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A Comprehensive Analysis Of Recognizing And Addressing Anatomic Variations And Iatrogenic Errors In Maxillary First Permanent Molar – A Case Report

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Abstract
Detection and management of variations in root canal anatomy are often an obstacle faced by the dental practitioner. In the current case, endodontic treatment initiated in maxillary left first molar revealed three root canals on the mesio-buccal root. This unusual root canal morphology was detected using various armamentarium and techniques carried out on the pulp chamber floor. The canal configuration was confirmed by radiographic examination using radiovisiography (RVG) and cone beam computed tomography (CBCT). CBCT report reveals root canal configuration of Gulabivala's type (3-2) and Sert and Bayirli's type XV on the mesio buccal root. Distal and palatal roots have Vertucci's type I canal configuration. Ledge created along the outer curvature of the apical third of bayonet shaped distobuccal root is also very well explained beginning with the difficulty in instrumentation, diagnosis of the procedural error and the steps adopted for its effective management.
Keywords*: Root canal; First molar; Cone Beam Computed Tomography; Treatment; Pulp chamber.*

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I. Introduction

The most common cause of treatment failures in permanent maxillary first molars have been attributed to failure in detecting additional canals especially in the mesiobuccal root and therefore has resulted in more research and clinical investigation than any other root [1]. A correct diagnosis is often the most important step towards clinical success in treatment of any pathology.

The mesiobuccal root (MB) of the maxillary first molar was used as the type specimen by Weine et al. [2] in 1969 to provide the first clinical classification of multiple canal systems in a single root. With the more frequent use of the surgical operating microscope and specialized tools designed for microendodontics along with adopting to the modified endodontic access opening procedure, the number of canals identified can vary, with the second mesiobuccal canal being the most prevalent variant, ranging from 18 to 96.1%. Existence of three canals in the MB root is rare, reporting an incidence of 0.6%–4.2% clinically [3].

This case report details the effective management of a third canal in the mesiobuccal root of a permanent maxillary first molar, an anomalous and uncommon anatomical variation. This unusual morphology was confirmed with the aid of cone beam computed tomography (CBCT) scanning. CBCT axial images showed that the mesiobuccal root contained a Sert and Bayirli type XV canal configuration, whereas the distobuccal and palatal root showed Vertucci type I canal configuration. Additionally, it provides a comprehensive analysis of the management of procedural errors that happened during the therapy.

II. Case Report

A 12-year-old female patient reported to the department of conservative dentistry and endodontics with pain on the upper left back tooth region in the last two weeks. On clinical examination deep disto-occluso-palatal carious lesion was observed on the left maxillary first molar (tooth 26). Patient experienced tenderness to vertical percussion. On conducting pulp sensibility tests like electric pulp test, a gradually increasing level of electric current to the tooth is applied and the tooth showed delayed response when compared to the control teeth. Thermal test conducted on the tooth such as heated gutta percha elicited delayed pain response that is lingering. The preoperative radiograph discloses carious lesion involving the distal pulp horn along with widening of periodontal ligament space and rarefaction at the periapex along the palatal root. Pertaining to the clinical examination, pulp sensibility tests and the radiographic findings a diagnosis of symptomatic irreversible pulpitis with acute apical periodontitis in regard to tooth 26 was made and root canal therapy was commenced.

On examining the preoperative radiograph, three completely formed roots were seen (Figure 1A). Anaesthesia was carried out using 1.8 ml 2% lignocaine with 1:80,000 epinephrine (Indoco Warren Lignox

Lignocaine 2%). The tooth 26 was isolated using rubber dam (KCK Direct Nictone Rubber Dam Sheet). After the access cavity preparation and debridement of pulp tissue from the pulp chamber space, DG-16 (GDC Endo Explorer DG 16-1) endodontic explorer was used to locate the orifices on the pulp chamber floor after removal of dentin shelves and calcifications. Two mesiobuccal, one distobuccal and one palatal canal orifices were identified. Negotiating the mesiobuccal canals up to the apex of the root was laborious (Figure 1B). Number 06 C+ files (Udg M3-C Plus Files) coated with EDTA chelating agent using clockwise and counterclockwise reaming motion with apical pressure and withdrawal was performed along with the guidance of apex locator (J Morita). Root canal Irrigants like sodium hypochlorite and EDTA were also used to dissolve the organic and inorganic components respectively. After multiple attempts of performing watch winding and balanced force technique using number 06, 08 and 10 C+ files apical canal negotiation was achieved as indicated by the apex locator.

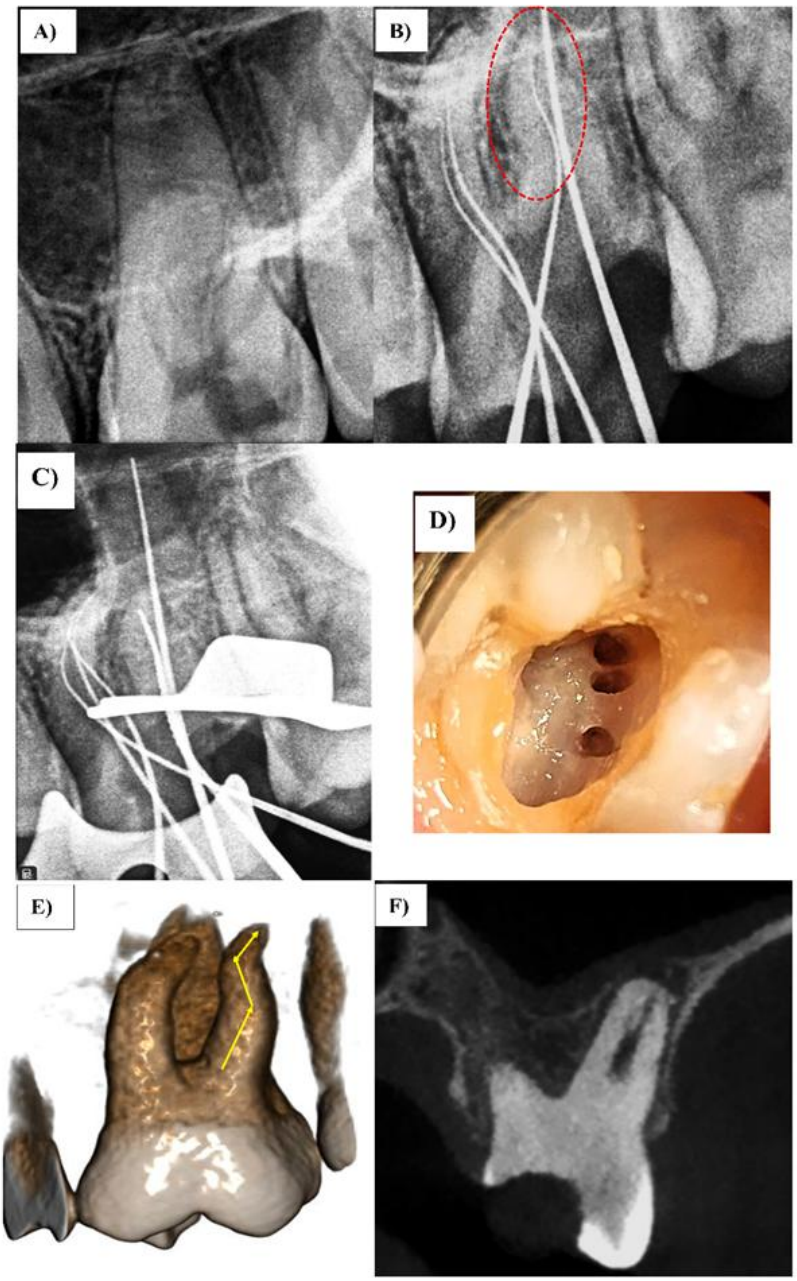

Figure 1. A) Pre-operative radiograph, B) Intraoperative radiograph showing calcified canals along the mesiobuccal root and S- shaped curvature along distobuccal root, C) Radiograph showing working length determination, D) Clinical photograph of tooth 26 showing 3 mesiobuccal canals, E) CBCT image of tooth 26 showing curvatures along mesiobuccal and distobuccal roots, F) CBCT Sagittal section showing ledge created along the distobuccal root while rotary instrumentation.

Distobuccal and palatal canals were also negotiated and working length was confirmed both using the apex locator and radiographs. Pulp tissue within the canals were extirpated using barbed broach (Mani). An unusually large canal was noticed in relation to the palatal aspect and a bayonet shaped curvature appreciated along the distobuccal root (Figure 1B and E). Hand filing was done using 10 and 15 K files after pre-curving in order to achieve patency. Biomechanical preparation was done using protaper gold rotary files in the sequence orifice enlarger, shaping files S1 and S2, finishing files F1 and F2 in the mesiobuccal canals.

Following rotary instrumentation Champagne test was conducted and tiny bubbles were seen emanating along the mesial root suggestive of either organic debris or a missed canal. DG-16 endodontic explorer was used to trace along the developmental grooves, a depression 2-3mm below MB2 was appreciated and scouting was carried out using C+ files. Excess dentin covering the missed orifice in relation to the MB root was removed using ultrasonic tips (Dr Talals Endo Kit) MB3 canal was located and carted up to full patency in multiple attempts (Figure 1C). After hand filing, rotary files of the same brand were used to shape the canals in a similar manner (Figure 1D). Since the palatal canal was very large, circumferential filing was done using both hand files and rotary files upto F5 protaper gold. In the case of distobuccal canal, due to double curvature, finishing files failed to reach up till the entire working length and tactile sensation using files suggested that it met with a hard stop which was confirmed radiographically. Hand filing could negotiate the distobuccal canal after pre-curving, beginning with number 10 K file to file 30 K up till working length. Protaper rotary files were again introduced but only to fail. Successively calcium hydroxide intracanal medicament was placed and the access cavity was temporized with a sterile cotton pellet and zinc oxide eugenol temporary restorative material.

When the patient reported for the second appointment, she was asymptomatic. For a better understanding about the canal configuration after obtaining an informed consent from the patient CBCT was arranged. CBCT for tooth 26 reveals a total of 5 canals, 3 mesiobuccal, 1 distobuccal and 1 palatal canal. Three orifices along the mesiobuccal root named MB1, MB2 and MB3 starting from the buccal aspect, where MB1 exited as a single foramen from the orifice till apex, MB3 is seen joining MB2 along its course and exiting as a single foramen following Sert and Bayirli's type XV anatomic classification (Figure 2A, C and D). A very large palatal canal can be appreciated along the palatal root (Figure 2B). In the case of distobuccal canal, a deviation along the anatomical path could be appreciated at the junction of the middle and the apical third in the form of a ledge suggestive of a procedural error that had occurred while using the protaper gold rotary file system (Figure 1F). Periapical osteolysis was appreciated along all roots. Coronal sections of mesiobuccal, distobuccal and palatal roots can be viewed in Figures 2E and F.

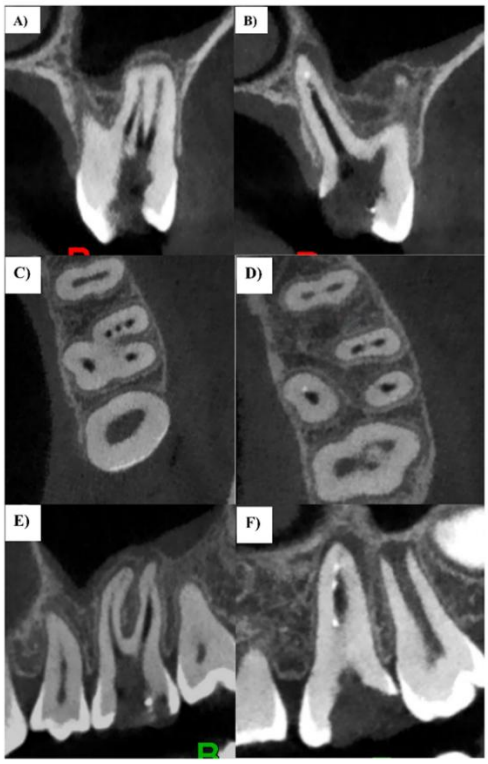

Figure 2, A) Sagittal section of mesiobuccal root showing three canals, B) Sagittal section of palatal root. C) and D) are CBCT axial sections along the cervical and apical aspects of the roots respectively. E) and F) are CBCT coronal sections, E) mesiobuccal and distobuccal roots, F) palatal root.

Further treatment of the distobuccal canal was carried out using hand files after precurving them and performing anticurvature filing in order to reduce the ledge created so as to introduce Hyflex CM rotary files system. The rotary files were precurved and inserted into the canal in their proper sequence to reach the entire working length, after repeated attempts of angulating the files in various aspects the canal shaping was accomplished. Irrigation was carried out using 5.25% sodium hypochlorite and ultrasonic activation was done using an ultrasonic activator device (Waldent Endo X Ultrasonic Activator). Master cones were selected corresponding to the type of rotary file system used and confirmed radiographically (Figure 3A). Obturation was done using single cone 6% protaper gutta percha points along with zinc oxide eugenol sealer in the mesiobuccal canals, cold lateral compaction was carried out in the distobuccal and palatal canals with the same sealer material. The pulp chamber was cleaned with a cotton pellet soaked in alcohol and restored provisionally with Glass Ionomer Cement (Figures 3B and C). Tooth was scheduled for a definitive coronal restoration thereafter. Patient was reviewed at 3, 6 and 9 months. During the 9th month recall digital radiographs and CBCT were taken (Figures 3D and 4). CBCT images in relation to all the roots show resolution of periapical osteolysis and bone formation suggestive of a successful endodontic therapy. Patient is completely satisfied due to the absence of any clinical symptoms and adequate functional rehabilitation.

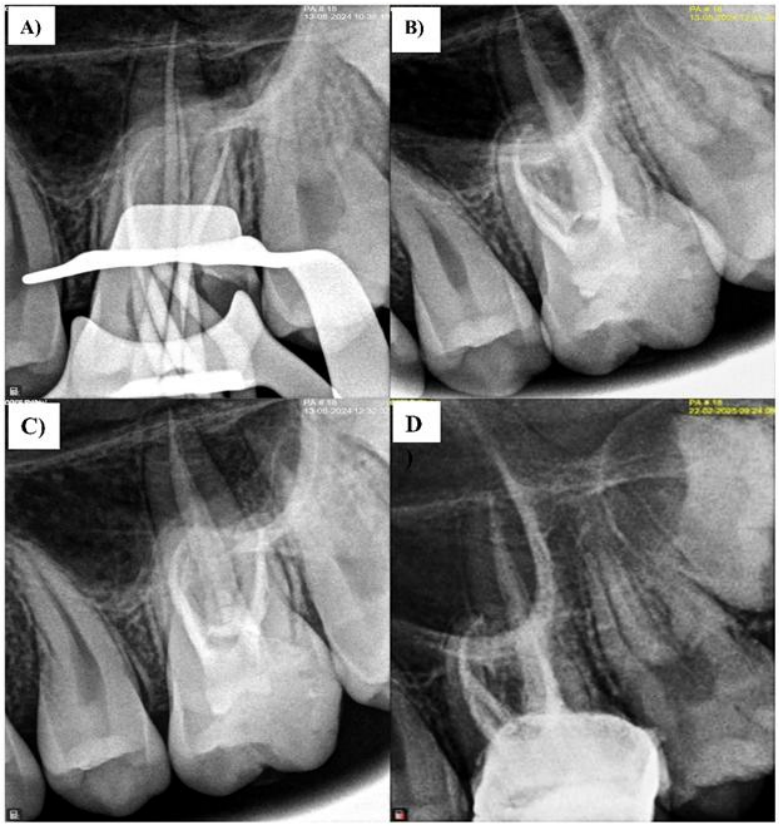

Figure 3. A) Radiograph of master cone selection, B) Immediate post operative radiograph (distal angulation), C) straight angulation, D) radiograph taken during the 9th month recall.

III. Discussion

In molar teeth, anatomical differences are prevalent. Most of these differences in maxillary molars are associated with the number of root canals in the MB root [4,5]. Numerous clinical and laboratory investigations evaluated the internal canal anatomy of the maxillary first molar's mesiobuccal root [6,7]. Depending on the approach, two distinct apical foramina were present 14% to 38.3% of the time, whereas a single apical foramen was detected 61.6% to 86% of the time [8]. Regarding the mesiobuccal root with two outlets, this case report details the existence of three root canals.

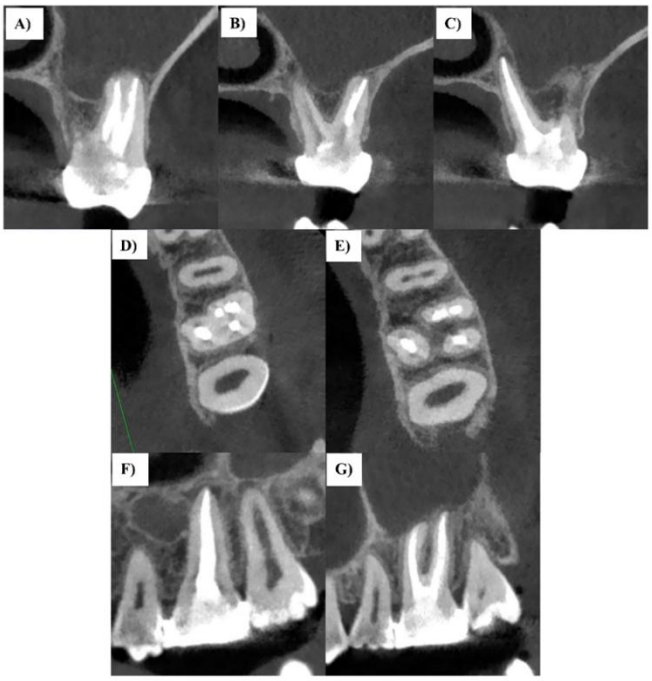

Figure 4. CBCT Sagittal sections of tooth after obturation taken during the 9th month recall, A) Mesiobuccal root, B) Distobuccal root, C) Palatal root. D and E are CBCT Axial sections of root after obturation, D) cervical 3rd and E) apical 3rd. F) and G) are CBCT Coronal sections after obturation F) palatal root, G) mesiobuccal and distobuccal roots.

There appear to be relatively few prior reports describing, locating, and obturating the third MB canal in the literature, despite the fact that it was identified in multiple in vitro investigations [9]. Pomeranz and Fishelberg highlighted the significance of better access as the need to locate the mesiopalatal canal by carefully probing the groove or fissure between the palatal and the MB canal, where the second mesiobuccal canal was usually found.

Extending the access cavity to remove any dentin shelves or calcifications that may be covering the orifices of MB2 and MB3 canals is crucial for successful detection. In the present case report changing the access cavity's conventional triangular outline form to a rhomboidal shape permitted straight line visualization, allowed the pulp chamber to be completely debrided, ultrasonic tips were used to carefully remove the dentin shelves and calcifications, allowing for better visualization of MB2 and MB3 canal orifice. Champagne test is an authentic method to detect hard-to-find canals during root canal therapy. The chamber was filled with NaOCl and left standing for few moments. Tiny bubbles were visible in the solution indicating the position of the missed canal orifice – MB3. Protocols for treating calcified root canals were followed in order to negotiate mesiobuccal canals up till the apex.

The observation of S-shaped anatomy with double curvatures in the distobuccal canal presented challenges in the present case to achieving optimal shaping and cleaning of the root canal system. Ledge formed in the distobuccal root was successfully bypassed by pre-bending files along with anticurvature filing for negotiating canal up till apex, followed by the use of CM Niti files to shape the canal. Controlled memory allows the files to be pre-bent to negotiate complex canal anatomies and return to their original shape after heat sterilization. Their flexibility and ability to follow the canal's natural curvature minimize the chances of creating ledges, perforations, or transporting the canal. Wide palatal canal with closed apex was managed by circumferential filing technique followed by copious irrigation and ultrasonic activation.

IV. Conclusions

Failure to detect and treat the MB2 and MB3 canal system will result in a decreased long-term prognosis. Among all the canals of the maxillary first molar, the MB2 and MB3 can be the most difficult to find and negotiate in a clinical situation. Though not used in this case the dental operating microscope and loupes make canal location easier by magnifying and illuminating the grooves in the pulpal floor and differentiating the colour differences between the dentin, the pulpal floor and walls.

Frequent errors that may occur during endodontic procedure in a dilacerated root is the failure to maintain root canal curvature, resulting in ledge formation, apical transportation, zipping, perforation, and instrument breakage. To avoid these mishaps, the basic principles of endodontic therapy must be followed, that is a good

preoperative radiograph, straight line access to apical foramen or the root canal's first curvature, pre-curving the endodontic hand instrument, frequent recapitulation, thorough irrigation and use of flexible Ni- Ti instruments.

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