

Endodontic Management of C-Shaped Canals: A Case Series

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ABSTRACT:

A detailed grasp of endodontic anatomy and its variations is vital for effective planning and execution of root canal treatments, contributing to effective outcomes. 'C' shaped canal system is a distinctive anatomical variation that shows ethnic predilection, which is higher in Asian population. A distinctive root canal configuration, found in lower second molars, has been reported in different teeth. These systems are categorized based on canal cross-sectional shapes. Notable characteristics, like a fin or web merging the mesial and distal canals, contribute to changes in canal's cross-sectional and three-dimensional form throughout root. Diagnosing these canal configurations with routine radiographic methods and achieving thorough debridement and obturation can be a demanding task. This paper discusses management of four different lower molars, each with a distinct C-shaped canal system.

Keywords: C-shaped system, mandibular second molar, AH-plus, anatomical variations, Fan's system, orifice

INTRODUCTION:

Cooke and Cox described C-shaped system in literature, referencing its unique cross-sectional appearance of root and root canal.¹

A distinctive feature of C-shaped canals is a singular, ribbon-like orifice spanning an arc of at least 180° within the pulp chamber.²

Below the orifice level, root structure may display variations.² Inability to identify as well as detect a C-shaped canal may result in preparing only main canals while neglecting connecting fins and webs, leading to inadequate cleaning. This contributes to endodontic treatment failure because of several factors, including presence of residual pulp in small branches, anatomical complexities such as an untreated isthmus between canals or an unaddressed apical ramification, missed canals that remain uninstrumented regardless of an isthmus, underfilling, and complications like perforation, separation of file, calcification.

To enhance understanding of C-shaped anatomy, several classifications were proposed. Melton et al. introduced a classification based on different orifice configurations within C-shaped systems.³

- **Class I:** A continuous C-shaped canal with no separation between canals.
- **Class II:** Canal orifices resemble a semicolon (;) where a C-shaped canal is present, isolated from another unique canal.
- **Class III:** Two or more canals are present, similar to typical anatomy of a lower molar having three canal orifices.
- **Class IV:** Single round or oval canal.³

An in-depth review of root canal anatomy as well as morphology on preoperative radiographs, along with precise canal identification and negotiation, is fundamental. Thorough mechanical and chemical debridement of the pulp tissue, along with complete

three-dimensional obturation, is vital for the success of managing a C-shaped system.

The endodontic management as well as difficulties concerned with four lower molars with a varied C-shaped system are the main topics of this case study.

These patients reported to the department and were successfully managed after obtaining the necessary ethical clearance as well as informed consent.⁵

Case Reports:

CASE I-Category I (C1): the shape was an uninterrupted “C” with no separation or division.

The patient, a 27-year-old male, sought treatment at the department due to pain in the lower right tooth for the past one week. Clinical examination detected proximal caries on tooth #47, which was tender to percussion. An intraoral periapical (IOPA) xray showed distoproximal decay involving the pulp, along with apical radiolucency (Fig.1a)⁶

After obtaining informed consent, access cavity was performed. Clinical examination of pulp chamber showed a deeply situated C-shaped floor, classified as Fan’s C1 category, an uninterrupted C-shape having no division (Fig.1b). Rotary files were used for cleaning and shaping (Fig.1c), followed by obturation using the cold lateral compaction technique (Fig.1d)⁶



Fig.1a Pre-operative



Fig.1b Access cavity

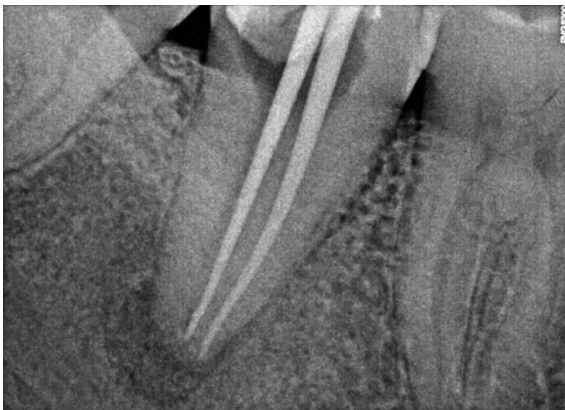


Fig.1c Master cone



Fig.1d Post-operative

CASE II-Category II (C2): the canal shape resembled a semicolon resulting from a discontinuation of the “C” outline.

The 36-year-old male patient's main complaint when he came to the department was that his lower right posterior tooth had been hurting and was extremely sensitive to heat and cold for the previous few days. Intraoral examination revealed deep occlusal caries in the region of tooth #47 (Fig.2a). The tooth exhibited an abnormal response to thermal vitality tests.

Radiographic evaluation showed a radiolucent area extending into the pulp space, associated with

distinguishing characteristics including tightly spaced mesial as well as distal roots and a deeply located pulp floor. These implied that a C-shaped canal was present.

Using same methodology as in Case 1, patient was diagnosed with irreversible pulpitis and booked for endodontic treatment.

Access preparation and debridement were carried out following acquisition of informed consent. Direct examination confirmed a deeply situated C-shaped pulp floor with two orifices resembling a semicolon (Fig.2b). Cleaning, shaping, and obturation were carried out as described in Case 1. (Fig.2c , Fig.2d)³

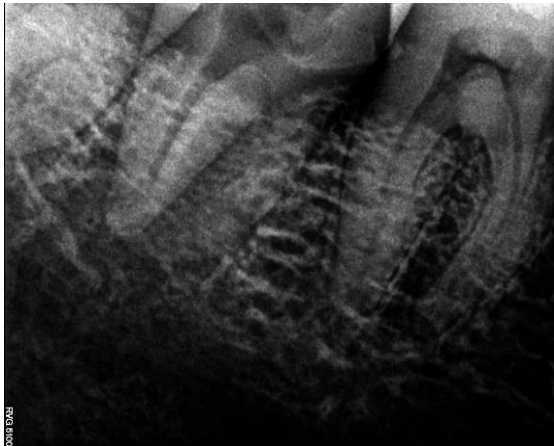


Fig.2a Pre operative



Fig.2b Access cavity



Fig.2c Master cone

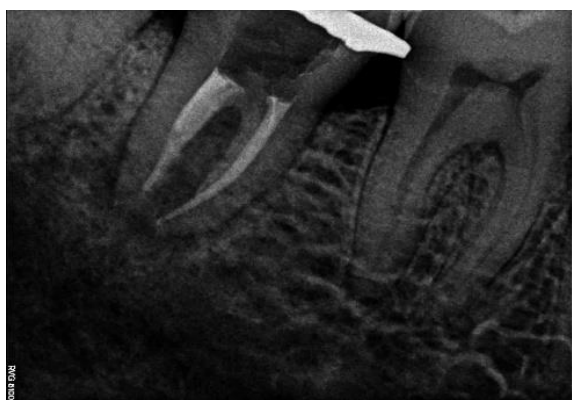


Fig.2d Post operative

CASE III-Category III (C3): two or three separate canals.

A 48-year-old female presented with a deep occluso-proximal caries in tooth #37, accompanied by symptoms(Fig.3a). The assessment revealed a case of irreversible pulpitis. A C-shaped design was suggested by radiographic examination, which showed a root with two canal outlines.

An access opening was created following isolation and anesthetic administration. Upon exploration of pulp chamber, two orifices were identified (Fig.3b). Root exhibited both mesial as well as distal canals, corresponding to Fan's Type II radiographic classification. Manual instrumentation was employed for canal cleaning and shaping (Fig.3c), followed by obturation with gutta-percha(Fig.3d) and AH-Plus sealer using the warm vertical condensation method (Fig.3e).



Fig.3a Pre-operative



Fig.3b Access cavity

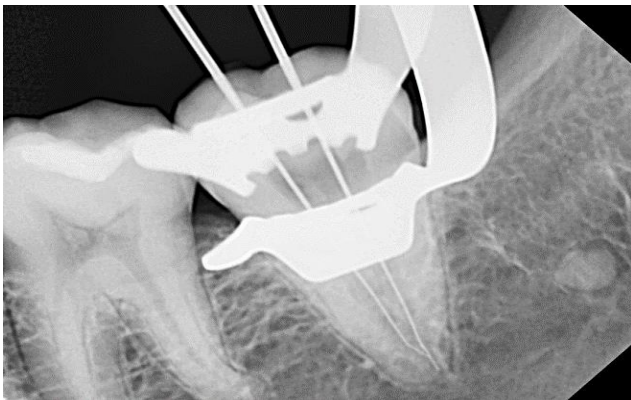


Fig.3c Working length



Fig.3d Master cone



Fig.3e Post operative

CASE IV-Category IV (C4): only one round or oval canal in that cross section.

A 25-year-old woman reported having experienced spontaneous, on-and-off pain in the lower left posterior area over the past week. Findings were proximal caries in left mandibular second molar (Fig.4a). A preoperative X-ray indicated a root having a wide canal, which led to diagnosis of asymptomatic irreversible pulpitis.

After preparing access and examining pulp chamber closely, disclosing a C-shaped configuration having a

single canal, categorized as Category IV based on Fan's system (Fig.4b). The canals were cleaned, shaped, and circumferential filing was performed with a #30 K-file (Fig.4c). Biomechanical preparation performed following same protocol as in Case 1.

Obturation was achieved by #40 (6%) gutta-percha cone (Fig.4d) and AH-plus sealer. Post obturation restoration was done using composite resin (Fig.4e)⁷



Fig.4a Pre operative



Fig.4b Access cavity

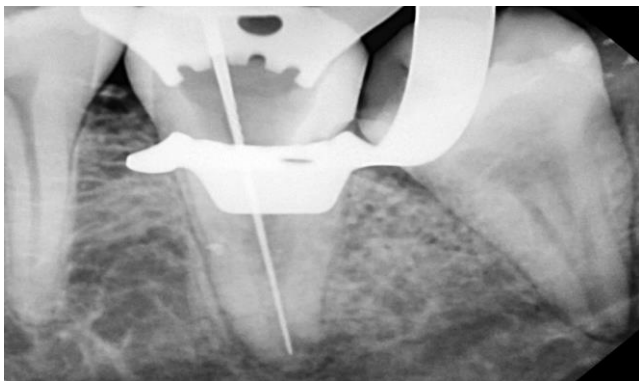


Fig.4c Working length

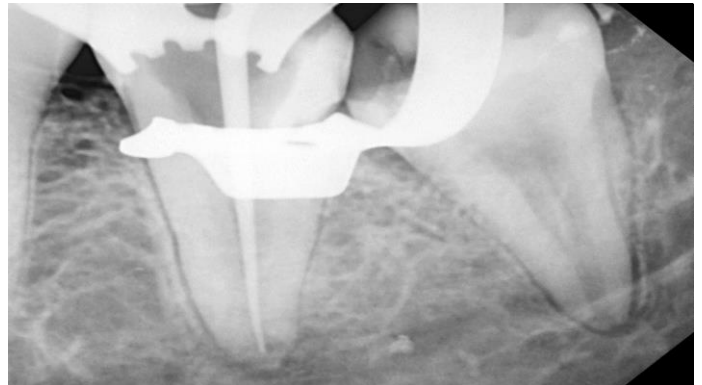


Fig.4d Master cone



Fig.4e Post-operative

DISCUSSION:

This has been documented by a small number of authors in relation to upper first, second, as well as third molars, lower first, third, and premolars, as well as upper lateral incisors. Second molars in mandible often have a C-shaped system, with frequencies ranging from 2.7% to 45.5%. Research suggests that the C-shaped canal configuration is more prevalent among certain ethnic groups, especially East Asians, where its occurrence ranges from 0.6% to 41.27% in Chinese populations and from 31.3% to 44.5% in Koreans.⁸

In a C-shaped canal configuration, pulp chamber contains a single, elongated orifice resembling a ribbon, covering an arc of 180° or greater.

This case series reviews the endodontic management of four lower second molars using a C-shaped canal system.

Cases described followed classification system given by Fan Bing, which is a modified version of Melton's classification. Preoperative diagnosis is most important aspect while managing such cases which facilitates proper management. A combination of a preoperative as well as supplementary radiograph with a 20° mesial or distal angle offered a noninvasive way in assessing canal morphology clinically.

Pulp chamber must be accessible in order to make a clinical diagnosis of C-shaped canals. According to Fan et al., if a mandibular second molar possesses all three of following characteristics, it is said to have a C-shaped canal system:

- a. Roots fused
- b. A longitudinal groove on the root's buccal or lingual surface
- c. The C1, C2, or C3 configurations should include at least one cross-section of the canal.⁹

If the orifice follows a continuous C-shape or arc-like pattern, such as Mesiobuccal-Distal (MB-D), canals vary between one to three. Oval orifices have one to two canals, and round orifices generally contain a single canal. While cleaning a C-shaped root canal, special focus should be placed on 'isthmus,' 'trough,' and 'fin.' These narrow, ribbon-shaped connections between root canals harbor pulp or pulp-derived tissue, making them potential reservoirs for bacteria.

Vast canal space often prevents intracanal instruments from reaching and cleaning entire continuum, emphasizing importance of irrigation. C-shaped systems should incorporate ultrasonic irrigation alongside rotary instruments. Additionally, role of chemical agents in disinfection is vital when managing C-shaped canal systems. Cold lateral condensation was method employed for obturation in each case.⁹

CONCLUSION:

An in-depth comprehension of anatomy and its variations plays a main role in ensuring successful therapy. C-shaped canal presents variations in both number as well as location of canals, making it essential in accurately assessing anatomical variations and performing endodontic instrumentation. Adequate irrigation and obturation technique are necessary for improving the prognosis and effectively managing C-shaped canal systems. Due to their complexity, C-shaped canals differ from those in normal teeth, requiring the endodontist to adhere strictly to the principles of biomechanical preparation and three-dimensional obturation for successful management.

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