

# Rare but Possible: Three Roots with Three Canals in Maxillary First Premolars in Pakistani Subpopulation

Shaher Bano <sup>1</sup>, Malik Adeel Anwar <sup>2</sup>, Khadija Arif <sup>2</sup>, Rai Sadaf Nawaz <sup>3</sup>, Annam Aziz <sup>4</sup>, Fatima Khalil <sup>2</sup>

<sup>1</sup>Department of Oral Biology, Rahbar College of Dentistry, Lahore, <sup>2</sup>Department of Oral Pathology & Oral Diagnostics, University College of Medicine and Dentistry, The University of Lahore, <sup>3</sup>Department of Oral Biology, Fatima Memorial Hospital College of Medicine & Dentistry, Lahore, Pakistan, <sup>4</sup>Department of Medical Education, University College of Medicine and Dentistry, The University of Lahore, Pakistan.

## ABSTRACT

**Background:** The anatomical complexity of maxillary first premolars in root and canal configurations can present challenges in endodontic treatment and extractions. Maxillary first premolars may occasionally have three roots and three canals, affecting treatment outcomes. Therefore, this study was designed to assess the variations in the number of roots and root canals in maxillary first premolars in the Pakistani subpopulation using Cone Beam Computed Tomography.

**Methods:** Using convenient sampling, a cross-sectional study was conducted from January 2023 to January 2024 at Fatima Memorial Hospital. A total of 270 maxillary first premolars were analyzed on 143 CBCTs to identify several roots and canals. Patients aged 13 years and older with premolars having fully erupted and completely formed roots were included. Data was analyzed using SPSS version 23 with a Chi-square test to evaluate the differences between genders on both sides.

**Results:** A Total of 143 participants were analyzed, having 270 maxillary first premolars. 14.8% (n=40) had one root and one canal, 9.3% (n=25) had one root and two canals, 73.3% (n=198) had two roots and two canals, and 2.6% (n=7) exhibited three roots and three canals. A statistically significant difference ( $p=0.036$ ) in root and canal morphology was observed between genders, with males showing more variations. Bilateral symmetry was noted in 88.7% (n=127) of cases, with the right side showing a slightly higher prevalence of three roots and three canals (2.96%; n=4).

**Conclusion:** The study highlighted the uncommon but possible occurrence of three roots and three canals in maxillary first premolars, underlining the importance of thorough radiographic evaluation for successful treatment.

**Keywords:** Root, Root Canals, Incidence, Cone Beam Computerized Tomography, Anatomical Variations, Root Canal System.

### Corresponding Author:

**Dr. Shaher Bano,**

Department of Oral Biology,  
Rahbar College of Dentistry,  
Lahore, Pakistan.

Email: shaher.bano2@gmail.com

ORCID: <https://orcid.org/0009-0002-6755-318X>

Doi: <https://doi.org/10.36283/ziun-pjmd14-2/024>

**How to cite:** Bano S, Anwar MA, Arif K, Nawaz RS, Aziz A, Khalil F Rare but Possible: Three Roots with Three Canals in Maxillary First Premolars in Pakistani Subpopulation. Pak J Med Dent. 2025 April ;14(2): 151-156. Doi: <https://doi.org/10.36283/ziun-pjmd14-2/024>

**Received:** Sat, October 26, 2024 **Accepted:** Wed, March 26, 2025 **Published:** Sun, April 13, 2025

This is an open-access article distributed under the terms of the Creative Commons Attribution License (CC BY) 4.0  
<https://creativecommons.org/licenses/by/4.0/>

## INTRODUCTION

Many patients visit the dental outpatient department (OPD) with painful, carious teeth requiring treatments from extractions to conservative approaches like root canal therapy (RCT). RCT involves removing infected coronal and radicular pulp, a process complicated by the intricate and variable root canal systems<sup>1</sup>. Therefore, a thorough understanding of root and root canal anatomy is vital to successful endodontic treatment, which includes comprehensive cleaning and shaping of canals, three-dimensional obturation, and a tightly sealed coronal restoration to prevent any leakage<sup>2</sup>.

Successful endodontic outcomes rely on a thorough understanding of the root canal morphology, particularly in premolars and molars, where anatomical variations can complicate the treatments<sup>3</sup>. Effective chemo-mechanical preparation and filling of the root canal system depend on knowledge of normal root canal anatomy and its variations, as identified in various studies<sup>4</sup>. Missed canals, often due to limited anatomical knowledge, lead to poor treatment outcomes<sup>5</sup>. Notably, the presence of three roots and three canals in maxillary first premolars is through rare presents a significant challenge for clinicians in terms of diagnosis and treatment<sup>6</sup>.

Accurate RCT and the safest extraction mandate precise knowledge of several canals and roots is mandatory<sup>7</sup>. Premolars and molars are known for variation in the number of roots and canals, ranging from one to three across different populations<sup>8</sup>. This variability is further influenced by individual and population-specific anatomical differences<sup>9</sup>.

Traditionally, two-dimensional imaging is the standard for dental radiographic examinations, but it often results in superimposed or distorted images, hindering accurate diagnosis and treatment planning<sup>10</sup>. To overcome these limitations, various methods such as dye injection, decalcification, and sectioning enhanced radiographic imaging with contrast media have been employed to study tooth morphology<sup>11</sup>.

Since its introduction in 1998, Cone Beam Computed Tomography (CBCT) has become a valuable tool in dentistry, providing precise three-dimensional images. CBCT is widely used in oral and maxillofacial surgery, implant dentistry,

endodontics, orthodontics, and general dentistry. It also aids in understanding the complex root canal morphologies and dental anomalies associated with cleft lip and palate with a generation of less ionizing radiation along with better magnification and better measurements without geometric distortion<sup>12,13,14</sup>.

The maxillary first premolar typically erupts between the ages of 10 and 11 years, with root development completed by ages 12 to 14 years<sup>15</sup>. These premolars are predominantly two-rooted with two<sup>16</sup>. Therefore, this study aimed to explore variations in the number of roots and root canals in the maxillary first premolar within the Pakistani subpopulation.

## METHODS

The study was a cross-sectional study conducted from January 2023 to January 2024 in the Department of Radiology, Fatima Memorial Hospital (FMH) College of Medicine and Dentistry, Lahore. It was approved by the Institutional Review Board (Reference number: FMH-26/12/2022-IRB-1156). The sample size was calculated by using the formula  $(n=p(1-p)(Z/e)^2)^{12}$ . Using CBCT imaging, data on 143 maxillary first premolars were collected via convenient sampling and recorded in a structured proforma.

CBCT scans, calibrated to 90kV and 10mA, with a 12-second exposure, were analyzed bilaterally to identify roots and canals. Standardized settings included a scan diameter of 100mm, a volume of 80mm, and a slice thickness of 0.35mm. Images were evaluated using Planmeca Romexis software (v6.0.0.3) on a 24-inch monitor in a dimly lit environment. Patient demographics, including age and gender, were documented.

Patients aged 13 years and older with fully formed maxillary first premolars were included, while those under 13 or missing these teeth were excluded. Informed consent was obtained, and confidentiality was ensured.

Data were analyzed using SPSS v23, with categorical variables presented as frequencies and percentages. Chi-square test were performed to assess significant differences by gender and side, with a p-value  $\leq 0.05$  considered statistically significant.

**RESULTS**

**Table 1: Participants' Demographics and Premolar Analysis Overview**

Mean Age (Years)	Gender		Premolars Analyzed	
	Male	Female	Right	Left
36.94± 13.83	57 (40%)	86 (60%)	135 (50%)	135 (50%)
	Total Participants: 143 (100%)		Total Premolars: 270 (100%)	

The present study assessed maxillary first premolars in 143 participants with 57 (40%) males and 86 (60%) females using CBCT imaging with a mean age of 36.94 ± 13.83. A total of 270 teeth were analyzed after accounting for missing or extracted premolars (Table 1).

**Table 2: Variation in Number of Roots and Canals of Maxillary First Premolar**

Root/s Canal/s	Left	Right	Total
One Root, One Canal	20 (14.8%)	20 (14.8%)	40 (14.8%)
One Root, Two Canals	13 (9.6%)	12 (8.9%)	25 (9.3%)
Two Roots, Two Canals	99 (73.4%)	99 (73.4%)	198 (73.3%)
Three Roots, Three Canals	3 (2.2%)	4 (2.9%)	7 (2.6%)
Total	135 (100%)	135 (100%)	270 (100%)

The majority of premolars, 198 (73.3%), had two roots, followed by 40 (14.8%) with one root and one canal, 25 (9.3%) with one root and two canals, and 7 (2.6%) with three roots and three canals (Table 2).

CBCT images illustrating three bilateral roots and three canals are shown in Figure 1.



**Figure 1: CBCT Slices Showing Bilateral Three Roots and Three Canals. Slices: A) Cervical, B) Middle, C) Apical.**

Bilateral symmetry in root morphology was observed in 88.7% (n=127) of participants, while 11.3% (n=16) exhibited asymmetry. CBCT images illustrating bilateral asymmetry are shown in Figure 2.



**Figure 2: CBCT Slices Showing Bilateral Asymmetry with One Root (One Canal) on the Right Side (Yellow arrows) and Two Roots (Two Canals) on the Left Side (White arrows). Slices: A) Cervical, B) Middle, C) Apical.**

**Table 3: Distribution of Root Numbers and Root Canals in Maxillary First Premolars (Left and Right Sides)**

Distribution	Root number		Root canals	
	Left	Right	Left	Right
One	33 (24.4%)	32 (23.7%)	20 (14.8%)	20 (14.8%)
Two	99 (73.3%)	99 (73.3%)	112 (82.9%)	111 (82.2%)
Three	3 (2.22%)	3 (2.22%)	3 (2.22%)	4 (2.96%)
Total	135 (100%)	135 (100%)	135 (100%)	135 (100%)

Three roots were observed infrequently at 2.22% (n=3) on both sides, while the corresponding three root canals were more common on the right side (2.96%; n=4) (Table 3).

**Table 4: Distribution of Root and Canal Configurations in Maxillary First Premolars by Gender and Side**

Root and Canal Configuration	Maxillary Left First Premolar		Maxillary Right First Premolar	
	Males n=55	Females n=80	Males n=57	Females n=78
One Root, One Canal	5 (9.1%)	15 (18.75%)	5 (8.8%)	15 (17.4%)
One Root, Two Canals	7 (12.7%)	6 (7.5%)	6 (10.5%)	6 (7.0%)
Two Roots, Two Canals	41 (74.6%)	58 (72.5%)	43 (75.4%)	56 (65.1%)
Three Roots, Three Canals	2 (3.6%)	1 (1.25%)	3 (5.3%)	1 (1.2%)
P-value	0.326		0.036*	

\*Significant p-value

Gender analysis revealed that males had a slightly higher prevalence of two roots with two canals (74.6% on the left and 75.4% on the right). Three roots with three canals were rare, with a slightly higher occurrence in males on the right side. Additionally, three roots and three canals were rarely observed in females (Table 4).

## DISCUSSION

The findings showed 24.4% of maxillary premolars had a single root, aligning with a study done in Saudi Arabia (23.7%) and in Jordan (30.8%) but differing significantly from studies in Nepal (65.9%) and Japan (80.8%),<sup>17-20</sup>. The most common configuration was two roots with two canals (73.3%), consistent with Jordanian (63.2%), Saudi (75.1%), and Kosovar (70.14%) populations<sup>18,21,22</sup>. However, a study reported 33.7% of two-rooted premolars in Nepal<sup>19</sup>.

Single-rooted premolars with a single canal were observed in 14.8%, and 9.3% had a single root with two canals. Side-specific differences in canal configuration were also noticed. While most of the teeth on both sides had two roots with two canals in alignment, studies on Egyptian and Jordanian populations reported similar values of 73.2% and 79.7%, respectively, with two roots and two canals<sup>23,18</sup>.

Three roots with three canals were rare (2.6%), aligning with the Saudi study (1.2%) but differ from Koçani reporting 8.14% in the Kosovar population<sup>21,22</sup>. Jordan, Nepal, and Japan showed lower frequencies (0.8%, 0.4%, and 1.6%)<sup>18,19,20</sup>. In the study, the right side exhibited a slightly higher percentage of three roots and three canals. This suggests that two-rooted maxillary first premolars are typical globally, while single and three-rooted variations exist regionally.

Gender-based variations were evident. Males had a

higher prevalence of two roots with two canals (74.6% left and 75.4% right) compared to females (72.5% left and 71.8% right). Conversely, females exhibited a slightly higher prevalence of single-rooted premolars (18.75% left and 17.4% right) compared to males (9.1% left and 8.8% right). These findings align with a study done in 2023 that reported gender differences in root morphology<sup>24</sup>.

Additionally, three-rooted premolars were more frequently observed in males (3.6% on the left and 5.3% on the right) compared to females (1.25% and 1.2%, respectively). Similar gender-based variations have been reported in other studies, such as the research on the Chinese population, where males exhibited a higher prevalence of complex root configuration<sup>25</sup>.

Bilateral symmetry was observed in 88.7% of participants, while 11.3% showed asymmetry. This suggests that in most cases, clinicians can reasonably expect similar root configuration on both sides consistent with a study done in 2024 by Olczak's observation on bilateral variability<sup>7</sup>.

Compared to national studies, our findings align with a study done in Lahore, where 60% of participants had two roots and 72% had two canals<sup>26</sup>. However, it was observed that there were more three-rooted premolars compared to the study that reported no three-rooted cases<sup>26</sup>. In Karachi, research found a lower prevalence of single-rooted premolars (31.5%) but a similar distribution of two canals (89.6%)<sup>27</sup>.

Contrastingly, Peshawar showed a higher prevalence of single-rooted premolars (92.8%) and fewer two-rooted premolars (7.14%)<sup>28</sup>. These regional differences suggest variability in root morphology within Pakistan, potentially due to genetic diversity or environmental factors.

The study's limitations include its focus on a single population, representing a Punjabi subpopulation in Lahore. Future studies should expand to include diverse samples across Pakistan to better understand root morphology across demographics.

## CONCLUSION

The complex root and canal morphology of maxillary first premolars is significantly with two roots and two canals. However, the presence of three roots and three canals through rare was observed. The bilateral symmetry noted in most participants emphasizes consistency in morphology, yet variations, particularly the occurrence of three-rooted premolars, demand attention during clinical and endodontic procedures. Thus, adds unique insight into the morphological diversity in this population, aiding in improved diagnosis and treatment planning strategies for dental practitioners.

## LIST OF ABBREVIATIONS

**OPD:** Outpatient Department

**RCT:** Root Canal Therapy

**CBCT:** Cone Beam Computerized Tomography

**FMH:** Fatima Memorial Hospital

## ACKNOWLEDGEMENTS

The authors would like to thank the Department of Radiology, FMH College of Medicine & Dentistry, Lahore, for their support and facilitation in providing the CBCT scans.

## CONFLICT OF INTEREST

None

## FUNDING

None

## ETHICAL APPROVAL

The study received ethical approval from the Institutional Review Board of Fatima Memorial College of Medicine and Dentistry, Lahore, under reference number (FMH-26/12/2022-IRB-1156).

## AUTHORS' CONTRIBUTIONS

**SB**, as the corresponding author, conceived the idea, examined cases, interpreted data, and contributed to manuscript writing. **MMA** was responsible for results interpretation and manuscript writing. **KA** examined cases and assisted in manuscript writing, while **RSN** also examined cases and entered data into **SPSS**. **AA** and **FK** contributed to the manuscript writing.

## REFERENCES

- Acharya N, Humagain R, Dahal S, Kafle D. The need for endodontic therapy among patients attending a tertiary care center in Central Nepal. *Kathmandu Univ Med J*. 2022 July-Sep; 79(3):264-7. <https://www.kumj.com.np/issue/79/264-267.pdf>
- Shakeel S, Fahim A, Tariq K, Haider I, ur Rehman I, Anwar MA et al. Root Canal Configuration Using Cone Beam Computed Tomography in Mandibular Incisors of Pakistani Individuals: Root Canal Configuration Using Cone Beam Computed Tomography in Mandibular Incisors. *PJHS*. 2024 Dec 31;5(12):87-92. doi: 10.54393/pjhs.v5i12.2115
- Kumar A, Sawhney MK, Goel M, Kiran B, Tandon S, Sharma R. A cone-beam computed tomography-guided endodontic management of internal variations in the root canal anatomy of maxillary molar. *Indian J Dent Sci*. 2024 Jan 1;16(1):38-42. doi: 10.4103/ijds.ijds\_33\_23
- Aras SD, Borkar AC, Mujumdar SV, Maral SA, Barbhai SS, Gambhir AS. Endodontic management of an aberrant root canal anatomy: a case report and literature review. *Front Oral Maxillofac Med*. 2024 Sep 10;6:29. doi: 10.21037/fomm-22-68
- Manik K, Ikhara A, Patel A, Chandak M, Bhopatkar J, Rathod P, et al. Anatomical variations in mandibular molars: focus on mid-mesial canals. *Cureus*. 2024 Jun 5;16(6): e61711. doi: 10.7759/cureus.61711.
- Jiannan C, Yangpeng Z, Huanhuan S, Qiang Z. Endodontic Treatment of Maxillary Premolar With Three Roots: A Case Report. *Case Rep Dent*. 2024 Jul 22; 2024:5525349. doi: 10.1155/2024/5525349.
- El Taher H, Kamel S, Nofal S, Tewfik H, Sabet N, Fakhr M, et al. Cone beam computed tomographic evaluation of root canal morphology of maxillary and mandibular molars in the Egyptian population. *J Fundam Clin Res*. 2024 June 1;4(1): 96-106. doi: 10.21608/jfcr.2024.271833.1075.
- Celikten B, Orhan K, Aksoy U, Tufenkci P, Kalender A, Basmaci F, et al. Cone-beam CT evaluation of root canal morphology of maxillary and mandibular premolars in a Turkish Cypriot population. *BDJ Open*. 2016 Jan 29;2(1):1-5. doi: 10.1038/bdjopen.2015.6
- Olczyk A, Malicka B, Skośkiewicz-Malinowska K. Root anatomy and canal configuration of human permanent maxillary third molar: a systematic review. *Folia Morphol (Warsz)*. 2024 June 18. doi: 10.5603/fm.98475.
- Santos ÁHMFD, De Almeida Santos JP, De Souza Moura CG, Bernardo LF, De Almeida Couto VB, De Sousa Carvalho Saboia R. Imaging in dentistry. *Health Soc*. 2023 Jan 5;2 (2):56-66. doi: 10.51249/hs.v2i06.1090.
- Dinakar C, Shetty UA, Saliyan VV, Shetty P. Root canal morphology of maxillary first premolars using the clearing technique in a South Indian population: an in vitro study. *Int J Appl Basic Med Res*. 2018 Jul-Sep;8(3):143-7. doi: 10.4103/ijabmr.IJABM-R\_46\_18.
- Bano S, Asif SM, Shehzad F, Idrees N, Ihsan A,

- Anwar MA. Exploring variation in root canal morphology of maxillary second premolars: a cone-beam computed tomography study in a Pakistani subpopulation. *Pak J Health Sci.* 2024 Aug 31;5(8):60-5. doi: 10.54393/pjhs.v5i08.1622.
13. Huda NU, Shahzad HB, Noor M, Ishaq Y, Anwar MA, Kashif M. Frequency of different dental irregularities associated with cleft lip and palate in a tertiary care dental hospital. *Cureus.* 2021 April 13;13(4):1-5 e14456. doi: 10.7759/cureus.14456
14. Hanif F, Ahmed A, Javed MQ, Khan ZJ, Ulfat H. Frequency of root canal configurations of maxillary premolars as assessed by cone-beam computerized tomography scans in the Pakistani subpopulation. *Saudi Endod J.* 2022. Jan-Apr;12(1):100-5. doi: 10.4103/sej.sej\_141\_21
15. Nagaş IÇ, Eğiimez F, Kivanç BH. The permanent maxillary and mandibular premolar teeth. In: *Dental Anatomy*. 1st ed. London: IntechOpen; 2018. doi: 10.5772/intechopen.79464 .
16. Gupta S, Sinha D, Gowhar O, Tyagi S, Singh N, Gupta S. Root and canal morphology of maxillary first premolar teeth in north Indian population using clearing technique: an in vitro study. *J Conserv Dent.* 2015 May-June;18(3):232. doi: 10.4103/0972-0707.157260.
17. Alenezi MA, Al-Nazhan SA, Al-Omari MA. Three-dimensional evaluation of root canal morphology of maxillary first premolars: micro-computed tomographic study. *Saudi Dent J.* 2022 Jul 29;34(7):611-6. doi: 10.1016/j.sdentj.2022.07.004.
18. Awawdeh L, Abdullah H, Al-Qudah A. Root form and canal morphology of Jordanian maxillary first premolars. *J Endod.* 2008 Aug 1;34(8):956-61. doi: 10.1016/j.joen.2008.04.013.
19. Shrestha S, Joshi N, Prajapati D, Sharada D, Wagle D, Nyachhyon D, et al. Cone beam computed tomography analysis of the root canal morphology of the maxillary first premolar. *J Nepal Dent Assoc.* 2023 Jan-Jun;23(36):51-6. [https://www.researchgate.net/publication/381551177\\_Cone\\_Beam\\_-\\_Computed\\_Tomography\\_Analysis\\_of\\_the\\_Root\\_Canal\\_Morphology\\_of\\_Maxillary\\_First\\_Premolar](https://www.researchgate.net/publication/381551177_Cone_Beam_-_Computed_Tomography_Analysis_of_the_Root_Canal_Morphology_of_Maxillary_First_Premolar).
20. Yoza T, Serikawa M, Sugita T, Harada T, Usami A. Cone-beam computed tomography observation of maxillary first premolar canal shapes. *Anat Cell Biol.* 2021 Dec 31;54(4):424-30. doi: 10.5115/acb.21.110.
21. Alqedairi A, Alfawaz H, Al-Dahman Y, Alnassar F, Al-Jebaly A, Alsubait S. Cone-beam computed tomographic evaluation of root canal morphology of maxillary premolars in a Saudi population. *Biomed Res Int.* 2018 Aug 15;2018(1):1-8. doi: 10.1155/2018/8170620.
22. Koçani F, Kamberi B, Dragusha E, Kelmendi T, Sejfića Z. Correlation between anatomy and root canal topography of first maxillary premolar on Kosovar population. *Open J Stomatol.* 2014 Jul 1;4(7):332-9. doi: 10.4236/ojst.2014.47046.
23. Saber SEDM, Ahmed MHM, Obeid M, Ahmed HMA. Root and canal morphology of maxillary premolar teeth in an Egyptian subpopulation using two classification systems: a cone beam computed tomography study. *Int Endod J.* 2018 Sep 17;52(3):267-78. doi: 10.1111/iej.13016.
24. Karobari MI, Iqbal A, Batul R, Rahman NA, Khalid MF, Al-Qahtani MQ. Assessment of root canal morphology of maxillary premolars: a CBCT study exploring age and gender variations. *Res Sq. Epub ahead of print Oct 19, 2023.* doi: 10.21203/rs.3.rs-3449226/v1.
25. Cheng XL, Weng YL. [Observation of the roots and root canals of 442 maxillary first premolars]. *Shanghai Kou Qiang Yi Xue.* 2008 Oct 1;17(5):525-8.
26. Haider I, Siddique S, Tirmazi S, Moazzam M, Sana U, Rasheed M, et al. Evaluation of root canal morphology of maxillary first premolars by cone beam computed tomography. *Pak J Med Health Sci.* 2021 Dec 31;15(12):3663-5. doi:10.53350/pjmh2115123663.
27. Nazeer MR, Khan F, Ghafoor R. Evaluation of root morphology and canal configuration of maxillary premolars in a sample of Pakistani population by using cone beam computed tomography. *J Pak Med Assoc.* 2018 Mar 1;68(3):423-7. [https://ecommons.aku.edu/cgi/viewcontent.cgi?article=1046&context=akunonotext=pakistan\\_fhs\\_mc\\_surg\\_dent\\_oral\\_maxillofac](https://ecommons.aku.edu/cgi/viewcontent.cgi?article=1046&context=akunonotext=pakistan_fhs_mc_surg_dent_oral_maxillofac)
28. Shah SA. Cone beam computed tomography evaluation of root canal morphology of maxillary premolars in north-west sub-population of Pakistan. *Khyber Med Univ J.* 2023. Jun 30;15(2):116-21. doi:10.35845/kmu.j.2023.23168.