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PREVALENCE OF MIDDLE MESIAL CANAL IN MANDIBULAR FIRST MOLAR: A CONE BEAM COMPUTED TOMOGRAPHY STUDY

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ABSTRACT

OBJECTIVE: To determine the prevalence of middle mesial canal in the mandibular first molar using cone beam computed tomography in patients presenting outpatient department of Bakhtawar Amin Dental Hospital.

MATERIALS AND METHODS: Study design was Descriptive cross-sectional study atOut Patient Department of Operative Dentistry, BADCH Multan with duration of 6 months. Sampling technique used was Consecutive non-probability sampling. Sample size was calculated using the findings of Tahmasbi et al [3] who reported that prevalence of middle mesial canal in mandibular first molar was 16.4%. Sample size was calculated using the WHO sample size calculator. Confidence level set at 95%. Margin of error was 5% with sample size of211. Sample selection was done with inclusion criteria as intact crowns, patient with ages between l5-60 years ofboth genders, teeth diagnosed with irreversible pulpitis, (deep caries lesion causing sharp, severe and radiating pain of longer duration assessed clinically and radiographically as radiolucency encroaching on the pulp).Data Analysis done by using version 25.0 SPSS for Windows, Frequency and percentages were calculated for middle mesial canal and genders. The $p < 0.05$ was considered statistically significant.

RESULTS: The study revealed no statistically significant difference in MMC prevalence based on gender, with 9 male patients (52.9%) and 8 female patients (47.1%) exhibiting the canal ($p > 0.05$). A significant association was observed with age, as both the young adult group (15-30 years) and the middle-aged adult group (31-45 years) showed a higher prevalence of MMC compared to the elderly

group (46-60 years) and overall prevalence of the MMC was found to be 8.1%. The decrease in prevalence in the elderly group is likely due to secondary dentin deposition with age, resulting in narrowing and potential obliteration of such additional canals. Morphologically, the confluent type was the most common configuration.

CONCLUSION: The Middle Mesial Canal is an anatomical variant in the mandibular first molar within the studied population of South Punjab, Pakistan. Clinicians must maintain a high index of suspicion during endodontic treatment planning. The use of advanced diagnostic tools like CBCT is recommended to ensure the identification and proper management of the MMC. Clinicians must be thoroughly familiar with this variation and employ meticulous exploration techniques to achieve a successful and predictable long-term outcome.

INTRODUCTION

The mandibular first molars (MFMs) are the first permanent molars to erupt in the oralcavity, and have a high risk of decay and subsequent pulp damage: thus, this tooth frequently requires endodontic treatment. The success of endodontic treatment depends on various factors including the anatomical configuration of the root and root canal, making it an essential factor, because a canal that is overlooked and goes untreated may provoke microbial colonization resulting in treatment failure [1].

The root canal system has anatomic complexities in the form of additional canals intercanal communications, lateral canals, and multiple foramina. Usually, mandibular first molar has two roots; mesial and distal with two canals in mesial and one canal in the distal root [2]. In 1974, De Pablo discovered the existence of a third canal between the mesiobuccal canal(MBC) and mesiolingual canal(MLC) in the mesial root of mandibular first molar [3]. Pomeranz et al. then divided the canal into three types: independent, confluent, and fin. In the independent type, the canal runs independently from the orifice to the apex ofthe root. In the confluent type, the middle mesial canal (MMC) joins either the MBC or MLC before the apex, while in the fin type, an isthmus may be present between the MMC and the MB or ML canal at any point along its length [4]. Later, this type of root canal was also called the "middle mesial canal" and "accessory mesial canal".

Although conventional radiography is widely applied and still has an essential role in the diagnosis and treatment planning for root canal pathologies, cone beam computed tomography(CBCT) provides high-quality three-dimensional images, thereby overcoming the limitations of conventional radiographs such as distortion and superimpositionof bony and dental structures[l]. Before the introduction ofcone beam computed tomography (CBCT), the prevalence of MMC ranged between 1 and 15%, whereas a recent study has reported a much higher prevalence of 46.2% in mandibular first and second molars [2].

A study was performed to identify the prevalence of middle mesial canal and isthimi in the mesial root of mandibular molars by Tahmasbi et al. 90 limited field of view cone-beam computed tomographic scans of
122 mature mandibular first and second molars were observed. Of the 122 teeth, 20 (16.4%) had true MMC. The prevalence of MMC was 26% in first molars and 8% in second molars ($p < .05$). The frequency of isthmiin the mesial roots was 64.7% [3].

Another study was performed on de-identified cone beam image sets from 3 private radiology centers in Kerman by Kuzekananiet al. A total of 100 mandibular first molars from 62 patients (mean age 32 years) were

included.The overall prevalence of MMC in the mandibular first molars was 8.1% (10.0% in females and 6.3% in male) [4].

Knowledge of the prevalence and distribution of the MMC in mandibular molar teeth among different populations is important. The detection and biomechanical cleaning of these areas during nonsurgical or surgical root canal treatment is critical for successful treatment outcome. A number ofstudies have reported that the variations in root canal morphology and anatomy of molar teeth may be due to racial and ethnic factors, making these anatomical variations occur at different rates in populations living in different parts of the world affecting root canal treatment outcome, thus posing a need to investigate these variations.

MATERIAL AND METHODS

Study design was Descriptive cross-sectional study. Study setting was Out Patient Department of Operative Dentistry, BADCH Multan. Duration of the study was 6 months after the approval of synopsis. Sampling technique used was Consecutive non-probability sampling. Sample size was calculated using the findings of Tahmasbi et al [3] who reported that prevalence of middle mesial canal in mandibular first molar was 16.4%. Sample size was calculated using the WHO sample size calculator. Confidence level set at 95%. Margin of error was 5%. This gave us a sample size of 211. Sample selection was done as inclusion criteria including intact crowns, patient with ages between l5-60 years of both genders, teeth diagnosed with irreversible pulpitis, (deep caries lesion causing sharp, severe and radiating pain of longer duration assessed clinically and radiographically as radiolucency encroaching on the pulp). While, exclusion criteria excluded patients with immature apices (teeth with open apices that are not fully developed, assessed radiographically), ankylosed teeth (infra-occlusion and metallic sound on percussion, assessed clinically, loss of lamina dura and no periodontal space, assessed radiographically), root resorption (physiological or pathological process resulting in loss of dentin, cementum and/or bone, assessed radiographically). Data collection Procedure was done after the ethical approval from institutional review board of Bakhtawar Amin Medical and Dental College, Multan (Ref. No 902/21). Study included 211 patients visiting operative dentistry department of Bakhtawar Amin Dental Hospital, Multan after informed consent. Baseline /data including age and gender of the patient was noted. CBCT images were obtained using a CBCT scanner (Carestream 3D 9600) with a field view of 50 x 37mm and voxel size of 76pm. The operating parameters were set at l20kVp and 4.0mA with a scanning time of l5s. The measurements were evaluated using Carestream Dental Imaging Software 3D module v2.4 (CarestreamHealth,Inc). Presence of MMC was noted per operational definition. All the data recorded on the performa(attached). Data Analysis Procedure was done as, data entered and analyzed by using version 25.0 SPSS for Windows, Frequency and percentages were calculated for middle mesial canal and genders. Mean and standard deviation was
calculated for age. Data was stratified for age groups (young adults I 5-30 years, middle age adults 3l-45 years, elderly 46-60 years) and genders. The prevalence of MMC was compared between males and females and age groups using chi-square test. The $p < 0.05$ was considered statistically significant.

RESULTS

A total of 211 patients were included in this cross-sectional descriptive study conducted at the Outpatient Department of Operative Dentistry, Bakhtawar Amin Dental Hospital, Multan. All 211 mandibular first molars met the inclusion criteria and were analyzed using Cone Beam Computed Tomography (CBCT) to determine the prevalence and

characteristics of the Middle Mesial Canal (MMC). The demographic characteristics of the study population are summarized in Table 1. The mean age of the participants was 34.7 years (± 8.6), with 105 males (49.8%) and 106 females (50.2%).

Table 1: Demographic Characteristics of the Study Population (n = 211)

CHARACTERISTIC	FREQUENCY (N)	PERCENTAGE (%)
Total Patients	211	100.0
Gender		
Male	105	49.8
Female	106	50.2
Age (years)		
Mean ± SD	34.7 ± 8.6	
Range	15 - 60	

The overall prevalence of the MMC in the mesial root of the mandibular first molar was found to be 8.1% (17 out of 211 teeth). This finding underscores the importance of a careful clinical and radiographic examination to identify this anatomical variation for achieving a successful endodontic outcome.

The distribution of MMC presence based on gender is presented in **Table 2**. A total of 17 teeth exhibited an MMC, with 9 cases (52.9%) found in male patients and 8 cases (47.1%) in female patients. The chi-square test confirmed that this difference was not statistically significant ($p > 0.05$), indicating that gender has no significant effect on the prevalence of the MMC.

Table 2: Prevalence of Middle Mesial Canal (MMC) Based on Gender (n = 17)

GENDER	NUMBER WITH MMC (N)	PERCENTAGE OF MMC CASES (%)	P-VALUE
Male	9	52.9	> 0.05
Female	8	47.1	
Total	**17**	**100.0**	

When the data was stratified by age groups, both the young adult group (15-30 years) and the middle-aged adult group (31-45 years) showed a higher prevalence of MMC compared to the elderly group (46-60 years), as shown in **Table 3.** The differences in prevalence across the age groups were found to be statistically significant (p = 0.043). The observed decrease in prevalence in the elderly group is likely attributable to secondary dentin deposition with age, which results in the narrowing of the canal and can eventually lead to its obliteration.

Table 3: Prevalence of Middle Mesial Canal (MMC) Based on Age Groups (n = 211)

AGE GROUP (YEARS)	NUMBER OF TEETH (N)	NUMBER WITH MMC (N)	PREVALENCE OF MMC (%)	P-VALUE
Young Adults (15-30)	80	7	8.8	0.043
Middle-Aged Adults (31-45)	72	7	9.7	
Elderly (46-60)	59	3	5.1	

The morphological classification of the detected MMCs is detailed in **Table 4.** Among the 17 teeth exhibiting an MMC, the most common configuration was the confluent type, observed in 10 teeth (58.8%). In this type, the MMC joined either the mesiobuccal (MBC) or mesiolingual (MLC) canal before reaching the apex. An independent type, where the MMC ran as a separate canal from the orifice to the apex, was identified in 5 teeth (29.4%). The fin type, characterized by a narrow isthmus connecting the MMC to an adjacent canal, was present in 2 teeth (11.8%).

Table 4: Morphological Classification of the Middle Mesial Canal (MMC) (n = 17)

TYPE OF MMC	NUMBER OF TEETH (N)	PERCENTAGE (%)
Independent	5	29.4
Confluent	10	58.8
Fin	2	11.8
Total	**17**	**100.0**

This figure is a composite image presenting three sequential axial CBCT slices from the same mandibular first molar tooth. The scans demonstrate the presence and course of the middle mesial canal (MMC) at different levels within the mesial root. The top image shows the MMC in the middle third of the root. The middle image depicts the canal in the apical

third, illustrating how it may merge with an adjacent main canal. The bottom image provides another view, confirming the persistence of the MMC through the root structure. This visual sequence highlights the three-dimensional complexity of the root canal system and the necessity of using advanced imaging like CBCT for accurate diagnosis.The presence and morphology of the MMC were confirmed through high-resolution CBCT imaging, which provided detailed three-dimensional visualization of the root canal system.

Representative axial CBCT slices demonstrating the presence of the MMC at different levels of the root are presented in **Figure 1**.

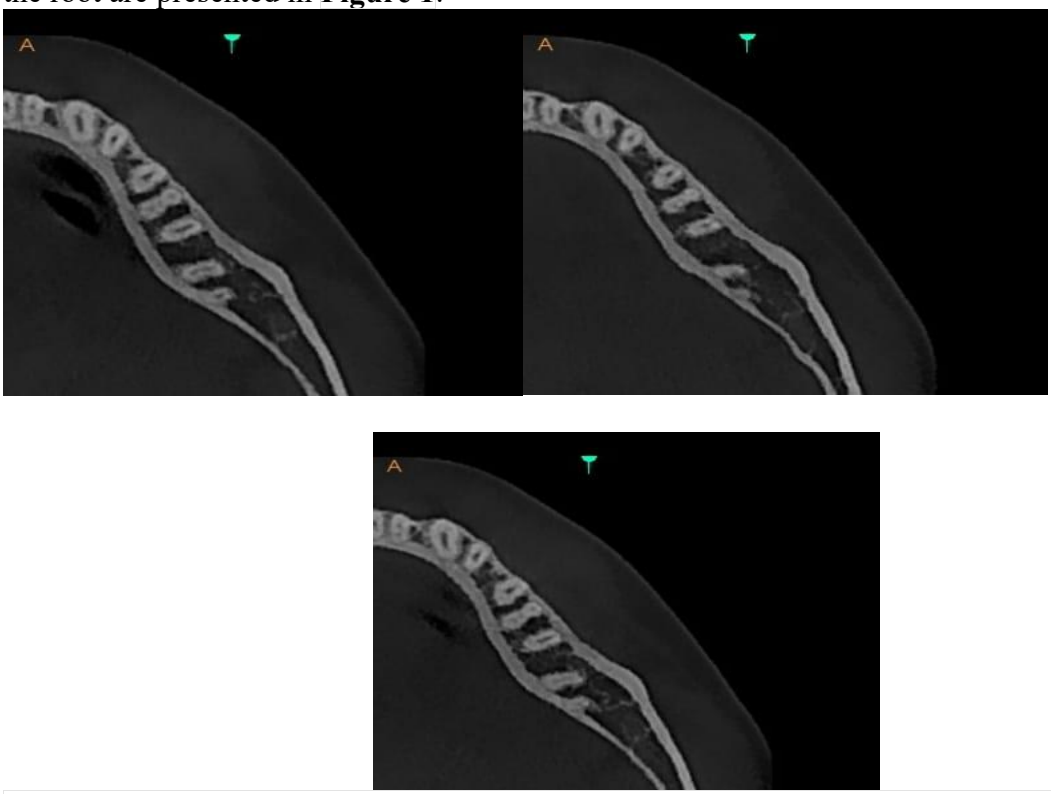

Figure 1: Selected scans with axial sections showing the presence of middle mesial canal in middle third and apical third of lower first molar.

DISCUSSION

The mesial root of the mandibular first molar exhibits considerable anatomical heterogeneity in its internal canal morphology, which presents a significant challenge in endodontic diagnosis and treatment (5). The reported prevalence of the middle mesial canal (MMC) in permanent mandibular first molars varies widely across global populations (6), with limited epidemiological data available specifically for the population of South Punjab, Pakistan.

In recent years, cone-beam computed tomography (CBCT) has become an indispensable diagnostic tool in endodontics, particularly for identifying complex anatomical features such as the middle mesial canal. Patel and Horner emphasized the clinical utility of CBCT in enhancing diagnostic accuracy, while advocating for adherence to the ALARA (As Low as Reasonably Achievable) principle to minimize radiation exposure (7). Despite its advantages, they highlighted the need for

further research to establish standardized protocols for CBCT utilization in endodontic diagnosis and management (8). This has been reinforced by the European Society of Endodontology, which has issued a position statement outlining evidence-based guidelines for the appropriate use of CBCT in endodontic practice (9).

The formation of a middle mesial canal is attributed to incomplete fusion of the mesial root developmental lobes, with subsequent deposition of secondary dentin creating a distinct or partially separated canal space. This developmental variation can result in the presence of a third canal within the mesial root of mandibular molars (10). In the present study, conducted on a population from South Punjab, Pakistan, the overall prevalence of the MMC was found to be 8.1%. This finding is consistent with some previous reports and highlights that while not ubiquitous, the MMC is a clinically relevant anatomical variant that practitioners in this region should be aware of.

The wide variation in reported prevalence across different studies may be influenced by several factors, including methodological differences, imaging modalities, and the resolution settings of the imaging equipment used. Notably, the study by Azim et al. reported an exceptionally high prevalence, which has

been widely cited in subsequent literature. This outlier finding may be explained by their combined use of high-resolution CBCT and dental operating microscopy, along with a relatively narrow age range in their study population both of which have been shown to enhance the detection rate of accessory canals (12). In contrast, Al-Maswary et al. found no significant correlation between patient age and the presence of the MMC (13), while Akbarzadeh et al. highlighted the ongoing controversy in the literature, as existing studies present conflicting evidence regarding the influence of age on MMC occurrence (14).

The interpretation of middle mesial canal (MMC) prevalence can be influenced by the diagnostic methodology employed. Tahmasbi et al. cautioned that the high detection rates reported in certain studies may be attributable to the inclusion of isthmuses — narrow, tissue-filled connections between main canals as true accessory canals, particularly when identified under dental operating microscopy. These structures, while anatomically significant, do not always represent a distinct, patent third canal with independent apical foramina, potentially leading to overestimation of MMC prevalence in microscopic studies. In contrast, Azim et al. attributed their high prevalence to the younger age range of their study population, where incomplete secondary dentin deposition and minimal canal calcification may preserve the patency of the MMC, thereby enhancing its visibility on imaging.

Notably, Tahmasbi et al. observed that when the prevalence of both true MMCs and isthmuses in the apical third of the mesial root were combined, the cumulative frequency reached 53.3%. This figure closely approximates the high detection rates reported by Azim et al., suggesting that the total burden of complex anatomy including both discrete canals and intercanal communications is substantial. This finding has critical clinical implications, as uncleaned isthmuses and undetected MMCs are frequently implicated in persistent periapical pathology and endodontic failure, underscoring the necessity for meticulous cleaning, shaping, and obturation of the entire mesial root complex.

CONCLUSION

The Middle Mesial Canal is an anatomical variant in the mandibular first molar within the studied population of South Punjab, Pakistan. The findings of this study indicate that gender has no significant effect on its prevalence. However, age appears to be a factor, with a lower prevalence observed in the elderly group, likely due to age-related

secondary dentin deposition leading to canal obliteration. The use of advanced diagnostic tools like CBCT is highly recommended to ensure the identification and proper management of the MMC. Failure to locate and treat this canal can be a cause of persistent periapical pathology and endodontic treatment failure. Therefore, clinicians must be thoroughly familiar with this variation and employ meticulous exploration techniques to achieve a successful and predictable long-term outcome.

REFRRENCES

1- Hiraiwa T, Ariji Y, Fukuda M, Kise Y, Nakata K, Katsumata A, et al. A deep Learning artificial intelligence system for assessment of root morphology of the mandibular first molar on panoramic radiography. DentomaxillofacRadiol. 2019;48(3):01-07

2- Jabali AH. Middle mesial and middle distal canals in mandibular first molar. J Contemp DentPract. 2018; 19(2):233-6.

3- Tehmasbi M, Jalali P, Nair MK, Barghan S, Nair UP. Prevalence of middle mesial canal andisthimi in the mesial root of mandibular molars; an in vivo cone beam ted tomographic study. J Endod. 2017;43(7): 1080-3.

4- Kuzekanani M, Walsh LJ, Amiri M. Prevalence and distribution of the middle mesial canal inmandibular first molarteeth of the kerman population: ACBCT study. Int J Dent. 2020;2020:815-22

5- Nagahara T, Takeda K, Wada K, Shirawachi S, Iwata T, Kurihara H, et al. A mandibularsecond molar with a middle mesial root canal. Clin Case Rep. 2020;8(6): 1015-20

6- Asher S, Suominen AL, Stephen R, Ngandu T, Koskinen S, Solomon A. Association of tooth location, occlusal support and chewing ability with cognitive decline and incident dementia. Journal of Clinical Periodontology. 2024 doi: 10.1111/jcpe.13970.

7- Penukonda R, Pattar H, Nambiar P, Al-Haddad A. Middle mesial canal in mandibular first molar: A narrative review. Saudi Dental Journal. 2023;35(5):468–75.

8- Gambarini G, Ropini P, Piasecki L, Costantini R, Carneiro E, Testarelli L. A preliminary assessment of a new dedicated endodontic software for use with CBCT images to evaluate the canal complexity of mandibular molars. International Endodontic Journal. 2018;51(3):259–68.

9- Mantovani VDO, Gabriel AEDS, Silva RG, Savioli RN, Sousa-Neto MD, Cruz-Fiiho AM. Analysis of the mandibular molars root canals morphology. Study by computed tomography. Brazilian Dental Journal. 2022;33(5):1.

10- Tredoux S, Warren N, Buchanan GD. Root and canal configurations of mandibular first molars in a south african subpopulation. Journal of Oral Science. 2021;63(3):252–6.

11- Bhatti UA, Muhammad M, Javed MQ, Sajid M. Frequency of middle mesial canal in mandibular first molars and its association with various anatomic variables. Australian Endodontic Journal. 2022;48(3):494–500.

12- Senthil K, Solete P. Prevalence of middle mesial canal in the mesial roots of mandibular molar using cone beam computed tomography - an in-vivo radiographic study. International Journal of Clinical Dentistry. 2021;14(3):345–52.

13- Hasheminia M, Razavian H, Khorrami L, Mosleh H, Mohamadi S. Prevalence of middle mesial canal in mandibular first molars using cone-beam computed tomography technique. Dent Res J (Isfahan) 2021;18:42.

14- Qiao X, Zhu H, Yan Y, Li J, Ren J, Gao Y. Prevalence of middle mesial canal and radix entomolaris of mandibular first permanent molars in a western Chinese population: An in vivo cone-beam computed tomographic study. BMC Oral Health. 2020;20(1):224.

15- Alsanah AS, Alqahtani FA, Alshehri DM, Alqahtani AM, AbuMelha AS. Prevalence of Middle Mesial Canal in Mandibular Molars of a Saudi Subpopulation: A Prospective Cone-Beam Computed Tomography Study. Cureus. 2023;15(2):3–9.
16- Weinberg EM, Pereda AE, Khurana S, Lotlikar PP, Falcon C, Hirschberg C. Incidence of Middle Mesial Canals Based on Distance between Mesial Canal Orifices in Mandibular Molars: A Clinical and Cone-beam Computed Tomographic Analysis. Journal of Endodontics. 2020;46(1):40–3.
17- Hasheminia M, Razavian H, Khorrami L, Mosleh H, Mohamadi S. Prevalence of middle mesial canal in mandibular first molars using cone-beam computed tomography technique. Dental Research Journal. 2021;18(1):42.
18- Al-Maswary AA, Almadhoon HW, Elkhateb A, Hamdallah A, Halboub E. The Global Prevalence of Middle Mesial Canal in Mandibular First and Second Molars Assessed by Cone Beam Computed Tomography: A Systematic Review and Meta-Analysis. Journal of Endodontics. 2023;49(6):638–56.
19- Patel S, Brown J, Semper M, Abella F, Mannocci F. European Society of Endodontology position statement: Use of cone beam computed tomography in Endodontics: European Society of Endodontology (ESE) developed by. International Endodontic Journal. 2019;52(12):1675–8.