic files (autoclaving, sterilization with carbon dioxide laser, chemical sterilization with glutaraldehyde, and glass bead sterilization) and concluded that sterilization by autoclaving is effective.

Nevertheless, because the Reciproc and WaveOne reciprocating systems were designed for single use, manufacturers have installed a silicone ring at the end of the instruments' coupling shank. Thus, when the instrument is sterilized, the ring expands from the heat, precluding a new coupling to the contra-angle and thereby making it difficult to reuse.

Pirani et al (5) conducted a scanning electron microscopic study to evaluate the surface changes that had occurred after the third sequential use of reciprocating instruments (Reciproc R25 [VDW] and WaveOne Primary [Dentsply Maillefer]) in single-rooted extracted teeth and found that both instruments presented only limited changes, such as deformation of the tip and a certain degree of surface wear. Under an optical microscope, no signs of plastic deformation were observed. Thus, the authors concluded that both files were safe for use in the endodontic treatment of multirooted teeth.

There are certain socioeconomic settings in which the use of reciprocating systems may not be considered a viable option because of their cost or are otherwise not considered the best choice in terms of health economics. Furthermore, although the multiple use of reciprocating instruments is a reality (whether in more than 1 tooth or in more than 1 root in a single tooth) and has been preliminarily investigated, no clear standardized protocol for it is yet available. To date, and to the best of our knowledge, no clinical study has been conducted to evaluate the fracture rate of reciprocating instruments used for more than 1 clinical case of multirooted teeth. Thus, with the aim of shedding light on deciding whether reciprocating instruments should be used in more than 1 clinical case of multirooted teeth, this study evaluated the fracture resistance of the Reciproc R25 and WaveOne Primary instruments according to the number of uses during the preparation of root canals in up to 3 posterior teeth.

Materials and Methods

The study protocol was approved by the institutional research ethics committee (opinion no. 560.834). An *ex vivo* pilot study was conducted to establish our methodology and protect patients from possible unforeseen risks. It involved using 12 extracted teeth and the same instrument types and number of uses used in the main study.

Three endodontic specialists working routinely with the WaveOne and Reciproc systems for over 4 years performed all the clinical procedures. The operators and researchers discussed and agreed upon a written protocol for all treatment and evaluation procedures as described later. Any required deviation from this protocol because of individual clinical circumstances or patient needs prompted the exclusion of the case from the study sample.

A sample size calculation was performed using Cochran's method. Based on a type I error of 0.05, a sample size of 385 would be required to detect differences between the 2 study groups. Therefore, a total of 386 molars and premolars were selected from patients who sought care from the endodontists involved in the study.

The teeth had indications for conventional endodontic treatment for curative or prosthodontic purposes. Patients having teeth with incomplete root formation, curvatures greater than 45° (13), calcified canals, canals with a radiographically visible double curvature, and previous endodontic treatment were excluded from the study.

During the study, dropouts accounted for a total of 26 teeth, leaving a final sample of 360 teeth for which a total of 120 instruments were assigned to perform the treatment. Thus, each of the 60 WaveOne Primary and 60 Reciproc R25 instruments were used to treat 3 teeth, totaling 180 cases treated using each of the studied systems.

The choice of the file to be used in each case was determined at random using software available at www.random.org. Numbers 1 through 6 were used to assign instruments to cases as follows: 1: Primary file, first use; 2: Primary file, second use; 3: Primary file, third use; 4: R25 file, first use; 5: R25 file, second use; and 6: R25 file, third use.

Access was obtained conventionally with spherical diamond burs with sizes compatible with the volume of each pulp chamber used at high speed. Once the form of convenience was established, isolation was conducted, and straight-line access to canal orifices was obtained with CPR 3D ultrasonic inserts (Obtura Spartan, Algonquin, IL) under 8× magnification. The canals were explored with K-type #08 or #10 hand files (Dentsply Maillefer) depending on the initial diameter of the foramen and the degree of curvature of the canal using a watch-winding motion up to 2 mm short of the initial length of the tooth.

Afterward, the cervical third of the root canals was prepared with a reciprocating instrument, either WaveOne (Primary) or Reciproc (R25), using 3 in-and-out movements and incorporating a brushing action of the instrument against the canal walls followed by irrigation with 5 mL 2.5% sodium hypochlorite. The middle third was then prepared as performed for the cervical third.

The working length (WL) was established 1 mm short of the apical foramen using a Mini Root ZX II electronic foraminal locator (J Morita Corp, Fushimi-ku, Kyoto, Japan). Then, the apical third of the root canals was prepared, repeating the same movement until reaching the WL, and verified with a #25 K-type file.

A total of 25 mL irrigating solution was dispensed with a 24-G needle (Max-I-Probe; Dentsply Tulsa Dental, York, PA) during access and with a 31-G NaviTip needle (Ultradent Products Inc, South Jordan, UT) when reaching the WL after each file insertion. The canals were kept filled by the irrigating solution, which was continuously renewed.

The instruments were driven by a VDW Silver Reciproc electric motor in "Reciproc All" and "WaveOne All" modes (preprogrammed speed and torque), respectively, for Reciproc and WaveOne instruments. Foramen patency was checked with a #10 K-type file inserted 1 mm beyond the tooth's real length and was maintained during the entire instrumentation procedure.

Whenever apical enlargement was needed at the end of the reciprocating instrumentation of the apical third, as in palatine and distal canals, this was done with large or R40 files (Reciproc) depending on the system previously used for root canal preparation. After completing the canal shaping procedure, irrigation/aspiration was performed with 5 mL 17% EDTA. This solution was maintained in the root canal for 3 minutes followed by irrigation with 5 mL 2.5% sodium hypochlorite. Final suction was performed with a capillary tip (25.0 × 0.35 mm). The canals were dried with absorbent paper cones.

All the instruments were observed with a dental operating microscope (Opmi Pico; Carl Zeiss, Göttingen, Germany) under 8× magnification after each use. The following visual criteria were adopted to control how many times the instruments were used:

1. First-use files: instruments that were used immediately after being removed from the original manufacturer blister, still having an intact silicone ring. After the first use, these instruments underwent a cleaning process in an ultrasonic bath with an enzymatic detergent for a period of 20 minutes. Afterward, they were placed in individual packages and sterilized by autoclaving at 134°C for 24 minutes (2340EK; Tuttnauer USA Co, Hauppauge, NY).