



ORIGINAL ARTICLE

# The mid-mesial canal prevalence in mandibular molars of a Saudi population: A cone-beam computed tomography study



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## KEYWORDS

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**Abstract** *Introduction:* The aim was to assess the prevalence of Mid Mesial Canal (MMC) in the first and second mandibular molars in a Saudi subpopulation sample and assess its relation to side, gender, and age using Cone beam computed tomography (CBCT).

*Methods:* The CBCT scans at King Saud University Dental Hospital between 2016 and 2019 were reviewed and filtered. The MMC of the mandibular molars were assessed according to Pomeranz et al. classification which was: (1) independent; (2) fin; (3) confluent with the mesiobuccal canal; and (4) confluent with the mesiolingual canal. Three calibrated observers examined the MMC on all planes at both sides. Age and gender factors were used to analyze that prevalence. A chi-squared test was used and ( $P \leq 0.05$ ) was considered to be statistically significant.

*Results:* 395 patients, and 1377 teeth met the inclusion criteria. The total number of mid-mesial canals was 12 (0.9%): nine at the mandibular first molar (1.3%) and three in the mandibular second

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molar (0.4%). The most common type of mid-mesial canal was confluent ( $n = 10$ ), of which 6 fused with the mesiobuccal canal and 4 fused with the mesiolingual canal. Two canals were of the fin type, and there was no instance of independent mid-mesial canal. There was no significant difference between all variables: tooth type, tooth side, patient gender, and patient age group ( $p > 0.05$ ).

**Conclusion:** In this study, the most common MMC configuration was the confluent type followed by the fin type and no independent type were found. The patient side, gender and age did not influence the prevalence of the MMC.

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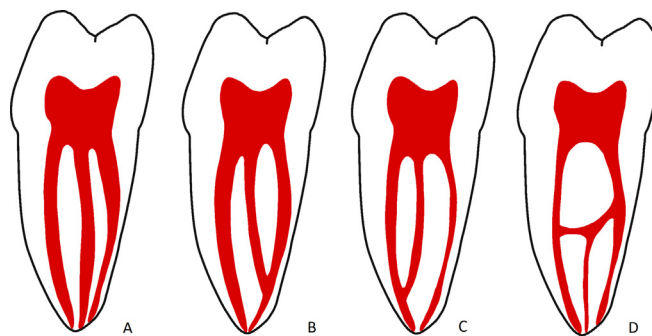
## 1. Introduction:

To achieve successful endodontic therapy, it is crucial for clinicians to be well-informed regarding the root morphology and the configuration of the root canals of the tooth they intend to treat. The root canal treatment may be compromised when one or more root canals are left untreated, particularly in cases of multirooted teeth (Baugh and Wallace, 2004). Variations in roots and root canal morphology are not uncommon, and these variations may include the presence of deltas, fins, accessory canals, loops, and multiple orifices (Navarro et al., 2007). Mandibular first and second molars have been commonly described as having two roots, one mesial and one distal. The mesial root often possesses a buccal and lingual canal, while the distal root usually has only one root canal (Vertucci, 1984). One variation in root canal morphology in the mesial root of mandibular molars is the presence of an extra root canal between the buccal and lingual canal, commonly termed the mid-mesial canal (MMC). Pomeranz et al. (Pomeranz et al., 1981) classified the MMC into 3 categories (Fig. 1): (1) the canal originates from a separate orifice and continues independently without interacting with the mesiobuccal or mesiolingual canals all the way to the apex (independent); (2) the canal fuses and continues with either the mesiobuccal or mesiolingual canal (confluent); and (3) the canal is joined by an isthmus with the mesiobuccal or mesiolingual canal along its path (fin). The most common type of MMC is confluent, followed by fin, and the least common type is independent (Bansal et al., 2018).

In the literature, a wide range of MMC prevalence has been observed, ranging from 0.2% to more than 50% (Bansal et al., 2018). This wide range of variation is usually attributed to multiple factors, one of which is the study method. Many tools and methods have been used to assess the morphology of root

canals. These include clinical studies, microscopic teeth sections (Vertucci, 1984), transparent tooth specimens (Chen et al., 2009), staining and clearing of root canals (Weng et al., 2009), conventional radiography (Yew and Chan, 1993), cone beam computed tomography (CBCT) (Wang et al., 2010), and micro-CT (Versiani et al., 2016). CBCT has gained immense popularity in recent years, as it has the advantage of clearly displaying anatomical structures without the burden of superimposition and blurring that is often seen in conventional 2D imaging such as periapical and panoramic radiography. CBCT offers the ability to assess teeth in three dimensions, which increases the clinician's ability to better identify the root canal morphology. CBCT currently plays an important role in the diagnosis and treatment of teeth with complicated root canal anatomies that require endodontic treatment. The latest position statements of both the American Association of Endodontics (AAE) and the American Academy of Oral and Maxillofacial Radiology (AAOMR) (Fayad et al., 2015) stated that "Limited field of view (FOV) CBCT should be considered the imaging modality of choice for initial treatment of teeth with the potential for extra canals and suspected complex morphology".

It has also been shown that the roots and root canal morphology varies among different ethnicities (Sert and Bayirli, 2004). The MMC is not an exception; Versiani et al. (Versiani et al., 2016) reported a significant difference when they compared the prevalence of MMC in mandibular first molars of a sample of Brazilian and Turkish populations. Currently, there is a limited number of studies assessing the prevalence of MMC in the Saudi population utilizing CBCT imaging. Hence, the aim of this study was to assess the prevalence of MMC in the first and second mandibular molars in a Saudi subpopulation sample and assess its relation to gender and age using CBCT imaging.



**Fig. 1** Pomeranz et al. (1981) classification of the MCC, A) Independent type, B) Confluent with mesiobuccal canal, C) Confluent with mesiolingual canal, D) Fin type.

## 2. Materials and methods

This study received ethical approval from the ethics committee of the College of Dentistry Research Center. The CBCT data of patients who underwent CBCT scanning at the Oral and Maxillofacial Department in the Dental University Hospital at King Saud University between 2016 and 2019 were reviewed. All patients who met the inclusion criteria were included. The inclusion criteria were: (1) Patients of Saudi nationality; (2) Presence of either the first or second mandibular molar; and (3) Patients aged 12 and older. Teeth that had previous endodontic treatment, periapical pathology, or were not fully included in the CBCT scan were excluded.

All CBCT images were acquired using a Planmeca Promax 3D Max digital imaging device (Planmeca, Helsinki, Finland) at 90 kVp and 11 mA. Images had isotropic voxels with sizes between 0.1 and 0.4 mm. CBCT examinations were previously acquired to assess different diagnostic tasks, mainly including implant site assessment, assessment of mandibular third molar proximity to vital structures, and endodontic treatment. The images were reviewed using the native imaging software Planmeca Romexis 5.2 (Planmeca, Helsinki, Finland). CBCT images were assessed by two oral and maxillofacial radiologists (MA, AA) and one endodontist (RA).

The mesial roots of the mandibular first and second molars were examined to assess the presence of MMC and were classified into the following categories according to the classification of [Pomeranz et al. \(1981\)](#): (1) independent; (2) fin; (3) confluent with the mesiobuccal canal; and 4) confluent with the mesiolingual canal. The axial, sagittal, and coronal planes were aligned with the root long axis and then the root was examined on all planes. The MMC was recorded when it could be clearly seen in both the axial and coronal sections. To assess the inter-examiner agreement, we conducted a pilot study among the three examiners. The resulting inter-examiner reliability was high ( $r = 0.94$ ).

Statistical analysis was performed using SPSS software, version 20.0 (SPSS, Inc., Chicago, IL, USA). A chi-squared test was used to assess statistical significance. A P-value equal to or less than 0.05 was considered to be statistically significant.

## 3. Results:

The CBCT data of 395 patients were included in this observational study of the mesial roots of the mandibular first and second molars. Overall, 203 teeth were not included for the following reasons: missing teeth (97), endodontically treated teeth (80), and teeth that were not fully included in the CBCT scan (26). In total, 1,377 teeth met the inclusion criteria, 687 first molars and 690 s molars. There were 181 male patients (45.8%) with a mean age of 31.5 years (SD = 11.35 years) and 214 female patients (54.2%) with a mean age of 28.9 years (SD = 9.11 years). The total number of mid-mesial canals was 12 (0.9%): nine at the mandibular first molar (1.3%) and three in the mandibular second molar (0.4%). Despite this difference, it was not statistically significant ( $P = 0.07$ ). There was no significant difference in the prevalence of mid-mesial canal between males and females ( $P = 0.78$ ) or between the right and left side ([Table 3](#)) ( $P = 0.93$ ).

The age distribution of the patients is presented in [Table 1](#). There was no statistical significance between the different age groups ( $P = 0.68$ ). The most common type of mid-mesial canal was confluent ( $n = 10$ ), of which 6 fused with the mesiobuccal canal ([Fig. 2](#)) and 4 fused with the mesiolingual canal ([Fig. 3](#)). Two canals were of the fin type ([Fig. 4](#)), and there was no instance of independent mid-mesial canal. The complete distribution of mid-mesial canal types is presented in [Table 2](#).

## 4. Discussion

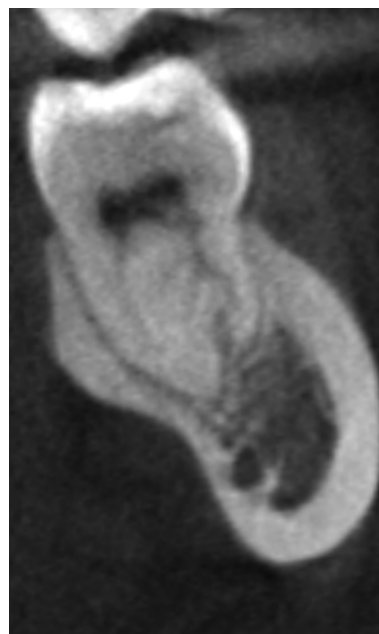
Mandibular first molars are one of the teeth most encountered in clinical practice that need endodontic treatment ([Navarro et al., 2007](#)). This is because they are one of the first permanent teeth to erupt and are the most susceptible to caries development, which can lead to endodontic treatment. The success of endodontic treatment depends on thorough instrumentation and irrigation of all root canals, followed by obturation. Variations in the root canal morphology can pose a challenge for clinicians, especially variations in the MMC in the roots of the first and second mandibular molars because it is not a common finding and requires additional effort for identification and treatment. Several methods have been used to evaluate the prevalence of MMC, including intraoral radiography ([Yew and Chan, 1993](#)), CBCT ([Wang et al., 2010](#)), micro-CT ([Versiani et al., 2016](#)) and clinical studies ([Azim et al., 2015](#)). The use of CBCT imaging has become increasingly popular among endodontists in recent years because it offers images of dental tissues without superimposition or blurring, which is often seen in intraoral and panoramic radiographs. Thus, CBCT is commonly used in dental morphology studies. CBCT has also been shown to be accurate in identifying extra root canals, such as the second mesiobuccal canal in maxillary first molars ([Zheng et al., 2010](#)). One of the more significant advantages of CBCT is the ability to examine vital and untreated teeth. This is in contrast to study techniques that require extracted teeth, which are usually affected by periodontal or endodontic disease, and these diseases can alter the root canal morphology ([Tahmasbi et al., 2017](#)).

A large variation in the prevalence of MMC can be seen in the literature. The study method and design, as well as the sample ethnicity, contribute to this variation. In the current study, the MMC was present in 9 of 687 (1.3%) first molars and in 3 of 690 (0.4%) second molars. Our results are in agreement with a similar study by [Kim et al. \(2013\)](#) who examined the CBCT data of 976 Korean subjects and found a 0.35% prevalence of MMC in the first mandibular molar. [Wang et al. \(2010\)](#) found a slightly higher prevalence of 2.7% in the first mandibular molar when assessing the CBCT data of 558 Western Chinese subjects. [Srivastava et al. \(2018\)](#) found a significantly higher prevalence of MMC compared to our results; these authors found a prevalence of 18.2% when assessing the CBCT data of 130 Saudi subjects. This finding could possibly be explained by differences in both sample size and methodology. The current study applied a very strict criterion where MMC was registered only when it could be clearly seen in more than one plane, typically in both the axial and paracoronal planes.

In the present study, we found more MMCs in the roots of first mandibular molars than in the roots of second molars.

**Table 1** Distribution of mid mesial canal among different age groups. Data presented as frequency.

Age	10–29	30–49	50 and above	Total
No mid mesial canal	918	373	74	1365
Mid mesial canal	9	2	1	12
Total	927	375	75	1377

**Fig. 2** Mid-mesial canal fused with mesiobuccal canal.**Fig. 4** Mid-mesial canal fin type.**Fig. 3** Mid-mesial canal fused with mesiolingual canal.

Tahmasbi et al. (2017) found similar results when evaluating the CBCT images of 90 patients. These authors found a 16.4% prevalence of MMC in the first molars and 8% in the second molars. Nosrat et al. (2015) also found more MMCs in the first molars than in the second molars when assessing the root canal configuration of 75 mandibular first and second molars using a dental operating microscope.

In our study, we did not find any independent MMCs with a separate orifice and foramen. This finding is similar to the findings of most studies assessing MMCs in mandibular molars, where the independent MMC type is by far the lowest in prevalence (Bansal et al., 2018). The most common MMC type in the current study was the confluent type of which 6 joined with mesiobuccal canal and 4 joined with the mesiolingual canal. Versiani et al. (2016) found similar results in their assessment of 258 M under micro-CT. In that study, confluent MMCs were the most common MMC type, and more MMCs fused with the mesiobuccal canal than with the mesiolingual canal.

Controversy remains when the effect of age on the incidence of MMC is considered. One theory (Peiris et al., 2008) suggests that the incidence of MMC is higher in the 30–40 year old age group, which coincides with the completion of root canal differentiation. This theory states that the root canal configuration changes and matures after the completion of root development and closure of the apical foramen. Further-

**Table 2** Distribution and frequency of mid mesial canal types. Data presented as frequency.

Types of mid mesial canals	Independent	Fin	Confluent		Total
			Mesiobuccal	Mesiolingual	
Frequency	0	2	6	4	12

**Table 3** Distribution of mid mesial canal among mandibular first and second molars both right and left.

Tooth	36	37	46	47	Total
No mid-mesial canal	343	347	335	340	1365
Mid-mesial canal	4	2	5	1	12
Total	347	349	340	341	1377

more, the continuous deposition of secondary dentin occurs within the root canals, leading to a more complicated root canal configuration and the possibility of developing a third root canal in the mesial root of the first and second mandibular molars (Bhargav et al., 2017). Another theory suggests that the MMC is progressively more difficult to find as age increases (Pomeranz et al., 1981) owing to the deposition of secondary dentin, which leads to calcification and blockage of the MMC (Azim et al., 2015). In the current study, no statistical difference was found between age groups, which could be explained by our sample being skewed towards a younger age group; 63% of our sample was younger than 30 years; however, this is representative of the Saudi population.

A limitation of the current study is the inclusion of heterogeneous CBCT data that includes volumes with different voxel sizes. This might have led to the inability to detect some MMCs, as a narrow MMC might be missed when a larger voxel size is used during scanning. We suggest performing MMC observations with limited-field CBCT scans to ensure the use of smaller voxel sizes.

In conclusion, clinicians treating the first or second mandibular molars in a Saudi patient must be diligent in locating the MMC. Because of their low prevalence, such cases are not commonly encountered in daily practice.

#### CRediT authorship contribution statement

**Mazen A. Aldosimani:** Conceptualization, Methodology, Writing - original draft, Writing - review & editing, Investigation. **Riyadh I. Althumairy:** Investigation, Writing - review & editing. **Adel Alzahrani:** Investigation. **Fahd A. Aljarbou:** Writing - original draft, Writing - review & editing, Formal analysis. **Mohammed S. Alkatheeri:** Writing - original draft. **Muhannad A. AlGhizzi:** . **Turki K. Abughosh:** .

#### Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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The authors deny any conflict of interest related to this study.

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