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USE OF CONE BEAM COMPUTED TOMOGRAPHY TO EVALUATE THE PREVALENCE OF C-SHAPED CANALS IN MANDIBULAR FIRST AND SECOND MOLARS IN CENTRAL INDIAN POPULATION

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Abstract:

Introduction: Successful treatment of root canal depends on the proper identification and debridement of the canal. The use of Cone-beam computed tomography [CBCT] has made identification of C-shaped canal configuration easier. Studies in the Central Indian population are limited and most do not show prevalence in mandibular first molar hence this study was designed with the intent of using Cone-beam Computed Tomography [CBCT] to evaluate the prevalence of C- shaped canals in mandibular first and second molars in the central Indian population.

Materials and Method: A total of 300 patients' data were examined from January 2019 to July 2019 for the central Indian population. The CBCT was used for the examination in coronal, axial, and sagittal views. The canal configurations in both mandibular first and second molars were checked. The comparison was done between mandibular first and second molars, male and female populations, and the quadrants between right and left.

Results: Mandibular second molar [8.2%] showed more occurrence of C-shaped canals than first [0.2%]. It was seen more in females in mandibular second molars [9.3%] than in males [7.1%]. Only one case of C-shape was seen in mandibular first molar which was in males [0.4%]. The left [9.1%] quadrant showed more prevalence than the right [7.0%]. There was no significant difference found in the C-shaped canals of mandibular first and second molars with respect to gender as well as the quadrant system as the P-value obtained for them was not less than 0.05.

Conclusion: The C-shaped root canal structure in mandibular second molars as compared to mandibular first molars has a racial predilection and a high prevalence rate.

Keywords: C-shaped canal, Cone-beam Computed Tomography, Mandibular first molar, Mandibular second molar, Root canal anatomy

Introduction

The successful and proper treatment of root canals is dependent on proper debridement of the entire canal. [1–5] In case the dentist is unable to find an additional canal, then even after extirpating the pulp, disinfecting the canals, and properly filling the canals, there are chances that there is a failure of the root canal treatment. Thus, it becomes necessary for the dentist to know about the different forms of canal systems as it will facilitate the detection of hidden canals, their negotiation, and proper further intervention. One such variation known as C-shaped canals has only one single ribbon-shaped orifice with a 180° arc. [6] This variation is the result of the failure or inability of the Hertwig's epithelial root sheath to properly fuse with the root surface on the buccal or the lingual aspect. [7–9]

Studying the morphologic variations of the root canal system has endodontic significance. [4,5,10] Also, the

morphologic variations in the canal are several among various population groups and even in independent persons within a population group. [11–13] Root canal morphologic variations have been classified in many ways by numerous investigators. [10,14,15] The first classification as suggested by Weine *et al*. [15] categorizes this system in 4 types based on the pattern of how the root canal of a tooth divides along the course from the pulpal floor to the apical foramen. Vertucci [10] classification is more descriptive and has eight types. This particular classification has been extensively utilized by many investigators to classify the canal system of different teeth.[1,11–14] The first molar in the mandibular arch usually has two roots, a mesiodistally flat mesial root and an almost straight and round distal root. [3] The most common variant is the occurrence of a third root.[1,3] Melton *et al.* [16] proposed a distinct classification of the C-shaped canals in 1991, which was designed as per the cross-sectional shape of the canals. Later in 2004, another classification was proposed, which was based on the anatomic shape and also included the radiographic appearance of the roots. This was given by Fan *et al.* [17]

Various methods have been tried to examine the root canal of the first molar. They comprise of plastic resin injection and roentographs with endodontic files placed in the root canals, retrospective evaluation of radiographs, clearing the sample using and not using ink injection, sectioning and macroscopic or scanning electron microscopy [SEM] evaluation, computed tomography [CT], spiral CT, micro CT, and cone-beam CT. [3] Two canals were seen in 15–17% of the cases [10,14,15] and three canals were identified in 1.7% of the roots present distally. [18,19] Other than the principal canals, furcation canals can also be found in 32% of the observed cases. [10]

The failure of the treatment in the case of endodontics is an outcome of missed canals that act as infection nidus. This can be because of several reasons, like not having the knowledge of the prevalent root canal systems like the C-shaped canal system. Though rare, these canals can cause problems in adequate management of canals. [10,15] Therefore, the main aim is to use Cone - Beam Computed Tomography [CBCT] as a diagnostic modality to evaluate C-shaped root canal prevalence in both second and first molars of the mandible in the subpopulation group of central India. This research will benefit clinicians in the diagnosis of such unique cases. The results of the study could be of value in order to perform endodontic treatment in the correct manner, with more confidence.

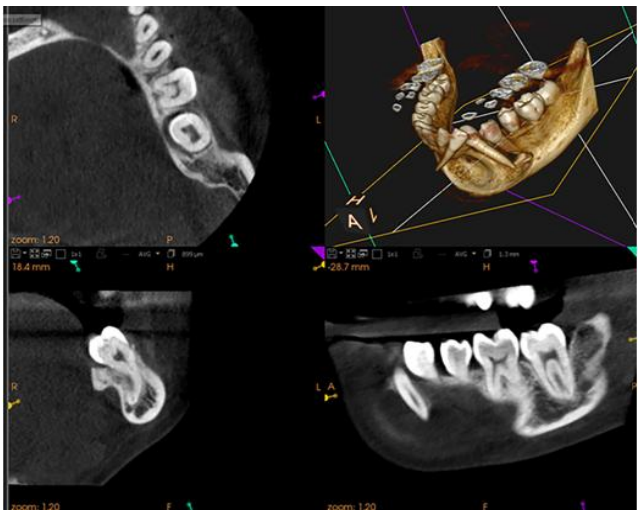
Materials and Method

The research was designed as per the recommendation of the research committee of Sri Aurobindo College of Dentistry, Indore [M.P.]. CBCT [Carestream Health, Inc., USA] images of 300 patients who needed a radiographic examination by CBCT for their dental treatment were examined from the database of the diagnostic imaging center in Central India. The sample size analyzed was from the data collected from January 2019 to July 2019. The CBCT used the following protocol of Voxel size – 180µm, Acquisition time – 8.00 sec, Tube voltage – 90kV, Filament current – 5.0mA, Field of view – 10 x 5 cm. The inclusion of the cases was taken when they showed well developed mandibular first and second molars with complete root formation and a minimum of one canal cross-section showing the C-shaped canal anatomy. The cases that were to be excluded was decided on the presence of deep caries associated with mandibular first and second molars, teeth with open apices, resorption, or calcifications, also teeth with vertical root fracture and teeth that have obturated canals.

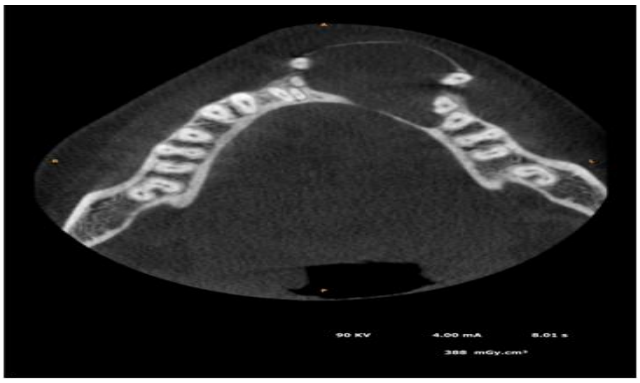
Analysis of image was done on KODAK CS9300 imaging software. The CBCT image has been utilized in three [coronal, sagittal, and axial] planes. The canals were understood to be "C" shaped only if they satisfied the criteria given by Fan *et al.* [2004]. The axial images were also seen at different levels of the root to reconfirm the possible presence of the C-shape of a canal [Fig. 1-4]. The analysis was conducted by two separate radiologists and two endodontists to remove any form of observational bias.

Statistical Analysis

The frequency and percentages of variables were calculated. Data were analyzed using Fisher's exact test. $P < 0.05$(level of significance) was considered statistically significant. Data analysis was performed using the Statistical Package for the Social Sciences (SPSS) software for Windows. [SPSS version 21.0, IBM, Armonk, New York, USA]



1(A)



1(B)

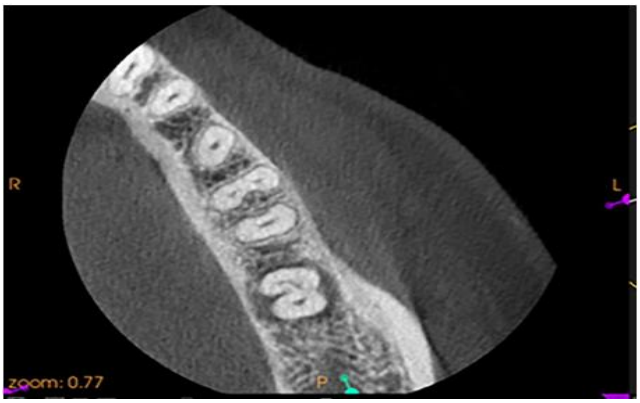
Figure 1: (a) CBCT image of the mandible in the Kodak software. (b) CBCT image of mandible used in the study showing bilateral C - shaped canal configuration in second mandibular molars

2(A)

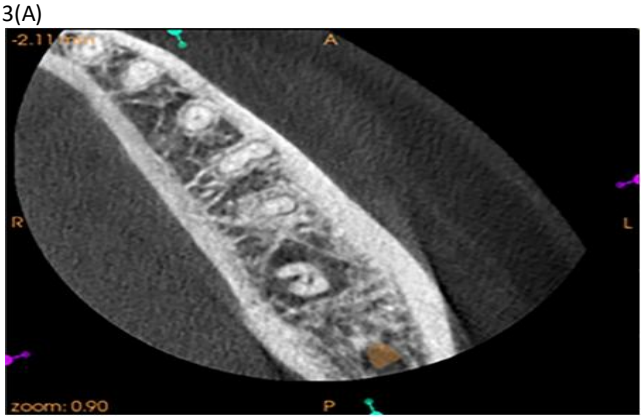
2(B)

2(C)

Figure 2: Shows a section of the mandible in (a) axial view, (b) coronal view and (c) sagittal view of a C-shaped canal in the mandibular second molar

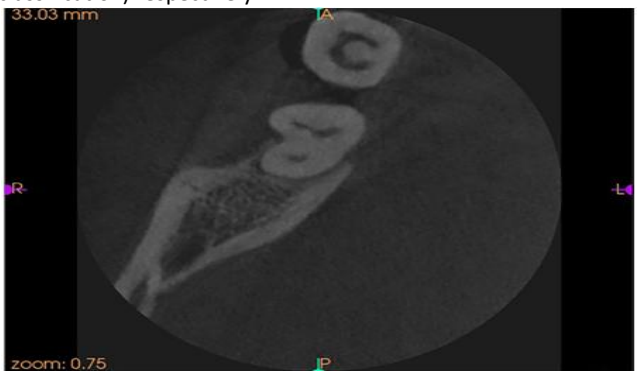


3(A)



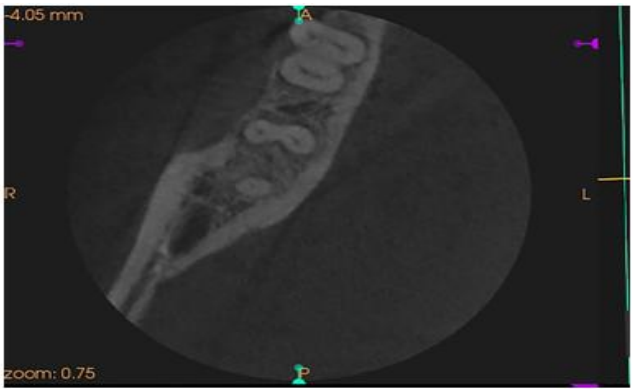
3(B)

Figure 3: Section of CBCT image of the mandible with (a) middle and (b) apical aspect of mandibular second molar showing C2 and C3 shape of root canal configuration(Category II and III of Fan's classification) respectively



4(A)

4(B)



4(C)

Figure 4: A section of the image of mandible showing (a) coronal, (b) middle and (c) apical aspect of a mandibular first molar showing C-shape canal configuration of C1, C2, and C3 type (Category I, II and III of Fan's classification) respectively.

Table 1: Prevalence of C-shaped canals in mandibular second and first molars

	Total	Present	Absent	Fisher's exact test, P
Mandibular Second Molar	592	48 [8.1%]	544 [91.9%]	<0.00001
Mandibular First Molar	581	1 [0.2%]	580 [99.8%]	(significant)
Total	1173	49 [4.2%]	1124 [95.8%]	

Fisher's exact test statistic value is < 0.00001. The result is significant as P < 0.05.

Table 2: Prevalence of C-shaped canals in the male and female populations

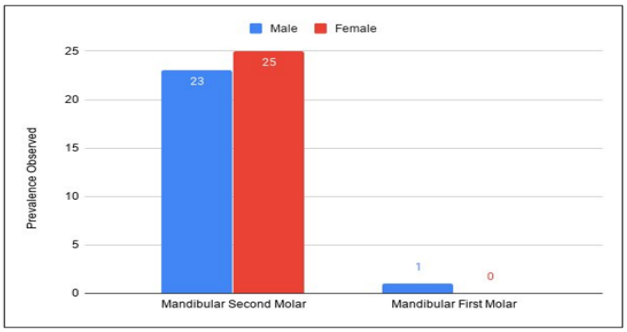
Gender	Mandibular Second Molar				Mandibular First Molar			
	Total	Present	Absent	Fisher's exact test, P	Total	Present	Absent	Fisher's exact test, P
Male	324	23 [7.1%]	301 [92.9%]	0.3651 (not significant)	318	1 [0.4%]	317 [99.6%]	1(not significant)
Female	268	25 [9.3%]	243 [90.7%]		263	0 [0.0%]	263 [100%]	
Total	592	48 [8.1%]	544 [91.9%]		581	1 [0.2%]	580 [99.8%]	

The results are not significant as P is not < 0.05.

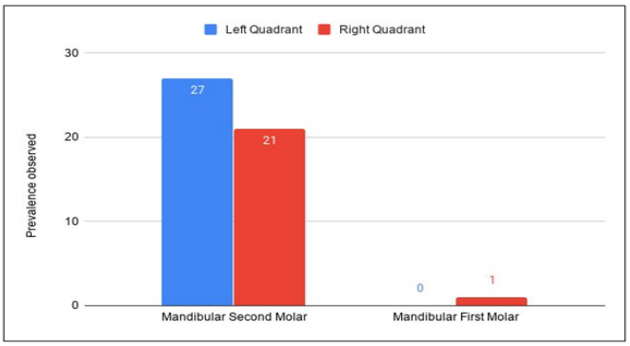
Table 3: Prevalence of C - shaped canal in right and left quadrants

Quadrant	Mandibular Second Molar				Mandibular First Molar			
	Total	Present	Absent	Fisher's exact test, P	Total	Present	Absent	Fisher's exact test, P
left	294	27 [9.1%]	267 [90.9%]	0.3689 (not significant)	288	0 [0%]	288 [100%]	1 (not significant)
right	298	21 [7.0%]	277 [93%]		293	1 [0.4%]	292 [99.6%]	
Total	592	48 [8.1%]	544 [91.9%]		581	1 [0.2%]	580 [99.8%]	

The results are not significant as P is not < 0.05



5(A)



5(B)

Figure 5: (a) Graph showing the prevalence of C-shaped canals in male vs female population, (b) Graph showing the prevalence of C-shaped canals in the left vs right quadrant.

Burma presented a prevalence of 22.4%, more than the Indian [7.5%], Thai or Sri Lankan individuals. [5,12,13,25,26] Even though this shape is seen most commonly in mandibular second molars,[27–29] it has also been observed in literature in first molars in the mandible [28] and maxilla [0.12%],[29] third molars of maxilla [4.7%] and mandible [3.5%-4%], first and second premolars in the mandible [1%][30,31] and even also seen in lateral incisors of the maxilla. [32] C-shaped canals are seen bilaterally in 70%-81% [33,34] of cases. Singla & Aggarwal noted this configuration in the palatal canal of a maxillary second molar. [35]

A separate study conducted by Wadhwani *et al.* 2017, [36] studied the prevalence of C- shaped canals if any, in mandibular second and third molars in the population of central India using CBCT analysis and found it to be 9.7% and 8.0% respectively. A case report by Raghvendra *et al.* 2015 [37] found the first molar with a C-shape of root canal in India. An *in vitro* study conducted by Reuben *et al* [38] with 125 sample sizes in first mandibular molars from an Indian subpopulation discovered only a single sample of single root and single canal of C- shape. To the best of our knowledge, no such research has been published on C-shaped canal prevalence in the first Mandibular molar in the central Indian population. Thus this study was designed with the aim to use CBCT, as a diagnostic modality to evaluate C-shaped root canal prevalence in second and first molars of the mandible in the subpopulation group of central India.

In our study, the prevalence of C-shape was found to be 8.1% in mandibular second molars, and 0.2% in mandibular first molars. This is comparable to the Middle East. When the prevalence was observed between first and second molar, it was seen that mandibular second molar had a higher occurrence of C- shape than mandibular first molars. This result is found to be in contrast to the one found in the Brazilian population in a study by Azevedo *et*

al in 2019 [39], where they found the prevalence to be 21.32% for second and 24.01% for the first molars in mandible. The result was similar to the study on the Saudi population by Alfawaz *et al*, 2019 [40], where they found a prevalence of 9.1% for second molars and 0.19% for mandibular first molars.

In our study, the prevalence of C-shape root canals in mandibular second molars was 9.3% and 7.1 % in females and males respectively. Thus more prevalence was seen in females which is in similarity with research done by *Kim et al*. in 2018 [41] on the Korean population which showed a more prevalence for the female population [47.8%] than the male population [28.4%]. For mandibular first molars, the prevalence was 0.4% for males while no C- shape canal was observed in females in this study.

On comparing the right and left quadrants, the prevalence was found to be 0.4% for left and 0.0% for the right quadrant for mandibular first molars and 9.1% in the left quadrant and 7% in the right quadrant for mandibular second molars. This is in contrast to the observations of Wadhwani *et al.* 2017, [36] who observed that the prevalence in second molars was 4.2% in the left and 5.5% in the right quadrant.

Conclusion

The prevalence of C-shaped canals in central Indian population was found to be more in mandibular second molars than in mandibular first molars, it was more in males than females for first molars but more in females than in males for second molars. The prevalence was also seen more in the left quadrant in comparison to the right quadrant for the second molar. For mandibular first molars only one case was found (0.4%) with the C-shaped canal, which was in the mandibular left quadrant.

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