Computer-aided Design/Computer-aided Manufacturing–guided Endodontic Surgery: Guided Osteotomy and Apex Localization in a Mandibular Molar with a Thick Buccal Bone Plate

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Abstract

A mandibular molar with a thick buccal bone plate is a challenging problem in endodontic surgery despite the increase in the success rate of endodontic surgery nowadays. This report describes the application of a surgical template to guide osteotomy and facilitate apex localization in a mandibular molar with a thick buccal bone plate. A 57-year-old woman visited the authors' clinic for pain in tooth 19 and was diagnosed with symptomatic apical periodontitis in this previously treated tooth. Nonsurgical retreatment was performed; however, 2 years later, the patient reported pain in the same tooth. A periapical lesion was confirmed using cone-beam computed tomographic (CBCT) imaging, and endodontic surgery on the mesial root of tooth 19 was planned. After CBCT imaging and cast scan data were transferred to implant surgical planning software, the data were superimposed. In the superimposed model, an anchor pin was designed to target the mesial root apex of tooth 19. The surgical template was then printed using a 3-dimensional printer. Endodontic microsurgery included application of this printed surgical template. A computer-aided design/computer-aided manufacturing (CAD/CAM)-guided surgical template minimized the extent of osteotomy and enabled precise targeting of the apex in this case. There were no postoperative complications. A CAD/CAM-guided surgical template is useful in endodontic surgery for complicated cases. *(J Endod 2017;■:1–6)*

Key Words

3D printing, apical surgery, computer-aided design/computer-aided manufacturing, endodontic surgery, surgical guide

Significance

Introducing a CAD/CAM-guided surgical template in endodontic surgery would make guided osteotomy and precise targeting of the root apex possible. The surgical template would be especially useful in performing endodontic surgery on teeth with potentially problematic anatomic structures.

Computer-aided design/computer-aided manufacturing (CAD/CAM) and 3-dimensional (3D) printing technology were first developed and applied in the late 1980s and 1990s (1). Currently, CAD/CAM and 3D printing have diverse applications in dentistry including the fabrication of dental models, temporary restorations, surgical guides for orthognathic surgery, and trays for indirect bonding of orthodontic brackets (1). Surgical guide templates using CAD/CAM and 3D printing, in particular, are commonly used in implant surgery (2). These templates have also been recently introduced in endodontic fields. Templates used in orthograde guide access cavity preparation in calcified canals (3) and guided osteotomy in endodontic surgery have been described (4, 5).

Endodontic surgery is 1 of the treatment options to manage persistent apical periodontitis after the failure of nonsurgical treatment (6). The success rate of conventional endodontic surgery is relatively low, between 43.5% and 74% (7). However, by applying contemporary techniques, including high-power magnification and illumination, microsurgical instruments, and modern filling materials (8), success rates of surgery have significantly increased, and, in turn, surgery has become a more effective treatment. Success rates for endodontic microsurgery have been reported to be between 88.9% and 100% (7).

Prognostic factors influencing endodontic surgery outcomes include lesion type, root-end filling material, and coronal restoration, among others (9). Some studies have found that tooth position also has an influence on outcome(s). In particular, the lower molars have been reported to have lower success rates than teeth in other positions. The difficulty in accessibility caused by thick buccal bone and anatomic obstacles, including the mental foramen or inferior alveolar nerve, has been attributed to poorer outcomes (10, 11).

Another factor known to be associated with improved and faster healing is the extent of periapical bony destruction (12). The extent of osteotomy also influences the degree of postoperative complications such as pain and swelling (13). However, the extent of osteotomy tends to be increased in cases with an intact buccal bone plate

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because it is difficult to locate the exact location of the root apex (14). In this report, we present a method involving the application of a surgical template to guide osteotomy and facilitate precise apex localization in a case involving a thick buccal bone plate.

Case Report

A 57-year-old woman visited the clinic because of spontaneous pain in the left mandibular area. She felt tenderness to percussion on tooth 19. Periapical images revealed a periapical radiolucent lesion in the mesial root of tooth 19 (Fig. 1*A*). Periodontal probing was within normal limits. The patient reported that tooth 19 underwent root canal treatment several years previously. Given the diagnosis of symptomatic apical periodontitis in a previously treated tooth, nonsurgical retreatment was planned.

After local anesthesia with 2% lidocaine with epinephrine (1:100,000) and rubber dam application, an access cavity was prepared. A gutta-percha cone was removed using Gates-Glidden drills (Dentsply Maillefer, Ballaigues, Switzerland) and the ProTaper Universal rotary system (Dentsply Maillefer). The working length was determined using an apex locator (Root ZX; J Morita Mfg Corp, Kyoto, Japan). Additional root canal preparation was performed with the ProTaper Universal system. Irrigation was performed using 5.25% sodium hypochlorite solution. The canals were dried with sterile paper points. Obturation was performed using a continuous wave of condensation technique (System B; SybronEndo, Orange, CA) and thermoplasticized gutta-percha backfilling (Obtura III, SybronEndo). AH 26 (Dentsply Maillefer) was used as the root canal sealer.

Two years later, the patient reported bite pain in tooth 19 again. Clinical examination revealed tenderness in tooth 19 on percussion, but the tooth had normal probing depths. The remaining periapical lesion on the mesial root was confirmed on periapical radiography (Fig. 1*B*). The lesion was confirmed using cone-beam computed tomographic (CBCT) imaging (Alphrad 3030; Asahi Roentgen Ind Ltd, Kyoto, Japan), and apical surgery on the mesial root of tooth 19 was planned (Fig. 1*C* and *D*). Because the tooth had a thick and intact buccal cortical bone (Fig. 1*D* and *E*), which made exact apex localization difficult, a surgical template was designed and fabricated.

A preliminary impression was made using irreversible hydrocolloid, whereas the diagnostic cast was fabricated using yellow stone. Scanning data of the cast were generated using a blue-light benchtop 3D scanner (Identica Blue; Medit, Seoul, Korea) (Fig. 2*A*). After tooth CBCT and cast scan data were uploaded into implant surgical planning software (Ondemand3D; Cybermed Co, Seoul, Korea) (Fig. 2*B*), the data were superimposed using the In2Guide module (Cybermed Co) (Fig. 2*C*). In virtual surgical planning, an anchor pin was designed to target the mesial root apex of tooth 19, with the buccal flange extended to include the anchor pin. The guide depth was preplanned on the computer and incorporated into the stent to prevent the anchor pin from penetrating the lingual plate (Fig. 2*D*). To avoid interference with the lips and buccal cheek, the angle of the anchor pin was tilted forward approximately 30° (Fig. 2*E*). A surgical template was designed and exported in a stereolithography file format (Fig. 2*F*). This file was printed using a photopolymer printer (Object EDEN260V; Stratasys, Eden Prairie, MN). Biocompatible clear resin (MED 610, Stratasys Ltd), which

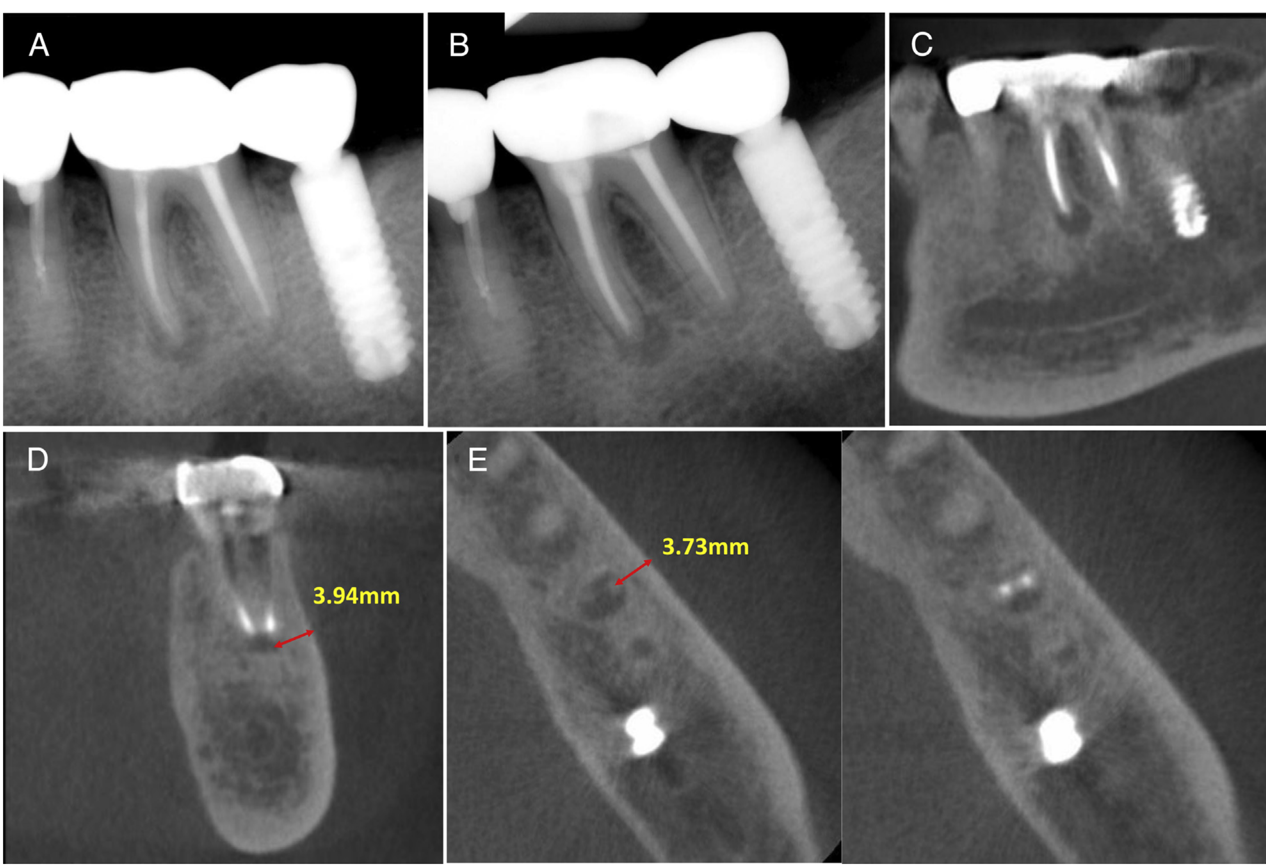

Figure 1. (*A*) The initial periapical x-ray of tooth 19 exhibiting a periapical lesion. (*B*) The periapical x-ray 2 years after nonsurgical retreatment. (*C*) A reformatted panoramic view of the CBCT scan revealing a periapical lesion in the mesial root of tooth 19. (*D*) A coronal view of the CBCT scan. A thick and intact buccal cortical bone was detected on (*E*) the axial view of the CBCT scan.