

“C”-shaped root canal configuration in mandibular second molars: A case series

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ABSTRACT

The C-shaped root canal configuration is an unusual variation encountered in mandibular second molars. One should be prepared and equipped to treat such unusual features when performing endodontic treatment. The present cases represent different C-shaped canal configurations on the basis of both the appearance of the canal orifices and the configuration along the roots. Use of cone-beam computed tomography, dental operating microscope, rotary and hand instrumentation assisted with sonic and ultrasonic activation of irrigants, and modified obturation techniques further aid in effective management of these anomalous canal configurations and ensure a three-dimensional fill of the canal system.

Key words: C-shaped root canal anatomy, mandibular second molar, root canal treatment

INTRODUCTION

A thorough knowledge of root canal anatomy and being familiar with its variations not only aids in location and negotiation of canals but also in their subsequent management, thus enhancing success of endodontic therapy.^[1] One of the most important anatomic variations in the posterior teeth is C configuration of the canal system which was reported by Cooke and Cox in 1979 in a mandibular second molar. These variations pose a great challenge in diagnosis, debridement, and obturation, especially because the course of the canal from floor of the pulp chamber to the apical third of the root is unpredictable.^[2] Their incidence in the second molar ranges between 2.7% and 45.5% and this configuration has also been reported in mandibular first molar, mandibular first premolar, maxillary first molar, and even in the maxillary lateral incisor which is a rare anatomy may be as low as 0.09%.^[3] There are various classifications available in the literatures which help the clinician in true diagnosis and management. Melton and others in 1991 have proposed a classification based on their cross-sectional shape which was modified by Fan *et al.*, in 2004, [Figure 1] who also gave the radiographic classification [Figure 2] of the C-shaped roots.^[4,5]

This paper presents a series of cases with C-shaped configuration in mandibular second molars diagnosed during endodontic therapy with their pre-operative, intraoperative and post-operative radiographs and pulpal floor anatomy [Figure 3].

CASE REPORT

Five patients with no relevant medical history in the age group of 20–50 years in whom mandibular second molar were indicated for root canal treatment and who consented for the treatment

were selected. For root canal therapy, the tooth was anesthetized using 2% lignocaine containing 1:80:000 epinephrine (LIGNOX 2% a Indoco Remedies Ltd., India) and isolation with rubber dam was accomplished, an access cavity was prepared under Dental Operating Microscope at 1.6 X magnification (600 Operating Microscope, Seiler, Seiler Precision Microscopes, St Louis, Missouri, USA), pulp chamber was irrigated with 2.5% sodium hypochlorite (Vishal Dentocare, Pvt Ltd, Ahmedabad, India). Working length was determined using electronic apex locator (Root ZX, J. Morita CO, Tustin, CA) and radiographs. Cleaning and shaping was done with hand K files (Dentsply Maillefer, Switzerland) and with ProTaper rotary files (Dentsply Maillefer, Ballaigues, Switzerland). After completing the preparation, the canals received a final rinse of 10 ml 17% EDTA (Dentwash, Prime Dental Products Pvt Ltd, India) followed by 10 ml of 2.5% sodium hypochlorite (Vishal Dentocare, Pvt Ltd, Ahmedabad, India) and the canals were dried with paper points (Protaper Universal Absorbent points, Dentsply, Tulsa Dental, United States). Master cone apical fit was confirmed with a radiograph. AH Plus (Dentsply, Konstanz, Germany) sealer was mixed according to manufacturer's instructions and applied with a lentulo spiral (Dentsply Maillefer, Ballaigues, Switzerland). The obturation was done with either lateral compaction technique using gutta-percha cones (Dentsply, Tulsa Dental Specialities, United States) or thermoplasticized gutta-percha (Obtura II Spartan, Fenton, MO, USA) or a combination of both. Postendodontic restoration was done after 1 week of obturation using composite resin (Tetric N-Ceram, Ivoclar Vivadent, Mumbai, India). Out of the five patients, two (Patient B and E) agreed for a cone-beam computed tomography (CBCT) imaging (Secunderabad dental imaging and diagnostics, Sarojini Devi Road, Hyderabad, Telangana State, India) which are shown in Figure 4.

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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's anatomic classification: (a) Category I- C1, (b) Category II- C2, (c) Category III- C3, (d) Category IV- C4, (e) Category V- C5

Type I		The C-shaped canal system actually appears as two distinct canals, because the isthmus that links the mesial and distal "main" canals is very thin and hence is not detected radiographically.
Type II		The mesial and distal canals assume their own individual course to the apex. Thus, there are apparently two distinct canals on the radiograph.
Type III		One canal continues its course to the apex giving the image of a distinct canal whereas the other(s) proceeds very close to or within the fused area, that is, the "web" between the two main roots in the apical third. Hence, the canal may seem to exit into the groove radiographically.

Figure 2: Fan's radiographic classification: (a) Type I, (b) type II, and (c) type III

DISCUSSION

The main cause of C-shaped roots is the failure of the Hertwig's epithelial root sheath to fuse on the lingual or buccal root surface, giving rise to a C-shaped canal anatomy. It may also be formed by coalescence because of deposition of the cementum with time. What appears to be C-shaped canals is just a fusion of mesial and distal roots which can happen on the buccal or lingual aspect. The two roots remain connected and the fusion is irregular. The connection of the roots is by an inter-radicular ribbon. It may be a single continuous canal or a "C"-shaped groove with two or three canals.^[6]

It appears from the available literature that majority of mandibular second molars with C-shaped canal system showed an orifice with an uninterrupted "C" configuration and Jin *et al.*, in 2006, reported an incidence of 44.5% of the continuous C-shaped canal.^[4] Radiographically, 30% of mandibular second molars showed type I radiographic image, 40% type II, and 30% type III.^[5]

When considering the C-shaped mandibular second molar, the most studied C-shaped location; it has been documented that this morphologic configuration has significant ethnic variation. In the White population, the incidence ranges from 2.7% to 7.6%; in the Lebanese population, 19.1%, a reported 31.5% in the Chinese population, and 44.5% in Koreans. These types of configurations have a bilateral incidence of 70%.^[7]

The reported cases in this article represent three different types of C-shaped configurations according to Fan's classification. The challenge during treatment of such cases is accurate diagnosis and a proper method of cleaning and shaping followed by obturation.

Various studies show that CBCT; an indispensable tool for the diagnosis of tooth anomalies is far superior to other diagnostic methods as reported by Matherne *et al.*^[8]

	Pre op	Working length	Pulp chamber floor	Master Cone	Obturation	Fan's Radiographic Classification Type	Fan's Anatomic Classification Type
Patient A						Radiographic-II	Anatomic-C3
Patient B						Radiographic-I	Anatomic-C3
Patient C						Radiographic-I	Anatomic-C1
Patient D						Radiographic-III	Anatomic-C2
Patient E						Radiographic-I	Anatomic-C3

Figure 3: Series of cases (patient A–E) with C-shaped canal configurations (Pre-operative, Working Length, Pulp chamber anatomy, Master cone, and Obturation)

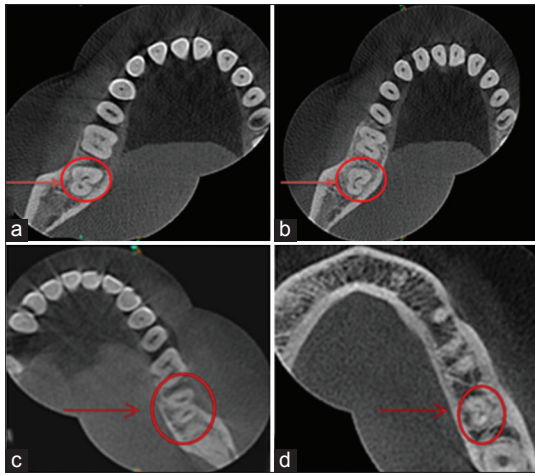


Figure 4: Cone-beam computed tomography images. Patient B: CBCT confirmed the presence of two broad mesial and distal canals (a) which merged to form a C-shaped anatomy (b) in the apical third region of the root. Patient E: CBCT confirmed the presence of two roots and root canals which were distinct till middle third (c) and merged to form a C-shaped anatomy (d) in the apical third region of the root

CBCT which offers a non-invasive reproducible technique for 3D assessment of root canal systems involves exposure to ionizing radiation. Therefore, it is advised to be used with operating microscope to visualize the internal anatomy in a precise manner to correctly diagnose root canal aberrations. This would also keep the patient's exposure to radiation as low as reasonably achievable.^[9]

Despite the differences in anatomies in all the five cases, same precautions had to be made concerning the correct cleaning and shaping of the root canal system. Passive ultrasonic irrigation with 5.25% sodium hypochlorite was used to clean the isthmus and grooves; ultrasonic agitation was done to maximize the root canal disinfection.^[7] A combination of different obturation techniques has been used for a better approach. As long as the basic principles of root canal preparation and crown rehabilitation are followed, the outcomes of the endodontic treatment on the C-shaped anatomies are similar to other anatomies.

CONCLUSION

One of the great challenges faced is diagnosing C-shaped canals and its management. However, with the help of magnification, illumination, and other new diagnostic methods hard to detect C-shaped configurations can be treated effectively. Proper access cavity preparation, meticulous mechanical and chemical debridement, and a three-dimensional obturation should be carried out to successfully manage canals with C-shaped configurations.

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