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Case Report

Maxillary First Molars with Two Palatal Root Canals

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Understanding the anatomical variations in the roots and root canal systems of a tooth is important for the success of root canal treatment. The palatal roots of the maxillary molars have fewer anatomical variations than the other roots, and fewer variations occur in the first molars than in the second molars. This case report describes two distinct cases of maxillary first molars with two palatal canals. For the root canal treatment of teeth with anatomical variations, it is essential to plan specific treatment strategies using cone-beam computed tomography and to execute them using a dental operating microscope. Knowledge of the anatomical variations in the palatal roots of maxillary first molars will help to increase the success rate of root canal treatments.

1. Introduction

Successful root canal treatment requires knowledge of the anatomy of the root and root canal [1]. However, anatomical variations can occur, which can complicate root canal treatment. Incomplete endodontic treatment is more likely to occur in teeth with such anatomical complexities, resulting in the failure of endodontic treatment [2].

More than 95% of the maxillary first molars have three roots—mesiobuccal, distobuccal, and palatal. The mesiobuccal root has the highest anatomical variability and has two or more canals in 56.8% of cases [1]. In contrast, the palatal root has the lowest variability, with a single canal in 99% and a single apical foramen in 98.8% of cases [1]. Stone and Stroner [3] reported very low proportions of maxillary molars with two palatal roots. However, Slowey [4] reported the root canal treatment of a maxillary molar with two palatal roots. In 1991, Christie et al. proposed a classification for maxillary molars with two palatal roots, depending on the shape and degree of root fusion [5]. According to this classification, type I maxillary molars have two widely divergent palatal roots, type II have four separate roots, which are short and parallel, while type III molars are constricted with the mesiobuccal, mesiopalatal, and distopalatal root dentin showing a web form. Following Christie's classification, Baratto-Filho et al. proposed an additional type IV, in which the mesiobuccal and palatal roots may be fused in the coronal two-thirds [6] Since then, rare cases of maxillary molars with palatal root abnormalities have been reported [7–16]; however, data on the various types of anatomical variations and their incidence are limited. These variations are more frequently reported in maxillary second molars than in maxillary first molars [8–11, 15, 17, 18]. This case report describes the nonsurgical root canal treatment of maxillary first molars with two palatal root canals in two patients.

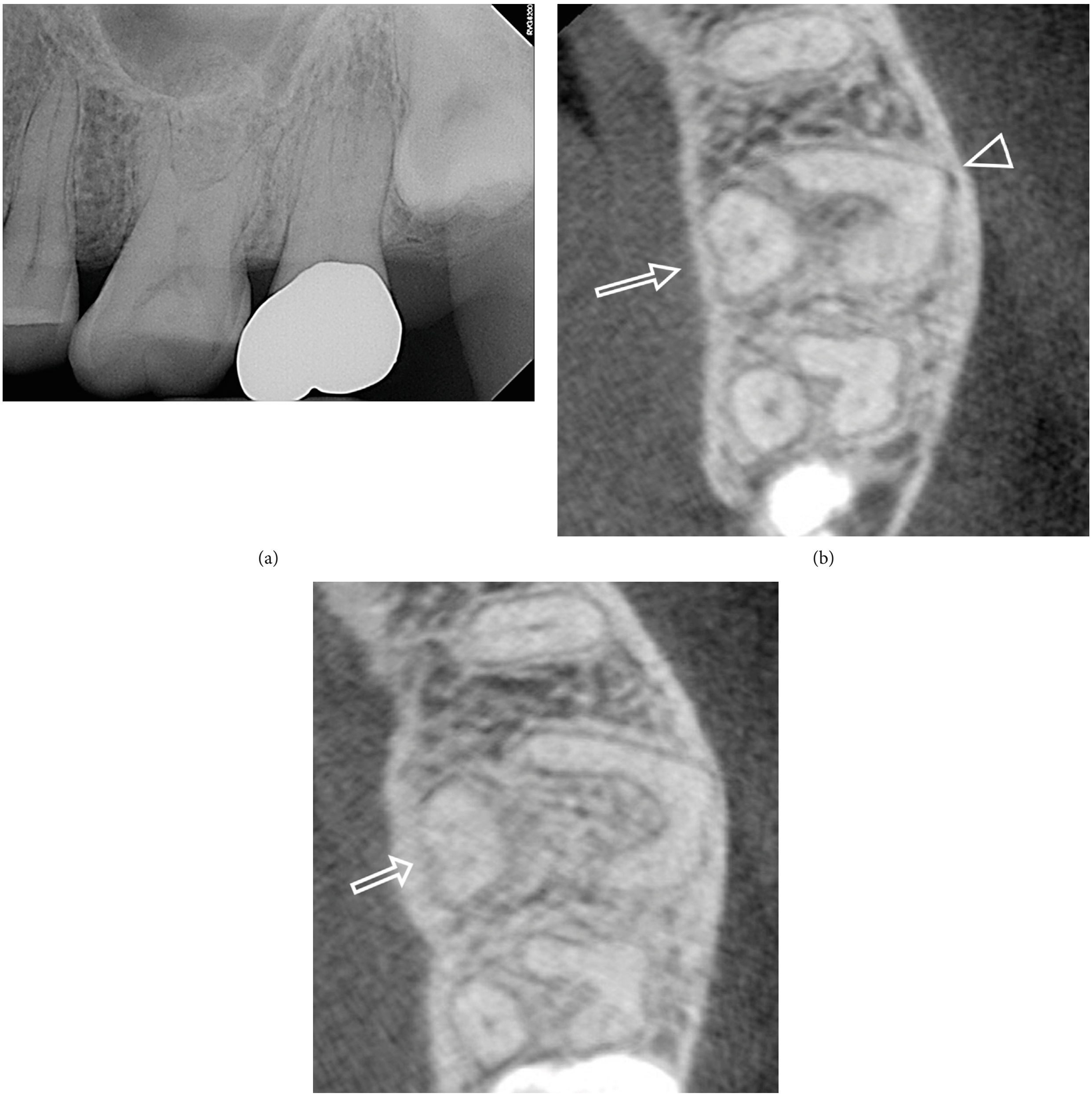
2. Case Presentations

2.1. Case 1. A 53-year-old woman was referred to the Chosun University Dental Hospital with complaints of persistent pain in the left maxillary molar. Her medical history was noncontributory. The patient reported persistent pain in the left maxillary posterior area following a composite resin restoration. On clinical examination of the left maxillary first molar, spontaneous pain and tenderness on percussion were detected. The response of tooth 26 to cold and electric pulp testing (Parkell Electronics, Farmingdale, NY, USA) was negative. A periapical radiograph of the tooth showed divergent buccal roots and a palatal root that was not clearly distinguishable (Figure 1(a)). To clearly visualize the tooth anatomy, cone-beam computed tomography (CBCT) (CS9300; Carestream Health Inc., Rochester, NY, USA) was performed with a 10×5 field of view (FOV). The CBCT revealed that the mesiobuccal and distobuccal roots were fused from the cervical third to the apex, forming a C-shaped root (Figure 1(b)), and the root canal of the single palatal root was bifurcated at its middle third. Each branched root canal had an independent apical foramen (Figures 1(b) and 1(c)). The left maxillary first molar was diagnosed with symptomatic irreversible pulpitis and symptomatic apical periodontitis, and a nonsurgical root canal treatment was planned. An informed consent form was obtained after the treatment plan was established.

The tooth was anesthetised using 2% lidocaine containing 1 : 100,000 epinephrine and was isolated with a dental dam, and endodontic treatment was performed under a dental operating microscope (Global Surgical, St. Louis, MO, USA). A conventional access cavity was prepared using a no. 330 carbide bur and an Endo Access bur no. A0164 (Dentsply Maillefer, Ballaigues, Switzerland). On the pulpal floor, the orifices of the mesiobuccal, midbuccal, distobuccal, and palatal canal were observed (Figure 2(a)). Coronal flaring was performed using the ProTaper SX rotary file (Dentsply Maillefer, Ballaigues, Switzerland) to establish straight-line access. The glide path was established using a ProGlider file (Dentsply Maillefer, Ballaigues, Switzerland). The working lengths of the root canals were determined using ISO 10 K-files (Dentsply Maillefer, Ballaigues, Switzerland) and an electronic apex locator (Dentaport II; J. Morita, Tokyo, Japan). The three buccal root canals were shaped using ProTaper Next files (Dentsply Maillefer, Ballaigues, Switzerland) up to size ×2. Irrigation was performed using 3.5% sodium hypochlorite (NaOCl) solution between instrumentations. After access opening, only one orifice of the palatal canal was observed on the pulpal floor. Since bifurcation of the roots occurred in the middle third of the roots in the CBCT examination, the root canal was enlarged from the orifice to the bifurcation area using a long neck round bur (EndoTracer; Komet, Lemgo, Germany) with a specially designed long neck to prevent obstruction of the visual field on the dental microscope. After enlarging the root canal using a long neck round bur, two orifices were confirmed (Figure 2(b)). After scouting and working length determination, the two palatal root canals were prepared in the same way as the other root canals using ProTaper Next files. Finally, three and two root canals in the buccal and palatal roots, respectively, were subjected to root canal shaping. Excluding the palatal canals, the three buccal canals were filled with gutta-percha cones and a calcium-silicate-based sealer (EndoSeal MTA; Maruchi, Wonju, Korea) using a continuous wave compaction technique (Figure 2(c)). The two palatal canals beyond the bifurcation were filled with gutta-percha cones and calcium-silicate-based sealer using a one-cone technique. The root canal above the bifurcation area was back-filled with gutta-percha. The access cavity was restored using composite resin, and the tooth was permanently restored with a gold crown.

Twelve months later, the patient was recalled for follow-up and was asymptomatic. The 12-month follow-up radiograph showed a no evidence of pathology (Figure 2(d)).

2.2. Case 2. A 58-year-old man complaining of gingival swelling in the right maxillary molar area was referred to the Chosun University Dental Hospital. His medical history was noncontributory. On clinical examination, a sinus tract was found in the buccal gingival region of tooth 16. The response of tooth 16 to cold and electric pulp testing (Parkell Electronics, Farmingdale, NY, USA) was negative. Intraoral examination revealed a deep gingival pocket with a probing depth of 8 mm on the buccal aspect. Preoperative periapical radiography revealed a radiolucent periapical lesion and narrowed root canals. Two buccal roots and one palatal root were observed on the radiograph; however, the periodontal ligament space on the mesial side suggested the possibility of additional roots (Figure 3(a)). Shadows due to fractures of the crown in the mesiocervical area were observed on preoperative radiographs, and there were no additional caries. After a diagnosis of pulpal necrosis and chronic apical periodontitis was established, nonsurgical root canal treatment was planned. An informed consent was obtained after the treatment plan was established. Local anesthesia was induced using 2% lidocaine with 1 : 100,000 epinephrine, and endodontic treatment was performed under a dental operating microscope (Global Surgical, St. Louis, MO, USA). After dental dam isolation, an access cavity was prepared using a no. 330 carbide bur and Endo Access bur no. A0164 (Dentsply Maillefer, Ballaigues, Switzerland). As the preoperative radiograph suggested a possibility that two palatal roots existed, modification was required when preparing the access cavity. The access cavity was prepared in the conventional form on the buccal side, but when preparing the palatal side, it was made wider in the mesiodistal direction than the conventional preparation. The orifice of one palatal root canal was observed distopalatally on the pulpal floor, and an additional root canal orifice was observed at the mesiopalatal position. Four canal orifices, including the two palatal canal orifices, were identified on the pulpal floor, and endodontic treatment was performed. Glide paths were established using ProGlider files (Dentsply Maillefer, Ballaigues, Switzerland). The working lengths of all canals were determined using ISO 10 K-files (Dentsply Maillefer, Ballaigues, Switzerland) and an electronic apex locator (Root ZX; J. Morita, Tokyo, Japan). To understand the anatomy of the buccal and palatal root canals, intraoperative radiographs were obtained with K- and H-files in the buccal and palatal root canals, respectively (Figure 3(b)). All root canals were shaped using ProTaper Next files (Dentsply Maillefer, Ballaigues, Switzerland) up to size ×2 under copious irrigation with 3.5% NaOCl. Root canal filling was performed using the continuous wave compaction technique with gutta-percha cones and a calcium-silicate-based sealer (EndoSeal MTA; Maruchi, Wonju, Korea). Subsequently, the access cavity was sealed with composite resin, and the tooth was permanently restored with a gold crown. Postoperative periapical radiography revealed two long palatal and two short buccal canals (Figure 3(c)). Figure 3(d) shows the four canal orifices over the pulpal floor after obturation. At the 6-month follow-up, the patient was asymptomatic. Clinical examination showed that the probing depth of the buccal gingival sulcus recovered to within the normal range (<3 mm). The periapical radiograph shows



(a) (b) (c)

Figure 1: (a) Preoperative periapical radiograph. Note the divergence of the buccal roots and the unclear palatal root. (b) Axial CBCT image at the cervical third of the roots showing fusion of the buccal roots (triangle) and one palatal canal (arrow) in the palatal root. (c) Axial CBCT image at the middle third of the roots showing two canals in the palatal root (arrow).

partial resolution of the periradicular radiolucency (Figure 3(e)).

3. Discussion

Studies on the number and shape of the roots of the maxillary molars have shown higher anatomical variability in the maxillary second molars than in the first molars in various ethnic groups [19–22]. Previous studies on the anatomical variations in maxillary molars have focused mainly on the mesiobuccal root. In this regard, it has been reported that the maxillary first and second molars have two or more root canals in 40.3%–87.2% and 15.1%–57.94% of cases, respectively [23–29]. However, relatively few studies have been conducted on palatal root anatomy, which exhibits less variability. Stone and Stroner examined 500 extracted maxillary molars, excluding third molars, and reported that the palatal root had additional root canals in <2% of cases [3]. A CBCT study of the number of palatal root canals in 802 maxillary first molars and 660 upper second molars in Koreans showed that only 1.82% of the latter had two root canals [19]. In another study, Mohara et al. reported that in the maxillary first molars, the mesiobuccal and palatal roots had additional root canals in 64.22% and 0.31% of cases, respectively; in the

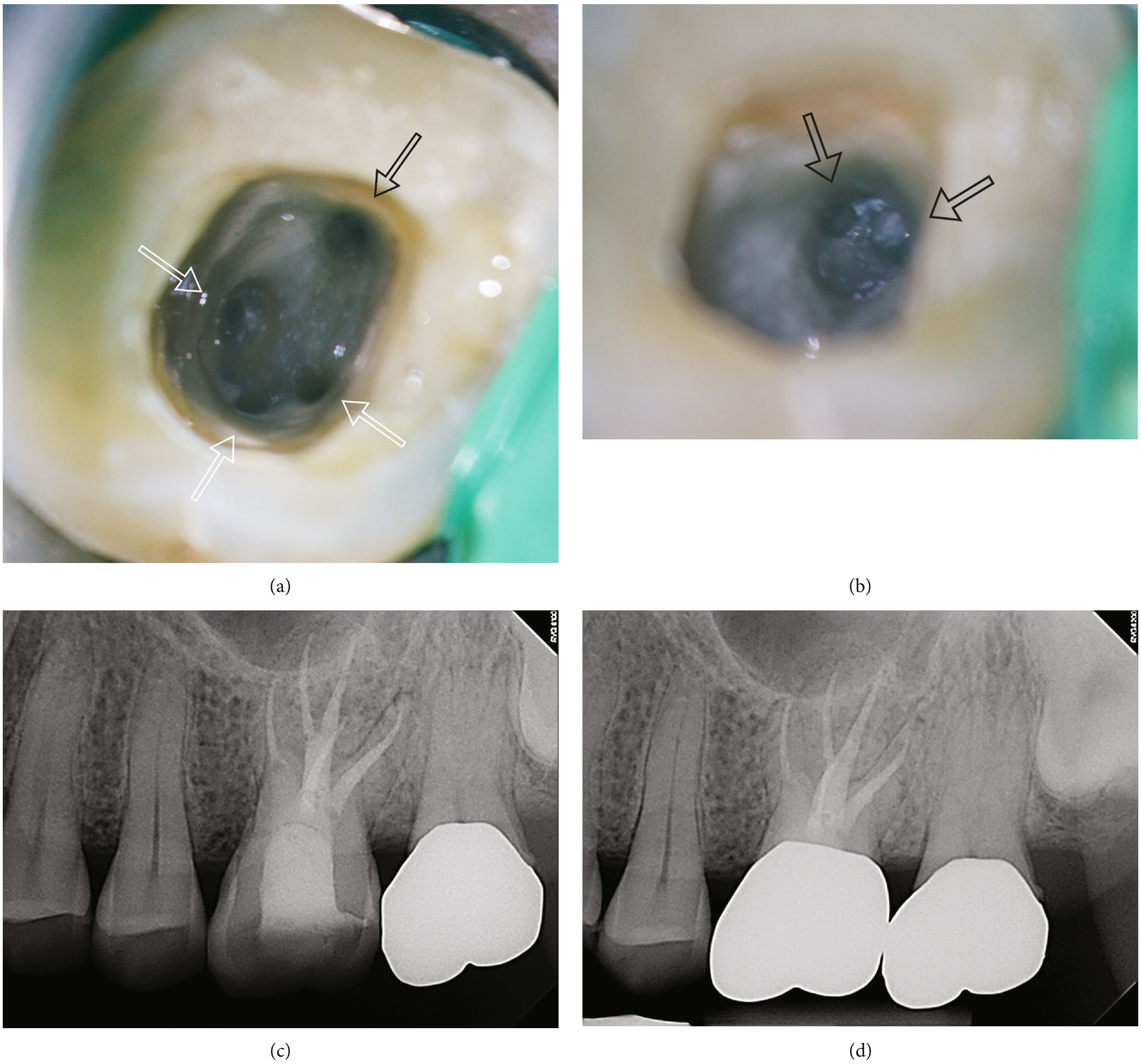


Figure 2: (a) Microscopic image of the pulpal floor of tooth 26. At the level of the pulpal floor, one palatal canal orifice (black arrow) and three buccal canal orifices (white arrows) can be seen. (b) Microscopic image at the level of the bifurcation of the palatal canal. Two canal orifices (black arrows) can be seen. (c) Postoperative radiograph, showing two separate canals in the palatal root. (d) Radiograph at the 12-month follow-up visit.

second molars, additional root canals in the mesiobuccal and palatal roots were seen in 33.56% and 0.34% of cases, respectively [30].

The C-shaped root canal configuration is a unique anatomical variation that is caused by the fusion of the roots and characteristically occurs in mandibular molars. In the maxillary molars, C-shaped root canals due to the fusion of roots are rarely observed [31]. Studies of various ethnic groups have shown root fusions in 0.61%–7.1% and 9.91%–25.2% of the maxillary first and second molars, respectively [30, 32, 33]. The fusion of the distobuccal root to the palatal root occurs more frequently than that of the mesiobuccal root to the distobuccal root [1].

In the first patient, the distobuccal and mesiobuccal roots were fused, and canal bifurcation occurred inside the palatal root. This was an extremely rare case in which two types of anatomical abnormalities occurred simultaneously. In the second patient, tooth 16 had two separate palatal roots, each with one orifice, one canal, and one apical foramen. As seen in these two patients, various anatomical variations may occur in the palatal roots of maxillary first molars, and more cases may be reported with the increased use of CBCT and dental operating microscopes.

In the case of midroot bifurcation, as in the first case, it is important to allow the device to access the bifurcation area. For this, illumination using a dental operating microscope is essential, and a long neck round bur that does not interfere with the FOV is very useful. The EndoTracer bur (Komet, Lemgo, Germany) used in this case has a total length of 31 mm with a long neck portion, which helps to form an

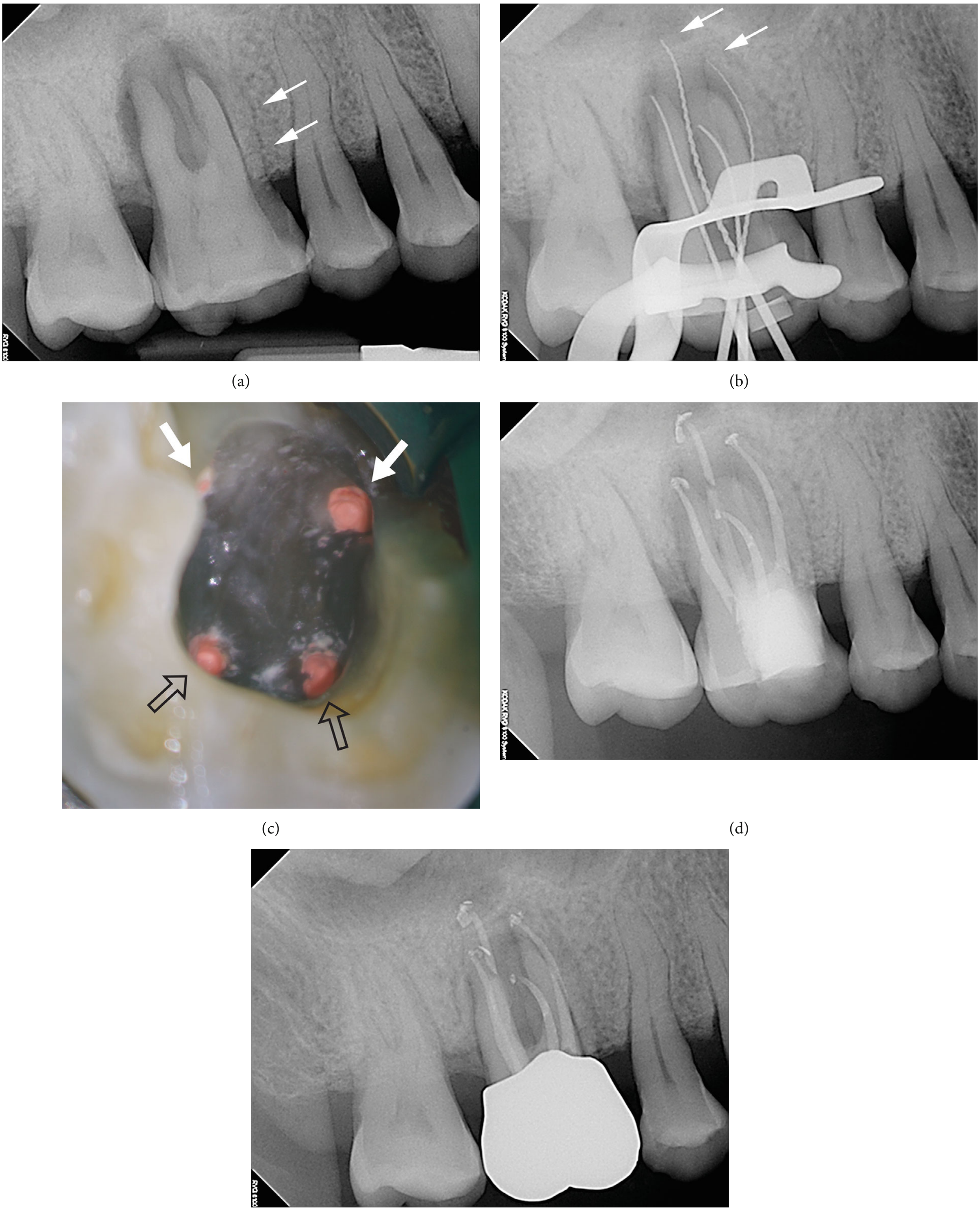


Figure 3: (a) Preoperative radiograph. Note the PDL space of the mesial side (white arrow) suggesting an additional root. (b) Intraoral radiograph shows two long palatal (white arrows) and two relatively short buccal root canals. Positioning of H-files on the palatal root canals and K-files in the buccal root canals to distinguish between the buccal and palatal sides. (c) Postoperative radiograph showing four separate canals. (d) Microscopic image of the pulpal floor of tooth 16 showing two buccal root canal orifices (black arrows) and two palatal root canal orifices (white arrows). (e) Radiograph at the recall visit at 6 months showing partial resolution of the periradicular radiolucency.

effective path without obstructing the FOV. For canal obturation beyond the bifurcation area, a one-cone technique using calcium silicate sealer and gutta-percha cone was performed, and backfill was performed from the bifurcation area to the pulpal floor.

In the second case, the possibility of the presence of an additional palatal root was suggested by the preoperative radiographs. When it is possible that two palatal roots exist, modification of the access cavity is required. In particular, if the orifice of the palatal root canal is not in the center relative to the tooth shape, but is located mesially or distally, the possibility of an additional root canal should be considered. In this case, the orifice of the first palatal root canal was located mesially, and the access cavity was expanded in the distal direction using a round bur. Checking the color of the pulpal floor through a dental operating microscope while preparing the access cavity may help to find the root canal orifice. Unlike the first case, in which bifurcation occurred in the midroot area, in the second case, two orifices were found on the pulpal floor, so a 31 mm long round bur was not used.

In this report, two important tools were used to manage anatomical variations. CBCT is a useful tool for identifying the internal anatomy of a tooth before treatment. In particular, it is useful to identify the number and curvature of the roots and the anatomical variation through 3D reconstruction [34, 35]. Clinicians can use CBCT for treatment planning before root canal treatment of maxillary molars with complex anatomy to understand the root structure. The second tool, the dental operating microscope, is essential for root canal treatment of teeth with complex anatomical structures. It provides better visualization of the operative field through effective illumination and higher magnification. Without it, detection of anatomical clues to find uncommon root canal bifurcation, such as that seen in the first patient, is difficult. The use of a dental operating microscope can help clinicians assess the treatment site and conduct complex treatment effectively.

Various anatomical variations can occur in the palatal root canal of the maxillary molar, and it is crucial that clinicians are aware of the possible aberrations or anomalies of the tooth. Through knowledge of the variations occurring in the palatal root and appropriate modifications, the clinician can increase the success rate of endodontic treatment. However, in some cases, the patient must be referred to an endodontist to receive specialized treatment.

4. Conclusion

In this case report, we presented the anomalies of the palatal roots and root canal system of the maxillary first molars. Clinicians should be aware of the possibility of anatomical variations, even though they rarely occur in the palatal root of the maxillary first molars.

In cases with two palatal root canals, CBCT can help establish a treatment plan, and a dental operating microscope can help with proper treatment. In addition, depending on the case, it is necessary to modify the shape of the access cavity according to the location of the orifice or to increase the accessibility by using a special long neck bur.

Finally, if a highly difficult endodontic treatment is expected, referral to an endodontist may be an option.

Conflicts of Interest

The authors do not have any conflicts of interest related to this study.

Authors' Contributions

All authors have contributed significantly to this study and have approved this manuscript.

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