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Original Article

# Detection of MB2 in Maxillary First Molar and Its Relation to the MB1 in the Egyptian Population: A Cone-Beam Computed Tomography Study

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**Abstract**

**Aim:** This study aimed to assess CBCT scans for correlation between the MB root canal configuration (RCC), intercanal distance (ICD), and the root length (RL) of 177 permanent maxillary first molar teeth.

**Subjects and methods:** The RL; from the sagittal plane; was calculated from cementoenamel junction to root apex. Both ICD and RCC; based on Vertucci's classification; were measured and assessed from axial section. The ICD was measured when MB2 was first noticed. The correlations between gender and prevalence of MB2 and RCC were assessed.

**Results:** A second mesiobuccal canal (MB2) was present in 67.2% with mean RL of 13.1 mm and mean ICD of 2.2 mm. The most prevalent RCC was Vertucci type III (40.1%) with average RL 13.4 mm. Type II, type V and type IV were noticed with less prevalence. No statistical correlation was found between gender and MB2 incidence nor gender and RCC.

**Conclusion:** The incidence of MB2 is high in the Egyptian population with a high prevalence of type III.

**Keywords:** CBCT, MB2, Mesibuccal Canal, Maxillary molars, Egyptian population.

## *I. INTRODUCTION*

Adequate chemomechanical preparation and 3D obturation of the intricate root canal are crucial for the effectiveness of endodontic treatment. To accomplish these goals, the endodontist needs to be sufficiently knowledgeable about root canal configuration (RCC) (Vertucci, 2005). Posttreatment diseases develop as a sequela of insufficient disinfection of root canal system or missed canals. The commonness of endodontic failure due to missed MB2 was stated to be from 46%-78% (Wolcott et al., 2005). This denotes

the necessity of finding and treating the second mesiobuccal canal (MB2).

Many studies have been conducted on the mesiobuccal (MB) root of the permanent maxillary molars (U6) (Filho et al. 2009, Cleghorn et al. 2006, Thomas et al 1993). MB2 is revealed with cone-beam computed tomography (CBCT) with an incidence of 85.4% (Zhang et al, 2017). Therefore, with this frequency, the presence of two MB canals (MB1), and (MB2) is the norm rather than the exception. The MB canals may have separate exits or may exhibit confluence. This discrepancy develops owing to differences in methodological and ethnic causes. Its detection is difficult due to its tiny orifice, dentin shelf covering its orifice, or branches from MB1 at diverse levels from MB orifice.

The inter-canal distance (ICD) for Vertucci type IV was found to be substantially greater in the mesial root of mandibular first molars than for type II-RCC (Cimilli et al. 2006)**.** This fact on the MB root of U6 has not been validated. Furthermore, upon clinical observations, it was postulated that RCC might be determined by the root length.

More precise and non-invasive identification of the pulp anatomy has been made possible by technological advancements, particularly the widespread use of CBCT (Martins et al.,2018; Reis et al. 2013)**.** CBCT's scan time and radiation dosages are significantly lower than conventional computed tomography scans, making it a reliable tool for endodontic diagnosis (Venskutonis et al., 2014; Patel; 2009)**.** The current investigation was designed to determine the incidence of MB2 and to correlate between the RCC, ICD, and root length (RL) of permanent maxillary first molars in Egyptian population.

## *II. SUBJECTS AND METHODS*

One hundred-seventy-seven (177) CBCT scans were included in this retrospective analysis as part of diagnostic and treatment planning process. The scans were attained from the database of Oral and Maxillofacial Radiology Department, Faculty of Dentistry, Cairo University. These CBCT scans included 82 males and 95 females, and ages ranging from 20-60 years (an average age, 40 years). The Planmeca Promax® 3D Mid CBCT scanner (Planmeca, Helsinki, Finland) was used for all scans. The exposure parameters were adjusted to 90 kVp and 12.5 mA, with an exposure time of 15s and an isotropic voxel size of 0.2 $mm^3$.

**Sample size calculation:**

According to Habib and Howait, 2021**,** the prevalence of MB2 was 86.6% with confidence level 95%. It was found that a sample size of 177 teeth is adequate to detect the prevalence in Egyptian population using the (Epi info version 3) software.

**Inclusion criteria:**

The CBCT imaging data of both genders in the 20–60 age range were examined in this study. The CBCTs that are included were obtained for implant surgery, orthodontic treatment, and wisdom teeth extraction, among other uses. Mature maxillary first molars (U6) were included in the study; they were free of periapical periodontitis and other conditions, and the CBCTs showed clear, distortion-free and overlap-free images.

**Exclusion criteria:**

CBCT shows teeth having no prior endodontic treatment, restoration or resorption.

**Image Assessment:**

Three independent researchers assessed the CBCT images for mesiobuccal root identification and measurements: two endodontists and an oral and maxillofacial radiologist.

**MB Root Length measurements:**

A line drawn from the mesial to the distal cementoenamel junction (CEJ) on the sagittal view was used as the reference plane, and the length of the root in millimetres (mm) was

measured from this line to the root's highest point.

**ICD measurement:**

The ICD measurement was performed on the axial view on the slice where the MB2 was initially evident. The ICD measurement in mm was determined by drawing a line that connects centres of MB1 and MB2.

**RCC assessment:**

On the axial view; from CEJ to root apex; the slices were evaluated along the whole root length. Vertucci type II was identified if the outlines of the two radiolucent canals merged (2-2-1). While Vertucci type III is characterized by separation of the main canal into 2 radiolucent canals below the cervical line which unite again short to the apex (1-2-1). However, Vertucci type IV was classified if two radiolucent canal outlines were seen along the length of the root (2-2-2).

## *III. RESULTS*

Whereas frequencies and percentages were used to represent categorical data, the mean and standard deviation (SD) were used to describe continuous data. and standard deviation (SD) were used to describe continuous data.

For categorical variables, significance level was established at $p < 0.05$. Association was examined using the chi-square test for independence.

The statistical study was conducted utilizing IBM Corp 2017 SPSS program (Version 25.0 IBM SPSS Statistics for Windows. N Y, Armonk: IBM Corp.)

The 177 individuals whose CBCT scans included in the study were 95 (53.7%) females and 82 (46.3%) males. MB2 was present in 119 out of 177 maxillary first molar patients, meaning that 67.2% of maxillary first molar had MB2 overall. In 32.8% of cases, the MB2 was absent (i.e. Vertucci type I). In roots with MB2 canal, the most prevalent RCC was Vertucci type III (40.1%). Afterwards, type II (23.7%), type V (2.3%) and type IV (1.1%) with the least prevalence. The mean (SD) of MB- RL both with and without MB2 was 13.1 (1.6) mm and the ICD was 2.2 (0.2) mm **(Table 1, Figure 1).**

The Vertucci type III root canals' mean (SD) root length was 13.4 (1.7) mm. The mean (SD) root length in Vertucci types II, V, and IV was 12.9 (1.3), 11.1 (0.1), and 10.8 (0.0) mm, respectively. The mean (SD) of ICD of both type III and II, was 2.3 (0.2) mm. While for type IV and V the mean (SD) ICD was 2.3 (0.0) and 1.7 (0.3), respectively **(Table 2).**

Chi-square test revealed that the presence of MB2 and gender distribution did not correlate ($p = 0.357$) **(Table 3).** Moreover, the Chi-square test showed no correlation ($p = 0.089$), between the gender distribution and the root canal configuration **(Table 4).**

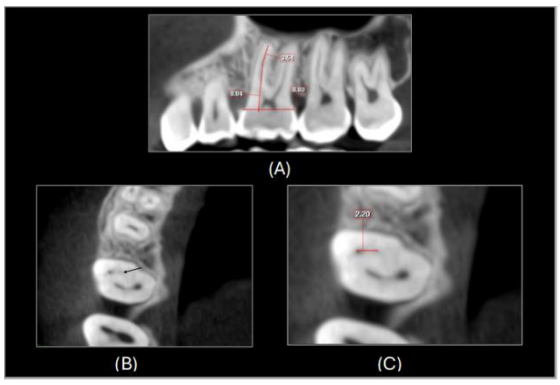


**Figure 1:** CBCT reconstructions of the MB root in the maxillary first molar tooth. (A) Root length measurement in the sagittal section, (B) The first axial section in which the MB2 canal was visualized and (C) ICD measured between the MB1 and MB2 canal

**Table (1): Showing gender distribution, incidence of MB2, prevalence of different Vertucci root canal configurations, root canal length (mm) and intercanal distance (mm).**

| | | N | % |
|---|---|---|---|
| **Gender** | **Males** | 82 | 46.3% |
| | **Females** | 95 | 53.7% |
| **MB2** | **Present** | 119 | 67.2% |
| | **Absent** | 58 | 32.8% |
| **RCC** | **I** | 58 | 32.8% |
| | **II** | 42 | 23.7% |
| | **III** | 71 | 40.1% |
| | **IV** | 2 | 1.1% |
| | **V** | 4 | 2.3% |
| **RL** | | 13.1 | 1.6 |
| **ICD** | | 2.2 | 0.2 |

Where RCC: root canal configuration, RL: root length, ICD: intercanal distance

**Table (2): Showing descriptive statistics of root length (mm) and inter-canal distance (mm) in different root canal configurations**

| **RCC** | **RL** | | **ICD** | |
|---|---|---|---|---|
| | **Mean** | **SD** | **Mean** | **SD** |
| **I** | 13.1 | 1.5 | | |
| **II** | 12.9 | 1.3 | 2.3 | 0.2 |
| **III** | 13.4 | 1.7 | 2.3 | 0.2 |
| **IV** | 10.8 | 0.0 | 2.3 | 0.0 |
| **V** | 11.1 | 0.1 | 1.7 | 0.3 |

Where RCC: root canal configuration, RL: root length, ICD: intercanal distance

**Table (3): Frequencies, percentages and Chi-Square test for association of presence of MB2 canal by gender:**

| | | | **MB2** | | ***p-value*** |
|---|---|---|---|---|---|
| | | | **Present** | **Absent** | |
| **Gender** | **Males** | **N** | 58 | 24 | 0.357 |
| | | **%** | 70.7% | 29.3% | |
| | **Females** | **N** | 61 | 34 | |
| | | **%** | 64.2% | 35.8% | |

**Table (4): Frequencies, distribution and Chi-Square test for association of RCC by gender:**

| | | | RCC | | | | |
|---|---|---|---|---|---|---|---|
| | | | **Type I** | **Type II** | **Type III** | **Type IV** | ***p-value*** |
| **Gender** | **Males** | **N** | 24 | 26 | 32 | 0 | 0.089 |
| | | **%** | 29.3% | 31.7% | 39.0% | 0% | |
| | **Females** | **N** | 34 | 16 | 39 | 2 | |
| | | **%** | 37.4% | 17.6% | 42.9% | 2.2% | |

## *IV. DISCUSSION*

This study was designed to identify the occurrence and configuration of MB2 in the MB root of Egyptian permanent maxillary first molars (U6) using CBCTs. The position of MB2's confluence with MB1 at various root levels, the average root length (RL) of the MB root, and the distance (ICD) between the MB1 and MB2 canals were further objectives.

Identification of all canals is an essential initial step for successful root canal therapy. Using CBCT scans, Karabucak et al., 2016, assessed the prevalence of undetected and untreated canals in teeth that had received prior root canal therapy. As per their findings, there was a 4.38 times higher likelihood of periapical disease in teeth with missing canals. They also discovered that MB2 was the most overlooked.

The clearing method is the benchmark for evaluating canal anatomy. However, it necessitates the extraction of a tooth, which reduces the study's sample size, and cross-infection is an ongoing risk. All these problems are resolved by CBCT imaging, which yields results that are on par with the clearing technique (Neelakantan, et al., 2010)**.** An in vitro study by Blattner et al., 2010, determined the accuracy of detection of MB2 with CBCT. They reported a positive correlation between CBCT and sectioning technique and concluded that CBCT imaging is a dependable tool for locating MB2. Moreover, as per Bauman et al., 2011**,** MB2 was detected at a higher percentage (93.3%) at a 0.125 mm voxel size than 60.1% at a 0.4 mm voxel size.

Before endodontic treatment, some features of the tooth's internal and external anatomy may help identify the RCC. One of the key components is the ICD. According to Vertucci, 1984, research, the distance between the canals indicates whether they merge or stay apart and leave through distinct foramina. A higher ICD was deemed by Cimilli et al., 2006, to be a significant clinical criterion in determining the Vertucci type of the canals. More research has revealed that the canals only tend to stay apart completely when the IOD is more than 3 mm (Rotstein and Ingle, 2019)**.**

According to our findings, 67.2% of maxillary first molars have an MB2 canal. Numerous worldwide anatomical studies reported a prevalence between 69% and 90% (Zheng et al., 2010; Al Shalabi et al., 2000; Imura et al., 1998) and our findings are comparable. According to a study by Ghobashy et al., 2017, 25.45% of Egyptians have a type I root canal system in the MB root of their maxillary first molars. This contradicted our findings, which could be explained by the other study's varied sample size and CBCT setting conditions. In line with earlier research ( Zheng et al., 2010; Kim et al. 2012; Pattanshetti et al., 2008)**,** gender does not affect the existence of MB2 or the RCC.

Vertucci type III (40.1%) was the most common RCC. Type II (23.7%), type V (2.3%), and type IV (1.1%) were the next most

common configurations. This contrasted with Ghobashy et al., 2017, who demonstrated that type II, type IV, and type I were the most prevalent Vertucci classifications for the MB root for maxillary first molars in the Egyptian population. Fortunately, our research revealed that the MB2 originates below the cervical line, indicating that to navigate the MB2, ultrasonic troughing under magnification is required.

Our research revealed that MB2 formed an acute angle with the MB after branching off from the main MB canal below the cervical line. This made it difficult to locate and negotiate the MB2, during the mechanical preparation. To lessen the bending stresses on the enlarging tools and prevent separation, straight-line access to the apical region, sufficient orifice enlargement, and preflaring of the coronal portion of root canal are necessary (Bahcall et al., 2005)**.**

The mean root length in Vertucci type III was 13.4 mm, type II was 12.9 mm, type V was 11.1 mm and type IV 10.8 mm. It was found that the root length acts as predictive finding to indicate the presence of one or two apical foramina. The ICD was 2.3 mm in type II, III and IV while in type V it was 1.7mm. This was consistent with the results of Habib and Howait, 2021, who reported that MB1 and MB2 were separated by an average of 2.52 mm. The clinician can use this information to determine where to locate the extra canal in the mesiobuccal root. Also, this finding indicates that mesiobuccal root mostly ends with one apical foramen as the ICD was always less than 3mm (Rotstein and Ingle, 2019)**.**

A small sample size and sample gathering from a single centre were two of the study's shortcomings. Additionally, because the first molar erupts early and is typically discovered carious or restored by maturity, our sample was restricted to teeth without prior root canal therapy, cemented posts, or extensive coronal restorations. These restrictions made it difficult to gather these types of teeth. It is advised to increase the sample size and gather data from several centres which will enable firmer conclusions to be drawn on the shared morphological traits and anatomical variances of maxillary first molars in the Egyptian population.

## *V. CONCLUSION*

The incidence of MB2 is high in the Egyptian population with a high prevalence of type III.

**Conflict of Interest:**

The authors declare no conflict of interest.

**Funding:**

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**Ethics:**

This study protocol was approved by the ethical committee of the faculty of dentistry-Cairo University on: April 2024, approval number: 25-4-24.

**Data availability:**
Data are provided by the authors upon request.

**Author Contributions:**
All authors contributed to the study's conception and design. Material preparation, data collection, analysis and writing. All authors read and approved the final manuscript.

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