OPEN ACCESS

Saudi Journal of Oral and Dental Research

Abbreviated Key Title: Saudi J Oral Dent Res
ISSN 2518-1300 (Print) | ISSN 2518-1297 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com

Case Report **Dentistry**

Bilateral Continuous C-Shaped Canal Configuration in Mandibular Second Molars: A Case Report

Dr. Akanksha Kumari[1]*, Dr. Ajay Kumar Nagpal[1], Dr. Abhishek Sharma[1], Dr. Muhammad Mutiur Rahman[1], Dr. Arunima Jana[1], Dr. Seemran Panda[1], Dr. Astha Bhargava[1]

[1]K.D. Dental College and Hospital, Mathura, UP, India

DOI: https://doi.org/10.36348/sjodr.2026.v11i06.001 | **Received:** 28.03.2026 | **Accepted:** 22.05.2026 | **Published:** 05.06.2026

***Corresponding author:** Dr. Akanksha Kumari
K.D. Dental College and Hospital, Mathura, UP, India

Abstract

C-shaped canal configuration is a complex anatomical variation most commonly in mandibular second molars. It is characterized by fused roots and a continuous or semicircular canal system with fins, webs, and interconnections that complicate cleaning, shaping, and obturation. The prevalence of C-shaped canals varies significantly among different populations, with higher incidence reported in Asian groups encountered and frequent bilateral occurrence when present unilaterally. Fan's classification provides a standardized method to categorize C-shaped canal morphology. Successful management requires modification of conventional endodontic techniques and the use of thermoplastic obturation methods to achieve three-dimensional sealing. This case report describes the nonsurgical management of bilateral continuous C-shaped canals (Fan's C1 configuration) in mandibular second molars of a 24-year-old male patient using controlled rotary instrumentation up to size 25/.06 followed by single cone obturation technique.

Keywords: C-shaped canal, bilateral occurrence, mandibular second molar, Fan's classification, single cone obturation.

Copyright © 2026 The Author(s): This is an open-access article distributed under the terms of the Creative Commons Attribution **4.0 International License (CC BY-NC 4.0)** which permits unrestricted use, distribution, and reproduction in any medium for non-commercial use provided the original author and source are credited.

INTRODUCTION

A comprehensive understanding of root canal morphology is fundamental to the success of endodontic therapy. Anatomical variations may significantly influence treatment outcomes if not accurately identified and managed. Among these variations, the C-shaped canal configuration is regarded as one of the most challenging anatomical presentations in clinical endodontics [1,2].

The C-shaped canal system is characterized by fused roots and a cross-sectional morphology resembling the letter "C," frequently containing fins, webs, and intercanal communications [1,2]. Manning first described the C-shaped configuration in mandibular second molars, emphasizing its unique anatomical features and clinical implications [3]. Later, Fan *et al.,* proposed a detailed classification system (C1–C5) based on cross- sectional morphology at different root levels, which remains widely accepted [2].

The prevalence of C-shaped canals shows considerable variation among different populations. Cheung and Liu reported a high prevalence in a Chinese population [4]. Subsequent CBCT-based studies have demonstrated varying prevalence rates across different ethnic groups, with notable bilateral occurrence when present on one side [5,8]. Alfawaz *et al.,* reported prevalence in a Saudi population using CBCT imaging [4], while Wadhwani *et al.,* evaluated prevalence in a central Indian population [6]. More recent studies have further confirmed bilateral tendencies and demographic variations [7,8]. A systematic review and meta-analysis by Yousefi *et al.,* summarized global prevalence patterns and highlighted ethnic variability [9].

Advanced imaging modalities, particularly CBCT, have significantly improved detection and morphological assessment of C-shaped canals [5,9]. Zhang *et al.,* demonstrated the value of CBCT in evaluating root and canal morphology in mandibular molars [15].

Several case reports have documented unusual and bilateral presentations of C-shaped canal systems [10–13]. Zhou *et al.,* described bilateral C-shaped canal systems and emphasized the importance of careful

morphological assessment and modified treatment approaches [10]. Similar rare morphological variations have been reported by Ravi and Honwad [11] and Vasileva *et al.,* [12]. Raghavendra et al. also reported C-shaped configuration in mandibular molars, reinforcing the need for clinician awareness [13]

Due to the intricate internal anatomy, conventional instrumentation techniques may be insufficient for adequate debridement. Enhanced irrigation protocols and thermoplastic obturation techniques such as warm vertical condensation are recommended to achieve effective three-dimensional sealing in such complex canal systems [1,2].

The present case report describes the diagnosis and nonsurgical endodontic management of bilateral continuous C-shaped canals (Fan's C1 configuration) in mandibular second molars of a 24-year-old male patient using controlled rotary instrumentation and warm vertical condensation technique.

CASE REPORT

A 24-year-old male patient, Shivam, reported to the Department of Conservative Dentistry and Endodontics, K.D. Dental College and Hospital, Mathura, with a chief complaint of intermittent pain and food lodgement in the lower right and left posterior tooth region for the past three weeks. Subjective symptoms included sensitivity to thermal stimuli and increased in intensity of pain. The patient's medical history was not contributory. There is no previous dental history.

Clinical examination of left and right second mandibular molar revealed the presence of deep occlusal carious lesion which was sensitive to percussion. Periodontal probing around the tooth showed normal alveolar bone, normal sulcular depth, absence of pocket and mobility within physiological limits. Intraoral examination revealed deep occlusal caries and disto proximal caries with respect to teeth 37 and 47. Both teeth were tender on vertical percussion. No swelling, sinus tract, or periodontal pocketing was observed.

Sensibility test with dry ice cause intense lingering pain whereas electrical pulp testing showed exaggerated response. Intraoral periapical radiographs revealed radiolucency involving the pulp in both mandibular second molars. The roots appeared fused with a longitudinal radicular groove suggestive of C-shaped canal configuration (Fig 1). To confirm canal morphology and evaluate the complexity of the root canal system, cone-beam computed tomography (CBCT) was performed. Axial CBCT sections revealed a continuous C-shaped canal configuration (Fan's C1 type) extending from the coronal third with interconnecting fins and web-like extensions. The roots were fused with a single conical root structure (Fig 2). Based on clinical and radiographic findings, a diagnosis of symptomatic irreversible pulpitis with symptomatic apical periodontitis was made and routine non-surgical endodontic treatment was planned. Treatment plan was explained.

Management of Tooth 47 Visit 1

Anesthesia and Isolation

Local anesthesia was administered using 2% lignocaine with 1:80,000 adrenaline via inferior alveolar nerve block. Rubber dam isolation was achieved to ensure aseptic field.

Access Opening

Access cavity preparation was performed using a round diamond bur and refined with Endo-Z bur. Upon deroofing the pulp chamber, a continuous C-shaped canal orifice extending from mesiolingual to distal aspect was observed (Fig 3).

Working Length Determination

Initial canal scouting was performed using #8 and #10 stainless steel K-files with watch- winding motion.

Working length was determined using an electronic apex locator and confirmed radiographically.

Working length: 16.5 mm for distal canal and 16 mm for the mesial canal. Apical patency was maintained using #10 K-file throughout instrumentation (Fig 4).

Glide path was established up to #15 K-file using balanced force technique to allow safe progression of rotary instruments.

Biomechanical Preparation

Cleaning and shaping were performed using the NT Rainbow S nickel–titanium rotary file system in a crown-down technique using 21 mm length at the Speed of 300 rpm and Torque: 2.0–2.5 Ncm (as recommended by manufacturer). Considering the continuous C- shaped canal morphology with thin radicular walls, controlled circumferential brushing motion was used to contact buccal, lingual, and isthmus extensions without excessive dentin removal.

Rotary Sequence Used:
17/.04, 20/.04, 25/.04 ,20/.06 ,25/.06

Final apical preparation was maintained at 25/.06 at 16.5 mm and 16mm for distal and mesial canals respectively. Care was taken to avoid strip perforation along the thin lingual wall.

Irrigation Protocol

Copious irrigation was performed between each file using:
3% Sodium hypochlorite during instrumentation
17% EDTA for 1 minute to remove smear layer
Final rinse with normal saline

Irrigation was delivered using a side-vented needle and ultrasonic irrigator placed 1–2 mm short of working length. Due to the presence of fins and anastomoses in continuous C-shaped canals, chemical debridement was emphasized. The canal was dried using sterile paper points corresponding to 25/.06 taper. Temporary restoration was placed.

Visit 2 – Obturation of Tooth 47

The patient returned asymptomatic. After isolation and irrigation, single cone obturation was performed. Master Cone Selection was done using 25/.06 gutta-percha cone at 16.5 mm for distal canal and 16mm for mesial canals (Fig 5). Tug-back confirmed clinically and radiographically. Zinc Oxide Eugenol (ZOE) based sealer was mixed to creamy consistency and applied uniformly to canal walls. After inserting the master cone to the working length, sear it off at orifice with a heat carrier, and lightly compact the coronal end. Post endodontic restoration was done using glass ionomer cement (Fig 6).

Management of Tooth 37 Visit 3

Anesthesia and Isolation

Local anesthesia was administered using 2% lignocaine with 1:80,000 adrenaline via inferior alveolar nerve block. Rubber dam isolation was achieved to ensure aseptic field.

Access Opening

Access cavity preparation was performed using a round diamond bur and refined with Endo-Z bur. Upon deroofing the pulp chamber, a continuous C-shaped canal orifice extending from mesiolingual to distal aspect was observed (Fig 11).

Working Length Determination

Initial canal scouting was performed using #8 and #10 stainless steel K-files with watch- winding motion (Fig 12).

Working length was determined using an electronic apex locator and confirmed radiographically.

Working length: 18 mm for distal canal and 19mm for the mesial canal.

Apical patency was maintained using #10 K-file throughout instrumentation.

Glide path was established up to #15 K-file using balanced force technique to allow safe progression of rotary instruments.

Biomechanical Preparation

Cleaning and shaping were performed using the NT Rainbow S nickel–titanium rotary file system in a crown-down technique using 21 mm length at the Speed of 300 rpm and Torque: 2.0–2.5 Ncm (as recommended by manufacturer). Considering the continuous C- shaped canal morphology with thin radicular walls, controlled circumferential brushing motion was used to contact buccal, lingual, and isthmus extensions without excessive dentin removal. Rotary Sequence Used: 17/.04, 20/.04, 25/.04, 20/.06, 25/.06

Final apical preparation was maintained at 25/.06 at 18 mm and 19 mm for distal and mesial canals respectively. Care was taken to avoid strip perforation along the thin lingual wall.

Irrigation Protocol

Copious irrigation was performed between each file using:

3% Sodium hypochlorite during instrumentation 17% EDTA for 1 minute to remove smear layer

Final rinse with normal saline

Irrigation was delivered using a side-vented needle and ultrasonic irrigator placed 1–2 mm short of working length. Due to the presence of fins and anastomoses in continuous C-shaped canals, chemical debridement was emphasized. The canal was dried using sterile paper points corresponding to 25/.06 taper. Temporary restoration was placed.

Visit 4 – Obturation of Tooth 37

The patient returned asymptomatic. After isolation and irrigation, single cone obturation was performed. Master Cone Selection was done using 25/.06 gutta-percha cone at 18 mm for distal canal and 19mm for mesial canals (Fig 13). Tug-back confirmed clinically and radiographically. Zinc Oxide Eugenol (ZOE) based sealer was mixed to creamy consistency and applied uniformly to canal walls. After inserting the master cone to the working length, sear it off at orifice with a heat carrier, and lightly compact the coronal end. Post endodontic restoration was done using glass inomer cement.

Post-Endodontic Rehabilitation

After completion of root canal treatment in both teeth, post-endodontic restoration was planned after 2 weeks. Considering extensive loss of coronal tooth structure, endocrown prosthesis was fabricated for both mandibular second molars to ensure adequate strength and cuspal coverage (Fig 7, 8, 9, 14, 15).

Tooth preparation involved:

Butt joint margin design 2mm occlusal reduction and Retention achieved from pulp chamber space. Impressions were made, and indirect porcelain fused metal endocrowns were fabricated and cemented using resin cement. Final occlusion was checked and adjusted.

Outcome

At follow-up, the patient was asymptomatic. Radiographic evaluation showed satisfactory obturation with dense filling of continuous C-shaped canal systems.

© 2026 | Published by Scholars Middle East Publishers, Dubai, United Arab Emirates

Endocrown restorations were clinically stable with good marginal adaptation.

Fig. 1: Pre Operative

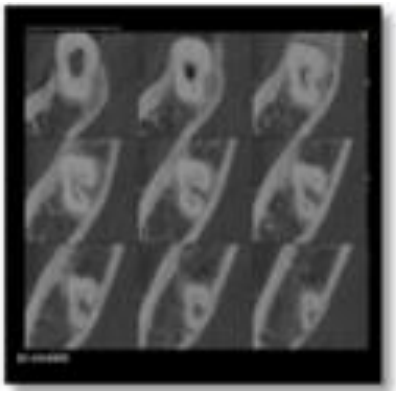

Fig. 2: Cbct Image

Fig. 3: Access Opening

Fig. 4: Working Length

Fig. 5: Master Cone

Fig. 6: Post Endodontic

RESTORATION

Fig. 7: Crown Preparation

Fig. 8: Impression

Fig. 9: Crown Cementation

Fig. 10: Pre Operative

Fig. 8: Access Cavity

Fig. 9: Working Length

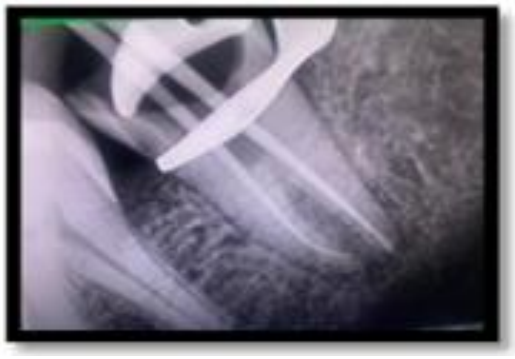

Fig. 13: Master Cone

Fig. 14: Tooth Preparation

Fig. 15: Crown Cementation

DISCUSSION

C-shaped canal configuration represents one of the most complex anatomical variations encountered in endodontic practice. It is most commonly associated with mandibular second molars and is characterized by fused roots with a longitudinal radicular groove and a continuous or semicircular canal system containing fins, webs, and interconnections. Literature reviews by Fernandes *et al.,* [1] and Jafarzadeh and Wu [2] comprehensively describe the embryological basis, anatomical characteristics, and clinical implications of C-shaped canals. The present case demonstrated bilateral continuous C-shaped canals (Fan's C1 configuration) in mandibular second molars, reinforcing the anatomical complexity described in these foundational reviews [1,2]

The anatomical presentation observed in this patient is consistent with the classical description provided by Manning [3], who first detailed the C-shaped configuration in mandibular second molars and emphasized its clinical challenges. The presence of fused roots with a single conical morphology and a continuous C-shaped orifice extending from mesiolingual to distal aspects in both teeth corresponds closely with these early anatomical observations [3].

Population-based studies have demonstrated significant ethnic variability in the prevalence of C-shaped canals. Cheung and Liu [4] reported a high prevalence in a Chinese population, suggesting a strong racial predilection. Similarly, Alfawaz *et al.,* [5] documented the occurrence of C-shaped canal systems in a Saudi population using CBCT imaging, while Wadhwani *et al.,* [6] evaluated prevalence in a central Indian population and confirmed its presence within the Indian demographic. More recent CBCT investigations by Sönmez Kaplan *et al.,* [7] and Mingo *et al.,* [8] further validated variability in prevalence and highlighted frequent bilateral occurrence when present unilaterally. A recent systematic review and meta-analysis by Yousefi *et al.,* [9] consolidated global prevalence data and emphasized the strong influence of ethnicity and geographic distribution. The bilateral presentation observed in this case aligns with the bilateral tendencies reported in these epidemiological studies [4,9].

Several case reports have described unusual and bilateral C-shaped canal systems. Zhou *et al.,* [10] reported bilateral C-shaped canals in mandibular molars and stressed the importance of careful morphological assessment prior to instrumentation

Similar rare morphological variations have been documented by Ravi and Honwad [11] Vasileva *et al.,* [12] and Raghavendra *et al.,* [13], all of whom emphasized clinician awareness and modification of treatment strategies. The present case supports these findings, as bilateral continuous C1 configurations were identified and managed successfully.

Fan *et al.,* [14] provided a detailed anatomical classification system (C1–C5) based on cross-sectional morphology at different root levels, which remains the most widely accepted classification. In the present case, CBCT axial sections revealed a continuous C- shaped canal from coronal to apical third, corresponding to Fan's C1 configuration as described by Fan *et al.,* [14]. Accurate classification aided in treatment planning and selection of an appropriate instrumentation strategy.

Advanced imaging modalities have significantly improved diagnostic accuracy in identifying complex canal systems. Zhang *et al.,* [15] demonstrated the clinical value of CBCT in evaluating root and canal morphology of mandibular molars. In this case, CBCT imaging confirmed root fusion and continuous canal morphology, enabling precise working length determination and better appreciation of isthmus extensions and thin radicular walls, thereby minimizing the risk of procedural errors.

Biomechanical preparation of C-shaped canals presents considerable challenges due to thin dentinal walls and irregular canal extensions. Conventional round rotary preparation may inadequately clean fins and isthmuses. Therefore, controlled circumferential brushing motion with conservative apical enlargement up to 25/.06 was employed in this case to minimize excessive dentin removal while ensuring adequate shaping. Emphasis was placed on chemical debridement through copious irrigation with 3% sodium hypochlorite

and 17% EDTA, recognizing that irrigation plays a critical role in cleaning inaccessible areas within C-shaped canal systems, as emphasized in earlier reviews [1,2]

Although thermoplastic obturation techniques such as warm vertical condensation are often recommended for C-shaped canals to enhance three-dimensional sealing [1,2] a single cone obturation technique with 25/.06 gutta-percha and ZOE-based sealer was used in this case. Careful sealer application and confirmation of tug-back ensured adequate adaptation within the continuous canal space. Radiographic evaluation demonstrated dense obturation with satisfactory filling of the C-shaped canal system, and the patient remained asymptomatic at follow-up.

Post-endodontic rehabilitation is equally critical in structurally compromised molars. Given the extensive loss of coronal tooth structure, endocrown restorations were planned to provide cuspal coverage and distribute occlusal forces effectively. The favorable clinical outcome with stable restorations further supports comprehensive management combining accurate diagnosis, careful biomechanical preparation, effective irrigation, and appropriate coronal rehabilitation.

Overall, this case corroborates previous literature regarding the anatomical complexity, bilateral occurrence, and clinical challenges of C-shaped canal systems [1,15] It highlights the importance of CBCT-based diagnosis, adherence to morphological classification, conservative instrumentation strategies, enhanced irrigation protocols, and appropriate restorative planning to achieve predictable treatment outcomes in such anatomically demanding cases.

The successful management of this case can be attributed to:

- Early identification of continuous C-shaped morphology
- Use of CBCT for three-dimensional assessment
- Conservative and controlled rotary instrumentation
- Adequate irrigation protocol
- Appropriate full-coverage endocrown restoration

CONCLUSION

C-shaped canal configuration is a complex anatomical variation commonly seen in mandibular second molars and may occur bilaterally. This case demonstrated successful nonsurgical management of bilateral continuous C-shaped canals (Fan's C1 configuration) using CBCT-based diagnosis, conservative rotary instrumentation, enhanced irrigation, and single cone obturation.

Appropriate post-endodontic rehabilitation with endocrowns further ensured structural integrity and functional stability. Early identification and modified treatment strategies are essential for predictable outcomes in teeth with C-shaped canal systems

Source of Funding: None.

Conflict of Interest: None.

REFERENCES

1. Fernandes M, de Ataide I, Wagle R. C-shaped root canal configuration: a review of literature. J Conserv Dent. 2014;17(4):312-319.
2. Jafarzadeh H, Wu YN. The C-shaped root canal configuration: a review. J Endod. 2007;33(5):517-523.
3. Manning SA. Root canal anatomy of mandibular second molars. Part II. C-shaped canals. Int Endod J. 1990;23(1):40-45.
4. Cheung GSP, Liu C-H. A retrospective study of C-shaped root canal configurations in mandibular second molars in a Chinese population. Int Endod J. 2009;42(10):954-964.
5. Alfawaz H, Alqedairi A, Alkhayyal AK, et al. Prevalence of C-shaped canal system in mandibular first and second molars in a Saudi population assessed via CBCT: a retrospective study. Clin Oral Investig. 2019;23(1):107-112.
6. Wadhwani S, Singh MP, Agarwal M, et al. Prevalence of C-shaped canals in mandibular second and third molars in a central India population: a CBCT analysis. J Conserv Dent. 2017;20(5):351-354.
7. Sönmez Kaplan S, Kaplan T, Sezgin GP. Evaluation of C-shaped canals in mandibular second molars using CBCT: prevalence and configuration. Odontology. 2021;109(4):949-955.
8. Mingo E, Noguera M, Jiménez F, et al. Prevalence and morphology of lower second molars with C-shaped canals: a CBCT analysis. J Clin Exp Dent. 2025;17(2): e160-e167.
9. Yousefi F, Mohammadi Y, Shokri E. Prevalence of C-shaped canal morphology in premolars and molars assessed by CBCT: a systematic review and meta- analysis. BMC Oral Health. 2025; 25:1657.
10. Zhou R, Shen L, Wei C. C-shaped root canal systems in the bilateral mandibular first molars: a case report and literature review. BMC Oral Health. 2025; 25:711.
11. 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.
12. Vasileva VR, Borisova-Papancheva T, Zaneva-Hristova D, Georgieva S, Miteva AM. C-shaped canal in second mandibular molar: a case report. Cureus. 2025;17(4): e81784.
13. Raghavendra SS, Napte BD, Desai NN, Hindlekar AJ. Single C-shaped canal in mandibular first molar: a case report. J Conserv Dent. 2015;18(2):168-171.
14. Fan B, Cheung GSP, Fan M, Gutmann JL, Bian Z.

C-shaped canal system in mandibular second molars: Part I—Anatomical features. J Endod. 2004;30(12):899-903.

15. Zhang R, Wang H, Tian YY, Yu X, Hu T, Dummer PMH. Use of CBCT to evaluate root and canal morphology of mandibular second molars in a Chinese population. Int Endod J. 2011;44(11):990-999.