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Original Research Article

Prevalence of Two Roots Canals in Mandibular Incisors in Patients Visiting a Dental College (Using Magnification 3.5x)

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Abstract: *Successful endodontic treatment depends on accurate identification and management of root canal anatomy. Mandibular incisors often exhibit anatomical variations, including the presence of two root canals, which may be overlooked during treatment and contribute to endodontic failure. Vertucci's classification provides a standardized system for evaluating root canal morphology. The use of magnification aids may improve the detection of additional canals and enhance treatment outcomes.* ***Objective:*** *To determine the frequency of two canals in mandibular incisors according to Vertucci's classification using a magnifying loupe.* ***Methods:*** *This descriptive cross-sectional study was conducted on 85 patients at the Department of Operative Dentistry, Peshawar, from December 03, 2023, to June 03, 2024, using a consecutive nonprobability sampling technique. Male and female patients aged 20–60 years with irreversible pulpitis, pulp necrosis, or periapical pathosis involving mandibular incisors were included. Patients with an allergy to local anesthesia, internal root resorption, calcified canals, or pregnancy were excluded. The presence of two canals was defined as two distinct root canals within a single mandibular incisor, confirmed through both clinical and radiographic examination. Canal identification was performed by trained dental professionals using the Same Lingual Opposite Buccal (SLOBE) radiographic technique and a 3.5× magnifying loupe. Root canal morphology was assessed according to Vertucci's classification. Frequencies of canal configurations were stratified by age, gender, tooth type, and educational status. Statistical analysis was performed using the chi-square test and Fisher's exact test, with a p-value <0.05 considered statistically significant.* ***Results:*** *The mean age of the participants was 35.96 ± 11.08 years, and 35 (41.18%) were females. The most frequently examined tooth was the left mandibular lateral incisor (37.65%), followed by the left mandibular central incisor (34.12%). A single canal configuration was observed in 57 (67.06%) teeth, whereas two canals were identified in 28 (32.94%) teeth. A single root was present in 59 (69.41%) teeth. Two canals were more frequently observed in males (64.29% of two-canal cases) and among patients aged 20–40 years (75.0% of two-canal cases). However, no statistically significant associations were found between the presence of two canals and age, gender, educational status, or tooth type (p > 0.05).* ***Conclusion:*** *The frequency of two canals in mandibular incisors was relatively high, being present in approximately one-third of the examined teeth. Clinicians should be aware of these anatomical variations and utilize careful clinical and radiographic assessment, including magnification, to improve canal detection and optimize endodontic treatment outcomes.*

Keywords: Mandibular Incisors, Two Canals, Vertucci Classification, Magnifying Loupe, Root Canal Morphology

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Introduction

Anatomical variability of the root canal system poses challenges for endodontic treatment (1). Therefore, a thorough understanding of both normal anatomy and common and uncommon variations in root canal structure is crucial for successful treatment (2). Considering anatomical variations can significantly enhance the quality of endodontic procedures. Many issues encountered during and after root canal treatment stem from inadequate understanding of the pulp space anatomy (3).

Studies on dental internal anatomy have indicated that anatomical variability can occur across all types of teeth and can be quite complex. This is also applicable to the lower incisors, where many clinicians fail to detect a second canal (4). The current understanding of pulp space anatomy is primarily based on research conducted on various populations. Numerous studies have examined the root canal systems of mandibular incisors, yet there remains a significant inconsistency in the reported occurrence of second canals in these teeth. These inconsistencies may be linked to differences in study designs (in vivo vs. in vitro), the methods used to identify canals (including imaging, sectioning, and/or clearing), or possible ethnic variations (5, 6).

Cone Beam Computed Tomography (CBCT) is an accurate, non-invasive imaging method that produces 3D images while exposing patients to less radiation than traditional computed tomography. It is supported by the European Society of Endodontology for evaluating root canal morphology, providing evidence-based guidance for clinicians (7). However, because of its higher radiation dose, CBCT is not recommended for routine use in endodontics and is generally reserved for more complex cases where standard radiographs may not provide sufficient information (8).

In endodontic procedures, using a magnifying loop is a common practice to visualize the internal anatomy of the root canal system. This allows for better detection of additional canals, leading to improved treatment outcomes and reduced risks of complications. The use of a magnifying loop is particularly important in detecting the lingual canal, which can be challenging to locate due to its small size and varying morphology (9).

A previous study conducted in Germany using 302 CBCT scans involving 1,208 mandibular incisors reported that in 12.3% of cases, all four incisors showed two root canals (10). Other studies reported that 11–68% of mandibular incisors possess two canals (11).

This study aims to explore the significance of identifying and treating all root canals of a tooth for successful root canal therapy. Specifically, locating the lingual root canal in mandibular incisors can be difficult, emphasizing the need for more data on the Prevalence and internal structure of root canals in these teeth. To date, no research has examined the occurrence of two canals in mandibular incisors within this population. Additionally, the number of root canals in lower incisors varies among individuals due to genetic and environmental factors. As such, investigating the prevalence and anatomy of root canals in mandibular incisors could provide valuable insights to improve root canal treatment outcomes.

The objective of this study is to determine the frequency of two canals in mandibular incisors, based on the Vertucci classification, using a magnifying loupe among patients visiting Peshawar Dental College.

Methodology

This descriptive cross-sectional investigation was conducted at the Department of Operative Dentistry, Peshawar, from December 03, 2023, to June 03, 2024, using a consecutive, non-probability sampling technique. The sample size of 85 participants was calculated using the WHO sample size calculator at a 95% confidence level and a 7% margin of error, based on a 12.3% prevalence of two canals reported in the literature (10).

The study included both male and female participants aged 20 to 60 years. Eligible cases included patients with irreversible pulpitis in mandibular incisors, identified by a history of spontaneous pain; pulp necrosis in mandibular incisors, confirmed as non-vital using an electric pulp tester; and periapical pathosis in mandibular incisors, as evidenced by radiolucency on a periapical radiograph or pain upon percussion. The exclusion criteria included patients with a known allergy to local anesthesia, those presenting with internal root resorption or calcified canals, and pregnant females, as radiographic examination is contraindicated during pregnancy.

Approval from the hospital's ethics committee was obtained. Patients who met the inclusion criteria were invited to participate in the study from the Operative Dentistry outpatient department. They were informed about the study's purpose, what it involved, potential risks, and expected benefits. Their written consent was obtained, and participation was completely voluntary. They were also assured that their personal information and any data collected from their records would be kept confidential.

After conducting a detailed clinical and radiographic examination of the mandibular incisor, local anesthesia was administered to all participants for their comfort during the procedure. A rubber dam was used to isolate the tooth, ensuring a dry and controlled environment. An access cavity was then created buccolingually with a round bur, providing access to the root canal system. After preparing the access cavity, the canals were explored with a number 15 K-file to evaluate their patency and location. The number of canals was documented clinically using a magnifying loupe for accurate assessment. When two canals were identified, two periapical radiographs were taken using the horizontal SLOBE technique. This technique involved adjusting the X-ray angle by approximately 45 degrees between the two images to confirm the presence of two canals.

Two canals in mandibular incisors were defined as the presence of two separate root canals within a single mandibular incisor, confirmed through both radiographic and clinical examination. The identification of two canals was performed by trained dental professionals (second-year FCPS trainees) using the SLOBE rule and a magnifying loupe (3.5x magnification) to improve visualization and accuracy.

Vertucci's classification system was used to categorize the canals based on their structure. There were five types: Type I had a single canal running from the pulp chamber to the root apex; Type II had two canals that merged into one before reaching the apex; Type III started as a single canal that split into two, then came back together as one; Type IV had two separate canals running independently from the pulp chamber to the apex; and Type V had a single canal that split into two distinct canals.

Bias and confounders in the study were controlled by strictly adhering to the inclusion and exclusion criteria, with participants included or excluded according to the specific criteria outlined above. Additionally, stratification was performed by age, gender, tooth type, and educational level to further mitigate potential biases.

The data were analyzed using R software version 4.3.2. Numerical data were described in the form of the mean and SD. Frequencies and percentages were determined for qualitative variables, including gender and the number of canals in lower incisors. Canal frequencies were stratified by gender, age group, tooth type, and educational level. A post-stratification chi-square test was used to assess differences in canal frequencies. When the chi-square test assumptions were not met, Fisher's exact test was used. $p<0.05$ was set as the significant threshold.

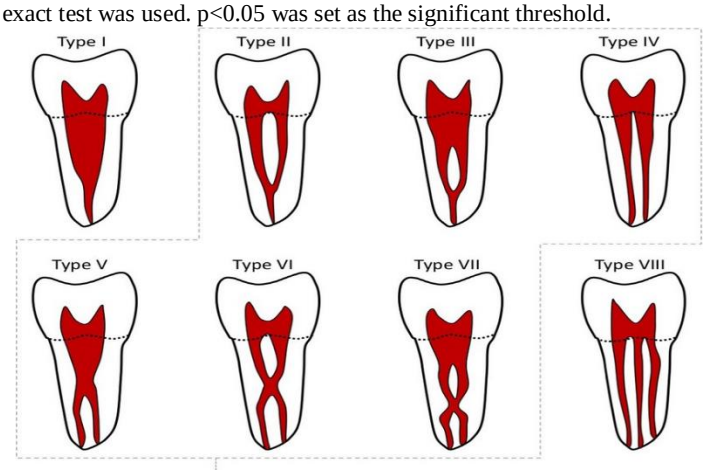


Fig 1: Vertucci's classification (12)

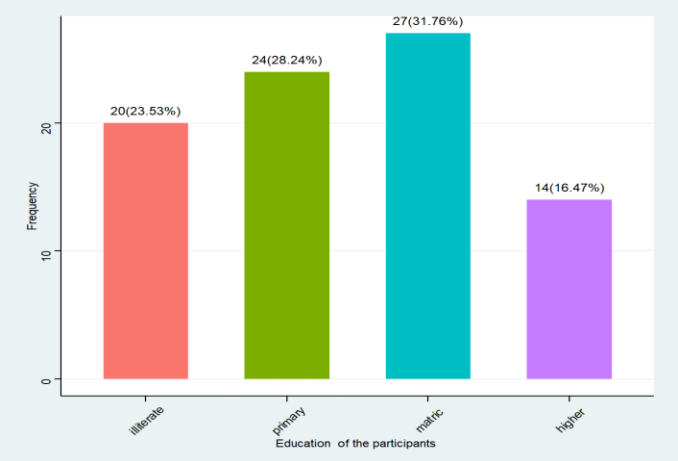
Results

The mean age was 35.96 years (SD = 11.08). The gender distribution was 35 (41.18%) females and 50 (58.82%) males. The age distribution was 54 (63.53%) participants aged 20-40 years and 31 (36.47%) aged 41-60 years (Table 1).

The most common educational level among the 85 participants was matric, with 27 (31.76%) participants. This was followed by primary education (24, 28.24%), illiterate participants (20, 23.53%), and higher education (14, 16.47%). (Figure 2)

The most common tooth type was left lateral, with 32 (37.65%) occurrences, followed by left central (29, 34.12%), right lateral (16, 18.82%), and right central (8, 9.41%). The most common canal configuration was a single canal, found in 57 (67.06%) teeth, followed by two canals (28, 32.94%). The most common root type was a single root, seen in 59 (69.41%) teeth, while 26 (30.59%) teeth had two roots. The most common canal type was Type I (14, 16.47%), followed by Type III (7, 8.24%), Type IV (4, 4.71%), and Type II (3, 3.53%) (Table 2).

Two canals were most common in the 20-40 age group (n = 21, 75%) and among males (n = 18, 64.29%). Regarding educational level, primary education had the highest frequency of two canals (n = 10, 35.71%), followed by higher education (n = 6, 21.43%). For tooth type, two canals were the most common in left central teeth (n = 14, 50.00%). However, no significant differences were found for age (p = 0.12), gender (p = 0.47),



educational level (p = 0.37), or tooth type (p = 0.09) **(Table 3).**

Fig 2. Educational level of the participants

Table 1: Demographics of the participants

Characteristic	N = 85
Age (mean ±SD)	35.96 ± 11.08
Gender	
Female	35 (41.18)
Male	50 (58.82)
Age categories	
20-40 years	54 (63.53)
41-60 years	31 (36.47)

Table 2: Frequency of Tooth Types, Roots, Canals, and Canal Types

Characteristic	N = 85
Tooth Type	
Left central	29 (34.12)
Left lateral	32 (37.65)
Right central	8 (9.41)
Right lateral	16 (18.82)
Canal	
Single	57 (67.06)
Two	28 (32.94)
Root	
Single	59 (69.41)
Two	26 (30.59)
Canal Type	
Single canal	57 (67.06)
Type I	14 (16.47)
Type II	3 (3.53)
Type III	7 (8.24)
Type IV	4 (4.71)

Table 3: Stratification of frequency of canal in lower incisor by age, gender, education, and tooth type

Characteristic	Number of canals		
	single, N = 57	two, N = 28	p-value*
Age group			0.12
20-40	33 (57.89)	21 (75.00)	
41-60	24 (42.11)	7 (25.00)	
Gender			0.47
Female	25 (43.86)	10 (35.71)	
Male	32 (56.14)	18 (64.29)	
Educational Level			0.37
illiterate	16 (28.07)	4 (14.29)	
primary	14 (24.56)	10 (35.71)	
matric	19 (33.33)	8 (28.57)	
higher	8 (14.04)	6 (21.43)	
Tooth type			0.09
left central	15 (26.32)	14 (50.00)	
left lateral	26 (45.61)	6 (21.43)	
Right central	6 (10.53)	2 (7.14)	
Right lateral	10 (17.54)	6 (21.43)	

Pearson's Chi-squared test; Fisher's exact test

Discussion

Our findings showed that two canals were present in 32.94% of cases. The left lateral incisor was the most common tooth type, and single canals were most frequent, though two canals were observed in a significant number of teeth. Two canals were most common in males, the 20-40 age group, and participants with primary education. No significant differences were found based on age, gender, educational level, or tooth type.

In a study by Sert et al. (12), clearing and staining techniques were applied to extracted mandibular permanent incisors to investigate the presence of additional root canals. The results revealed that 68% of mandibular central incisors and 63% of mandibular lateral incisors had a second canal, indicating a significant prevalence of anatomical variation in these teeth. The discrepancies between Sert et al.'s findings and the current study could be attributed to several factors, including differences in sample size, methodology, and the specific racial or ethnic group studied. Variations in these elements can influence the detection and reporting of canal systems, potentially leading to differing outcomes between studies. Furthermore, a case report suggested that all mandibular incisors possess two canals. While this may not apply universally across all populations, it supports the notion that multiple canals are common in mandibular incisors (13).

Geduk et al. (14) conducted a detailed assessment of mandibular incisor canal morphology using cone-beam computed tomography (CBCT). Their findings revealed that the most common configuration was Type 1, present in 64.41% of cases, indicating that the majority of mandibular incisors had a single canal and a single root—results closely aligned with the current study. The second most frequently observed configuration was Type 3, observed in 19.41% of cases, further supporting the variation in canal anatomy. In contrast, another study reported different trends. It identified Type 5 canals as the second most prevalent configuration at 12.91%, suggesting a notable presence of more complex canal systems. This was followed by Type 4 canals at 0.71% and Type 2 at 0.31%, showing less frequent but still important anatomical variations (15).

Additionally, Zitong Lin et al. (16) also examined mandibular incisor canal patterns and found that Type 1 canals were the most dominant, with a prevalence of 81.81%. Type 3 canals were the next most common, at 12.71%, consistent with both Geduk et al.'s and our study's findings on the frequency of Type 3 canals. However, a key point of divergence lies in the third-most-common configuration. While Zitong Lin et al. identified Type 2 canals in this position, our findings indicated a higher prevalence of Type 5 canals, suggesting population-based or methodological differences in canal morphology.

This study was conducted at a single center, so the results may not apply to other populations or clinical settings. Different regions and patient groups may exhibit variations in tooth anatomy, so a broader sample would yield more generalizable findings. Another factor to consider is the operator's experience—since evaluations were done manually, differences in skill or technique could have influenced the results. While magnifying loupes improve visibility, they have limitations. CBCT is widely considered the most reliable method for identifying root canal systems because it gives highly detailed, 3D images. It's possible that some canals were missed using loupes alone, so incorporating CBCT could have provided a more accurate picture of the root canal anatomy.

Conclusion

Two canals were found in one-third of mandibular incisors in this study. The most common canal type was Type I, followed by Type III, Type IV, and Type II. No significant associations were observed between canal configuration and age, gender, education, or tooth type.

Declarations

Data Availability Statement

All data generated or analysed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department concerned. (IRB-PMDC-0243/24)

Consent for publication

Approved

Funding

Not applicable

Conflict of interest

The authors declared the absence of a conflict of interest.

Author Contribution

SR (PGR), IA (Professor)

Contributed to study design, data collection, and initial manuscript drafting

Assisted in data acquisition, literature review, and manuscript editing

Performed statistical analysis and contributed to the interpretation of results

Helped in methodology development, data organization, and manuscript formatting

MN (PGR), SZ (PGR), SSAS (PGR)

Contributed to patient recruitment, data entry, and results compilation

Assisted in referencing, proofreading, and final revisions of the manuscript

Guided study execution and critically reviewed the manuscript

Supervised the research, coordinated among authors, finalized the manuscript, and approved the final version

All authors reviewed the results and approved the final version of the manuscript. They are also accountable for the integrity of the study.

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