



RESEARCH ARTICLE

CBCT EVALUATION OF UNUSUAL C-SHAPED ROOT CANAL ANATOMY IN LINGUALLY TITLED MANDIBULAR SECOND PREMOLARS: A CASE REPORT

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ABSTRACT

Background: The root canal morphology of mandibular second premolars shows considerable anatomical variability, creating challenges during endodontic treatment. Among these variations, the C-shaped canal configuration is a rare but clinically significant anomaly that may be overlooked during routine diagnosis. Its occurrence in lingually tilted mandibular second premolars further complicates canal identification and treatment planning. **Methods:** This article reviews the incidence, classification, etiology, and clinical implications of C-shaped canals in mandibular second premolars through relevant literature and rare case reports. Diagnostic methods, including conventional radiography and cone-beam computed tomography (CBCT), were evaluated for their role in detecting complex canal anatomy. **Results:** C-shaped canals in mandibular second premolars were found to be uncommon but clinically important because of their complex morphology and variable presentation. Lingually tilted premolars posed additional challenges in access preparation and canal negotiation. Conventional radiographs often failed to provide sufficient diagnostic information, whereas CBCT offered accurate three-dimensional visualization of the canal configuration, enabling better diagnosis and treatment planning. **Conclusion:** C-shaped canal configurations in mandibular second premolars are rare anatomical variations that require careful evaluation for successful endodontic management. CBCT significantly enhances diagnostic accuracy and aids clinicians in identifying complex canal systems, particularly in lingually tilted premolar.

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INTRODUCTION

Enhancing understanding and accurately identifying the anatomy and morphological variations of the root canal system (RCS) prior to starting root canal treatment (RCT) improves the predictability of the procedure¹. Mandibular premolars pose a challenge in endodontic treatment due to their potential anatomical variations. A thorough understanding of their morphology, combined with an accurate diagnosis, is essential for achieving successful outcomes in endodontic therapy². Identifying and managing additional roots or canals in mandibular premolars presents a significant endodontic challenge. To address this effectively, the clinician must possess a comprehensive knowledge of typical root canal anatomy and its common variations⁹. Investigations into internal canal morphology have shown that 75.8% of teeth possess a single canal, while 24.2% contain two or more canals. Additionally, a single apical foramen was observed in 78.9% of the teeth, whereas 21.1% exhibited two or more apical foramina.⁵

MATERIALS AND METHODS

This article presents two rare case reports of C-shaped canal configurations in lingually tilted mandibular second premolars identified using cone-beam computed tomography (CBCT). The classification systems used for canal morphology assessment included the Fan et al. classification (Table 1) and Vertucci classification (Table 2).

Case Report 1

A 16-year-old male patient reported to the Department of Oral Medicine and Radiology for CBCT evaluation prior to fixed orthodontic therapy. General physical examination revealed a moderately built and nourished patient with no signs of clubbing, cyanosis, icterus, or anemia. Facial profile was symmetrical, temporomandibular joint functions were normal, and no relevant extraoral findings were observed.

Radiographic examination showed missing 14 and 24, fixed orthodontic brackets in the maxillary anterior and first molar regions, impacted 38 and 48, and erupting 28. CBCT axial images of 45 revealed a single root with two root canals exhibiting a C-shaped canal configuration. The tooth was lingually tilted, with the crown positioned lingually and the root apex directed buccally (Fig. 1A, 1B, 1C).

CASE REPORT 1

Case Report 2

A 15-year-old male patient was referred for CBCT evaluation before orthodontic treatment. General and extraoral examinations were unremarkable. Radiographic findings revealed impacted 35 and 45 bilaterally, impacted 38, coronal radiopacity with respect to 46 suggestive of restoration, and coronal radiolucency involving the crown suggestive of dental caries. CBCT examination demonstrated lingually tilted mandibular second premolars with C-shaped canal morphology in both 35 and 45. In both teeth, the crowns were positioned lingually while the root apices were directed buccally (Fig. 2A, 2B, 2C).

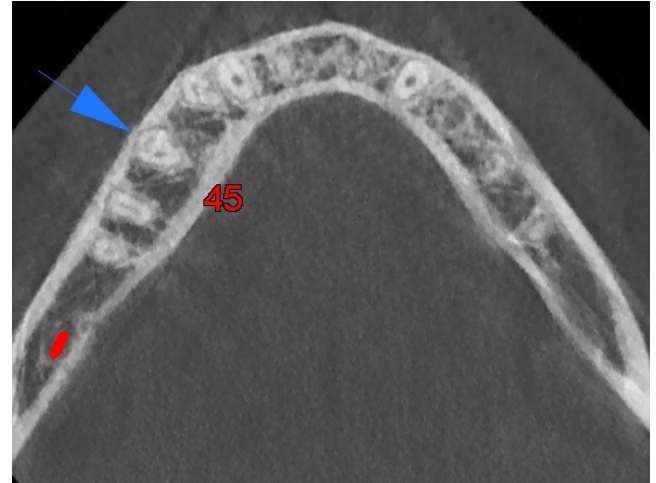


Fig. 1A AXIAL SECTION

RESULTS

Both cases demonstrated rare occurrences of C-shaped canal configurations in lingually tilted mandibular second premolars. CBCT imaging enabled accurate three-dimensional visualization of the canal morphology, root orientation, and canal configuration. Conventional radiographic assessment alone would have been insufficient for detailed anatomical evaluation. The cases also demonstrated bilateral or symmetrical occurrence of anatomical variation.

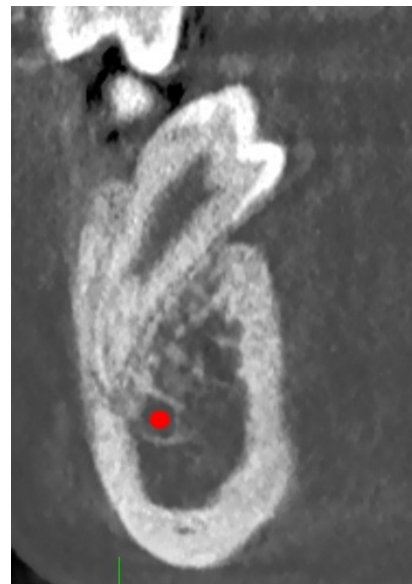


Fig. 1B CORONAL SECTION

1. FAN ET AL CLASSIFICATION⁹

FAN ET AL CLASSIFICATION	
C1	Forms an uninterrupted C
C2	Semicolon shaped, C interrupted
C3	Two separate round, oval or ribbon shaped canals
C4	Single, round, oval or ribbon shaped
C4a	Round
C4b	Oval
C4c	Ribbon shaped
C5	Three or more separate canals
C6	Absence of root canal lumen, localised close to apex

VERTUCCI CLASSIFICATION¹⁰

VERTUCCI CLASSIFICATION	
TYPE I	A single main canal is present starting from the pulp chamber to the root apex.
TYPE II	Two separate canals leave the pulp chamber but join to form one canal to the apex.
TYPE III	One canal leaves the pulp chamber and divides into two smaller canals which later merge again to exit through one canal.
TYPE IV	Two separate as well as completely distinct canals run from the pulp chamber to the root apex.
TYPE V	there is a single canal exiting the pulp chamber which divides into two canals with separate apical foramina.
TYPE VI	Two separate canals join at the middle of the root to form one canal which extends till the apex, just short of the apex, and again divides into two.
TYPE VII	The canal starts as a single until the middle third of the root then divides into two separate canals that rejoin after some distance and then, near the apex, divides into two again.
TYPE VIII	The pulp chamber near the coronal portion divides into three separate canals extending till the apex



Fig. 1C SAGGITAL SECTION

CASE REPORT 2

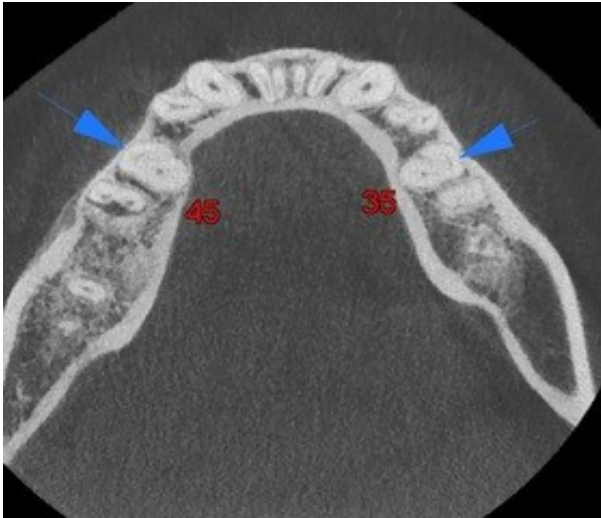


Fig. 2. A AXIAL SECTION



Fig. 2C Saggital Section

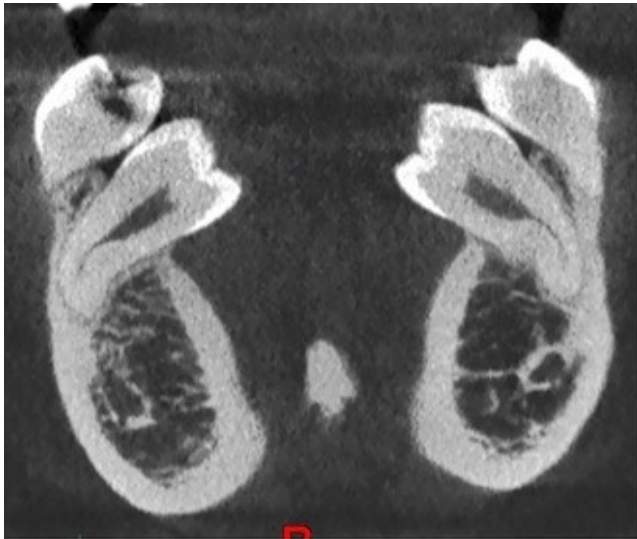


Fig. 2. B Coronal Section



DISCUSSION

Mandibular premolars are considered among the most challenging teeth for endodontic treatment because of the presence of multiple canals, apical deltas, and lateral canals. Among these anatomical variations, the C-shaped canal configuration represents one of the most difficult morphologies to diagnose and manage because the canal anatomy may vary from the coronal to apical portions of the root. The term “C-shaped canal” was first described by Cooke and Cox in 1979 because of its cross-sectional resemblance to the letter “C.” Earlier, Nakayama referred to it as a “gutter-shaped root” and emphasized the importance of meticulous cleaning during endodontic treatment. Takahashi et al. later observed thinner dentin on the lingual aspect of C-shaped roots, attributing it to slower dentin formation in that region.

Diagnosis and management of C-shaped canals are clinically challenging due to the presence of fins, webs, and isthmuses connecting the canals. Several techniques have been used to study these configurations, including tooth clarification, cross-sectional analysis, scanning electron microscopy, conventional radiography, micro-computed tomography (micro-CT), and CBCT. Conventional radiographs provide only two-dimensional information and may fail to identify complex canal anatomy. CBCT offers accurate three-dimensional visualization and is considered highly effective for in vivo assessment of root canal morphology. Although micro-CT is regarded as the gold standard for anatomical studies because of its high-resolution imaging capabilities, its application is limited to in vitro analysis. The present cases highlight the rare occurrence of C-shaped canals in lingually tilted mandibular second premolars, with crowns positioned lingually and root apices directed buccally. Recognition of such anatomical variations and possible bilateral symmetry is important for successful endodontic diagnosis and treatment planning.

CONCLUSION

C-shaped canal morphology in mandibular second premolars is an uncommon but clinically significant anatomical variation that may complicate endodontic diagnosis and treatment. These case reports highlight the rare occurrence of C-shaped canals in lingually tilted mandibular second premolars. Advanced imaging modalities such as CBCT play a crucial role in accurately identifying these complex canal systems and improving treatment planning. Thorough knowledge of root canal anatomy, careful radiographic interpretation, and meticulous clinical management are essential for achieving successful treatment outcomes. Recognition of potential symmetry in canal morphology should also encourage clinicians to evaluate the contralateral tooth whenever such anomalies are detected.

KEYWORDS

- C shaped canal
- CBCT
- Mandibular premolars

REFERENCES

1. Mashyakhy MH, Chourasia HR, Jabali AH, Bajawi HA, Jamal M, Testarelli L, Gambarini G. C-shaped canal configuration in mandibular premolars and molars: prevalence, correlation, and differences—an in vivo study using cone-beam computed tomography. *Niger J Clin Pract.* 2020; 23:232–9.
2. Brea G, Gomez F, Gomez-Sosa JF. Cone-beam computed tomography evaluation of C-shaped root and canal morphology of mandibular premolars. *BMC Oral Health.* 2021; 21:236.
3. Chauhan R, Singh S, Chandra A. A rare occurrence of bilateral C-shaped roots in mandibular first and second premolars diagnosed with the aid of spiral computed tomography. *J Clin Exp Dent.* 2014; 6(4):e440–3.
4. Barril JY, Cochet C, Ricci C. Treatment of a canal with a "C" configuration. *Rev Fr Endod.* 1989 Sep;8(3):47–58.
5. Kato A, Ziegler A, Higuchi N, Nakata K, Nakamura H, Ohno N. Aetiology, incidence and morphology of the C-shaped root canal system and its impact on clinical endodontics. *Int Endod J.* 2014 Nov; 47(11):1012–33.
6. Kolarkodi SH. The importance of cone-beam computed tomography in endodontic therapy: a review. *Saudi Dent J.* 2023 Nov;35(7):780–4.
7. Ahmed HMA, Farook MS. Micro-computed tomography analysis and ex-vivo detection of six root canals in a four-rooted mandibular first premolar. *BMC Oral Health.* 2025; 25:498.
8. Moshfeghi M, Sajadi SS, Sajadi S, Shahbazian M. Conventional versus digital radiography in detecting root canal type in maxillary premolars: an in vitro study. *J Dent (Tehran).* 2013 Jan; 10(1):74–81.
9. Khidir HS, Dizayee SJ, Ali SH. Prevalence of root canal configuration of mandibular second molar using cone-beam computed tomography in a sample of Iraqi patients. *Polytech J.* 2021; 11(1):5.
10. Karobari MI, Parveen A, Mirza MB, Makandar SD, Nik Abdul Ghani NR, Noorani TY, Marya A. Evaluation of root canal morphology using CBCT: a systematic review. *Int J Dent.* 2021 Feb 19; 2021:6682189.
