

IMAGING THE C- SHAPED CANALS

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ABSTRACT

Knowledge of the C-shaped canal configuration is essential to achieve success in endodontic therapy. Radiographic and clinical diagnoses can aid in identification and negotiation of the fan-shaped areas and intricacies of the C-shaped anatomy. The definition of the C-shaped root canal system is that the morphology of its horizontal cross-section is in the form of a C, with canals which may or may not be separate. C-shaped canal configuration is a variation that has a racial predilection and is commonly seen in mandibular second molars. The aim of this article is to review and discuss the etiology, incidence, anatomic features, classification, diagnosis and management of the C-shaped canal configuration.

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KEY WORDS

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INTRODUCTION

One of the most important anatomic variations is the “C” configuration of the canal system. The C-shaped canal, which was first documented in endodontic literature by Cooke and Cox in 1979, is so named for the cross-sectional morphology of the root and root canal [1]. The definition of the C-shaped root canal system is that the morphology of its horizontal cross section is in the form of a C, with canals which may or may not be separate [2]. It occurs mainly in mandibular second molars, but has also been reported in maxillary first molars, first and third mandibular molars, and in mandibular lower pre-molars [3-4]. Molars with C-shaped root canal systems display fusion of the roots from the buccal or lingual aspect, with a radicular ridge opposite to a convex surface, and a root morphology which may be conical or square or in C-shaped [5-6].

ETIOLOGY

The shape and the number of roots are determined by Hertwig's epithelial sheath, which bends in a horizontal plane below the cemento-enamel junction and fuses in the center leaving openings for roots. Failure of the Hertwig's epithelial root sheath to fuse on the lingual or buccal root surface is the main cause of C-shaped roots, which always contain a Cshaped canal [7-9].

CLASSIFICATION

Melton's Classification: Melton et al in 1991 proposed the following classification based on the different configurations of the orifices in C-shaped canal systems [10]

Category I: Continuous C-shaped canal running from the pulp chamber to the apex defines a C-shaped outline without any separation

Category II: The semicolon-shaped orifice in which dentine separates a main C shaped canal from one mesial distinct canal.

Category III: Refers to those with two or more discrete and separate canals:

- Subdivision I: C-shaped orifice in the coronal third that divides into two or more discrete and separate canals that join apically.
- Subdivision II: C-shaped orifice in the coronal third that divides into two or more discrete and separate canals in the midroot to the apex.
- Subdivision III: C-shaped orifice that divides into two or more discrete and separate canals in the coronal third to the apex.

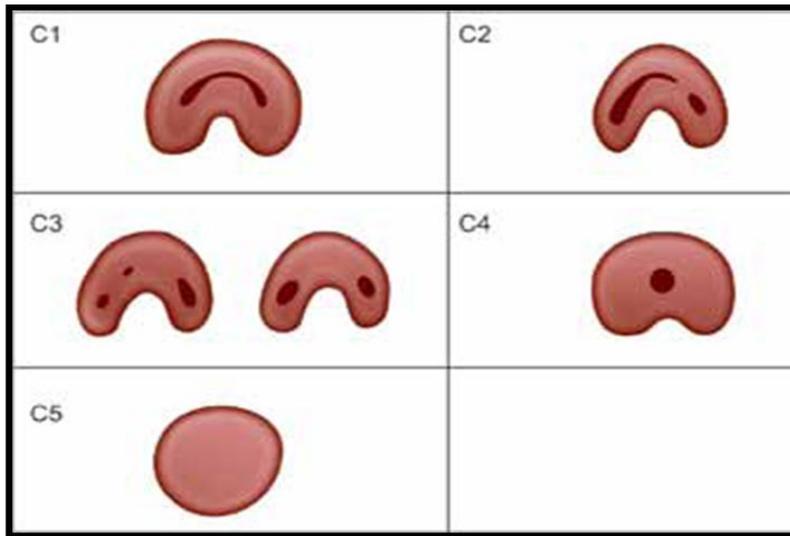


Fig: 1. Classification of C-shaped root canal configuration according to Melton

Fan et al in 2004 modified Melton's method of classification into the following categories-

- Category I (C1): The shape was an interrupted 'C' with no separation or division.
- Category II (C2): The canal shape resembled a semicolon resulting from a discontinuation of the 'C' outline, but either angle or should be no less than 60°.
- Category III (C3): Two or three separate canals and both angles, and were less than 60°.
- Category IV (C4): Only one round or oval canal in that crosssection.
- Category V (C5): No canal lumen could be observed (which is usually seen near the apex only).

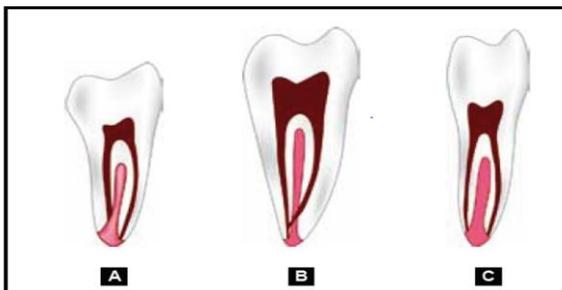


Fig 2: A to C: Fan's radiographic classification

Fan's Classification (Radiographic Classification) [11]

Fan et al classified C-shaped roots according to their radiographic appearance into three types.

1. Type I: Conical or square root with a vague, radiolucent longitudinal line separating the root into distal and mesial parts. There was a mesial and a distal canal that merged into one before exiting at the apical foramen (foramina).

2. Type II: Conical or square root with a vague, radiolucent longitudinal line separating the root into distal and mesial parts. There was a mesial and a distal canal, and the two canals appeared to continue on their own pathway to the apex.

3. Type III: Conical or square root with a vague, radiolucent longitudinal line separating the root into distal and mesial parts. There was a mesial and a distal canal, one canal curved to and superimposed on this radiolucent.

RADIOGRAPHIC DIAGNOSIS

Good radiographic technique should alert the practitioner to unusual anatomy, such as C shaped canals. The C-shaped canal may have the appearance of a fused root with very fine canals. A pulp chamber that looks unusual the dentine areas on the pulp floor map should give some idea of the location of root canals, and of the relationship of the floor to surrounding tooth structure. The preoperative awareness of a C-shaped canal configuration before treatment can facilitate effective management. Radiographic interpretation is overall more effective when based on film combinations ('preoperative and working length radiographs' or 'preoperative and final radiographs' or 'all three radiographs') than on single radiographs. Among the latter, working length radiographs are more helpful [Figure- 4] than the preoperative [Figure- 3] and final ones, whereas preoperative radiographs are the least effective in diagnosing the C-shaped cases.



Fig. 3



Fig. 4

Fig: 3 and 4. The working length intraoral periapical radio

graphing the C-shaped canal as, Melton's category III

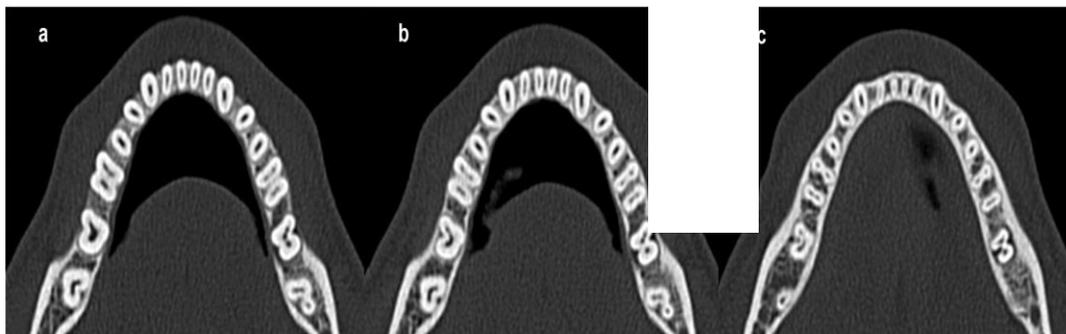


Fig: 5. CT image of C-shaped canal at various levels: (a) Coronal 3rd, (b) Middle 3rd, (c) Apical 3rd

Recent research used a spiral computed tomography [Figure-6] scan to diagnose the canal anatomy, but the dissolution of the image is not yet high enough to show irregular or fine canal structures.

DISCUSSION

A preoperative radiograph usually provides various clues in the identification of any variation in root canal morphology. However, there are differences in opinions on the value of a preoperative radiograph in diagnosing a C-shaped case. Cooke & Cox were of the opinion that it is not possible to diagnose C-shaped canals on

preoperative radiographs [12]. Conversely, some investigators described four radiographic characteristics that can allow prediction of the existence of this anatomical condition: radicular fusion, radicular proximity, a large distal canal or a blurred image of a third canal in between. Hence, a C-shaped root in a mandibular second molar may present radiographically as a single-fused root or as two distinct roots with a communication [13-14]. When the communication or fin connecting the two roots is very thin, it is not visible on the radiograph and may thus give the appearance of two distinct roots. The radiograph may also reveal a large and deep pulp chamber, usually found in C-shaped molars.



Fig. 6. CBCT image of C-shaped canal system in both mandibular left and right molar teeth

Fan et al. divided the radiographic appearance that the C-shaped teeth are present with three types. In 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. In the radiographic 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. In 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. Wang et al. reported a higher incidence in the recognition of C-shaped canals using a combination of radiography and clinical examination under the microscope (41.27%) than using the radiography (34.64%) or clinical examination (39.18%) alone [15-16]. Working length radiographs are more helpful than preoperative and final radiographs in diagnosing C-shaped canals. In a true C-shaped canal, (single canal running from the orifice to the apex) it is possible to pass an instrument from the mesial to the distal aspect without obstruction [17-18]. In the semicolon type, (one distinct canal and a buccal or lingual C-shaped canal) whenever an instrument was inserted into any side of the C-shaped canal, it always ends in the distal foramen of the tooth and a file introduced in this canal could probe the whole extension of the C. When negotiating the C-shaped canal, instruments may be clinically centered. Radiographically, the instruments may either converge at the apex or may appear to be exiting the furcation, thus adding to the confusion and troublesome task of determining whether a perforation has occurred [20-21].

CONCLUSION

The C-shaped root canal configuration has an ethnic predilection and a high prevalence rate in mandibular second molars. Radiographic examination is effective for rule out the C shape canal morphology. Understanding the anatomical presentations of this variation will enable the clinician to manage these cases effectively.

CONFLICT OF INTEREST

The authors declare that they have no conflicts of interest.

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REFERENCES

- [1] Chai WL, Thong YL. [2004] Cross sectional morphology and minimum canal wall widths in C-shaped roots of mandibular molars. *J of Endodon*, 509–512.
- [2] Cooke HG, Cox FL [1979] C-shaped mandibular canal configurations in molars. *J Am.Dent. Assoc*,
- [3] Dankner E, Friedman S, Stabholz A. [1990] Bilateral C-shaped configuration in maxillary first molars. *J of Endodon*, 601–603.
- [4] Demoor RJ. [2002] C-shaped root canal configuration in maxillary first molars. *Int Endod J*, v.35. n.2, p.200-08, Feb.,
- [5] Fan B, Cheung GS, Fan M, Gutmann JL, Bian Z. [2004] C-shaped canal second system in mandibular molars: Part I - Anatomical features. *J of Endodon* 899–903
- [6] Chai WL, Thong YL. [2004] Cross-sectional morphology and minimum canal wall widths in C-shaped roots of mandibular molars. *J Endod.*;30:509–512.
- [7] Rahimi S, Shahi S, Lotfi M, Zand V, Abdolrahimi M, Es'haghi R. [2008] Root canal configuration and the prevalence of C-shaped canals in mandibular second molars in an Iranian population. *J Oral Sci*;50:9–13.
- [8] Jin GC, Lee SJ, Roh BD. [2006] Anatomical study of C-shaped canals in mandibular second molars by analysis of computed tomography. *J Endod.*;32:10–13.
- [9] Ahmed HA, Abu-bakr NH, Yahia NA, Ibrahim YE. [2007] Root and canal morphology of permanent mandibular molars in a Sudanese population. *IntEndod J*, 40:766–771.
- [10] Neelakantan P, Subbarao C, Subbarao CV, Ravindranath M. [2010] Root and canal morphology of mandibular second molars in an Indian population. *J Endod*, 36:1319–1322
- [11] Wang Y, Guo J, Yang HB, Han X, Yu Y. [2012] Incidence of C-shaped root canal systems in mandibular second molars in the native Chinese population by analysis of clinical methods. *Int J Oral Sci*;4:161–165.
- [12] Velmurugan N, Sandhya R. [2009] Root canal morphology of mandibular first premolars in an Indian population: A laboratory study. *IntEndod J* 42:54–58.
- [13] Khedmat S, Assadian H, Saravani AA. [2010] Root canal morphology of the mandibular first premolar in an Iranian population using cross-sections and radiography. *J Endod*, 36:214–217
- [14] Sandhya R, Velmurugan N, Kandaswamy D. [2010] Assessment of root canal morphology of mandibular first premolars in the Indian population using spiral computed tomography: An in vitro study. *Indian J Dent Res*;21:169–173
- [15] Fan B, Ye W, Xie E, Wu H, Gutmann JL. [2012] Three-dimensional morphological analysis of C-shaped canals in mandibular first premolars in a Chinese population. *IntEndod J*, 45:1035–1041.
- [16] Kuzekanani M, Haghani J, Nosrati H. [2012] Root and canal morphology of mandibular third molars in an Iranian population. *J Dent Res Dent Clin Dent Prospects.*;6:85–88.
- [17] Fan B, Yang J, Gutmann JL, Fan M. [2008] Root canal systems in mandibular first premolars with C-shaped root configurations. Part I: Microcomputed tomography mapping of the radicular groove and associated root canal cross-sections. *J Endod*;34:1337–1341.
- [18] Gao Y, Fan B, Cheung GS, Gutmann JL, Fan M. [2006] C-shaped canal system in mandibular second molars part IV: 3-D morphological analysis and transverse measurement. *J Endod*;32:1062–1065
- [19] Walid N. [2000] The use of two pluggers for the obturation of an uncommon C-shaped canal. *J Endod*, 26:422–424.
- [20] Jafarzadeh H, Wu YN. [2007] The C-shaped root canal configuration: A review. *J Endod.*, 33:517–523
- [21] Cheung LH, Cheung GS. [2008] Evaluation of a rotary instrumentation method for C-shaped canals with micro-computed tomography. *J Endod*;34:1233–1238.

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