Microguided Endodontics: Accuracy of a Miniaturized Technique for Apically Extended Access Cavity Preparation in Anterior Teeth

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Abstract

Introduction: The aim of this study was to assess the accuracy of guided endodontics in mandibular anterior teeth by using miniaturized instruments. This technique is designed to treat teeth with pulp canal calcifications and narrow roots by using a printed template that guides a bur to the calcified root canal. **Methods:** Sixty sound mandibular anterior teeth were used in 10 mandibular models. Preoperative surface and cone-beam computed tomography scans were matched by using the coDiagnostix software. Virtual planning was performed for the access cavities, and templates were used for guidance. The templates were produced by a three-dimensional printer. Two operators performed the access cavities. A postoperative cone-beam computed tomography scan was superimposed on the virtual plan, and the deviation was measured in 3 dimensions and angles. Descriptive statistical analyses were performed, and 95% confidence intervals were calculated for both operators and each measured aspect. **Results:** The deviations between the planned- and prepared-access cavities were low, with means ranging from 0.12 to 0.13 mm for different aspects at the base of the bur and 0.12 to 0.34 mm at the tip of the bur. The mean of angle deviation was 1.59°. A considerable overlap of the 95% confidence intervals indicated no significant difference between the operators. The mean treatment time, including planning and preparation, was approximately 10 minutes per tooth. **Conclusions:** Microguided endodontics provides an accurate, fast, and operator-independent technique for the preparation of apically extended access cavities in teeth with narrow roots such as mandibular incisors. *(J Endod 2017;■:1–4)*

Key Words

Accuracy, guided endodontics, printed templates, pulp canal calcification, root canal treatment

Significance

Endodontic treatment of teeth with pulp canal calcifications is very challenging and associated with a high technical failure rate. Microguided endodontics provides an accurate technique for the preparation of access cavities and is therefore of high clinical relevance.

Pulp canal calcification (PCC) is a common sequela of dental trauma and may occur in 15%–40% of patients after luxation injuries (1, 2). In elderly patients, PCC may develop because of a lifelong apposition of the secondary and tertiary dentin (3). Furthermore, orthodontic treatment may initiate the accelerated deposition of secondary dentin (4, 5).

PCC is considered a sign of pulp vitality, and unless there is clinical and radiographic evidence of pulp necrosis, root canal treatment is not indicated (6).

However, up to one third of teeth with PCC may develop apical pathology in the long term (7). Root canal treatment is very challenging in these cases and is associated with a high failure rate, especially in mandibular incisors (8). Therefore, the American Association of Endodontists rated the treatment of teeth with PCC as having a high difficulty level (9).

Even with the use of a dental microscope, the preparation of an adequate access cavity may lead to excessive substance loss that impairs stability and thereby reduces the long-term prognosis of the tooth (10).

Recently, a new treatment approach for teeth with PCC by using a printed template with incorporated sleeves that guide the bur to the calcified root canal has been developed (11, 12). This technique provides an accurate access cavity and has already been used in the clinic (13–15).

In these studies, mainly maxillary teeth had been treated. The sizes of the burs used (diameter, 1.2–2.4 mm) are not suitable for the treatment of teeth with PCC and narrow roots such as mandibular incisors.

Therefore, the aim of this study was to assess the accuracy of guided endodontics in mandibular anterior teeth by using miniaturized instruments.

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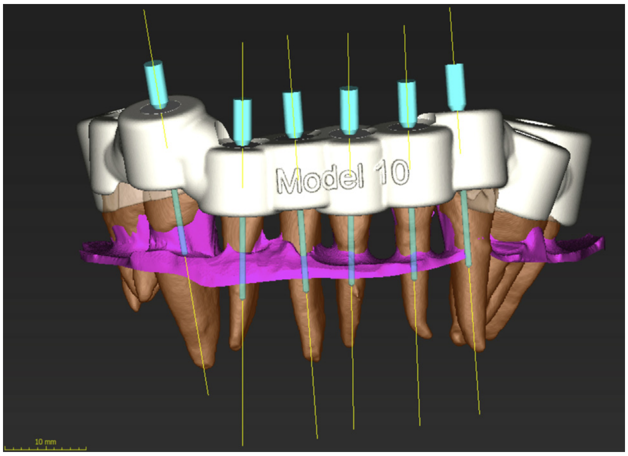

Figure 1. Virtual planning: 3D view of planned access cavities including burs and template.

Materials and Methods

Ten mandibular models were fabricated by using 100 sound human teeth that were extracted for periodontal reasons. Ethical approval was obtained from the local Research Ethics Committee (EKNZ UBE-15/111).

All teeth were fixed according to their anatomic position in a cast to mimic a partly dentate mandible with bilaterally missing molars. Mandibular incisors and canines (n = 60, 6 teeth per model) were used as test teeth, and premolars were included to improve the support of the printed template.

For each model, a preoperative cone-beam computed tomography (CBCT) scan with a voxel size of 80 μm was performed (Morita Accuitomo 80; J. Morita Mfg Corp, Kyoto, Japan) and stored in Digital Imaging and Communication (DICOM) format. In addition, surface tessellation language (STL-) files were created via a three-dimensional (3D) intraoral scanner (iTero; Align Technology Inc, San Jose, CA). Both types of data were uploaded to software that was originally designed for guided implantology purposes (coDiagnostiX Version 9.2; Dental Wings Inc, Montreal, Canada). Virtual images of the bur and the corresponding sleeve for access cavity preparation were designed and implemented in the software.

The specially designed bur had a total length of 28 mm with a working length of 20 mm, and the diameter was 0.85 mm (Gebr. Brasseler GmbH & Co KG, Lemgo, Germany). The sleeve had an inner diameter of 0.88 mm, an outer diameter of 4 mm, and a length of 6 mm (steco-system-technik GmbH & Co KG, Hamburg, Germany). Access to the root canal was planned by the superimposition of the virtual bur (Fig. 1). The position was checked in every 3D aspect. Then the virtual sleeve was placed. The STL data were uploaded to the same software, and scans were matched by aligning the outlines of the teeth. The template was designed via the application of an inbuilt tool and fabricated with a 3D printer (Objet Eden 260 V, Material: MED610; Stratasys Ltd, Minneapolis, MN). Subsequently, the sleeves were integrated into the template.

The 10 models were randomly assigned to 2 operators with 5 models (n = 30 teeth) per operator.

The fit of each template was checked on its dental model, and marks were set through the sleeves to indicate the exact coronal position of the access cavity. First, the enamel was removed with a diamond bur until the dentin was exposed. Next, the microguided bur was used at 10,000 RPM through the sleeve and the template with pumping movements to gain access to the root canal (Fig. 2). The bur was cleaned regularly during preparation by using a clean stand with foam rubber (Dentsply Maillefer, Ballaigues, Switzerland). The access cavity according to the virtual plan was finalized when the bur reached the sleeve. The bur was checked after every access cavity for deformation. If no deformation was visible, the bur was replaced regularly after 5 teeth.

The time required for each workflow step (surface scan of the whole model, virtual planning of the access cavity of each tooth, design of the template, removal of the enamel, and preparation of the access cavity) was recorded for each of the operators.

After completion of the access cavity preparations, a postoperative CBCT scan with the same parameters was performed, and DICOM data were uploaded to the coDiagnostix software. The preoperative and

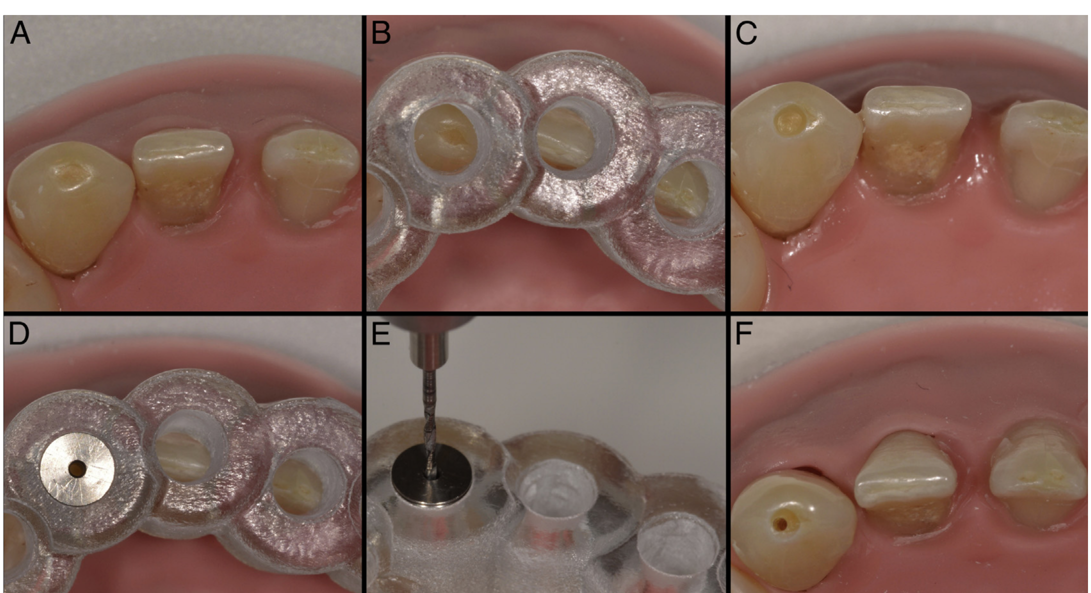

Figure 2. Clinical procedure for microguided endodontics: (*A*) preoperative situation, (*B*) adaption of the template, (*C*) removal of the enamel until the dentin is exposed, (*D*) template with incorporated sleeve, (*E*) guided preparation through the sleeve, and (*F*) access cavity according to planning.