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Morphologic Variations and Gender Dimorphism in Mandibular First Premolar Root Canal Pattern: A CBCT Study in South Indian Population

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Research Article

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ABSTRACT

Objective: The study aimed to evaluate the variations in the RCM of mandibular first premolars (MFP) in south Indians and also evaluated the gender dimorphism and contralateral symmetry of pattern.
Methods: 200 Cone Beam Computed Tomography (CBCT) images of MFP of patients above 18 years were analysed for the root canal morphology after excluding the distorted images, endodontically treated tooth or fractured root. The teeth were carefully evaluated in cross sectional, axial and coronal sections and the information regarding the number of roots and the type of root canal as per Vertucci's classification. Interobserver and intraobserver reliability were also checked.
Results: Single rooted teeth with Type I (73.01%) variation was the most prevalent pattern observed in the study population, which was followed by Type III (14.11%) and Type V (5.52%), respectively. Type IV and Type VIII variations were not found in our study.
Conclusions: In both males and females, type I configuration was the most common pattern with symmetry in contralateral mandibular single-rooted first premolars.

Key words: Cone Beam Computed Tomography, Mandible, Morphology, Premolar, Root Canal.

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Introduction

The maxillary and mandibular premolar teeth are known to have significant morphological variations in root canals compared to other teeth. It is reported more commonly in maxillary second premolars and mandibular first premolars.[1–4] A thorough knowledge and understanding of root canal morphology(RCM) is vital for the success of root canal therapy.[3,5,6]

Mandibular first premolars (MFP) have two pulp horns; a large buccal horn with sharp outline and an inconspicuous round lingual horn.[7] Access to the buccal root canal is easily achieved, whereas the lingual canal access is complicated due to the deviating path. The lingual inclination of these teeth also makes it difficult to locate the lingual orifice as the file insertion will be directed towards the buccal aspect of the tooth[8]. Moreover, frequent morphologic variations like C-shaped canals and extra root canals cause challenges in the biomechanical preparation and in obturation phases.[9–15]

Various methods have been used to identify and record the root canal morphologies, some of which are two-dimensional radiographs, staining methods for root canals, sectioning of the dental hard tissues, micro-CT, and CBCT (Cone-Beam Computed Tomography) scanning. CBCT is superior to traditional radiographs and other digital imaging methods.[16] The images procured by the CBCT are depicted in axial, sagittal, and coronal sections, and it also shows reduced superimposition by adjacent structures.

There is a general lack of literature on the variations in RCM of MFP in the south Indian population.[9,17–20] Hence, we aimed to evaluate the variations in RCM of MFP in the south Indian subpopulation. We also aimed to compare the root canal configurations with gender and symmetry considering the number of roots in MFP. The study aimed to evaluate the variations in the RCM of mandibular first premolars (MFP) in south Indians and also evaluated the gender dimorphism and contralateral symmetry of pattern.

Material and Methods

A retrospective study on 200 CBCT images with MFP was conducted. We included CBCT images of individuals aged above 18 years with MFP. We have excluded images that were distorted, images with MFP which had endodontic treatment, fractured root, incomplete root formation, coronal or post endodontic restorations, and

physiological or pathological processes such as root resorption. A well-experienced radiologist performed CBCT imaging following the recommended protocol with the minimum exposure necessary for adequate image quality. CBCT images were obtained with i-CAT 17-19 Imaging System (Imaging Sciences International, USA). Exposure parameters were further adjusted according to patient indication for imaging. Image enhancement tools like zooming, contrast, and brightness adjustments, were used for better visualization and adjustment. Coronal, cross-sectional, and axial sections of the images were used to analyze the root morphology pattern. This study was conducted in the department of Oral Medicine and Radiology. The study protocol was approved by the institutional ethics committee, Kasturba Medical college and Kasturba Hospital, Manipal, India (Decision date- 8.10.2019, IEC no- 726/2019)

The CBCT images were assessed using Anatomage software under standard illumination conditions by a single trained radiologist. Repeat assessment of 10% images was done after one month. Also, 10% of the images were randomly evaluated by an experienced radiologist. A Kappa value of 0.7 was obtained, showing substantial inter and intra-observer reliability. Each image was studied based on the number of roots and the canal morphology in each root according to the Vertucci's classification.[21]

All the analysis was done using SPSS version 20. A p-value of <0.05 was considered statistically significant. Right, and left side variations, intra, and inter-examiner reliability were assessed using Kappa Coefficient. Comparison of RCM with sex was done using Fisher's exact test.

Results

A total of 200 MFP were assessed for their RCM, out of which 102 were left MFP, 166 had single root, 33 had two roots, and one had three roots (Table 1). In both right and left MFP, Vertucci's Type-I was the most common root canal configuration present (69.6% and 93% respectively), followed by and Type V (12.5%) on the right side and Type III (12.3%) on the left side (Table 1).

In single-rooted teeth, the right and left distribution of various RCM was compared using the Kappa coefficient. There was a 74% similarity on the right and left side distribution of RCM (Kappa=0.39). The right and left distribution of RCM was done independently for buccal and lingual root canals in two rooted teeth. In the buccal root, the similarity was 54.54% (Kappa=0.058). However, a high similarity was seen in the lingual root (81.81%; Kappa = 0.421).

Significant differences were seen in the distribution of RCM of single-rooted teeth on both the sides. In both right and left MFP, the distribution of the type I pattern was significantly higher in females than males (P=0.046 and 0.041), respectively (Table 2). However, no significant differences were seen in the distribution of RCM of two rooted teeth with sex on both the sides in buccal and lingual root canals (Table 3).

Discussion

The number of roots and root canal morphology in human population shows great diversity. Previous studies have utilized different methodologies to assess the root canal morphology and have reported complex internal anatomy of the MFP. Thorough knowledge of such variations in every population is indispensable. The advances in dental materials and diagnostic tools have along with thorough knowledge of canal morphology have increased the success rate of endodontic therapy, even in complex root canal configurations.[17,22]

Literature shows the presence of extra root and extra canals in the mandibular first premolar.[23,24] Present study showed that 79.8% of the teeth had a single root and 16.7% had two roots, and only one tooth had three roots. These observations were similar to previous studies. Studies done in India have reported that single RCM is the most common canal morphology.[19,25] Sert and Bayirli reported 60.5% with a single canal and 39.5% with two or more canals.[3] Singh and Pawar reported that 76% had a single canal, 22 had two canals, and 2% had three canals.[25] Trope *et al*. showed 89.1% to have single-rooted teeth, 10.9% to have two rooted teeth.[23] Yu *et al*. reported that 98% had a single root, and 2% had two roots.[9] Yang *et al*. reported 77.14% had single-rooted canals.[26]

Our study showed that Type I configuration (85.5%) is the most common pattern in MFP, which was in line with observations from the previous researches (50-88%) (Table 4).[3,9,27–35,10,17–21,25,26] This was followed by Type III configuration (13%), which was similar to study by Sert and Bayirli among the Turkish population.[3] However, these studies have reported that the 2nd most common pattern was C-shaped morphology. On the contrary present study, C-shaped configuration was noted in only 1% of the sample (Table 4).

Very few studies in the literature have evaluated the significant differences in RCM with respect to gender and quadrant wise distribution. We observed type I configuration to be the most commonly present configuration in both males and females on the right and left sides, which was in accordance to earlier reports.[3,33] The symmetry of RCM in contralateral premolars has been studied previously.[33,36,37] Our study also showed that in single-rooted teeth, there was 74% symmetry, while in two rooted teeth, it was only 55% in buccal and 82% in lingual root canals. This was lower than previous studies.[33,37] While one study reported that there were only a few pairs that showed such symmetry.[36]

Our sample showed one 3-rooted tooth, and 1% of the sample showed C-shaped canals. Previous studies have reported diverse and miscellaneous configurations like circumferential canals[30], Types like 1-3, 1-2-3, 2-1-3, and 2-1-2-1, [31] types 2-3, and 1-4.[20] However, such patterns were not reported in our sample. In both males and females, type I configuration was the most common pattern with symmetry in contralateral mandibular single-rooted first premolars. We used CBCT images to assess the variations in the RCM, which is superior to conventional

radiography and digital radiographic techniques. It is validated valuable tool to evaluate the complex canal morphology to improve the outcomes of endodontic therapy.

Conclusions

In the present study using CBCT, Vertucci's Type I root canal configuration was the most common variant followed by Type III configuration and there was no difference noted in canal morphology variations when evaluated quadrant wise. Further studies on larger and different sub-populations are required to understand the canal morphological variations for better endodontic treatment outcomes and good prognosis.

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Conflicts of Interest

There are no conflicts of interest.

Table 1. Sample characteristics, number of roots and root canal morphology

	Number of teeth	Number of roots			Root canal Morphology						
		1	2	3	Type I	Type II	Type III	Type V	Type VI	Type VII	C-shaped
Left	102	82	20	0	93 (76.2)	2 (1.6)	15 (12.3)	8 (6.6)	0(0)	3(2.5)	1(0.8)
Right	98	84	13	1	78(69.6)	3(2.7)	11(9.8)	14(12.5)	2(1.8)	3(2.7)	1(0.9)
Total	200	166	33	1	171	5	26	20	2	6	2

Table 2. Comparison of root canal morphology with sex on right and left side in single rooted premolars (n=77)

	Sex		P-value
	Male	Female	
Left	N(%)	N(%)	
Type I	27(69.2)	34(89.5)	
Type II	1(2.6)	1(2.6)	
Type III	8(20.5)	1(2.6)	0.041; Sig
Type V	1(2.6)	0(0)	
Type VII	2(5.1)	1(2.6)	
C	0(0)	1(2.6)	
Right			
Type I	24(61.5)	30(78.9)	
Type II	2(5.1)	1(2.6)	
Type III	6(15.4)	4(10.5)	
Type V	4(10.3)	0(0)	0.046; Sig
Type VI	0(0)	2(5.3)	
Type VII	3(7.7)	0(0)	
C	0(0)	1(2.6)	

Table 3. Comparison of root canal morphology with sex on right and left side in double rooted premolars (n=11)

		Sex		P-value
		Male	Female	
Buccal		N(%)	N(%)	
Left	Type I	5(83.3)	4(80)	>0.99
	Type III	1(16.7)	1(20)	
Right	Type I	3(50)	4(80)	0.545
	Type V	3(50)	1(20)	
Lingual				
Left	Type I	4(66.7)	5(100)	-
	Type III	1(16.7)	0(0)	
	Type V	1(16.7)	0(0)	
Right	Type I	4(66.7)	5(100)	0.455
	Type V	2(33.3)	0(0)	

Table 4. Review of root canal morphology from earlier studies

Author	Year	Population	N	Method used	Root canal morphology (%)									
					I	II	III	IV	V	VI	VII	VIII	Miscellaneous	C shaped
1. Pineda et al	1972	Mexico	202	Radiograph	69.3	0	4.9	1.5	23.4	0	0	0		
2. Zillich & Dowson	1973	US	1393	Radiograph	66	5.2	0	17.5	0	0	0	0.4	7.6^	
3. Vertucci	1984	US	400	D&C	70	0	4	1.5	24	0	0	0		
4. Baisden et al	1992	US	100	Sectioning	76	0	0	24	0	0	0	0		
5. Caliskan et al	1995	Turkey	100	D&C	64.15	7.55	3.77	7.55	9.43	1.89	0	5.66		
6. Sert & Bayirli	2004	Turkey	200	D&C	60.5	18.5	11.5	7	2.5	0	0	1		
7. Iyer et al*	2006	India	2000	RVG	75.4	1		20.8	2.4	0	0	0.4		
8. Lu Tzu- Yi et al	2006	China	82	Sectioning	54	6	6	10	0	0	0	0	6†	18
9. Awawdeh & Al-Qudah	2007	Jordan	500	D&C	58.2	4.8	1.4	14.4	16.8	0.8	1	0	Type 1-3= 1 Type 1-2-3= 0.4 Type 2-1-3= 0.8 Type 2-1-2-1=0.4	
10. Velmurugan&Sandhya	2009	India	100	D&C	72	6	3	10	8	0	0	0		1
11. Jain & Bahuguna	2011	India	138	D&C	67.39	7.97	3.62	2.89	17.39	0.72	0	0		
12. Parekh et al	2011	India	40	D&C	50	5	5	25	12.5	2.5	0	0		
13. Yu et al.	2012	China	174	CBCT	86.8	0	1.7	0	9.8	0	0	0.6		1.1
14. Yang et al	2013	China	440	CBCT	76.14	3.41	2.73	6.59	9.32	0	0	0.68		1.14
15. Shetty et al	2014	India	1186	CBCT	83.81	0.3	2.1	0.27	11.97	0.1	0	0.3	0.08‡	0.92
16. Singh and Pawar	2014	India	100	D&C	80	6	0	10	2					
17. Abraham & Gopinath	2015	UAE	100	Clearing method	65	2	3	13	14	0	0	0	Type 2-3 = 1% Type 1-4 = 2%	
18. Alfawaz et al	2019	Saudi Arabia	391	CBCT	88	3.6	3.1	2	1.5	0.3	0	1.5		
19. Shrestha et al	2019	Nepal	150	D&C	72	2.6	3.3	2.6	18.6	0	0	0	0.66††	
20. Present study	2021	India	200	CBCT	85.5	2.5	13	0	11	1	3	0		1

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