ORIGINAL ARTICLE

Journal of Research in Dental and Maxillofacial Sciences

DOI: 10.61186/jrdms.9.4.34

Position of Second Mesiobuccal Canal Relative to Distobuccal and Palatal Canals of Maxillary Molars in an Iranian Population

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Article History
Received: 6 June 2024
Accepted: 24 Sep 2024

Abstract

Background and Aim: This study assessed the position of the second mesiobuccal (MB2) canal relative to the distobuccal (DB) and palatal (P) canals of maxillary molars in an Iranian population using cone-beam computed tomography (CBCT).

Materials and Methods: This cross-sectional study evaluated 110 CBCT scans of patients retrieved from a radiology clinic in Isfahan, Iran. The MB1-MB2 inter-orifice distance, and the angle formed between the MB1-MB2 line and the DB-P line were measured on reconstructed axial sections. The angulation of MB2 orifice relative to the DB and P canals was categorized as positive, negative, and parallel. Data were compared by Student t-test, Fisher's exact test, and Chi-square test (alpha=0.05).

Results: The mean MB1-MB2 inter-orifice distance was not significantly different in first and second molars, in the right and left sides, or in males and females (P>0.05). Negative angulation of MB2 orifice relative to the DB and P canals had the highest frequency (72.7%) followed by positive angulation (23.6%). Angulation of MB2 orifice had no significant correlation with tooth type (first/second molar), laterality, or gender (P>0.05).

Conclusion: The mean MB1-MB2 inter-orifice distance had no significant correlation with tooth type, laterality, or gender. Negative angulation of the MB2 relative to the DB and P canals had the highest frequency, indicating that if a hypothetical line is drawn from the MB1 orifice parallel to the DB-P line, the MB2 orifice would be probably at the distal of this line. Angulation of MB2 orifice had no significant correlation with tooth type, laterality, or gender.

Keywords: Maxilla; Molar; Cone-Beam Computed Tomography

Cite this article as: Mosadeghian S, Torkzadeh A, Ranjbarian P, Asaadi R. Position of Second Mesiobuccal Canal Relative to Distobuccal and Palatal Canals of Maxillary Molars in an Iranian Population. **J Res Dent Maxillofac Sci. 2025; 10(1):34-39.**

Introduction

Endodontics is a dental field that deals with dental pulp and peri-radicular tissues, and root canal treatment for tooth preservation. Endodontic treatment is performed aiming to clean and shape the root canal system, followed by its optimal obturation with proper root filling materials.

Two-dimensional periapical radiography is commonly used for endodontic treatment, and plays a major role in endodontic diagnosis. However, it provides a two-dimensional image of a three-dimensional structure, which is a major limitation. Therefore, dental clinicians should be well aware of the possible anatomical variations in the root canal morphology of different teeth to maximize the success of endodontic treatment and minimize procedural errors and treatment failure [1].

The number of root canals varies depending on tooth type. Abnormal root canal morphology, presence of isthmi and ramifications, and presence of additional canals are among the most important anatomical variations that can complicate the process of root canal therapy and lead to treatment failure [2].

The role of race and ethnicity in root canal anatomical variations has been previously confirmed, such that presence of 4 root canals in molar teeth is highly prevalent in Asian communities [3]. Maxillary molars have high anatomical variations and complexities in their mesiobuccal (MB) canal, which can challenge the root canal treatment, and resultantly, such teeth have the highest rate of endodontic treatment failure [4,5]. Presence of a second MB canal (MB2) is the most important factor responsible for endodontic treatment failure of maxillary molars [6,7]. Due to the large buccolingual dimension of the MB root, and depressions in its mesial and distal surfaces, presence of two canals in the MB root is highly possible; however, palatal (P) and distal (D) roots often have one single canal [8].

The MB2 canal is less commonly detected in clinical studies compared with in vitro conditions; the prevalence of MB2 is as high as 70% in vitro while this rate is 40% in clinical studies [9,10]. The incidence of MB2 is estimated at 61.45% in the Iranian population, highlighting the need for further investigations about the number of canals in the MB root of maxillary molars [11,12].

Several methods have been employed for detection of MB2 of maxillary molars, which can be categorized into two groups of laboratory techniques, such as sectioning, staining, clearing, micro-computed tomography, and scanning electron microscopic inspection of pulp chamber floor, and clinical techniques, such as observation during endodontic treatment with/without magnification, and radiography. Conventionally, dental clinicians visually inspect the pulp chamber and mentally visualize the root canal system and additional canals [13].

The anatomy of the root canal system was first evaluated in 1925, and several different methods have been used for this purpose since then [14]. Clinically, periapical radiography is most commonly used for assessment of the anatomy of the root canal system; however, interpretation of periapical radiographs is difficult due to superimposition of structures, and detection of number of canals according to a periapical radiograph is not highly reliable [15]. Cone-beam computed tomography (CBCT) may be employed for anatomical and morphological assessment of the root canal system. It does not have the limitations of two-dimensional radiography [16].

The majority of the available studies regarding the MB2 have focused on its incidence or MB1-MB2 inter-orifice distance [17-22], and the angulation of canals relative to each other has been less commonly addressed in the literature; while this information may aid in identification of the exact location of MB2. Therefore, the purpose of this study was to assess the position of the MB2 relative to the distobuccal (DB) and P canals of maxillary molars and measure the angulation and distance between the canals in an Iranian population using CBCT.

Materials and Methods

This retrospective cross-sectional study evaluated 110 CBCT scans of patients retrieved from a radiology clinic in Isfahan, Iran (ethical approval code: IR.IAU.KHUISF.REC.1402.262).

Sample size:

The sample size was calculated to be 106 according to a previous study by Tonelli et al, [23] assuming alpha=0.05, standard deviation of 0.57, maximum error of 20% from the standard deviation, and 10% possible dropouts.

Eligibility criteria:

The inclusion criteria were high-quality CBCT scans visualizing maxillary first and/or second molars, presence of MB2 in the mesiobuccal root, no history of previous endodontic treatment, no coronal caries, and complete root development and tooth eruption.

The exclusion criteria were presence of internal/external root resorption, calcific metamorphosis, teeth with extensive restorations causing noise on images, and no visualization of MB2 orifice at 1 mm distance from the pulp chamber floor.

Data collection:

The CBCT scans of 110 maxillary first and second molars taken with NewTom Giano CBCT scanner (QR, Verona, Italy) with high resolution and exposure settings of 90 kV tube potential and 10 mAs tube current, 0.5 mm2 voxel size, and 36 s exposure time were evaluated. The CBCT scans were observed by a senior dental student trained by a radiologist in a semi-dark room on a 24-inch LG monitor (Flatron IPS226) using NNT Viewer 3D software. The images were reconstructed such that the MB root was visible on all multiplanar sections. Maxillary molars were assessed on axial sections visualizing the orifice of the MB2 at the pulp chamber level or 1 mm below it. After finding the MB2 canal, a plane 1 mm below the pulp chamber floor was used for the measurements. To prevent the observer fatigue, 10-11 scans were evaluated per day.

Linear and angular measurements:

A straight line was drawn connecting the center of the orifices of MB1 and MB2, indicating the MB1-MB2 inter-orifice distance [24]. The DB-P line was also drawn connecting the center of the DB and P orifices. The two lines were extended to cross each other and form an angle. If the intersection of the two lines was in the buccal side, the angle was categorized as positive, and if it was in the palatal side, it was categorized as negative. If the two lines did not cross, they were considered to be parallel [24]. Also, a line was drawn parallel to the DB-P line from the MB1 orifice, which formed an angle with the MB1-MB2 line. If the MB2 orifice was mesial to this hypothetical line, the angle was categorized as positive and if it was distal to the line, the angle was categorized as negative. Also, if the MB2 was exactly on the line, it was categorized as parallel. The measurements were made as such, and recorded (Figures 1-3).

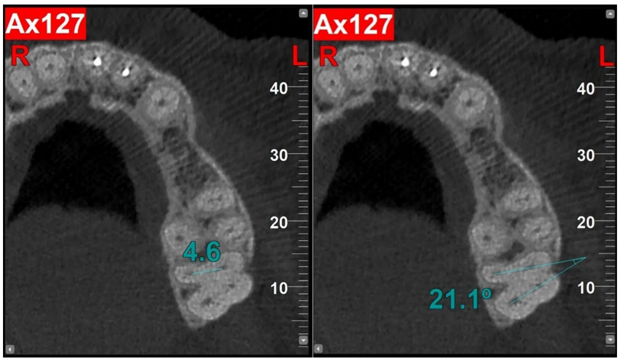

Figure 1. MB1-MB2 inter-orifice distance of 4.6 mm and positive angulation in a maxillary left second molar

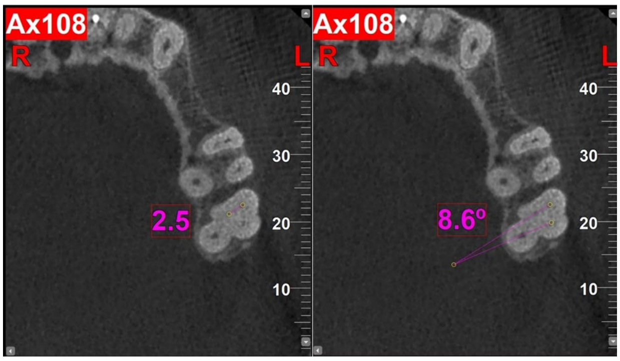

Figure 2. MB1-MB2 inter-orifice distance of 2.5 mm and negative angulation in a maxillary left second molar

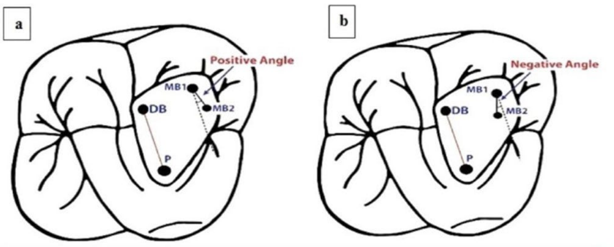

Figure 3. Schematic view of measuring the MB2 angulation and MB1-MB2 inter-orifice distance

Statistical analysis:

Data were compared by the Fisher's exact test, Chi-square test, and Student t-test using SPSS version 24 (SPSS Inc., IL, USA) P<0.05 was considered statistically significant.

Results

The CBCT scans of 110 maxillary molars were evaluated, including 75 (68.2%) first molars and 35 (31.8%) second molars. There were 68 females (61.8%) and 42 males (38.2%). Of all teeth, 43 (39.1%) were in the right side, and 67 (60.9%) were in the left side. The angulation was negative in 80 (72.7%), positive in 26 (23.6%), and parallel in 4 (3.6%) teeth.

MB1-MB2 inter-orifice distance:

The MB1-MB2 inter-orifice distance in first and second molars, in the right and left sides, and in males and females is presented in Table 1. The results showed that the MB1-MB2 inter-orifice distance data did not have a normal distribution (P=0.000). However, since the sample size was > 25, this parameter was compared by t-test, which showed no significant difference in the mean MB1-MB2 distance between the first and second molars (P=0.230), in the right and left sides (P=0.158), or in males and females (P=0.935).

Angulation of MB2:

Table 2 presents the frequency of different angulation types based on tooth type, laterality, and gender. Negative angulation of MB2 orifice relative to the DB and P canals had the highest frequency (72.7%) followed by positive angulation (23.6%). The Fisher's exact test showed no significant correlation between angulation and tooth type (P=0.42), laterality (P=0.343), or gender (P=0.936).

Table 1. MB1-MB2 inter-orifice distance in first and second molars, in the right and left sides, and in males and females

Parameter	Category	Number	Mean	Std. deviation
Tooth type	First molar	75	2.01	0.39
	Second molar	35	2.11	0.59
Laterality	Right	43	2.01	0.36
	Left	67	2.06	0.52
Gender	Female	68	1.98	0.48
	Male	42	2.13	0.41

Table 2. Frequency of different angulation types based on tooth type, laterality, and gender

Parameter	Category	Positive	Parallel	Negative	Total
Tooth type	First molar	20 (26.7%)	2 (2.7%)	53 (70.7%)	75 (100%)
	Second molar	6 (17.1%)	2 (5.7%)	27 (77.1%)	35 (100%)
	Total	26 (23.6%)	4 (3.6%)	80 (72.7%)	110 (100%)
Laterality	Right	11 (25.6%)	0 (0%)	32 (74.4%)	43 (100%)
	Left	15 (22.4%)	4 (6%)	48 (71.6%)	67 (100%)
	Total	26 (23.6%)	4 (3.6%)	80 (72.7%)	110 (100%)
Gender	Male	16 (23.5%)	2 (2.9%)	50 (73.5%)	68 (100%)
	Female	10 (23.8%)	2 (4.8%)	30 (71.4%)	42 (100%)
	Total	26 (23.6%)	4 (3.6%)	80 (72.7%)	110 (100%)

Discussion

The present study addressed the position of MB2 relative to the DB and P canals of maxillary molars. The results showed that the MB1-MB2 inter-orifice distance was 2.01 mm in maxillary first molars and 2.11 mm in maxillary second molars, with no significant difference. Thus, dental clinicians can more easily find the approximate location of MB2. The same results were reported by Lee et al. [17] on maxillary first and second molars of a South Korean population; they did not find any significant difference in this regard between the first and second molars. Vhorkate et al. [24] in India reported this distance to be 3.12 to 3.31 mm in maxillary first molars, and 2.8 to 3.1 mm in maxillary second molars, which were approximately 1 mm larger than the values obtained in the present study, highlighting inter-racial differences in this parameter. Tonelli et al. [23] in Brazil and Zhang et al. [25] in China measured the MB1-MB2 inter-orifice distance in maxillary first molars to be 2.3 mm and 1.9 mm, respectively. Their results were in agreement with the present findings. The mean MB1-MB2 inter-orifice distance was not significantly different in the right and left sides, or in males and females in the current study.

To more precisely and quickly locate the orifice of the MB2, the angle parameter should also be taken into account in addition to the inter-orifice distance. This angulation was categorized into three groups in the present study, and the results showed that the negative angle had the highest frequency (72.7%) followed by the positive angle (23.6%). Thus, if a hypothetical line is drawn from the MB1 orifice parallel to the DB-P line, the MB2 orifice would be probably at the distal of this line. Similarly, Lee et al. [17] reported higher prevalence of the negative angulation in first molars; however, positive angulation had a higher frequency in second molars, which was in contrast to the present findings, probably due to inter-racial differences. Furthermore, Vhorkate et al. [24] reported higher prevalence of positive angulation, which was different from the present results probably as the result of inter-racial variations. The current findings showed no significant correlation between the angulation type and tooth type, laterality, or gender.

Limitation of the software in performing some measurements was the main challenge encountered in this study. Further investigations with a larger sample size are recommended to obtain more reliable results.

Conclusion

The mean MB1-MB2 inter-orifice distance had no significant correlation with tooth type, laterality, or gender. Negative angulation of MB2 relative to the DB and P canals had the highest frequency, indicating that if a hypothetical line is drawn from the MB1 orifice parallel to the DB-P line, the MB2 orifice would be probably at the distal of this line. Angulation of MB2 orifice had no significant correlation with tooth type (first/second molar), laterality, or gender.

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