Effect of EDTA Preparations on Rotary Root Canal Instrumentation

Evan R. Whitbeck, DDS, MS, Kelli Swenson, DDS, MS,* Patricia A. Tordik, DMD,* Shayne A. Kondor, MSAE,* Terry D. Webb, DDS, MS,* and Jirun Sun, PhD†*

Abstract

Introduction: The aim of this study was to evaluate whether rotary instrumentation using saline, EDTA 17% solution, or RC-Prep (Premier Dental, Philadelphia, PA) resulted in differences in root canal transportation. The secondary objective was to assess if instrumentation using these agents caused changes in the working length and canal volume. **Methods:** Moderately curved mesiobuccal roots of 24 maxillary molars were standardized in length and randomized into 1 control and 2 experimental groups. The canals were instrumented with 0.04 taper rotary files to size #30. All groups were irrigated with saline. Group 1 was also irrigated using EDTA 17% solution (Pulpdent Corp, Watertown, MA), and in group 2, RC-Prep was used. X-ray micro–computed tomographic scans and working length measurements were made before and after instrumentation. Three-dimensional models were created from the pre- and postinstrumentation scan data and compared for volume changes. Centroid points were calculated in cross-sectional slices of the canals, and transportation was determined by measuring the distance between the pre- and postinstrumentation points. The data were analyzed with 1-way analysis of variance (α = 0.05) and the Tukey post hoc test. **Results:** Less transportation was observed in group 2 than in group 1 (P = .001) and the control group (P = .014). Transportation in group 1 and the control group was not significantly different. Canal volume in group 1 was increased relative to group 2 (P = .004) and the control group (P = .022). No significant differences in the working length were observed. **Conclusions:** The use of chelating agents during root canal instrumentation did not significantly increase apical transportation. *(J Endod 2015;41:92–96)*

Key Words

Chelating agents, EDTA, root canal preparation, transportation, x-ray micro–computed tomographic imaging

From the *Naval Postgraduate Dental School, Bethesda; and †Dr Anthony Volpe Research Center, American Dental Association Foundation, Gaithersburg, Maryland.

Address requests for reprints to Dr Evan R. Whitbeck, Naval Postgraduate Dental School, 8955 Wood Road, Bethesda, MD 20889-5628. E-mail address: whitbeck.evan@gmail.com

0099-2399/$ - see front matter

Published by Elsevier Inc. on behalf of American Association of Endodontists.

http://dx.doi.org/10.1016/j.joen.2014.07.023

Maintaining the original canal morphology during endodontic treatment, including minimizing transportation, has been shown to increase healing by up to 40% (1).

EDTA was introduced to endodontics in 1957 and was advocated to decrease instrumentation time, with minimal effects on the oral tissues and root canal instruments (2). Despite a lack of evidence showing improved outcomes, contemporary indications for EDTA include canal lubrication during rotary instrumentation (3), enhanced antibacterial activity (4), and smear layer removal (5,6).

It is unclear whether EDTA use during instrumentation increases apical transportation. More deviation was reported in curved canals prepared with EDTA (7), but the concentration, volume, and contact time of the chelator was not disclosed (7). Prolonged use of EDTA has been shown to cause excessive erosion with increased tubule aperture size (6). Conversely, 0.08-mm apical transportation was reported among curved canals prepared with a 6-minute, intermittent EDTA irrigation versus no deviation in a saline control, but the difference was not significant (8).

Root canal curvature can be assessed several ways. Schneider (9) drew 2 lines on a radiograph and measured the acute angle formed. When measured before and after instrumentation, the angulation change indicates canal transportation. Canal preparation and transportation can also be assessed by photographing cross-sections of teeth before and after instrumentation (10). Each technique has limitations. The Schneider technique measures curvature in 1 plane, whereas photographing cross-sections requires disassembly and reconstruction of the specimen.

X-ray micro–computed tomographic (micro-CT) imaging is a newer technology available to researchers. With voxel resolutions as small as 15 μm (11), computer software can fabricate 3-dimensional (3D) models of the internal and external tooth surfaces with great accuracy (12, 13). Studies have used micro-CT scanning to evaluate changes in canal volume, surface area, and transportation after instrumentation with different filing systems (14, 15). This technique is nondestructive (13) and superior to other methods for assessing canal transportation (16). Despite these benefits, no studies have used micro-CT imaging to assess canal transportation when instrumenting curved canals with chelating agents.

The primary objective of this study was to evaluate whether rotary instrumentation using saline, EDTA 17% solution, or RC-Prep (Premier Dental, Philadelphia, PA) resulted in differences in root canal transportation. The secondary objective was to determine if instrumentation using these agents caused changes in the working length or canal volume. The experimental hypothesis was that apical transportation increases when chelating agents are used.

Methods

Tooth Selection

Twenty-four deidentified maxillary molars from an inventory of extracted, human teeth stored in 1% chloramine-T (Ricca Chemical Company, Arlington, TX) were selected as specimens. Each was examined under a dental operating microscope at 8× magnification (Global Surgical Systems, St Louis, MO) and radiographed in the mesiodistal and buccolingual planes. Teeth with root caries, cracks, resorption, incomplete apices, or <10 mm in root length were excluded. Teeth with ribbon-shaped or unidentifiable mesiobuccal (MB) canals were also excluded. Using Schneider's technique (9), only teeth with MB roots curved from 10°–30° in both planes were included.

Specimen Preparation

The palatal root of each tooth was removed. Endodontic access cavities were prepared using carbide burs (Dentsply Maillefer, York, PA), and the primary MB canal orifice was located. Without coronal flaring, an ISO #10 FlexoFile (Dentsply Maillefer) was placed into the canal to ensure patency. Tooth length was standardized to 19 mm by removing coronal tooth structure; the working length for each specimen was 18 mm. All measurements were confirmed with a #10 file and a digital caliper (Digimatic Caliper; Mitutoyo America Corp, Aurora, IL).

Specimens were mounted in modified polypropylene centrifuge tubes (Thermo Fisher Scientific, Waltham, MA) using acrylic resin (Varidur; Buehler LTD, Lake Bluff, IL). The distobuccal root was embedded into resin to align the MB root perpendicular to the long axis of the tube. A hole was cut in the centrifuge tube over the access cavity to enable root canal instrumentation.

Randomization and Experimental Groups

The 24 specimens were assigned a reference number and randomized into 3 groups ($n = 8$) using the random sequence generator at www.random.org. The first 8 numbers returned were assigned to the control group, the next 8 to group 1, and the final 8 to group 2. Control specimens were irrigated with 2.0 mL 0.9% saline (Baxter Healthcare Corp, Deerfield, IL) between files. In group 1, the canals and pulp chamber were flooded with EDTA 17% solution (Pulpdent Corp, Watertown, MA) before using each file. Canals were irrigated with 2.0 mL 0.9% saline between each file. In group 2, the pulp chamber was filled with RC-Prep and carried into the canals using files. Saline irrigation was performed between files, as in the other groups. All liquid irrigants were delivered using a 30-G, side-vented needle (Max-i-Probe; Dentsply Rinn, Elgin, IL). Both chelating agents were used according to manufacturers' instructions.

Canal Preparation

All specimens were instrumented using a crown-down technique with 0.04 taper nickel-titanium rotary files (ProFile; Dentsply Tulsa Dental Specialties, Tulsa, OK) to a master apical file size #30. A pilot study determined the average instrumentation time for each canal to be 9 minutes. Therefore, the total instrumentation and irrigant contact time for each tooth was standardized to 9 minutes.

Micro-CT Scanning

All tooth specimens were scanned individually using a micro-CT device (Scanco μCT40; Scanco Medical, Bassersdorf, Switzerland) at an isotropic resolution of 18 μm, I = 114 μA, E = 70kVp, and an integration time of 300 ms before and after establishing the working length and canal instrumentation.

Change in Working Length

The distance from the coronal reference point to the apical foramen was measured before and after instrumentation using a size #10 file. The difference in length was recorded for each specimen.

3D Modeling

Preinstrumentation and postinstrumentation models of the MB canal were created using 3D modeling software (Mimics 15.0; Materialise, Leuven, Belgium). Micro-CT data were imported as a set of planar grayscale images spaced at regular intervals along the axis normal to the image plane. Thresholding was performed to segment the voxels within the root canal by capturing only those within a specified range of gray

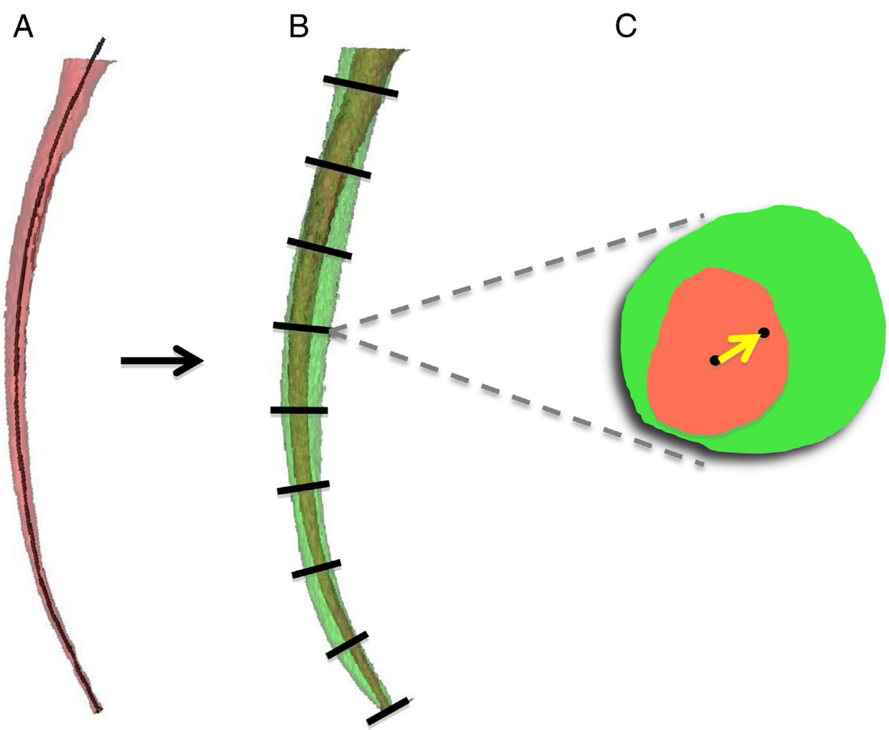

Figure 1. (*A*) A centerline was fit to the preinstrumentation model (*red*). (*B*) After superimposing the models, planes were created perpendicular to this centerline at 1-mm increments from D0–D8 in the preinstrumentation (*red*) and postinstrumentation models (*green*). (*C*) A cross-sectional view of the superimposed preinstrumentation (*red*) and postinstrumentation (*green*) planes at D5. In each cross-sectional plane, computer modeling software was used to calculate the centroid points (*black*). The movement of the centroid point between the preinstrumentation and postinstrumentation models (*yellow arrow*) was defined as transportation and measured (mm).