Research Article

MANAGEMENT OF C SHAPED CANALS – CASE SERIES AND REVIEW OF LITERATURE

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Abstract

A thorough understanding of the anatomical structure and changes of the root canal is an important parameter that determines the clinical success of endodontic treatment. The "C"-shaped canal system is a special anatomical variation that represents a high-incidence ethnic tendency among Asian populations. According to reports, this feature of root canal anatomy appears in various teeth, but it is most common in lower second molars. These root canal systems are named after the transverse morphology of the root and root canal. The presence of fins or nets connecting each mesial and distal root canal causes changes in the cross-section and 3D shape of the root canal along the root. The diagnosis through conventional radiographic techniques and the management of debridement and filling are usually a challenge for dentists. The purpose of this article is to report the successful endodontic treatment of two mandibular molars with a C-shaped root canal system and to review technical details.

Keywords: Anatomical variation, Cone beam computed tomography, Hertwig's epithelial root sheath, Mandibular second molar, Root canal configuration, Thermoplasticized gutta-percha

I. Introduction

An in depth knowledge of root canal anatomy and possible variations are crucial for successful diagnosis and endodontic treatment.[1] The "C-shaped" root canal system is a complex anatomical variation, which was first documented in the literature by Cooke and Cox in 1979.The term proposed is based on the transverse morphology of the root and root canal.[2] According to Weine, the C-shaped configuration refers to a continuous slit between all the canals so that a horizontal section through the root yields a space in the shape of a letter 'C'.[3]

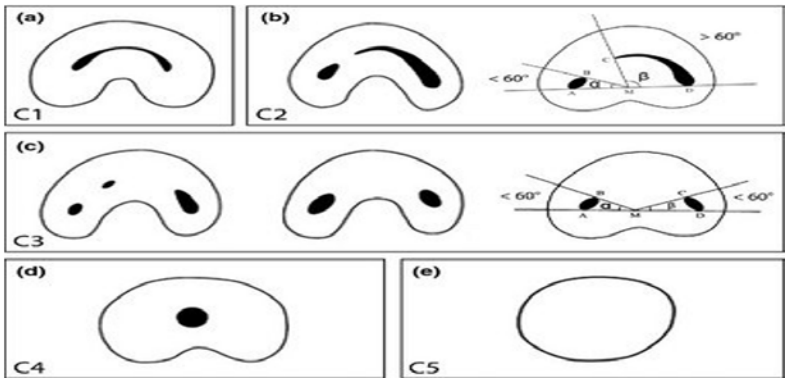
The etiology for C-shaped morphology is failure of the Hertwig's epithelial root sheath to fuse on the lingual or buccal root surface.

This fusion failure results in a groove on the opposite side of the root that is present coronoapically. The C-shaped root may also be formed by coalescence because of deposition of the cementum with time.[4] Other reasons documented are reduced dentin formation on one side, formation of a subpulpal lobe or genetic reasons.[5]

No correlation of C-shaped canal configuration has been found with gender, age or tooth position but racial prediction is found to be highest in the Asian population with more frequency in Chinese population (29.7%) and Koreans (31.3%-45.5%).2 According to reports, this root canal anatomy is seen in various teeth, but mandibular second molars (2.7% - 45.5%) has a high prevalence.[6]

Fan et al modified Melton's method into the following categories (Figure 1) [7]

1. Category I (C1): interrupted "C" with no separation or division.
2. 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◦.
3. Category III (C3): 2 or 3 separate canals and both angles, α and β less than 60◦ .
4. Category IV (C4): Only one round or oval canal in the cross- section.
5. Category V (C5): No canal lumen could be observed (which is usually seen near the apex only).



Four types of pulpal floors were found in mandibular second molars: (Fig. 2).[8]

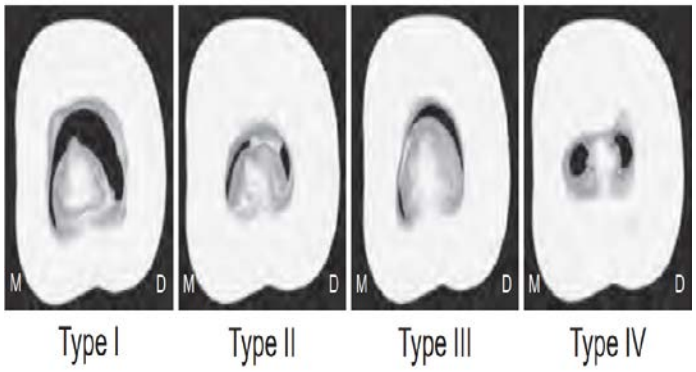
Type I: A peninsula-like floor with continuous C-shaped orifice.

Type II: A buccal, striplike dentin connection between the peninsula-like floor and the buccal wall of the pulp chamber that separates the C-shaped groove into mesial (M) and distal (D) orifices. Sometimes the mesial orifice is separated into a mesiobuccal (MB) orifice and a mesiolingual (ML) orifice by another striplike dentin connection between the peninsula-like floor and the mesial wall of the pulp chamber (most common).

Type III: Only one mesial, striplike dentin connection between the peninsula-like floor and the M wall, which separates the C-shaped groove into a small ML orifice and a large MB-D orifice. The MB-D orifice was formed

by the merging of the MB orifice and the D orifice (second most common).

Type IV: Non–C-shaped floors. One distal canal orifice and one oval or two round mesial canal orifices are present (least common).

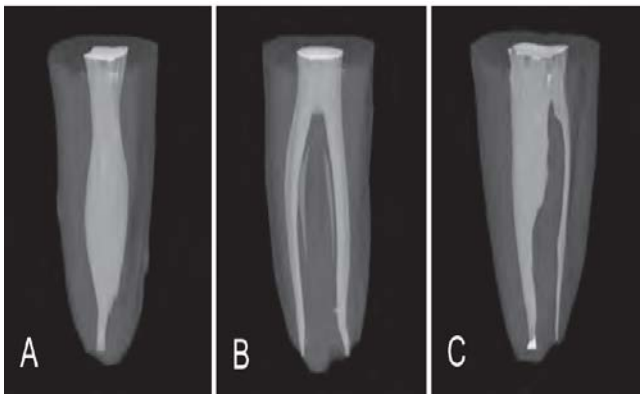


Furthermore, 3-D classification of C-shaped canal configuration in mandibular second molars(Fig. 3).[9]

Type I (merging type): Canals merge to one main canal before exiting at the apical foramen

Type II (symmetric type): Separated mesial and distal canals in each root exit as separate canals

Type III (asymmetric type): Separated mesial and distal canals, with the distal canal having a long isthmus across the furcation area



The salient features of these root canal structure is the presence of fins or webs connecting each mesial root canal and the distal root canal, causing the cross section and 3D shape of the root canal to change along the root, posing challenges for debridement and sealing.[10] Therefore, all dentists must be familiar with this variable root canal anatomy in order to obtain a better success rate. This case series involves two cases of endodontic treatment of two mandibular molars with a C-shaped canal system which were successfully treated with different obturation techniques.

Case 1 (Fig 4a)

A 16-year-old female patient reported to the department of conservative dentistry and endodontics with chief complaint of pain and sensitivity in the lower right back tooth region since 7-8 months. Medical history was noncontributory. On clinical examination, occlusal caries was seen w.r.t 4, The tooth was sensitive to percussion, palpation and gave prolonged response to cold and heat tests. Radiograph showed coronal radiolucency extending into dentin and pulp along with ill defined periradicular radiolucency w.r.t 47. The mandibular second molar had some additional imaging features, such as a single fused tapered root, a mesial and distal root canal connected at the level of the third root tip. These findings indicate that the tooth has a C-shaped root canal anatomy. Diagnosis of irreversible pulpitis was established and treatment plan of endodontic treatment was recommended. The treatment was initiated after taking the consent from guardian. After adequate anesthesia and isolation with rubber dam, an access cavity was prepared w.r.t 47. The pulp chamber was irrigated copiously with 5.25% NaOCl to rinse, debride and identify the floor of the chamber. An unusual anatomical structure was observed, with a large and deep C-shaped pulp floor with three holes (two mesials and one distal), Fan et al C3 type canal anatomy was found. Working length was then established using Apex Locator (Root ZX, J. Morita, USA) and confirmed with radiographs. The radiographic examination also revealed files joining at the apical level. Biomechanical preparation was done till 30/0.06 taper using the crown-down technique, followed by circumferential hand filing with small K files, supplemented with endoactivator (Dentsply Maillefer, USA) for passive ultrasonic irrigation (5.25% NaOCl). The canal was dressed with $Ca(OH)_2$ followed by temporary restoration. In the second appointment (after one week), the master cone were selected and confirmed radiographically. The tooth was obturated with lateral condensation with addition of auxiliary cones and AH plus sealer (Dentsply Maillefer, USA) followed by composite post-endodontic restoration. Patient was found to be asymptomatic during the monthly follow-ups.

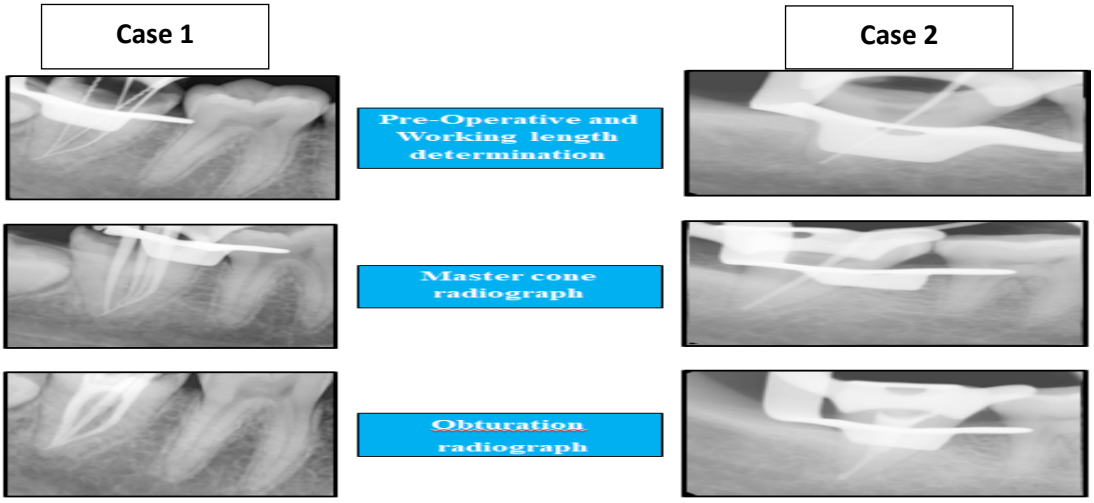


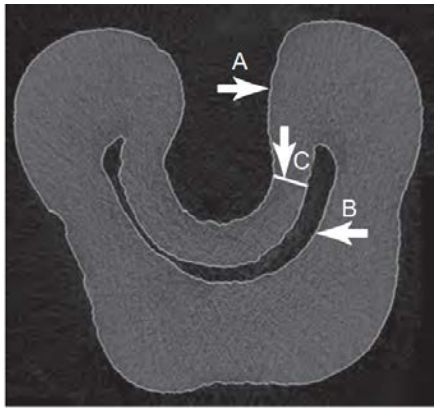
Fig 4 a Fig 4 b

Case 2 (Fig 4b)

A 44-year-old female patient reported to department of conservative dentistry and endodontics with the chief complaint of food lodgment and pain on chewing in the right lower back region of jaw since 1 month. Past dental history and medical history was noncontributory. On clinical examination, occlusal caries was seen w.r.t 4, The tooth was sensitive to percussion, palpation and responded abnormally to heat and cold tests. Radiographic examination showed coronal radiolucency invading the pulp space with specific features such as single conical fused roots, large and deep pulp chamber, single canal extending till apical third. The ethnicity of the patient and radiographs indicated the presence of the of the C-shaped root canal system in this tooth. The patient was diagnosed with 47 cases of irreversible pulpitis with apical periodontitis and planned to undergo root canal treatment similar to that described in case 1. After obtaining informed consent, access preparation and debridement, visual inspection revealed a deep C shape. The pulp floor had single oval canal, Fan et al C4 type canal anatomy was found. After copious irrigation, working length was established with apex locator and radiograph. As described in Case 1, cleaning and shaping with circumferential filing and passive ultrasonic activation was performed w.r.t 47. The canal was then obturated with sectional gutta percha technique followed by thermoplasticized gutta percha. During a one-year follow-up the patient was asymptomatic.

II. Discussion

The morphological C-shaped canal variation is unuaual but radiographic and clinical diagnosis can aid in identification and negotiation of the C-shaped anatomy. The diagnosis of such teeth can be made based on specific clinical findings like peculiar anatomy of pulp floor, persistent hemorrhage or pain when separate canal orifices are observed and narrow root grooves causing localized periodontal disease.[10] Accurate diagnosis can also be made by various radiographical techniques such as cone beam computed tomography (CBCT), spiral CT, microCT to avoid difficulties during treatment.[11] However, such techniques should only be used when traditional dental radiography or alternative methods cannot be utilized for proper diagnosis.[12] Management of the C-shaped root canal system includes careful exploration with the small file and the use of deep orifice preparation to identify the root canal anatomy. Surgical microscope is beneficial as it can facilitate identification of positioning and handling of additional channels, due to the significantly higher and lighter field magnification.[13-15] It is recommended to widen the orifice of the cleft, but not as deep as the apex to avoid perforation.[4] The isthmus should not be prepared with larger than no. 25 files; otherwise, strip perforation is likely. High chances of strip perforation are due to small amount of dentin present between internal canal system and external surface of root especially on the lingual side.[16] The anticurvature filing technique is recommended to avoid danger zones that are frequently presently at mesiolingual walls (Figure 5).[2,9]



Microcomputed tomographic image of the minimal wall thickness measurement. A, Outer root surface. B, Inner canal wall. C, Thinnest wall thickness.

Recent studies done on mandibular molars with C-shaped roots demonstrated that NiTi rotary instrumentation showed higher percentage (59.6%) of non-instrumented canal areas than the manual K-file group (41.6%) with more removal of dentine from the convex aspect of the C-shaped canal system. Also, rotary NiTi instruments appears to be safer in such type of canal, and therefore, it is recommended to use an apical size no larger than size 30/0.06 taper.[17-18] Then,hand files can be used especially for the isthmus area with assisted ultrasonic activation. Sonics or ultrasonic activation allows more cleansibility in fan-shaped areas of the C-shaped canal due to an increased irrigant volume and deeper penetration with small instruments [19-20] Biomechanical preparation with Self - adjusting file system is also found to be efficacious C-shaped canals.[21] In a study by Zhao Y *et al*, XP-S systems showed lower areas of untouched canal wall after instrumenting C-shaped canals. Also, Passive ultrasonic irrigation and and XP-Finisher irrigation caused more debris removal than than Syringe and needle irrigation when using the rotary system.[22] Latest advancements in irrigation and disinfection such as Gentlewave system and photoactivated disinfection (PAD) have reported to eliminate existing microorganisms in main canal and narrow isthmuses, further enhancing the success rate of endodontic treatment.[23-24] The use of thermoplacticized gutta-percha is considered more suitable for sealing in irregular channels. However due to ease and speed of the lateral condensation technique, it is widely used in clinical practice.[2] In a study by Soo WK *et al*, four gutta-percha filling techniques (cold lateral compaction, ultrasonic compaction, single cone with injectable gutta percha [Obtura IITM] and core-carrier [ThermafilR]) were evaluated in simulated C-shaped canals based on filling quality at three cross-sectional levels, filling time and the apical extrusion of gutta-percha. The the most effective technique was found to be core-carrier based technique when assessed by gutta-percha area in the simulated C-shaped canal.[25] For post-endodontic preparation, the floor of the pulp chamber is deep which can aid in ample retention from the available undercuts. Chamber-retained composite or endocrown is a better choice in these teeth.[2] However, increased risk of perforation of root has been reported in C-shaped canals during shaping and post space preparation procedures because the buccal and lingual canal walls are very narrow at mesial locations. Hence, post placement or antirotational pins in the mesiolingual and mesiobuccal areas of C-shaped root canal can cause perforation, so if a post is indicated, the post width should be minimized and placed in the distal canal.[4,26]

III. Conclusion

The C-shaped root canal system is a complex anatomical variation, showing a preference for races, with a high prevalence of mandibular second molars. The prognosis of such difficult cases can be improved by better understanding of characteristics, diagnosis and effective management techniques.

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