

C-shaped Root Morphology with Four Canals in Mandibular First Molar: A Rare Case Report

Ravi SV¹, Swapna Honwad²

Received on: 11 September 2024; Accepted on: 18 October 2024; Published on: 27 January 2025

ABSTRACT

Aim: Aim of this case report is to present an unfamiliar case of mandibular first molar with a C-shaped root having four canals.

Background: Root canal system (RCS) is generally very complex, and it is always important for every practitioner who perform root canal treatment to have a knowledge of unusual variations in the root anatomy and root canal configuration, such as the C-shaped configuration. The frequency of C-shaped root canals is more common in mandibular second molars but very rare in mandibular first molars.

Case description: A 28-year-old male patient presented with a history of spontaneous pain, intermittent in nature, in the right mandibular first molar region, for about 2 months. On clinical inspection, a large, carious lesion was noted distally in the mandibular first molar and was nonresponsive to percussion. A preoperative orthopantomograph (OPG) confirmed the involvement of pulp with widening of PDL space, and hence was diagnosed as symptomatic irreversible pulpitis with asymptomatic apical periodontitis. A nonsurgical endodontic treatment was planned. During access cavity preparation, four distinct orifices were located in the pulp chamber, which was not uncommon and hence, proceeded with obturation by the cold lateral compaction method and access cavity restoration with resin composite. Though the initial preoperative OPG or clinical examination of the access cavity did not reveal any significant morphological variation, on contrary, master-cone check radiograph had a different view from the common variation of the mandibular molar. Hence, postoperative cone beam computed tomography was conducted to verify the same, which revealed a C-shaped root with four canals, a rare morphological and unfamiliar variation of the mandibular first molar.

Conclusion: An awareness and understanding of this unusual root and its root canal morphology can contribute to the successful outcome of root canal treatment.

Clinical significance: Knowledge of root morphology and the configuration of the pulpal space play an important role in ensuring thorough debridement and the outcome of root canal treatment.

Keywords: C-shaped root, C-shaped root canal, Case report, Mandibular first molar, RCS rainbow one files.

The Journal of Contemporary Dental Practice (2024): 10.5005/jp-journals-10024-3736

INTRODUCTION

For a successful endodontic therapy, it is critical to have knowledge of unusual variations in the root anatomy and root canal configuration. The intricate anatomy of root canals, including variations such as the C-shaped configuration, which presents significant challenges to endodontists. While C-shaped canals are more commonly encountered in mandibular second molars, their occurrence in mandibular first molars is less frequent.¹

Since the first reports of C-shaped root canal configurations in 1979 by Cooke and Cox numerous investigations in this field have been conducted. Published literature shows that the frequency of C-shaped root canals is more common in mandibular second molars with high amount of diversity in different parts of the world ranging from 2.7% (USA), 4.6% (Greece), 8.1% (India) 29% (China) to 44.5% (Korea).^{2,3} These variations underscore the importance of considering geographical factors when assessing the likelihood of encountering this anatomical anomaly in clinical practice. All the studies are based on including all the mandibular molars, not particularly on first molars alone.

The mandibular first molar most commonly will have two roots and with two canals in mesial root and maybe one or two canals in the distal root. There have been much published literature on mandibular molars regarding configuration, form and number of roots and root canals like up to seven additional canals, in the

¹Department of Conservative Dentistry and Endodontics, KMCT Dental College, Kozhikode, Kerala, India

²Department of Oral and Maxillofacial Pathology, KMCT Dental College, Kozhikode, Kerala, India

Corresponding Author: Ravi SV, Department of Conservative Dentistry and Endodontics, KMCT Dental College, Kozhikode, Kerala, India, Phone: +91 9539351676, e-mail: svravismg@gmail.com

How to cite this article: Ravi SV, Honwad S. C-shaped Root Morphology with Four Canals in Mandibular First Molar: A Rare Case Report. *J Contemp Dent Pract* 2024;25(11):1077–1080.

Source of support: Nil

Conflict of interest: None

Patient consent statement: The author(s) have obtained written informed consent from the patient for publication of the case report details and related images.

mesial root such as middle mesial canal, in the distal root such as middle distal canal, four canals in mesial root, four canals in distal root, additional roots such as radix entomolaris, radix paramolaris, C-shaped canals and many more.⁴

According to a study using cone beam computed tomography of the Indian subpopulation only 0.7% of the mandibular first molars had a C-shaped root canal configuration with one root.⁵

A few of the recent case reports also found with C-shaped root canals with one root. But so far, there have been no cases reported of C-shaped roots with four canals in the mandibular first molars.

While it is generally acknowledged that a comprehensive understanding of root canal system variations is beneficial, it is important to recognize that unique or atypical case may be encountered that have not been previously described in the literature.⁶

The presented case reports a unique instance of a mandibular first molar with a C-shaped root canal morphology, emphasizing the importance of ongoing research and clinical observation.

So, the purpose of this case report is to discuss the management of a mandibular first molar with an uncommon anatomy of C-shaped root morphology having four root canals.

CASE DESCRIPTION

A male patient of 28-years old reported to the dental clinic in Kozhikode, Kerala, India, in the month of January 2024 with a chief complaint of pain in his right lower jaw. He gave a history of spontaneous pain which was intermittent in right mandibular first molar region for about 2 months. As per the patients description, pain increased in intensity 3 days before he reported to the clinic and specified that pain used to aggravate while consuming hot food. There was no contributory medical history. His dental history revealed that he had undergone multiple extractions due to deep carious lesions which were uneventful, which was confirmed on intraoral examination as multiple missing teeth were noted in the oral cavity (Teeth no: 14, 25, 36, 37, 38, 44, and 48). A large carious lesion was noted distally in the mandibular first molar tooth (Tooth no: 46) which was non-responsive to percussion, while periodontal health appeared to be normal. A vitality test was conducted with dry ice on tooth no – 46 which resulted in intense pain, while an electric pulp test initiated an exaggerated response. Preoperative orthopantomograph (OPG) was obtained which revealed distal caries involving pulp in the tooth no – 46 (tooth of interest), root stumps of tooth no – 15 and missing teeth no: 14, 25, 36, 37, 38, 44, and 48 (Fig. 1). Multiple impacted teeth – 43, 45 and two supernumerary teeth.

After being diagnosed as symptomatic irreversible pulpitis in relation to tooth no - 46,

noninvasive endodontic treatment was initiated after obtaining informed consent from the patient.

Firstly, local anesthesia was administered, followed by caries excavation. The distal lost wall was built-up with a temporary restorative material. The endodontic access cavity revealed a poorly distinguished floor of the pulp chamber with four distinct orifices similar to radix entomolaris, or radix paramolaris, hence, the treatment protocol was continued. But the locations of the orifices made us skeptical enough to believe that it's a common and known variation. Though the mandibular molar with four separate canals was thought to be a common variation, a master-cone radiograph showed the unusual location of the mesiolingual canal in the central part of the tooth and an extra distolingual root (Fig. 2A).

Since the canals were curved and narrow, we anticipated procedural errors. So we used high quality, controlled-memory NITI files, which are heat-treated. Cleaning and shaping were done using RCS Rainbow one rotary files, up to size 25 (Suzhou Ramo Medical Instrument co., Ltd, China) for all the canals since they have high fatigue resistance to fracture. Normal saline, 5.25% sodium hypochlorite solution, and 17% EDTA were used for the irrigation protocol, and the final flushing of the canals was done with normal saline.

Despite initial suspicion of a furcal perforation, a thorough examination revealed no evidence of such a defect. Apex locator

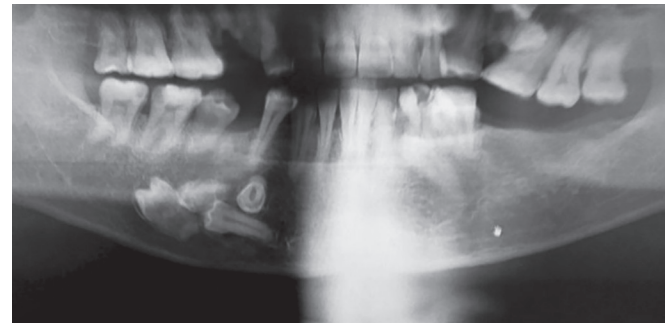
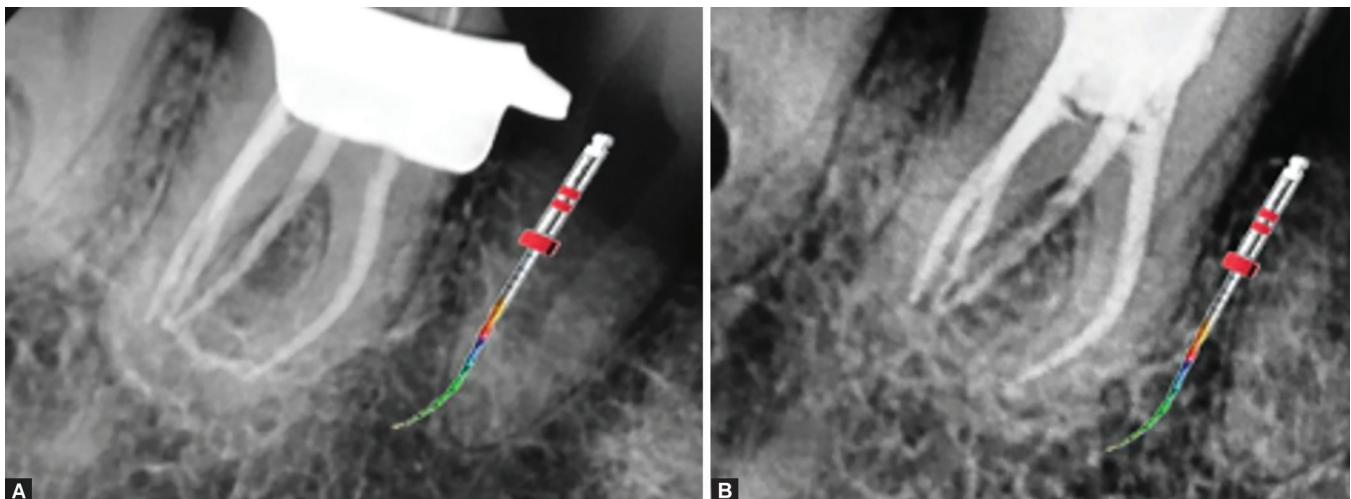
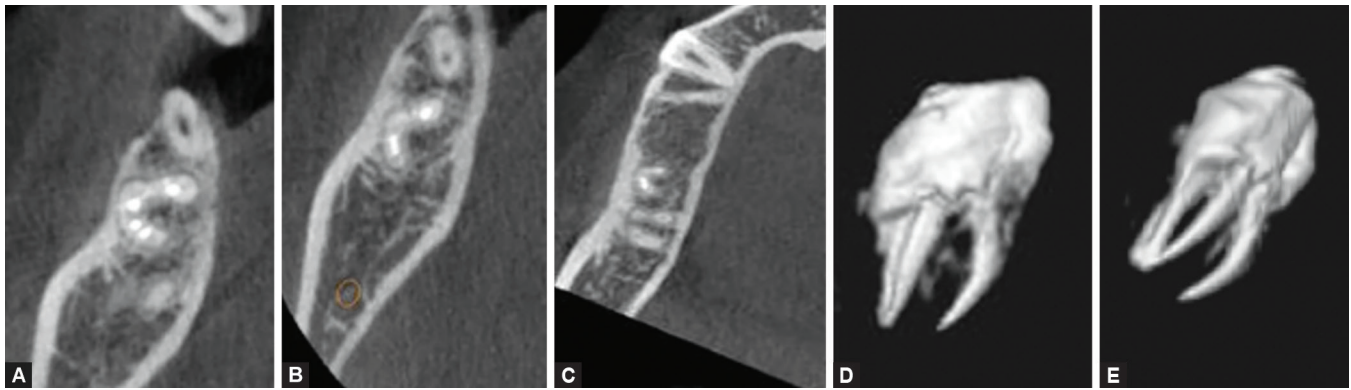


Fig. 1: Preoperative orthopantomograph depicting tooth no 46 showing distal caries involving pulp (tooth of interest). Other significant findings- root stumps 15; missing teeth – 14, 25, 36, 37, 38, 44, and 48; multiple impacted teeth – 43, 45, and two supernumerary teeth



Figs 2A and B: Intraoral periapical radiography of 46. (A) Master cone check radiograph; (B) Post obturation radiograph



Figs 3A to E: CBCT images. (A) Cross section at cervical third – showing four separate orifices; (B) At middle third – showing that 3 canals starting to fuse; (C) At apical third – showing that 3 canals fused and one canal remain separate; (D and E) – 3-dimensional image of mandibular first molar

confirmation and careful inspection of the pulpal floor for bleeding points assured us that the tooth was intact. Subsequently, obturation was successfully performed using the cold lateral compaction technique and the access cavity was restored using restorative composite resin and the treatment was completed in a single visit (Fig. 2B).

Preoperative and intraoperative radiographic evaluations raised concerns about the morphological variation of the mandibular right molar tooth. To clarify the root anatomy, a CBCT scan was acquired post-treatment. The imaging revealed a rare morphological variant: A C-shaped root with four distinct canals. While three of the four canals-mesiolingual, distolingual and distobuccal fused at the apex, the mesiobuccal canal remained separate (Fig. 3). The patient was informed about the unusual finding and assured that it was just an of morphological variation and the treatment intervention was not hindered. When the patient was recalled after 6 months for follow-up, the tooth remained asymptomatic clinically with no periapical changes radiographically. Patient is currently under prosthetic rehabilitation for missing teeth.

DISCUSSION

Although extensive knowledge of root canal system anatomy is desirable, clinical practice often presents cases that deviate from typical patterns and may not be fully documented in existing literature.

In the presented case, preoperative radiography didn't reveal much on variation in root canal morphology, so we didn't advise preoperative CBCT imaging. After locating four distinct orifices, we also noted that the canals were not of conventional oval or round-shaped but rather ribbon shaped and curved, so we had to choose root canal files which have high fatigue resistance to fracture. A rainbow one is one such heat-treated files [The first Diamond-like carbon (DLC) treatment file in the world], which poses a great advantage in using it with confidence in severely curved canals. The master cone radiograph revealed an atypical mesiolingual canal positioned centrally within the tooth and an additional distolingual root. This unusual anatomy could have been misinterpreted as a furcal perforation on conventional periapical radiographs, where the presence of instruments or filling material in the furcation region might appear misleading. However, this radiographic finding were correlated with clinical findings of floor of the pulp chamber without any bleeding after canal preparation and also with the help of electronic apex locator findings we confirmed that it is not

a perforation. Once we prepared canals which had gutter shaped appearance, we carefully compacted obturation material to develop fluid tight seal.

With all the above findings, we were sure that it's an uncommon anatomy. So we decided to study the anatomy further using CBCT imaging. Upon CBCT imaging it was confirmed to be an uncommon anatomy of mandibular first molar with C-shaped roots and 4 distinct canals.

The variations in canal anatomy are seen due to disturbances during the differentiation and root completion. During tooth development, Hertwig's epithelial sheath determines and shape and the number of roots. The failure of Hertwig's epithelial root sheath to fuse on the lingual or buccal aspect of the root gives rise to a C-shaped root. The C-shaped root may also be formed by coalescence because of the deposition of the cementum with time. The C-shaped canals appear when fusion of either the buccal or lingual aspects of the mesial and distal roots occurs. This fusion will remain irregular, and the two roots will be connected by an interradicular ribbon.⁷

Normally, when a deep groove is present on lingual or buccal surfaces of the root, a C-shaped canal can be expected to be present. Usually this kind of fused roots and C-shaped roots presents with narrow root grooves which are prone to localized periodontal disease, and that can be a first diagnostic indication of such anatomic variance.⁸

De Pablo et al.,⁹ and Ballulaya et al.,¹⁰ conducted a systematic review of the literature on the canal morphology of the mandibular first molars, and Reuben et al.¹¹ conducted an *in-vitro* study on mandibular first molars involving the Indian population. These studies revealed that only one sample had a C-shaped root canal with a single root, and a single canal. The root and canal morphology of mandibular first and second molars in the Turkish population was evaluated by Demirbuga et al.,¹² and reported an incidence of 0.12% for C-shaped canals, Sooriaprakas et al.,¹³ reported an incidence of 0.85% for C-shaped canals in mandibular first molars, which are for single root and canal.

But all the studies and case reports of C-shaped root canals of mandibular first molar are about single root and single root canals. To the best of our search, no case reports or studies in the existing literature at the moment presented with four distinct root canals with C-shaped roots in mandibular first molars.

C-shaped root canals were classified by Melton into three categories in the year 1991. But, Fan et al. observed that few types

of morphology were different and would not fall into any category with Melton's classification and therefore proposed a different system in 2004.

Fan's Classification of C-shaped Canal Systems

Anatomic Classification

Category I (C1): "Incomplete C" – The canal system resembles a continuous, uninterrupted "C" shape with no distinct separation or division.

Category II (C2): "Modified Semicolon" – The canal system resembles a semicolon (";") due to a single discontinuity in the "C" outline. Both angles formed by the discontinuity must be at least 60°.

Category III (C3): "Multiple Canals" – Two or three separate canals are present within the root structure. Both angles created by the canal separation are less than 60°.

Category IV (C4): "Single Canal" – A single round or oval canal is observed in the cross-section of the root.

Category V (C5): "Absent Lumen" – No visible canal lumen is present, typically seen near the apex.

Radiographic Classification

Type I

"Single Fused Canal" – The radiograph shows a conical or square root with a faint, radiolucent line suggesting a potential division between distal and mesial sections. A single canal appears to merge from these sections before exiting at the apical foramina.

Type II

"Separate Canals to Apex" – The radiograph displays a conical or square root with a faint, radiolucent line, suggesting a potential division between distal and mesial sections. Two distinct canals are visible, seemingly following separate pathways towards the apex.

Type III

"One Canal Follows Radiolucency" – The radiograph shows a conical or square root with a faint, radiolucent line, suggesting a potential division between distal and mesial sections. Two canals are observed: one appears to curve and overlap this radiolucent line as it progresses towards the apex, while the other maintains a separate trajectory.

Though these were the widely used classifications worldwide, since the presented case had C-shaped root but not C-shaped root canals, we could not find a category in the classification to which our presented case fall into as classifications describe about root canal shape rather than external morphological shape of the root.

But then on further search we found one literature where authors have classified C-shaped roots before Melton proposed a classification.

In 1976, Fukuya classified C-shaped roots into,

- *Fused Side*: Deep concave groove, shallow concave groove, flat, convex.
- *Unfused Side*: Inverted, U-shaped, V-shaped, flat.

In 1990, Carlsen classified into 3 categories:

- None of the grooves are extremely pronounced
- One or two of the grooves are extremely pronounced
- Tooth with a supernumerary radicular structure.^{14,15}

Though all of the above-mentioned classifications are based on study of mandibular second molars and the presented case was about first molar, with a classification by Fukuya we can believe that the present case falls into a category of fused side-convex and unfused side – U shaped.

CONCLUSION

This case report presents the uncommon anatomy of the mandibular first molar with C-shaped roots and 4 distinct canals. It is important to recognize that unique or atypical cases may be encountered that have not been previously described in the literature.

REFERENCES

1. Qian Y, Li Y, Song J, et al. Evaluation of C-shaped canals in maxillary molars in a Chinese population using CBCT. *BMC Med Imaging* 2022;22(1):104. DOI: 10.1186/s12880-022-00831-4.
2. Cooke HG, Cox FL. C-shaped canal configurations in mandibular molars. *J Am Dent Assoc* 1979;99(5):836–839. DOI: 10.14219/jada.archive.1979.0402.
3. Felsypremila G, Vinothkumar TS, Kandaswamy D. Anatomic symmetry of root and root canal morphology of posterior teeth in Indian subpopulation using cone beam computed tomography: A retrospective study. *Eur J Dent* 2015;9(4):500–507. DOI: 10.4103/1305-7456.172623.
4. Woelber JP, Bruder M, Tennert C, et al. Assessment of endodontic treatment of C-shaped root canals. *Swiss Dent J* 2014;124(1):11–15. DOI: 10.61872/sdj-2014-01-01.
5. Raghavendra SS, Napte BD, Desai NN, et al. Single C-shaped canal in mandibular first molar: A case report. *J Conserv Dent* 2015;18(2):168–171. DOI: 10.4103/0972-0707.153060.
6. Versiani MA, Basrani B, Sousa-Neto MD (Eds). *The root canal anatomy in permanent dentition*. New York, USA; Springer. 2019. pp. 181–239.
7. Lynn EA. Conventional root canal therapy of C-shaped mandibular second molar. A case report. *NY State Dent J* 2006;72(6):32–34. PMID: 17203853.
8. Lambrianidis T1, Lyroudia K, Pandelidou O, et al. Evaluation of periapical radiographs in the recognition of C-shaped mandibular second molars. *Int Endod J* 2001;34(6):458–462. DOI: 10.1046/j.1365-2591.2001.00417.x.
9. de Pablo ÓV, Estevez R, Sánchez MP, et al. Root anatomy and canal configuration of the permanent mandibular first molar: A systematic review. *J Endod* 2010;36(12):1919–1931. DOI: 10.1016/j.joen.2010.08.055.
10. Ballulaya SV, Vemuri S, Kumar PR. Variable permanent mandibular first molar: Review of literature. *J Cons Dent* 2013;16(2):99–110. DOI: 10.4103/0972-0707.108176.
11. Reuben J, Velmurugan J, Kandaswamy D. The evaluation of root canal morphology of the mandibular first molar in an Indian population using spiral computed tomography scan: An in vitro study. *J Endod* 2008;34(2):212–215. DOI: 10.1016/j.joen.2007.11.018.
12. Demirbuga S, Sekerci AE, Dincar AN, et al. Use of cone beam computed tomography to evaluate root and canal morphology of mandibular first and second molars in Turkish individuals. *Med Oral Patol Oral Cir Bucal* 2013;18(4):e737–e744. DOI: 10.4317/medoral.18473.
13. Sooriaprakas C, Ballal S, Velmurugan N. Mandibular first molar with a single root and single canal. *Case Rep Dent* 2014;2014:159846. DOI: 10.1155/2014/159846.
14. Kato A1, Ziegler A, Higuchi N, et al. Aetiology, incidence and morphology of the C-shaped root canal system and its impact on clinical endodontics. *Int Endod J* 2014;47(11):1012–1033. DOI: 10.1111/iej.12256.
15. Yilmaz Z, Tuncel B, Serper A, et al. C-shaped root canal in a maxillary first molar: A case report. *Int Endod J* 2006;39(2):162–166. DOI: 10.1111/j.1365-2591.2006.01069.x.