Cleaning and Shaping Oval Canals with 3 Instrumentation Systems: A Correlative Micro–computed Tomographic and Histologic Study

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Abstract

Introduction: The present study evaluated the cleaning and shaping ability of 3 instrumentation systems in oval canals of extracted vital teeth using a correlative analytic approach. **Methods:** Oval distal canals from 33 freshly extracted mandibular molars with pulp vitality were scanned by micro–computed tomographic (micro-CT) imaging for sample selection. Specimens matched by anatomic similarities were distributed into 3 experimental groups according to the instrument system to be evaluated: the Self-Adjusting File (SAF; ReDentNOVA, Ra'anana, Israel), TRUShape (Dentsply Sirona, Tulsa, OK), and XP-endo Shaper (FKG Dentaire, La Chaux-de-Fonds, Switzerland). The irrigant was 5.25% sodium hypochlorite heated at 37°C. After rescanning with micro-CT imaging, the unprepared surface areas were identified, measured, and then histologically evaluated for the amount of pulp remnants in each root third. **Results:** When the apical 4-mm canal segment was evaluated, the SAF exhibited significantly less unprepared areas than the XP-endo Shaper ($P < .05$), and there were no significant differences for the other comparisons ($P > .05$). Analysis of the full canal length showed no statistically significant differences between the 3 tested systems ($P > .05$). Likewise, the tested systems did not differ significantly in cleaning the unprepared walls ($P > .05$). **Conclusions:** There was no significant difference in the amount of unprepared surface areas between the 3 instrument systems, except for the comparison between the SAF and XP-endo Shaper in the apical 4-mm segment. None of them prepared 100% of the root canal walls. The cleaning ability of the 3 systems was similar. *(J Endod 2017;■:1–7)*

Key Words

Cleaning and shaping, endodontic treatment, histology, micro–computed tomography

Significance

The cleaning/shaping efficacy of 3 instrumentation systems was evaluated in oval root canals. The SAF instrument left less unprepared areas in the apical canal than the XP-endo Shaper, but cleaning was similar. The 3 systems performed similarly in cleaning/shaping the full canal length.

Oval-shaped canals pose a significant challenge for adequate root canal cleaning, shaping, and disinfection, especially when rotary instruments are used for preparation (1). This is because rotary instrumentation usually sculpts a round cross-sectional shape, which leaves behind untouched recesses in the extremities of the largest diameter of the oval canal. The incidence of oval-shaped canals is high in mandibular incisors, maxillary second premolars, and the distal root of mandibular molars (2). Studies using micro–computed tomographic (micro-CT) imaging have revealed that the amount of unprepared canal surface areas ranges from 5%–80% in oval-shaped canals after using different instrumentation techniques (3–10).

Instruments with different designs and concepts have been introduced to deal with canals with complex anatomy, including oval-shaped canals. They include the Self-Adjusting File (SAF) (ReDentNOVA, Ra'anana, Israel), TRUShape (Dentsply Sirona, Tulsa, OK), and XP-endo Shaper (FKG Dentaire, La Chaux-de-Fonds, Switzerland) systems.

The SAF instrument was designed to adapt tridimensionally to the cross-sectional shape of the canal. Its abrasive surface enables the root canal to be widened with no significant alteration of its original form (11). In addition, the instrument operates under a continuous flow of irrigant that circulates through its hollow cylinder. Studies have reported good results for the SAF when it comes to cleaning and disinfection of oval-shaped root canals (12–14). As for the shaping ability in oval canals, studies have reported an occurrence of 6%–35% of unprepared walls after using the SAF system (4, 7–9, 15).

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The TRUShape 3-dimensional (3D) conforming file is made from a thermally treated nickel-titanium alloy. It features an S-curve in its longitudinal axis to provide greater surface contact with the root canal walls and, consequently, has the potential to improve preparation of oval-shaped canals. The TRUShape system is available in the following sizes/tapers: 20/.06v, 25/.06v, 30/.06v, and 40/.06v; v stands for a taper of .06 in the apical 2 mm, which is otherwise variable along the instrument working part. The TRUShape system promoted greater preservation of dentin than Vortex instruments (Dentsply Sirona), but the amount of unprepared areas was similar between the 2 systems (6). Another study evaluating the amount of unprepared surface areas in oval canals showed that, at full canal length, TRUShape instruments worked better than Reciproc instruments (VDW GmbH, Munich, Germany) (16). However, exclusive analysis of the apical canal showed no difference between them.

The XP-endo Shaper is an innovative broad-spectrum shaping instrument that is made with the MaxWire alloy (Brasseler, Savannah, GA). Like SAF, it is a "1-file shaper." At the body temperature within canals, the XP-endo Shaper is claimed to expand and contract to adapt itself to the canal morphology. The instrument has a size/taper of 30/.01, which, according to the manufacturer, makes it more flexible and resistant to cyclic fatigue. The XP-endo Shaper can reach a final canal preparation of a minimum of 30/.04. Its Booster Tip enables the instrument to start shaping a canal with the initial diameter smaller than the instrument's. So far, no studies have evaluated the ability of the XP-endo Shaper to clean and shape oval canals.

Micro-CT technology has been widely used to evaluate the amount of unprepared root canal surface. Numerous studies have revealed that a relatively large amount of surface area of the main canal remains uninstrumented, especially in oval canals, irrespective of the instruments used (4, 6, 17, 18). Untouched areas have been suggested to harbor remnants of bacterial biofilms and pulp tissue (4, 19). This has been confirmed by a recent study evaluating the morphologic conditions of the uninstrumented canal surfaces; using a correlative micro-CT and microscopic approach, Siqueira et al (20) reported that, except for the coronal portion of canals with vital pulps, most uninstrumented areas from vital and necrotic teeth contained tissue remnants and/or bacteria.

The present study was undertaken to evaluate the cleaning and shaping efficacy of the SAF, TRUShape, and XP-endo Shaper systems in oval root canals. Sodium hypochlorite (NaOCl) was used as the irrigant. Shaping was evaluated by micro-CT imaging. Cleaning of the uninstrumented areas revealed by micro-CT imaging was evaluated by correlative histologic analysis.

Materials and Methods

Specimen Selection and Preparation

The study protocol was approved by the institutional ethics committee of human research. Thirty-three vital human mandibular molars freshly extracted for reasons not related to this study were selected. Immediately after extraction, teeth were stored in 10% buffered neutral formalin. Pulp vitality was confirmed by the presence of bulk soft tissue in the pulp chamber after access preparation and later by histologic analysis. The inclusion criteria considered only distal roots with a single canal that was oval-shaped 3 mm short of the apex based on buccolingual and mesiodistal radiographic projections. To be considered oval shaped, the canal had to present a buccolingual distance at least twice as large as the mesiodistal distance (11).

Cusps were reduced up to 2 mm from the cementoenamel junction to establish a plateau, conventional access cavities were prepared, and the 2 roots were separated. The distal roots were subjected to preoperative scanning in the SkyScan 1174 v.2 micro-CT device (Bruker micro-CT, Kontich, Belgium) using the parameters described later. The mesial roots were stored in 10% neutral buffered formalin and served as controls (root canals that were not instrumented/irrigated) for histologic processing.

Teeth were matched in trios according to the similarities in micro-CT measurements of preoperative canal volume, canal surface area, and specimen length as well as the root curvature as determined by Schneider's method (21). A specimen from each trio was randomly assigned (www.random.org) to each of the 3 experimental groups (n = 11): SAF, TRUShape, and XP-endo Shaper.

Size 10 and 15 K-files (FKG Dentaire) were used to explore the root canal until the instrument tip was seen at the apical foramen using a stereomicroscope. This measure was recorded as the patency length, and the working length (WL) was set 1 mm shorter. The apical foramina of each root were sealed with Topdam (FGM, Joinville, SC, Brazil) in order to create a closed-end system. The root was wrapped in moistened gauze and held by a metal clamp for stabilization during all preparation steps on a benchtop.

The SAF System

Before preparation with the SAF, the root canal was irrigated with 1 mL 5.25% NaOCl, and then the coronal 3-mm segment of the canal was enlarged using the Pre-SAF Orifice Shaper (#40/.10, ReDentNOVA) with gentle strokes and operated at 600 rpm (1.5 Ncm). Afterward, irrigation was performed with 1 mL NaOCl, and a glide path to the WL was created using hand K-type size 15 and 20 files (FKG Dentaire) and the pre-SAF 2 instrument (#20/.04, ReDentNOVA). The canal was irrigated with 1 mL NaOCl after each hand instrument change and 2 mL after pre-SAF 2. A size 10 file was used to check and maintain the patency of the root canal any time an instrument was removed from the canal.

Root canals were prepared with the SAF 2.0-mm instrument used for 4 minutes at the WL under continuous irrigation with 5.25% NaOCl at 5-mL/min flow. The SAF instrument was coupled to an in-and-out vibrating handpiece (GENTLEpower; KaVo, Bieberach/Riß, Germany) combined with an RDT3-NX head (ReDentNOVA) at 5000 rpm and an amplitude of 0.4 mm powered by an EndoStation (ReDentNOVA), which was equipped with a peristaltic pump for simultaneous and continuous irrigation. Each root canal was instrumented with a single SAF.

The TRUShape System

After irrigation with 1 mL NaOCl, the coronal 3-mm segment of the canal was enlarged with the Orifice Modifier instrument (20/.08) (Dentsply Sirona) followed by irrigation with 2 mL NaOCl. A glide path was prepared with a #15 hand K-type file followed by irrigation with 1 mL NaOCl and then a #20 hand K-type file followed by irrigation with 2 mL NaOCl. The canal was instrumented up to the WL by the sequential use of TRUShape instruments 20/.06v, 25/.06v, and 30/.06v. Each instrument was operated in the VDW Silver motor (VDW GmbH) at 300 rpm (3 Ncm). A gentle in-and-out pecking motion of about 2–3 mm in amplitude with light apical pressure was applied to each instrument until it reached the WL. Canals were irrigated with 7 mL NaOCl after the 20/.06v and 25/.06v instruments and 6 mL NaOCl after the #30/.06v instrument delivered by a syringe and NaviTip needle (Ultradent, South Jordan, UT) placed 2 mm short of the WL.

The XP-endo Shaper

Initially, the canal was irrigated with 1 mL NaOCl, and a Scout RaCe 15/.02 instrument (FKG Dentaire) was used at the WL (600 rpm, 1.5 Ncm). After irrigation with 2 mL NaOCl, a glide path was created using a #15 hand K-type file followed by irrigation with 1 mL NaOCl, a hand file size 20, and then 2 mL NaOCl. The XP-endo Shaper instrument was operated in the VDW Silver motor at 800 rpm

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