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Frequency of Middle Mesial Canal in Mandibular Molars

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ABSTRACT

Being the most difficult to detect unusual canal in mandibular molars, creating greater anatomical complexity and thereby variability, it is important that careful investigation aids in successful endodontic treatments. **Objective:** To evaluate the incidence and features of MMC in mandibular molars; to study demographic parameters and dental factors that may have an effect on its detection. **Methods:** A cross-sectional study was performed at Shahida Islam Medical College (SIMC), Lodhran from September 2023 to March 2024, and contained a total of 148 patients. Data was assessed for the presence of MMC in first, second and third mandibular molars. Two expert dental radiologists evaluated the results of the X-ray films. **Results:** The prevalence of MMC was 18%, with complete and partial compartments seen in more than half the patients (77%). It was shown that MMCs were most commonly observed in 51-65 age group (21.28%); however, there were non-significant differences based on patient's age and gender or tooth type and position accompanying OAC site. **Conclusions:** In present study, MMC was noted in 18% patients. Statistically insignificant demographic or dental predictors for MMC were identified.

INTRODUCTION

For successful endodontic treatments, complexity of root canal anatomy plays very crucial role. For the understanding of presence and configuration of root canals, like middle mesial canal (MMC) in lower mandibular molars, is important for achieving successful treatment [1]. MMC located between the mesiobuccal and the mesiolingual canals, is often difficult to be identified and treated because of its complex and hidden position [2]. New diagnostic imaging modalities like CBCT and micro-CT scanning have immensely contributed to our understanding of MMC, particularly in terms of 3D images that are essential for accurate analysis regarding canals [3]. The incidence of MMC as reported in the literature varied widely, like a Saudi study reported frequency of MMC in only 2.6% of 1st mandibular molars and 0.2% of 2nd mandibular molars [4]. The frequency of MMCs and their detection may vary according to age, gender and specific tooth characteristics. The detection or identification of MMCs can be difficult, requiring sophisticated imaging, thorough clinical assessment and the use of magnification to guarantee that indolent lesions are found [5, 6]. Studies on prevalence of MMCs in Pakistan is scarce. Bhatti *et al.*, found MMC in only 7.7% patients and Rehman *et al.*, found MMCs in 9 patients out of 189 patients [7, 8]. The aim of this study was to evaluate the cases in which MMC were diagnosed on mandibular molars, and also discuss their

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clinical difficulties encountered by either being hidden or related with complex location. Knowledge of the prevalence and clinical characteristics of MMC in Pakistani population may help improving diagnosis, practice patterns, treatment outcomes associated with endodontic management.

This study aimed to enrich local data and current global knowledge on MMC, towards the creation of better tailored endodontic protocols.

METHODS

From September 1, 2023, to March 30, 2024, this cross sectional study was conducted at Department of Dentistry, Shahida Islam Medical College, Lodhran. Ethical approval was taken from ethical review committee of the hospital (Approval No. SIMC/H.R./7720/23). We enrolled 148 patients, either male or female having age between 18-65 years, presented for routine dental examinations or treatment and required dental radiographs for diagnostic or treatment planning purposes. Patients with fully erupted mandibular 1st, 2nd or 3rd molars were eligible for the study. We exclude patients with history of endodontic treatment, significant dental anomalies, or systemic conditions impacting dental morphology. Informed consent was obtained from all participants. The sample size of 148 selected patients was calculated using frequency of 10.79% of MMC, 95% confidence level and 5% margin of error [9]. Radiographic assessment was done by using initial digital panoramic radiographs (Planmeca ProMax® 3D Classic) for the assessment of general dentition and check for retained mandibular molars. This was followed by targeted periapical radiographs by using Kodak 6100 Digital Radiography System to focus on the mandibular molars of interest. MMCs were confirmed on x-ray by using periapical radiographs which were very important for evaluating any ambiguous cases based on visual discernment of additional canal spaces within the mesial root of mandibular molars. For the purpose of radiographic analysis, images demonstrating both the presence and absence of MMCs were included to illustrate the variable occurrence of this anatomical feature. This was instrumental in supporting the study's findings and providing clear evidence of MMC identification. The primary variable of this study was the presence of MMCs in mandibular molars. Secondary variables included patient demographics and specific tooth characteristics such as age, gender, molar type (first, second, or third), position (right/left side), and treatment history. These variables were analyzed to determine their potential association with the presence of MMCs. The data collected were analyzed with SPSS version 26.0. Means and standard deviations were used to describe age, whereas frequencies with percentages described categorical variables including the presence of MMC (yes/no), gender (male/female), tooth type (first molar/ second molar /third molar), tooth position (left/right) and treatment history (treated/ untreated). Stratification of the data was done according to age, sex, type of retained tooth correction (tooth number or teeth group), position in dental arch and history of orthodontic treatment. The association of MMC location with categorical variables was assessed using chi-square tests in a post-stratification fashion. A p-value ≤0.05 was determined as statistically significant.

RESULTS

In the current study, the average age of the participants was 42.34 years, with a standard deviation of 13.31 years, highlighting a broad age range among the sampled individuals. Notably, the middle mesial canal (MMC) was detected in 26 of the 148 patients, accounting for 18% of the study population (Figure 1).

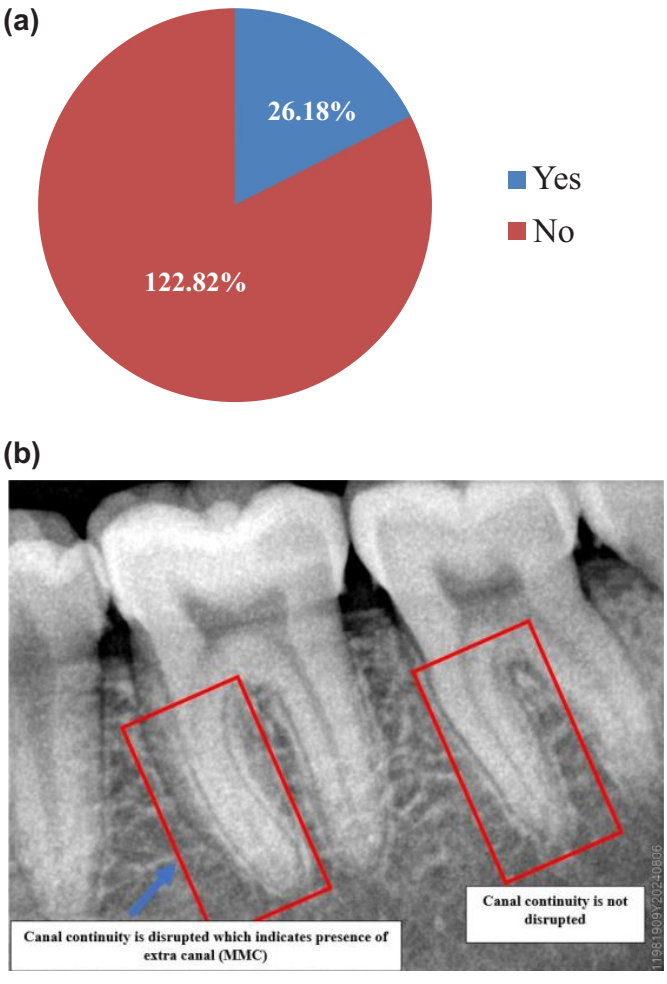

Figure 1: Part A Showed Frequency of MMC Found in Our Study, Part B Showed Radiograph for The Presence and Absence of MMC

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The examination of MMC across different age brackets revealed the highest prevalence in the 51-65 age group, where 10 out of 47 patients (21.28%) exhibited this anatomical feature. This represents 31.76% of the total study cohort. Conversely, the 41-50 age group showed the lowest incidence, with only 4 patients (10.26%) demonstrating MMC out of the same group size. Although these variations were notable, the chi-square test confirmed that they were not statistically significant (P=0.2891), suggesting that age may not be a primary factor in MMC presence (Table 1).

Table 1: Association of Middle Mesial Canal with Age Groups

Age Groups	Middle Mesial Canal		Total N (%)	P value
	Yes N (%)	No N (%)		
18-30 Years	7 (17.95%)	32 (82.05%)	39 (26.35%)	0.2891
31-40 Years	5 (21.74%)	18 (78.26%)	23 (15.54%)	
41-50 Years	4 (10.26%)	35 (89.74%)	39 (26.35%)	
51-65 Years	10 (21.28%)	37 (78.72%)	47 (31.76%)	
Total	26 (17.57%)	122 (82.43%)	148 (100.00%)	

Gender comparison showed a slightly higher occurrence of MMC in males (15 out of 70; 21.43%) than in females (11 out of 78; 14.10%). However, statistical analysis indicated that this difference was not significant (P=0.2413), implying that gender does not critically influence the presence of MMC (Table 2).

Table 2: Association of Middle Mesial Canal with Gender

Gender	Middle Mesial Canal		Total N (%)	P value
	Yes N (%)	No N (%)		
Male	15 (21.43%)	55 (78.57%)	70 (47.30%)	0.241
Female	11 (14.10%)	67 (85.90%)	78 (52.70%)	
Total	26 (17.57%)	122 (82.43%)	148 (100.00%)	

When classified by tooth type, second molars were most commonly associated with MMC (12 out of 59; 20.34%), followed by third molars (8 out of 47; 17.02%) and first molars (6 out of 42; 14.29%). Despite these findings, the statistical tests showed no significant differences (P=0.8223), suggesting that the type of tooth does not significantly dictate the likelihood of MMC occurrence (Table 3).

Table 3: Association of Middle Mesial Canal with Tooth Type

Tooth Type	Middle Mesial Canal		Total N (%)	P value
	Yes N (%)	No N (%)		
First Molar	6 (14.29%)	36 (85.71%)	42 (28.38%)	0.822
Second Molar	12 (20.34%)	47 (79.66%)	59 (39.86%)	
Third Molar	8 (17.02%)	39 (82.98%)	47 (31.76%)	
Total	26 (17.57%)	122 (82.43%)	148 (100.00%)	

Analysis based on tooth position revealed that MMC was more frequently observed in right mandibular molars (15 out of 72; 20.83%) than in left mandibular molars (11 out of 76; 14.47%). Despite this apparent disparity, it was not statistically significant (P=0.3475), indicating that the side of the mandible was not a determining factor for MMC detection (Table 4).

Table 4: Association of Middle Mesial Canal with Tooth Position

Tooth Position	Middle Mesial Canal		Total N (%)	P value
	Yes N (%)	No N (%)		
Left	11 (14.47%)	65 (85.53%)	76 (51.35%)	0.347
Right	15 (20.83%)	57 (79.17%)	72 (48.65%)	
Total	26 (17.57%)	122 (82.43%)	148 (100.00%)	

Interestingly, MMC was more prevalent in patients with previous dental treatments (17 out of 80; 21.25%) compared to those without such history (9 out of 68; 13.24%). However, the lack of statistical significance (P=0.2891) suggests that past dental interventions do not markedly affect the identification of MMC (Table 5).

Table 5: Association of Middle Mesial Canal with Treatment History

Treatment	Middle Mesial Canal		Total N (%)	P value
	Yes N (%)	No N (%)		
Treated	17 (21.25%)	63 (78.75%)	80 (54.05%)	0.2891
Not-treated	9 (13.24%)	59 (86.76%)	68 (45.95%)	
Total	26 (17.57%)	122 (82.43%)	148 (100.00%)	

DISCUSSION

The complexity of anatomy in mandibular molars was highlighted in the search for the middle mesial canal (MMC). Our study identified an MMC rate of approximately 18% in a cohort of 148 patients, which aligns with the variability reported in international studies and underscores certain anatomical peculiarities unique to this study population. This rate contrasts with previously reported rates in Pakistan where Bhatti *et al.*, found a 7.7% prevalence and Rehman *et al.*, observed MMCs in about 4.76% of mandibular molars examined using CBCT [7, 8]. The notably higher prevalence found in our study could be attributed to several factors: first, the utilization of more advanced CBCT technology allowing for better visualization and detection of MMCs compared to traditional imaging methods possibly used in earlier studies; second, our sample might represent a demographically distinct subset of the Pakistani population with potential anatomical variations; and finally, variations in the rigorousness of the radiographic analysis performed by different researchers could also contribute to discrepancies in prevalence rates. Talabani *et al.*, reported MMC prevalence 14.7% and 19.3% respectively on right and left side which was slightly higher than our results. This might suggest anatomical discrepancies or variations in detection techniques [10]. In a Brazilians study, Barros-Costa *et al.*, found MMC in 11.1% patients, lower than our findings that could indicate regional anatomic differences [11]. Azim *et al.*, reported frequency of MMC as 46.2%, demonstrating the power of high magnifications and resolution in uncovering some features missed by conventional techniques [12]. Nosrat *et al.*, and Yang *et al.*, studies highlighted age-related developmental constraints in MMC formation, arguing for an individualized diagnostic strategy [13, 14]. In a study by

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Iqbal *et al.*, conducted in India, authors found MMC in 21.8% patients, indicating that ethnic or genetic factor might be responsible for formation of MMC [15]. In an Iranian study by Hosseini *et al.*, conversely a lower MMC rate was reported i.e. 9%, maybe due to an infrequent use of modern diagnostic tools [16]. Kuzekanani *et al.*, found that 8.1% of the patients had MMCs visible on CBCT technology, indicating the significance of advanced imaging in locating complex root canal systems [17]. Hatipoğlu *et al.*, reported in their study that there was a considerable impact of demographic factors on the prevalence of MMC. They reported substantial variations in MMC detection rates by countries [18]. Mahajan *et al.*, analyzed the MMC in India using CBCT presented with significant anatomical variations and stated that 3D imaging was a necessity for accurate identification [19]. Stomatitis *et al.*, also found morphological variations of MMC in a North Indian subpopulation, indicating that geographical and ethnic backgrounds significantly influence MMC characteristics [20]. In the results of our study, based on age distribution, gender and subtypes of teeth (specific tooth types,) we could not find significant differences in MMC presence, suggestive that factors such as patient age or gender were less effective for development of MMC. These results highlight the critical importance of widespread imaging and structured examination techniques for identifying all MMC at presentation to facilitate appropriately aggressive treatment.

CONCLUSIONS

The results of our study showed rate of MMC as 18%. We found statistically insignificant association of development of MMCs with age and gender of patients, side of tooth and previous history of dental treatment. These results also indicate that the occurrence of MMCs was primarily influenced by individual anatomical variability, not demographic or clinical factors. Consequently, advanced imaging was crucial for the accurate detection of MMCs to ensure effective endodontic treatment planning for all patients.

Authors Contribution

Conceptualization: AMC

Methodology: SN, MH

Formal analysis: SN, AS

Writing, review and editing: AR, MHA

All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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