Evaluation of Two Trephine Techniques for Removal of Fractured Rotary Nickel-titanium Instruments from Root Canals

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Abstract

Introduction: The aim of this *in vitro* study was to evaluate the effects on root dentin of 2 trephining techniques using an ultrasonic tip or a trepan bur in the mesial canals of mandibular molars during attempts to remove fractured file fragments using micro–computed tomographic imaging. **Methods:** Twenty-one teeth with a similar anatomic configuration in mesial (buccal and lingual) canals were selected. A 4-mm apical segment of K3 file size 25/.06 was fractured in each mesiobuccal and mesiolingual canal 5 mm apically from the canal orifice. A staging platform was prepared at the coronal aspect of the broken instrument followed by either ultrasonics or a new trepan bur technique to expose a 1- to 1.5-mm length of the fragment. If the broken instrument could not be removed by exposing it either by ultrasound or the trepan bur, a microtube device was used to attach to and withdraw the fragment. Micro-CT scanning was performed before and after removing the broken instrument. Canal volume, diameter, and furcal root dentin thickness were measured by using image analysis software. The time required for the removal of the instrument fragments was recorded. The result was statistically analyzed using the paired *t* test. **Results:** The trepan bur technique had significantly less impact on canal volume, diameter, and furcal root dentin thickness change than the ultrasonic technique ($P < .001$). The time consumed for successful removal of the fragments was significantly less in the trepan bur group (8.9 $\pm$ 3.5 minutes) than in the ultrasonic group (25 $\pm$ 11.9 minutes) ($P < .001$). **Conclusions:** A new small-sized trepan bur technique was superior to the use of ultrasound with regard to the amount of dentin removed and the speed in the removal of fractured instruments from root canals. *(J Endod 2016;■:1–5)*

Key Words

Broken instrument removal, trepan bur, trephine technique, ultrasonic

Significance

A new small-sized trepan bur technique is superior to the use of ultrasound with regard to the amount of dentin removed and the speed in the removal of fractured instruments from molar root canals.

Mechanized nickel-titanium (NiTi) endodontic instruments are commonly used to prepare root canals. They possess good shaping ability (1) and have been suggested to result in an improved success rate of treatments (2). However, instrument separation, which sometimes occurs, may hinder root canal procedures and affect the outcome (3).

Many techniques have been used for the retrieval of separated files (4–6). Sufficient enlargement of the root canal coronal to the fragment is essential for successful retrieval. Ultrasonics has been shown to be a highly successful technique in removing separated instruments *in vitro* and *in vivo* in association with the operating microscope (7). The technique presented by Ruddle (8) is to prepare a staging platform in the pre-enlarged canal and to trephine dentin around the fractured segment using ultrasonic tips. If the direct application of ultrasonic energy does not loosen the separated instrument sufficiently to remove it, the fragment must be grabbed and retrieved. The staging platform is further reduced by trephine dentin using an ultrasonic tip until enough of the separated instrument is exposed to retrieve. This can be accomplished with a variety of techniques, many of them using some variant of a microtube. The disadvantages of the retrieval of separated files have been excessive removal of root dentin during trephine, which may result in perforation or predispose the teeth to vertical root fracture, especially in the apical third (9–12).

A Masserann Kit (Micro-mega, Besancon, France) is a traditional hollow cutting-end tube device with a diameter from 1.1–2.4 mm specifically designed for the removal of intracanal metallic objects. It requires the removal of a considerable amount of dentin because of the large diameter of the tube. Recently, a new small-diameter trepan burs system (Micro-Retrieve & Repair System; Superline NIC Dental, Shenzhen, China) with an outside diameter from 0.7–1.2 mm and thickness of 0.15 mm was introduced for the removal of instrument fragments from the root canal. The system consists of trepan bur and microtubes. In addition to a small external diameter, the bur and

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microtube length can be individually adjusted to improve access in the molar area. The trepan bur is operated with an endodontic motor in a counterclockwise direction. When the fragment is exposed to a 1- to 1.5-mm length, then the microtube is used to withdraw the fragment.

Earlier studies usually used digital photographic and radiographic images or sectioned the tooth to assess the root canal after the removal of fractured files and to measure the remaining thickness in the cross section (13). However, 2-dimensional images are not accurate for determining the actual root anatomy, the section methods are destructive, and the samples cannot be used for further studies. Thus, a more advanced and nondestructive method to investigate the root canal after the removal of fractured files is desirable. Nowadays, micro–computed tomographic (micro-CT) technology is frequently used for the study of root canal anatomy and the assessment of changes in root canal morphology by instrumentation (1, 14, 15). Madarati et al (16) used micro-CT scanning to assess changes of root canal space after the removal of fractured files using the ultrasonic technique in canine teeth. However, instrument separation often occurs in narrow and curved canals, such as mesiobuccal canals of maxillary molars and the mesial canal of mandibular molars, because of their canal curvature and complex anatomy (17). Therefore, the purpose of this study was to use micro-CT imaging to evaluate the root canal volume, diameter, and furcal root dentin thickness changes in mandibular molars after attempted removal of the fractured fragments with 2 trephining techniques: ultrasonics or a new small-diameter trepan bur technique. The null test hypothesis was that the 2 trephining techniques do not affect root canal volume, diameter, and furcal root dentin thickness in mandibular molars during attempts to remove file fragments.

Materials and Methods

Sample Preparation

Forty-three extracted mandibular intact molars collected from a native Chinese population were ultrasonically cleaned and stored in thymol solution until used. The study has been approved by the university ethics board (WCHSIRB-D-2013-171). The teeth were scanned using a micro-CT system (μCT-50; Scanco Medical, Bassersdorf, Switzerland) with an isotropic voxel size of 30 μm. The scanned data were processed on an HP 6600W workstation computer (Hewlett Packard, Palo Alto, CA) running Windows 7 (Microsoft, Redmond, WA). According to the pilot study, the sample size calculation was 20 in each group. Twenty-one teeth (42 canals) with mesiobuccal and mesiolingual canals that were symmetric in shape, size, and curvature were selected for the study.

Size 25/.06 K3 NiTi instruments (SybronEndo, Orange, CA) with a 4-mm apical segment were fractured in the mesial canals, 5 mm apically from the canal orifice as described in a previous study (6). Instruments were notched to a depth of half the instrument thickness at 4 mm from the tip by using a low-speed 0.3-mm-thick diamond disk. The notched instruments were introduced into the canals at 250 rpm and fractured 5 mm apically from the canal orifice when they engaged the canal wall dentin. The teeth with a separated instrument were scanned using a micro-CT system with the same parameters described earlier. The mesial canals of each extracted molar with the fractured NiTi instrument were randomly distributed to be trephined using ultrasonics/microtube or trepan bur/microtube techniques for the removal of the broken instrument.

Coronal Enlargement and Creation of a Staging Platform

Coronal enlargement of the canals with a funnel shape to visualize the most coronal aspect of the broken instrument was performed by using Gates Glidden burs (nos. 1–3) (Dentsply Maillefer, Ballaigues, Switzerland) and a dental microscope (Pico; Carl Zeiss, Jena, Germany). A staging platform was then prepared at the most coronal aspect of the broken instrument using modified Gates Glidden burs (no. 3). The procedure has been comprehensively described by Ruddle (8).

Trephine Technique

Ultrasonics. Fine ultrasonic tips (ET25; Satelec Corp, Merignac Cedex, France) were used to trephine dentin around the fragment 1–1.5 mm deep to unlock it and free it from the canal. The power of the ultrasonic generator (Newtron P5, Satelec Corp) was set to 6 in order to have sufficient energy but to prevent the fracture of the ultrasonic tips. If the broken instrument could not be removed with ultrasound, then the microtube device was used to withdraw the fragment (Micro-Retrieve & Repair System) (Fig. 1*A* and *B*). The needle cannula with a side window was inserted into the enlarged root canal and placed over the previously exposed instrument. The broken fragment was gripped and locked in the needle cannula with an insert wedge so that the broken instrument could be retrieved. All ultrasonic work below the orifice was performed dry in order to maintain constant vision of the energized tip around the broken instrument.

Trepan Bur Technique. After creating the staging platform as described previously, a trepan bur (Micro-Retrieve & Repair system) (Fig. 1) with a 0.9-mm outside diameter and a 0.6-mm inside diameter was operated with an endodontic motor (Dentsply Maillefer) in a counterclockwise direction (500 rpm) to expose a 1- to 1.5-mm length of the fragment. If the broken instrument did not come loose just by exposing it with the trepan bur, then the microtube device was used to withdraw the fragment. All instrument removal procedures were performed by the same operator. Time was recorded from starting trephining dentin around the fragment until the instrument was successfully removed. Specimens in which the removal process exceeded 45 minutes were considered unsuccessful removal attempts.

All mesial roots were rescanned by micro-CT imaging after instrument removal using the same scanning parameters as mentioned earlier. CT-Analyser software (SkyScan; Bruker micro-CT, Kontich, Belgium) and VGStudio MAX 2.0 (Volume Graphics GmbH, Heidelberg, Germany) were used for the 3-dimensional reconstruction, analysis, and measurement of the root canal volume, the average root canal diameter, and the furcal root dentin thickness. All measures were confined to the regions of interest, from the orifice to 1.5 mm apically from the broken instrument tip (Fig. 1).

Data were presented as mean and standard deviation values. The paired *t* test was used for comparison between means. The significance level was set at $P < .05$. All analyses were performed with a statistical package (SPSS 21.0; SPSS Inc, Chicago, IL).

Results

In the ultrasonic/microtube technique, only 1 fragment could not be successfully removed within 45 minutes; this specimen was excluded from the study. Four fragments were removed from the mesial canals without using the microtube device after ultrasound, and in 2 canals a perforation occurred. In the trepan bur/microtube technique, all fractured instruments were successfully removed, but 1 perforation occurred. Two fragments were seized by the trepan bur and held in place by dentin debris; the fragment was pulled out of the mesial root in a rotary motion directly, and the microtube was not needed in these 2 cases.

There were significant differences in the mean root canal diameter, canal wall thickness, canal volume increase, and the time consumed between the ultrasonic and trephine bur groups (Table 1) ($P < .001$). The root canal volume and the mean canal diameter after