The Effect of Cervical Preflaring Using Different Rotary Nickel-Titanium Systems on the Accuracy of Apical File Size Determination

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Abstract

Introduction: An exact determination of the apical root canal diameter is crucial for correct cleaning and shaping of a root canal. The aim of this study was to investigate the discrepancies of the initial apical root canal diameter and the diameter that is measured by the initial apical file (IAF) after cervical flaring using current rotary nickel-titanium systems. **Methods:** Mesiobuccal canals of 40 extracted mandibular molars were randomly assigned to four groups. In the first group, root canals were not flared. Root canals of the other groups were preflared using FlexMaster (VDW, Munich, Germany), ProTaper (Dentsply, Konstanz, Germany), or RaCe (FKG Dentaire, Genf, Switzerland) instruments. The tooth length was determined by inserting an ISO 06 K-file to the apical foramen. The working length (WL) was set 1 mm short of the apical foramen. File sizes were increased after binding sensation was felt at the WL. Transversal sections of the WL regions were examined under stereomicroscope, and the diameter of the root canal and the IAF at WL were assessed. **Results:** Canals preflared with RaCe instruments had the lowest discrepancy between the apical root canal diameter and the IAF diameter (15.7 $\pm$ 9.7 μm) followed by ProTaper (22.2 $\pm$ 11.0 μm) and FlexMaster (35.0 $\pm$ 17.2 μm). **Conclusions:** Preflaring of root canals prevents underestimation of the actual apical root canal diameter. The type of instruments used for preflaring show differences on the accuracy of IAF determination. Preflaring with larger tapered instruments leads to a more accurate apical sizing, and this information is crucial concerning the appropriate final diameter for complete apical shaping. *(J Endod 2010;36:1669–1672)*

Key Words

Apical diameter, apical shaping, cervical flaring, flaring, IAF, initial apical file, preflaring, root canal

Current standards in endodontic treatment are cleaning and shaping of the root canal before filling (1). Endodontic success relies on the accurate determination of the working length (WL) and adequate enlargement of the root canal (2). The use of electronic apex locaters increases the determination of the WL and precisely localizes the apical foramen (3). The amount of apical enlargement is typically based on the estimation of the diameter at the apical constriction. The initial apical size of a root canal is determined by inserting K-files with increasing ISO size to the apex. The initial apical size of a root canal is assumed as the size of the first file that binds at the WL and is defined as the initial apical file (IAF) (1). Continued and progressive dentin formation leads to progressive constrictions, mainly at the cervical third. Any morphologic discrepancy between the gauging instrument and the root canal leads to an early instrument engagement of the root canal wall, causing a prior apical binding.

Traditional methods used for the determination of the anatomic diameter solely based on the clinician's tactile sense are inaccurate and have underestimated the real diameter of the apical portion (4, 5). As a result, apical enlargement of the root canal with three instruments with increasing file diameter does not guarantee the total removal of infected dentine from root canal walls (6). Previous studies investigated the influence of different rotary instruments for cervical flaring on the determination of the IAF (7–9). In these studies, hand files, Gates-Glidden drills, and different types of rotary instruments were used for preflaring (5, 8–10).

The objective of the present study was to investigate the influence of preflaring using current and widely used rotary nickel-titanium instruments (FlexMaster [FM; VDW, Munich, Germany], ProTaper [PT; Dentsply, Konstanz, Germany], and RaCe [RC; FKG Dentaire, Genf, Switzerland]) for cervical flaring on the determination of the IAF. These systems include files with a large taper for cervical flaring of the root canal and files for apical enlargement.

Materials and Methods

Tooth Selection and Preparation

For this study, only mesiobuccal root canals of 40 intact extracted permanent mandibular molars displaying normal pulp chambers, patent root canals, and fully formed apices without any sign of resorption were used. No tooth has had a previous root canal treatment or root filling. The roots had a slight or severe curve with an angle from 10° to 70°. The angle of the curve was defined as described previously (11). The cusps of the teeth were cut horizontally to get a plane occlusal zone to determine the working length precisely. Standard access cavities were performed, and the apical region of the mesial root was covered with wax. Teeth were embedded in methacrylate

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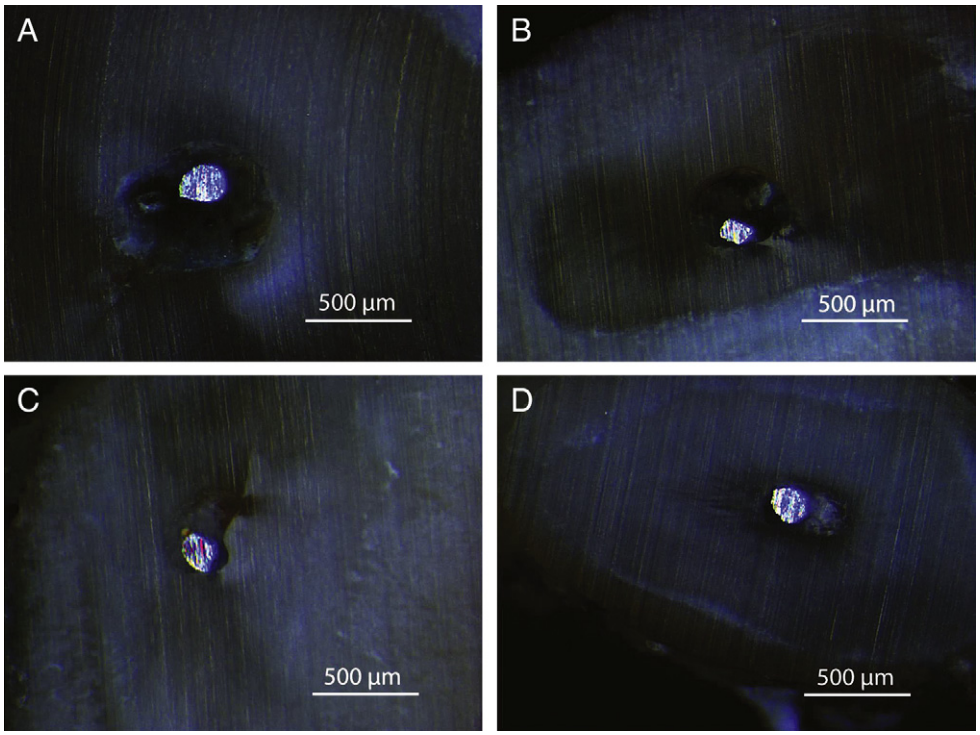

Figure 1. Stereomicoscope pictures of transverse sections of root canals at the WL with the IAF fixed in the root canal to show the discrepancies of root canal diameter and diameter of the IAF of (*A*) nonflared root canals and root canals preflared using (*B*) FM, (*C*) PT, and (*D*) RC instruments. (This figure is available in color online at www.aae.org/joe/.)

(Techovit 4070; Haereus Kulzer, Wernheim, Germany). The apical foramen was not covered by methacrylate.

Sizing of Canals

The precise tooth length was specified by inserting an ISO 06 K-file (VDW) into the canal until the file was visible at the apex. Then, the file was placed exactly at the apex of the tooth to determine tooth length using 5× magnification. The WL was set 1 mm short of the tooth length.

Flaring the Coronal and Middle Section of the Root Canals

Coronal and middle flaring were performed using FM, PT, or RC instruments in combination with Endo IT Professional (VDW) at 250 rpm. The 40 molars were randomly divided into four groups (n = 10). Teeth of the first group were not flared (NF). Coronal flaring of the teeth of the other groups was performed using FM, PT, or RC instruments. Flaring was perfomed system specific according to the manufacturer's recommendation for each system. Flaring of the FM group was performed using the intro file (0.11/22) of the FlexMaster instruments. Then, files 0.06/25 and 0.04/25 were used for flaring terminating 3 mm short of the WL. Teeth of the PT group were flared coronal to two thirds of the WL using ProTaper SX (ISO 19, taper 3.5%-19%), S1 (ISO 17, taper 2%-11%), and S2 (ISO 20, taper 4%-11.5%) instruments. Coronal flaring of teeth of the RC group was performed using RC instruments. Files of size 0.10/40 and 0.08/35 were used for flaring 10 mm of the WL. Then, the IAF was determined. Each file was used for flaring 5 root canals.

Determination of IAF

Files were inserted into the mesiobuccal root canal starting with K-file ISO 08/02 at the WL. At ISO 10, the file size was typically increased in increments of 5 ISO units or 5×10^{-2}. The first file that had apical friction at the WL was fixed with methacrylate in the root canal. One millimeter of the apex of the root was cut horizontally with a microcutter (Exact, Norderstedt, Germany) so that the remaining tooth was at the WL. The apical cross-section was visualized using a Leica M3Z System (Leica, Bensheim, Germany), and images were taken from the sectioned apical region using a Zeiss AxioCam MRc 5 system (Carl Zeiss Imaging Solutions, Hallbergmoos, Germany). Axio Vs 40 V 4.5.0.0 software (Carl Zeiss Imaging Solutions) was used to determine the diameter of the root canal and the diameter of the IAF. The largest and the smallest diameter of the root canal and the largest diameter of the instrument were recorded. Data were submitted to a nonparametric Mann-Whitney U test and one-way analysis of variance (Kruskal-Wallis) to assess the effect of preflaring techniques on the discrepancies found between the diameter of the binding instrument and the anatomic diameter of root canals.

Results

Flaring of the coronal and middle section and the type of instruments had a significant effect on apical size estimate. Preflaring with RaCe instruments leads to the most accurate determination of the IAF. In the RC group, the maximal apical root canal diameter and the diameter of the IAF had the lowest discrepancy (15.7 ± 9.7 μm), whereas ProTaper (22.2 ± 11.0 μm) and FlexMaster (35.0 ± 17.2 μm) showed greater discrepancies between the IAF diameter and apical root canal diameter (Fig. 1).

By flaring the coronal and middle section of the root canal, file size reading was increased. The IAF was determined one (FM group and RC group) to two (PT group) ISO sizes larger after cervical flaring compared with root canals without preflaring (NF group). The discrepancies of maximal root canal diameter and the IAF are shown in Table 1.