OPEN ACCESS
ORIGINAL ARTICLE

TOMOGRAPHICAL ANALYSIS OF ROOT CANAL VARIATIONS IN PERMANENT MANDIBULAR CENTRAL INCISORS

[1]ARBAB ZIA UR REHMAN, [2]ASMA ALI, [3]MUHAMMAD BILAL KHALID, [4]ASMA SATTAR, [5]NAHEED IMRAN, [6]MOMENA RASHID, [7]FATIMA IQBAL

ABSTRACT

Objective: *The objective of this study was to analyze root canal variations in permanent mandibular central incisors using cone beam computed tomography.*

Design Place and Duration of Study: *This descriptive study was undertaken in department of radiology, Rehman college of Dentistry, Peshawar, from 15th October 2022 till 15th April 2023.*

Methodology: *Cone Beam Computed Tomography scans of 128 patients of both genders between 18 and 60 years of age were studied and The Cone Beam Computed Tompgraphy scans were studied for type of mandibular central incisor. Results were analyzed with the help of SPSS (version 21). Chi square test was done to stratify teeth type among genders to see effect modifiers. P-value of 0.05 was considered significant.*

Results: *Out of 128 CBCT scans of patients (n=128), there were 70 females (54.68 %)and 58 males (45.32%) having mean age of 28.7 years, ranging from 22-41 years with a standard deviation of 5.25 years. Most of the mandibular central incisors were type I (n=91, 71.09%) followed by Type III canals (n=37, 28.91%). Type II and type IV were not found.*

Conclusion: *Most of the mandibular central incisors are type I followed by type III. Type II and IV were not found in our population.*

Keywords: *Canals, roots, incisors, morphology, mandible, cone beam computed tomography,*

This article may be cited as: Zia Ur Rehman A, Ali A, Khalid MB, Sattar A, Imran N, Rashid M, Iqbal F. Tomographical Analysis of Root Canal Variations in Permanent Mandibular Central Incisors. Pak Oral Dent J, 2024; 44(2):23-27.

INTRODUCTION

Dental anatomy and morphology play a critical role in endodontic treatment success.[1] The complexity of root canal systems within teeth, particularly in mandibular incisors, presents significant challenges for clinicians aiming to achieve optimal treatment outcomes.[2] Proper knowledge of the root canal configurations is crucial to ensure effective cleaning, shaping, and obturation of the root canal system.[3] Despite the advancements in endodontic techniques and technology, a comprehensive understanding of the intricate root canal variations in mandibular incisors remains imperative.

The anatomy of mandibular incisors has been widely studied, revealing a range of variations in root canal configurations.[4] Traditional studies, mainly based on two-dimensional radiographs and sectioned teeth, have contributed to our understanding of these variations. However, these methods often lack precision in representing the intricate three-dimensional structure of root canal systems. With the advent of Cone Beam Computerized Tomography (CBCT), researchers and clinicians now have a more accurate and detailed tool to visualize and analyze the internal structure of teeth.[5]

Cone Beam Computerized Tomography (CBCT) has emerged as a revolutionary imaging modality in the field

[1] Dr. Arbab Zia ur Rehman, BDS, FCPS, Associate Professor, Oral Biology, HBS Dental College and Hospital, Taramri, Islamabad, Pakistan Cell: 03348292066 Email: arbabzia6@gmail.com
[2] Dr. Asma Ali, BDS, MPhil, Assistant Professor, Oral Biology. Bacha khan College of Dentistry, Sheikh Maltoon town, Mardan, KPK, Pakistan. Cell: 03459331550 Email: khan_hoti26@hotmail.com
[3] Dr. Muhammad Bilal Khalid, BDS, House Officer, Pakistan Institute of Medical Sciences, Islamabad, Pakistan. Cell: 03135748989 Email: drbilal23@gmail.com
[4] Dr Asma Sattar, BDS, MPhil, Lecturer in Oral Biology, Peshawar Dental College, Warsak Road, Peshawar,KPK, Pakistan. Cell: 091520219194 Email: drasmasattar1@gmail.com
[5] Dr. Naheed Imran, BDS, MPhil, Lecturer in Oral Biology, Frontier Dental College, Abbottabad, KPK, Pakistan. Cell: 0992406777 Email: naheedimran.13293@gmail.com
[6] Momena Rashid, BDS, MPhil, Assistant Professor, Oral Biology, Rehman College of Dentistry, Peshawar, KPK, Pakistan. Cell: 03339533076 Emial: rashid@rmi.edu.pk
[7] Fatima Iqbal, BDS Student, Rehman College of Dentistry, Hayatabad, Peshawar, KPK, Pakistan. Cell: 0915838000 Email: Iqbal@rmi.edu.pk

Received for Publication: Mar 11, 2024
Revised: May 21, 2024
Approved: May 26, 2024

of endodontics, enabling researchers and practitioners to examine dental structures in three dimensions. CBCT provides high-resolution images, allowing for the precise identification and classification of root canal configurations.[6] This technology has significantly enhanced our comprehension of the complexities associated with root canal morphology, aiding in the diagnosis and treatment planning of endodontic cases[7]. Mandibular incisors have variations in their canal configurations and they need to be evaluated for proper treatment of these teeth.

The rationale for this study lies in the need to bridge the gap between traditional methods of understanding root canal anatomy and the capabilities offered by Cone Beam CT imaging. By addressing the challenges posed by complex root canal morphology in mandibular incisors, this study aims to provide valuable insights that can lead to improved clinical outcomes and more effective endodontic treatments.

The objective of this study was to analyze root canal variations in permanent mandibular central incisors using cone beam computed tomography.

METHODOLOGY

This descriptive study was done in department of radiology at Rehman college of dentistry after getting ethical approval from ethical committee review board (RCD-10-06-116). It was carried out from 15th October 2022 till 15th April 2023. After taking consent, CBCT scans of 128 patients of both genders above 18 years of age were included. The G* Power software version 3.1.9.4 with a 29.9% proportion of type III root canals at a p-value of 0.05, medium-power (0.3) and confidence level of 95.1% was used to calculate sample size.[8] Non probability , consecutive sampling technique was used to enroll patients. Patients who had restorations or caries in their mandibular central incisors and those CBCT which had distorted images were excluded. The radiographs were taken by "Carestream Ger, model 90003D" with 73.9 kv (male patients), 69.9kv (female patients), 10.1mA. These values were adjusted according to manufacturer's radiation protocols for different age groups and genders. Standard resolution of 0.30 mm voxel and 10.80 s was used for all scans. Images were analyzed by using CS Imaging Browser 7.0.20 software. Two experiences examiners studied these images. The images were observed in cornal, sagittal and axial views. Number and configuration of root canals was recorded and classified according to classification done by Weine et al.[9] According to this classification mandibular central incisors were classified into 4 types i.e.

Type I having a single canal.

Type II having two canals which fuse into one canal near the apical area of root.

Type III having one canal which later divides into two separate ones.

Type IV having two separate canals.

Results were analyzed with the help of SPSS (version 21). Chi square test was done to stratify pulp canals among genders to see effect modifiers. P-value of 0.05 was considered significant.

RESULTS

Scans of 128 patients were analysed using CBCT (n=128). There were 70 females (54.68%) and 58 males(45.32%) having a mean age of 28.7 years ranging from 22-41 years with a standard deviation of 5.25 years(Table 1). CBCT scans revealed that most of the teeth were of type I(n=91,71.09%). Type III canals were also found (n=37, 28.91%). Type II and type IV canals were not found in the studied CBCT scans. No significant statistical difference was observed between the male and female groups (P > 0.05) . These results are summarized in table 2.

Figure 1 showing classification of permanent mandibular central incisors according to Weine et al.[9]

Figure 2a: CBCT scan showing Axial view of Class I

TABLE 1: AGE AND GENDER DISTRIBUTION (N=128)

Age	Gender
Range: 22-41 years	Male: 58 (45.32%)
Mean: (+/- SD): 28.7 years(+/- 5.25)	Female: 70 (54.68 %)

TABLE 2: TYPE OF ROOT CANALS IN PERMANENT MANDIBULAR CENTRAL INCISORS (N=128)

TYPE OF ROOT CANALS	Male	Female	Total	P-value
I	48(52.74%)	43(47.26%)	91(71.09%)	
II	0(0%)	0(0%)	0(0%)	
III	17(45.94%)	20(54.06%)	37(28.91%)	
IV	0(0%)	0(0%)	0(0%)	
Total	65(54.16%)	63(45.84%)	128(100%)	0.121

right mandibular central incisor

Figure 2b: CBCT scan showing sagittal view of Class I right mandibular central incisor

Figure 2c: CBCT scan showing Coronal view of Class I right mandibular central incisor

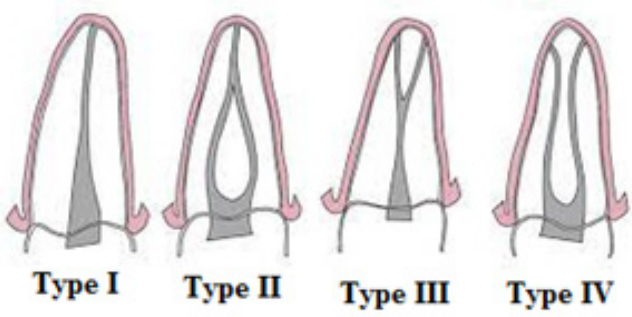

Fig 1: Classification of mandibular central incisor root canals.

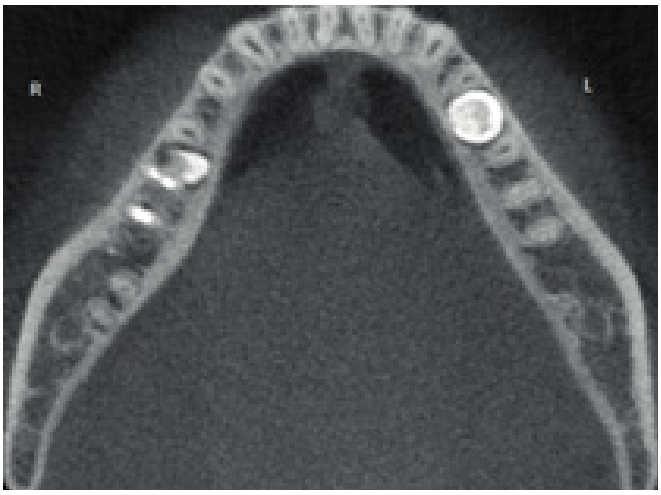

Fig 2a: CBCT scan of Mandibular central incisor

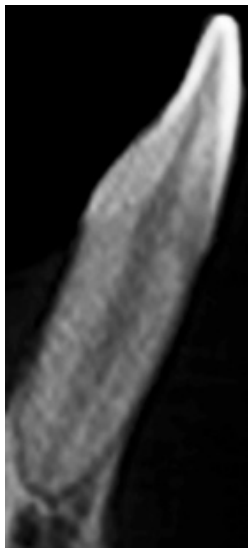

Fig 2b:

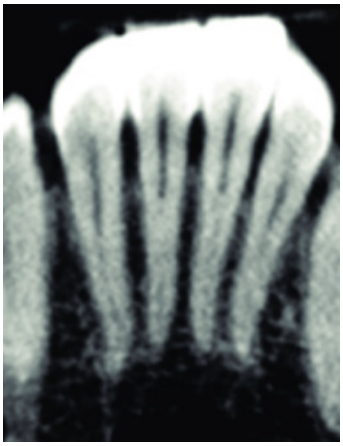

Fig 2c:

DISCUSSION

Endodontic treatment failure in mandibular central incisors can result from a combination of factors. The complexity of root canal morphology, the challenges associated with proper disinfection and obturation, as well as patient-related and procedural variables, can all contribute to treatment failure.[10] In effective cleaning and disinfection, missed canals, incomplete obturation, root fractures, periapical pathology, coronal leakage contribute to endodontic failures.[11] Proper understanding of root canal morphology, utilization of advanced imaging, adherence to thorough cleaning and shaping protocols, and attention to proper obturation techniques are crucial to minimize the risk of treatment failure in these teeth.[12] To mitigate the risk of endodontic treatment failure in mandibular central incisors, it's essential for clinicians to have a thorough understanding of root canal morphology, utilize advanced imaging techniques like Cone Beam CT to identify anatomical variations, adhere to proper cleaning and shaping protocols, ensure proper obturation, and provide adequate patient education for post-treatment care and maintenance.[13] Differences in teeth types among different populations arise from a combination of genetic, environmental, and cultural factors.[14] These variations have implications for dental treatment, research, and forensic identification.[15] Dentists and researchers must consider these differences to provide effective dental care and contribute to the broader understanding of human dental diversity.[16]

Our study found type I mandibular central incisors to be the most prevalent type followed by type III. Similar results were found in studies done in India where they found 84% of patients had Type I, 8% had Type II, 4% had Type III, and 4% had Type IV.[17] Another study done in Iran found 83.1% of mandibular central incisors to be Type I and 16.9% of teeth to be Type II.[18] In majority of studies done worldwide, scientists have found mandibular central incisors to have single roots but Kany□lmaz AN et al in a study done in Turkey

examined 400 teeth and found 67.5 % of permanent central incisors had more than one root.[19] While the exact causes may not be fully elucidated, several factors are believed to contribute to this anatomical variation. This may be a result of a complex interplay between genetic, developmental, evolutionary, and environmental factors.[20] Further research, including genetic studies and investigations into the developmental pathways of tooth formation, could provide more insights into the specific causes of this variation in the Turkish population and beyond.[21] Our study found no difference in mandibular central incisor types among genders. A study in china found a higher incidence of type I in males when compared to females. The higher incidence of Type I mandibular central incisors in males in China can likely be attributed to a combination of genetic, developmental, and hormonal factors.[22] While the precise causes may not be fully understood, several factors are thought to contribute to this phenomenon. This dental morphological variation reflects the complex interplay of biological processes that result in differences between genders.

CONCLUSION

Most of the mandibular central incisors are type I followed by type III. Type II and IV were not found in our population.

REFERENCES

1 Saberi E, Bijari S, Farahi F. Endodontic Treatment of a Maxillary Lateral Incisor with Two Canals: A Case Report. Iran Endod J. 2018;13(3):406–408

2 Bansal,R.Hegde,S.Astekar,M.S. Classification of Root Canal Configurations: A Review and a New Proposal of Nomenclature System for Root Canal Configuration. J Clin Diagn Res JCDR 2018;12(5):01-05

3 Saati S, Shokri A, Foroozandeh M, Poorolajal J, Mosleh N, Saati S, et al. Root Morphology and Number of Canals in Mandibular Central and Lateral Incisors Using Cone Beam Computed Tomography. Braz Dent J. 2018;29(3):239–44.

4 Shemesh A, Kavalerchik E, Levin A, Itzhak JB, Levinson O, Lvovsky A, et al. Root Canal Morphology Evaluation of Central and Lateral Mandibular Incisors Using Cone-beam Computed Tomography in an Israeli Population. J Endod. 2018;44(1):51–55.

5 Hwang SY, Choi ES, Kim YS, Gim BE, Ha M, Kim HY. Health effects from exposure to dental diagnostic X-ray.Environ Health Toxicol. 2018;33(4): e2018017

6 Lo Giudice R, Nicita F, Puleio F, Alibrandi A, Cervino G, Lizio AS, et al. Accuracy of Periapical Radiography and CBCT in Endodontic Evaluation. Int J Dent. 2018;6206562/

7 Jacobs R, Salmon B, Codari M, Hassan B, Bornstein MM. Cone beam computed tomography in implant dentistry: recommendations for clinical use. BMC Oral Health. 2018 15;18(1):88.

8 Khan NB, Azhar M, Baig AM, Ishfaque Q, Raza A, Abbasi N. ROOT CANAL CONFIGURATIONS IN PERMANENT MANDIBULAR INCISORS: A CONE BEAM COMPUTERISED TOMOGRAPHY STUDY. PODJ. 2020;40(4):240-43.

9 Mashyakhy M. Anatomical analysis of permanent mandibular incisors in a Saudi Arabian population: Anin Vivo cone-beam computed tomography study. Niger J Clin Pract 2019;22(11):1611-16

10 Maghfuri S, Keylani H, Chohan H, Dakkam S, Atiah A, Mashyakhy M. Evaluation of root canal morphology of maxillary first premolars by cone beam computed tomography in Saudi Arabian southern region in subpopulation: An in vitro study. Int J Denti 2019;19:25-31.

11 Lo Giudice R, Nicita F, Puleio F, Alibrandi A, Cervino G, Lizio A, et al. Accuracy of periapical radiography and CBCT in endodontic evaluation. Int J Denti 2018;2018:45-50.

12 Qiao X, Xu T, Chen L, Yang D. Analysis of root canal curvature and root canal morphology of maxillary posterior teeth in Guizhou, China. Medical Science Monitor: I M J E C R. 2021;27:758-61.

13 Mirza MB, Gufran K, Alhabib O, Alafraa O, Alzahrani F, Abuelqomsan MS et al. CBCT based study to analyze and classify root canal morphology of maxillary molars-A retrospective study. E R M P S. 2022;26(18):367-9.

14 Regnstrand T, Torres A, Petitjean E, Lambrechts P, Benchimol D, Jacobs R. CBCT□based assessment of the anatomic relationship between maxillary sinus and upper teeth. C E D R. 2021;7(6):1197-204.

15 Maia LM, de Carvalho Machado V, da Silva NR, Júnior MB, da Silveira RR, Júnior GM, Sobrinho AP. Case reports in maxillary posterior teeth by guided endodontic access. J Endod. 2019;45(2):214-8.

16 Motiwala M, Arif A, Ghafoor R. A CBCT based evaluation of root proximity of maxillary posterior teeth to sinus floor in a subset of Pakistani population. JPMA. 2021;71(8):1992-3

17 Nivedhitha S. Pradeep. Retrospective CBCT Analysis Of Root Canal Morphology Of Mandibular Incisors In Indian Sub Population. Int J Dentistry Oral Sci. 2021;8(05):2591-6.

18 Kany□lmaz AN, Okumu□ Ö, Sunay H. Assessment of root canal anatomy of mandibular incisors using cone-beam computed tomography in a Turkish subpopulation: Root Canal Anatomy of Mandibular Incisors Using CBCT. I D R. 2021;11(1):46-53.

19 Jadhav V, Tiwari M, Seegavadi V, Kamble R, Daigavane P. A formula for estimating the mesiodistal width of permanent mandibular central incisors. J D I M S U. 2021;16(1):29-32.

20 Jang E, Lee J, Nam S, Kim H. Spontaneous eruption of a dilacerated mandibular central incisor after trauma of a primary tooth: two case reports. J K A P D. 2021;48(1):115-21.

21 Martins JN, Marques D, Silva EJ, Caramês J, Mata A, Versiani MA. Influence of demographic factors on the prevalence of a second root canal in mandibular anterior teeth–a systematic review and meta-analysis of cross-sectional studies using cone beam computed tomography. Archiv Ora Biol. 2020;116:749-53.

22 Soundarya N, Jain VK, Shetty S, Akshatha BK. Sexual dimorphism using permanent maxillary and mandibular incisors, canines and molars: An odontometric analysis.JOMFP. 2021;25(1):183-4.

	CONTRIBUTIONS BY AUTHORS	
1	**Arbab Zia ur Rehman:**	Study conception and design
2	**Asma Ali:**	Data Collection and Image Analysis
3	**Muhammad Bilal Khalid:**	Data Entry
4	**Asma Sattar:**	Abstract writing
5	**Naheed Imran:**	Critical Revision
6	**Momena Rashid:**	Analysis and interpretation of data
7	**Fatima Iqbal:**	Manuscript writing