MAR Dental Sciences & Oral Rehabilitation (2025) 5:12

Research Article

Evaluation of Root Canal Systems in Kashmiri Maxillary First Permanent Molars.

Dr. Parvaze Ahmad Parvaze *[1], Dr. Shafiat Ullah Khateeb [2], Dr. Aamir Rashid Pura[3], Dr. Ajaz Masoodi[4]

1. Dr. Parvaze Ahmad Parvaze, BDS, MDS, Dental Restorative Specialist, PHCC, Doha, Qatar.

2. Dr. Shafiat Ullah Khateeb, BDS, MDS, Assistant Professor, Department of Restorative Dental Sciences, College of Dentistry, King Khalid University, KSA.

3. Dr. Aamir Rashid Pura, BDS, MDS, Professor and Head of department, Govt. Dental College and Hospital, Srinagar, J&K, India.

4. Dr. Ajaz Masoodi, BDS, MDS, Asistant Professor, Govt. Dental College and Hospital, Srinagar, J&K, India.

***Correspondence to**: Dr. Parvaze Ahmad Parvaze, BDS, MDS, Dental Restorative Specialist, PHCC, Doha, Qatar.

Received: 28 May 2025

Published: 03 June 2025

DOI: https://doi.org/10.5281/zenodo.15590481

ABSTRACT

Introduction: *Understanding the root canal system is crucial for successful endodontic therapy. This study aims to evaluate the root canal systems of maxillary first permanent molars in the Kashmiri population, addressing the gap in research on non-Caucasian populations.*

Objective: *To investigate the variations in the root canal systems of maxillary first permanent molars in the Kashmiri population and provide insights to improve endodontic therapy outcomes.*

Materials and Methods: *An in-vitro study was conducted on 100 extracted maxillary first permanent molars from Kashmiri patients. Teeth were prepared, cleaned, and examined using Indian ink and demineralization techniques to visualize the canal systems.*

Results: *The study revealed that 99% of maxillary first molars in the Kashmiri population possess three separate roots. Two canals in the mesiobuccal root were present in 52% of specimens, with various canal configurations observed. Lateral canals and intercanal communications were found in 6% and 18% of roots, respectively.*

Discussion: *The findings highlight the anatomical complexity of the root canal system and the need for clinicians to adopt thorough and methodical approaches to endodontic treatment. The prevalence of two-canalled mesiobuccal roots and the presence of lateral canals and intercanal communications emphasize the importance of advanced irrigation techniques.*

Conclusion: *This study documents the root canal anatomy of maxillary first permanent molars in the Kashmiri population, revealing significant variations in canal morphology. Understanding these population-specific anatomical variations is essential for improving endodontic treatment success. Future research with larger sample sizes and advanced imaging techniques is recommended.*

Introduction

Understanding the root canal system is a fundamental aspect of planning and executing successful endodontic therapy. Optimal outcomes depend on locating all root canals, thoroughly debriding them, and achieving a three-dimensional seal with an inert root filling material. Failure to identify and treat all canals can result in

untreated spaces that serve as a nidus for infection, ultimately leading to treatment failure.

Although intricate anatomical features such as fins, webs, and inter-canal communications may not always significantly impact clinical outcomes, the identification of the number and configuration of root canals is critical for predictable treatment [1]. Recognizing variations in canal anatomy, particularly among different racial and ethnic groups, plays a vital role in the accurate location, negotiation, and management of canals during endodontic therapy.

The study of root canal anatomy has clinical importance in endodontics [2] and anthropological [3,4,5] significance. Several studies have identified differences in root and canal morphology [6,7,8] among populations, including variations in the shape, number, and configuration of canals. These differences are thought to be genetically [9,10,11] determined and have been used to trace the racial origins of populations. However, most studies investigating root canal systems have been conducted predominantly in Europe and North America, focusing on Caucasian populations. There is a significant gap in research on non-Caucasian populations, particularly in regions outside Europe and North America.

Permanent maxillary first molars are often affected by caries early in life, necessitating root canal therapy for long-term retention. These teeth are particularly important in the context of endodontic research due to their frequent involvement in clinical cases. Despite their importance, there is no published data on the root canal anatomy of maxillary first permanent molars in the Kashmiri population.

Objective

This study aims to evaluate the root canal systems of maxillary first permanent molars in the Kashmiri population. The findings will contribute to the understanding of anatomical variations in this region and provide valuable insights to improve the predictability and outcomes of endodontic therapy in this demographic.

Materials and Methods

An **in-vitro** study was conducted to investigate variations in the root canal systems of maxillary first permanent molars in the Kashmiri population. The study sample consisted of 100 extracted maxillary first permanent molars obtained from native Kashmiri patients attending the Department of Exodontia, Government Dental College & Hospital, Srinagar. The age, gender, and reason for extraction of the patients

were not recorded, as the teeth were extracted for reasons unrelated to the study. Written informed consent for tooth extraction was obtained from patients in accordance with the ethical guidelines governing dental practice in Jammu & Kashmir. Dentists were instructed to include only teeth extracted from Kashmiri patients, with the collected teeth designated for research purposes.

Teeth were collected over a two-year period and stored in a 10% formalin solution until the start of the investigation. The teeth were subsequently immersed in 3% sodium hypochlorite for two hours and cleaned of any adherent soft tissue, bone fragments, and calculus using scaling instruments. The number of roots and their morphology were recorded through visual examination. Tooth preparation followed the method described by Yang et al.[12] with modifications.

Endodontic access cavities were prepared using a diamond fissure bur and high-speed handpiece. The teeth were then placed in 3% sodium hypochlorite for 24 hours to dissolve organic tissue within the root canal system, rinsed under running water for two hours, and air-dried overnight. To visualize the canal systems, Indian ink was injected into the pulp chamber using a hypodermic syringe equipped with 30-gauge Max-I-Probes. The root apex was connected to a suction system until the ink exited through the apical foramina.

Teeth were then demineralized in 10% nitric acid at room temperature for six days. The acid was changed daily for the first three days with manual agitation, while for the subsequent three days, the acid was left unchanged to prevent over-decalcification. The softness of the teeth was assessed daily using a needle. After demineralization, the teeth were washed under running water for four hours and dehydrated in successive solutions of 75% and 95% alcohol for 24 hours each. Finally, the teeth were immersed in methyl salicylate for approximately two hours, rendering them transparent.

The transparent specimens were examined under a lens with a magnification power of 4x. The following parameters were recorded:

1. Number of roots and their fusion/separation.
2. Number and configuration of root canals.
3. Presence of lateral canals.
4. Intercanal communications.
5. Number and position of apical foramina.

Lateral canals were defined as branches of the main canal that diverged at right or oblique angles to exit on

the lateral aspect of the root. Root canal configurations were classified according to Vertucci's classification system as follows:

Type I: A single canal extends from the pulp chamber to the apex.

Type II: Two canals leave the pulp chamber and merge to form one canal before exiting.

Type III: A single canal leaves the pulp chamber, divides into two canals within the root, and merges again to exit as one.

Type IV: Two separate canals extend from the pulp chamber to the apex.

Type V: A single canal divides into two distinct canals before exiting the apex.

Type VI: Two canals leave the pulp chamber, merge, and then re-divide to exit as two separate canals.

Type VII: A single canal leaves the pulp chamber, divides, rejoins, and divides again before exiting.

Type VIII: Three distinct canals extend from the pulp chamber to the apex.

Results

Out of the 100 maxillary first permanent molars studied, 99% exhibited three distinct and separate roots. Fusion of the mesiobuccal and palatal roots in the cervical and middle thirds was observed in only one specimen. Two canals in the mesiobuccal root (MB-2) were present in 52% of the specimens. The canal configurations of the mesiobuccal root included Vertucci Types I, II (35%), III, IV (15%), V, and VI (2%). The distobuccal (DB) and palatal (P) roots predominantly exhibited a Type I configuration (96%), with rare occurrences of Type II (2%) and Type V (2%) configurations. The detailed distribution is summarized in Table 1.

Table – 1 :Number & percentage of canal system types in Kashmiri maxillary first molars

	No. of Roots	Fused Roots	Separate Roots	Type 1	Type II	Type III	Type IV	Type V	Type VI	Type VII	Type VIII	Additional types
MB-Root	100	1 (1%)	99 (99%)	40 (40%)	35 (35%)	2 (2%)	15 (15%)	6 (6%)	2 (2%)	-	-	-
DB-Root	100	-	100 (100%)	99 (99%)	-	-	-	1	-	-	-	-
P-Root	**100**	**1 (1%)**	**99 (99%)**	**96 (96%)**	**2 (2%)**	**-**	**-**	**2 (2%)**	**-**	**-**	**-**	**-**

INCIDENCE OF LATERAL CANALS AND INTERCANAL COMMUNICATIONS IN KASHMIRI MAXILLARY FIRST PERMANENT MOLAR:

Out of 300 roots examined, lateral canals were found in 18 roots (6%), primarily in the apical third. Intercanal communications were observed in 54 roots (18%), most commonly in the coronal third (Table 2).

Table2: Number and percentage of Kashmiri maxillary first molar roots with lateral canals and intercanal communications.

	Number of roots	Lateral canals			Intercanal communications		
		Coronal third	Middle third	Apical third	Coronal Third	Middle Third	Apical Third
Maxillary first molar	300	-	-	18 (6%)	54 (18%)	-	-

Discussion

The root canal system exhibits significant anatomic complexity, with multiple foramina, accessory canals, and intercanal communications frequently observed. Since Hess and Zurcher [13] first documented the intricate structure of the pulp canal system, numerous studies have reinforced the notion that a tapering canal with a single foramen is the exception rather than the rule. Variations such as fins, loops, deltas, and C-shaped canals emphasize the need for clinicians to approach each tooth with an assumption of potential complexity.

Various methodologies have been employed to study root canal morphology, including radiography [14], root sectioning [15], micro-computed tomography [16], and staining and clearing techniques [17]. Among these, the clearing technique [18,19,20] remains a gold standard for visualizing three-dimensional root canal anatomy due to its simplicity, cost-effectiveness, and ability to provide detailed insights into the internal structure of the root canal system. This method was adopted in the present study to investigate the root canal anatomy of maxillary first permanent molars in the Kashmiri population, a group for which no prior data existed.

The findings revealed that 99% of maxillary first molars in the Kashmiri population possess three separate and distinct roots, with only 1% exhibiting fusion between the mesiobuccal and palatal roots. The prevalence of two canals in the mesiobuccal root (52%) was consistent with findings in other Asian populations, such as studies conducted by Wasti et al. [21] and Ting Ng et al. [22] However, this prevalence was lower compared to studies from non-Asian populations, such as those by Imura et al. [23] and Ng et al.[24] using similar staining and clearing techniques.

The variation in canal configurations, particularly in the mesiobuccal root, highlights its clinical significance.

Vertucci's Type II (35%) and Type IV (15%) configurations were the most common patterns in two-canalled mesiobuccal roots. Clinicians must be aware of these configurations as they have direct implications for locating and negotiating canals during treatment. Studies suggest that canal complexity increases with age due to continuous dentin deposition, which can obscure canal systems and present challenges in older patients.

The simplicity of canal configurations in the distobuccal (99% Type I) and palatal (96% Type I) roots aligns with findings [2] in other populations. However, the rare occurrence of Type II and V configurations in these roots, as observed in this study, underscores the importance of meticulous exploration during treatment.

Lateral canals and intercanal communications were observed in 6% and 18% of roots, respectively, with lateral canals most commonly found in the apical third and intercanal communications in the coronal third. These findings have important clinical implications, as these structures can harbor residual microorganisms and impede thorough debridement and sealing. The use of advanced irrigation techniques, such as ultrasonic activation of sodium hypochlorite, may enhance cleaning efficacy in such anatomically complex areas.

The results of this study provide valuable insights into the root canal anatomy of maxillary first permanent molars in the Kashmiri population. The high prevalence of two-canalled mesiobuccal roots and the presence of lateral canals and intercanal communications emphasize the need for clinicians to adopt a thorough and methodical approach to endodontic treatment.

Conclusion

This study is the first to document the root canal anatomy of maxillary first permanent molars in the Kashmiri population. While the majority of teeth exhibited the expected three-rooted morphology, significant variations in canal configurations, particularly in the mesiobuccal root, were observed. These findings underscore the importance of understanding population-specific anatomical variations to improve the success of endodontic treatment. Future studies with larger sample sizes and advanced imaging techniques are recommended to further explore the endodontic anatomy of this population.

References

1. Weine FS, Healey HJ, Gerstein H, Evanson L. Canal configuration in the mesiobuccal root of the maxillary first molar and its endodontic significance. Oral Surg Oral Med Oral Pathol Oral Rdiol Endod 1969;28:419–25.

2. Vertucci FJ. Root canal anatomy of the human permanent teeth. Oral Surg Oral Med Oral Pathol Oral Rdiol Endod 1984;58:589–99.

3. Walker RT. Root form and canal anatomy of mandibular first molars in a Southern Chinese population. Endod Dent Traumatol 1988a;4:19–21.

4. Dahlberg AA. Geographic distribution and origin of dentitions. Int Dent J 1965;15:348–55.

5. Cooke HG, Cox FL. C-shaped canal configurations in mandibular molars. J Am Dent Assoc 1979;90:836–9.

6. Al-Nazhan S. Incidence of four canals in root-canal-treated mandibular first molars in a Saudi Arabian sub-population. Int Endod J 1999;32:49–52.11.

7. Pattanshetti N, Gaidhane M, Al Kandari A M. Root and canal morphology of the mesiobuccal and distal roots of permanent first molars in a Kuwait population – a clinical study. Int Endod J 2008;41, 755–762.

8. Sperber GH. Genetic mechanisms and anomalies in odontogenesis. J Canad Dent Assoc 1967;33:433–42.

9. Tratman EK. Three-rooted lower molars in man and their racial distribution. Part I. Brith Dent J 1938;64:264–74.

10. Somogyi-Csizmazia W, Simons AJ. Three-rooted mandibular first molars in Alberta Indian children. J Can Dent Assoc 1971;37:105–6.

11. Salwa AY, Abdullah RA, Mohammad FF. Three rooted permanent mandibular first molars of Asian and Black groups in the Middle East. Oral Surg Oral Med Oral Pathol Oral Rdiol Endod 1990; 69:102–5.

12. Yang ZP, Yang SF, Lin YC, Shay JC, Chi CY. C-shape root canals in mandibular second molars in a Chinese population. Endod Dent Traumatol 1988;3:160–3.

13. Hess W, Zurcher E. The Anatomy of Root Canals of the Teeth of the Permanent and Deciduous Dentitions. New York: William Wood & Co, 1925.

14. Omer OE, Al Shalabi RM, Jennings M, Glennon J, Claffey NM. A comparison between clearing and radiographic techniques in the study of the root-canal anatomy of maxillary first and second molars. Int Endod J 2004;37:291–6.

15. Jung IY, Seo MA, Fouad AF, Larz S.W. Spångberg, Lee SJ et al. Apical anatomy in mesial and mesiobuccal roots of permanent first molars. J Endod 2005;31(5):364- 8.

16. Mannocci F, Peru M, Sherriff M, Cook R, Pitt Ford TR. The isthmuses of the mesial root of mandibular molars: a micro-computed tomographic study. Int Endod J 2005;38:558–63.

17. Robertson D, Leeb J, McKee M, Brewer E. A clearing technique for the study of root canal systems. J Endod 1980;6:421–4.

18. Gulabivala K, Opasanon A, Ng Y-L, Alavi A. Root and canal morphology of Thai mandibular molars. Int Endod J 2002; 35:56–62.

19. Al-Qudah AA, Awawdeh LA. Root and canal morphology of mandibular first and second molar teeth in a Jordanian population. Int Endod J 2009;42:775–84.

20. Vertucci F, Williams R. Root canal anatomy of the mandibular first molar. J New Jers Dent Assoc 1974;45:27–8.

21. Wasti F, Shearer AC, Wilson NHF. Root canal systems of the mandibular and maxillary first permanent molar teeth of south Asian Pakistanis. Int Endod J 2001; 34:263–6.

22. Ting PCS, Nga L. Clinical detection of the minor mesiobuccal canal of maxillary first molars. Int Endo J 1992;25:304–6.

Medtronic