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Anatomical variation of maxillary first molar with two roots and two canals: a rare case report

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Abstract

This case report describes the endodontic management of a maxillary first molar with an unusual anatomical configuration, consisting of a single buccal root and a single palatal root, each containing one root canal with a Vertucci Type I configuration. Cone-beam computed tomography (CBCT) confirmed the atypical root morphology and facilitated appropriate treatment planning. The case highlights the significance of recognizing anatomical variations and the utility of advanced imaging techniques in complex endodontic cases.

Keywords: *anatomical variation, cone-beam computed tomography, maxillary first molar, two-rooted maxillary molar*

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Introduction

The internal anatomy of the root canal system plays a crucial role in the success of endodontic therapy. A comprehensive understanding of root and canal morphology is essential to ensure thorough debridement, disinfection, and obturation of the root canal system, thereby reducing the risk of persistent infection and treatment failure (Schilder, 1974).

The maxillary first molar is widely regarded as one of the most anatomically complex teeth in the human dentition. It typically presents with three roots, mesiobuccal, distobuccal, and palatal, and often contains four canals, with a second mesiobuccal canal frequently reported (Pecora, 1992). However, considerable anatomical variations have been documented, including fused roots, single-rooted molars, C-shaped canals, and variations in the number and configuration of canals (Christie & Peikoff, 1991; Cleghorn *et al.*, 2006; Martins *et al.*, 2018).

Failure to recognize aberrant root canal morphologies may result in missed canals, inadequate disinfection, and subsequent endodontic failure. Vertucci classified root canal configurations into eight types (Table figure11) (Vertucci, 1984). Clinicians should remain vigilant for such variations and employ advanced imaging modalities when indicated.

Table 1. Vertucci's classification of root canal configurations (Types I–VIII).

Type	Configuration	Description
I	1-1	A single canal extends from the pulp chamber to the apex.
II	2-1	Two canals leave the chamber and merge into one before the apex.
III	1-2-1	One canal leaves the chamber, divides into two, and rejoins before the apex.
IV	2-2	Two separate canals extend from the chamber to the apex.
V	1-2	One canal leaves the chamber and divides into two with separate apical foramina.
VI	2-1-2	Two canals leave the chamber, merge in the root, and redivide before the apex.
VII	1-2-1-2	One canal leaves the chamber, divides, rejoins, and divides again before the apex.
VIII	3-3	Three distinct canals extend from the pulp chamber to the apex.

This case report describes the successful non-surgical root canal treatment of a maxillary first molar presenting with only two roots and two canals, exhibiting Vertucci's Type I configuration. The unusual morphology was confirmed using CBCT, highlighting the importance of 3D imaging in accurately diagnosing complex anatomical variations.

Case report

A 39-year-old female patient presented to the Department of Endodontics, SJM Dental College and Hospital, with the chief complaint of spontaneous pain in her maxillary right first molar, persisting for the past three days. The patient's medical history was non-contributory. Clinical examination revealed sensitivity to thermal stimuli and electric pulp testing, along with tenderness to vertical percussion. The pre-operative periapical radiograph showed caries extending to the pulp with associated periapical periodontal ligament widening (Figure 1).

Based on clinical evaluation and radiographic findings, the diagnosis was established as symptomatic irreversible pulpitis with symptomatic apical periodontitis. After administration of local anesthesia (2% lidocaine with 1:80,000 epinephrine), the tooth was isolated with a rubber dam. Following caries removal, the pulp chamber was irrigated with normal saline. Initial exploration identified a single buccal and palatal canal orifice. The buccal canal orifice appeared relatively large. No additional orifices were identified despite thorough inspection using ×4.5 magnification with prismatic loupes (Zeiss Eyemag Pro S; Carl Zeiss SpA, Arese, Italy) and a dental operating microscope (Labomed Prima DNT; Labomed Inc., USA) (Figure 2).

Figure 1. Pre-operative radiograph.

Figure 2. Access opening on maxillary first molar showing two root canal orifices.

To confirm the canal morphology, CBCT was performed (Carestream Dental, Rochester, NY, USA). CBCT imaging clearly demonstrated the presence of only two roots and two root canals with no evidence of fusion or additional canals (Figures 3A–C).

At the subsequent appointment, working length determination was carried out using an electronic apex locator (Root ZX Mini, J. Morita Corp., Japan), and confirmed radiographically (Figure 4A). Canal preparation was performed using the ProTaper Gold rotary system (Dentsply Sirona, Switzerland), following the manufacturer's protocol. Both canals were prepared up to size F4. A master cone radiograph was taken to verify fit and length (Figure 4B).

Irrigation was carried out with 5.25% sodium hypochlorite (Nice Chemicals Pvt. Ltd., Kochi, India), activated using the EndoActivator (Dentsply Sirona), followed by 17% EDTA (Nice Chemicals Pvt. Ltd.) for one minute per canal. The final rinse was performed with sterile normal saline (Infutec Healthcare Ltd., Indore, Madhya Pradesh, India). Canals were then dried with sterile paper points, and F4 ProTaper Gold Conform Fit gutta-percha cones (Dentsply Sirona) were placed at the working length.

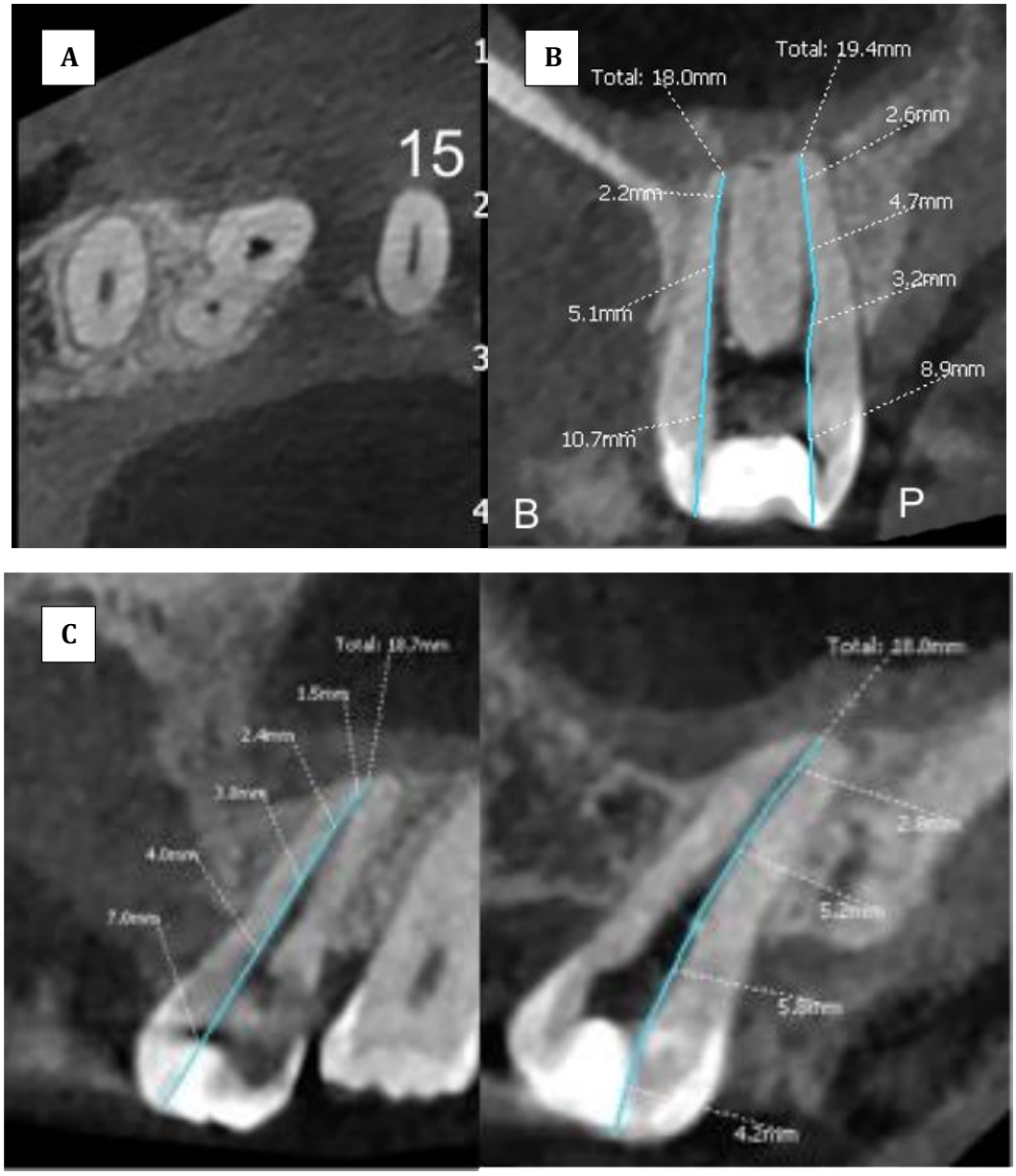

Figure 3. CBCT images showing two distinct buccal and palatal roots and root canals: (A) axial section, (B) coronal section, (C) sagittal section.

Obturation was performed using a resin-based sealer (AH Plus, Dentsply Sirona) and the continuous wave of condensation technique. Down-packing was accomplished using the System B unit (SybronEndo, USA), with a plugger selected to bind 4–5 mm short of the working length. Backfilling was completed using the Obtura II system (Obtura Spartan, USA) (Figure 4C).

The pulp chamber was cleaned with isopropyl alcohol, and the canal orifices were sealed with a flowable composite resin (Supraflow, R&S, France). The access cavity was restored using bulk-fill composite resin (Figure 5).

Due to misalignment of the tooth within the dental arch, full-coverage restoration was planned. The tooth was prepared for a metal crown designed to close the proximal gap and achieve proper occlusal alignment. The crown was cemented using Type I glass ionomer luting cement (Fuji I Glass Ionomer Cement, GC Corporation) (Figure 6).

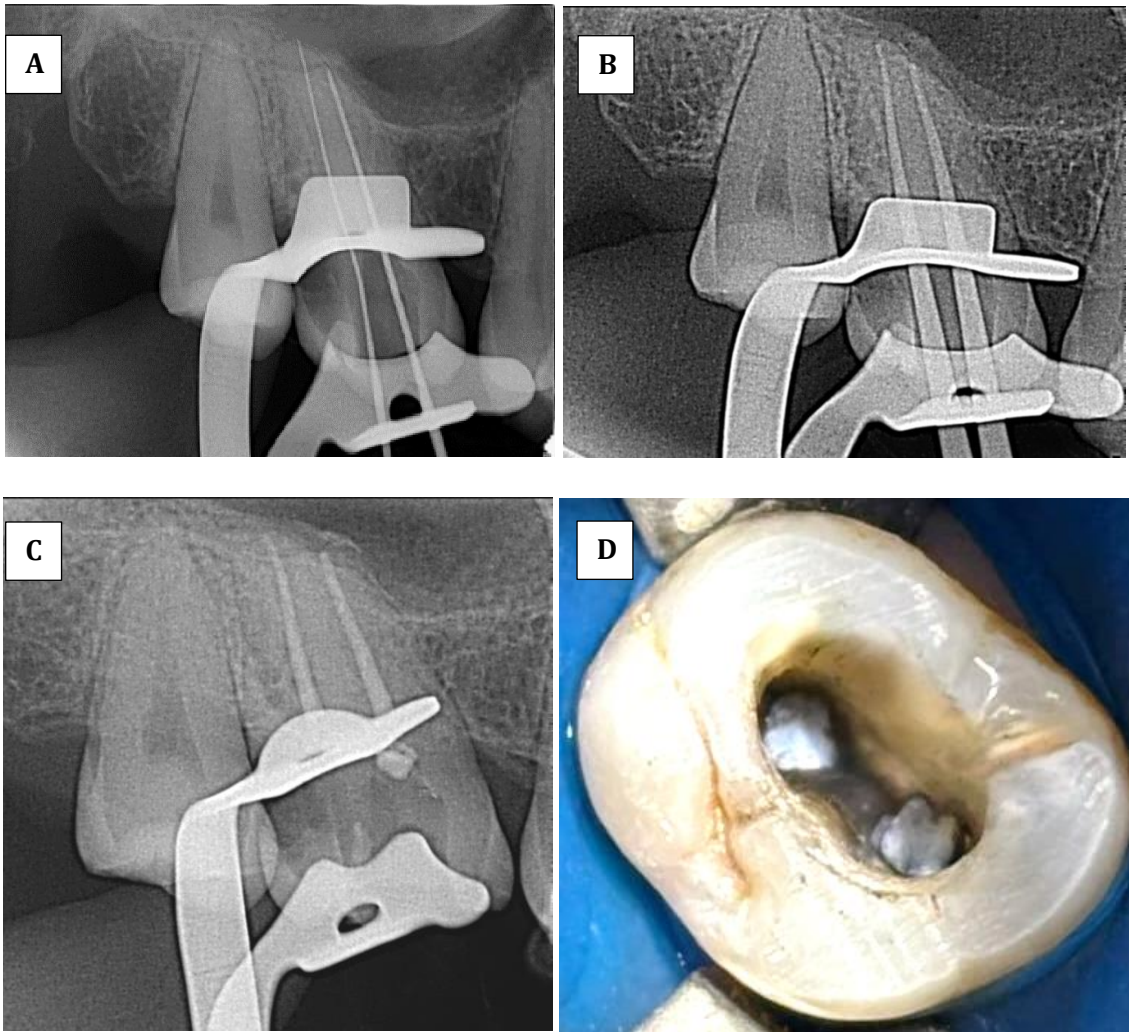

Figure 4. A: Periapical radiograph (PA) image of working length determination, B: PA of master cone verification, C: PA of 3 complete obturation, D: Clinical image of orifices after obturation.

Figure 5. Post-endodontic restoration with composite.

Figure 6. Correction of misalignment with full metal crown.

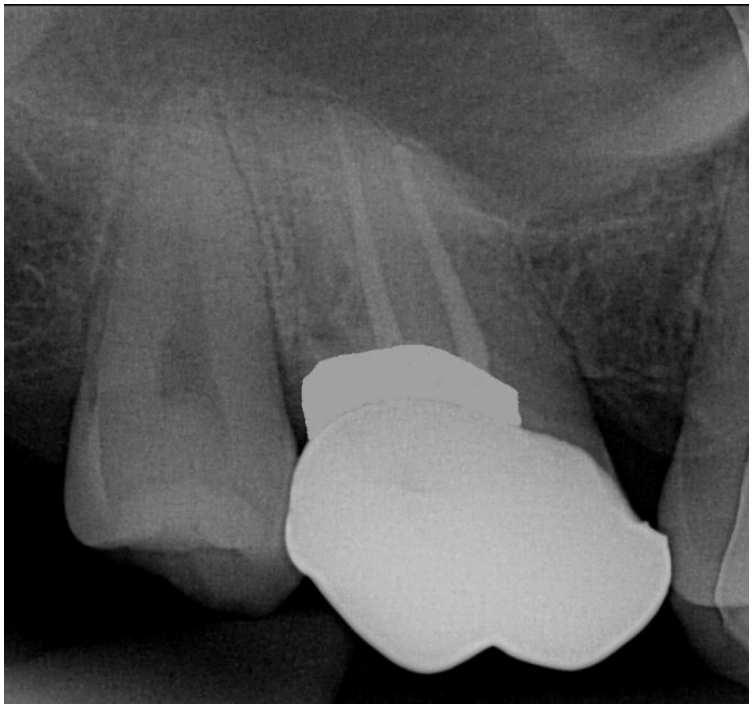

Figure 7. One-year follow-up. The patient reported no symptoms, and clinical and radiographic examination confirmed successful healing.

Discussion

Anatomical knowledge is fundamental to the success of endodontic therapy. The maxillary first molar is one of the most extensively studied teeth due to its frequent anatomical complexity. Typically, it presents with three distinct roots, mesiobuccal, distobuccal, and palatal, with the mesiobuccal root often containing two canals. However, deviations from this typical anatomy, such as root fusion or a reduced number of canals, although rare, can present significant diagnostic and therapeutic challenges (Ounsi & Simao, 2012).

This case presents a rare maxillary first molar variation with two roots, one buccal and one palatal, each containing a single canal. Comparable presentations have been reported: Rahimi & Ghasemi (2013) detailed a similar two-root, two-canal structure in a maxillary first molar, while a later 2018 case

report highlighted the effectiveness of CBCT in accurately identifying such unusual root canal morphologies, reinforcing the necessity of advanced imaging for complex anatomical cases

Recent studies have underscored the value of CBCT in visualizing complex root canal anatomy. Olczak & Pawlicka (2017) reported that all maxillary first molars examined had three roots, with the majority having four canals; only a minority exhibited variations such as an MB2 canal. Similarly, Magalhães *et al*. (2022) identified variations in the canal system, supporting CBCT's superiority over conventional radiographs.

Understanding root canal anatomy and anticipating potential variations are crucial for preventing procedural errors. In this case, confirmation of two roots and two canals facilitated a more conservative and precise access preparation, reducing the risk of iatrogenic damage.

Anatomical variations in the maxillary first molar most commonly involve differences in root number. CBCT studies report that approximately 5% of maxillary first molars have only two roots (Sharma *et al.*, 2022), and a mere 0.4% present with a single root. Cases featuring just one buccal and one palatal root are especially rare.

The development of multiple roots in molars is influenced by the epithelial root sheath, which forms the epithelial diaphragm (Yamamoto *et al*., 2015). Differential growth of this structure divides the root trunk into multiple roots. If this process fails or is altered, it may result in fusion of roots or a reduced number of roots. Fusion of the two buccal roots resulted in a single buccal root housing a single canal, while the palatal root remained separate (Gopikrishna *et al.,* 2008).

Large orifices may appear misleading and resemble a single canal, even when bifurcations or additional canals are present deeper within the root. Despite magnification, only two orifices were confirmed clinically and radiographically. Treatment was carried out with careful attention to cleaning and shaping protocols suited for this unusual morphology.

Root coalescence, especially of the buccal roots, is one of the more commonly reported anatomical aberrations of maxillary molars. Studies report that approximately 0.4% of maxillary first molars and 2.2% of maxillary second molars exhibit this variation (Demirtaş & Duman, 2023). Clinicians must always be prepared for such deviations.

The following Table 2 summarizes previously reported cases of maxillary first molars with two roots and two canals, highlighting the variation in root and canal anatomy across different studies:

Table 2. Reported cases of maxillary first molars with two roots and two canals.

Reference	Country	Gender	Ethnicity	No. of Canals	Features of the Root Canals	Vertucci Canal configuration	Symmetry
Shakouie *et al*. (2013)	Iran	Female	Not specified	2	Fused buccal roots with a single canal and a separate palatal canal	Type I	Not specified
Rahimi & Ghasemi (2013)	Iran	Female	Not specified	2	Two separate roots (buccal and palatal), each with a single canal	Type I	Not specified
Bansal *et al*. (2018)	India	Female	Not specified	2	One buccal and one palatal root, each with a single canal (Vertucci's Type I)	Type I	Yes
Soni *et al. (*2016)	India	Female	Not specified	2	One buccal and one palatal root, each with a single canal	Type I	Not specified
Liu *et al*. (2019)	China	Female	Not specified	2	Fusion between MB and DB canals, and a single palatal canal	Type II	Yes

This table summarizes previously reported cases of maxillary first molars with two roots and two canals, emphasizing the rarity of such anatomical presentations. The current case adds to the limited body of literature, highlighting the importance of thorough diagnostic assessment, including CBCT, in identifying and successfully managing atypical root canal anatomy.

Conclusion

This case highlights the importance of recognizing atypical root canal anatomy in maxillary first molars, specifically the rare presentation of two roots and two canals. Accurate diagnosis, facilitated by CBCT imaging and enhanced visualization through magnification, was critical to the successful outcome. One-year follow-up (Figure 7) confirmed the patient remained asymptomatic with satisfactory clinical and radiographic healing. Awareness of anatomical deviations, combined with meticulous treatment planning, is essential to achieving predictable endodontic results.

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