Research Article

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Prevalence of C-Shaped Canals in Mandibular Second Molars In South Indian Population: A Retrospective Study

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ABSTRACT

Background: A successful endodontic treatment requires proper knowledge and thus management of aberrant root canal systems. The study was aimed to determine the prevalence of C shaped canals in mandibular second molars in South Indian population using cone beam computed tomography (CBCT) and trace this occurrence as geographical phenomenon.

Materials and Method: A total of 141 CBCT images of patients from native Indian population were obtained. It includes images of 72 males and 69 females for mandibular second molars with a total of 171 teeth. 111 samples had unilateral teeth images and 30 samples had bilateral teeth images. Image analysis was done by two examiners for more accurate results. Images were categorized according to Fan et al (2004) classification of C-shaped canal configurations and frequency of each category was determined. Subsequently prevalence and gender distribution were also determined.

Result: 33 out of 171 teeth (19%) exhibited C-shaped canal configuration. Occurrence in third and fourth quadrants were equal while greater frequency was observed in females (30%) compared to males (12.5%). Category C1 was observed in highest frequency followed by Category C2 and C3.

Conclusion: The present study shows that there is significant prevalence of C shaped canal configuration in mandibular second molars in South India population.

Keywords: Cone beam computed tomography; C-shaped canal systems; mandibular second molar; South Indian population.

INTRODUCTION

The fundamental prerequisite for endodontic treatment is to have an explicit knowledge on the complexities in the root canal system.[1] One of the frequently encountered anomalies by an endodontist is C-shaped canals which was initially reported by Cooke and Cox in 1979.[2] The diagnosis, pulp space preparation and the subsequent obturation are extremely challenging.

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The definition of C shaped root canal system is that the canals are arranged in a letter form of 'C' when viewed in any horizontal section from the orifice to the apex.[3] Preoperative radiographs show closed or fused roots or sometimes even show two distinct roots if the fin connecting between them is thin and less radiodense.[4] Instruments appear to be exiting the furcation or can be converging at the apex.[5]

Hertwig's epithelial root sheath (HERS) determines the shape and number of roots. The failure of or non-uniform fusion of Hertwigs epithelial root sheath results in the formation of grooves creating a thin interradicular ribbon connecting the roots together. A conical or prism-shaped root is formed when the there is failure of fusion of HERS on both buccal and lingual sides.This ultimately forms a very wide, slot-like, single, continuous root canal morphology which resemble the shape of a letter C.[6]

The reported frequency of C-shaped canal ranges from 2.7% to 8%.[3] The incidence of C-Shaped canals has a significant ethnic variation. It is seldom found in white people and commonly found in Asians than in whites. [7] Although C-shaped canal can be formed in any tooth, they are mostly found in permanent mandibular second molars.[2]

A mandibular second molar has two roots and three root canals but great deal of variations could be seen. Predicting and negotiating a C shaped root canal configuration is challenging, especially because the C shape orifice found on the pulp chamber floor does not always continue to the apical third of the root. Early recognitions of this configuration allows for better debridement and obturation.[8]

With the advent of Cone-beam computed tomography (CBCT), 3- dimensional images of the root canal anatomy can be obtained which provides accurate details of the morphology of the root canal which is almost impossible to obtain via conventional radiographic techniques.[9]

The aim of this study was to evaluate the prevalence of C shaped canals in mandibular second molars in South Indian population.

MATERIALS AND METHODS

Cone beam computed tomography images of patients visiting a Dental Hospital in Bangalore, which includes local and referred patients, in the time period of January to August 2018 was evaluated for the study. The images were taken as a part of their routine examination for diagnosis and dental treatment planning. The study was approved by the Institutional Ethical Committee.

INCLUSION CRITERIA

1)Mandibular second molars with matured apices.

EXCLUSION CRITERIA

1) Post and core restored teeth,
2) Teeth with Hypoplastic defects,
3) Teeth with hemisection or bicuspidisation procedures
4) Previously root canal treated teeth.

CBCT images of 141 patients were obtained, 72 males and 69 females for mandibular second molars which. 111 samples had unilateral teeth images and 30 samples had bilateral teeth images and hence totally there were 171 teeth with C-Shaped canals.

The 3D Accuitomo CBCT machine Kodak Carestream PS9000 was used. The machine operated at 70 kV, 5.0 mA, and 16 second exposure time. The images were viewed in CS3D software from Carestream Inc. 2015 by two examiners.

Fan et al classification (2004) was considered for identification. Frequency distribution of canals was obtained in males and females.

In horizontal sections,[10] Fan et al (2004) modified Melton's classification(1991) into following:

1. Category C1: interrupted "C" with no separation or division (figure 1a).

2. Category C2: resembled a semicolon resulting from a discontinuation of the "C" outline [Figure 1b], but either angle α or β (figure 2) should be no less than 60°.

3. Category C3: 2 or 3 separate canals (figure 1c and 1d) and both angles, α and β, less than 60°.

4. Category C4: Only one round or oval canal in the cross section (figure 1e).

5. Category C5: No canal lumen could be observed (which is usually seen near the apex only) (figure 1f).

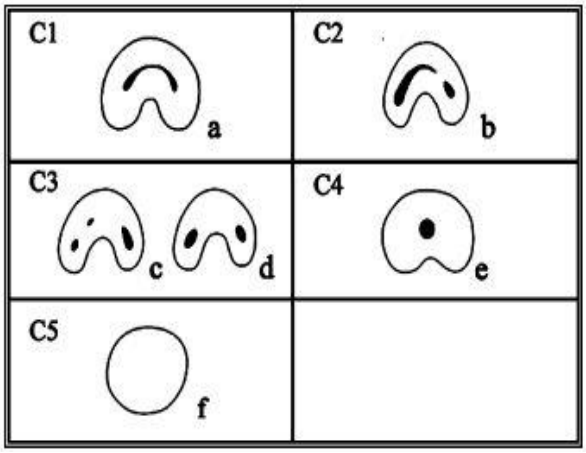

Fig 1: Modified Melton's classification,

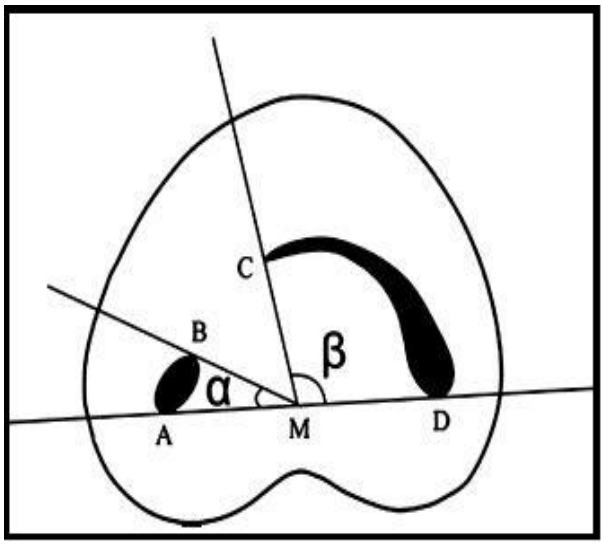

Fig 2: Measurement of angles for the C canal configuration. Angle β is more than 60°. A and B are ends of one canal cross-section; C and D are ends of the other canal cross-section; M, middle point of line AD; α is angle between line AM and line BM; β is angle between line CM and line DM [16](Fan et al.2004).

RESULTS

FREQUENCY:141 individuals with unilateral or bilateral mandibular second molars between ages 16years to 75 years with a mean age of 42 years were evaluated. Of the 171 molar teeth, 33 teeth (19.3%) exhibited C-shaped canals (table 1).

Table 1 Frequency of C shaped canals in mandibular second molars

	C shaped	Normal	Total
	33	138	171
Proportion (%)	19.3	80.7	100

GENDER AND TOOTH POSITION: Canal distribution shows higher frequency in females as compared to males. There was more predominance on the left side than the right side.

Table 2: The distribution of C shaped canal systems in the mandibular second molars by gender and tooth position.

	Gender		Tooth position	
	Male	Female	Left	Right
	n = 72	n = 69	n = 93	n = 78
No. of teeth with C shaped canals	9	21	18	15
Frequency (%)	12.5	30.43	19.3	19.23

Table 3 Frequency distribution of root morphology in mandibular second molars.

Root morphology	Mandibular second molars (n=171), %
All roots separate	138 (80.7%)
Fused roots	33 (19.3%)
With buccal groove	2 (6%)
With lingual groove	28 (84.84%)
With both lingual and buccal groove	3 (9%)
Total	171 (100%)

Root Morphology: Out of 171 teeth examined, 33 teeth had fused roots. Most of them had only one

longitudinal groove on the lingual side where as 2 teeth had only buccal groove.

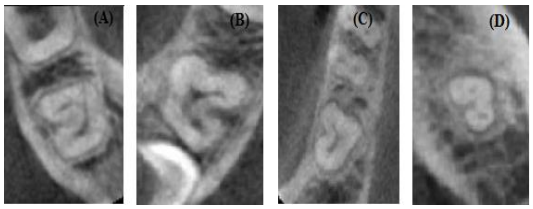

Fig 3: CBCT images of teeth with canal anatomy . (A) at canal orifice, (B) coronal third level, (C) mid root level, (D) apical third level.

Table 4 Cross-sectional canal shapes of C shaped canals

	C1	C2	C3	C4	C5
Number of teeth	22	5	6	0	0

Canal Configuration:

Most of the teeth exhibited C1 canal configuration followed by C2 and C3 in equal frequencies.

Frequency of Unilateral/Bilateral Presence:

6 out of 30 samples with bilateral second molars had C shaped canals on either side.

DISCUSSION

Fan et al. (2004) modified Melton's classification of the C-shaped root canal system using micro-CT analysis. According to him, this type of root canal system exhibit all the following three features: (a) fused roots; (b) a longitudinal groove on the lingual or buccal surface of the root; and (c) at least one cross-section of the canal belonging to the C1, C2 or C3 configuration (Fan et al. 2004).This classification system was used to identify type of C-shaped canal in the present study.

The CBCT images collected in this study includes individuals from purely ethnic Indian population. It has been established that C shaped canals occur in higher frequency in Asians than in other racial groups with the prevalence ranging from 2.7%–45.5%.[10] The Indian population is considered to be hybrid of various ethnic groups resembling features of Caucasian, Mongoloid and Negroid races, which are generally referred to as the Dravidian group.[11] Such study among the Indian population is scarce.[13]

The incidence of C-shaped canal in mandibular second molars in various populations based on literature/ studies is as follows:

- 10% in Sudanese
- 2.7%–7.6% in American
- 8% in Turkish
- 10.6% in Saudi Arabian
- 19.1% in Lebanese
- 31.5% in Chinese, and
- 32.7%–44.5% in Korean populations [14]

A study conducted in North Indian population showed the overall incidence of C-shaped root canals to be 6.72%[15] and a study performed in Central Indian population it was found to be 9.7%.[16] Present study conducted in a sample of South Indian population revealed that 19% of teeth had C-shaped canals. As India lies between far eastern countries like China and Korea and Middle East countries like Saudi Arabia, Lebanon and Turkey, the geographical location of India could be an answer to this phenomenon.

It is established that there is no correlation of C-shaped canal configuration with gender, age and tooth position.[17] However in this study the incidence was found to be more in females(30.435%) than males(12.5%). Bilateral occurrence of C-shaped canals in the present study was 100% unlike 70-81% reported in previous studies .[18]

Category C1 was observed in highest frequency in this study agreeing with the results of Zheng Q et al (2011), followed by category C2 and C3 in equal frequencies. None of the canal systems was found with C4 and C5 configuration. C1 and C2 canal types pose much more difficulties to cleaning and shaping than C3 and C4 type canals.

For effective cleaning and shaping of C shaped canals irrigation is a crucial part because it attains debridement beyond what root canal instrumentation cannot achieve alone. Alternatives such as using ultrasonics for debridement would be more effective in these teeth (Cheung LH 2008). The

isthmus should not be prepared with larger than size 25 files, especially in C1 and C2 configurations in which the thickness of remaining dentin can be as low as 0.26mm (Chai WL 2004), otherwise strip perforation is likely. Risk of root perforation is higher in thinner mesiolingual wall and in the coronal areas. Anti-curvature filing technique is recommended for safe preparation in these areas. Though the Ni-Ti rotary instruments seem to be safe in such canals, apical enlargement greater than size 30 (0.06 taper) is not recommended. Gates Glidden drills should be used with extreme caution. For obturation, Cold lateral condensation technique, or thermoplasticized gutta-percha technique can be used. Keeping in mind the requiste for low condensation force, the latter technique may prove to be more beneficial.

Bonded amalgam or composite is a better choice as core or final restoration as the pulp chamber is deep and provides ample retention. Placement of posts is not recommended as the remaining dentin thickness is almost always less than 1mm in the furcal aspect (Cheung LH 2008).

As discussed earlier that the C configuration appears due to deviated development of HERS from normal, it is not surprising that the C-shaped canals also had been reported in maxillary first molars (0.12%), maxillary third molars (4.7%), mandibular third molars (3.5%-4%) and mandibular second premolars (1%).[17] A case was reported having a C-shaped palatal canal in maxillary second molar.[19] In a case report in maxillary lateral incisors, type III radicular groove has also been documented.[20] Thus, the emphasis should be placed on accurate identification of such canal systems for overall successful treatment outcome. This canal configuration may easily be missed in two-dimensional IOPA radiographs. Other techniques such as fiber-optic transillumination, computer aided tomography, and magnetic resonance imaging can help in identification of three-dimensional anatomy. [21]

As an emerging technology in endodontics, CBCT, with its lower radiation and higher resolution than traditional CT scans , has produced valid root and canal details in three dimensions for diagnosis and prognosis in the context of endodontic therapy, hence CBCT images were considered for identifying C-shaped canal in this retrospective study.[25]

CONCLUSION

The results of this study shows that there is significant prevalence of C shaped canal configuration in mandibular second molars in the sample population included. Thus, accurate detection of anatomic variations in the root canal morphology and its changes in configuration at different levels from coronal to apical segment will help the clinician to deliver the most appropriate treatment to the patient. Further studies are necessary to confirm the prevalence of C shaped canals as a geographical phenomenon.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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