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A Review of the Second Mesiobuccal (MB2) Canal in Maxillary Molars Across Different Demographic Factors: Gender, Age, and Geographical Region

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Abstract

The root canal system has always been one of the most complicated aspects of dentistry, especially in endodontic. Lack of knowledge about the root canal system could lead to missing the additional root canal, which can later cause the endodontic treatment failure. The second mesiobuccal (MB2) canal which is the popular additional canal in maxillary molar is one of the most discussed topics. There will be different variations regarding the MB2 canal in various demographic factors. Thus, gender, age and geographical region factors should be considered to determine the anatomical variability and the frequency of the MB2 canal. **Objectives:** To review the available evidences on the prevalence of MB2 canal among different demographic factors such as gender, age and geographical region. Literature search was performed using PubMed, Scopus, Medline and Google Scholar databases to identify the related articles using systematic search strategy. From the available evidences among the selected articles, the prevalence of MB2 canal is 43.6%-73.0% in male and 23.2%-71% in female. The prevalence of MB2 canal is 27.3%-74.4% in younger age group and 10%-69.4% for the older age group. The prevalence of MB2 canal is 52.0%-57.8% in China and 45.6%-59.9% in Malaysia. According to the gender, the prevalence of MB2 canal is more frequent in male compare to female. In the age group aspect, the prevalence of MB2 canal is more frequent in the younger compare to older age group. The pattern also showed that the prevalence of MB2 canal varies randomly regardless of any geographical region.

Keywords

Literature review, second mesiobuccal (MB2) canal, gender, age, geographical region

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Introduction

The root canal system has always been one of the most complicated aspects of dentistry, especially in endodontic. The primary goal of endodontic therapy is to prevent and treat endodontic conditions, such as apical periodontitis. Since the root canal system is complicated and has anatomical variances, having a precise understanding of its anatomy and morphology is essential to the effectiveness of endodontic treatment [1]. Furthermore, an endodontist may have an uphill battle when it comes to identifying, cleaning, and contouring the whole root canal system during endodontic therapy. The complex structure of the root canal system is directly correlated with the frequency and risk of missing especially when working on molars.

Each tooth has a different root canal system, particularly molars. The molar teeth's root canal system has a complex structure. Recent research has shown that the molar root canal system is extremely complex since the canals split and unite on their path to the apex [2]. The interior morphology of teeth is a complex challenge for dentists, who must utilize their knowledge and abilities to the fullest extent possible to prevent errors during root canal therapy procedures [3].

The second mesiobuccal (MB2) canal in the maxillary molar is the most discussed topic in endodontic. It is also one of the most frustrating aspects of the maxillary molar root canal [4]. The maxillary molar is the most intricate root canal structure, may require the most treatment, and is also the least understood [5]. The elusive MB2 canal is also one of the biggest mysteries in endodontic [6]. A number of studies have been conducted to evaluate their anatomical features. The maxillary first molar has been found to have three roots and four canals, and more than 50% of mesiobuccal root MB2 canal incidences have been documented. [7]. The MB2 canal orifice in the maxillary molar is generally located either mesial to or within the pulpal groove connecting the main mesiobuccal canal and the palatal canal. It lies within 3.5 mm palatally and 2 mm mesially from the main mesiobuccal canal [6]. When there are two canals present in a mesiobuccal root, the root canal's shape might be either oval or ribbon-shaped [2].

Furthermore, it is well known that a significant contributing factor to the failure of root canal therapy may be the incapacity to identify and treat every canal in the system. [6]. This knowledge will help the clinician in endodontic treatment planning and decreases the incidence of endodontic failure. That is why, understanding the tooth anatomy is crucial for effective endodontic treatment. It is very crucial to deeply understand the morphology of the root canal system before any endodontic procedure. Lack of knowledge about the root canal system could lead to missing the additional root canal, which can later cause the endodontic treatment failure [2]. This is because, successful endodontic treatment depends on the adequate cleaning, shaping and filling of the root canal system. A thorough knowledge of root canal morphology is essential to achieve this goal. The inability to detect, debride and obturate all of the extant canals is one of the major cause of endodontic failure [7]. The failure to locate, debride, and fill existing MB2 canals will lead to a poorer prognosis [8]. Post-treatment disease can also be attributed to the presence of any undetected and subsequently unfilled anatomical spaces in the root canal system which can act as a nidus for infection leading to treatment failure [6].

A comprehensive understanding of root canal morphology and the anticipation of potential morphological differences are essential in minimizing the failure of endodontic treatment, as unidentified root canals during treatment can serve as reservoirs for bacteria, hindering healing and facilitating the development of new inflammatory lesions in the periapical tissues, potentially leading to the failure of root canal therapy [3,9]. The root canal system exhibits numerous anatomical variations across different populations and demographics, even within the same population, and these differences, particularly in the MB2 canal, may be attributable to hereditary factors [10]. Therefore, it is crucial to acknowledge that differences in the MB2 canal will occur across diverse demographic parameters. Many studies have researched this area, and this review provides a summary of all the studies involved. Therefore, it is crucial to consider factors such as gender, age, and geographical region to determine the anatomical variability and frequency of the MB2 canal.

Materials and Methods

Databases used
This study is a narrative review of the literature synthesizing the findings of the literature retrieved from searches of computerized databases from reliable sources of data such as PubMed, Scopus, Medline and Google Scholar.

Inclusion and exclusion criteria
The inclusion criteria in this study are articles that have the keywords of interest and articles published in English while the exclusion criteria are Wikipedia or unknown sources, articles published in other languages, editorials papers, commentaries and abstract.

Keywords
The information is searched using different combinations of the following keywords such as "second mesiobuccal (MB2) canal", "gender", "age", and "geographic".

Search period
Relevant articles are from 2010 to 2021 were identified, and duplicates are removed. Full text of the determined articles is collected and reviewed to make sure that it is related to the research title.

Results

Prevalence of MB2 canal among different gender

A study was conducted by Al-Kadhim *et al.,* in 2017, to assess the prevalence of MB2 canal among different gender which consist of male and female. 241 Malaysian patients were involved in this study. As a result, the prevalence of MB2 canal in male is 49.1% for the first maxillary molar and 44.3% for second maxillary molar. In female, the prevalence of MB2 canal is 41.3% for first maxillary molar and 45.5% for the second maxillary molar. Next, another study was conducted on 1100 maxillary molars using Cone beam computed tomography (CBCT) to calculate the prevalence MB2 canal among different gender. From this study, 550 CBCT images of the first maxillary molar and 550 CBCT images of the second maxillary molar were analysed. There are some significant differences in the presence of canals that were observed, with 55.2% in male and 44.8% in female for the first maxillary molar. For the second maxillary molar, the prevalence of MB2 canal was 59.3% in male an 40.7% in female [11].

Other than that, another study showed that the prevalence of MB2 canal in male is 73.0% and only 71.0% in female [6]. In addition, a study conducted by Kim, Lee and Woo [12] in Korean population showed male predominance in the prevalence of MB2 canal which is 68.4% in first maxillary molar and 36.7% in second maxillary molar while the prevalence of MB2 canal in female is 59.1% in first maxillary molar and 32.0% in second maxillary molar. Next, the root canal system of 114 Taiwanese patients were examined using CBCT images [13]. Out of all the patients examined, the prevalence of MB2 canal in male patient is 58% while the prevalence of MB2 canal in female patient is 42.0%.

Other than that, another study showed that the prevalence of MB2 canal in male is 28.7% and 9.1% in female for first maxillary molar. In second maxillary molar, the prevalence of MB2 canal is 21.8% in male and 13.1% in female [14]. Next, based on the study conducted by Mohan *et al.,* in 2017, the prevalence of MB2 canal in male is 67.1% for first maxillary molar and 24.3% for second maxillary molar. For the data regarding the female patient, the prevalence is 64.3% for first maxillary molar and 21.5% for second maxillary molar. Moving on to the next study conducted by Olczak and Pawlicka [3], the prevalence of MB2 canal in male is 68.6% for first maxillary molar and 34.7% for second maxillary molar. For the female patient, the prevalence is 53.9% for first maxillary molar and 17.0% for second maxillary molar.

Plus, another study conducted by Abd Rahman, Halim, Khamis and Abd Ghani [15] showed that the prevalence of MB2 canal in male is 65.3% for first maxillary molar and 43.5% in second maxillary molar. For female patient, the prevalence of MB2 canal is 54.0% for the first maxillary molar and 24.7% for the second maxillary molar. Lastly, a study from Zheng, Wang, Zhou, Wang, Zheng and Huang [7] showed that the prevalence of MB2 canal in male is 54.3% and 50.0% for female. From the results and data presented, it can be seen that male has higher prevalence of MB2 canal compared to female. It can be due to the demineralisation and loss of bone mass in adult is three times greater in female compare to male, which

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would prevent the correct observation of the canal through computerised tomography due to lack of contrast, thus lowering the incidence of MB2 canal in female compare to male [16]. The findings are consolidated and presented in Table 1.

Table 1: The prevalence of the MB2 canal in the first and second maxillary molars, categorized by gender, with references to various studies

Gender	Prevalence of MB2 canal		References
	First maxillary molar	Second maxillary molar	
Male	49.1%	44.3%	[17]
Female	41.3%	45.5%	
Male	55.2%	59.3%	[11]
Female	44.8%	40.7%	
Male	73.0%	-	[6]
Female	71.0%	-	
Male	68.4%	36.7%	[12]
Female	59.1%	32.0%	
Male	58.0%	-	[13]
Female	42.0%	-	
Male	28.7%	21.8%	[14]
Female	9.1%	13.1%	
Male	67.1%	24.3%	[18]
Female	64.3%	21.5%	
Male	68.6%	34.7%	[3]
Female	53.9%	17.0%	
Male	65.3%	43.5%	[15]
Female	54.0%	24.7%	
Male	54.3%	-	[7]
Female	50.0%	-	

Prevalence of MB2 canal in different age group

In a study conducted by Agwan, Sheikh, Dh and Rashid [19], 100 Saudi patients were involved to study regarding the prevalence of MB2 canal among different age groups. The patients were grouped into three different age groups which are 10-24, 25-50 and >50 years old. The prevalence of MB2 canal according to those age groups were 53.0%, 42.0% and 5.0% respectively. Next, in a study conducted by Das, Warhadpande, Redij, Jibhkate and Sabir [6], the age of the patients was grouped into three groups such as

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18–25, 26–35 and 36–45 years old. The frequency of MB2 canals were 74%, 73%, and 68% respectively. Other than that, in a study conducted by Falcão, Albuquerque, Amorim, Freitas, Santos, Matos and Ferraz [20], the patients were grouped into three different age groups which are <30, 30-40 and >40 years old. The prevalence of MB2 canal according to those age groups were 76.9%, 53.9% and 51.9% respectively.

Moving on to another study conducted by Faraj [16], 343 patients in Iraq were involved to study regarding the prevalence of MB2 canal among different age groups. The patients were grouped into six different age groups which are 10-20, 21-30, 31-40, 41-50, 51-60 and >60 years old. The prevalence of MB2 canal according to those age groups were 54.2%, 52.5%, 54.5%, 57.7%, 54.5% and 30.0% respectively. Plus, in a study conducted by Jing, Ye, Liu, Zhang and Ma [21], the patients were grouped into five different age groups which are <20, 20-30, 30-40, 40-50 and >50 years old. The prevalence of MB2 canal according to those age groups were 26.9%, 37.3%, 30.1%, 36.2% and 22.1% respectively. In a study conducted by Kim, Lee and Woo [12], the prevalence of MB2 canal was determined in different age groups such as 10-19, 20-29, 30-39, 40-49 and ≥50. The results in order were 58.4%, 65.6%, 68.1%, 51.8%, 69.4% for first maxillary molar and 31.9%, 30.8%. 38.8%, 29.9%, 41.4% for second maxillary molar. Next, another study was conducted by Lee, Kim, Lee, Park, Jeong, Lee, Gu, Chang, Son, Lee, Baek, Bae and Kum [22], to assess prevalence of MB2 canal among different age groups. 276 Korean patients were involved in the study, and they were grouped into six different age groups which are 10-20, 20-30, 30-40, 40-50, 50-60 and >60 years old. The prevalence of MB2 canal according to those age groups were 81.5%, 72.5%, 85.5%, 70.7%, 59.2%, 50.0% for first maxillary molar and 71.2%, 48.0%, 46.9%, 28.4%, 24.6%, 22.2%, respectively for second maxillary molar. The findings are consolidated and presented in Table 2.

Table 2: The prevalence of MB2 canal in different age group

Age group	Prevalence of MB2 canal		References
	First maxillary molar	Second maxillary molar	
10-24	53.0%	-	19
25-50	42.0%	-	
>50	5.0%	-	
18-25	74.0%	-	6
26-35	73.0%	-	
36-45	68.0%	-	
<30	76.9%	-	20
30-40	53.9%	-	
>40	51.9%	-	
10-20	54.2%	-	16
21-30	52.5%	-	
31-40	54.5%	-	
41-50	57.7%	-	
51-60	54.5%	-	
>60	30.0%	-	
<20	26.9%	-	21

20-30	37.3%	-	
30-40	30.1%	-	
40-50	36.2%	-	
>50	22.1%	-	
10-19	58.4%	31.9%	12
20-29	65.6%	30.8%	
30-39	68.1%	38.8%	
40-49	51.8%	29.9%	
≥50	69.4%	41.4%	
10-20	81.5%	71.2%	22
20-30	72.5%	48.0%	
30-40	85.5%	46.9%	
40-50	70.7%	28.4%	
50-60	59.2%	24.6%	
>60	50.0%	22.2%	
13-25	27.3%	22.7%	14
26-40	14.5%	17.1%	
>40	10.0%	8.0%	
20-30	90.7%	-	23
31-40	92.1%	-	
41-50	82.6%	-	
51-70	81.9%	-	
10-20	50.2%	-	7
20-30	68.3%	-	
30-40	51.2%	-	
40-50	42.1%	-	
50-60	44.0%	-	
>60	40.0%	-	

Prevalence of MB2 canal in different geographical region

A study on the prevalence of MB2 canal in Malaysian population was conducted by Al-Kadhim, Rajion, Malik and Bin Jaafar [17]. In the research study, CBCT images of 421 maxillary molars from Malaysian patients that attended Universiti Sains Islam Malaysia (USIM) and Universiti Sains Malaysia (USM) dental clinics were identified in the database and the prevalence of MB2 canal is 45.6%. Next, in a study conducted by Kim, Lee and Woo [12], 415 Korean patients were examined to identify the prevalence of the MB2 canal in Korean population and the result was 63.6% for the first maxillary molar and 34.4% for the second maxillary molar. Moving on to the next region, Taiwan, the prevalence of the MB2 canal is 56% for the first maxillary molar and 7.7% for the second maxillary molar [13]. Other than that, in a study conducted by Magat and Hakbilen [14], 200 patients were examine to assess the prevalence of MB2 canal among Turkish population. The incidence of MB2 canal was found to be 33.5%. Plus, in a study done by Mohan *et al.,* in 2017, 143 maxillary first molars and 139 second maxillary molars were examined using CBCT to assess the prevalence of MB2 canal in Indian population. The incidence of MB2 canal is 64.1% for the first maxillary molar and 23.0% for the second maxillary molar among the Indian population.

In a study conducted by Olczak and Pawlicka [3], CBCT images of 112 maxillary molars were examined to investigate the prevalence of MB2 canal in Poland population. As a result, there is 59.5% prevalence of MB2 canal in first maxillary molar and 23.2% in second maxillary molar. Next, in another study, it was found out that the prevalence of MB2 canal among the Malaysian population is 59.9% for the first maxillary molar and 35.2% for the second maxillary molar [15]. Other than that, a study was conducted by Ratanajirasut, Panichuttra and Panmekiate [24] regarding the MB2 prevalence in Thailand population. In the study, 476 maxillary first molars together with 475 maxillary second molars was evaluated by receiving CBCT examination. The prevalence of MB2 canal among the Thailand population is 63.6% for the first maxillary molar and 29.4% for the second maxillary molar. Then, the MB2 canal prevalence in China is 57.8% for the first maxillary molar and 29.7% for the second maxillary molar [25]. Lastly, a total of 269 patients with healthy, untreated and well developed maxillary molars were enrolled in the study conducted by Zheng, Wang, Zhou, Wang, Zheng and Huang [7]. The results is that, the prevalence of MB2 in China population is 52.0%. From the data, it can be seen that the prevalence of the MB2 canal varies randomly regardless of any geographical area. The findings are consolidated and presented in Table 3.

Table 3: Prevalence of MB2 canal in different geographical region

Geographical region	Prevalence of MB2 canal		References
	First maxillary molar	Second maxillary molar	
Malaysia	45.6%	-	17
Korea	63.6%	34.4%	12
Taiwan	56.0%	7.7%	13
Turkey	33.5%	-	14
India	64.1%	23.0%	18
Poland	59.5%	23.2%	3
Malaysia	59.9%	35.2%	15
Thailand	63.6%	29.4%	24
China	57.8%	29.7%	25
China	52.0%	-	7

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Discussion

In this review, prevalence of the MB2 canal is higher in males than females, more common in younger age groups compared to older ones and shows no consistent pattern across different geographical regions.

This review indicates that the prevalence of the MB2 canal is higher in males compared to females, as observed through computerized tomography (CT) imaging. This disparity may be attributed to differences in bone density and mineral composition between genders. In females, the rate of bone demineralization and loss of bone mass is approximately three times greater than in males, particularly in adulthood [16]. These changes can affect the visibility of finer anatomical structures, such as the MB2 canal, on CT scans due to reduced contrast between the canal and surrounding structures. Reduced bone mass and mineral density in females can lead to decreased radiographic contrast, potentially hindering the accurate identification of MB2 canals on CT imaging [26]. This limitation may result in an underreporting of MB2 canal prevalence in females compared to males. These findings align with previous studies suggesting a gender-based variation in the visibility and identification of dental structures using imaging modalities [27]. However, further studies using advanced imaging techniques or larger sample sizes are needed to confirm these observations and mitigate imaging-related biases. Understanding these gender-based differences in MB2 canal prevalence is critical for endodontic diagnosis and treatment planning. Clinicians should consider potential imaging limitations when evaluating female patients and may need to employ alternative or enhanced imaging techniques to ensure accurate detection of anatomical structures. Future research could explore the use of advanced imaging technologies, such as cone-beam CT with higher resolution, or investigate alternative methods for assessing MB2 canal prevalence across genders.

From this review indicates that the predominance of the MB2 canal diminishes with increasing age. The observed tendency is attributable to the diminishing likelihood of identifying the second mesiobuccal canals with advancing age. With age, it may be inferred that teeth endure multiple adversities such as caries, attrition, and erosion, resulting in the calcification of the orifice or the canal [6]. Other than that, this occurrence might be due to an increase in the canal calcification, tertiary dentin formation and porosity of the cortical bone [28]. Moreover, it could also be due to secondary dentin deposition separated a flattened canal into two canals or even create a calcified imperforate canal [7]. Furthermore, as age progresses, canal architecture tends to simplify due to the calcification of root canal branches. Consequently, due to the presence of more calcified canals in older patients and the smaller width of the additional canal compared to the first mesiobuccal (MB1) canal, it becomes exceedingly challenging to distinctly identify the additional canal in CBCT pictures, thereby lowering the prevalence of the MB2 canal in older patients.

The inconsistent prevalence of the MB2 canal across different geographical regions can be attributed to a combination of genetic, environmental, and methodological factors. Genetic variability influences root canal anatomy, as populations with different ancestries may have distinct morphological traits [29]. Environmental factors, such as diet, fluoride exposure, and oral habits, further shape tooth development and canal structure, which vary regionally [30,31] . Methodological differences, including the diagnostic tools used (e.g., CBCT versus traditional radiographs) and the experience of clinicians, also contribute to discrepancies in detection rates [32]. Additionally, variations in study populations, such as age distribution and dental history, can skew findings. This inconsistency highlights the importance of tailoring diagnostic and treatment approaches to account for regional and individual anatomical variations, as well as the need for standardized methodologies in future research to better understand these differences.

Conclusion

As a conclusion, it can be seen that according to the gender, the prevalence of MB2 canal is more frequent in male compared to female. In the age group aspects, the prevalence of MB2 canal is more frequent in the younger age group compared to older age group. The pattern also showed that the prevalence of MB2 canal varies randomly regardless of any geographical region. This review reinforces the concept that root canal morphology exhibits variability among different population groups. Familiarity with these variants is crucial due to their potential therapeutic and anthropological significance. This information can facilitate the identification of the canals, along with their subsequent management in clinical practice. Thus, it is important to keep in mind that is that the prevalence of the MB2 varies in different demographic factors, and it should be strongly considered when treating the maxillary molar. These values may help dentists to

locate the additional canal in the maxillary molar and thereby achieve better outcomes for the endodontic treatment of these teeth.

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Conflict of Interest Disclosure

None to declare.

Authors contribution

All authors have made equal contributions to this review

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