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KEY WORDS: Cone-beam computed tomography; Endodontic treatment; Mandibular first premolar; Root canal anatomy

ENDODONTIC MANAGEMENT OF A MANDIBULAR FIRST PREMOLAR WITH A DEEP APICAL CANAL SPLIT: A CASE REPORT

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ABSTRACT

Background: Mandibular first premolars exhibit considerable anatomical variability and are often associated with complex root canal configurations. A single canal that bifurcates in the apical third can present significant diagnostic and clinical challenges, increasing the risk of missed anatomy and inadequate endodontic treatment. This case highlights the importance of three-dimensional assessment and careful canal negotiation in managing such anatomical variations. **Case Description**: A 20-year-old male patient presented with continuous pain in the mandibular right posterior region. Clinical and thermal examination indicated irreversible pulpal inflammation. Preoperative intraoral periapical radiography of tooth 44 revealed an abrupt disappearance of the main canal trace in the apical third, suggestive of canal bifurcation. Limited field-of-view cone-beam computed tomography confirmed a single coronal canal bifurcating into separate buccal and lingual canals with independent apical exits, corresponding to Vertucci Type V configuration. The canals were negotiated using precurved K-files, prepared with ProTaper Gold instruments, and irrigated with sodium hypochlorite with sonic activation. Following EDTA irrigation, obturation was performed using thermoplastic gutta-percha and AH Plus sealer. **Conclusion:** Accurate recognition of deep canal bifurcation using CBCT, combined with magnification, ultrasonic troughing, careful tactile negotiation and meticulous chemomechanical preparation, facilitates predictable management of complex mandibular premolar anatomy.

INTRODUCTION

Endodontic success relies fundamentally on an accurate diagnosis, thorough chemomechanical debridement, and complete three-dimensional obturation of the root canal system.[1] Inadequate knowledge of root canal morphology and missed canals remain primary factors contributing to post-treatment apical periodontitis.[1] Mandibular premolars present substantial clinical challenges and have often been described as the "Endodontist's enigma" due to their high degree of anatomical complexity.3) In particular, a single main root canal dividing into multiple distinct canals at the middle or apical third presents considerable procedural difficulty during instrumentation.[4] The detection and negotiation of such deep canal splits necessitate careful tactile exploration with precurved small hand files along with an adequate access cavity preparation.[5]

The limitations of two-dimensional periapical radiography in resolving aberrant root morphologies often contribute to untreated canal anatomy and post-treatment disease.1This case report highlights how utilizing cone-beam computed tomography (CBCT) allowed complete three-dimensional spatial assessment of intricate radicular anatomy . Coupling this multiplanar guidance with enhanced visual magnification and ultrasonic troughing facilitates conservative removal of restrictive dentin shelves, allowing predictable visual access ,proving that a meticulous, technology-driven protocol is vital for treating such endodontic variants.5

CASE REPORT

A 20-year-old male patient presented to the Department of Conservative Dentistry and Endodontics with a chief complaint of continuous pain in the lower right posterior tooth region for one week. The medical history was non-contributory. Clinical examination of the mandibular right first premolar (tooth 44) revealed extensive deep occlusal caries. The tooth was tender to vertical percussion, while periodontal probing depths and tooth mobility were within normal physiological limits. Thermal pulp testing using refrigerant spray (Coltène/Whaledent) elicited an immediate, exaggerated, and lingering painful response. Thermal testing with heated gutta-percha similarly produced no response, confirming irreversible pulpal inflammation. Preoperative intraoral periapical radiograph (IOPAR) (Figure 1a) revealed deep coronal radiolucency approaching the pulp chamber and an abrupt disappearing trace ("fast break") of the main canal in the apical third, suggesting an anatomical division. A definitive diagnosis of symptomatic apical abscess was established, and non-surgical endodontic therapy was initiated.

Following written informed consent, local anaesthesia was administered and the tooth was isolated with a rubber dam. After complete excavation of caries, an access cavity was prepared. Inspection of the pulpal floor revealed a single centrally placed canal orifice; careful exploration with a DG-16 endodontic explorer showed no additional orifices in the coronal floor. Working length was explored initially using a size 10 K-file (Dentsply Maillefer, Ballaigues, Switzerland), and the radiograph indicated an off-centered, vague lumen outline in the apical third. Due to this suspected anatomical complexity, limited field-of-view cone-beam computed tomography (CBCT) was performed.

Axial and sagittal CBCT reconstructions confirmed a single coronal canal bifurcating in the apical third into two separate canals (buccal and lingual) with independent apical exits(Weine's Type IV configuration) .(Figure 1b).Guided by the three-dimensional images, the access cavity was refined lingually using ultrasonic tips (Start-X, Dentsply Sirona) to facilitate straight-line entry to the bifurcation. A size 10 K-file with a pronounced apical precurve was introduced to scout and negotiate the lingual canal branch alongside the buccal file. Angled radiographs confirmed two separate files tracking independently to the root apex.

Working length was determined using an electronic apex locator (Tri Auto ZX2 Plus, J. Morita, Tokyo, Japan) and confirmed radiographically (Figure 1.c). Glide path was established sequentially with hand K-files (sizes 10, 15, and 20). Canals were cleaned and shaped using ProTaper Gold rotary instruments (Dentsply Sirona) up to size F2 (25/.06) under continuous irrigation with 5.25% sodium hypochlorite (SafeEndo) between each file change. Sonic activation (SuperEndo) of the sodium hypochlorite irrigant was performed to enhance debridement within the bifurcation area. Smear layer removal was accomplished with 17% ethylenediaminetetraacetic acid

(EDTA), followed by a final sterile saline rinse.

The root canals were dried thoroughly with sterile paper points, and master cone fit (ProTaper Gold F2) was confirmed radiographically (Figure 2.a). The master cones were seared off at the bifurcation level and followed by back fill using thermoplastic gutta percha (Meta Biomed gutta percha) and AH plus sealer(Figure b,c). For post-endodontic coronal rehabilitation, two glass fiber posts were cemented into the coronal canal space using dual-cure resin cement, followed by a core build-up with composite resin .The tooth was subsequently prepared for full-coverage crown restoration (Figure 2.d).

DISCUSSION

Mandibular premolars are widely recognized as having some of the most complex internal and external radicular variations in the human dentition, earning their characterization as an "Endodontist's enigma."[3] Studies by Vertucci established that mandibular first premolars possess two canals in 25.5% of cases and three canals in 0.5% of cases, with racial and gender factors contributing to wide variances in branching frequency.[2] The high rate of endodontic failure in this tooth group is frequently attributed to untreated canal bifurcations that harbor persistent necrotic tissue and bacterial biofilms.[6] In historical epidemiological evaluations, mandibular first premolars demonstrated the highest non-surgical endodontic failure rate among all tooth groups at 11.45%.[7] According to Vertucci's classification, the pattern observed in this case represents a Type V (1–2) configuration, wherein a single coronal canal splits into two independent canals terminating in separate apical foramina.4 Under the newer classification system proposed by Ahmed et al., which comprehensively accounts for external root count and continuous canal pathway transitions, this morphology is accurately coded as (_^144)1"–" 2.(_^8)

Conventional two-dimensional intraoral periapical radiographs often fail to clearly delineate deep canal divisions due to the superimposition of adjacent hard tissues.(_^1) A critical diagnostic sign is the "fast break" appearance, characterized by an abrupt disappearance or sharp narrowing of the main canal lumen radiolucency in the middle or apical third of the root.(_^9) While multi-angulated radiographs assist in revealing buccal and lingual deviations, cone-beam computed tomography provides non-invasive, multiplanar three-dimensional visualization of the internal canal pathway.(_^10) Sagittal and axial reconstructions are pivotal for identifying the exact level of the deep radicular division, ruling out extra roots, and directing conservative coronal dentin removal.(_^11)

Managing deep canal splits presents substantial mechanical challenges, particularly regarding straight-line access, orifice negotiation, and file breakage prevention.(_^3) The lingual canal orifice frequently branches off the main trunk at an acute or steep angle, while the natural lingual inclination of the mandibular premolar crown tends to guide exploring instruments buccally.(_^5) To overcome this, modifying the access cavity buccolingually and selectively troughing with ultrasonic tips under magnification eliminates restrictive dentinal shelves over the division point.(_^4) Tactile exploration using small-sized K-files with sharp apical precurves is necessary to scout, negotiate, and establish an initial glide path in the split branches without causing canal transportation or ledge formation.(_^5) Furthermore, the use of flexible nickel-titanium instruments with controlled memory allows safe preparation of slender, bifurcated canals while respecting root anatomy.(_^1)

Complete debridement of irregular split spaces requires optimized irrigation regimens, as mechanical files cannot thoroughly reach narrow isthmuses and anatomical fins.(_^1) Agitation of sodium hypochlorite using sonic activation promotes acoustic streaming and irrigant penetration deep into the apical bifurcation zone.7 Smear layer removal with 17% ethylenediaminetetraacetic acid ensures open dentinal tubules for optimal sealer adaptation.(_^4) To achieve a dense, hermetic three-dimensional seal, a combination of warm vertical compaction with an epoxy resin sealer was utilized.(_^7) Compacting and searing the gutta-percha master cones at the level of the bifurcation generated adequate hydraulic pressure to seal the apical exits while vacating space in the broad coronal trunk for structural rehabilitation. The subsequent placement of dual glass fiber posts and direct composite core provided favorable stress distribution and an impermeable coronal barrier against microleakage.4

CONCLUSION

Managing mandibular premolars with deep apical splits demands a departure from standard anatomical assumptions and a high index of clinical suspicion. Overlooking such complex radicular configurations remains a primary cause of endodontic failure. As demonstrated in this case, cone-beam computed tomography provides critical three-dimensional spatial mapping of the aberrant canal architecture. Combining this multiplanar diagnostic insight with visual magnification under the dental operating microscope and selective ultrasonic troughing facilitates conservative access to the hidden lingual split. Furthermore, careful tactile scouting with precurved hand files, followed by flexible nickel-titanium instrumentation and warm vertical compaction, ensures complete chemomechanical debridement and a hermetic three-dimensional obturation. Integrating these advanced diagnostic and operative modalities is essential for preventing procedural mishaps and securing predictable long-term endodontic success.

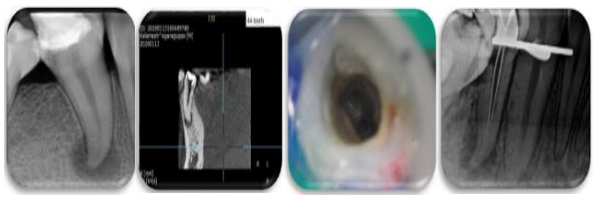
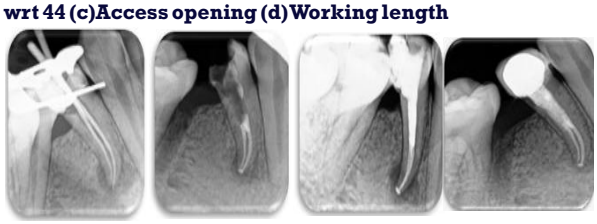


FIGURE 1: (a) Pre operative wrt 44 (b)Pre operative CBCT wrt 44 (c)Access opening (d)Working length



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