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Original Article

Analysis of patients with a second canal in mesiobuccal root of maxillary molars in Southern China: a retrospective study

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Abstract: Previous studies have shown that the prevalence of a second mesiobuccal canal (MB2) in the mesiobuccal root of maxillary molars is inversely correlated to age, and also correlated with the location within the three sections of the tooth (i.e., coronal, middle and/or apical). However, little is known whether this finding is true for populations from different ethnic backgrounds. The aim of this study was to investigate the prevalence of MB2 in the mesiobuccal root of the first and second maxillary molars in a southern Chinese subpopulation by using cone-beam computed tomography (CBCT), and to investigate whether these findings correlate with patient age, gender, location within the tooth and tooth position. A total of 337 male and 310 female adult patients from Southern China with healthy, untreated, well-developed maxillary molars were enrolled. Maxillary first (n = 953) and second (n = 1066) molars were analyzed *in vivo* using CBCT scanning. Teeth with three roots were identified, and the presence of MB2 was analyzed for correlation with patient age, gender, location within the tooth and tooth position. Interestingly, a positive correlation was observed between the prevalence of MB2 and age. In addition, there was a correlation between both gender (male) and tooth position (left side) with higher MB2 prevalence. MB2 was more distinct in the middle than in the coronal and apical third. Significant associations were also found between the overall presence of MB2 and patient gender, age and tooth position. To sum up, the prevalence of MB2 in maxillary molars is declining in younger patients, which may be a result of evolution. The detective rate of MB2 decreases from middle to, coronal, and further to apical third. In addition, we found an association with gender, age and tooth position with MB2.

Keywords: Cone-beam computed tomography, maxillary molars, second mesiobuccal canal, Southern China, evolution

Introduction

A complete understanding of the root canal anatomy is essential for a successful outcome before surgical and non-surgical root canal treatment. Due to the high anatomic complexity, understanding the anatomic configuration and variations of maxillary molars is important for ensuring that they are treated properly [1]. The most commonly missed canals are the second canals in the mesiobuccal (MB2) root [2]. Missed diagnosis of MB2 may lead to an unfavorable prognosis, failure of treatment, or even loss of the whole tooth. Therefore, the use of auxiliary imaging, especially in the diagnosis of teeth with a complicated root canal anatomy, has become indispensable.

Technologic advancements in dentistry, specifically endodontics, have allowed clinicians to perform endodontic treatments with increasing success [3]. These include technologies such as tuned aperture computed tomography, magnetic resonance imaging, ultrasound, computed tomography and cone beam computed tomography (CBCT). Among these techniques, CBCT appears to be an effective and safe way to overcome some of the problems associated with conventional radiographs [3] due to its good performance, low cost, and low radiation dose [4]. Thus, CBCT imaging is a suitable diagnostic technique for detecting a missed MB2 in endodontically treated teeth, as it offers high degree of sensitivity, specificity and accuracy [5].

Previous studies have investigated the correlations between the prevalence of MB2 in maxillary molars with patient age [6-9], as well as gender [6, 8-11]. However, evidence regarding correlations between the prevalence of MB2 and tooth position [9], or tooth section (i.e., coronal, middle and/or apical) [8] are limited. To our knowledge, all the previous studies found a negative correlation between the prevalence of MB2 and age [6-9], but conflicting results were found between the prevalence of MB2 and gender [6, 8-11]. However, due to the lack of verification from large samples studies and similar studies of different ethnic populations, the correlation between the prevalence of MB2 and tooth position, as well as tooth section, are not clear.

The aim of this study was to investigate the prevalence of MB2 in the first and second maxillary molars in a southern Chinese subpopulation by using CBCT, and to identify correlations between MB2 and patient age, gender, tooth position and third section (the presence of MB2 in different root thirds). More data will contribute to our better understanding of possible factors that affect the prevalence of MB2.

Materials and methods

Patients

CBCT images of 953 maxillary first molars and 1066 maxillary second molars from 647 Southern Chinese people (337 men and 310 women) with a mean age of 46.3 years (ranging from 18 to 80 years) were identified in the database of the Oral Radiology Department, Nanfang Hospital, Guangzhou, China, between February 2010 and December 2015. All patients required radiographic examination by CBCT as part of their dental treatment. The images were taken as part of the routine examination, diagnosis, and treatment planning of patients that included those suffering facial trauma or maxillary sinusitis, who required a pre-operative assessment for implants, or who needed orthodontic treatment because of an impacted tooth. Informed consent was obtained from the patients and this study was approved by the Ethics Committee of Nanfang Hospital.

The CBCT images were selected for enrollment in this investigation based on the following criteria: (i) maxillary permanent molars without periapical lesions; (ii) the teeth involved had not been endodontically treated; (iii) no root canals with open apices, absorption or calcification; and (iv) the CBCT images were of good quality [12].

Radiographic techniques

The CBCT images were taken using a Planmeca Romexis 3D CBCT scanner (Planmeca, Finland) operating at 84 kV and 14 mA, and the exposure time was 12 s. The voxel size was 200 μm × 200 μm and the minimum slice thickness was 0.2 mm. The resolution of detection was 1024 × 1024 pixels and the pixel size was 127 μm × 127 μm. Scans were made according to the manufacturer's recommended protocol. All the CBCT examinations were carried out by a licensed radiologist with the minimum exposure necessary for the adequate image quality. The lowest dose of radiation and radiation field was ensured.

Evaluation of the images

The CBCT images were reconstructed in 3D by using a patented Feldkamp reconstruction algorithm, analyzed with inbuilt software and ran in a 32-bit Windows 7 system. All the images were analyzed by a Lenovo LCD screen with a resolution of 1280 × 1024 pixels in a dark room. Contrast and brightness of images could be adjusted using the image processing tool of the software to ensure optimal visualization. Two professional oral radiologists evaluated all the images separately. These two groups of raw data were matched and compared, the inconsistent data were second-checked and evaluated by the two oral radiologists and an experienced endodontist concurrently to reach consensus on the interpretation of the radiographic findings. A second analysis was performed one month after the first one using approximately 20% of the images for intraobserver reliability assessment. A second analysis was performed one month after the first one using approximately 20% of the images for intraobserver reliability assessment.

Teeth with three roots were radiographically examined by CBCT for (i) the presence of MB2, (ii) the presence of MB2 in different thirds of the MB root. Examiners could scroll through the axial, coronal, and sagittal views. Each MB root image was scrolled axially from the pulp cham-

Table 1. The total number of teeth, teeth with 3 roots, and the presence/absence of MB2 in 3-rooted first and second maxillary molars

Tooth	Total teeth *N*	Teeth with 3 roots n (%)	MB2 present n (%)	MB2 absent n (%)
1MMR	476	465 (97.7)	289 (62.2)	176 (37.8)
1MML	477	465 (97.5)	356 (76.6)	109 (23.4)
2MMR	525	378 (72.0)	91 (24.1)	287 (75.9)
2MML	541	379 (70.1)	121 (31.9)	258 (68.1)
Total	2019	1687 (83.6)	857 (50.8)	830 (49.2)

Table 2. Distribution of teeth according to patient gender

Sample	Female n (%)	Male n (%)	Total n (%)
Total teeth	991 (49.1)	1028 (50.9)	2019 (100)
Teeth with 3 roots	789 (46.8)	898 (53.2)	1687 (100)
MB2 present	370 (46.9)	487 (54.2)	857 (100)
MB2 absent	419 (53.1)	411 (45.8)	830 (100)

Table 3. The prevalence of MB2 canal in first and second maxillary molars according to patient age

Age (y)	No. of patients	No. of teeth	Presence of MB2 n (%)		
			1MM	2MM	Total
18-29	110	332	112 (61.9)	20 (13.2)	132 (39.8)
30-39	112	322	117 (63.9)	40 (28.8)	157 (48.8)
40-49	141	370	140 (70.7)	52 (30.2)	192 (51.9)
50-59	133	317	127 (72.6)	47 (33.1)	174 (54.9)
>60	161	346	149 (77.2)	53 (34.6)	202 (58.4)

ber floor to the radiologic apex. The most apical and cervical measures obtained on the images were used to divide the root into thirds (coronal, middle, apical). Each root third was analyzed for the presence of an MB2. If positive for an MB2, the specific location (i.e., coronal, middle and/or apical) of the MB2 was detected.

Data analysis

The prevalence of a MB2 was analyzed in accordance with tooth position, patient gender and age, and in relation to their distribution within the thirds of the tooth. Statistical analysis was performed using the SPSS 13.0 software. The difference was considered to be statistically significant when the *P* value was <0.05.

The presence or absence, and prevalence of MB2 according to the distribution of the root within the tooth were expressed as absolute and percentage frequencies. The association between the presence of MB2 and gender, age, and root section were assessed using the Pearson chi-square (when N>40 and the minimum expected count was >1) and Fisher exact test (when N<40 or the minimum expected count was <1). Contingency coefficients of the associated variables were investigated. The intraobserver and interobserver reliability were measured using the Cohen kappa. The alpha value was set to 0.05.

Results

This study included 337 males and 310 females. The number of patients aged 18-29, 30-39, 40-49, 50-59 and 60-80 years was 100, 112, 141, 133 and 161, respectively. Intraobserver reliability was satisfactory for both observer 1 (R = 0.85) and observer 2 (R = 0.89), and the interobserver reliability as assessed by the Cohen kappa was excellent (R = 0.88). As a result, a total of 1,687 teeth with 3 roots were analyzed (**Table 1**). The prevalence of MB2 was 54.2% for males and 46.9% for females (**Table 2**), and the prevalence decreased with age (**Table 3**).

Our data showed that patient age (older age), gender (male), and tooth position (left maxillary molars) correlated with a higher MB2 prevalence. Specifically, the Chi-square test and contingency coefficient revealed that there was a significant association between the presence of MB2 and patient age, gender and tooth position (i.e., left and right) in maxillary first molars (1MM) and maxillary second molars (2MM) (**Table 4**). Paired-comparison results of the correlation between the presence of MB2 and the different age groups (Supplementary Table 1) showed that the prevalence of MB2 became lower when patient age was less than 40 years, but the age boundary of 1MM and 2MM was 60 and 30 years, respectively. However, when statistics were performed separately by position (where 'R' and 'L' represents 'Right' and 'Left', respectively) for 1MMR, 1MML, 2MMR and 2MML, a significant difference was observed for 2MMR, with respect to the correlation between MB2 and patient age (Supplementary Table 2). A significant difference was also observed for 1MMR

Table 4. Correlation between presence of MB2 canal in the MB root and patient age, gender, tooth position

Tooth	Age correlation		Gender correlation		Tooth position correlation	
	Presence of MB2	*P* value	Presence of MB2	*P* value	Presence of MB2	*P* value
1MM	0.121*	0.008	0.105*	0.001	0.154*	0.000
2MM	0.168*	0.000	0.104*	0.004	0.087*	0.016

*Statistically significant (P<.05).

Table 5. The prevalence of MB2 canal according to root third

Tooth	Coronal third n (%)	Middle third n (%)	Apical third n (%)	Contingency Coefficient	*P* Value
1MMR	266 (92.0)	272 (94.1)	247 (85.5)	0.125*	0.001
1MML	316 (88.8)	339 (95.2)	307 (86.2)	0.126*	0.000
1MM	582 (90.2)	611 (94.7)	554 (85.9)	0.121*	0.000
2MMR	88 (96.7)	91 (100)	87 (95.6)	0.117	0.052
2MML	117 (96.7)	120 (99.2)	113 (93.4)	0.127*	0.040
2MM	205 (96.7)	211 (99.5)	200 (94.3)	0.121*	0.009

*Statistically significant (P<.05).

and 2MMR, but not 1MML or 2MML, with respect to the correlation between MB2 and patient gender (Supplementary Table 2).

The prevalence of MB2 was also significantly associated with the root section (i.e., the prevalence of MB2 was different for the coronal, middle and apical section) for 1MM and 2MM (**Table 5**). Generally, the prevalence of MB2 decreased from middle, to coronal to apical third. However, there were six variants representing the presence or absence of MB2 canal in the different root thirds in maxillary molars (**Figure 1**). In order to exclude potential interference of different root canal types according to Vetucci's classification, we assessed the prevalence of MB2 in type IV MB canals (type 2-2, two separated canals from two canal orifices to two apical foramina with no connections in the root), according to the root section (Supplementary Table 3). The results were similar to **Table 5**, showing a similar trend of decreasing MB2 prevalence from middle, to coronal to apical third. With the exception of patients with 1MML aged 40-49, all of the 1MM teeth for the different age groups showed a consistent trend, as mentioned above. In contrast, the 2MM teeth showed no consistent trend with the presence of MB2 in tooth sections according to patient age (**Table 6**). However, when we excluded the data that MB2 was not detected in the coronal third, most of the data showed a trend of decreasing MB2 prevalence from coronal, to middle to apical third (Supplementary Table 4). Similar findings were found in the different age groups (Supplementary Table 5).

Discussion

The present study used CBCT to detect the presence of MB2 in maxillary first and second molars in a Southern Chinese subpopulation, and analyzed the correlation of MB2 prevalence with patient age, gender, tooth position and tooth section. Most importantly, compared with similar studies, the present study is one of the largest clinical studies, with respect to sample size, as far as we know.

To our surprise, several interesting findings were found. First of all, the prevalence of MB2 in maxillary molars is decreasing with age. Secondly, statistical analysis revealed that both gender and tooth position are correlated with the prevalence of MB2, with males and left molars tending to have a higher prevalence of MB2. Last but not least, the prevalence of MB2 has a different distribution in the different sections of the root: the middle third has the highest prevalence of MB2, followed by the coronal, and least was the apical third.

Our study revealed that the prevalence of MB2 has a positive correlation with age, which is in sharp contrast with similar studies. Most of the previous studies tried to explain the positive correlation between the prevalence of MB2 and age with an age-related root canal anatomy perspective [6-9]. For example, it was postulated that the prevalence of MB2 decreased with age because of narrowing or even disappearance of the root canals, which resulted from age-related changes, such as canal calcification. Specifically, a previous study [13] using micro-CT confirmed that pulp cavity size and shape decrease with age. Nevertheless, Gilles and Reader [14] speculated that although it is probable that canals and orifices become smaller with age, complete occlusion is improbable. It is possible that none of the techniques used are discerning enough to detect

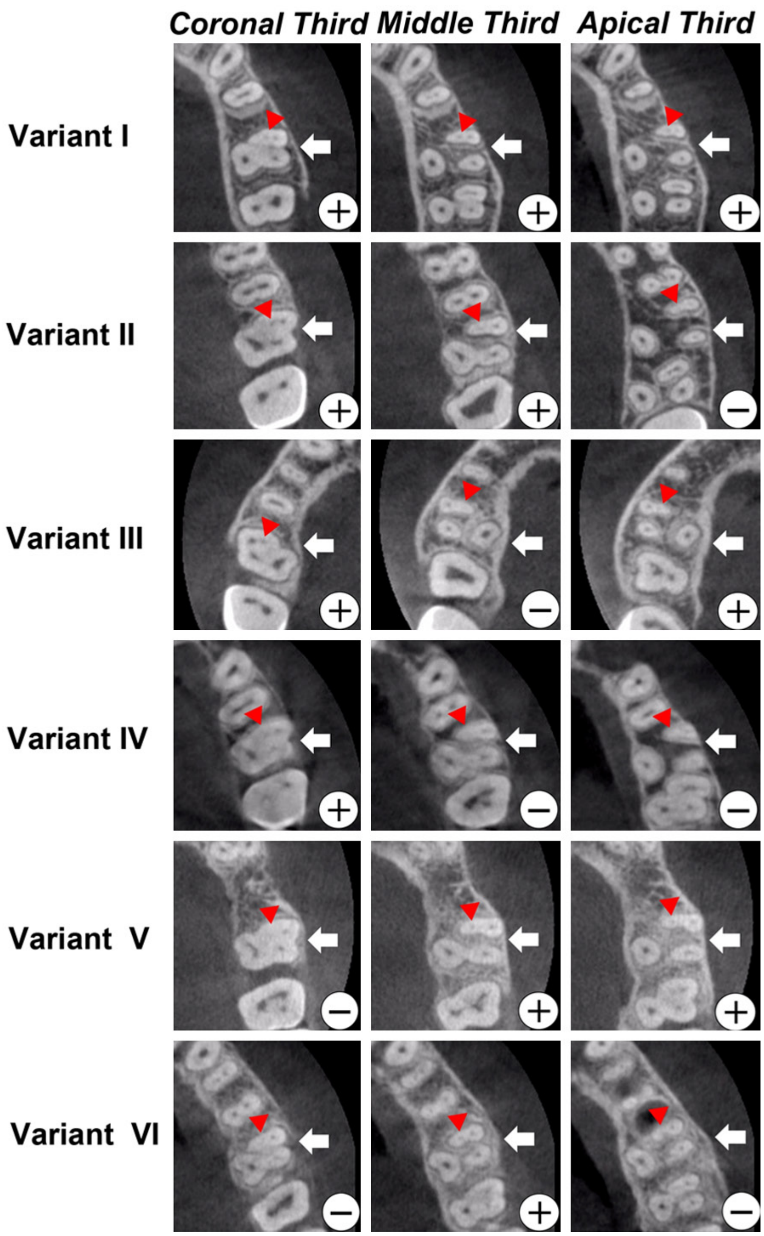

Figure 1. Axial slices of the coronal, middle, and apical thirds of maxillary molars. Six variants (Variant I-VI) represent the presence or absence of MB2 canals in the different thirds of the axial planes in maxillary molars. White arrows show the examined teeth, red triangles indicate the presence or absence of MB2 canals, '+' indicates the presence of MB2 canal and '-' indicates the absence of MB2 canal.

the canals narrowed by increasing age and that canals in older subjects. In other words, the prevalence of MB2 may have decreased as the root canals were getting more difficult to be detected in older subjects. Excluding this age-related factor, to some extent, this point of view supports the notion that the prevalence of MB2 remains constant in a particular population. However, every aspect of our physiology may be undergoing evolution. Facing the pressure of natural selection, the unnecessary anatomies may eventually disappear.

For example, the orthodontic problem of third-molar impaction occurs ten times more frequently in industrialized populations than in hunter-gatherers [15]. On one hand, mismatch between jaw length and tooth size results in insufficient room for proper implantation of our back teeth, so the front ones are pushed forward or forced out of proper alignment [16]. On the other hand, reduced dental wear with agriculture and the abrasive-free diets of industrialized society also may contribute to such modern orthodontic problems [17]. Our jaws are underdeveloped because softened, highly processed foods do not provide the chewing stress needed to stimulate normal growth of the jaw during childhood. As a result, human jaws, on average, have become shorter since the Paleolithic period [18].

Hence, here we propose a hypothesis that the prevalence of MB2 in the Southern Chinese population has decreased as a subject's age gets younger out of evolution. With the economic boom in China over the past decades, the diet has changed, with the incorporation of more softened and highly processed foods. As a result, the jaws have become shorter in the younger population. Facing this selective pressure, the prevalence of MB2 is getting lower as the prevalence of third-molar impaction is getting higher. However, this hypothesis needs to be further investigated with longer observational study.

Table 6. The presence of MB2 canal in the 3 thirds of the root in first and second maxillary molars according to patient age

Age (n)	IMMR			1MML			2MMR			2MML		
	Coronal n (%)	Middle n (%)	Apical n (%)	Coronal n (%)	Middle n (%)	Apical n (%)	Coronal n (%)	Middle n (%)	Apical n (%)	Coronal n (%)	Middle n (%)	Apical n (%)
18-29 (132)	47/49 (95.9)	42/49 (85.7)	36/49 (73.5)	55/63 (87.3)	59/63 (93.7)	49/63 (77.8)	6/6 (100)	6/6 (100)	6/6 (100)	14/14 (100)	14/14 (100)	14/14 (100)
30-39 (157)	46/51 (90.2)	44/51 (86.3)	38/51 (74.5)	60/66 (90.9)	63/66 (95.5)	55/66 (83.3)	17/17 (100)	17/17 (100)	16/17 (94.1)	23/23 (100)	22/23 (95.7)	20/23 (87.0)
40-49 (192)	63/66 (95.5)	64/66 (97.0)	59/66 (89.4)	68/74 (91.9)	68/74 (91.9)	67/74 (90.5)	19/19 (100)	19/19 (100)	19/19 (100)	33/33 (100)	33/33 (100)	31/33 (93.9)
50-59 (174)	53/59 (89.8)	58/59 (98.3)	56/59 (94.9)	61/68 (89.7)	66/68 (97.1)	62/68 (91.2)	25/25 (100)	25/25 (100)	25/25 (100)	20/22 (90.9)	22/22 (100)	21/22 (95.5)
>60 (202)	57/64 (89.1)	64/64 (100)	58/64 (90.6)	72/85 (84.7)	83/85 (97.6)	74/85 (87.1)	21/24 (87.5)	24/24 (100)	21/24 (87.5)	27/29 (93.1)	29/29 (100)	27/29 (93.1)

Other possible reason for this discrepancy between the present study and other studies are as follows: (1) Ethnicity may be a possible factor. The results from the present study are only taken from a southern Chinese subpopulation, and therefore these findings may not apply to other ethnic populations. (2) The small sample size from previous studies may have skewed the results. Studies of different sample sizes can lead to different outcomes, and effect the conclusions. Small sample size studies may result in less convincing conclusions. (3) The image resolution can affect the ability to detect MB2. The reliability of detecting maxillary molar MB2 canals in CBCT scans has increased as the resolution has improved [19]. Even though similar studies that use CBCT to detect the presence of MB2, different resolutions in different CBCTs from different companies may lead to distinct differences.

Our study suggested that male or left molars tend to have a statistically significant higher prevalence of MB2. In contrast, few studies [9, 20] found a significant correlation between the prevalence of MB2 and gender, and most of the studies [8, 9, 20, 21], as far as we know, found no statistically significant association between the prevalence of MB2 and tooth position. Again, this may be explained by different sample sizes and ethnicities in these studies. The higher prevalence of MB2 in males may be explained by gender differences, because it is normal that many anatomies [22, 23] exhibit a gender difference. As for the tooth position preference of MB2, it may be due to behavioral differences. Unlike left-right asymmetry distribution of internal organs [24], as well as the nerves of the brain [25], vertebrate teeth appear to be in bilaterally symmetry. According to a study on a western Chinese subpopulation, Zhang *et al.* [12] revealed that 84% of the subjects had perfect symmetry in the root and canal morphology of homonym teeth on the opposite side. However, not all the anatomies of a maxilla or a mandible are symmetric, for example, the mandible lengths of the left and right sides are different [26]. Thus, besides the congenital factors, here we hypothesize that acquired dispositions may play a part. The higher MB2 prevalence of left side may, to some extent, due to acquired dispositions, such as chewing side preference [27]. Subject health habit information such as oral acquired dispositions should be elaborately designed and included in similar prospective studies.

In this study, we found that the prevalence of MB2 decreases from middle, to coronal to apical sections, which is not totally consistent with the conclusion of previous study from a Brazilian population. Reis *et al.* [8] concluded that the prevalence of MB2 decreases as the root canal approached the apical third and age increases, i.e., coronal third has the highest prevalence of MB2. However, the present study supported that middle third has the highest prevalence of MB2. The key reason of this discrepancy lies in the inclusion criteria: Reis *et al.* [8] adopted and analyzed the CBCT image when the canal orifice of a MB2 can be found. This may help in standardizing and simplifying the data, but this may not usually happen in clinical practice because the coronal third of a MB2 may not always be detected. On one hand, from an anatomic view, not all the MB2 canals exist in the coronal third of the MB root. For example, according to Vertucci's classification, only one canal can be detected in the coronal third of type III, type V and type VII canals, thus the presence or absence of a MB2 cannot be identified in the coronal third of a MB root. On the other hand, the coronal third image of an MB2 may be indistinct due to calcification while the middle and apical thirds are still distinct. In order to verify this explanation, we excluded the data that the coronal third of the MB2 are absent. Reanalysis revealed that the prevalence of MB2 decreases from coronal, to middle and apical third, which is perfectly consistent with Reis *et al.* (Supplementary Tables 4 and 5). In addition, for the purpose of excluding the potential distraction of different root canal types according to Vertucci's classification, data of type IV MB canals were gathered and analyzed. The result was consistent with the result that mixed all of the Vertucci's classifications (Supplementary Table 3), and confirmed that the prevalence of MB2 decreases from the middle to coronal, and coronal to the apical third.

In summary, the present study revealed a significant association between gender, age, tooth position, and the prevalence of MB2 in a southern Chinese subpopulation. CBCT scanning is effective in mapping MB2 in maxillary molars, even in the different sections of the root. Furthermore, the prevalence of MB2 decreases from middle to coronal, and from coronal to the apical third. Importantly, the prevalence of MB2 in maxillary molars is getting lower in younger patients, which may be a result of evolution.

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Disclosure of conflict of interest

None.

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Supplementary Table 1. Correlation between Presence of MB2 Canal and Different Age Groups using Paired-comparisons

Age Group Pair	1MM		2MM		Total	
	Contingency Coefficient	*P* Value	Contingency Coefficient	*P* Value	Contingency Coefficient	*P* Value
1 and 2	0.021	0.685	0.188*	0.001	0.021	0.090
1 and 3	0.093	0.069	0.200*	0.000	0.121*	0.001
1 and 4	0.113	0.032	0.230*	0.000	0.150*	0.000
1 and 5	0.164*	0.001	0.243*	0.000	0.183*	0.000
2 and 3	0.072	0.159	0.016	0.780	0.031	0.411
2 and 4	0.275	0.282	0.047	0.433	0.061	0.121
2 and 5	0.144	0.005	0.063	0.283	0.096	0.013
3 and 4	0.021	0.690	0.031	0.586	0.030	0.432
3 and 5	0.074	0.144	0.047	0.396	0.065	0.081
4 and 5	0.053	0.306	0.016	0.780	0.035	0.365

Age group: 1: 18-29 years; 2: 30-39 years; 3: 40-49 years; 4: 50-59 years; 5: >60 years. *Statistically significant (*P*<.005).

Supplementary Table 2. Correlation between presence of MB2 canal in the MB root and patient age and gender

Tooth	Age correlation		Gender correlation	
	Presence of MB2	*P* value	Presence of MB2	*P* value
1MMR	0.120	0.146	0.128*	0.005
1MML	0.128	0.103	0.090	0.051
1MM Total	0.121*	0.008	0.105*	0.001
2MMR	0.216*	0.001	0.110*	0.031
2MML	0.151	0.066	0.096	0.061
2MM Total	0.168*	0.000	0.104*	0.004

*Statistically significant (*P*<.05).

Supplementary Table 3. The prevalence of MB2 canal in type IV MB canals according to root section

Tooth	Coronal third n (%)	Middle third n (%)	Apical third n (%)	Contingency Coefficient	*P* Value	*n*
1MMR	93 (84.5)	102 (92.7)	83 (75.5)	0.190*	0.002	110
1MML	103 (85.1)	112 (92.6)	98 (81.0)	0.138*	0.030	121
1MM	196 (84.8)	214 (92.6)	181 (78.4)	0.163*	0.000	231
2MMR	16 (88.9)	18 (100)	17 (94.4)	0.194	0.236	18
2MML	27 (96.4)	28 (100)	24 (85.7)	0.249*	0.043	28
2MM	43 (93.5)	46 (100)	41 (89.1)	0.188*	0.026	46
Total	239 (86.3)	260 (93.9)	222 (80.1)	0.163*	0.000	277

*Statistically significant (*P*<.05).

Supplementary Table 4. The prevalence of MB2 canal according to root third (coronal third absence data were excluded)

Tooth	Coronal third n (%)	Middle third n (%)	Apical third n (%)	Contingency Coefficient	*P* Value
1MMR	266 (100)	252 (94.7)	231 (86.8)	0.156*	0.000
1MML	316 (100)	302 (95.6)	278 (88.0)	0.188*	0.000
1MM	582 (100)	552 (95.2)	509 (87.5)	0.175*	0.000
2MMR	88 (100)	88 (100)	84 (95.5)	0.173*	0.012
2MML	117 (100)	116 (99.1)	110 (94.0)	0.174*	0.002
2MM	205 (100)	204 (99.5)	194 (94.6)	0.173*	0.000

*Statistically significant (*P*<.05).

Supplementary Table 5. The presence of MB2 canal in the 3 thirds of the root in first and second maxillary molars according to patient age (coronal third absence data were excluded)

Age (n)	1MMR			1MML			2MMR			2MML		
	Coronal n (%)	Middle n (%)	Apical n (%)	Coronal n (%)	Middle n (%)	Apical n (%)	Coronal n (%)	Middle n (%)	Apical n (%)	Coronal n (%)	Middle n (%)	Apical n (%)
18-29 (122)	47/47 (100)	42/47 (89.4)	36/47 (76.6)	55/55 (100)	52/55 (94.5)	45/55 (81.8)	6/6 (100)	6/6 (100)	6/6 (100)	14/14 (100)	14/14 (100)	14/14 (100)
30-39 (146)	46/46 (100)	40/46 (87.0)	36/46 (78.3)	60/60 (100)	67/60 (95.0)	51/60 (85.0)	17/17 (100)	17/17 (100)	16/17 (94.1)	23/23 (100)	22/23 (95.7)	20/23 (87.0)
40-49 (183)	63/63 (100)	61/63 (96.8)	56/63 (88.9)	68/68 (100)	63/68 (92.6)	62/68 (91.2)	19/19 (100)	19/19 (100)	19/19 (100)	33/33 (100)	33/33 (100)	31/33 (93.9)
50-59 (159)	53/53 (100)	52/53 (98.1)	51/53 (96.2)	61/61 (100)	60/61 (91.8)	56/61 (91.8)	25/25 (100)	25/25 (100)	25/25 (100)	20/20 (100)	20/20 (100)	19/20 (95.0)
>60 (177)	57/57 (100)	57/57 (100)	52/57 (91.2)	72/72 (100)	70/72 (97.2)	64/72 (88.9)	21/21 (100)	21/21 (100)	18/21 (85.7)	27/27 (100)	27/27 (100)	26/27 (96.3)