

CASE REPORT

Root canal treatment of a maxillary first molar with unusual anatomy

ABSTRACT

Aim: To describe the management of a maxillary first molar with six root canals, two in each root.

Summary: A 36-year-old male patient presented with a complaint of discoloration and decay on an upper left back tooth. Clinical examination revealed the presence of deep occlusal caries on the maxillary left first molar. A detailed clinical and radiographical examination led to a diagnosis of pulp necrosis with asymptomatic apical periodontitis. Non-surgical root canal treatment was performed. Due to the suspected anatomical variation, Cone beam computed tomography (CBCT) imaging was obtained. CBCT imaging and clinical identification using the DOM revealed the presence of six root canals, two in each root, with the code (${}^326 MB^2 DB^2 P^{2-1}$) using Ahmed et al. system. Root canal treatment was successfully performed and confirmed radiographically. The tooth was restored with a resin composite restoration. The patient was referred for prosthodontic evaluation for extracoronary restoration.

Key Learning Points:

- This case highlights how clinicians must approach root canal treatment with a comprehensive mindset that considers the potential for extraordinary anatomical complexities.
- Preoperative knowledge of root canal anatomy and proper armamentarium are mandatory for successful root canal treatment procedures.

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Introduction

Root canal treatment (RCT) aims to three-dimensionally seal the root canal space after proper sterilization (1). The root canal system refers to the internal space within a tooth that contains pulp tissue. It consists of the pulp chamber located in the anatomical crown of the tooth and the root canals encased within the roots (2-5). This system can be quite intricate, with teeth often displaying extra roots and additional root canals (6). These variations in tooth anatomy can pose challenges during root canal treatment, underscoring the importance of dental practitioners adhering to recommended guidelines for identifying and addressing these canals to ensure the success of RCT (7). The maxillary first molar typically exhibits three roots: the mesiobuccal (MB), distobuccal (DB), and palatal (P) roots (8). In most cases, the MB root contains two root canals (referred to as MB1 and MB2), while each of the distobuccal and palatal roots has a single root canal (9,10). However, it is worth noting that the prevalence of two root canals in the palatal root has been reported ranging from 1.2 to 3% (11, 12), and the presence of a second DB root canal in maxillary first molars falls within the range of 1.1 to 2.5% (11, 13). Table 1 provides a comprehensive overview of the reported cases involving maxillary first molars with six or more root canals (14-23). Recognizing such anatomical variances is essential to prevent the risk of missed canals, which can lead to treatment failure and complications (24). This case study describes an unusual presentation of a maxillary first molar featuring six separate root canals, with two canals in each root. Managing this case underscores the significance of thorough preoperative evaluation and meticulous treatment planning.

Report

History and clinical examination

A 36-year-old male patient from Nepal presented with a complaint of discoloration and decay in the maxillary left pos-

terior tooth (tooth #14 per the Universal numbering system). There was no associated pain, and the patient had no significant medical history. Upon clinical examination, deep occlusal decay was observed on tooth #14. The tooth did not respond to thermal and electrical pulp vitality tests using a Digitest 3 Pulp Vitality Tester (Parkell, Long Island, NY, USA), and it did not exhibit tenderness upon percussion or palpation. Probing depths were within the normal range, and there was no mobility of the tooth. An intraoral periapical radiographic examination revealed a periapical radiolucency along with the loss of lamina dura, in addition to the presence of relatively wide mesiobuccal, distobuccal, and palatal roots, as shown in Figure 1.

Detailed clinical and radiographic assessments led to a diagnosis of pulp necrosis with asymptomatic apical periodontitis. Non-surgical root canal treatment was recommended for tooth #14. Following the diagnosis and formulating the treatment plan, the patient was informed about the procedure, its associated risks and benefits, and written informed consent was obtained.

Clinical management

Local anesthesia using 2% lidocaine with 1:100,000 epinephrine (Septodont, Saint-Maur-des-Fossés, France) was administered, followed by the placement of a rubber dam to isolate the tooth. The access cavity was prepared after removing the caries. Due to suspicions about the anatomy of the relatively wide mesiobuccal, distobuccal, and palatal roots, a cone-beam computed tomography (CBCT) scan was obtained using a Planmeca Promax 3D CBCT machine. The scan was performed with the following parameters: 90 kV, 12 mA, 15 seconds of exposure, a voxel size of 75 μ m, and axial sections with a thickness of 0.225 mm. The scan revealed the presence of 6 root canals, with two root canals in each root, as shown in Figure 2. To examine the pulpal floor and assist in locating the 6 root canal orifices (2 mesiobuccal canals - MB1 & MB2, 2 distobuccal canals - DB1 & DB2, and 2 palatal canals - P1 & P2), a DG-16 probe and Global A6

Table 1

Summary of the reported cases of maxillary first molar showing 6 or more root canals using Ahmed et al coding system (5)

Year	Author	Method of detection	Anatomical classification (Ahmed et al.)
1983	Martínez-Berná & Ruiz Badanelli (14)	Intraoral Periapical Radiographs	³ 26 MB ^{3,2} DB ² P ¹
1988	Bond et al. (15)	Intraoral Periapical Radiographs	³ 16 MB ² DB ² P ^{2,1}
2002	Maggiore et al. (16)	DOM	³ 26 MB ² DB ¹ P ³
2007	Adanir (17)	Intraoral Periapical Radiographs	⁴ 16 MB ¹ MP ^{2,1} DB ^{2,1} P ¹
2009	de Almeida-Gomes et al. (18)	Intraoral Periapical Radiographs	³ 26 MB ² DB ^{2,1} P ^{2,1}
2010	Albuquerque et al. (3 cases) (19)	DOM	³ 26 MB ^{2,1} DB ^{2,1} P ^{2,1}
2010	Karthikeyan and Mahalaxmi (4 cases) (20)	Intraoral Periapical Radiographs	³ 26 MB ² DB ^{2,1} P ^{2,1}
2010	Kottoor et al. (21)	CBCT and DOM	³ 26 MB ^{3,2} DB ^{2,1} P ^{2,1}
2011	Kottoor et al. (22)	CBCT and DOM	³ 26 MB ^{3,2} DB ^{3,2} P ^{2,1}
2021	Lin et al. (23)	CBCT and DOM	³ 16 MB ² DB ² P ^{2,1}
2023	Singh et al. (Current case)	CBCT and DOM	³ 26 MB ² DB ² P ^{2,1}

dental operating microscope (DOM) (Global Surgical Corporation, St. Louis, Missouri, USA) were used. Once the orifices' locations were confirmed, the working length of the 6 root canals was determined using a Root ZX electronic apex locator (J. Morita, Kyoto, Japan) and subsequently verified with intraoral periapical radiographs, as shown in Figure 3.

The canals were negotiated using #10 and #15 K files (Mani, Utsunomiya, Japan). Cleaning and shaping of the root canals were carried out using the ProTaper Gold rotary system (Dentsply Maillefer, Switzerland) following the manufacturer's recommended speed and torque settings. Copious irrigation was performed using sodium hypochlorite (3%) and EDTA (17%) solutions with a 30-gauge needle NaviTip (Ultradent, UT, USA). The 4 buccal canals,

MB1, MB2, DB1, and DB2, were prepared up to the F2 file, while the 2 palatal canals were prepared up to the F3 file. After the instrumentation of all 6 root canals, they were thoroughly dried using paper points. Master gutta-percha cones were clinically verified and confirmed radiographically. The root canals were filled using gutta-percha (Meta Biomed, Chungcheongbuk-do, Korea) in combination with NeoSEALER root canal sealer (Avalon BioMed, Houston, TX, USA).

The two MB and two DB root canals were filled using a single cone technique, while the two palatal root canals were filled using the warm vertical compaction technique. The tooth was restored with a resin composite restoration. The patient was referred for prosthodontic evaluation for an extra-coronal restoration.



Figure 1
Preoperative intraoral periapical radiograph of the left maxillary first molar (Tooth #14).

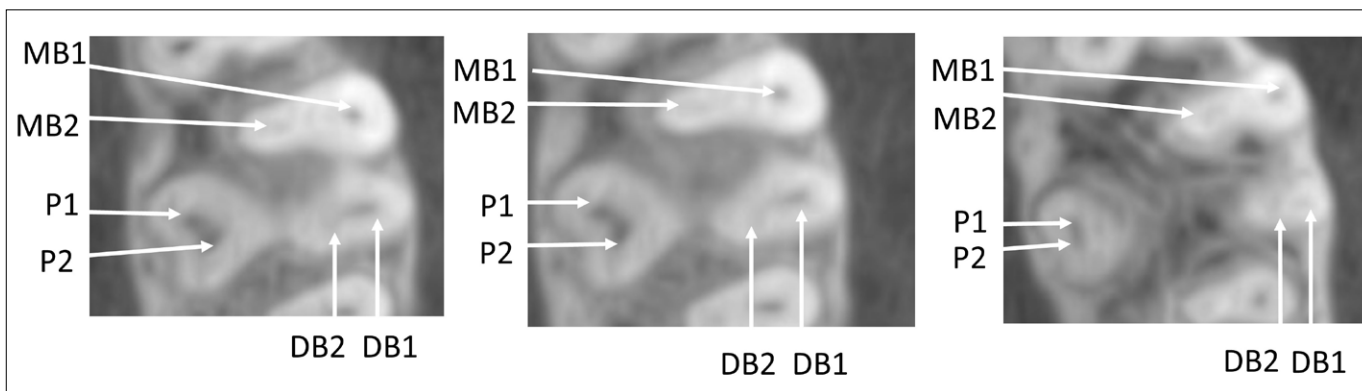
Discussion

Root canal treatment procedures of molars with complex anatomy is a challenging task, and can lead to complications if not performed successfully (18, 25-27). This case presented the management of an unusual root canal anatomical variation of a maxillary first molar. The CBCT scan revealed the presence of six root canals, an exceptionally rare phenomenon (18). CBCT is a precise diagnostic tool with minimal radiation exposure, capable of providing detailed views of the root and the root canal anatomy (28-30). It offers three-dimensional images with excellent spatial resolution, making it invaluable for endodontic diagnosis and treatment planning (31, 32). When com-

bined with a DOM, the enhanced magnification further facilitates the visualization of tiny root canal orifices and branching structures originating from the main canals (33).

Earlier studies have established a wide variation of root canal configurations in the maxillary first molars, varying from a single root canal to as many as seven root canals (14, 19, 34, 35). The literature contains reports of eight cases featuring the presence of two root canals in the palatal root of the maxillary first molars (36-41). Additionally, five cases have been documented in the literature where a second distobuccal (DB) root canal was identified in the maxillary first molars (14, 15, 42). Martinez-Berna and Ruiz-Badanelli (14) reported clinical management of maxillary molars with six root canals. Albuquerque et al reported the successful nonsurgical endodontic treatment of three permanent maxillary first molars, each with three roots and six root canals (19). Almeida-Gomez et al also identified and managed a maxillary first molar encasing six root canals, utilizing similar clinical procedures (18). Kaushik et al detailed the endodontic management of two maxillary first molars, both presenting six root canals, with the aid of a DOM and CBCT (34). While the number of reported cases in the literature featuring maxillary first molars with six or more root canals is limited, the majority of them employed magnification and three-dimensional imaging to identify

Figure 2
Preoperative cone beam computed tomographic axial views, a) at the coronal one third of the root; b) at the middle one third of the root; c) at the apical one third of the root.



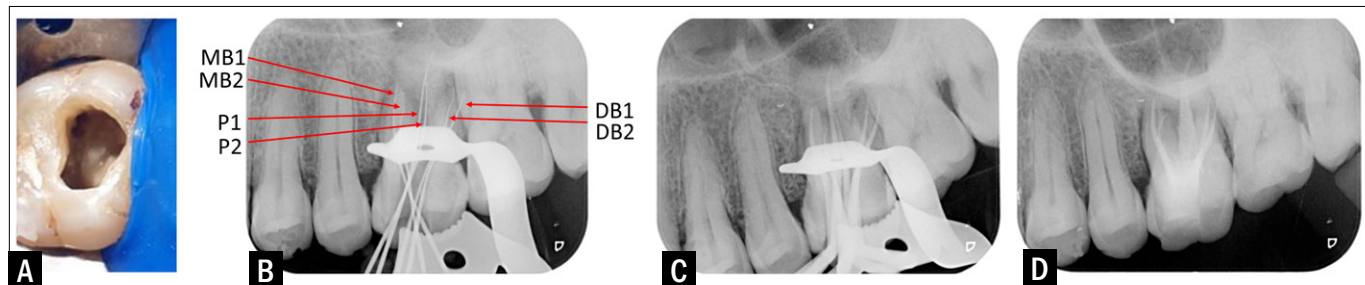


Figure 3

Operative records of the root canal treatment of the left maxillary first molar (Tooth #14) showing root canal morphology ${}^326 MB^2 DB^2 P^{2-1}$.

- A)** Intraoral photograph of the access cavity preparation;
- B)** Intraoral periapical radiograph showing the working length determination;
- C)** master cone intraoral periapical radiograph showing six root canals; **D)** postoperative intraoral periapical radiograph.

or confirm this variation. The most common configuration of such cases is the code ${}^326 MB^2 DB^2 P^{2-1}$ according to the Ahmed et al system (5). The adoption of the Ahmed system for root canal classification has proven to be valuable in presenting both the number of roots and root canal configuration in a precise and straightforward manner. The accuracy of this coding system has been documented in a recent systematic review (43). One of the contributing factors to such anatomical variations is the difference in the ethnic backgrounds of the populations studied (44). Lin et al pointed out that, among nine case reports of maxillary first molars with multiple root canals published between 2010 and 2020, seven of these cases were documented in India (23). They found that the configuration of multiple canals is more frequently observed in Asian ethnic groups, with most of these cases originating from India. The current case report, featuring a patient from Nepal, provides additional perspectives that reinforce the correlation indicating a higher prevalence of multi-canal configuration in maxillary first molars among individuals of Asian ethnic backgrounds.

This case report underscores the importance of preoperative awareness regarding both typical and atypical anatomical variations in the maxillary first molars. The employment of high-resolution diagnostic instruments, such as CBCT, plays a significant role. Following the latest guidelines for access cavity preparation techniques and conducting a comprehensive examination of the pulp chamber floor are crucial steps in iden-

tifying root canal orifices in teeth exhibiting additional canals.

Conclusion

This case report describes the root canal therapy performed on a maxillary first molar with a unique root canal configuration. A comprehensive preoperative evaluation, supported by radiographic imaging and state-of-the-art diagnostic equipment, is indispensable for the recognition and successful treatment of such cases.

Clinical Relevance

Maxillary first molars show a wide variations in the number of root canals. Using 3D diagnostic imaging and the dental operating microscope pave the way for accurate detection of additional canals for teeth scheduled for root canal treatment procedures.

Conflict of Interest

None.

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None.

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