Rotary Versus Reciprocation Root Canal Preparation: Initial Clinical Quality Assessment in a Novice Clinician Cohort

Hamid R. Hamid, DDS, MSD, Alan H. Gluskin, DDS,* Ove A. Peters, DMD, MS, PhD,*† and Christine I. Peters, DMD*†*

Abstract

Introduction: Reports comparing clinical outcomes using nickel-titanium (NiTi) reciprocating instruments with other instrumentation modalities are scarce. This study examined initial shaping outcomes after an instrumentation change of root canal instrumentation technique in a doctor of dental surgery educational program. Student characteristics, faculty/student ratio, facility, and overall endodontic treatment guidelines remained unchanged. **Methods:** A total of 200 nonsurgical initial molar root canal treatments completed by third-year dental students were evaluated. The cases were examined regarding the number of treatment appointments, access cavity preparation, canal taper, canal transportation, perforations, missed canals, presence of ledges, fractured instruments, obturation length, obturation quality, and sealer extrusion. Two independent evaluators determined the number of appointments per case; 4 independent and blinded evaluators analyzed radiographs at 4 treatment stages: preoperative situation, working length, cone fit, and obturation. **Results:** The following factors were significantly different between the 2 cohorts: the number of appointments, preparation length, taper, and occurrence of ledges. The WaveOne (Dentsply Sirona, York, PA) cohort had a significantly reduced treatment time compared with hand/GT rotary instrumentation (Dentsply Tulsa Dental, Tulsa, OK) (average of 3.3 vs 4.3 appointments). Appropriate length control and adequate taper were significantly more frequent in the WaveOne group. The frequency of ledges was significantly larger in the hybrid group. Other variables, such as access cavity preparation, canal transportation, perforations, missed canals, fractured instruments, obturation quality, and sealer extrusion, were statistically similar between the 2 groups. **Conclusions:** NiTi reciprocation instrumentation was superior to hybrid hand/NiTi rotary instrumentation in reducing both patient appointments and the incidence of ledging and in improving obturation length and taper in a dental student clinic setting. *(J Endod 2018;■:1–6)*

Key Words

Canal preparation, clinical, quality assessment, reciprocation, rotary

Significance

Used by novice practitioners in a dental school setting, molar root canal preparation with a reciprocating instrument system resulted in superior immediate clinical outcomes compared with a hybrid technique with a tapered nickel-titanium rotary instrument and apical finishing with a set of K-files.

A principal aim of endodontic treatment is the prevention and treatment of apical periodontitis (1), a goal frequently accomplished through nonsurgical treatment. Root canal treatment procedures include mechanical preparation, chemical irrigation, and fluid-tight obturation of the root canal system. In 2006, the European Society of Endodontology issued quality guidelines on the working length, preparation, irrigation, and outcome assessment (2).

Besides the assessment of symptoms such as spontaneous pain, swelling, and sinus tracts, clinicians evaluate radiographic images to judge the quality of the endodontic treatments rendered. Despite an increasing availability of small field of view cone-beam computed tomographic scans, intraoral radiography remains the most universally used imaging method in dental practices (3, 4). Periapical radiography is the primary means to evaluate preparation diameter, centeredness and length, density of root canal fills, procedural errors, and healing of periapical pathosis (5).

Biologic and technological advancements have improved scientific understanding and treatment of pulpal and periapical disease. For example, the introduction of nickel-titanium (NiTi) rotary instruments has considerably decreased the frequency of severe canal preparation errors during root canal therapy (6, 7). In addition, NiTi preparation rendered decontamination of infected root canals more efficient by preventing canal obstructions. Despite these advantages, challenges such as file fractures remain an issue in canal preparation (8). Instruments used in continuous rotation may fracture because of flexural fatigue and torsional stress (9). As a consequence, reciprocating instruments were introduced with the specific goal of increasing cyclic fatigue resistance (10). Yared (11) documented effective canal preparation in a case series using

From the *Department of Endodontics, University of the Pacific Arthur A. Dugoni School of Dentistry, San Francisco, California; and †University of Queensland Dental School, UQ Oral Health Center, Herston, Queensland, Australia.

Address requests for reprints to Dr Christine I. Peters, Department of Endodontics, Arthur A. Dugoni School of Dentistry, 155 5th St, San Francisco CA 94103. E-mail address: cpeters@pacific.edu

0099-2399/$ - see front matter

https://doi.org/10.1016/j.joen.2018.04.017

reciprocating motion for ProTaper F2 NiTi instruments (Dentsply Maillefer, Ballaigues, Switzerland). He described a technique in which after initial canal negotiation using a single size #8 K-file or instrumentation to a size #15 K-file in cases of significant canal curvature, a single F2 rotary file powered in reciprocating motion completed canal instrumentation. Yared's work (11) was based on the results of 2 studies: the principle of balanced force described by Roane et al in 1985 (12) and a dissertation (13) that investigated the degree of rotation a file can undertake before breaking.

In their current form, reciprocating preparation techniques use single-use files of greater taper and are often made of heat-treated NiTi alloys. The cutting motion is an asymmetric clockwise/counterclockwise rotation (14, 15).

In vitro research has indicated that reciprocating rotary NiTi files are associated with a decreased incidence of file fracture (15, 16), an increased fatigue life span (17), and preservation of the original canal anatomy (18). Besides the reduction of torsional loading and flexural fatigue, other benefits of single-use files are considered to be cost-effectiveness and efficiency (19). Furthermore, single-use instruments reliably eliminate cross contamination (eg, with prion particles that are resistant to autoclave sterilization) (20).

However, one downside of simplified single-file techniques is the limited number of file sizes per system and, consequently, selectable apical finishing diameters. Nevertheless, reciprocating NiTi file systems appear to be a relatively easy-to-manage choice of instrumentation for dental students with limited experience in clinical endodontics.

Endodontics is a challenging subject to teach; in 1924, Blayney (21) described certain difficulties and the need for an optimized methodological strategy in teaching endodontics to dental students. Specifically, problems in teaching diagnosis, the importance of documentation, and the benefits of using extracted teeth for instrumentation (21) were highlighted. Supporting this educational challenge, an *in vitro* micro–computed tomographic study found that instrumentation performed by undergraduate students was variable in quality (22).

To assess success or failure, principal outcome parameters are delineated. Carr (23) defined 3 types of endodontic outcomes: process centered, disease centered, and patient centered. For example, a process could be represented by scrutinizing cleaning and shaping of a root canal, disease outcome by ascertaining healing of apical periodontitis, and patient satisfaction through evaluating the resolution of pain and tooth survival (23). Patient-centered outcomes and measurements shift the focus away from classic disease-centered outcomes and eliminate procedural results that do not directly benefit the patient or consider the patient's wishes and well-being (24, 25).

Starting from the academic year 2013 to 2014, the Arthur A. Dugoni School of Dentistry in San Francisco, CA, implemented a change of instrumentation technique. Instead of using hand and rotary files, the students switched to preparation of all root canals with reciprocating files.

To date, there is no clinical study documenting the impact on patients associated with rotary and reciprocation instrumentation in addition to evaluating treatment quality. The aim of this study was to investigate whether switching dental students from hybrid rotary/hand preparation to reciprocating NiTi instruments (WaveOne [WO]; Dentsply Sirona, York, PA) affected the clinical quality of preparation, obturation, and the number of appointments for nonsurgical molar root canal treatments.

Materials and Methods

The institutional review board of the school of dentistry approved the study under process number #16-155. Study subjects were patients who received nonsurgical endodontic treatment of molars by dental students at the school of dentistry in their final academic year. The time frames investigated were 2010 to 2011 (hybrid group, $n = 422$) and 2013 to 2014 (WO group, $n = 451$).

In the hybrid group, the following protocol was used for root canal preparation: K-file hand instrumentation (Lexicon K-Files; Dentsply Tulsa Dental, Tulsa, OK) to a glide path size #20 and orifice enlargement with Gates Glidden burs (Lexicon Gates Glidden drills #2–4, Dentsply Tulsa Dental) in the coronal one third of the root canal. GT rotary instrumentation was accomplished in a crown-down fashion starting with GT #20/.10 (Dentsply Tulsa Dental) followed by #20/.08 and then #20/.06 to 2 mm short of the working length. K-file hand instrumentation to a minimum size #25 or the first file to bind completed the apical preparation. A step-back procedure in 1-mm increments followed until merging with crown-down rotary enlargement was achieved and the files no longer cut at their respective length.

In the WO group, the protocol steps were as follows: K-file hand instrumentation to a glide path size #20, and then WO reciprocating files size 25/.08 (primary) or 40/.08 (large) were used to the full working length (Fig. 1).

In both groups, obturation occurred with cold lateral condensation using standardized .02 taper gutta-percha cones (Lexicon, Dentsply Sirona) and Roth's 801 sealer (Roth International, Chicago, IL) in conjunction with finger spreaders (assorted Lexicon finger spreaders, Dentsply Sirona) or hand spreaders (Lexicon spreader, Dentsply Sirona).

Cases of nonsurgical retreatment were excluded from the study. Students in both groups received training in the respective technique with identical clock hours and teaching methodology and the same preclinical course instructors.

Except for the instrumentation technique, all other treatment variables remained identical between the 2 experimental groups. Variables included the number and education level of faculty, the type of clinical facility, rubber dam isolation, irrigation with 1:1 diluted sodium hypochlorite (Chlorox, Oakland, CA), the use of a size #8 or 10 K-file for patency confirmation, the use of size #10 to #20 K-files for glide path preparation, and the obturation technique.

Patient Sample

The sample size for the present retrospective analysis was determined through a power analysis based on a preliminary study of 30 randomized cases, 15 per treatment arm. The preliminary investigation provided a mean value of 3.93 appointments (standard deviation ± 0.70) for the hybrid group with a mean value of 2.92 appointments (standard deviation ± 1.11) for the WO group. A 2-tailed power analysis with an alpha value of 0.05 and a beta of 0.02 indicated that the study required 37 cases per group for this patient-centered aspect of the study. For the second aspect of the study, treatment quality assessment and the incidence of preparation errors, overall low-occurrence frequencies were noted. For example, in the preliminary data set, the proportion of rotary or reciprocating instrument fractures was 5% in the hybrid group and 1% in the WO group. Based on these rates of occurrence and using the same alpha and beta values as before, a sample size of 98 cases per group was deemed appropriate. It was decided that the final data set should consist of 100 cases per treatment arm.

Randomization was achieved by creating 2 spreadsheets with 100 unique random numbers produced by a Web-based algorithm (www.random.org) in which the range was set to the number of cases per given year. Inclusion criteria were the presence of complete records, treatment notes, and radiographs.