ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at:www.ijdsir.com

Volume – 8, Issue – 5, September – 2025, Page No. : 68 - 76

Endodontic Management of Mandibular Premolar Teeth with Unusual Root Canal Anatomy: A Report of 2 Cases

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Citation of this Article: Dr. Prajakta Swami, Dr. Nandan Rao K, Dr. Amit Padmai, Dr. Shilpa Shetty, Dr. Gargee Kasar, Dr. Shreya Gondhali, "Endodontic Management of Mandibular Premolar Teeth with Unusual Root Canal Anatomy: A Report of 2 Cases", IJDSIR- September – 2025, Volume – 8, Issue – 5, P. No. 68 – 76.

Type of Publication: Case Report

Conflicts of Interest: Nil

Abstract

The successful execution of endodontic therapy relies on the understanding and awareness of potential anatomical variations within the root canal system to effectively locate, prepare, and seal the root canals. There are significant variations and unique root canal anatomies in mandibular premolars, which can pose diagnostic challenges. Typically, mandibular premolars feature a single root with a single canal, while the occurrence of two or three canals in distinct roots is uncommon. This case report presents two instances of endodontic treatment for mandibular premolars with two and three root canals.

Keywords: Endodontic management, Mandibular first premolar, CBCT, magnification

Introduction

Achieving successful root canal treatment requires a comprehensive understanding of the root canal system, precise three-dimensional cleaning and shaping, and an effective, hermetic seal of the root canals.[1] Among all teeth, mandibular premolars are particularly challenging due to their complex and variable anatomy. Failure to detect and treat all canals can lead to persistent infection, resulting in post-treatment complications.[2]

Mandibular premolars, especially the first premolars, are typically considered to have a single root and canal. However, anatomical studies have revealed significant

variation. The occurrence of multiple canals varies widely between 2.7%–62.7% in mandibular first premolars and between 0%–34.3% in mandibular second premolars.[3] Mandibular first premolars show a single root in approximately 97.1% of cases, bifurcation in 2.7%, three roots, an extremely rare variation, in only 0.2%.[4] Mandibular second premolars generally have a single canal at the apex in 97.5% of cases, two canals in 2.5%, rare occurrence of 3 canals [5] while presence of three canals was found in only 0.4%.[6]

These findings highlight the necessity for clinicians to expect and identify canal variations during endodontic procedures. These teeth are among the most difficult to treat, due to their unpredictable canal morphology.[7] Untreated canals can harbor residual necrotic tissue and microorganisms, leading to post-treatment apical periodontitis.[8]

The identification of all canals is essential for long-term treatment success. Missed or untreated canals can severely compromise the outcome of root canal therapy. This underlines the importance of using advanced diagnostic tools such as CBCT (cone-beam computed tomography) and multiple angulated radiographs to assess complex anatomy.[9] Also magnification with loupes or dental operating microscope (DOM) is an indispensable tool to locate extra canals.[10]

This clinical report presents a rare and noteworthy case of nonsurgical endodontic treatment involving three separate canals in both a mandibular first and second premolar, confirmed through periapical radiographs and CBCT imaging. Such cases emphasize the critical need for awareness of anatomical variations and the application of modern imaging techniques in endodontic diagnosis and treatment planning.

Case 1

A 39-year-old female patient presented to the Department of Conservative Dentistry and Endodontics with a primary concern regarding decay in her lower left posterior teeth region. Her medical history was not significant. Upon clinical examination, deep caries were found on the distal and occlusal surfaces of the mandibular left canine and first premolar. The tooth exhibited tenderness upon percussion. The radiographic evaluation displayed carious involvement of the pulp and a widened periodontal ligament. The preoperative radiograph indicated two distinct roots and canals in the mandibular left canine and three canals in the mandibular first premolar. A cold test using EndoFrost (Coltene Whaledent, Langenau, Germany) and an electric pulp test on the affected tooth yielded no response compared to the corresponding teeth on the opposite side. A diagnosis of pulp necrosis accompanied by asymptomatic apical periodontitis was established for the mandibular left canine (#33) and first premolar (#34). Nonsurgical endodontic treatment was proposed for these teeth, with written informed consent obtained.

An inferior alveolar nerve block was performed using 2% lignocaine to ensure effective anesthesia. The affected teeth were isolated with a rubber dam (Hygenic Coltene Whaledent). After caries removal, a standard access cavity was created utilizing a diamond round bur and Endo Access bur (Dentsply Maillefer, Switzerland). A DG 16 explorer was employed to assess the pulpal floor and identify canal bifurcation at the mid-third level (Hu-Friedy, USA), and dental loupes were utilized to reveal two orifices in tooth #33 and three in tooth #34, respectively.

For #34, two buccal orifices and one lingual orifice were located. The access cavity was slightly adjusted to allow for straight-line access. In tooth #33, both buccal and

lingual canals were found using a #15 K file (K-FILES, MANI, Tochigi, Japan). Similarly, in #34, a pre-curved SS #10 K-file was placed into the mesiobuccal and distobuccal canal orifices. An additional #10 K-file was inserted into the lingual canal. The canal length was initially determined with an apex locator (Root ZX mini, Morita, Japan), which was subsequently verified using periapical radiographs.

Following root length confirmation, the canals were negotiated with a #10 K file, along with Glyde EDTA gel (Dentsply Maillefer, USA) utilized as a lubricant. Initial canal preparation was carried out using an ISO 25 K-file (K-FILES, MANI, Tochigi, Japan). Biomechanical preparation was performed using Hyflex CM (Coltene). The canals were irrigated with 2mL of 5.25% sodium hypochlorite (NaOCl) followed by normal saline through a side-vented endodontic irrigation needle, with each irrigation lasting one minute per canal, and irrigants were activated with a sonic irrigation device (Endoactivator). Further canal shaping was accomplished to reach a final apical diameter of #30 with a 4% taper. A final rinse of 2 ml of 17% ethylene diamine tetraacetic acid (EDTA) was used to eliminate the smear layer, followed by rinsing with normal saline.

The canals were dried utilizing paper points and filled with calcium hydroxide paste via a Lentulo spiral (Dentsply Maillefer) size 25. The access chamber was sealed with Cavit (3M ESPE) for a duration of two weeks. The patient was scheduled for a follow-up appointment after two weeks.

During the second visit, after re-isolating with a rubber dam, the temporary filling was removed, and the access cavity was meticulously examined. Calcium hydroxide was taken out using an SS file #25 along with sodium hypochlorite irrigation solution. The canals were dried using paper points before being obturated with gutta-percha cones and AH Plus (Dentsply) as a sealer utilizing the lateral condensation technique. A radiograph was taken to verify the obturation, and the access cavity was subsequently sealed.

Figure 1: Preoperative radiograph

Figure 2: Working length determination

Figure 3: Calcium hydroxide medicament

Figure 4: 3 Canals with 34

Figure 5: 2 canals with 33 and 3 canals with 34

Figure 6: 2 canals with 33

Figure 7: Master cone radiograph

Figure 8: Obturation

Figure 9: Clinical picture of obturated canals with 33,34

Figure 10: Preoperative radiograph with 35

Figure 11: Working length determination

Figure 12: Master cone

Figure 13: Postoperative radiograph with 33, 34, 35

Radiographic examination with #35 showed thin radiopacity over the pulp chamber suggestive of insufficient dentin thickness with two root canals and normal periodontal ligament space and intact lamina dura. After local anesthesia administration and rubber dam isolation (Hygenic Coltene Whaledent) access cavity was prepared with diamond round bur and Endo Access bur (Dentsply Maillefer, Switzerland) Two canals were scouted with precurved #10 K file directed from lingual and buccal aspect in lingual and buccal canal respectively. The canal length was preliminarily taken using an apex locator (Root ZX mini, Morita, Japan) which later confirmed with periapical radiographs. After confirmation of the root length the canals were negotiated with #10 K file, with Glyde EDTA gel (Dentsply Maillefer, USA) as a lubricant. The canals

were prepared till #35 K file and obturated with gutta percha and AH plus sealer using cold lateral compaction technique. Permanent restoration was done. A follow-up radiograph was taken.

Case 2

A 39-year-old female referred from the Department of Prosthodontics to the Department of Conservative Dentistry and Endodontics for the intentional endodontic treatment of mandibular left second premolar. The patient's medical history was non-contributory. Clinical evaluation identified a mandibular second premolar with a lingual inclination and an atypical crown morphology. Percussion testing of the tooth yielded normal results. A preoperative radiograph revealed two distinct roots and root canals in the mandibular second premolar. A nonsurgical root canal treatment was planned for the left mandibular second premolar after obtaining informed written consent.

An inferior alveolar nerve block was administered using 2% lignocaine to achieve adequate anesthesia. The tooth was isolated with a rubber dam (Hygenic, Coltene Whaledent). A standard access cavity was created using a round diamond bur and Endo Access bur (Dentsply Maillefer, Switzerland). The pulpal floor was examined with a DG 16 endodontic explorer (Hu-Friedy, USA) to detect canal bifurcation.

Two canals—buccal and lingual—were identified. The access cavity was slightly adjusted to allow for straight-line access. Initial canal exploration was performed using a #10 K-file (MANI, Tochigi, Japan), and the preliminary canal lengths were estimated with an apex locator (Root ZX mini, Morita, Japan). A periapical radiograph was then taken due to suspicion of a third canal. Radiographic findings indicated a potential third canal, prompting a CBCT scan for confirmation.

The CBCT imaging confirmed the presence of a third canal, specifically a bifurcated mesiobuccal canal at the middle third of the root. The working lengths were verified with both an apex locator and periapical radiographs. Canal negotiation was performed using a #10 K-file in conjunction with Glyde EDTA gel.

Initial canal preparation was performed up to size ISO 25 using K-files (MANI, Tochigi, Japan) with lubricant assistance. Biomechanical shaping was subsequently achieved with Hyflex CM rotary files (Coltene). After each instrument, the canals were irrigated with 2 mL of 5.25% sodium hypochlorite (NaOCl) followed by saline using a side-vented irrigation needle for one minute per canal, with activation provided by a sonic irrigation device (Endoactivator). Final shaping was completed to an apical size of #25 with a 4% taper. To remove the smear layer, 2 mL of 17% EDTA was applied as the final rinse, followed by saline.

The canals were dried with sterile paper points and medicated with calcium hydroxide paste delivered via a Lentulo spiral (size 25, Dentsply Maillefer). The access cavity was sealed with Cavit (3M ESPE), and the patient was recalled after two weeks.

At the second appointment, following rubber dam isolation, the temporary filling was removed and the chamber re-examined. Calcium hydroxide was eliminated using a size 25 stainless steel file and NaOCl irrigation. The canals were again dried and obturated with gutta-percha cones and AH Plus sealer (Dentsply) by the lateral condensation technique, followed by permanent coronal restoration.

Cone-beam computed tomography (CBCT) provided additional diagnostic value in identifying complex internal and external canal morphology.

Figure 1: Preoperative radiograph with 35

Figure 2: 2 canals located

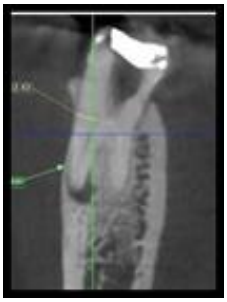

Figure 3: Sagittal section of CBCT of location of 3rd canal

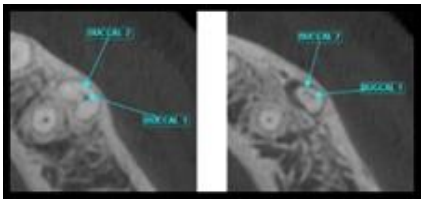

Figure 4: Axial view of CBCT of location of 2 buccal canals

Figure 5: Working length determination

Figure 6: Master cone radiograph

Figure 7: Obturation

Figure 8: Postoperative radiograph

Discussion

Mandibular premolars, particularly the first premolars, show the greatest anatomical variability among all teeth. They may present with one to four canals and diverse configurations, most commonly Vertucci type V.[11] This anatomical complexity is a significant cause of endodontic failure when additional canals go undetected or untreated. 19.48% of mandibular first premolars and 3.85% of second premolars may have multiple canals.[12] Majority of mandibular first premolars have a single root 97.9 %, while 1.8 % have two roots, 0.2 % have three roots, and less than 0.1 % have four roots.[13]

Understanding these variations is vital to ensure complete debridement, shaping, and obturation. Missed canals are

a leading cause of failure in root canal therapy. Studies show 8.8% of failures were due to untreated canals.[14] 42% of retreatment cases had previously missed canals.[15] A Washington study found an 11.45% failure rate in mandibular first premolars, often due to undetected canal morphology.[16]

Given these statistics, thorough canal detection and careful case assessment are essential before and during treatment. According to Cantatore, Berutti, and Castellucci, knowledge of the internal anatomy of roots and canals should ensure better cleaning, shaping, and filling, resulting in excellent endodontic treatments and a reduction in the rates of iatrogenic problems.[17]

Standard periapical radiographs are often insufficient for complex cases due to their two-dimensional limitations. A combination of radiographic angulations and advanced techniques improves detection. Two angled radiographs (0° and 20° mesial) are recommended for premolars.[18] Sudden narrowing or a fast break in the canal outline may indicate canal bifurcation. CBCT imaging, as endorsed by the American Association of Endodontists (AAE) and the European Society of Endodontology (ESE) provides three-dimensional views critical for identifying missed or aberrant canals. However, its use should be justified based on radiation exposure.[19]

Dental loupes and DOMs enhance visualization. The American Association of Endodontists have reported the benefits of magnification in locating hidden canals.[20] Various ranges of magnification levels are available, typically 2.5x to 4.5x is recommended to visualize the the extra canal with increased depth of field.[13]

Proper access preparation and use of tactile and visual aids can significantly improve canal detection. Krasner and Rankow's symmetry laws and pulpal floor landmarks such as color changes and developmental grooves provide guidance in locating additional canals.[21] DG-16 explorers, magnification, and strong illumination help visualize hidden orifices. Use of Gates-Glidden drills to enlarge the middle third can expose bifurcations. Hand files and careful tactile exploration remain essential for confirming the presence of bifurcations or extra canals.[22]

In both cases, the lingual wall of the access cavity was extended to facilitate localization of the lingual canal and to establish a straight-line path. Coronal flaring, along with pre-curved hand files, aided in identifying canal bifurcations. During instrumentation, careful file selection was critical—excessively tapered instruments risked strip perforations, canal transportation, and loss of the natural anatomy, especially in roots with radicular grooves.[23]

Obturation of teeth with two or more canals presents clinical challenges due to limited space for cone placement and sealing. Sequential obturation of each canal helps maintain pericervical dentin integrity. Use of pre-mixed temporary cements improves sealing by reducing manipulation errors. Maintaining a clean, sealed system is critical to prevent reinfection and ensure long-term treatment success.

The successful management of complex premolar anatomy requires: Detailed anatomical knowledge to anticipate possible variations and avoid iatrogenic errors. Careful radiographic interpretation, including use of angled views and CBCT when warranted. Proper access cavity design to allow full visibility and access to canal orifices. Routine magnification to improve visualization of intricate internal structures.

In the present case, identification and treatment of three independent canals in both mandibular first and second premolars were made possible through thorough exploration and CBCT confirmation. Proper cleaning, shaping, and obturation of each canal contributed to the successful nonsurgical endodontic outcome.

Conclusion

Mandibular premolars present significant endodontic challenges due to their variable and often complex anatomy. Failure to identify and treat additional canals is a major cause of endodontic failure. This case underscores the importance of comprehensive knowledge of root canal morphology, careful clinical exploration, and the judicious use of magnification and CBCT. Adopting these practices improves diagnosis, treatment accuracy, and overall success rates in endodontics.

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