

Incidence of C-Shaped Root Canals in Mandibular Second Molars in North Indian Population: An in-vivo study

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Abstract and Keywords

Aim: *The aim of the study was to investigate the incidence and configuration of C-shaped root canals in mandibular second molars in North Indian population using clinical and radiographic method and to compare the relative efficacies of these two methods.*

Methods and Material: *500 patients with mandibular second molar teeth scheduled for root canal treatment over a period of 1.5 years were examined during 2018-2019. C-shaped root canals were determined by clinical examination using modified Melton's criteria and by radiographic method using Fan's criteria.*

Results: *Incidence of C-shaped root canals was found to be 6.80% using clinical method and 5.20% using radiographic method. Females had greater (9.4%) predilection than males (4.69%) clinically. There were only 19 teeth in which presence of C-shaped root canal were confirmed both clinically and radiographically.*

Conclusion: *The study indicated higher incidence of C-shaped root canals in mandibular second molars in North Indian population. Both the methods were equally effective in diagnosing the C-shaped canals. This study recommended use of both methods simultaneously in all the patients for early diagnosis of C-shaped canals.*

Keywords: *C-shaped root canals, incidence, mandibular second molar, endodontics.*

INTRODUCTION

The literature describes various root canal morphotypes in human dentition. One of the important findings is the C-shaped canal morphology. A C-shape canal appears when fusion of either the buccal or lingual aspect of the mesial and distal roots occur. This fusion remains irregular, and the two roots stay connected by an interradicular ribbon.^{1,2} In 1979 Cooke and Cox documented C-shaped canal in endodontic literature first, and C-shaped canal is so named for the cross-sectional morphology of the root and root canal. The main anatomic feature of the system is the presence of a fin or web connecting the individual root canals. Instead of having several discrete orifices, the pulp chamber of the C-shaped canal is a single ribbon shaped orifice with 180° arc which in mandibular molar starts at the mesiolingual line angle and sweeps around the buccal to the end at the distal aspect of pulp chamber. Typically, this canal configuration is found in the teeth with fusion of the roots either on its buccal or lingual aspect. It is an anatomic variation occurring mostly in mandibular second molars, especially in Asian populations, although it can also occur in maxillary and other mandibular molars.³ Once recognized, the C-shaped canal provides a challenge with respect to debridement and obturation, especially because it is unclear whether the C-shaped orifice found on the floor of the pulp chamber actually continues to the apical third of the root.⁴ Thus, correct diagnosis and identification of the C-shaped root canal is an essential step. Because of the great diagnostic and treatment difficulties in the configuration of the C-configuration canal and the crucial need to properly manage it, this study was conducted to supply information on the distribution in mandibular second molars of the C-configuration canal anatomy using radiography and clinical examination under dental operating microscope and determine its level in northern India. The early recognition of their form allows one to better clean, shape and obturate the canal. The aim of the study was therefore to investigate the incidence of C-shaped root canals in mandibular second molars among population of North India with the help of radiographic examination, clinical examination under dental operating microscope and compare the relative efficacies of these commonly used methods.

MATERIALS AND METHODS

The present study was conducted in the Department of Conservative Dentistry and Endodontics of Maharishi Markandeshwar College of Dental Sciences and Research, Mullana, Ambala after obtaining ethical clearance (Project No: IEC-1013) and written informed consent was obtained from all subjects after providing a complete description of the interventions that were to be performed. The present study was an in-vivo cross-sectional study. Simple random sampling

method was used for the selection of study participants among patients attending department of Conservative Dentistry and Endodontics MMCD SR, Mullana, Ambala for treatment. The study was systematically scheduled to spread over a period of one and a half years from March 2018 to September 2019. After obtaining informed consent from the subjects, the selected teeth were scheduled for radiographic and clinical examination. 500 mandibular second molar teeth were examined.

Inclusion Criteria - New patients enrolling the department ready to give consent were included in the study.

Exclusion Criteria - Old patients in the OPD, medically compromised patients, patients with missing mandibular second molar tooth, edentulous patient, psychiatric patient, patients not willing to include in the study.

Radiographic examination and its identification categories:- In the radiographic examination, two preoperative radiographs, one working length radiograph and two postoperative radiographs were taken using RVG. One of the preoperative radiograph was taken at 90° angulation to the tooth structure in buccolingual direction and other at mesial angulation of approximately 20° using shift cone technique to allow better visualization of buccolingual anatomy. The two postoperative radiographs were taken by same method as preoperative ones to confirm canal configuration. The taken radiographs were analyzed and identified C-shaped canals were divided into 3 groups according to Fan's classification.⁵ (Figure 1)

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

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

Type III: Conical or square root with vague, radiolucent longitudinal line separating the root into distal and mesial parts. There was a mesial and distal canal, one canal curved to and superimposed on this radiolucent line when running toward the apex, and the other canal appeared to continue on its own pathway to the apex.

Clinical examination and its identification categories:- Clinical examination was carried out after adequate anesthesia and rubber dam isolation. Access cavity was prepared and careful probing of pulp chamber floor was done at 10 X magnification using dental operating microscope. After orifice location no. 8 or no.10 K-file was introduced within the canal and radiographs were taken to determine working length and demonstrate root canal configuration. The identified C-shaped canals were analyzed and divided into 3 groups according to Melton's classification.⁶ (Figure 2)

Category I: continuous C-shaped canal running from pulp chamber to the apex.

Category II: semicolon shape (;) orifice in which dentine separates 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 mid root to apex. subdivision III: C- shaped orifice that divides into two or more discrete and separate canals in the coronal third to the apex.

Statistical Analysis

The number of C-shaped root canals examined by means of radiographs and clinical examination were calculated respectively and the data was transformed from pre-coded survey form to computer. The job of data entry, validity checks and formation of desired results (as per analysis plan) was done using statistical package of social sciences (SPSS version 22.0). Statistical analysis was done using CHI SQUARE TEST. The level of statistical significance was set at $P \leq 0.05$.

RESULTS

According to radiographic characteristics of 500 cases, the incidence of C-shaped canal systems was 5.20%. As for the C-shaped root canal, type I and type II accounted for 23.53%, 50%. Type III subdivision I - 14.71%, subdivision II - 2.94% , subdivision III – 8.82%. Incidence by clinical method was found to be 6.80%. There were only 19 teeth in which the presence of C-shaped canal were confirmed by both clinically and radiographically. The female patients showed the prevalence of 9.4% among the 223 teeth examined in the study clinically and 6.72% radiographically examined in the study. There were no significant difference in the prevalence of C-shaped canals between the right and left side in mandibular second molar.

DISCUSSION

The root canal anatomy shows considerable variation and complexity that requires special attention while performing root canal therapy. A thorough knowledge of root canal morphology is a fundamental prerequisite to help and ensure optimal outcomes of root canal treatment. This includes preoperative awareness and intra operative care to identify the landmarks of normal morphology as well as any unusual anatomy of root canal system. A good understanding of external and internal root anatomy helps to reduce the number of missed roots and root canals during treatment, thus increasing the rate of favorable outcomes following root canal treatment. In lower second molar usually there are two roots and three canals, as in first molar. But sometimes teeth with one root and teeth with three roots are also seen. Sometimes it has one fused root with limited number of canal configurations. Ingle in his first edition of textbook claimed that frequency of occurrence of one-rooted lower second molar was 27% but he did not

explain how this figure was obtained and later this information was excluded from the second edition. Radiographic and clinical analysis are the most common techniques to study the C-shaped canal configuration. Using radiographic^{7,8,9} and clinical analysis^{10,11,12} authors in various studies^{13,14} had reported the prevalence of C-shape canal configuration ranging from 2.7% to 44.25%. It was 2.7%–7.6% in American population, Turkish population shows 8%, Saudi Arabia 10.6%, Lebanese population 19.1%, Chinese population 31.5%, and Korean populations 32.7%–44.5%. However as of the date no detailed studies regarding the variations in the root morphology and canal anatomy of mandibular second molar are available for the Indian population. Hence this study was undertaken to evaluate and assess the variations in root canal anatomy and canal morphology. The prevalence of C- shaped canal by the clinical method was 6.80 % which was very close to the previous study done by Singh RD et al. on North Indian population showed that the prevalence of C-shaped root canals to be 6.72%.¹⁵ Another study done by Wadhvani S et al.¹⁶ found the prevalence of 9.7% among the central India population by using CBCT analysis. The radiographic appearance showed the prevalence of 5.2% while the clinical classification gave the prevalence of 6.8% which was similar to the study conducted by Neelakantan P et al.¹⁷ The bulk of the second molars had three pathways, two different roots (87.8%). 7.5% of the teeth examined had C-shaped channel morphology. There were large changes in channel number and structure, both in mesial and distal roots of two rooted molars. There were two apical foraminae with approximately 54.84 per cent of the teeth, and one (3.8 per cent), three apical foraminae were seen with the C-shaped roots. The prevalence was lower than the Saudi Arabian population. Bahammam LA.¹⁸ found the prevalence of 14.4 % in the Saudi Arabian population in 2018. It was highest in the Korean population where the prevalence was found to be 39.8% in the mandibular second molar by Kim HS et al.¹⁹ The prevalence of C-shaped roots was 40%, and C-shaped roots in combination with additional mesiolingual or distolingual roots were found in <1% of molars by Kim SY et al.²⁰ The present study showed that there was significant difference in the prevalence of the C-shaped canal among males and females. The females had higher prevalence of 9.4 % while it was lower in the male with the prevalence rate of 4.6%. The result was in accordance to the result of the Wadhvani S et al.¹⁶ who found significantly more prevalence of C-shaped canal among the females. 7.3% males had C-shaped canals in mandibular second molars whereas females had 11.3% C-shaped canals. The higher prevalence was seen among females in other part of the world. The study by Kim HS et al.¹⁹ showed significantly more prevalence in females with 47.8% in females and 28.4% in males among Korean population. The use of dental operative microscopes is strongly recommended if the clinician believes that additional channels are in the form of C because the magnification enhances identification. In fact, the microscope will help in these cases to avoid perforations.²¹

LIMITATIONS OF THE STUDY

The prevalence of C-shaped canal was found only in the patients attending the Department of Conservative Dentistry and Endodontics. This did not give the true prevalence of the country

population as the care was limited to only one section of the society. Only 2-dimensional radiographic method was used in the study as it was very commonly used. There is limitation of this method as the 3-dimensional images have been shown 2- dimensionally. This would decrease the sensitivity and specificity of test. There are limited comparisons within the Indian population as less studies have been conducted on the Indian population. Racial changes have been seen in the prevalence of C- shaped canal. In order to find the true prevalence of the population, the study recommends the survey with more sample size including residents from various parts of the population with diverse age, socio economic status, religion etc.

CONCLUSION

The results of the present study showed that there was a high prevalence of C-shaped canals in the population group evaluated. In the present study both the methods were equally effective in diagnosing C-shaped canals. This study recommends use of both methods simultaneously in all the patients for early diagnosis of C-shaped canals. Further studies are required to analyze the configuration of these canals at different levels for their effective management during endodontic procedures to ensure a predictable outcome.

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Table 1

Comparison of presence of C-shaped canals among mandibular second molars

	Present	Absent	Chi Square Value	P Value
Radiograph	26 (5.20%)	474(94.80%)	1.13	0.35
Clinical	34 (6.80%)	466(93.20%)		

Table 2

Type of C- shaped Canal on the Melton's classification

Classification	No of C shaped canal	Percentage	
Class I	8	23.53%	
Class II	17	50%	
Class III	sub I	5	14.71%
	sub II	1	2.94%
	sub III	3	8.82%
Total	34	100%	

Table 3

Type of C- shaped Canal on the basis of Fan's classification

Classification	No of C shaped canal
Class I	7 (26.92%)
Class II	10(38.46%)
Class III	9(34.62%)
Total	26 100%)

Table 4

Comparison of incidence of C-shaped canal on the basis of gender by clinical method

Gender	Total	Mandibular Second Molar			
		Present	Absent	χ^2 Value	P Value
Male Teeth	277	13 (4.69%)	264 (95.31%)	5.07	0.03*
Female Teeth	223	21 (9.4%)	202 (90.6%)		
Total	500	34 (6.80%)	466 (93.20%)		

Table 5

Comparison of clinical and radiographic diagnosis

	Total	Confirmed By other Method	Not Confirmed By other Method
C shaped Canal by Clinical Method	34	19	15
C shaped Canal by Radiological Method	26	19	7



Figure 1 - Radiographic types.

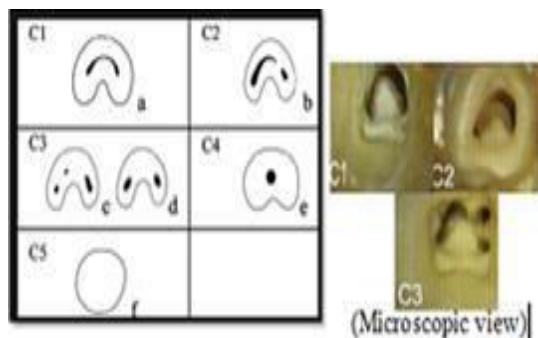


Figure 2- Melton's classification of C-shaped canal configuration

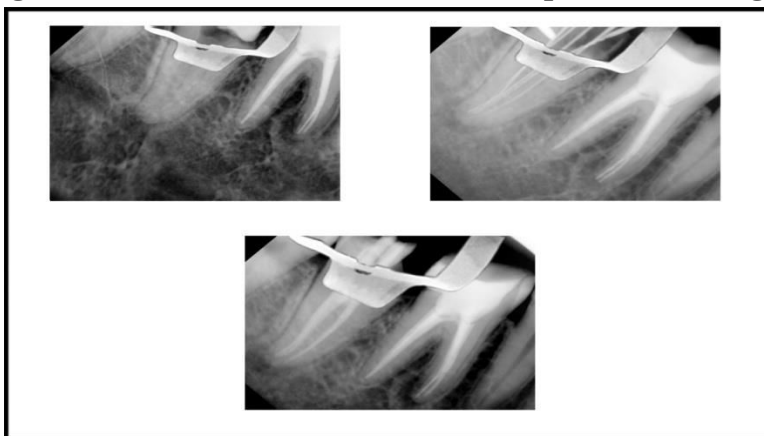


Figure 3 – Radiograph demonstrating C-shaped canal configuration



Figure 4 - Access opening showing C-shaped canal under dental operating microscope

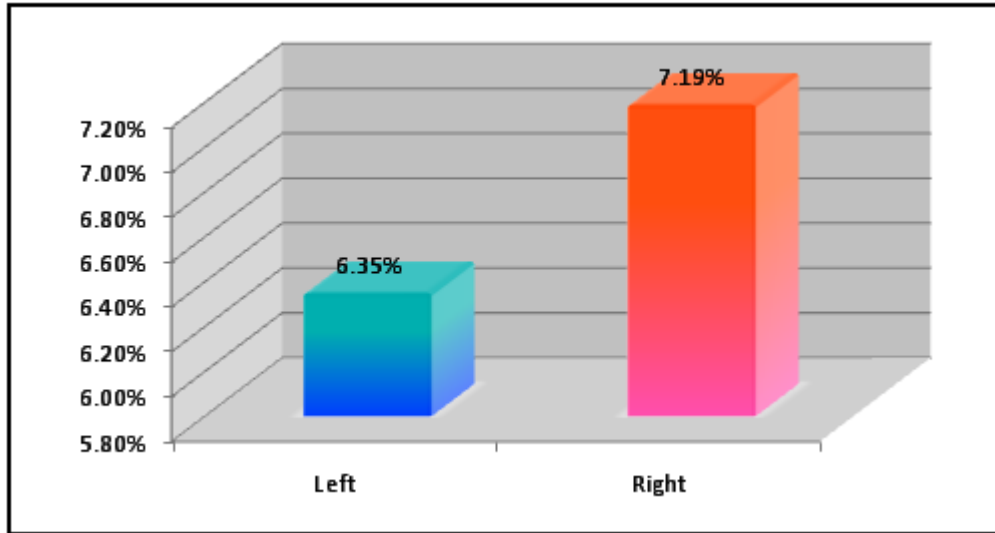


Figure 5- Comparison of incidence of C-shaped canal on the basis of quadrant by clinical method

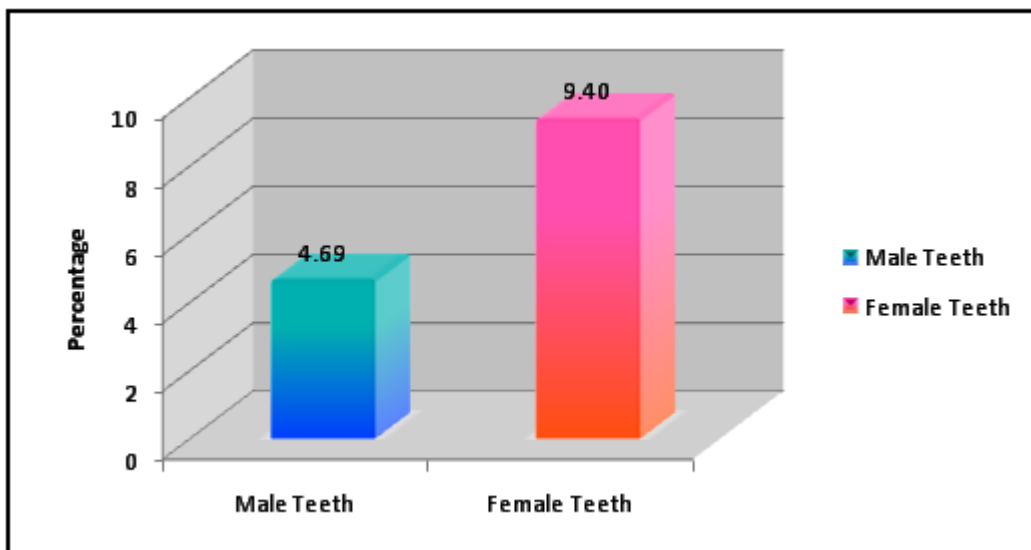


Figure 6- Comparison of incidence of C-shaped canal on basis of gender by clinical method