



BEYOND THE CURVE: INNOVATIVE APPROACHES IN MANAGING C-SHAPED ROOT CANALS – A CASE SERIES

Dental Science

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ABSTRACT

It is usually difficult to diagnose and treat unusual root canal anatomy. Therefore, the secret to their effective care is a comprehensive understanding of root canal structural variations along with appropriate diagnosis, treatment planning, and clinical expertise. One such abnormal canal morphology that is frequently seen in mandibular second molars is the C-shaped root canal arrangement. It frequently goes unnoticed, and because of the complex root canal structure, it can be challenging to navigate, debride, and obturate such canals, which can result in root canal treatment failure. **Case Reports:** Using the cold lateral condensation obturation procedure, this article describes how to manage four distinct C-shaped root canal configurations. **Conclusion:** The clinician will be able to handle these situations more skilfully if they are aware of the anatomical manifestations of this variant.

KEYWORDS

Anatomic variation, Cshaped canal, Mandibular second molars, Endodontic treatment, cold lateral compaction obturation

INTRODUCTION

Cooke and Cox initially described the C-shaped canal architecture in the mandibular second molar in 1979, however Weine et al. noted that a number of doctors had previously mentioned it in lectures.¹ Mandibular second molars with this kind of canal structure are very common (2.7%–45.5%).^{2–5} and has also been documented in mandibular third molars (3.5%–4%), mandibular second premolars (1%), maxillary first molars (0.12%), and maxillary third molars (4.7%).^{6–9} There is no link between the C-shaped canal structure and gender, age, or tooth location; however, there is ethnic heterogeneity, with the highest frequency observed in East Asian population groups like as Chinese (29.7%) and Koreans (31.3%–45.5%).¹ The morphology of the horizontal cross section of a C-shaped root canal system is defined as having canals that may or may not be separate.¹⁰

The reason for this anatomical variance is that during the teeth's developmental stage, Hertwig's epithelial sheath failed to form or fuse in the furcation area.²

Fan et al modified Melton's method into the following categories (Figure 1)

- Category I (C1): interrupted "C" with no separation or division.
- Category II (C2): resembled a semicolon resulting from a discontinuation of the "C" outline, but either angle α or β should be no less than 60°.
- Category III (C3): 2 or 3 separate canals and both angles, α and β less than 60°.
- Category IV (C4): Only one round or oval canal in the cross-section.
- Category V (C5): No canal lumen could be observed (which is usually seen near the apex only)

C1		The shape is an uninterrupted "C" with no separation or division
C2		The canal shape resembles a semicolon resulting from a discontinuation of the "C" outline, but either angle α or β should be no less than 60°
C3		Two or three separate canals and both angles, α or β are less than 60°
C4		Only one round or oval canal in that cross-section
C5		No canal lumen can be observed (which is usually seen near the apex only)

Figure 1: Fan Et Al's Anatomic Classification Of C-shaped Canal Configuration

The two-dimensional image of the radiograph makes the C-shaped canal difficult to diagnose radiographically. It is difficult to shape the

canal, thoroughly debride it, and obturate it when narrow fins, slits, and webs are present. In a C-shaped canal, irregular areas that can contain infectious material or soft tissue remains could evade complete cleaning or filling, which could result in bleeding and excruciating pain.¹¹ To obturate a C-shaped canal, it is crucial to choose the appropriate obturation technique. The treatment of C-shaped mandibular molar teeth with various obturation systems is discussed in this paper.

Case 1

A 25-year-old male patient reported to the Department of Conservative Dentistry and Endodontics with a chief complaint of pain in lower right back tooth since 5 days. Medical history was non-contributory. Intra oral examination revealed occlusal caries with respect to #47 and tenderness to percussion. Radiographically, the tooth was conical in shape with fused mesial and distal root with a thin radiolucent line between them, with a suspected C-shaped canal and occlusal caries seen with widened pdl space and radiolucency seen at the periapical region (Figure 2a). Hence, the final diagnosis was symptomatic irreversible pulpitis with apical periodontitis with tooth number 47. Root canal treatment was planned and explained to the patient. After proper isolation and anesthesia, an access cavity was prepared and Fan et al C2 type canal anatomy was found. After working length determination (Figure 2b), cleaning and shaping was done with ProTaper rotary files (Dentsply Maillefer, Switzerland) up to F3 followed by circumferential filing with hand K files (Dentsply Maillefer, Switzerland). 5% sodium hypochlorite (Acrylates, India) was used as an endodontic irrigant which was activated with Endo activator (Dentsply Maillefer, Switzerland). Calcium hydroxide was placed as an intracanal medicament. After a week patient was recalled, radiograph was taken to confirm fit of the master cone and obturation was completed using cold lateral compaction technique (figure 2c,d) and post endodontic restoration was done with composite resin.

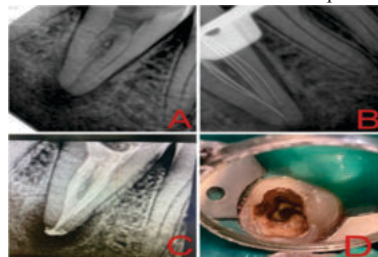


Figure 2: (a) Pre- Operative Wrt 47 (b) Working Length Determination (c) & (d) Obturation Wrt 47

Case 2

A 24 year old female patient reported to the department with a chief complaint of pain on eating food in lower right back tooth. The medical history was non-significant. Intraoral examination revealed carious # 37 with tenderness on percussion. Radiographically, a large occlusal radiolucency was seen in tooth 37 closely approximating the pulp space along with an associated widening of periodontal ligament space (Figure 3 a). Tooth was conical in shape with fused mesial and distal roots (figure 3a). Cold test using cold spray and Electric pulp testing gave negative response. The tooth was diagnosed with necrotic pulp with acute apical periodontitis. Root canal treatment was planned and explained to the patient. After proper isolation and anesthesia, an access cavity was prepared and Fan et al C1 type canal anatomy was found (figure 3b). After working length determination, canal was prepared with ProTaper rotary files (Dentsply Maillefer, Switzerland) up to F3 followed by circumferential filing with hand K files. 5% sodium hypochlorite (Acrylates, India) was used as an endodontic irrigant which was activated with Endo activator (Dentsply Maillefer, Switzerland) (Figure 3c). Calcium hydroxide (RC Cal Prime Dental Products, Thane, India) was placed as an intracanal medicament. After 1 week, patient was recalled and obturation was done using cold lateral compaction technique (Figure 3d). Post endodontic restoration with composite was done.

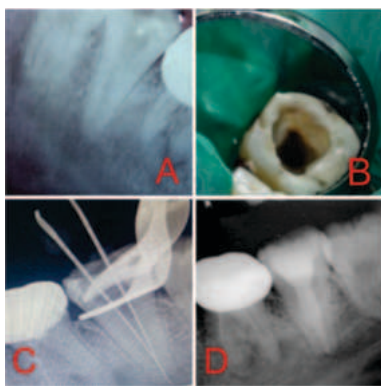


Figure 3: (a) Pre- Operative Wrt 37 (b) Access Opening Wrt 37 (c) Working Length Determination (d) Obturation Wrt 37

Case 3

A 35-year-old female patient reported to department of conservative dentistry and endodontics with pain in the lower left back teeth region. Intraoral examination revealed deep class II carious lesion on tooth 37 with tenderness on percussion. Radiographically, deep dental caries was seen involving pulp with periapical changes, there was radicular proximity of mesial and distal roots, a large distal canal and blurred image of a third canal in between (FIGURE 4a). All the features were predictive of existence of C-shaped root canal. The tooth was diagnosed with symptomatic irreversible pulpitis with symptomatic apical periodontitis. Root canal treatment was planned and explained to the patient. Tooth was anaesthetized and isolated under rubber dam. Access cavity was prepared a round bur (BR-45, Mani, Japan) and a safe-end bur (EX-24, Mani, Japan). The floor of the pulp chamber showed three distinct orifices. The mesiobuccal and distal orifices were seen close together with a fin connecting two orifices, and the mesiolingual orifice was seen distance from the mesiobuccal and distal orifices which was similar to Min's type III C-shaped root canal configuration (figure 4b). The pulp chamber was irrigated with 5% sodium hypochlorite (Cmident India, Delhi). Working length was determined using apex locator (Root ZX II, J Morita, Tustin, California, USA) and confirmed with radiographs. In the radiograph, the K-file placed in the mesiobuccal canal was seen ending in distal foramen of the tooth. Radiographically, the instrument is seen as if exiting the furcation and converging at the apex which is the most common feature of Fans C 2 Semicolon type C-shaped root canal configuration (figure 4c). Then cleaning and shaping of the canal was done using copious irrigants like 2.5% sodium hypochlorite and 17% EDTA and shaped the canal upto rotary file no 30 4%. Ultrasonic activation was done using sonic irrigator. The final irrigation with 2%w/v chlorhexidine was done. Patient was recalled after 3 days, she was asymptomatic. Canals were dried with paper points and obturated with gutta-percha along with ZOE sealer using cold lateral condensation technique (figure 4d).

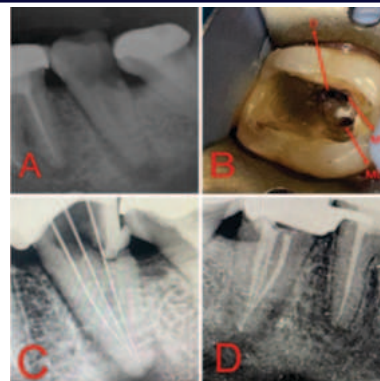


Figure 4: (a) Pre- Operative Wrt 37 (b) Access Opening Wrt 37 (c) Working Length Determination (d) Obturation Wrt 37

DISCUSSION

The failure of the Hertwig's epithelial root sheath to merge on the lingual or buccal root surface is the cause of C-shaped morphology. Because the cementum deposits over time, the C-shaped root can also form by coalescence.²

According to Melton et al.'s classification, there are three different kinds of C-shaped canals: continuous (C1), semicolon (C2), and distinct (C3). Fan et al. further altered this classification, and it now states that single orifices with an uninterrupted "C" shape arrangement are the most common type of C shape canal.³

Following features are a must for the canal morphology to be called as "C" shape:

1. Fused roots,
2. A longitudinal groove on the lingual or buccal surfaces of the root,
3. At least one cross-section of the canal belongs to the C1, C2, or C3 configuration.¹²

For medical professionals, managing this kind of canal arrangement is an extremely difficult undertaking. However, this anatomical aberration has been successfully managed with the introduction of more recent technological developments such as cone beam CT scans, operating microscopes, sonic and ultrasonic irrigation devices, and thermoplasticized obturation procedures.

When managing the morphology of a C-shaped canal, keep the following points in mind:

1. The preoperative radiograph will reveal fused roots, thus it will be helpful to deduce this configuration by adding an extra 20° mesial or distal angulation.
2. To prevent strip perforations, anti-curvature filing is advised and isthmus preparation should be limited until file number 25. Do not use Gates-Glidden drills for the same purpose.
3. The secret to success is irrigation combined with ultrasonic agitation, which would clean the hard-to-reach parts of the intricate "C" form anatomy.
4. Walid's method involves placing the master points in the C-shaped canal concurrently to guarantee correct positioning of the master cones in these canals. One of the searing master points has a big plugger on it, while the other master point has a smaller plugger down packed on it.¹³
5. Compared to cold lateral compaction, the thermoplasticized obturation approach is recommended because it guarantees a superior three-dimensional fill.

CONCLUSION

In mandibular second molars, the C-shaped root canal morphology is highly prevalent and has an ethnic preference. A comprehensive chemo-mechanical preparation with a three-dimensional obturation of C-shaped canals is necessary for successful endodontic therapy, as is accurate diagnosis and solid understanding of aberrant root canal anatomy to guarantee a favourable long-term prognosis.

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