

Evaluation of the Root and Canal Morphology of Maxillary First and Second Molar using Cone Beam Computed Tomography: A Retrospective Study

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ABSTRACT

Aim: The aim of this study was to investigate the root and canal morphology of maxillary first and second molars in Southern West Coastal Indian population using cone beam computed tomography (CBCT).

Materials and methods: Cone beam computed tomography images of (n = 143) maxillary first molar and (n = 139) maxillary second molar were obtained from Southern West Coastal Indian population. The number of roots, root canals, and presence of second mesiobuccal (MB2) canal were determined.

Results: Two roots were seen only in 1.4% of first molars and 8.6% of second molars. Three-rooted were the most common and seen in 98.6% of first molars and 89.9% of second molars. Single root was seen in 1.4% of second molars. The incidence of MB2 canal in the first molar is 64.1% and in second molar 23%. C-shaped canals were found in 1.4% of the second molars.

Conclusion: Southern West Coastal Indian population showed features that were similar to other regions of Indian Population. The CBCT is a wonder tool for the study of root canal morphology and a reliable source of information for retrospective studies.

Keywords: Cone beam computed tomography, Maxillary molars, Mesiobuccal 2 canal, Root morphology.

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INTRODUCTION

Clinicians must be aware of common root canal anatomy and any possible morphological variations of the roots

because of any successful endodontic treatment outcomes, it is essential to entirely debride, disinfect, and obturate the root canal system.¹ Understanding the variations in root canal anatomy is extremely important for successful endodontic treatment and diagnosis.

External surfaces have simple and uniform anatomy, which hides the internal complex anatomy.²

Maxillary molars show complex root anatomy and canal morphology. Most of the studies in the literature show that maxillary first molar has three roots and four canals.³⁻⁷ Additional anatomic variations, such as C-shaped canals, are also reported.⁸ It is reported that the main cause of poor long-term prognosis after root canal treatment in maxillary first molars is a failure to detect, debride, and fill a second mesiobuccal canal (MB2).^{9,10}

It is shown that root canal morphologies are genetically determined and have supportive significance in anthropology, so it is needed to establish any peculiar identification of root canal morphologies of different ethnic populations.¹¹ Root canal morphology varies in different races and individuals within the same race.¹² India is considered to be a subcontinent, and Indian population has diverse ethnic groups with characteristics of Caucasian, Negroid, and Mongoloid races, which normally alludes as the Dravidian group.¹³

There are several methods to identify root canal morphology, such as canal staining and tooth clearing, conventional radiographs, digital radiographic techniques, radiographic assessment enhanced with contrast media, cone beam computed tomography (CBCT) techniques, and modified canal staining and clearing.⁶ It is shown that for the evaluation of the MB2 root of maxillary molars CBCT is a viable radiologic device and also comparable with clinical studies or micro-CT in identifying the frequency of second MB2 canal.¹⁴ The CBCT is verified as a reliable tool for studying internal anatomy of the tooth.¹⁵

A recent study characterized the anatomy of maxillary molars in Indian population. There are reports on the root canal morphology of Indian maxillary molars but not much on subpopulation groups especially in the Southern West coastal area.⁶ In literature, there is no detailed data of the root canal anatomy of the maxillary first, and second molars in Southern West Coastal Indian population have been found using CBCT for evaluation.

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The aim of this retrospective study was to analyze number of roots in maxillary first and second molars, to determine the number of canals in maxillary first and second molars and to find out the prevalence of MB2 canal in maxillary first and second molars in West Coastal Indian population Indian population using CBCT.

MATERIALS AND METHODS

Ethical clearance was obtained from Manipal College of Dental Sciences, Manipal University, Mangaluru, Karnataka, India. Images were obtained with inclusion criteria: Fully erupted teeth with patient age above 16 years, root canals that are without root canal fillings and post, CBCT images of good quality. All the CBCT images are obtained from native regional settlers, no images from migrants and minority ethnicities were included. Exclusion criteria are image deformity on CBCT, incomplete root formation, roots with open apices, resorption, or calcification.

Sources of Data

Cone beam computed tomography images were obtained from Department of Oral Medicine, Diagnosis and Radiology, Manipal College of Dental Sciences, Manipal University, Mangaluru, Karnataka, India, from November 2013 to October 2014.

Image Acquisition

Cone beam computed tomography images stored in the institutional repository of patient records were used for this retrospective study. These images were obtained using a CBCT scanner (Planmeca ProMax 3D Mid, Romexis 3.25 software) according to the manufacturer's instructions. All the images were taken by an oral radiologist according to the manufacturer's protocol.

Image Evaluation

All the samples were analyzed by an oral radiologist and an endodontist at the same time but separately so as to achieve conformity. If the analysis of images does not concord between radiologist and endodontist, images were analyzed by another endodontist to give his opinion, and further discussion was conducted to reach a final opinion. The number of roots and canals were identified in the axial plane (Figs 1A to D). Coronal and sagittal planes were used wherever required. Whenever needed, contrast was adjusted and the magnifying tool was activated.

The specimens were investigated radiographically by CBCT and the following were observed:

- The number of roots
- The number of canals per root
- Frequency of MB2 canal.

The data collected were analyzed using chi-square test and Fisher's exact test.

RESULTS

A total of 143 CBCT images of maxillary first molar and 139 CBCT images of maxillary second molar that satisfy the selection criteria were included in the study. Overall, 98.6% of maxillary first molar had three roots and 1.4% was two-rooted. Whereas in maxillary second molar, 89.9% of teeth had three roots, 8.6% had two roots and 1.4% with a single-root was also seen (Table 1). The single-rooted maxillary second molar actually had C-shaped canal morphology. In males, 97.5% of maxillary first molars and in females, 100% were three-rooted. The rest 2.5% were two-rooted in the male category. Approximately 89.1% and 90.7% of second molars had three roots in males and females respectively. Around 10.8% of the second maxillary molars were two-rooted in males and 6.1% were two-rooted in females (Table 2).



Figs 1A to D: Various root and canal configuration in maxillary first and second molars: (A) Three-rooted with three canals; (B) three-rooted with total of four canals; additional mesio-buccal 2 canals in both first and second molars; (C) maxillary first molar with two roots; and (D) maxillary second molar with two roots

Table 1: Frequency and distribution of the number of roots in maxillary first and second molars

Tooth	Number of roots		
	1	2	3
First molar	0	2 (1.4)	141 (98.6)
Second molar	2 (1.4)	12 (8.6)	125 (89.9)

Values indicate a number of teeth that were identified. Values within parentheses are percentages (percentage of a total number of teeth examined)

Around 64.1% of first molars and 23% of second molars have shown MB2 canals. There is statistically significant difference in frequency of the MB2 canal between first and second molars with a chi-square value of 57.793 and level of significance at $p < 0.001$ (Graph 1). No other additional canals were identified. There was no statistically significant difference in frequency of MB2 canal between male and female with a chi-square value of 1.687 and level of significance at $p < 0.430$ for first molar and chi-square value of 3.361 at a significance level of $p < 0.339$ for second molar. In either males or females, there is no significant difference in the frequency of MB2 canal for both first and second molars. In the first molar, 67.1% of males and 64.3% of females showed MB2 canals. Whereas in the second molar, only 24.3% of males and 21.5% of females showed MB2 canal (Graph 2).

DISCUSSION

Cone beam computed tomography is superior to conventional periapical radiography technique as it has the ability to eliminate superimposition of the surrounding structures.¹⁶ Besides two-dimensional image segments visualization, CBCT further enables to assess in the three-dimensional (3D) reconstruction of the area of interest aiding the operator to visualize the tooth roots and canals in multiple slices. It allows investigation of

Table 2: Frequency and distribution of number of roots in males and females of maxillary first and second molars

Tooth	Number of roots (male)			Number of roots (female)		
	1	2	3	1	2	3
First molar	0	2 (2.5)	77 (97.5)	0	0	64 (100)
Second molar	0	8 (10.8)	66 (89.1)	2 (3.0)	4 (6.1)	59 (90.7)

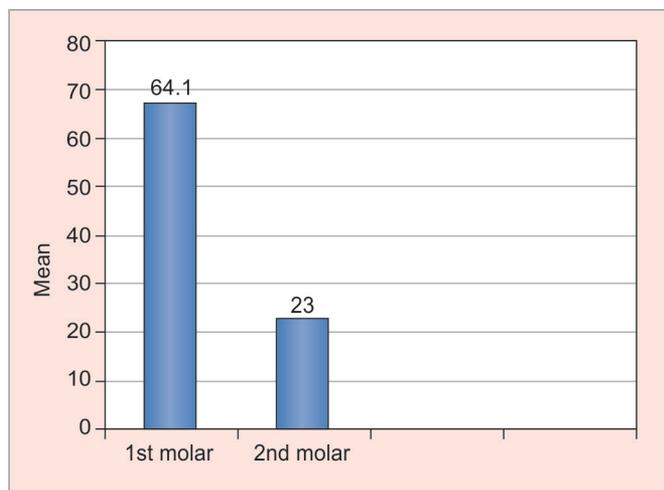
Values indicate a number of teeth that were identified. Values within parentheses are percentages (percentage of a total number of teeth examined)

dental anatomy in 3D views in axial, sagittal and coronal planes simultaneously.¹⁷

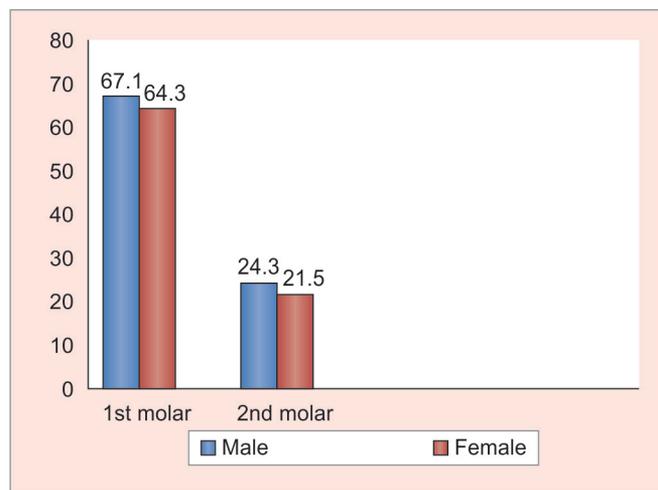
Cone beam computed tomography has the ability to identify the root canal system precisely, which is considered as better than other techniques to understand the root and canal systems.⁶ Regular computed tomography scan used in the medical field uses fan-shaped beams whereas CBCT uses cone-shaped beams.¹⁷

For the accurate and reliable evaluation of the root canal morphology, CBCT is relatively a newer diagnostic tool that has been used in the field of endodontics for the past two decades.¹⁸ It is found that for the identification of root canal anatomy, CBCT always resulted better than digital radiography.¹⁹ Till now, CBCT scanning is limited to only major developed cities and also very expensive.¹⁷

The maximum variations in our study were found in the MB roots of both first and second molars, which is in agreement with Singh et al,²⁰ who reported wide variations in MB roots of Indian maxillary second molars. According to Peikoff et al,²¹ in the maxillary second molar frequency of two separate roots with a single canal in each is 6.9%. Other authors who studied in Indian population noted that MB root of both maxillary first and second molars have shown maximum variations than any other roots, which is in agreement with the present study.^{6,20} Many authors found that MB2 canals had no differences



Graph 1: Frequency distribution of mesio Buccal two canals in maxillary first and second molars ($p < 0.01$)



Graph 2: Frequency distribution of mesio Buccal two canals in males and females ($p > 0.05$)

in relation to nationality or sex, which was found same in this study.^{6,7,22,23}

There are reports on the unusual morphology of roots in maxillary first molars, such as one, four, and five roots. Based on the case reports of one root or four roots or five roots, which are very rare, the incidence of them cannot be evaluated.²⁴ Literature shows a second MB2 canal is seen in 56.8 and 96.1% of the cases. This wide range in the frequency of MB2 canal in literature is because of various study methodology followed to identify the canals.²⁵⁻²⁷

Therefore, maxillary first molar frequency of C-shapes differ from 0.09 to 0.12%.²⁸ It was reported that C-shaped canals were encountered in 4.9% of the Chinese maxillary second molars.²⁹ We found 1.4% of maxillary second molars showed C-shaped canals.

In this study, we have found that:

- Statistically, a significant difference was seen in the prevalence of MB2 canal in maxillary first and second molars. It was 64.1% occurrence in first molar compared to 23% of second molar.
- There was no statistically significant difference in frequency of MB2 canals in male or females in both first and second molars.
- Around 8.6% of maxillary second molars showed two roots compared to 1.4% of first molar and prevalence was more in males (10.8%) than females (6.1%).

CONCLUSION

The incidence of MB2 canal in first molar was higher than second molar. There was no difference in prevalence for MB2 canal for male or female in either first or second molars. The incidence of two-rooted molars was more in second molars than first molars. The frequency of anatomic variations may not be high but it is essential for a clinician to have the knowledge of maxillary molars oddity to prevent mishaps in endodontic treatment and ensure treatment success. The CBCT will aid in the rationalizing the aberrations of root canal anatomy, with the ability to surpass the endodontic treatment outturn.

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