CASE REPORT

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Use of three-dimensional endodontic guide in a maxillary premolar tooth with an obliterated root canal: A case report

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The purpose of this case report is to demonstrate direct access to obliterated root canals and root canal treatment with the aid of guided endodontics (GE) created with a three-dimensional (3D) printer using 3D imaging techniques. A female patient presented to our clinic with the complaint of percussion sensitivity in the left upper second premolar. According to the clinical and radiographic examination of the tooth, root canal obliteration was detected, extending 2 mm below the cementoenamel junction of the tooth. The root canals were localized using cone beam computed tomography (CBCT). The endodontic guide was prepared by transferring the images obtained with the intraoral scanner and the CBCT data to a 3D printer with a special computer program. Root canals were accessed with the help of this guide using endodontic bur. Root canal treatment of the patient was completed with routine endodontic procedures. After the treatment with the aid of GE, it was observed that the patient's symptoms disappeared and the tooth was in function. In the treatment of teeth with obliterated root canals, many complications can be prevented by providing a safe endodontic intervention with the aid of GE obtained with 3D printers.

Keywords: Apical periodontitis, guided endodontics, pulp canal calcification.

Introduction

Prevention and treatment of apical periodontitis is the main goal of root canal therapy and can be achieved effectively by chemomechanical preparation of root canal and effective elimination of microorganisms (1,2). The endodontic access cavity has to be prepared to gain access to the root canals, and this step is crucial for the outcome and survival of the tooth (3). To achieve complete disinfection and debridement during root canal treatment, straight-line access to the orifices of the root canals is recommended (4,5).

Pulp canal calcification (PCC) is characterized by the accumulation of mineralized tissue along the canal walls. Consequently, a part or all of the root canal space can become obliterated (6,7). PCC cases are often associated with aging, caries, orthodontic forces, dental trauma, systemic conditions, and pulp therapy procedures (6–10). In cases of PCC, negotiation and localization of root canals are challenging steps in endodontic treatment, and canal deviations and root perforations may be encountered during these procedures (11–13).

Recently, guided endodontics (GE) has been introduced as an alternative treatment option in cases with partial or complete root canal obliteration requiring endodontic treatment (14,15). Digital impression with three-dimensional (3D) scan and cone beam computed tomography

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(CBCT) imaging are combined using special software, and access to the root canals is planned virtually. Afterward, a 3D template can to guide the drill into the remaining root canals (16). In cases with PCC, access to remaining root canals with the aid of GE has been shown to be safe and predictable (14,15,17). Additionally, some case reports of successful treatment with the aid of GE have been published (18–22).

This clinical report describes the 3D treatment plan and endodontic treatment of a maxillary premolar with PCC using GE.

Case Report

A 22-year-old female patient was referred to Kutahya Health Sciences University, Faculty of Dentistry, Turkey with a history of pain in the maxillary left second premolar teeth. In the patient's anamnesis, it was learned that the patient had previously received orthodontic treatment for 2 years between 2015 and 2017. According to clinical examination, negative responses to thermal and electrical tests and the presence of severe percussion sensitivity during bite pressure were observed. It was observed that there was no tooth discoloration and spontaneous pain. Radiographic examination revealed an obliterated pulp chamber and calcified root canal. There was no other periodontal disease associated with this tooth (Fig. 1). There were no caries, restorative treatment, and trauma in this tooth and it was thought that the PCC observed in this tooth was most likely related to the patient's previous orthodontic treatment.

CBCT imaging was performed using the OP300 Maxio device (Instrumentarium Dental, Tuusula, Finland) to identify the remaining root canal. The CBCT analysis revealed the presence of one canal and root canal space extending 2 mm below the cementoenamel junction of the involved tooth. According to CBCT analysis, it was observed that the length of the root canal was approximately 10.5 mm. The calcification was approximately 8 mm from the buccal cusp. After clinical and radiographic examination, it was determined that the most appropriate treatment approach was GE for this case. An informed consent form was obtained from the patient.

Fig. 1. Periapical radiography for diagnosis.

3D Treatment Planning

The 3D documentation was obtained using CEREC Omnicam intraoral scanner device (Sirona, Bensheim, Germany) and CBCT imaging. Both CBCT imaging (stored as DICOM files) and intraoral scans (stored as STL files) were aligned and processed with Blue Sky Plan software (Blue Sky Bio, Grayslake, IL, USA). A virtual copy of a 1-mm diameter and 20-mm-long endodontic bur was attached to the 3D scans in a position that would allow access to the root system. To ensure that the tip of the bur

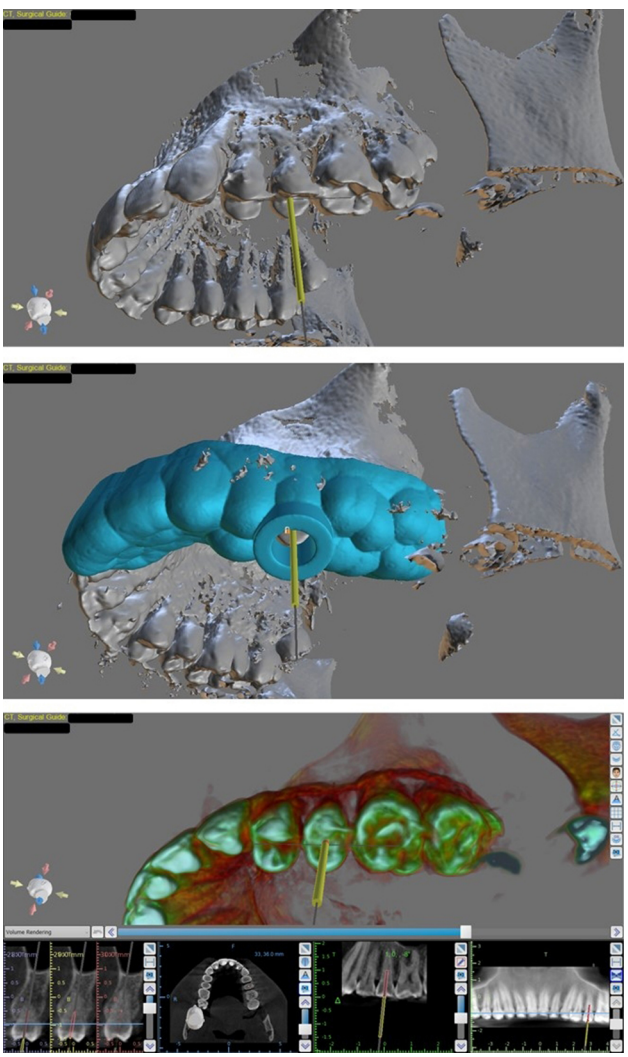

Fig. 2. 3D treatment plan with software.

reached the space of the remaining root canal, the position of the bur was confirmed in axial, sagittal, and coronal sections. Afterward, the 3D template was exported as an STL file and transferred to a 3D printer to print an endodontic guide (NovaFab Vega, Turkey) (Fig. 2).

Clinical Procedures

First, local anesthesia was administered and the location of the access cavity was marked using an endodontic guide. The enamel was removed with a diamond round bur from the marked area. Later, the guide was positioned on the teeth, and the positioning of the bur [1 mm diameter (the widest diameter of the tip of the bur), Meisinger, Germany] was checked in the mouth. The single standard bur was used with a low-speed handpiece, and drilling was performed with pecking movements to penetrate through the calcified part of the root canal. Access cavities and bur were copiously rinsed with saline. This procedure was repeated until the root canal could be negotiated with hand files. When the root canals were reached, the endodontic guide was removed and the rubber dam was placed (Fig. 3). A #10 K file was introduced and the working length was determined with an apex locator (RAYPEX 6, VDW, Munich, Germany) and digital radiography (Fig. 4). Chemomechanical preparation was performed using WaveOne Gold Primary instrument (#25, Dentsply Maillefer) and irrigated with 2.5% sodium hypochlorite. Calcium hydroxide intracanal medication was left for 2 weeks, and the access cavity was sealed temporarily.

At the second visit, the tooth was evaluated clinically, and it was observed that the tooth was asymptomatic. Intracanal medicament was removed with hand files under constant irrigation with sodium hypochlorite. After the removal of the intracanal dressing, passive ultrasonic irrigation was performed (a size 20 # ultrasonic tip, Woodpecker, Japan). Then the saline solution was used and final irrigation was performed with 2% chlorhexidine gluconate. The root canal fillings were completed at the same visit using a gutta-percha cone and AH Plus sealer (Dentsply Sirona Endodontics). The tooth was restored with composite resin (Fig. 5).

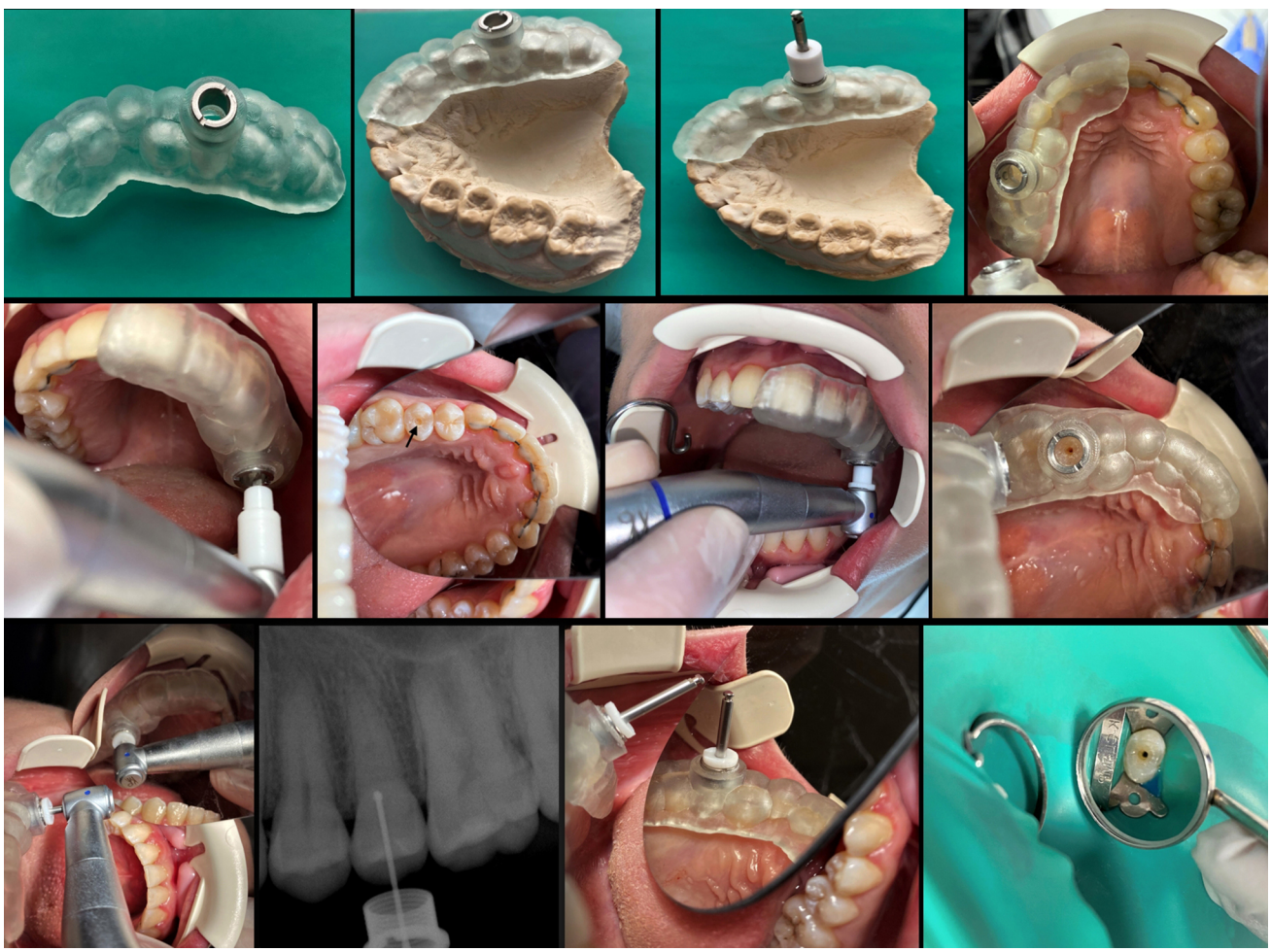

Fig. 3. Evaluation of the compatibility of the endodontic guide on the plaster model and in the mouth; performing the access cavity procedure using an endodontic guide.

Fig. 4. Determination of working length with periapical radiography.

Fig. 5. Periapical radiography after root canal treatment.

The patients were clinically evaluated at 7 days, 1 month, and 3 months after the treatment. In the follow-up period, it was observed that the patient's symptoms disappeared and the tooth was in function.

Discussion

In the literature, it was reported that the root canal treatment for teeth with PCC is only indicated in the presence of acute symptoms or apical periodontitis (6,7,23). Severe PCC is a challenge in cases of apical periodontitis, and although it has been determined that experienced endodontists can achieve a high level of success in the treatment of such cases, the risk of perforation and tooth loss should be considered (15,19). The use of ultrasonic tips and dental operating microscope has been reported to have a clinical success of approximately 74% to access the root canals in calcified teeth (11). There is a high risk of deviation or perforation in endodontic access cavity preparation of severely calcified root canals, even with the use of a dental operating microscope (24).

With the advances in endodontic technology, a new technique called GE has been proposed to increase these success rates in the treatment of such cases and at the same time provide more technical security in accessing calcified root canals (15). This technique can be easily applied during the endodontic treatment of calcified root canals, even by operators inexperienced in the field of endodontics, providing maximum preservation of the coronal and radicular tooth structure and reducing the risk of root perforation (14). In addition, ex vivo studies have shown that the guided endodontic technique results in significantly less dentin removal compared with the traditional approach (16,25).

When applying the guided endodontic technique, high precision is required, especially in the planning phase of the drill path. Due to the size of the root and the diameter of the remaining pulp space, even small deviations of depth and angle can cause failure. In this report, a bur with a diameter of 1 mm was used successfully in the maxillary premolar tooth. A disadvantage of this technique is the difficulty of cooling. In this case, the cavity was continuously irrigated with saline to prevent overheating of the tooth as described before (21).

In cases of PCC, the treatment time can be significantly reduced with the use of an endodontic guide. The treatment that will take a longer time than the traditional endodontic treatment can be completed in a shorter time due to faster access to the root canals by using the endodontic guide. In addition, cases treated without an endodontic guide may require multiple periapical X-rays to determine the correct position of the bur and to reach the root canals. As the number of radiographs taken will decrease with the use of endodontic guides, the amount of radiation that the patient is exposed to during CBCT could be compensated (16,19).

Although there are many advantages of guided endodontic treatment, the treatment method should be explained to the patient in detail before deciding on the treatment with the aid of GE. Possible complications and alternative treatment options such as apical surgery, intentional replantation, and tooth extraction should be mentioned to the patient. It should be noted that this treatment method requires high precision and care at the planning stage.

GE has some limitations. Due to the inability of the bur to be flexible, it may be difficult to apply in curved root canals. In addition, difficulties may be encountered during its use in patients with limited mouth opening, and application difficulties may be observed, especially in the posterior group teeth. In addition, the 3D scanning and planning stages of the endodontic guide could take a long time.

The PCC observed in this case is thought to be due to the previous orthodontic treatment of the patient. Orthodontic treatment has an effect on dental pulp, alveolar bone, and supporting structures (26). The forces generated by orthodontic tooth movement can cause pulp blood flow changes that cause pulp complications. In addition, many studies have reported that orthodontic tooth movement can affect the blood supply to the dental pulp (27,28). It is thought that orthodontic intrusive movements have a great impact on pulp blood supply and apical region (29). Calcifications can be observed in the pulp due to the influence of the pulpal blood supply (6).

In recent years, with the development and use of new technologies, scanning techniques have been used more in dentistry and endodontics. In this clinical case report presented, a successful treatment application of these technologies in the field of endodontics has been demonstrated. It is considered that such technologies should be used more in the field of endodontics, and guided endodontic procedures should be made more accessible and widespread (14).

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