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Endodontic Management Of Root Canal Anatomical Variations: A Case Series

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Abstract
Understanding root canal morphology is fundamental to successful endodontic treatment, yet anatomical variations often present unforeseen challenges that can compromise outcomes if not properly identified and managed. This case presentation explores the clinical significance of canal morphology variations and emphasizes the importance of adaptability, advanced diagnostic tools, and meticulous technique in navigating atypical anatomy. Through the presentation of a complex endodontic case with unexpected canal configurations, this report highlights strategies for accurate diagnosis, enhanced canal negotiation, and effective cleaning, shaping, and obturation. The case underscores the value of clinical vigilance, CBCT imaging, and magnification in mastering the unpredictable nature of root canal systems. This series aims to reinforce the clinician's ability to anticipate, recognize, and respond effectively to morphological anomalies for optimal treatment success.

Keywords: *Radix Entomolaris, C-shaped, CBCT, canal configuration, magnification, case report*

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I. Introduction

Successful endodontic therapy depends on a comprehensive understanding of root canal anatomy and its inherent variations. The intricate nature of the root canal system presents a significant challenge to clinicians, as undetected canals, accessory branches, or atypical morphologies may contribute to persistent infection and eventual treatment failure [1, 2]. Although each tooth type typically exhibits a characteristic canal configuration, numerous studies have demonstrated considerable variability both among populations and within the same tooth group. [3]

Root canal morphology is influenced by multiple factors, including genetic, racial, and developmental determinants. Advances in imaging modalities—such as cone-beam computed tomography (CBCT) and micro-computed tomography (micro-CT)—have greatly improved the visualization and three-dimensional classification of these anatomical variations. [4] While classic classification systems proposed by Vertucci (1984), Weine et al. (1969), and Gulabivala et al. (2001) remain foundational for describing canal configurations, contemporary imaging technologies continue to reveal complexities beyond traditional descriptions.

A thorough understanding of root canal morphology enables clinicians to effectively locate and negotiate all canals, select appropriate instrumentation techniques, and achieve optimal cleaning, shaping, and obturation. Consequently, knowledge of root canal anatomy is not merely of academic importance but is fundamental to achieving long-term clinical success in endodontic practice.

II. Case Reports

Case 1

A 22-year-old female patient presented to the Department of Conservative Dentistry and Endodontics with a chief complaint of severe, intermittent pain in the right lower back tooth for three days, aggravated by hot food and lasting 2–3 hours.

Clinical examination revealed presence of deep occlusal carious lesion involving pulp in #46 which was sensitive to percussion. Radiographs revealed the pulp extent of caries along with a periapical radiolucency and widening of periodontal ligament around the mesial and distal roots.(Fig 1)

Diagnosis was Chronic irreversible pulpitis with symptomatic apical periodontitis. Treatment advised was root canal therapy.

Access opening was done and exploration of the floor of the pulp chamber revealed an extra canal orifice distolingually and confirmed the presence of Radix Entomolaris. Dental microscope (Labomed) was also used to visualize and explore the canal orifice and dentinal map (Fig 2)

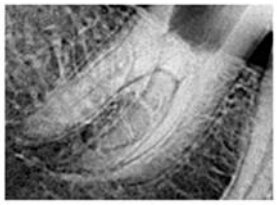

Fig.1: Pre-operative radiograph

Fig.2: Access cavity preparation

Patency was established with a #15 K-file (Mani, Japan). Working length was determined with an apex locator (Eighteeth Medical E-pex pro) and confirmed radiographically. (Fig 3)

Biomechanical preparation was done using Hyflex CM (Coltene) with 1.3% sodium hypochlorite irrigation and a final flush of 17% EDTA. Obturation was completed with gutta-percha using the cold lateral condensation technique, and the access cavity was restored with GIC. A post-obturation radiograph was taken to confirm the outcome. (Fig 4)

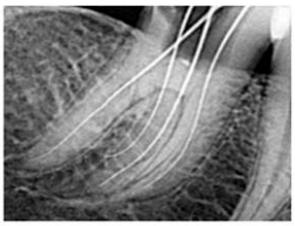

Fig.3: Working length

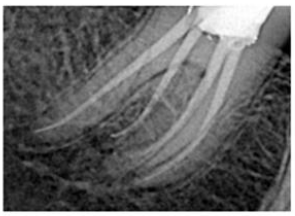

Fig.4: Obturation

Case 2

A 33-year-old female presented with dull continuous pain in the lower left back tooth region for the past seven days. Intraoral examination revealed deep occlusal caries in the left mandibular second molar. The preoperative radiograph showed a single conical root with outline of single root canal suggesting presence of C-shaped canal, and the case was diagnosed as Chronic irreversible pulpitis. (Fig 5)

After access preparation, careful inspection of the pulp chamber floor revealed a C-shaped canal corresponding to Category C I of Fan's anatomic classification. (Fig 6) Working length was determined electronically using an apex locator. (Eighteeth Medical E-pex pro) (Fig 7)

Fig.5: Pre-operative Radiograph

Fig.6: Access opening

Fig.7: Working length

Fig.8: Obturation

Cleaning and shaping were performed using the ProTaper gold system, with additional circumferential filing of fins and troughs using a #25 K-file (Dentsply) following ultrasonic irrigation (Woodpecker UDS E LED) with NaOCl 2.25%. The canal was obturated with gutta-percha (F3) followed by accessory cones to achieve an apical seal. (Fig 8)

Case 3

A 22-year-old female reported to the Department of Conservative Dentistry and Endodontics, with a chief complaint of food lodgement and pain in lower left back tooth region since 1 week. Pain was spontaneous with exaggerated response to hot and cold that persists even after removal of stimulus. Clinical examination revealed deep distoproximal caries in the left mandibular first premolar, which was tender on percussion.
Pulp Vitality test revealed the pulp was hyperresponsive to the cold test

On radiographic examination, an ill-defined radiolucency was seen on the disto-proximal surface of the tooth involving enamel, dentin and reaching pulp of #34 with widening of the periodontal ligament. On further examination, presence of additional canal was observed. (Fig 9) To confirm this finding the patient was furthered advised for a CBCT analysis

(CBCT) imaging of the mandibular first premolar reveals the presence of two distinct root canals. Sagittal sections demonstrated bifurcation of the canal system with canals diverging in the middle third of the root and continuing separately towards the apex indicating a Vertucci Type V canal configuration (Fig 9)

Fig.9: Pre-operative Radiograph and CBCT Image

The diagnosis was Chronic irreversible pulpitis with symptomatic apical periodontitis.
Under the administration of local anesthesia access cavity preparation was initiated. (Fig 10)

The two canals were located and negotiated using DG16 Explorer and K-Flex files (Dentsply Maillefer) under dental operating microscope (labomed). Working length was established using apex locator (Eighteeth Medical E-pex pro) and confirmed radiographically. (Fig 11) Canal disinfection was carried out with copious irrigation using 2.5% sodium hypochlorite, 17% EDTA, and saline. Cleaning and shaping was completed using Hyflex CM (Coltene) rotary files.

After drying the canals with sterile paper points, obturation was done using cold lateral compaction of gutta-percha with. A post-obturation radiograph was taken to confirm the quality of the obturation. (Fig 12)

Fig.10: Access opening

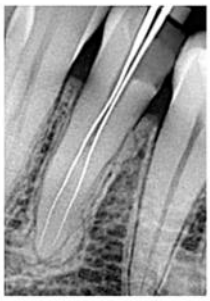

Fig.11: Working length

Fig.12: Obturation

III. Discussion

Understanding root canal morphology and its variations is essential for achieving predictable endodontic success. Anatomical deviations are not uncommon and may significantly affect treatment outcomes if not properly identified and managed. Failure to detect and negotiate additional canals can lead to persistent infection and eventual treatment failure.[1, 2]

The *radix entomolaris* (RE) is a notable anatomical variation characterized by the presence of an additional distolingual root in mandibular molars—most commonly in the first molar. [5] Its prevalence varies among populations, being significantly higher in Asian and Mongoloid groups.[6] Vertucci's (1984) investigation revealed that in mandibular first premolars, 0.5% had three canals at the apex, 25.5% had two, and 74.0% had only one canal. The presence of an RE complicates access cavity design and canal location because the extra root is typically small, curved, and concealed beneath the distolingual cusp. Modifying the access cavity to a more rectangular or trapezoidal shape and employing magnification can improve visualization and management of the additional canal. [7]

C-shaped canals are another significant anatomical variation, typically found in mandibular second molars, resulting from root fusion that produces an irregular C-shaped cross-sectional configuration.[8] Studies have reported prevalence rates of C-shaped canals ranging from 2% to 7.5% in different Indian subpopulations. [9, 10] Specifically, Wadhwani et al. (2017) observed an incidence of 6.72% in a North Indian population, while Sherwood et al. (2010) reported a 7% prevalence in a southern Indian cohort. Because the C-shaped configuration can vary along the root length, clinicians must adopt a dynamic approach during instrumentation. Techniques such as ultrasonic irrigation, passive ultrasonic activation, and thermoplasticized obturation have been recommended to enhance cleaning and sealing of these complex systems.[8]

Mandibular premolars are commonly considered single-rooted teeth with a single canal; however, variations involving two canals or even two roots are possible (Vertucci, 1984). The prevalence of RE in mandibular first molars has been reported to be approximately 12.14%, with a higher incidence among females (15%) compared to males (10%).[6] Bilateral occurrence of RE has been noted in 50–67% of cases.[5]

Clinicians should remain alert to radiographic indicators such as abrupt canal narrowing or disappearance, which may suggest canal division. Exploration under magnification and the use of DG16 explorers can aid in locating additional canal orifices. A thorough understanding of the possible canal configurations, as described by Vertucci (1984), remains crucial for effective cleaning, shaping, and obturation.

IV. Conclusion

Recognizing and managing variations such as radix entomolaris, C-shaped canals, and mandibular premolars with two canals are vital for endodontic success. Careful diagnosis, appropriate access modification, and use of magnification or CBCT enable precise canal detection and treatment. Awareness and adaptability allow clinicians to master the unexpected and achieve predictable outcomes.

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