Effect of Instrument Design and Access Outlines on the Removal of Root Canal Obturation Materials in Oval-shaped Canals

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Abstract

Introduction: The aim of this study was to compare the effectiveness of TRUShape (TS) instruments with ProFile Vortex Blue (VB) instruments for the removal of obturation materials during retreatment of single-canal mandibular premolars performed through 2 access outlines. **Methods:** Initial root canal treatment was completed through a contracted endodontic cavity (CEC) design. Canals were instrumented to an F2 ProTaper instrument, obturated with warm lateral condensation of gutta-percha with AH Plus sealer, and allowed to set for 30 days at 37°C and 100% humidity. For retreatment, specimens were divided into 2 groups (n = 24) on the basis of access outline, CEC or traditional endodontic cavity (TEC). Retreatment was initiated by using ProTaper Retreatment instruments (D1–D3). Specimens were then stratified, further divided (n = 12), and reinstrumented up to TS 40 .06v or 40 .06 VB. Irrigation was performed by using 8.25% NaOCl and QMix 2in1. Retreatment time was recorded. Teeth were sectioned and photographed, and the percentage of remaining obturation materials was measured. Data were analyzed with Kruskal-Wallis analysis of variance for two-factor tests ($\alpha < 0.05$). **Results:** The interaction between access design and instrument type showed that the combination of CEC-VB presented significantly higher amounts of remaining obturation materials on the canal surface when compared with TEC-VB, CEC-TS, and TEC-TS ($P \leq .05$). None of these other combinations were different from each other ($P > .05$). Significantly more time was required for retreatment with CEC-TS (27.68 ± 1.4 minutes) than the other groups ($P < .05$). **Conclusions:** Neither retreatment protocol was able to completely eliminate all obturation materials from the root canal surface of mandibular premolars. However, in the presence of a CEC access design, using TS instruments removed more obturating material in single-rooted, oval-shaped canals. *(J Endod 2016;■:1–5)*

Key Words

Endodontic cavity, instrumentation efficacy, nickel-titanium instrument, ProFile Vortex Blue, retreatment, TRUShape

Significance

Choosing rotary instruments that work through smaller access cavity designs and efficiently remove all obturating materials is of clinical relevance to the practicing endodontist.

The goal of retreatment of endodontically treated teeth is to eradicate persistent or emerged apical periodontitis and provide a favorable environment for healing (1, 2). Retreatment aims to remove all filling materials from the canal system, followed by chemomechanical disinfection and obturation (3). The most common obturation material is gutta-percha in combination with a sealer or cement as a luting agent (4). Mechanical removal of gutta-percha is routinely performed by using hand files, rotary instruments, ultrasonic tips, or heating devices (5–8). The presence of residual obturation materials on root canal walls can prevent irrigating solutions and intracanal medicaments from contacting the surface of the underlying dentin, hindering disinfection (2).

A major complicating factor in the elimination of materials from root canal systems is the cross-sectional anatomy. Rotary instrumentation with nickel-titanium (NiTi) instruments often machines a round area with limitations in treatment of oval-shaped canals because instrumentation is directed largely by the shape-memory of the alloy and the canal curvature (9–11). Although brushing or circumferential filing movements are often used to overcome this challenge, a high percentage of walls still remain untouched (11). Although the overall design of NiTi engine-driven instruments is suitable for augering root-filling debris coronally, to date, no studies have shown complete removal of the obturation materials during the retreatment of root canals regardless of the technique or instruments used (4, 7, 8, 12).

Instrument designs have been progressively altered to increase their cutting efficiency and resistance to fatigue. Newer instruments have focused on alterations to the taper, cross-sectional shape, variable pitch, and helical angles (13–15). Advances have also been made in the metallurgy, optimizing the nanocrystalline structure (16, 17) and with post-grinding heat treatment (15, 16). Despite changes in metallurgy and design,

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the long axis of endodontic instruments has remained linear to a large extent. TRUShape (TS) instruments (Dentsply Tulsa Dental Specialties, Tulsa, OK) have a multi-planar S-shaped curve from the tip of the instrument to the beginning of the shank, thereby creating an envelope of motion with the aim of increasing the percentage of walls touched during instrumentation of irregular cross sections. The ability of TS instruments to compress into smaller canal spaces and return to their original shape as the canal widens could enable their use through a contracted endodontic cavity (CEC) design minimizing tooth structure removal. Few studies have examined instrumentation through CEC (18, 19), and no studies have investigated the impact such an access design would have on retreatment effectiveness.

Therefore, the aim of the present study was to compare the effectiveness of the TS and ProFile Vortex Blue (VB) rotary instruments on the removal of obturation materials from single-rooted, oval-shaped mandibular premolars through CEC or traditional endodontic cavity (TEC) access designs.

Materials and Methods

After Institutional Review Board approval (14-03594-XM), human first and second mandibular premolars were obtained from a bank of teeth and screened in clinical and proximal radiographic views. Forty-eight teeth were selected with the following inclusion criteria: intact crowns, fully formed apices, single roots and canals, 21–24 mm length, and canals wide in the buccolingual direction. All endodontic procedures were performed by a single operator under the clinical microscope at ×10.9 magnification (OPMI Pico; Carl Zeiss Meditec Inc, Jena, Germany).

Initial Root Canal Treatment

Teeth were accessed with a high-speed mosquito 392 bur (Spring Health Diamonds, St Louis Park, MN) under water spray. The CEC access approach was used in all teeth (18). Briefly, premolars were accessed 1 mm buccal to the central fossa, and cavities were extended apically, maintaining part of the chamber roof and lingual shelf. A new bur was used for each specimen.

For instrumentation and reinstrumentation procedures, canals were approached by changing the entry angle of the instruments as if the teeth presented as 2 separate systems in a buccolingual direction because of the oval shape configuration. Working length was established by visualizing the tip of ISO #10 K-file at the canal foramen and subtracting 0.5 mm. A confirmatory radiograph was exposed to ensure accurate working length, and values were recorded for all specimens. Instrumentation was performed up to F2 ProTaper instrument (Dentsply Tulsa Dental Specialties). Canals were irrigated with 2 mL 8.25% NaOCl (Clorox Professional Products Company, Oakland, CA) between instruments, followed by irrigation with 5 mL 17% EDTA (Roth International LTD, Chicago, IL) for 3 minutes and finally by 5 mL 8.25% NaOCl. Canals were dried with paper points. AH Plus root canal sealer (Dentsply De Trey GmbH, Konstanz, Germany) was applied to the canal walls by using a 30/.04 gutta-percha master cone (Brasseler USA, Savannah, GA) and obturated with modified lateral compaction of warm gutta-percha. A proximal radiograph showing dense obturation material from orifice to apex with no voids was considered adequate. If voids were observed in the obturation mass, the specimen was replaced. Access cavities were sealed with Cavit G (3M ESPE, Neuss, Germany), and the teeth were stored in 100% humidity at 37°C for 30 days to allow full setting of the sealer.

Retreatment Technique

Teeth were divided into 2 groups by using a random number generator according to the access design used for retreatment, CEC or TEC. The CEC group was composed of 24 specimens from which only the temporary restorations were removed. The remaining 24 specimens were further enlarged to a TEC with an LA Axxess high-speed diamond (SybronEndo, Glendora, CA) under water spray to allow straight-line access to the obturation material and pulp chamber and eliminate remaining pulp horns. Final access outlines are demonstrated in Figure 1*A* and *C*. In all specimens, the bulk of the obturation material was removed with ProTaper Universal Retreatment instruments (Dentsply Tulsa Dental) at pre-set lengths: D1 (30/.09, 16 mm, coronal one third), D2 (25/.08, 18 mm, middle one third), and D3 (20/.07, 21 mm, apical one third) at 600 rpm. The stratified specimens were further divided into 2 subgroups, TS and VB.

Reinstrumentation with TS was carried out as follows: 20./08v TS orifice modifier followed by 20/.06v, 25/.06v, 30/.06v, and 40/.06v. The instruments were used passively at 300 rpm in the presence of 8.25% sodium hypochlorite, with gentle 2–5 mm pecking motions up to the mid-root and 2–3 mm pecking motions toward working length. The remaining 24 teeth were instrumented with 16 mm 20./08 ProFile Vortex Orifice Opener (Dentsply Tulsa Dental) and VB 20.06, 25.06, 30.06, and 40.06 at 500 rpm. Retreatment was considered complete when

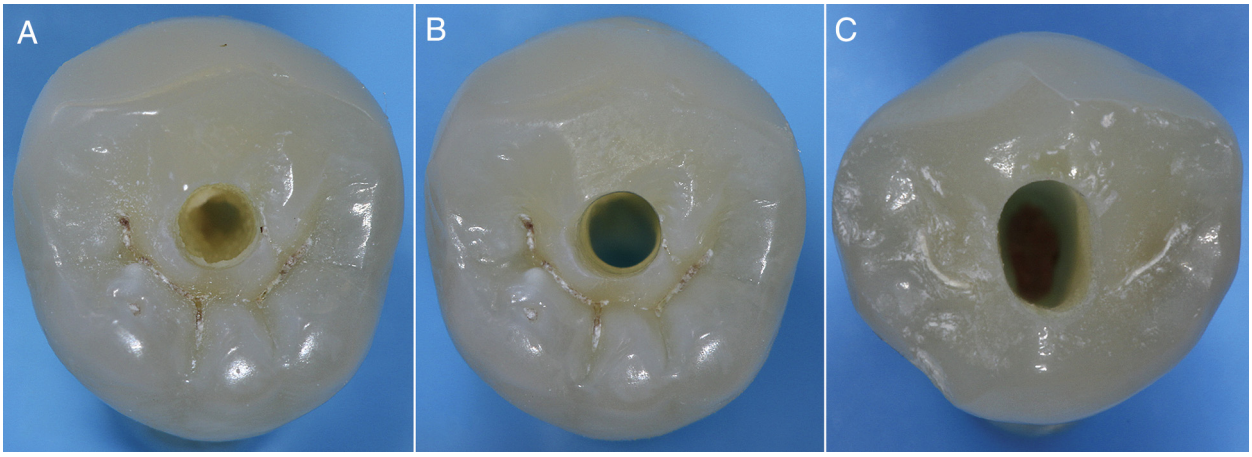

Figure 1. Photographs of occlusal surface of mandibular premolars showing (*A*) CEC before instrumentation, (*B*) CEC after instrumentation, and (*C*) TEC design.

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