



Endodontic Management of C-shaped Canals in Mandibular Second Molars

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Authors' contributions

This work was carried out in collaboration between all authors. Authors SS and MM designed the study and wrote the first draft of the manuscript. Authors DP and SG managed the literature searches. All authors read and approved the final manuscript.

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Case Study

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ABSTRACT

Aim: C shaped canal, a common root canal variation in mandibular molars mandates thorough identification and management, when present. Of the several known configurations of C-shaped canals, one often seen is the root canal form having an elongated ribbon shaped arc that continues uninterrupted till the apex. Occasionally, the apical exit of these canals may not be constricted and obturating such teeth three dimensionally is an operational challenge. Here, in this report, management of C shaped canals using mineral trioxide aggregate (MTA) is described.

Case Presentation: Two cases of mandibular second molars having C-shaped canal configuration and wide apical openings were diagnosed using basic diagnostic criteria in a routine clinical setting. The canals were thoroughly cleaned and shaped using stainless steel hand files and 5.25% NaOCl irrigation. Mineral trioxide aggregate (MTA) was carried into the canal in increments and the canal obturated partially or completely with MTA. Access cavities were sealed with bonded resin restorations. Six month recall showed both cases to be clinically asymptomatic.

Discussion: C-shaped root canals are frequently observed anatomic variations in mandibular molars. Owing to the complex and variable presentation of C canals, a clinician often faces several challenges during their diagnosis and treatment. Basic measures required for confirming the presence of these anatomic variations include intense exploration of the access cavity under

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adequate magnification coupled with high quality preoperative and intra treatment radiographs. MTA, a well known tricalcium silicate cement, has unique physiochemical and biological characteristics. Because of its anti bacterial and bio inductive properties combined with excellent marginal adaptation, it provides a superior seal and has successfully emerged as a suitable alternative barrier material to *Gutta percha*.

Conclusion: Diagnosis and treatment of C shaped canals is highly challenging owing to its variable presentation. Detection of C shaped canals in routine clinical setting is possible using high quality radiographs and precise clinical assessment. MTA can be successfully used to create an apical barrier in C canals with wide apical foramina.

Keywords: Molar; mineral trioxide aggregate; obturation; root canal.

1. INTRODUCTION

Thorough knowledge of a tooth's internal anatomy in addition to proper diagnosis and treatment planning is paramount for achieving endodontic treatment success [1]. Root canal anatomy, normal or aberrant, should be thoroughly identified to enable absolute debridement and obturation of the entire canal system, thus facilitating a three dimensional seal and preventing any ingress of organisms or toxins into the canal. A clinician often encounters C-shaped canals, one of the most prevalent anatomic root canal variations in mandibular second molars compared to first molars [2,3]. These are so named because of the horizontal cross sectional morphology of the root or root canal which resembles a 'C'.

Molars with C-shaped canals often exhibit fusion of roots on buccal or lingual aspect which may result in a longitudinal groove running along the root's buccal or lingual surface. Entrance to the canal generally presents as a C-shaped orifice running in the form of a single semilunar groove commencing at the mesiolingual line angle, sweeping around the buccal to end at the distal aspect of the pulp chamber [4]. Below the orifice level, broadly two root canal forms can be appreciated (a) a single canal which continues uninterrupted as a C shaped ribbon until the apex or (b) presence of two or more independent canals which exit separately or in unison. In some cases, the orifice may exist as an interrupted 'C' giving the appearance of a semicolon (;) [5,6].

A characteristic feature of C shaped canals is the existence of a fin or web communication between individual canals [4]. Great challenge exists when cleaning, shaping and filling canals with such anatomic complexities [5]. Thermoplasticized *Gutta percha* is the appropriate technique for obturation of such canals, as it allows dispersal

into irregularities [7]. However, in canals where there is a large apical opening and a proper apical stop cannot be established, sealing the canal effectively with softened *Gutta percha* without extrusion may not be feasible. This report presents the management of two mandibular second molars; each having C shaped canal and a wide apical foramen.

2. CASE 1

A 35 year old female patient reported to the Department of Conservative Dentistry with pain on food lodgment in the lower right posterior region. The patient had no significant medical history. Clinical examination revealed presence of an extensive and deep carious lesion in tooth #47. Tooth #46 was missing. Radiographic examination of tooth #47 revealed an exposed pulp with peri apical changes around the root tip, a fused root with blunted apex, single wide canal and a wide open apex indicating the possibility of a C-shaped canal (Fig. 1A). Pulp vitality testing using digital pulp tester elicited no response in the affected tooth. There was an absence of tenderness on percussion testing. A diagnosis of pulp necrosis with chronic peri apical periodontitis was made.

Under rubber dam isolation, tooth #47 was accessed through the crown. Pulp chamber was grossly debrided of the necrotic tissue with the help of an excavator and flushed with 5.25% sodium hypochlorite to clear it of any remaining debris. A single round orifice in the middle of the pulp chamber floor could be observed after thorough cleaning and drying of the cavity (Fig. 1B). Exploration of the orifice with small sized stainless steel K- files revealed the presence of a C-shaped form of the root canal within the chamber. Working length was determined using an electronic apex locator (Root ZX, Morita, Osaka, Japan). IOPA radiographs were taken to confirm the established working length. Root

canal was cleaned and shaped using crown down technique. Coronal part of the canal was enlarged using Gates-Glidden drills (#1-3). Instrumentation was done using stainless steel K-file sizes # 20 - 80 to a master apical file (MAF) size of #60. All canal walls were circumferentially filed under copious irrigation with 5.25% sodium hypochlorite. The canal was flushed with sterile water and dried with paper points.

Since the apical aperture of the canal appeared to be large and C-shaped, a definite apical stop could not be established. It was hence decided to create an apical plug and fill the entire canal with mineral trioxide aggregate (MTA). A thick mix of white mineral trioxide aggregate (MTA, ProRoot, Dentsply, Switzerland) was next prepared, carried and inserted into the canal using an amalgam carrier. The material was advanced into the canal with the butt end of a paper point

and vertically compacted using endodontic pluggers 1 and 2. After achieving compaction in the apical 4-5 mm, a radiograph was shot to assess the density and presence of any visible voids (Fig. 1C). Incremental placement and condensation of MTA was continued from the apical to coronal area using increasing sizes of pluggers until the entire canal was filled (Fig. 1D). Moistened cotton was placed over MTA in the chamber and the access cavity sealed with IRM (Caulk, Dentsply, USA). After 1 week, the cotton pellet was removed. Flowable compomer (Filtek Flow 3M/ESPE, St. Paul, MN, USA) was placed over exposed MTA and the access cavity permanently restored with bonded resin restoration. A fixed prosthesis was given to replace missing tooth # 46 using teeth # 45 and #47 as abutments. Six month recall revealed healing of peri apical lesion on the radiograph (Fig. 2).

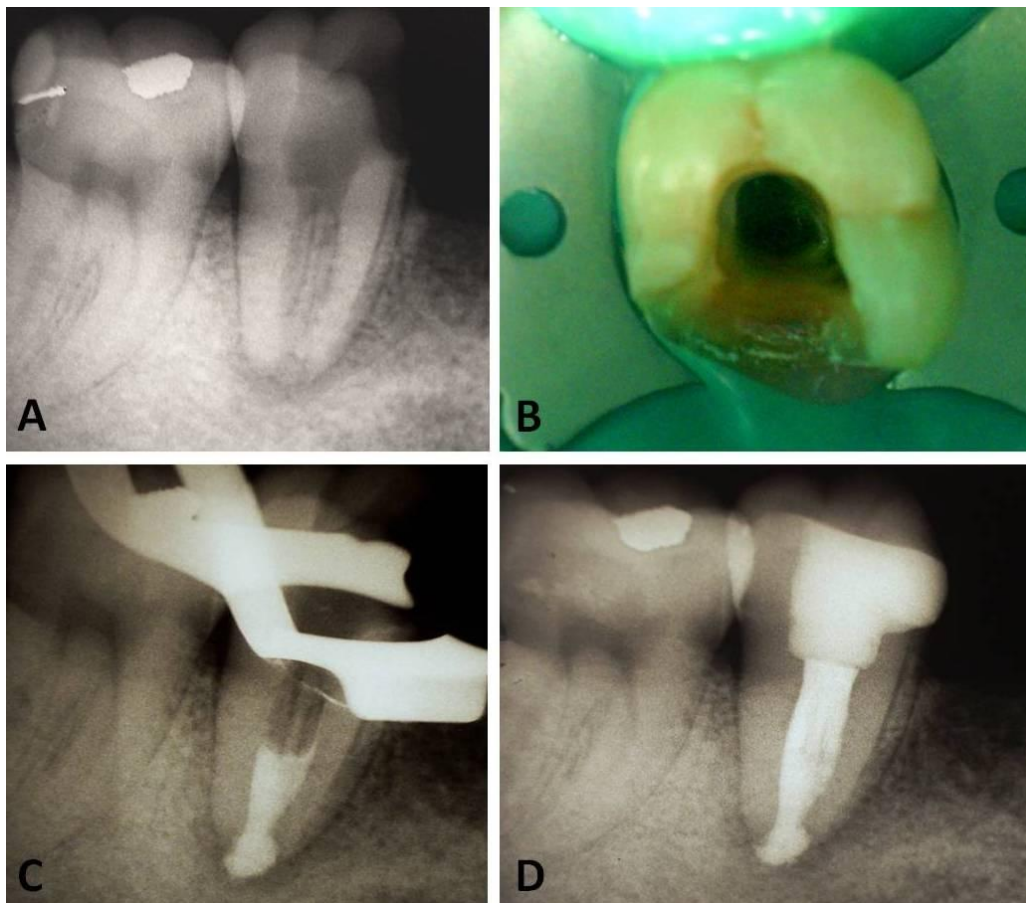


Fig. 1(A). Pre operative radiograph of tooth # 47, **(B)** Occlusal view of the endodontic access showing a single round orifice in the middle of the pulp chamber, **(C)** MTA compacted in the apical portion of the root canal, **(D)** Post obturation radiograph showing MTA filled in the entire canal



Fig. 2. Six month IOPA radiograph showing resolution of periapical radiolucency in relation to tooth #47

3. CASE 2

A 30 year old male patient reported to the Department of Conservative Dentistry with the complaint of occasional sensitivity to heat in lower right posterior region. Medical history was non contributory. Dental history revealed a recent root canal treatment. Despite the previous dentist having rendered endodontic treatment, the patient continued to feel temperature sensitivity. All adjacent teeth were thoroughly examined to rule out any possible etiology. IOPA radiographs were taken. Tooth #47 showed a faulty root canal treatment with a missed mesial canal (Fig. 3A). Thermal pulp testing of the suspect tooth gave variable responses. It was decided to repeat endodontic treatment in tooth #47.

After administering anesthesia consisting of 2% Lignocaine with 1: 1,00,000 epinephrine, rubber dam was applied for isolation. Entry was gained into pulp chamber after removal of old coronal restoration and the *Gutta percha* dissolved using Endosolv (Septodont, Cedex, France). The chamber and canal were thoroughly flushed with 5.25% sodium hypochlorite. On proper drying, a C-shaped canal orifice could be seen extending on the chamber floor from mesiobuccal to distobuccal corner of the tooth. A second orifice corresponding to missed canal was anticipated towards the mesiolingual angle of the chamber. Careful exploration with DG 16 endodontic explorer (Hu- Friedy, USA) under magnification using dental loupes (2.5 x, Daray, Derbyshire)

revealed a catch point which confirmed the presence of an additional canal, consistent with C2 (semicolon) category of C-shaped canal configuration (Fig. 3B).

A #15 K file was used to negotiate the mesiolingual canal through its rounded orifice. In curved portion of the semicolon shaped orifice, two separate files could be inserted, one each at the mesiobuccal and distobuccal line angles. Both canals united at the middle third and exited through a common apical foramen which lacked constriction. Working length was determined using an electronic apex locator (Root ZX, Morita, Osaka, Japan). IOPA radiographs were taken to confirm the established working length. Cleaning and shaping of both canals was done similar to as in case 1. Mesiolingual canal was obturated using *Gutta percha* (Dentsply Maillefer, Switzerland) and cold lateral compaction technique. In the other curved canal which also had a large apical aperture, MTA was compacted into the canal but was limited to the formation of an apical plug (Fig. 3C). Remaining part of the canal was obturated by means of thermoplasticized *Gutta-percha* (BeeFill®2in1, VDW GmbH, Germany) and AH-Plus sealer (Dentsply DeTrey GmbH, Konstanz, Germany) using the technique described by Walid et al. [8] (Fig. 3D). Access cavity was permanently restored with bonded resin restoration. Six month recall revealed sound periradicular architecture surrounding the root of tooth #47 on radiographic examination (Fig. 3E).

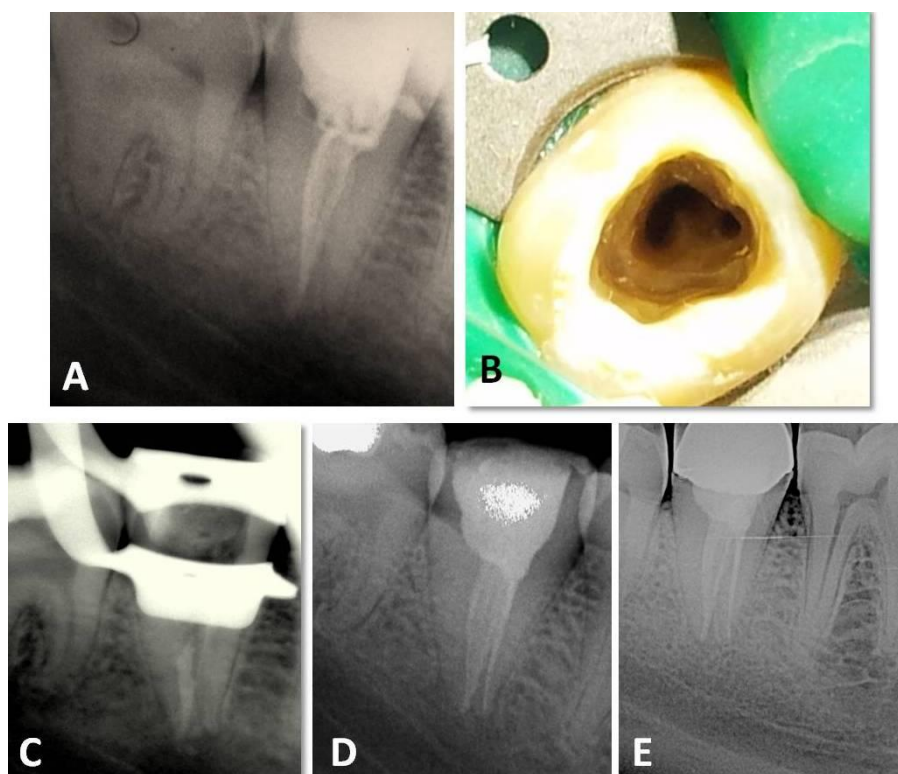


Fig. 3(A). Preoperative radiograph showing incomplete root canal treatment in tooth # 47, (B) Occlusal view of the endodontic access showing C 2 (semicolon) canal configuration, (C) MTA compacted in the apical portion of the distal root canal, (D) Post obturation radiograph, (E) 6 month IOPA radiograph showing sound periradicular architecture with tooth # 47

4. DISCUSSION

Diagnosis and treatment of C-shaped canals continues to be an ardent task because of its atypical presentation. Advanced diagnostic aids like cone beam computed tomography have greatly assisted in identifying C shaped canals, nonetheless in a routine clinical setting, recognition can be made possible using careful radiographic analysis combined with cautious clinical assessment. Radiographs are convenient, efficient and non invasive but alone may offer only limited information. Meticulous clinical observation under adequate magnification permitting direct vision of the pulp chamber morphology and orifices, followed by careful exploration of the pulp canals with hand files establishes the configuration more affirmatively [9].

In our first case presented here, preliminary radiograph of tooth #47 suggested the presence of a single fused root having a centrally located canal. Existence of two faint radiolucent lines imposed against a wide central pulp space most

likely indicated the presence of a deep longitudinal groove in the centre of the root. C1 canal configuration in accordance with Fan's classification of C-shaped root canals (Fig. 4) [6] was confirmed on exploring the canal with hand files that moved freely from one end of the canal to the other end. In the second case, both roots of tooth #47 existed in close proximity, with a large distal canal and a narrow mesial canal seen to continue along their own pathways to the apex. On preparation of access cavity, orifice shape resembling a semicolon indicative of C2 canal configuration in accordance with Fan's classification for C-shaped root canals (Fig. 4) [6] could be identified at the level of the pulpal floor. The larger orifice of 'C' extended from the distobuccal side of the chamber to the mesiobuccal line angle in a curve. Mesiobuccal canal originated separately in the C shaped orifice but swung back merging with the distal canal in the middle third exiting through a single wide apical foramen. Mesiolingual canal originated as a round and discrete orifice. It travelled separately throughout its course.

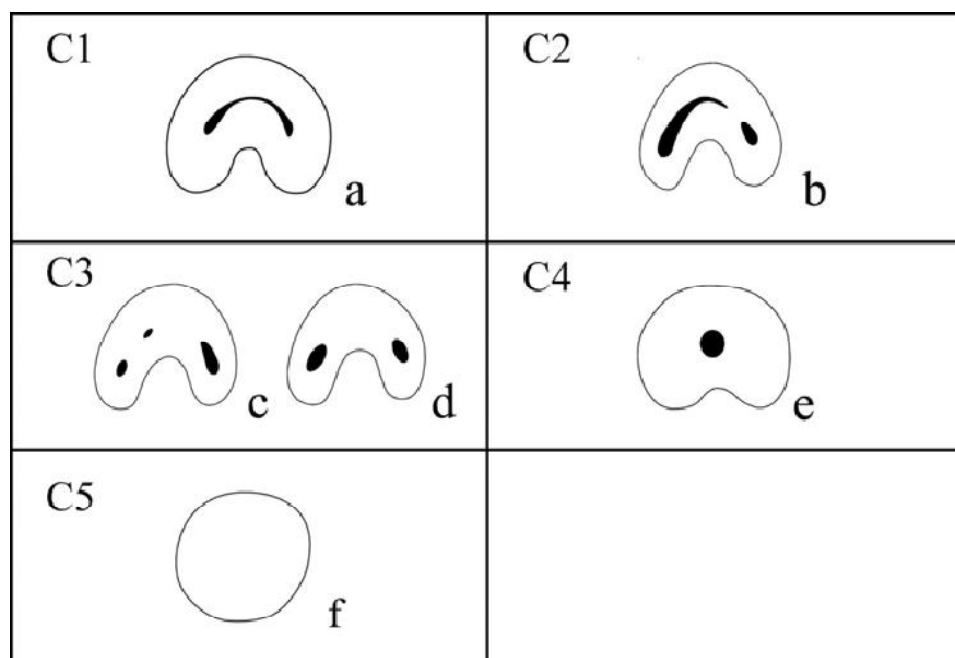


Fig. 4. Fan's classification of C-shaped canals. (a) C1- uninterrupted C shaped canal having no separation or division, (b) C2- semicolon C-shaped canal owing to the discontinuity in 'C' outline, (c & d) C3- two or three separate canals, (e) C4- only one round or oval canal in apical root portion and (f) C5- no canal lumen is observed near the apex

In both cases here, there was an absence of natural apical constriction. To establish an effective seal at the apex, MTA was selected as it is known to serve as a suitable sealing material [10,11]. In case 1, the entire C canal was filled with MTA whereas in case 2, MTA was used to partially obturate the canal and form an apical plug against which *Gutta percha* could be condensed. MTA possesses unique physiochemical and biological characteristics thus providing superior seal and excellent marginal adaptation [12]. Also, because of its antibacterial and bioinductive properties, it is known to induce biologic repair mechanisms more consistently compared to *Gutta percha*, proving to be a suitable alternative material. Long term placement of MTA further increases fracture resistance and overall fracture strength of the tooth [13]. Taking this property into consideration and understanding the increased risks of perforation associated with placing posts in C-shaped canals, the entire canal in tooth #47 of case 1 was filled with MTA as it was to serve as an abutment for fixed prosthesis.

At six month recall, both cases continued to be clinically asymptomatic. Follow up radiograph of the first case revealed periapical healing (Fig. 2).

In the second case, sound periradicular architecture surrounding the root could be well appreciated (Fig. 3E).

5. CONCLUSION

Observations from both these cases support the valuable application of calcium silicate materials like MTA for obturation of C shaped canals with wide unconstricted apices where sole use of *Gutta percha* may be inadequate for providing an efficient seal at the apex.

CONSENT

All authors declare that 'written informed consent was obtained from the patient (or other approved parties) for publication of this case report and accompanying images'.

ETHICAL APPROVAL

Not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Vertucci FJ. Root canal morphology and its relationship to endodontic procedures. *Endod Top.* 2005;10:3-29.
2. Cooke HG, Cox FL. C-shaped canal configurations in mandibular molars. *J Am Dent Assoc.* 1979;99:836-39.
3. Jerome CE. C-shaped root canal systems: Diagnosis, treatment and restoration. *Gen Dent.* 1994;42:424-27.
4. Jafarzadeh H, Wu YN. The C-shaped root canal configuration: A review. *J Endod.* 2007;33:517-23.
5. Melton DC, Krell KV, Fuller MW. Anatomical and histological features of C-shaped canals in mandibular second molars. *J Endod.* 1991;17:384-8.
6. Fan B, Cheung GS, Fan M, Gutmann JL, Bian Z. C-shaped canal system in mandibular second molars: Part I-anatomical features. *J Endod.* 2004;30:899-903.
7. Collins J, Walker MP, Kuliid J, Lee CA. Comparison of three *Gutta-percha* obturation techniques to replicate canal irregularities. *J Endod.* 2006;32:762-5.
8. Walid N. The use of two pluggers for the obturation of an uncommon C-shaped canal. *J Endod.* 2000;26:422-4.
9. Wang Y, Guo J, Yang HB, Han X, Yu Y. Incidence of C-shaped root canal systems in mandibular second molars in the native Chinese population by analysis of clinical methods. *International Journal of Oral Science.* 2012;4:161-165.
10. Woelber JP, Bruder M, Tennert C, Wrbas KT. Assessment of endodontic treatment of c-shaped root canals. *Swiss Dent J.* 2014;124(1):11-5.
11. Kathuria A, Chaudhry S, Talwar S, Verma M. Endodontic management of single rooted immature mandibular second molar with single canal using MTA and platelet-rich fibrin membrane barrier: A case report. *J Clin Exp Dent.* 2011;3(5):e487-90.
12. Torabinejad M, Falah R, Kettering JD, Pitt Ford TR. Comparative leakage of mineral trioxide aggregate as a root end filling material. *J Endod.* 1995;2:109-21.
13. Bogen G, Kuttler S. Mineral trioxide aggregate obturation: A review and case series. *J Endod.* 2009;35:777-790.

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