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## Introduction

The C-shaped canal system is an anatomical variation mostly seen in mandibular second molars, although it can also occur in maxillary and mandibular premolars and molars. It was first documented by Cooke and Cox in 1979. The main anatomical feature of C-shaped canals is the presence of a fin or web connecting the individual root canal the orifice may appear as a single ribbon shaped opening with a 180° arc linking the two main canals. They are typically found in teeth with fusion of roots either on its buccal or lingual aspect. The floor of the pulp chamber is usually situated deeply. The prevalence of C-shaped canals appears to be genetically determined.

The prevalence in second mandibular molars has been reported to be as high as 31.5% for the Chinese population, which is much higher than that reported for other populations. When found on one side, it is found in the contralateral teeth in over 70% of individuals. Roots containing a c-shaped canal often have a conical or square configuration. Manning speculated failure of the Hertwig's epithelial root sheath to fuse on the lingual or buccal root surface as the main cause of a C-shaped root, which always contains a c-shaped canal. The C-shaped root may also be formed by coalescence because of deposition of cementum with time. The c-shaped canal system can assume many variations in its configuration. Melton and co-workers in 1991, proposed a classification of C-shaped canals based on their cross-sectional shape

Type I: the continuous c-shaped canal.

Type II: the semicolon shaped canal.

Type III: two discrete and separate canals.

Fan in 2004, modified Melton's classification (figure I)

C1		The shape is an uninterrupted "C" with no separation or division
C2		The canal shape resembles a semicolon resulting from a discontinuity 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 I - Fan's classification

The radiographic appearance of C-shaped canals was also classified by Fan (fig II)

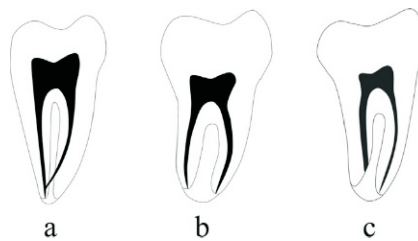


Figure II - Radiographic types (Fan)

1. Type I - conical or square root with visible separation of medial and distal part. Medial and distal canal merge near the apical foramen in a single one;
2. Type II - conical or square root with visible separation of medial and distal part. Medial and distal canal have separate apical foramen but run approximately in parallel and are almost equal in length;
3. Type III - conical or square root with visible separation of medial and distal part. Medial and distal canal have separate apical foramen, run approximately in parallel but one of them is longer than the other.

Recognition before treatment facilitates effective management. Cooke and Cox stated that it is difficult to recognize the existence of c-shaped canals on the basis of radiograph alone. Cone beam computed tomography (CBCT) is an effective aid in diagnosing C-shaped canals. The aim of this study is to present two case reports of C-shaped canals in mandibular second molars.

## Case Reports

**Case Report 1-** A 19 year old female patient with chief complaint of pain in lower left back region reported to our OPD. Upon examination, tooth no. 37 was carious and tender on percussion. IOPA revealed deep caries approximating the pulp with widening of pdl space of tooth no. 37. The tooth was vital on electric pulp testing. It was diagnosed as having irreversible pulpitis with periapical periodontitis and root canal treatment was planned. Under local anaesthesia and

after rubber dam application access opening was done with the aid of magnification loupes. The canal orifice was found to be deeply situated assuming a c-shaped configuration (fig III). It was classified as **Melton's Class I** according to the shape of the orifice which was an uninterrupted C.

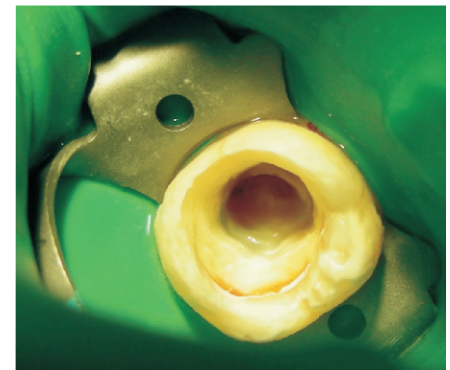


Fig III C-shaped orifice

Two distinct canals were located, mesial and distal. The canals did not merge at any point radiographically. Working length was determined with apex locator and confirmed with no. 10 K-files and RVG. Canals were prepared with K-files and protaper universal rotary files till size F2 for mesial canal & F3 for distal canal along with copious 5.25% NaOCl irrigation. The C-shaped fin was additionally cleaned with ultrasonic files and smear layer was

removed with 17% EDTA. Thermomechanical Obturation (Beefil system) was done apical third was obturated with heated and vertically condensed guttapercha and AH Plus sealer. Subsequently injectable guttapercha was used to backfill the canals upto the orifices. Access cavity was temporarily restored with Cavit. Patient was asymptomatic 1 week after treatment. Access cavity was restored with composite and a porcelain fused to metal fixed partial denture was placed from tooth no. 37 to 35.

## Case Report 2

A 30 year old male patient with chief complaint of spontaneous pain in lower left back region reported to our OPD. On examination, tooth no. 37 was carious and

tender on percussion.

IOPA revealed deep caries approximating the pulp with widening of PDL space and slight periapical radiolucency. The tooth was vital upon electric pulp testing.

Upon access opening under anaesthesia and rubber dam in place, the canal anatomy was found to be c-shaped with two distinct canal orifices (fig IV). The floor of the pulp chamber

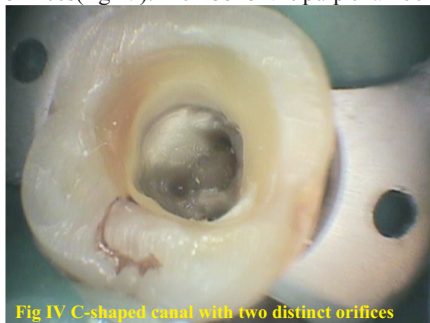
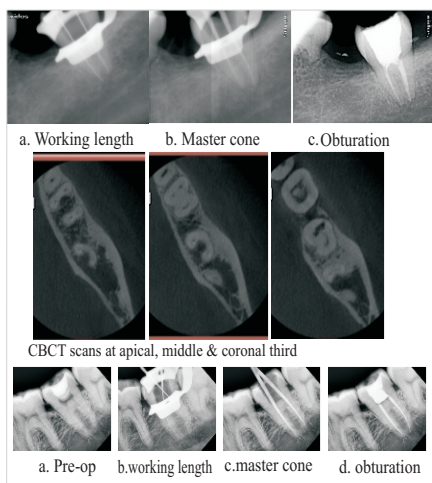


Fig IV C-shaped canal with two distinct orifices

was visualized with dental operating microscope which revealed an interrupted c-shaped configuration. It was decided to further confirm the canal anatomy with CBCT which confirmed a c-shaped canal configuration with respect to tooth no. 37. The tooth revealed a single root with a deep lingual radicular groove causing incomplete division of the root

into mesial and distal roots. The mesial arm of the 'C' was interrupted with dentinal isthmus, resulting in formation of a discrete mesiolingual root canal and a discrete distal canal. It was classified as melton's class 2. After working length determination, BMP was done with Hyflex

CM rotary files till size 40, 0.04 taper along with copious 5.25% NaOCl irrigation. The isthmus was additionally cleaned with ultrasonic files and smear layer was removed with 17% EDTA gel. Patient had inter-appointment pain which was treated with cresophene dressing and systemic antibiotics and analgesics. Obturation was done with System B guttapercha and AH Plus sealer. Access cavity was temporarily restored with Cavit.



Patient was asymptomatic 1 week after treatment. Access cavity was restored with composite and a full-coverage porcelain fused to metal crown.

#### Discussion

The "C" configuration of the root canal system is regarded as one of the most important anatomic variations of dentition.

According to a study<sup>1</sup> mandibular second molars qualified as having a C-shaped canal system had to exhibit all the following three features:

- (a) fused roots;
- (b) a longitudinal groove on lingual or buccal surface of the root;
- (c) at least one cross-section of the canal belongs to the c1, c2, or c3 configuration.

Conventional radiographs, due to their inherent limitations, have a limited value in determining the complexity of C-shaped root canal patterns. Multiple IOPA with various angulations help in identification.

Introduction of CBCT images has resulted in better understanding of root canal system. Clinical recognition of c-shaped canals is based on definite observable criteria, such as

-specific anatomy of the pulp chamber floor and

-haemorrhage or pain when separate canal orifices are found.

The pulp chamber may be large in the occlusoapical dimension, with a deep-lying bifurcation. Deep-orifice preparation and careful probing with small files characterize the c-shape more accurately. The mesiobuccal and distal canal spaces usually can be prepared normally. However, the isthmus should not be prepared with files larger than 25, otherwise a strip perforation is likely. Increased volume of irrigant (5.25% naocl) and deeper penetration with small instruments using alternative canal cleaning techniques such as sonics or ultrasonics allows greater cleansibility in fan-shaped areas of the c-shaped canal. The mesial and distal canal spaces can be prepared and obturated as standard canals; However, sealing the buccal/lingual isthmus is difficult if lateral condensation is the only method used. Therefore, Gutmann and Rakusin suggested use of thermoplastized guttapercha for complete obturation of c-shaped canals.

#### Conclusion

Management of c shaped canal represents a great challenge with respect to diagnosis and treatment. Magnification and illumination can help to identify these hard to detect configurations. CBCT is a very useful tool in assessing canal anatomy. Proper access cavity preparation, meticulous mechanical and chemical preparation and three-dimensional obturation should be carried out to successfully manage a C-shaped root canal.

#### References

References are available on request at [editor@healtalkht.com](mailto:editor@healtalkht.com)

## Event Alert

**11-12 April 2015**

**Expodent - 2015, Chennai**  
Chennai Trade Centre

**24-25-26 July 2015**

**Delhi Dental Show**  
Hall No. 12 A Pragati Maidan  
New Delhi

**16-17-18 October 2015**

**World Dental Show**  
M.M.R.D.A. Bandra Kurla  
Complex Mumbai