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Frequency of middle mesial canals in mandibular first and second molar using cone beam computed tomography in Hyderabad

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ABSTRACT

BACKGROUND & OBJECTIVE: There is still a lack of thorough research about the demographic characteristics that contribute to these differences, particularly age and gender. To determine the frequency and type of Middle Mesial Canal (MMC) in permanent mandibular first and second molars using CBCT.

METHODOLOGY: The inclusion criteria comprised individuals of any gender, aged 18 to 60 years, presenting with first or second mandibular permanent molars referred by the Department of Diagnosis due to unsuccessful endodontic therapy. Analyzed in a systematic manner, CBCT images were used to assess the intricacy of the root canal anatomy in the first and second mandibular molars in all three planes. The middle mesial canal (MMC) was identified and documented according to the classification established by Pomeranz.

RESULTS: In relation to the presence of middle mesial canals (MMC) in first molars, a small proportion (1.4%) exhibit MMC that are either connected to the mesiobuccal canal, separate from the mesiobuccal canal, or connected to the mesiolingual canal.

CONCLUSION: The presence of MMC in the first molars was rather rare, as the majority (95.8%) of the sample did not show this anatomical variation. No MMCs were observed in second molars in this study.

KEYWORDS: Anatomy, Cone Beam Computed Tomography, Dental Pulp, Molars, Prevalence Study.

INTRODUCTION

Endodontic treatments require a thorough understanding of the complex internal anatomy of the tooth, commonly referred to as the root canal system^[1]. While standard radiography methods have been significant, their limitations in two dimensions and superimposition require the utilization of advanced imaging techniques to fully observe the architecture of root canals. Cone-beam computed tomography (CBCT) is a non-invasive imaging technique that has significantly advanced endodontic diagnosis and treatment. It allows for the capture of high-resolution, three-dimensional images of tooth structures^[2,3]. Despite the numerous advantages of root canal configurations, there is a limited number of studies on specific features related to them, such as the frequency of middle mesial canals in first and second mandibular molars^[4].

Research on mandibular first molar highlight different number of canal anatomy and asymmetry in canal configuration in opposing molars^[5]. Furthermore, the frequency of middle mesial canals and the shadowy distolingual canals present unique challenges^[6]. The global prevalence of MMC in the first molar is 4.4%^[7]. While, examining the anatomy of the second mandibular molar reveals great variation in the incidence of middle mesial canals, with estimates ranging from 0% to 60%^[8]. However, there are limited research about the demographic characteristics that contribute to these differences, particularly age and gender in Pakistan.

Significant gaps exist in the available literature regarding demographic-related patterns of middle mesial canal predominance and the impact of anatomical changes on endodontic treatment strategies^[7]. This study seeks to fill gaps by investigating the relationship between gender

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and the incidence of middle mesial canal anatomy in the Pakistan region. Furthermore, while the diagnostic potential of CBCT in identifying aberrant canal shape is recognized, the development of established techniques and standards is still pending. This, in turn, will help to increase patient treatment and the general body of endodontic knowledge.

The complex nature of root canal morphology emphasizes the crucial need for advanced imaging techniques, which serve as justification for our research. Conventional radiography techniques often fail to capture the intricate complexities of canal architecture, underscoring the need for more precise modalities. By virtue of its enhanced diagnostic features, CBCT offers a solution to these challenges, enabling practitioners to more efficiently navigate the complexity of the root canal system^[9,10]. Therefore, this study aimed to employ CBCT to analyze and quantify the prevalence of middle mesial canals in mandibular first and second molars among patients who underwent non-surgical endodontic retreatment in the outpatient Department of Operative Dentistry at Liaquat University of Medical and Health Sciences.

METHODOLOGY

A descriptive cross-sectional design was used to conduct research at the Institute of Dentistry, Liaquat University of Medical and Health Sciences (LUMHS), located in Jamshoro/Hyderabad. The data collection spanned six months, from December 1, 2022, to May 31, 2023, following approval by the Research Ethics Committee of LUMHS (No. LUMHS/REC/-22, dated January 31, 2022)

The OpenEpi online sample size calculator was used to determine the sample size considering the following parameters: a population size (N) of 122, a frequency of the middle mesial canal of 16.4% and 5% confidence limits^[11]. The sample size for the teeth in the research was determined to be 78.

The participants were selected using a successive non-probability sampling approach. The inclusion criteria were as follows: persons of any gender, aged between 18 and 60 years, and holding first and second mandibular permanent molars that were referred by the department of diagnostics due to unsuccessful endodontic therapy. The exclusion criteria included any signs of root resorption or fracture.

The study comprised patients who visited the Department of Operative Dentistry & Endodontics for non-surgical retreatment of mandibular first and second molars. CBCT scans were taken for diagnostic purposes. The Department of Radiology at ADCC Hyderabad conducted scans with a volume of 0.2 mm at regular intervals. The volume was reconstructed using segments perpendicular to the horizontal axis of the alveolar process. The CBCT was examined at a resolution of 1366 x 768 pixels on a monitor using the integrated VILLA SISTEMI MEDICAL viewer program. The evaluation was conducted by the main researcher

and confirmed by three fellows in operative dentistry and endodontics, under conditions of total darkness, using a Dell Inspiron laptop equipped with a 15.6-inch LCD screen. The viewing experience was improved by using an image processing tool that adjusted the brightness and contrast of the CBCT images. The morphology of each tooth was thoroughly assessed by examining axial, coronal, and sagittal views with great attention to detail. Analyzed in a step-by-step manner, CBCT images were used to assess the intricate structure of the root canals in the first and second molars of the lower jaw, in all three dimensions. The middle mesial canal (MMC) was identified and documented following the classification established by Pomeranz et al. This classification has four distinct categories: independent, fin, confluent with the mesiobuccal canal, and confluent with the Mesiolingual canal^[12].

An intra-examiner reliability study was performed to measure the consistency of middle mesial canal (MMC) identification by the primary examiner. The primary examiner, who initially reviewed the complete dataset, conducted a separate evaluation of the subgroup after a 7-day interval to reduce the impact of recall bias.

Version 20.0 of the Statistical Package for the Social Sciences (SPSS) software was utilized to analyze the data. A Fisher's exact test was used to evaluate statistical significance, with a predetermined significance level of 0.05, and P-values of less than 0.05.

RESULTS

Intraexaminer reliability was assessed using the Kappa statistic for the presence of MMC, yielding a value of 0.86. The sample consists of an equal gender distribution, with 50% of the participants identifying as male (mean age, 34.67±11.11 years) and the remaining 50% as female (mean age, 24.89±4.81 years). Regarding the existence of middle mesial canals (MMC) (Figure-I) in the first molars, a minority (1.4%) display MMC confluent with the mesiobuccal canal, MMC independent of the mesiobuccal canal (Figure-II), and MMC confluent with the mesiolingual canal. While 95.8% do not exhibit MMC in first molars. It is noteworthy that approximately 100% of the participants lack middle mesial canals in their second molars (Table-I).

The association between gender and the presence of MMC in the first molar was not statistically significant. Due to the small sample size in the 'MMC Present' group, Fisher's Exact Test was employed to ensure the accuracy of the p-value. In the second molar, no MMCs were found in any participant (100%), making it impossible to compute a statistical association with gender. These findings suggest that the occurrence of MMCs is rare in the first molar and non-existent in the second molar, with no significant gender-related differences observed (Table-II).

Figure-I: Axial view showing the orifice of MMC (Arrow) near MB Canal.

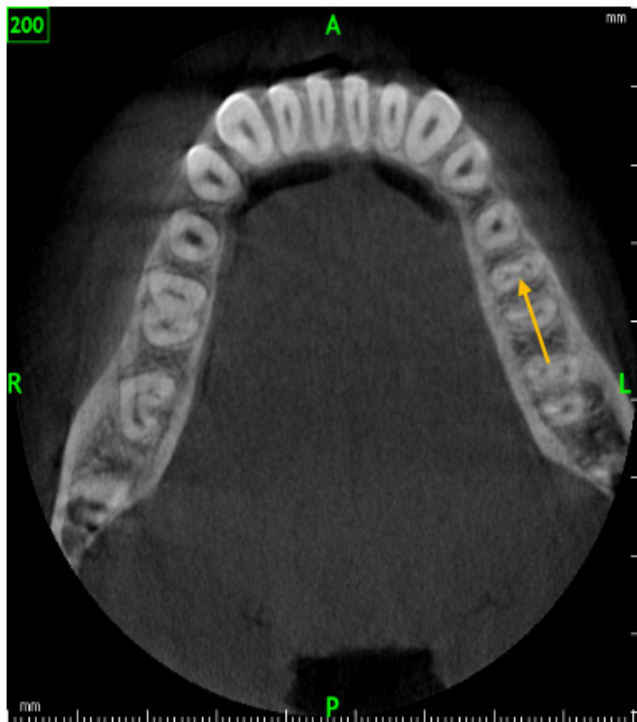


Figure-II: Multiplanar reconstruction depicting the separate MMC canal (Arrow) from MB Canal.



Table- I: Distribution of middle mesial canals (MMCs) in the mandibular first molar by gender.

1st Molar		No Middle Mesial Canal	Independent Middle Mesial Canal	MMC Confluent with MB Canal	MMC Confluent with DB Canal	Total
Gender	Male	35	1	0	0	36
	Female	34	0	1	1	36
Total		69	1	1	1	72

Table- II : Association between gender and the presence of middle mesial canals (MMCs) in mandibular first molars.

Variable	Categories	Gender		Total	Fisher Exact
		Male n(%)	Female n(%)		
First Molar MMC	MMC Absent	35(48.6)	34(47.2)	69(95.8)	1.000
	MMC Present	1(1.4)	2(2.8)	3(4.2)	
Total		36(50)	36(50)	72	

DISCUSSION

The recognition of middle mesial canals (MMCs) in mandibular molars carries substantial clinical significance for endodontic practitioners. A comprehensive understanding of the prevalence and types of these canals is pivotal for enhancing treatment precision and refining therapeutic strategies^[13]. This knowledge allows endodontists to anticipate and navigate intricate root canal anatomies more effectively, ensuring precise cleaning, shaping, and obturation during endodontic procedures. The failure to detect and treat MMCs may lead to persistent infections, incomplete root canal fillings, and treatment failures^[14]. Therefore, awareness of MMCs contributes to a more comprehensive understanding of root canal systems, minimizing the likelihood of missed canals and subsequent complications. Additionally, recognizing the prevalence of

MMCs enables practitioners to tailor treatment approaches based on individual anatomical variations, promoting more successful outcomes^[15].

The findings suggest that the occurrence of MMC in the first molars is very uncommon, as the majority (95.8%) of the sample investigated did not show this anatomical variation. Contrarily, the study conducted by Bhatti et al revealed a prevalence rate of 7.72% for middle mesial canals in first molars among the Pakistani population^[16]. However, the researchers did not assess the presence of these canals in mandibular second molars. Iqbal et al found that the prevalence of middle mesial canals in first molars in the Indian population was 29.7%^[17]. Xu et al. conducted a study in China and found a prevalence rate of 3.08% for MMC in first molars. The small proportion (1.4%) of cases where the mesiobuccal canal and distobuccal canal are connected to the

main mesiobuccal canal, known as independent MMC and MMC confluent with the mesiobuccal canal and distobuccal canal, respectively, demonstrate the wide range of root canal layouts. This emphasizes the intricate challenges that endodontic practitioners may face^[18].

Notably, all the second molars in the sample were found to be missing middle mesial canals (100%) which is in accordance with the available literature^[19]. The lack of MMC in the second molars could indicate a higher level of anatomical consistency in this tooth among the subjects of the study.

The results showed no significant association between gender and the presence of MMC in the first molars, indicating that gender did not appear to influence the prevalence or types of MMC in the studied population. However, given the limited sample size, these findings should be generalized with caution. The study's strengths lie in its utilization of CBCT. The slice-by-slice analysis in all three planes, aligned with the classification proposed by Pomeranz et al., adds precision to the identification and documentation of MMC^[12].

LIMITATIONS

The sample size of 72 participants, while calculated using appropriate statistical methods, may be considered relatively small for drawing definitive conclusions, and the study's generalizability may be limited to the specific demographic characteristics of the study population.

Future research endeavors could focus on expanding the sample size and exploring associations with other demographic factors such as age, race, or clinical history. Longitudinal studies could provide insights into the dynamic nature of MMC prevalence and types over time. Furthermore, investigations into the clinical implications of MMC, such as their impact on endodontic treatment outcomes, could enhance the practical relevance of the findings.

Patient's Consent

Informed consent was obtained from patients to publish the data concerning this study.

CONCLUSION

The occurrence of MMC in the first molars was uncommon, with only 4.2% of the sample exhibiting this anatomical variation. Notably, all second molars in the sample were found to lack middle mesial canals.

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Kheem Chand : Substantial contributions to the conception and design of the work.

Feroze Ali Kalhoro: The acquisition and analysis of data for the work.

Madiha: Interpretation of data for the work.

Shuja Aslam: Drafting the work.

Sarang Suresh: Reviewing it critically for important intellectual content.

Priya Rani: Final approval of the version to be published.