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Original Article

The frequency of the second mesiobuccal canal in maxillary first molars among a sample of the Kurdistan Region-Iraq population - A retrospective cone-beam computed tomography evaluation



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KEYWORDS

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Abstract *Background/purpose:* One of the most complexes in root and canal anatomy is the maxillary first permanent molar. This study aimed to analyze the frequency of mesiobuccal (MB2) canal and its apical portals of exit, in patients belonging to different gender-age groups and determine the possible relation with sex and age.

Materials and methods: A CBCT scan images were accessed from a documented database of 343 patients (178 male, 165 female), who had an oral and maxillofacial examination. The age of the patients ranging from 12 to 63 years. The frequency of the MB2 canal and its portals of exit apically were observed. Age and gender correlation were calculated using the χ^2 test. $P < 0.05$ was considered significant.

Results: A total of 634 maxillary first molars (335 male, 299 female) were included. The MB2 canal was found in 53.78% of the cases. A significantly higher incidence of the MB2 canal was detected in males than in females. No correlation in the presence and/or absence of the MB2 canal in terms of age. When MB2 canal present, a single apical foramen was observed in 66.28% of the cases, two apical foramina were present in 33.72% of the cases.

Conclusion: MB2 canals may be present in approximately half of the cases, from which one third of the cases have their own apical portal of exit.

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Introduction

Root canal morphology plays a very significant role in the success of endodontic treatment. Having adequate knowledge about the structure of the root & canals is essential for achieving this goal. Based on the published findings, the inability to recognize the presence of and to adequately treat all the root canals may lead to high percentages of treatment failure.^{1–4}

The prevalence and risk of missed anatomy are strictly linked with the complexity of the root canal configuration. One of the most complexes in root and canal anatomy is the maxillary first permanent molar, which has been studied widely in both in vitro and clinical studies. Throughout the literature, much of the focus of the maxillary first molar has revolved around the variation in the second mesiobuccal canal.^{5–10} In a recent systematic review and meta-analysis of prevalence studies performed using cone-beam computed tomography, the overall, prevalence of the MB2 canal in the maxillary first molar was 69.6% in the weighted average of all reported studies.¹¹

Cone-beam computed tomography (CBCT) imaging may be indicated to obtain information about the nature of complex root canal anatomy. CBCT gives an increased appreciation of the root canal anatomy, which should result in more conservative access preparation. The poor resolution of CBCT means that sclerosed and/or accessory anatomy may not be readily identified.¹² CBCT uses extraoral scanning to produce 3D orthogonal images of the maxillofacial skeleton and its structures, with a lower dose of radiation than conventional CT, have proven more accurate than digital x-rays in determining root canal systems.¹³

In the literature, several studies were using the CBCT to investigate the prevalence and morphology of the MB2 canal of permanent maxillary molars in various ethnicities.^{14–16,9,17,18} The methodologies used vary from in vivo techniques such as clinical findings, radiographic investigation, and CBCT scanning to ex vivo methodologies such as clearing or micro-computed tomographic imaging. These methodologies appear to be valid to study the mesiobuccal root anatomy. However, if the objective is to assess the proportion of MB2 canals in a particular population, CBCT imaging is a more suitable method.¹⁹

Many studies have concluded ethnically related differences in root canal configurations of different populations

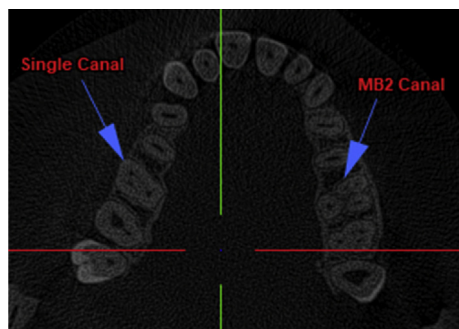


Figure 1 Representative axial section showing right maxillary first molar with an MB2 canal and a left maxillary first molar without an MB2 canal (arrows).

worldwide.^{20–24} The diversity of the internal anatomy of root canals is genetically determined and carries definite importance to consider ethnic variations during clinical treatment. Though, there were not sufficient studies that evaluated the MB2 canal in Kurdistan Region, Iraq populations and no previous literature regarding it. In this regard, this retrospective study aimed to investigate the incidence of the second mesiobuccal (MB2) canal in the permanent maxillary first molar, and analyze its apical portal of exit through a single foramen with the main mesiobuccal (MB1) canal or two separate foramina, utilizing CBCT scanning.

Material and methods

Experimental design

The study protocol was approved by the ethics institutional committee at Sulaimani University, Kurdistan Region, Iraq. The case record of 343 patients (178 males and 165 females), who had CBCT scans between January 2016 and September 2018 was retrieved from the database of three private dental imaging centers located in the Kurdistan Region, Iraq. The CBCT images were selected from two types of CBCT machines (NewTom Giano Verona, Italy and GALILEOS Sirona GmbH, Bensheim, Germany), and different focal of view (FOV). An experienced radiologist evaluated data acquisition, reconstruction, and other test parameters for image quality. The voxel sizes equal to or less than 0.25 mm were required. These reproducible objective measures were conveniently assessed by computer software. As an inclusion criterion; at least one fully developed permanent maxillary first molar should be present in any CBCT image. Teeth with open apices (not fully formed), root resorption, or calcification (partial or complete radiographic obliteration of the pulp chamber and root canals), and teeth with prior root canal treatment were excluded.

Observation methodology

A dataset created and the patients were divided into 6 groups according to their ages and based on the root end maturation of maxillary first molar and age change; group 1 (10–20 years), group 2 (21–30 years), group 3 (31–40 years), group 4 (41–50 years), group 5 (51–60 years), and group 6 (>60 years) for evaluation. A maxillofacial radiologist and an endodontist with more than 20 years of experience in interpreting CBCT data sets assessed the visibility of the MB2 canal concurrently until a final diagnosis was reached. Each CBCT image was seen in different planes; firstly, the sagittal and the coronal sections oriented parallel to the long axis of the root, and then axial sections were viewed. Brightness and contrast were adjusted to an appropriate value, and the images examined by rolling the toolbar downward and upward from the pulp chamber to the radiographic apex. Root canal orifices on the floor of the pulpal chamber were explored (Fig. 1). The frequency of the additional mesiobuccal (MB) canal in the coronal third up to the apical third and their apical portals of exit were evaluated.²⁵

Table 1 The frequency distribution of the MB2 canal by 6 age groups.

MB2 canal	10-20 y No. (%)	21-30 y No. (%)	31-40 y No. (%)	41-50 y No. (%)	51-60 y No. (%)	>60 y No. (%)	Total No. (%)	Chi square P-value
Present	32 (54.23%)	137 (52.49%)	85 (54.48%)	60 (57.69%)	24 (54.54%)	3 (30.0%)	341 (53.79%)	$\chi^2 = 3.13$
Not present	27 (45.76%)	124 (47.51%)	71 (45.51%)	44 (42.31%)	20 (45.45%)	7 (70.0%)	293 (46.21%)	$P = 0.678$
Total	59	261	156	104	44	10	634	

There is no significant relation between age group and incidence of 2 canal ($p > 0.05$).

Statistical analysis

The collected data were assessed using SPSS software (Version 22; IBM Corp, Armonk, NY). The primary outcome was the proportion of MB2 root canals in maxillary first molars in each age group, which was calculated and expressed with a 95% confidence interval. The chi-square test was used to evaluate the association of the MB2 canal to sex and age ($P < 0.05$).

Results

Data were obtained from 343 patients (178 males and 165 females). A total of 343 CBCT scan images were analyzed, among them only 634 maxillary first molars (332 male, 302 female) met the inclusion criteria as previously outlined. The mean age of the patients was 26.7, ranging from 12 to 63 years.

Frequency of MB2 canals and its relation to the patient’s age and sex

Overall, the incidence of MB2 canals in the permanent maxillary first molar was found to be 53.78% (341 teeth). [Table 1](#) illustrates the frequency distribution of the MB2 canal in both sexes by 6 age groups.

About the age of the patients, no statistically significant difference was found among the 6 age groups ($p > 0.05$).

The highest occurrence of the MB2 canal in maxillary first molars among all age groups was the 41- to 50-year age group (57.69%), whereas the lowest was the above 60-year age group (42.85%).

There was a significant correlation between males and females ($P < 0.05$) ([Table 2](#)). A higher incidence of MB2 canals was detected in male than in females. The incidence of the MB2 canal in maxillary first molars in males was 60.11% (205 teeth), and in females, it was 39.88% (136 teeth).

Distribution of MB2 canal through the apical portals of exit

Out of the total of 341 teeth with the MB2 canal, only 115 (33.7%) exhibited a separate apical foramen, while MB2 canal was found to be merged with the MB1 canal and distributed through a single apical foramen in 226 teeth, (66.2%) of the time ([Table 3](#)).

The results showed a statistically significant difference between MB2 canal with or without its own apical portal of exit among the 6 age groups ($p < 0.05$).

No significant correlation was found between gender and frequency of 2 apical foramina ($P < 0.05$) ([Table 4](#)).

Discussion

The prevalence of MB2 canals in maxillary first molars varied greatly in the literature. Previous studies mostly

Table 2 The frequency distribution of MB2 canal in relation to gender.

MB2 canal	Male No. (%)	Female No. (%)	Chi square P-value
Present	206 (32.5)	135 (21.3)	$\chi^2 = 19.14$
Not present	126 (19.9)	167 (26.3)	$P = 0.000012$
Total	332 (52.4)	302 (47.6)	

Table 4 The frequency distribution of MB2 canal with or without its own apical portals of exit among gender.

Apical portal of exit	Male No. (%)	Female No. (%)	Chi square P-value
2 apical foramina	61 (16.44)	54 (14.55)	$\chi^2 = 0.112$
Single foramen	131 (35.31)	125 (33.69)	$P = 0.73$
Total	192 (51.75)	179 (48.24)	

Table 3 The frequency distribution of MB2 canal with or without its own apical portals of exit among the 6 age groups.

Apical portal of exit	10-20 y No. (%)	21-30 y No. (%)	31-40 y No. (%)	41-50 y No. (%)	51-60 y No. (%)	>60 y No. (%)	Total No. (%)	Chi square P-value
2 apical foramina	5 (1.47)	52 (15.2)	30 (8.79)	24 (7.04)	3 (0.87)	1 (0.29)	115 (33.7%)	$\chi^2 = 11.78$
Single foramen	27 (7.91)	85 (24.9)	55 (16.13)	36 (10.55)	21 (6.15)	2 (0.58)	226 (66.2%)	$P = 0.037$
Total	32	137	85	60	24	3	341	

focused on root morphology and complex canal forms as well as impacting factors such as sex, age, and ethnicity of the subjects. However, few researchers have previously explored the association between the presence of an MB2 canal and the pattern of their apical portals of exit.

This study has two-fold objectives. Firstly to provide a new interpretation using objective findings from the present investigations and existing/known information confirmed in the scientific literature, specific to the impact of sex and age for the studied population on this anatomic feature. The second objective is to allow an explanation for the observed differences and likeness, with relevant studies that used similar methodology (CBCT imaging) to obtain an evidence-based background, which might be valuable on either clinical practice or anthropological perspective.

CBCT has been considered the most reliable tool to be used in prevalence in vivo studies as it allows analyzing in detail, specific anatomical characteristics of all groups of teeth in different sample sizes.^{5,19,26,27} The prevalence of the MB2 canal has been reported in many studies using CBCT scanning. The present findings were compared with the averages that have been reported in many studies. A recent study performed by Martins et al. looking at the worldwide prevalence of MB2 canals in 21 regions of the world using CBCT as the gold standard concluded the overall prevalence to be 73.8%, which is higher than that observed in the present study.¹⁹

A considerably higher percentage (69.6%), was also concluded by a recent systematic review and meta-analysis of prevalence studies using cone-beam computed tomography on the second mesiobuccal root canal in a human permanent maxillary first molar.¹¹ Whereas the percentages specific to the population in the present study, fall within the range reported by other systematic reviews using CBCT image analysis.^{28,29} Taken together, these findings reinforce the hypothesis that geographic region may influence the prevalence of the MB2 canal in maxillary molars. A similar conclusion was reached by other researchers.¹¹

However, the differences among these studies are caused by highly variable patient demographics, ethnic background, sample size, study design (clinical or laboratory-based), and the method of canal identification. Another concern that cannot be ignored is the differences in CBCT interpretation between the observers. Because of the factors previously mentioned, it's not appropriate to perform a formal statistical difference calculation between the different geographic regions.

From the results, it is clear that age does not influence the prevalence of the MB2 canal in the mesiobuccal root of the maxillary first molar. Previous studies also provide data on the presence or absence of the MB2 in different age groups. Contrary to the findings of Lee et al. (2011); Naseri et al. (2016) we did not find significant variations in the prevalence of MB2 in over 60 age group when compared to younger groups.^{30,31} However, in line with the ideas of Martins et al. (2020) it can be concluded that the age could not be associated with possible sources of variation in MB2 prevalence in comparison to younger groups.¹¹ Therefore, Clinicians should be made aware that MB2 canals could present at any age. Pattern of MB2 canal: In the MB roots of the maxillary first molar with additional canals 72% joined the main canal.

Two canals in the mesiobuccal root may run separately from each other or converge before reaching the apex.³¹ The closer the orifices are to each other, the greater are the chances that the two canals join at some point within the body of the root. The results go beyond previous reports, showing that most of the located two canals were joined in the apical 1–4 mm of the root canal and exited through one foramen.^{12,21,15} About the gender, the present finding showed a non-significant association between MB2 canal with or without its own apical portals of exit. In particular no study, to our knowledge, has considered the relation of gender and distribution of apical portals of exit in the presence of MB2 canal.

The results lead to a similar conclusion reported in previous studies belonging to different ethnic backgrounds,^{32,19,18,29} in which most of the MB2 canals joined the main canal and exited through 1 apical foramen in the 2-canaled MB roots of maxillary first molars. This is in contrast to results from other studies with a high prevalence of the 2 canals with 2 separate foramina.^{9–12,17}

The results obtained in the present study showed a significant association between the prevalence of the MB2 canal and gender. Similar findings were observed by several previous studies.^{33,21,25} Others have shown that there was no significant association between gender and MB2 prevalence.^{20,30} It remains unclear to which degree gender is attributed to a smaller detection rate of the MB2 canal in females than in male, however, some factors were discussed in the literature; like a higher demineralization rate and loss of bone mass in females than in males.³⁴ This may decrease the visibility of the boundary of an extra canal in the mesiobuccal root during image analysis in female cases that result in a lower incidence of MB2 canal in comparison to male cases. Another concern that cannot be ignored is the hypothesis that a specific gene of the X chromosome is involved in the regulation of root formation. This provides a good starting point for discussion and further research, to investigate if gender could be considered with continued attention as a factor that affects the incidence of the MB2 canal.^{5,35}

Under the conditions of this retrospective study, it can be concluded that the MB2 canal may be present in approximately half of the time, from which only one third of them may have its apical portal of exit. These results may be associated with the specificities of the studied population. The broad implication of the present research is that these preoperative diagnostic variables (sex, age, and root canal configuration), has important clinical relevance in root canal treatment of maxillary first molar because it is possible to anticipate a higher or lower rate of prognosis.

Declaration of Competing Interest

No conflict of interest for this submission.

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