

ROOT CANAL MORPHOLOGY OF MANDIBULAR FIRST PERMANENT MOLARS — KARACHI SAMPLE

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ABSTRACT

Asian populations show many variations in root canal morphology of permanent mandibular first molar. This in vitro study was done at Dr Ishrat ul Ibad Khan Institute of Oral Health Sciences and NED University Karachi, Pakistan to explore the number of roots and root canals, their configurations, occurrence of isthmi and apical deltas in mandibular permanent first molar teeth in Pakistani population. One hundred and twenty three mandibular first permanent molars were collected and exposed to clearing technique. The teeth were then viewed in a stereomicroscope under 7.5 x magnifications. The canal configurations were characterized using Vertucci's categorization of canal configuration. Although two roots were found in all teeth under study, 65.8% exhibited three root canals, 34.2% had four root canals. The most prevalent canal arrangements found in mesial roots were Vertucci's type (IV) 70.7% and in distal roots Vertucci's type (I) 65.8% respectively.

Key Words: Mandibular first molar, root canal morphology, canal configuration, mandibular first molar morphology.

INTRODUCTION

The goal of endodontic treatment is thorough mechanical and chemical debridement of the entire pulp cavity in addition to the attainment of hermetic seal along the entire root canal system.^{1,2} Therefore it is essential for the clinician to have adequate knowledge of root canal anatomy and morphologic variations in order to reduce the probability of treatment failure.³

It is now well accepted that mandibular first molar exhibits a number of anatomical variations not only in number of roots but also in canal morphology.^{2,4} Anatomically permanent mandibular first molar typically displays a mesial and a distal root with two mesial and one distal canal. Other studies describe high prevalence of two canals in distal root in different population.^{5,6,7}

Variations in morphology of canals and number of roots appear to have a genetic predisposition in addition to environmental influence.⁸ Hence a clinician should also be well aware of racially prevalent morphology.⁹

The significant variant in mandibular first permanent molar is the existence of supernumerary root that can be found distolingually. This structure was first discovered by Carabelli then named as Radix Entomolaris, and is generally smaller than the distobuccal and mesial root. Moreover, it may be partially fused with other roots or separated.¹⁰ The morphology of mesial root allows inter- canal communications and isthmi¹¹ - a narrow connection between two root canals that contain pulp tissues.¹²

Studies to explore root canal anatomy on first permanent mandibular molars have been performed on several populations including Pakistani population.^{8,13,14} The purpose of this study was to perform a detailed investigation examination to explore the number of roots and root canals, their configurations, occurrence of isthmi and apical deltas in mandibular permanent first molar teeth in Karachi sample by utilizing clearing technique.

METHODOLOGY

One hundred and twenty three mandibular first molars were collected from Department of Oral and Maxillofacial Surgery of Dr Ishrat ul Ibad Khan Institute of Oral Health Sciences, Karachi, Pakistan making sure that teeth belonged to native Pakistani population. Teeth with intact external morphology were selected. The teeth were washed under running tap water after extraction and then kept in 10% formalin. The attached soft tissue, and calculus remaining after

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extraction were removed by ultrasonic scalars. Each specimen was first inspected visually and labeled by the number of roots.

Then cavity were prepared using No. 2 Round diamond bur (Mani, Japan) in High Speed Air Rotor Hand piece (MRD, China) with air-water spray to get an access to the pulp chamber. Following this, pulp canals were identified by introducing size 06 k file. Next, the specimens were placed in 5.25% sodium hypochlorite for 24 hours for dissolving organic debris and remnants of pulp. Later, teeth were placed under flowing tap water for 2 hours.

The teeth were placed in 5% nitric acid at room temperature for decalcification and acid was changed daily for 5 days. Again, the teeth were placed for 4 hours under flowing tap water so as to remove traces of nitric acid. For dehydration teeth were kept under ascending concentrations of ethyl alcohol starting from 70% for 12 hours, followed by 90% for one hour and 3 rinses with 100% ethyl alcohol for one hour each. Methyl salicylate was used for approximately 2 hours to make the dehydrated teeth transparent. India ink dye was introduced into the pulp chamber with the help of 27-gauge needle. The dye was then allowed to flow through the canal system by generating negative pressure to the apices of the tooth through vacuum suction. The superfluous dye was removed from the teeth by the help of gauze soaking with 100% concentration of ethyl alcohol. The teeth were stored under methyl salicylate till the next step. The cleared teeth were observed under stereomicroscope at a magnification of 7.5 x. The canal configurations were classified using Vertucci's classification as follows.¹⁵

TABLE 1: NUMBER OF ROOTS AND CANALS IN MANDIBULAR FIRST MOLARS

No. teeth	No. Roots		No. of Canals per tooth		
	2	3	3	4	5
123	123	—	81	42	—
	100%	—	65.8%	34%	—

TABLE 2: CANAL CONFIGURATION AND THE TYPE OF ROOT CANAL IN MANDIBULAR FIRST MOLARS

Group (No. root)	Canal Configuration (Type)						
Mesial root (123)	I	II	III	IV	VI	VII	VIII
	—	33	—	87	3	—	—
		26.8%		70.7%	2.4%		
Distal root (123)	81	18	—	24	—	—	—
	65.8%	14.6%		19.5%			

Canal configurations were categorized using Vertucci's classification (1984).

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

Type II. Two separate canals leave the pulp chamber and join short of the apex to form one canal.

Type III. One canal leaves the pulp chamber, divides into two within the root, and then merges to exit as one canal.

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

Type V. One canal leaves the pulp chamber and divides short of the apex into two separate and distinct canals with separate apical foramina.

Type VI. Two separate canals leave the pulp chamber, merge in the body of the root, and re divide short of the apex to exit as two distinct canals.

Type VII. One canal leaves the pulp chamber, divides and then rejoins within the body of the root, and finally redivides into two distinct canals short of the apex.

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

The specimens were photographed to provide permanent visual demonstration of their root canal system as shown in Fig 1-4. They were vertically sectioned in buccolingual direction through the furcation. Mesial and distal roots were separated for viewing under stereomicroscope.

RESULTS

Of 123 teeth that were observed 100% had two roots. None of them exhibited extra distal root (radix entomolaris). 65.8% of specimens displayed three root canals (mesiobuccal, mesiolingual, distal) whereas 34.2% displayed four root canals two in mesial root (mesiobuccal, mesiolingual) two in distal roots (distobuccal and distolingual). (Table 1)

These mesial and distal roots displayed differences in canal configuration. Mesial roots dominated by type IV configuration (70.7%) followed by type II (26.8%)

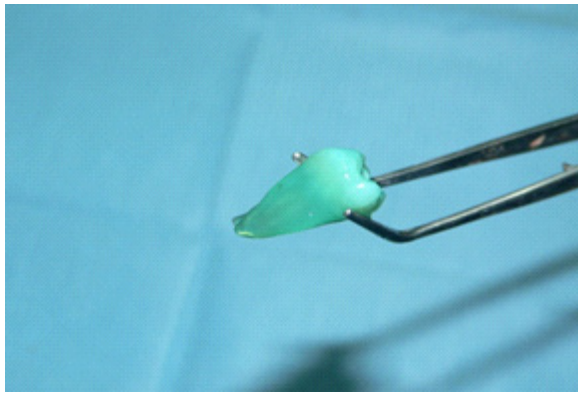


Fig 1: Mandibular molar after decalcification



Fig 2: Mandibular molar after clearing



Fig 3: Mesial Roots: After dye penetration



Fig 4: Distal Roots after dye penetration

and type VI (2.4). (Table 2). Distal roots dominated by type I (65.8%) and then type IV (19.5%) and type II (14.6%). Isthmi were found in (10%) of cases in mesial roots. Apical deltas were found in (5%) of cases in distal roots.(Table 3)

DISCUSSION

Over the years the method used to study root canal anatomy are replication technique^{1,2} use of radiopaque dyes and radiographs³, sectioning of teeth⁵, clearing technique^{4,5,6} and recently, spiral computed tomography (SCT)⁷, and cone beam computed tomography (CBCT). The decalcification and clearing technique provides a clearer picture of canal morphology providing a three dimensional view of the root canal system without gaining access into specimen with instruments. This helps to maintain the external shape and internal morphology of canals with their isthmi and interconnections. Hence, clearing technique was used in present study. The clearing technique is simple but there are some limitations. First of these limitations is the formation of opaque areas owing to incomplete dehydration. This is taken care of by additional dehydration in 100% ethyl

alcohol. Secondly there could be development of opacity after air drying; however this is readily reversible by immersion in methyl salicylate solution.

In the present study none of the teeth exhibited third root (radix entomolaris). The prevalence of three roots in mandibular first permanent molars was 1.44% as observed by Shahi S et al by clearing technique in Iranian population.⁸ According to Vertucci's study the prevalence of radix entomolaris was reported to be 2.02%.¹⁵ In contrast, Gulabivala et al observed that 13% of mandibular first molars in Thai population had three roots.⁹ Ethnic variations are probably responsible for the difference in number of roots observed.

In the present study it was established that 42 teeth (34.2%) of mandibular first molar had four canals. These results are close to those of Hartwell¹⁰ and Chaurasia¹¹, who found four canals in 35.1% and 36% of teeth respectively. In a study of Pakistani population in Peshawar by Hussain et al reported 40% of the teeth had four canals and 60% had three canals.¹³

Some studies have shown higher prevalence of fourth canal like Wang Y⁷, Al-Nazhan⁵ and Al-Qudah⁶ who reported 51.4%, 57.6% and 46% respectively. Similarly, Wasti and coworkers observed that in Pakistani population 47% had four canals and 53% had three canals.⁸

On the other hand, Skidmore and Bjorndal¹⁶, Zaatar et al¹², Sperber and Moreau¹⁹, Shahi S et al²³ reported 28.9%, 29%, 25%, 31.57% of teeth had four canals respectively which has a lower value than the current study.

In the current study, type IV configuration was most prevalent (70.7%) for mesial roots followed by type II (26.8%) configuration. Other authors have also reported high prevalence of type IV canal configuration in mesial root including Wang Y⁷, Al-Qudah⁶, H A Ahmad et al¹³ who reported 93.9%, 73%, 53% respectively. Furthermore Skidmore¹⁶, and Chaurasia²⁶ found out that type IV 54% was more prevalent followed by type II 36.6%, and type VI 8%. Shahi S et al²³ reported type IV 53.69% followed by type II 41.87%.

These results differ from Zaatar et al²⁷ and Al Nazhan⁵ who reported type II being most prevalent followed by type IV. The most prevalent configuration in distal root was type I (65.8%) followed by type IV (19.5%) and type II (14.6%). Similar prevalence of type I configuration has been reported by Chaurasia HR et al²⁶ (65.3%), Wang Y⁷ (62%), Al-Qudah⁶ (54%) and Shahi S et al²³ (68%). Type II canal configuration (14.6%) seen in the current study is similar to Shahi S et al²³ who reported type II (11%) prevalence, but lower than H A Ahmad et al²⁸ who reported type II (28%), Skidmore and Bjorndal¹⁶ type II (61.5%).

Type IV canal configuration in distal root of present study (19.5%), is similar to Shahi S et al²³ (17.22%) and H A Ahmad et al²⁸ (22%). Whereas it is higher than Chaurasia et al²⁶ who reported type IV (9.3%), and lower than reported by Skidmore and Bjorndal¹⁶ type IV (38.5%). In the present study isthmuses (anastomosis) were observed in 10% of cases in mesial root and which is lower than Chaurasia et al²⁶ 30%.

Apical delta was observed in 5% of cases in distal roots which is higher than reported by Chaurasia et al.²⁶ The presence of isthmi and apical deltas may be of clinical significance, because it may be difficult to debride and fill these ramifications adequately. The use of sodium hypochlorite preferably agitated by ultrasonics may help to reach the uninstrumented parts of the root canal system.¹⁴ Furthermore, these ramifications can be more satisfactorily obturated by using some thermoplasticized gutta-percha technique.¹⁵

CONCLUSION

Within the limitation of present study it was concluded that there is a high prevalence (34%) of four canals, two mesial and two distal in mandibular first molars. Access preparation for canals should therefore be rectangular. As isthmi are observed in mesial roots and apical deltas in distal roots, efficient delivery and activation of irrigants are more essential.

REFERENCES

- 1 De Moor RJ, Deroose CA, Calberson FL. The radix entomolaris in mandibular first molars: an endodontic challenge. *Int Endod J* 2004; 37: 789-99.
- 2 Prabhu NT, Munshi AK. Additional distal root in permanent mandibular first molars: report of a case. *Quintessence International* 1995; 26(8): 567-69.
- 3 Margarit R, Andrei OC. Anatomical variations of mandibular first molar and their implications in endodontic treatment. *Rom J Morphol Embryol*. 2011; 52(4): 1389-92.
- 4 Schumann C. Endodontic treatment of a mandibular first molar with radix entomolaris: a case report. *Endo (Lond Engl)* 2008; 2: 301-04.
- 5 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.
- 6 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.
- 7 Wang Y, Zheng Q-h, Zhou X-d, Tang L, Wang Q, Zheng G-n, et al. Evaluation of the root and canal morphology of mandibular first permanent molars in a western Chinese population by cone beam computed tomography. *J Endod* 2010; 36: 1786-89.
- 8 Wasti F, Shearer AC, Wilson NHF. Root canal systems of the mandibular and maxillary first permanent molar teeth of South Asian Pakistanis. *International Endodontic Journal* 2001, 34: 263-66.
- 9 Harty FJ. Endodontics in clinical practice. John Wright and Sons Ltd. 1990; 21-53.

- 10 Garg AK, Tewari RK, Kumar A, Hashmi SH, Agrawal N, Mishra SK. Prevalence of three rooted mandibular permanent first molars among the Indian population. *J Endod* 2010; 36: 1302-6.
- 11 De Pablo OV, Estevez R, Péix Sánchez M, Heilborn C, Cohenca N. Root anatomy and canal configuration of the permanent mandibular first molar: a systematic review. *J Endod* 2010; 36: 1919-31.
- 12 Hsu YY, Kim S. The resected root surface. The issue of canal isthmuses. *Dent Clin North Am.* 1997 Jul; 41(3): 529-40.
- 13 Hussain U, Iqbal N, Rehman K. Incidence of fourth canal in mandibular first molars- A study. *PODJ* 2013; 33 (3): 544-46.
- 14 Kim SY, Kim BS, Woo J, Kim Y. Morphology of mandibular first molars analyzed by cone-beam computed tomography in a Korean population: variations in the number of roots and canals. *J Endod.* 2013 Dec; 39(12): 1516-21.
- 15 Vertucci FJ. Root canal anatomy of the human permanent teeth. *Oral Surg Oral Med Oral Pathol* 1984; 58: 589-99.
- 16 Skidmore AE, Bjorndal AM. Root canal morphology of the human mandibular first molar. *Oral Surg Oral Med Oral Pathol* 1971; 32: 778-84.
- 17 Davis SR, Brayton SM, Goldman M. The morphology of the prepared root canal: A study utilizing injectable silicone. *Oral Surg Oral Med Oral Pathol* 1972; 34: 642-48.
- 18 De Souza-Freitas JA, Lopes ES, Casati-Alvares L. Anatomic variations of lower first permanent molar roots in two ethnic groups. *Oral Surg Oral Med Oral Pathol* 1971; 31: 274-78.
- 19 Sperber GH, Moreau JL. Study of the number of roots and canals in Senegalese first permanent mandibular molars. *Int Endod J* 1998; 31: 117-22.
- 20 Neelakantan P, Subbarao C, Subbarao CV, Ravindranath M. Root and canal morphology of mandibular second molars in an Indian population. *J Endod* 2010; 36: 1319-22.
- 21 Robertson D, Leeb IJ, McKee M, Brewer E. A clearing technique for the study of root canal systems. *J Endod* 1980; 6: 421-24.
- 22 Reuben J, Velmurugan N, Kandaswamy D. The evaluation of root canal morphology of the mandibular first molar in an Indian population using spiral computed tomography scan: An vitro study. *J Endod* 2008; 34: 212-15.
- 23 Shahi S, Yavari HR, Rahimi S, and Torkamani R. Root Canal Morphology of Human Mandibular First Permanent Molars in an Iranian Population. *Dent Res Dent Clin Dent Prospects.* 2008; 2(1): 20-23.
- 24 Gulabivala K, Opassanon A, Ng Y-L, Alavi A. Root and canal morphology of Thai mandibular molars. *Int Endod J.* 2002; 35: 56-62.
- 25 Hartwell G, Bellizzi R. Clinical investigation of in vivo endodontically treated mandibular and maxillary molars. *J Endod* 1982; 8: 555-57.
- 26 Chourasia HR, Meshram GK, Warhadpande M, Dakshindas D. Root Canal Morphology of Mandibular First Permanent Molars in an Indian Population. *Intl Journal of Dentistry Volume* 2012 (2012), Article ID 745152, 6 pages doi:10.1155/2012/745152.
- 27 Zaatar EI, al Anizi SA, al Duwairi Y. A study of the dental pulp cavity of mandibular first permanent molars in the Kuwaiti population. *J Endod* 1998; 24: 125-27.
- 28 H.A. Ahmed, N.H. Abu-bakr, N.A. Yahia & Y.E. Ibrahim. Root and canal morphology of permanent mandibular molars in a Sudanese population. *Int Endod J* 2007; 40: 766-71.
- 29 Reynolds MA, Madison S, Walton RE, Krell K, Rittman BR. An in vitro histological comparison of the step-back, sonic and ultrasonic instrumentation techniques in small curved root canals. *J Endod* 1987; 13: 307-14.
- 30 Weine FS, Members of the Arizona Endodontic Association. The C-shaped mandibular second molar: Incidence and other considerations. *J Endod* 1998; 24: 372-75.