CBCT-based Diagnosis of Periapical Lesion of Maxillary First Premolar Mimicking That of Second Premolar

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Abstract

Apical periodontitis is usually diagnosed based on clinical findings and dental X-rays. Recently, however, dental cone beam computed tomography (CBCT), which provides 3-D images of the maxillofacial region, has enabled dentists to examine patients undergoing endodontic therapy more effectively, improving diagnostic accuracy. Here, we describe a positive treatment outcome achieved using CBCT to diagnose apical periodontitis of the maxillary premolars, which had proven difficult to diagnose based on clinical findings and dental radiography alone. The patient was a 42-year-old Japanese man who presented with the chief complaint of gingival swelling in the maxillary right premolar region. Our initial diagnosis, based on clinical findings and dental X-ray, was apical periodontitis of the maxillary right second premolar, and treatment was started. However, after the patient failed to respond to the treatment, CBCT was performed. Based on these new findings, the diagnosis was changed to one of apical periodontitis of the upper right first premolar, and the patient was treated accordingly. Previous studies have described the complex anatomical morphology of the upper premolars, noting multiple roots and variation in the morphology of the root canals. The 3-D images provided by dental CBCT allow better assessment of oral conditions than the traditional 2-D images provided by dental X-rays, which in turn enables the dentist to better select the most appropriate treatment. Here, the patient showed no symptoms and was progressing well at a 6-month follow-up visit. The present results indicate that when clinical findings and dental X-rays alone are insufficient to allow a secure diagnosis, CBCT offers an effective alternative which will enable the appropriate treatment to be selected more reliably.

Key words: Endodontics — X-ray diagnosis — CBCT — Root canal treatment — Apical periodontitis
Introduction

The spread of dental caries or some other form of bacterial infection to the root canal can lead to the development of apical periodontitis. Therefore, eliminating such bacteria by cleaning, disinfecting, and sealing is essential in treating an infected root canal. The most common cause of endodontic treatment failure is a lack of adequate knowledge of the anatomical details of the root canal system. As a number of earlier studies have pointed out, however, the anatomical complexity involved makes determining the number and shape of the root canals of the upper premolars difficult\(^1,4,6-8,13,18,21\)\(^{,}\), which in turn makes it hard to completely eradicate bacteria from apical lesions. Conventional diagnosis of apical periodontitis has been based on clinical findings and dental X-rays. The big advantage of dental X-rays is that exposure to radiation can be kept to a minimum; the disadvantage is that it is impossible to manipulate those images, which means that experience is needed if the results are to be interpreted accurately\(^5,11\)\(^{,}\). In recent years, dental cone beam computed tomography (CBCT) has been used as an effective diagnostic tool in endodontic therapy. This imaging modality provides 3-D image data that can be used to identify not only morphological characteristics, but also lesion size and other relevant clinical variables that are difficult to assess with the 2-D images provided by dental X-rays, all of which contributes to improved, treatment outcomes\(^16\)\(^{,}\). The present report describes a good treatment outcome achieved using CBCT to diagnose apical periodontitis of the maxillary premolars, which had proven difficult to diagnose based on clinical findings and dental radiography alone.

Case Report

The patient was a 42-year-old Japanese man referred to Tokyo Dental College Chiba Hospital from a general dental office. The patient presented with the chief complaint of swelling in the gum in the maxillary right premolar region. The medical history of the patient was noncontributory. The patient had visited a private general practice 3 months earlier, where he was treated for suspected chronic suppurrative apical periodontitis of the maxillary secondary premolar. At the time of referral, the patient did not have any spontaneous pain but claimed to have discomfort in the premolar region. A sinus tract was observed near the center of the roots, between the first and second maxillary right premolars (Fig. 1). An electric pulp test indicated vitality in the first premolar, despite an increased sensation threshold, but no vitality in the second premolar. A percussion test revealed slight discomfort in the second premolar. Dental X-rays showed transparency near the center of the roots, between the first and second maxillary right premolars. Opacity, believed to be a root canal filling, was also observed in the second premolar (Fig. 2). It was difficult to determine whether the first or second premolar was responsible, and we therefore attempted to identify the offending tooth by inserting a gutta-percha (GP) point into the sinus tract and taking a dental X-ray. As a result, the tip of the GP point was introduced proximally to the adjacent mesial root of the second premolar (Fig. 3).

Based on these results, chronic suppurrative apical periodontitis in the maxillary second premolar was diagnosed and endodontic
treatment proposed. At the initial treatment, rubber dam isolation technique was applied and access cavity preparation performed with an air turbine hand-piece and diamond point (#301, Shofu, Kyoto, Japan). The GP points were then removed from the root canals. Next, the root canal was observed using an operative microscope (OPMI PROergo, Carl Zeiss, Oberkochen, Germany). There were no abnormal findings, just a single root canal with no cracks, perforations, or lateral branches. After confirming removal of the root canal filling materials, root canal length was measured using an electronic apex locator. The canal was shaped to an apical canal size of #35 and then cleaned with 3% EDTA solution (Smearclean, Nippon Shika Yakuhin, Shimonoseki, Japan), 10% sodium hypochlorite solution (Neo Cleaner, Neo Dental Chemical Products, Tokyo, Japan), and 3% hydrogen peroxide before drying with sterilized paper points. Calcium hydroxide paste (Calvital, Neo Dental Chemical Products) was then applied inside the root canal, and the enlarged access cavity sealed with a zinc-oxide eugenol temporary sealing material (Neo-dyne-a, Neo Dental Chemical Products). The same treatment was performed twice over the next 3 weeks, but the patient complained of persistent discomfort in the maxillary premolar region and a sinus tract was also observed.

Therefore, with fully informed consent from the patient, CBCT (3DX Multi-image micro CT; J. Morita, Kyoto, Japan) was used to investigate and determine the condition and any fractures, lesions, or other abnormalities in the root, root canal, and periapical region. The images obtained revealed that the root canal of the treated second premolar had a single root, but did not suggest root perforation or fracture. The apical region was visible, but was limited to the cancellous bone on both the buccal and lingual aspects; no rupture of the cortical bone was observed. On the other hand, the CBCT images of the maxillary first premolar revealed 2 roots, each with 1 root canal, and while there were no findings to suggest root perforation or fracture, there was a transparency adjoining the area proximal to the center of the distal root. This transparency at the center of the distal root was characterized by buccolingual absorption of the buccal alveolar bone extending as far as the cortical bone, while the lingual alveolar bone remained intact (Figs. 4a and 4b).

Based on these CBCT images, the lesion was diagnosed as apical periodontitis of the maxillary right first premolar. Endodontic...
treatment was proposed for and started on the maxillary right first premolar. The surgical field was disinfected with iodine and infiltration anesthesia was applied using 2% lidocaine. After applying a rubber dam, the pulp chamber was opened using an air turbine hand-piece and a diamond point. The length of the root canal was determined using an electronic apex locator. The canal was shaped to an apical canal size of #35 and then cleaned with 3% EDTA solution, 10% sodium hypochlorite solution, and 3% hydrogen peroxide before drying with paper points. Calcium hydroxide paste was then applied inside the root canal, and the enlarged dental cavity sealed with a temporary sealing material.

Before the root canals of the first premolar were treated 2 weeks later, the patient’s sinus tract disappeared and there was no discomfort on percussion. Therefore, it was decided to fill the root canals of the maxillary right first and second premolars. After applying a rubber dam, the temporary sealing material and calcium hydroxide paste were removed and the root canals cleaned and dried. The root canals were then filled using magnesium oxide sealer (MGO sealer, Neo Dental Chemical Products) and GP points (Zipperer, Munich, Germany) based on the lateral compaction method. The cavity was sealed using a temporary sealing material (Fig. 5). At follow-up visits at 1 (Figs 6a and 6b) and 6 months (Fig. 7) later, no sinus tract was observed and there were no symptoms of discomfort on percussion. Radiographic diagnostic imaging

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**Fig. 4** CBCT images of first and second maxillary right premolar area
Vertical section revealed transparency at center of distal root at first premolar (a); horizontal section revealed buccolingual absorption of buccal alveolar bone extending as far as cortical bone; lingual alveolar bone remained intact (b).

**Fig. 5** Periapical radiograph taken immediately after root canal filling of first and second maxillary right premolars
Considerable bone formation had taken place.
Discussion

The primary cause of apical periodontitis is bacterial infection of the root canal. Therefore, the better the understanding of the complex anatomical structure involved and more efficient the sterilization and filling, the more likely it is that a root canal procedure will be successful. Lesions are often located in the center of the radiographical apex, but some lesions are found in different locations. Weng et al.\textsuperscript{20} reported a high frequency of lesions in the lateral root canals (branches). A study by Cali\c{s}kan et al.\textsuperscript{21} on the percentage of lateral root canals (branches) by tooth found that the majority of maxillary canals (branches), at 52.5\%, occurred in the palatal root of the first molar, followed by 45\% in the canine and molar mesial roots, 33.3\% in the first premolar, and 34\% in the second premolar. Failure to thoroughly investigate the root canal system and to properly sterilize and clean the canal during surgery can lead to persistent periodontitis of the apical periodontal tissue. Understanding the root canal morphology of each individual patient prior to treatment is therefore essential in minimizing surgical errors.

In the present study, the patient’s discomfort was attributed to the maxillary second premolar based on conventional dental X-rays and clinical findings. However, subsequent 3-D images obtained by CBCT revealed a reduction in the lesion.

Fig. 6 One-month postoperative radiograph (a) and clinical photograph (b)
Clinical photograph revealed no sinus tract in gingiva; radiograph revealed reduction in transparency; redness of interdental papilla gingiva was present due to compression of temporary sealing agent.

Fig. 7 Postoperative periapical radiograph taken 6 months after root canal filling of first and second maxillary right premolars
Radiograph revealed no transparency at roots between first and second maxillary right premolars.
lesion that led us to identify the maxillary first premolar as the true cause of the discomfort. In the case of an abscess situated laterally to the root, identifying the offending tooth can prove difficult, depending on the size of the abscess; thus, a lesion is often difficult to locate when relying solely on conventional dental X-rays. Almeida et al. reported that CBCT imaging enabled a more precise diagnosis of apical periodontitis than conventional dental X-rays. Meanwhile, a study comparing dental X-rays and CBCT reported that a greater number of root canal systems were identified in the latter.

In cases where the lesion is difficult to locate or when the patient has a complex root canal system, CBCT imaging can be effective in understanding both the lesion and root canal system. One drawback of CBCT, however, is that it employs X-rays, which means that the patient will inevitably be exposed to radiation. The dose received from a single CBCT procedure is approximately 0.1 mSv, whereas the dose from a single dental X-ray is believed to be between only 0.01 and 0.03 mSv. Thus, although it offers a more effective diagnostic imaging tool in endodontic therapy, CBCT exposes the patient to a higher radiation dose than conventional radiography. Moreover, clinical findings and dental X-rays may be sufficient to make an informed diagnosis, so CBCT should only be used after careful consideration.

Proper removal of bacteria is crucial when performing root canal therapy. Bacteria may be located in areas distant from the main canal, including the lateral canals, an isthmus, or fins. Such areas are physically impossible to reach with standard dental instruments, which makes mechanical cleaning and obtaining the required concentration for the cleaning agent difficult. Ricucci et al. reported that adequate root canal filling may be precluded by abundant residual pulp tissue fragments in areas other than the main root canal. They also reported that even when the lateral canals appear to have been filled in dental X-rays, this may not in fact be the case, as the canal is actually filled by the remaining tissue, having conjoined with the filling material. As when treating the main canal, it is essential to mechanically widen the lateral canals, fins, and isthmus, as well as clean with sodium hypochlorite. However, mechanical cleaning can cause the formation of smear layers that prevent the irrigants from reaching the intended location, so it is important to use irrigants with an inorganic solvent action such as EDTA. In the present case, CBCT imaging suggested a lesion at the lateral root, and calcium hydroxide in combination with sodium hypochlorite and EDTA was selected. We attribute the successful treatment outcome in this patient to an accurate diagnosis based on CBCT and proper sterilization of the root canal.

In conclusion, the present findings remind us that CBCT offers a very effective diagnostic tool in endodontic therapy when diagnosis with dental X-rays proves inadequate.

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