Journal of Applied Dental and Medical Sciences
NLM ID: 101671413 ISSN:2454-2288
Volume10 Issue 1 Jan-Mar 2024

Original Research

Analysis of Root Anatomy and Canal Configuration of Mandibular Molars in Central Indian Population – A Cone Beam Computed Tomography Study and Review

Shabdika Baghel[1], Sanket Hans Pandey[2], Pallav Patni[3], Pradeep Jain[4], Swadhin Raghuwanshi[5], Katya Pandey[6]

[1]Department of Orthodontics and Dentofacial Orthopaedics,Sri Aurobindo College of Dentistry, Sri Aurobindo University, Indore
[2,3,4,5,6] Department of Conservative Dentistry and Endodontics, Sri Aurobindo College of Dentistry, Sri Aurobindo University, Indore

ARTICLE INFO

Keywords: Canal configuration, cone-beam computed tomography, Indian, mandibular molars, root anatomy, root canal.

ABSTRACT

Aim - The aim of this study was to identify morphological peculiarities of roots and analyze the root canal configuration in mandibular first and second molars using cone-beam computed tomography (CBCT) imaging in a Central Indian population.

Method - A total of 200 mandibular first and 200 mandibular second molars were examined by CBCT imaging. Only molars with healthy and fully matured apices were included in this study. Details regarding the number of roots, number of canals, and root canal configuration were recorded in Microsoft Excel 2013 and subjected to statistical analysis using IBM Statistical Package for the Social Sciences (SPSS) software. Fisher's exact test was used, and P-values less than 0.05 were considered significant.

Result - Among the mandibular first molars, 30% had 3 canals, 56% had 4 canals, and 14% had 5 canals. Middle mesial canals were present in 12% of mandibular first molars, while radix entomolaris was seen in 8%. 14% of mandibular second molars had 1 canal, 6% had 2 canals, 62% had 3 canals, and 18% had 4 canals. C-shaped anatomy was seen in 18% of mandibular second molars.

Conclusion - CBCT is a useful tool in assessing root canal morphology. Preoperative information on the root canal anatomy can help reduce the chances of missed canals and provide a better outcome for the patient.

Introduction

The goal of an endodontic treatment is to clean the canal and fill it with an inert material to eliminate any chances of re-infection. Failure to meet the standard principles results in failure of the treatment.[1] Failure in locating and treating the root canal is one the major reasons for failure of endodontic treatment.[2] Mandibular molars are most common tooth to undergo endodontic treatment.[3] Anatomical variations like additional distolingual roots have been reported for mandibular first and second molars.[4] Mandibular molars have also shown the presence of C-shaped root canal anatomy.[5] The occurrence of C-shaped anatomy in

* Corresponding author*:*
Dr. Sanket Hans Pandey,MDS ,Department of Conservative Dentistry and Endodontics,Sri Aurobindo College of Dentistry, Indore. Email: drsanketpandey@gmail.com Mobile:+919826836100

mandibular second molar has been discussed thoroughly in literature.[6] There are several methods to study the root canal configuration such as conventional dye injection method or by the use of 2-dimensional radiography. [7,8] However, dye injection method require extensive preparation of the sample and is time consuming in nature. Conventional radiography presents a 2D image of 3D object and thus is susceptible to errors. Cone Beam Computerized Tomography (CBCT) has found to be a useful tool in assessing the root canal morphology.[9,10] Several studies have used CBCT to assess the root canal anatomy of the regional population for better understanding to minimize any endodontic failures.[11,12] CBCT has proved to be superior to periapical radiographs for endodontic purposes.[13] Literature search showed that there have no studies utilizing CBCT to study the canal anatomy of mandibular molars in central Indian population. Hence, the purpose of this study was to investigate the mandibular molar root canal morphology of Central Indian population using cone-beam computerised tomography.

Materials and Methods

The research protocol underwent rigorous scrutiny and received approval from the institutional ethical committee, ensuring compliance with the principles outlined in the Helsinki Declaration (Approval no. IEC/2019-23). The study cohort comprised individuals from the Indian population necessitating Cone Beam Computed Tomography (CBCT) for dental diagnostic purposes during the period spanning from June 2020 to January 2021.

The enrolment criteria dictated the inclusion of CBCT scans encompassing both mandibular first and second molars, with distinction made between full mouth and limited field of view scans. Only mandibular molars that had fully emerged and exhibited complete apical root development were considered for inclusion, while those displaying open apices, canal calcifications, or image artifacts were systematically excluded from analysis. A total

of 200 mandibular first and 200 mandibular second molars were finally included in the study.

All CBCT scans were acquired utilizing the Kodak Carestream CS 9300 3D system, characterized by a voxel size of 90 micrometers, with exposure settings configured at 120 kilovolts peak (kVp) and 15 milliampere (mA). Subsequent visualization and analysis of axial, coronal, and sagittal sections were performed using Carestream Dental Imaging 3D software, with images rendered on a liquid crystal display (LCD) monitor boasting a resolution of 1920x1080 pixels (Dell, USA).

Two endodontists were tasked with CBCT interpretation, ensuring reliability through the presentation of duplicate images to assess intra-observer agreement. The Cohen's Kappa coefficient, calculated at 0.83, denoted a substantial level of concordance between the observers, validating the consistency of their assessments.

Data compilation and analysis were conducted using Microsoft Excel 2013 and IBM SPSS Statistics 23, respectively. Fisher's exact test was employed for statistical analysis, with significance set at P-values less than 0.05, indicative of noteworthy disparities within the dataset.

Results

Table 1 delineates the sample distribution based on the number of canals in mandibular first and second molars. Notably, while the majority of both molars exhibit three canals, there are notable differences between them. Mandibular first molars showcase a higher prevalence of four canals, particularly evident in the distal roots, whereas mandibular second molars predominantly feature three canals, with a significant portion exhibiting two canals in the distal roots. Table 2 provides insights into the percentage of canals in mesial and distal roots of mandibular molars. The mesial roots of both molars predominantly exhibit two canals, with a minority displaying single canals. Conversely, the distal roots primarily house

single canals, particularly in mandibular first molars, with a notable percentage of two canals in the distal roots of mandibular second molars. Further categorization based on Vertucci's classification, as showcased in Table 3, elucidates the specific canal configurations within each root. In mandibular first molars, the mesial roots predominantly manifest Type IV configuration, characterized by two separate canals joining at the apex. The distal roots of both molars predominantly exhibit Type I configuration, characterized by a single, straight canal.

Discussion

CBCT can provide accurate information regarding the root canal morphology of the tooth.[4,12] One of the possible limitation of CBCT includes an increased radiation exposure to the patient. CBCT should only be used when the need for imaging cannot be satisfactorily fulfilled by two-dimensional radiography.[14] Anatomical variations in number of root and root canals have been reported in literature for mandibular first molar. Fabra & Campos reported the presence of three mesial canals.[15] Several studies have reported the presence of additional lingual root.[16,17] The high frequency of 2 roots (92%) in mandibular first molar goes in synchrony with the other studies of the Asian population.[12] Higher variation was found in number of roots for mandibular second molar with single root in 20% population and two roots in remaining 80% of the population. Incidence of three rooted mandibular molar was found to be 4.2% in Caucasians, 5% in Eurasians 3% in Africans, and more than 5% (up to 40%) in Mongolian population by De Moor.[18] We found 8% of mandibular first molars to show the presence of radix entomolaris. However, we could not see the presence of radix paramolaris in our study. SS Chandra et al found an incidence of 18.6% of additional roots in mandibular first molars of south Indian population.[19]

The incidence of middle mesial canals in our

study was 12%. Tahmasbi et al reported an incidence of 16.4% middle mesial canals in their CBCT study on 122 teeth.[20] A study found that the incidence of negotiable middle mesials canals is higher in younger

Table 1 showing the distribution of samples according to the number of canals

Tooth Number	Mandibular 1st molar	Mandibular 2nd molar
Sample size	200	200
No. of tooth with 1 canal	0	28 (14%)
No. of tooth with 2 canals	0	12 (6%)
No. of tooth with 3 canals	60 (30%)	124 (62%)
No. of tooth with 4 canals	112 (56%)	36 (18%)
No. of tooth with 5 canals	28 (14%)	0
Middle Mesials	24 (12%)	0

Radix	16 (8%)	0
C shape	0	36 (18%)

Table 2 showing the percentage of canals in each root of mandibular molars

	Number of Canals (%)		
	1	2	3
Mesial root Mandibular 1st molar	0	86	14
Distal root Mandibular 1st molar	30	70	0
Mesial root Mandibular 2nd molar	12	88	0
Distal root Mandibular 2nd molar	64	36	0

Table 3 showing canal distribution in different roots of mandibular molars as per Vertucci's classification.

Vertucci Type	Type I	Type II	Type III	Type IV	Type V	Type VI	Type VII	Type VIII
Mesial root of Mandibular First Molar	-	17%	-	60%	-	11%	-	12%
Distal root of mandibular first molar	30%	27%	-	43%	-	-	-	-
Mesial root of Mandibular Second Molar	14%	17%	-	69%	-	-	-	-
Distal root of mandibular second molar	64%	15%	-	16%	-	5%	-	-

individuals.[21] A study conducted among the north Indian population found that with increase in patient age, the chances of locating the middle mesial canal decreases.[22]

C-shape canals in mandibular second molars can be challenging for the clinician and requires different protocols for management. Cooke et al were the first to describe C-shape canal configuration.[23] Asian populations have a higher incidence of C-shaped root canals than other ethnic group.[24] Fan et al performed a study to correlate the C-shape anatomical configuration with the radiographic appearance of the tooth.[25] We found an incidence of 18%

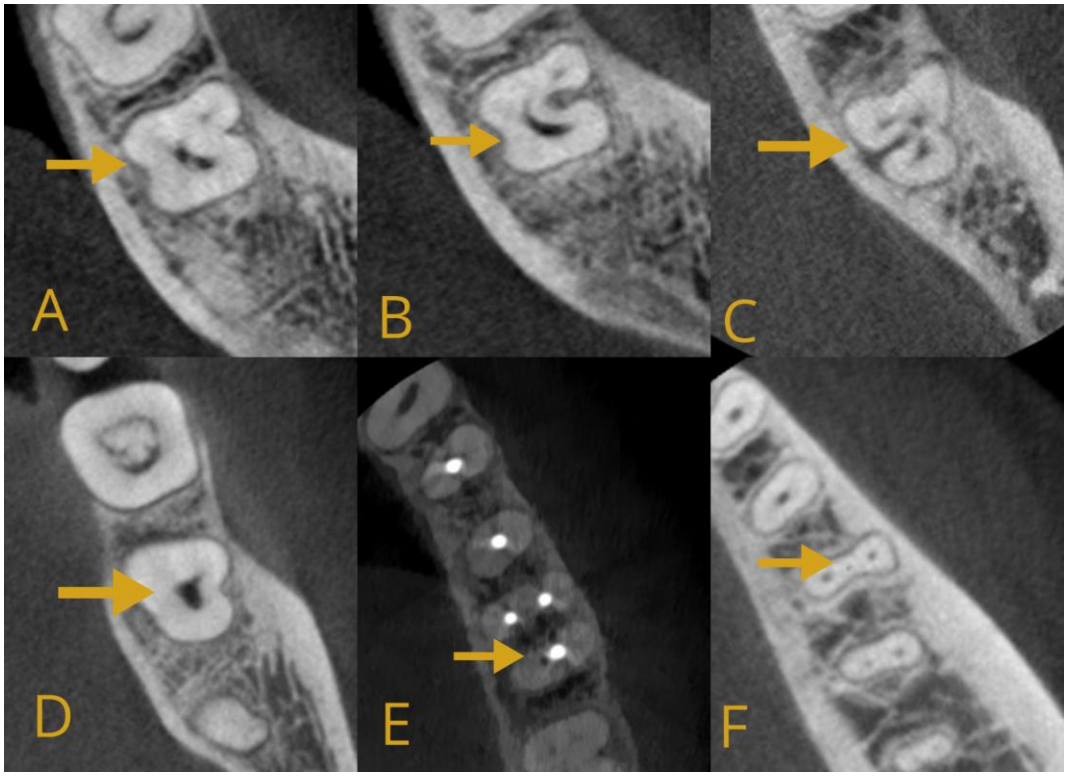

Figure 1A showing Fan's C3 classification, Fig.1B &1C Fan's C2 classification. Fig.1D showing Fan's C4 classification. Fig.1E showing missed mesiolingual canal, Fig.1F showing middle mesial canal in lower first molar.

of C-shape root canal anatomy in mandibular second molars. Zhang-R et al reported an incidence of 29% C-shape anatomy in Chinese population using CBCT.[4] Zuben et al, in the worldwide research for C-shape incidence, reported an incidence of 12.3% C-shaped canals in Indian population.[26] Martins et al reported 0.6% C-shape mandibular first molars and 8.5% C-shape mandibular second molars in Portuguese Caucasians.[27]

The Vertucci classification given in 1974 for root canal configuration is still widely used which classifies the canal into 8 different types.[28] In our study,for the mesial root of the mandibular first molar, the most common (72%) Vertucci configuration was Type IV. Only 17% of mesial roots of mandibular first molar showed Vertucci Type II configuration while Vertucci Type VI was seen in only 11% cases. The findings of mesial root of mandibular first molar is in accordance with findings of Chourasia et al who used dye penetration method.[29] 30% of distal root of mandibular first molar showed Type I Vertucci configuration while 27% showed Type II configuration, Type IV configuration was seen in 43%.

For the mesial root of mandibular second molar, 69% sample showed Vertucci Type IV configuration, 12% showed Vertucci Type I, 17% had Vertucci Type II configuration. High incidence of Type IV configuration of mesial root is in accordance with the study on Indian population by Neelkanthan et al who utilized clearing technique on 345 extracted mandibular second molars.[30] For the distal root, 64% had Type I, 15% had Vertucci Type II, 11% had Type IV and Type VI was seen in 5% of the samples (Table 3).

One of the limitations of this study is the cross-sectional design, which provides a snapshot of root canal anatomy in the Central Indian population at a specific point in time. However, root canal morphology can vary among individuals and may change over time due to factors such as age, dental pathology, and

treatment history. A longitudinal study tracking changes in root canal anatomy over time would provide a more comprehensive understanding of the variations in the population.

Conclusion

CBCT is a useful tool in assessment of root canal morphology. The Indian subpopulation showed a higher percentage of second distal canal in the mandibular first molar. Preoperative information of the root canal anatomy can help reduce the chances of missed canals and thus provide a better outcome for the patient.

References

1. Siqueira JF, Jr.: Aetiology of root canal treatment failure: why well-treated teeth can fail. International endodontic journal. 2001, 34:1-10. 10.1046/j.1365-2591.2001.00396.x

2. Cantatore G, Berutti E, Castelucci A: Missed anatomy: frequency and clinical impact. Endodontic Topics. 2006, 15:3-31. https://doi.org/10.1111/j.1601-1546.2009.00240.x

3. Ahmed H, Durr e S, Rahman M: Frequency and distribution of endodontically treated teeth. Journal of the College of Physicians and Surgeons--Pakistan : JCPSP. 2009, 19:605-608. 10.2009/jcpsp.605608

4. Zhang R, Wang H, Tian YY, Yu X, Hu T, Dummer PM: Use of cone-beam computed tomography to evaluate root and canal morphology of mandibular molars in Chinese individuals. International endodontic journal. 2011, 44:990-999. 10.1111/j.1365-2591.2011.01904.x

5. Bolger WL, Schindler WG: A mandibular first molar with a C-shaped root configuration. Journal of endodontics. 1988, 14:515-519. 10.1016/s0099-2399(88)80110-9

6. Weine FS: The C-shaped mandibular second molar: incidence and other considerations. Members of the Arizona Endodontic Association. Journal of endodontics. 1998, 24:372-375. 10.1016/s0099-2399(98)80137-4

]7. Vertucci FJ: Root canal anatomy of the human permanent teeth. Oral Surgery, Oral Medicine, Oral Pathology. 1984, 58:589-599. 10.1016/0030-4220(84)90085-9

8. Sert S, Bayirli GS: Evaluation of the root canal configurations of the mandibular and maxillary permanent teeth by gender in the Turkish population. Journal of endodontics. 2004, 30:391-398. 10.1097/00004770-200406000-00004

9. Kazemipoor M, Poorkheradmand M, Rezaeian M, Safi Y: Evaluation by CBCT of Root and Canal Morphology in Mandibular Premolars in an Iranian Population. The Chinese journal of dental research : the official journal of the Scientific Section of the Chinese Stomatological Association (CSA). 2015, 18:191-196.

10. Ozcan G, Sekerci AE, Cantekin K, Aydinbelge M, Dogan S: Evaluation of root canal morphology of human primary molars by using CBCT and comprehensive review of the literature. Acta odontologica Scandinavica. 2016, 74:250-258. 10.3109/00016357.2015.1104721

11. Liu J, Luo J, Dou L, Yang D: CBCT study of root and canal morphology of permanent mandibular incisors in a Chinese population. Acta Odontol Scand. 2014, 72:26-30. 10.3109/00016357.2013.775337

12. Zhang R, Yang H, Yu X, Wang H, Hu T, Dummer PM: Use of CBCT to identify the morphology of maxillary permanent molar teeth in a Chinese subpopulation. International endodontic journal. 2011, 44:162-169. 10.1111/j.1365-2591.2010.01826.x

13. D'Addazio PS, Campos CN, Ozcan M, Teixeira HG, Passoni RM, Carvalho AC: A comparative study between cone-beam computed tomography and periapical radiographs in the diagnosis of simulated endodontic complications. Int Endod J. 2011, 44:218-224. 10.1111/j.1365-2591.2010.01802.x

14. AAE and AAOMR Joint Position Statement: Use of Cone Beam Computed

Tomography in Endodontics 2015 Update. Oral surgery, oral medicine, oral pathology and oral radiology. 2015, 120:508-512. 10.1016/j.oooo.2015.07.033

15. Fabra-Campos H: Unusual root anatomy of mandibular first molars. Journal of endodontics. 1985, 11:568-572. 10.1016/s0099-2399(85)80204-1

16. Wang Y, Zheng QH, Zhou XD, et al.: Evaluation of the root and canal morphology of mandibular first permanent molars in a western Chinese population by cone-beam computed tomography. Journal of endodontics. 2010, 36:1786-1789. 10.1016/j.joen.2010.08.016

17. Zhang X, Xu N, Wang H, Yu Q: A Cone-beam Computed Tomographic Study of Apical Surgery-related Morphological Characteristics of the Distolingual Root in 3-rooted Mandibular First Molars in a Chinese Population. Journal of endodontics. 2017, 43:2020-2024. 10.1016/j.joen.2017.07.022

18. De Moor RJ, Deroose CA, Calberson FL: The radix entomolaris in mandibular first molars: an endodontic challenge. International endodontic journal. 2004, 37:789-799. 10.1111/j.1365-2591.2004.00870.x

19. Chandra SS, Chandra S, Shankar P, Indira R: Prevalence of radix entomolaris in mandibular permanent first molars: a study in a South Indian population. Oral surgery, oral medicine, oral pathology, oral radiology, and endodontics. 2011, 112:e77-82. 10.1016/j.tripleo.2011.02.016

20. Tahmasbi M, Jalali P, Nair MK, Barghan S, Nair UP: Prevalence of Middle Mesial Canals and Isthmi in the Mesial Root of Mandibular Molars: An In Vivo Cone-beam Computed Tomographic Study. Journal of endodontics. 2017, 43:1080-1083. 10.1016/j.joen.2017.02.008

21. Nosrat A, Deschenes RJ, Tordik PA, Hicks ML, Fouad AF: Middle mesial canals in mandibular molars: incidence and related factors. Journal of endodontics. 2015, 41:28-32. 10.1016/j.joen.2014.08.004

22. Sherwani O, Kumar A, Tewari R, Mishra S,

Andrabi S, Alam S: Frequency of middle mesial canals in mandibular first molars in North Indian population - An in vivo study. 2016, 6:66-70. 10.4103/1658-5984.180618

23. Cooke HG, 3rd, Cox FL: C-shaped canal configurations in mandibular molars. Journal of the American Dental Association (1939). 1979, 99:836-839. 10.14219/jada.archive.1979.0402

24. Manning SA: Root canal anatomy of mandibular second molars. Part II. C-shaped canals. International endodontic journal. 1990, 23:40-45. 10.1111/j.1365-2591.1990.tb00801.x

25. Fan B, Cheung GS, Fan M, Gutmann JL, Fan W: C-shaped canal system in mandibular second molars: Part II--Radiographic features. Journal of endodontics. 2004, 30:904-908. 10.1097/01.don.0000136206.73115.93

26. von Zuben M, Martins JNR, Berti L, et al.: Worldwide Prevalence of Mandibular Second Molar C-Shaped Morphologies Evaluated by Cone-Beam Computed Tomography. Journal of endodontics. 2017, 43:1442-1447. 10.1016/j.joen.2017.04.016

27. Martins JNR, Mata A, Marques D, Carames J: Prevalence of C-shaped mandibular molars in the Portuguese population evaluated by cone-beam computed tomography. Eur J Dent. 2016, 10:529-535. 10.4103/1305-7456.195175

28. Vertucci F, Seelig A, Gillis R: Root canal morphology of the human maxillary second premolar. Oral surgery, oral medicine, and oral pathology. 1974, 38:456-464. 10.1016/0030-4220(74)90374-0

29. Chourasia HR, Meshram GK, Warhadpande M, Dakshindas D: Root canal morphology of mandibular first permanent molars in an Indian population. International journal of dentistry. 2012, 2012:745152. 10.1155/2012/745152

30. Neelakantan P, Subbarao C, Subbarao CV, Ravindranath M: Root and canal morphology of mandibular second molars in an Indian population. Journal of endodontics. 2010, 36:1319-1322. 10.1016/j.joen.2010.04.001