Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol. 14, Issue 9s (2025)
https://www.jneonatalsurg.com

OPEN ACCESS

Management of a Fan's Type IV C-Shaped Canal in a Mandibular First Molar: Literature Review and Case Report

Dr. Vivek Devidas Mahale[1], Dr. Vigneshwar T MDS[*2]

[1]Postgraduate Student, Department of Conservative Dentistry and Endodontics, Saveetha Dental College and Hospitals, Saveetha Institute of Medical and Technical Sciences (SIMATS), Saveetha University, Chennai-600077, Tamil Nadu, India
[*2]Reader, Department of Conservative Dentistry and Endodontics, Saveetha Dental College, Saveetha Institute of Medical and Technical Sciences (SIMATS), Saveetha University, Chennai-600077, Tamil Nadu, India

***Corresponding Author:**
Dr Vigneshwar T MDS
Email ID: dr.vigneshwart@gmail.com

Cite this paper as: Dr. Vivek Devidas Mahale, Dr. Vigneshwar T MDS, (2025) Management of a Fan's Type IV C-Shaped Canal in a Mandibular First Molar: Literature Review and Case Report. *Journal of Neonatal Surgery*, 14 (9s), 1046-1050.

ABSTRACT

C-shaped canals represent one of the most complex anatomical variations encountered in mandibular molars, often posing significant challenges for diagnosis and treatment. They occur due to root fusion, creating irregular cross-sections with fins and webs that complicate cleaning, shaping, and obturation. Although more prevalent in mandibular second molars, C-shaped canals have also been reported in mandibular first molars, where their occurrence is relatively rare. This article presents the nonsurgical retreatment of a mandibular first molar (#36) with Fan's Type IV C-shaped canal morphology, six years after the initial root canal therapy. A comprehensive literature review is provided, highlighting the prevalence, classification, diagnostic tools, and treatment strategies associated with C-shaped canals. The present case demonstrates how careful diagnosis, the use of cone-beam computed tomography (CBCT), and modern retreatment techniques can lead to favorable outcomes in managing this anatomical variation.

Keywords: *C-shaped canal, mandibular first molar, Fan's classification, CBCT, retreatment, endodontics*

1. INTRODUCTION

Understanding variations in root canal anatomy is fundamental to successful endodontic therapy. Mandibular first molars, typically described as having two roots with three to four canals, are among the most frequently treated teeth in endodontics. However, they exhibit considerable anatomical variability, including additional roots (radix entomolaris and paramolaris), middle mesial and middle distal canals, fused roots, and C-shaped configurations. [1-3]

C-shaped canals, first described by Cooke and Cox in 1979, are characterized by a continuous fin or web of tissue connecting multiple canals, resulting in a "C"-shaped cross-section.[4] They most often arise from incomplete fusion of the mesial and distal roots.[5] While predominantly found in mandibular second molars, they are occasionally seen in mandibular first molars, where their management becomes even more challenging due to limited clinical anticipation of such morphology. [6,7]

Fan et al. proposed a widely accepted classification for C-shaped canals, ranging from continuous C-shaped configurations (C1) to a single round or oval canal (C4) and even an absent lumen (C5). Fan's Type IV (C4) morphology, as observed in this case, presents as a single round or oval canal in cross-section, typically representing the apical convergence of a C-shaped system.

This article reports the retreatment of a mandibular first molar (#36) that presented with a Fan's Type IV C-shaped canal configuration, six years after the initial root canal treatment. A literature review of the prevalence, diagnosis, and management of C-shaped canals is also included.

2. LITERATURE REVIEW

Prevalence of C-Shaped Canals

The prevalence of C-shaped canals varies significantly across populations, reflecting ethnic and genetic factors. A CBCT-based study in an Iranian population found C-shaped canals in 4.4% of mandibular first molars and 3.7% of second molars.[8] East Asian populations show the highest prevalence, up to 40–45% in mandibular second molars ,[9] while European cohorts

report as low as 0.6%.[10] Studies in Middle Eastern, Brazilian, and Turkish populations reveal intermediate prevalence rates.[11-14]

Table 1. Prevalence of C-shaped canals in mandibular molars across populations

Author & Year	Country/Region	Tooth Type	Sample Size	Prevalence (%)	Notes
Nouroloyouni et al., 2023	Iran	First molar	248	4.4	CBCT, Fan's classification
Nouroloyouni et al., 2023	Iran	Second molar	478	3.7	CBCT
Celikten et al., 2016	Turkey	First molar	384	0.5	Very rare
Martins et al., 2016	Portugal	First molar	695	0.6	European population
Park et al., 2014	Korea	Second molar	710	41.3	East Asian prevalence
Vaz de Azevedo et al., 2019	Brazil	First molar	389	23	South American population

Table 2. Fan's Classification of C-Shaped Canals

Type	Morphology	Description
C1	Continuous C-shaped	A continuous "C" outline without separation
C2	Semicolon-shaped	Incomplete "C" outline; α or $\beta > 60°$
C3	Two or three distinct canals	Both α and $\beta < 60°$
C4	Single round/oval canal	One distinct canal lumen (seen apically)
C5	No canal lumen	Obliteration of canal lumen

Classification of C-Shaped Canal Fan et al. classified C-shaped canals into five types based on their cross-sectional morphology at different root levels [8]

The Type IV morphology (C4) is often present in the apical third, where multiple orifices converge into a single oval canal.

Diagnostic Challenges

Conventional radiographs are limited in detecting C-shaped canals because of overlapping roots.[2] CBCT provides superior three-dimensional imaging and remains the gold standard in diagnosis.[15,16]Operating microscopes also aid in identifying atypical orifices and canal communications.[6]

Endodontic Management Considerations

C-shaped canals present significant challenges during cleaning, shaping, and obturation.[17] Their irregular cross-sections harbor residual tissue and microorganisms that are difficult to access. Circumferential filing with NiTi instruments, combined with copious irrigation and ultrasonic activation, is recommended.[18] Thermoplasticized obturation techniques ensure a homogeneous fill of the irregular canal space.

In retreatment cases, previous filling material and altered canal morphology increase complexity. Use of CBCT for diagnosis, microscopes for retreatment, and modern obturation systems are essential for predictable outcomes.

3. CASE REPORT

Patient History

A 34-year-old patient presented to the Department of Conservative Dentistry with pain and intermittent swelling in the mandibular left first molar (#36). The tooth had been treated with root canal therapy six years prior, but the patient reported recurrent discomfort over the last two months. Medical history was non-contributory.

Clinical and Radiographic Findings

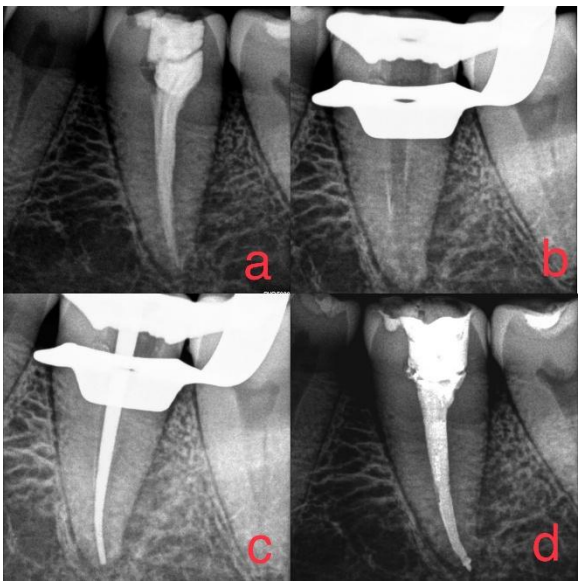
Clinical examination revealed a defective coronal restoration, mild tenderness to percussion, and no abnormal mobility. Periapical radiographs showed inadequate obturation with voids, periapical radiolucency, and evidence of fused roots. CBCT imaging confirmed a C-shaped root configuration with a Fan's Type IV (C4) single oval canal morphology in the apical third. A diagnosis of previously treated tooth with symptomatic apical periodontitis was established.

Treatment Procedure

After obtaining informed consent, nonsurgical retreatment was initiated. Local anesthesia (2% lidocaine with 1:80,000 adrenaline) was administered, and rubber dam isolation was achieved. The defective coronal restoration was removed, and access was refined under a dental operating microscope. Gutta-percha was removed using a combination of rotary retreatment files and solvent, revealing a single oval orifice consistent with Fan's Type IV configuration.

Working length was established using an electronic apex locator (Root ZX II) and confirmed radiographically. Cleaning and shaping were performed using a hybrid approach with NiTi rotary instruments and circumferential hand filing to address irregular canal walls. Copious irrigation with 3% sodium hypochlorite was delivered throughout instrumentation, activated ultrasonically for improved debridement of fins and webs. Final irrigation included 17% EDTA followed by 2% chlorhexidine.

Following thorough drying, canal was obturated with thermoplasticized gutta-percha (backfill technique) and AH Plus sealer, ensuring dense three-dimensional filling. The tooth was subsequently restored with resin composite, and a full-coverage crown was planned.



4. DISCUSSION

This case illustrates the complexities of managing a retreatment scenario in a mandibular first molar with a Fan's Type IV C-shaped canal. Unlike primary treatment, retreatment is complicated by previous obturation material, distorted anatomy, and secondary infection.

The literature underscores the rarity of C-shaped canals in mandibular first molars, with prevalence estimates ranging from 0.6% in European cohorts to 4.4% in Iranian populations. In most cases, the configuration varies coronally to apically, with Type IV (C4) morphology frequently present apically, as seen in this case.

Diagnosis was aided by CBCT, which confirmed fused roots and a single apical oval canal. Conventional radiographs alone may have underestimated the complexity. This aligns with recent reports emphasizing CBCT as a diagnostic adjunct in cases of unusual morphology.

Treatment success was facilitated by careful circumferential filing, ultrasonic activation of irrigants, and thermoplastic obturation. These approaches are supported by previous case reports, which recommend advanced irrigation and obturation strategies to manage irregular canal morphology.

5. CONCLUSION

C-shaped canals, though rare in mandibular first molars, pose considerable challenges in retreatment due to complex anatomy and irregular canal spaces. CBCT and dental operating microscopes are indispensable in diagnosis and management. Effective retreatment requires a combination of circumferential filing, irrigant activation, and advanced obturation techniques. The present case highlights the successful management of a Fan's Type IV C-shaped canal six years after initial treatment, with favorable clinical and radiographic outcomes.

REFERENCES

[1] Bahrololoomi Z, Ghafourifard R, Soleimani AA. Primary mandibular first molar with single root and single canal: a case report of a rare morphology. J Dent (Tehran) 2014;11:355–60.

[2] Raghavendra SS, Napte BD, Desai NN, Hindlekar AN. Single C-shaped canal in mandibular first molar: A case report. J Conserv Dent 2015;18:168–71.

[3] Ujariya U, Bharatiya R, Kothari A, Shah V, Parikh M, Pandey K, et al. A rare occurrence of bilateral single-rooted mandibular first molar. Case Rep Dent 2022;2022:1175630.

[4] Cooke HG 3rd, Cox FL. C-shaped canal configurations in mandibular molars. J Am Dent Assoc 1979;99:836–9.

[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;47:1012–33.

[6] Fernandes M, de Ataide I, Wagle R. C-shaped root canal configuration: A review of literature. J Conserv Dent 2014;17:312–9.

[7] Martins JNR, Marques D, Silva EJNL, Caramês J, Mata A, Versiani MA. Prevalence of C-shaped canal morphology using cone beam computed tomography - a systematic review with meta-analysis. Int Endod J 2019;52:1556–72.

[8] Nouroloyouni A, Moradi N, Salem Milani A, Noorolouny S, Ghoreishi Amin N. Prevalence and morphology of C-shaped canals in mandibular first and second molars of an Iranian population: A cone-beam computed tomography assessment. Scanning 2023;2023:5628707.

[9] Şendişçi Gök R, Tercanlı H, Ekinci A. Evaluation of root and canal morphology of mandibular molar teeth by cone beam computed tomography: cross-sectional study. BMC Oral Health 2025;25:798.

[10] Martins JNR, Mata A, Marques D, Caramês J. Prevalence of C-shaped mandibular molars in the Portuguese population evaluated by cone-beam computed tomography. Eur J Dent 2016;10:529–35.

[11] Al-Fouzan KS. C-shaped root canals in mandibular second molars in a Saudi Arabian population. Int Endod J 2002;35:499–504.

[12] Nejaim Y, Gomes AF, Rosado L de PL, Freitas DQ, Martins JNR, da Silva EJNL. C-shaped canals in mandibular molars of a Brazilian subpopulation: prevalence and root canal configuration using cone-beam computed tomography. Clin Oral Investig 2020;24:3299–305.

[13] Kantilieraki E, Delantoni A, Angelopoulos C, Beltes P. Evaluation of root and root canal morphology of mandibular first and second molars in a Greek population: A CBCT study. Eur Endod J 2019;4:62–8.

[14] Duman S, Duman S, Bayrakdar I, Yasa Y, Gumussoy I. Cone-beam computed tomography evaluation of C-shape canals and longitudinal grooves of mandibular first and second molar teeth. Ann Med Res 2019;26:2853.

[15] Worldwide Prevalence of Mandibular Second Molar C-Shaped Morphologies Evaluated by Cone-Beam Computed Tomography. Journal of Endodontics 2017;43:1442–7.

[16] Alfawaz H, Alqedairi A, Alkhayyal AK, Almobarak AA, Alhusain MF, Martins JNR. Prevalence of C-shaped canal system in mandibular first and second molars in a Saudi population assessed via cone beam computed tomography: a retrospective study. Clin Oral Investig 2019;23:107–12.

[17] Shekarian M, Majlesi M, Zare Jahromi M. Prevalence of C-shaped canals and three-rooted mandibular molars in the Iranian population by using cone-beam computed tomography. Clin Exp Dent Res 2023;9:906–12.

[18] Alazemi HS, Al-Nazhan SA, Aldosimani MA. Root and root canal morphology of permanent mandibular first and second molars in a Kuwaiti population: A retrospective cone-beam computed tomography study. Saudi Dent J 2023;35:345–53.