Int. J. Morphol.,
42(2):483-490, 2024.

Morphology of the Second Mesiobuccal Canal in the Maxillary Second Molar

Morfología del Segundo Canal Mesiovestibular en el Segundo Molar Maxilar

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SRI, L.; YOO, Y. J.; YU, S. K. & PARK, Y. S. Morphology of the second mesiobuccal canal in the maxillary second molar. *Int. J. Morphol., 42(2)*:483-490, 2024.

SUMMARY: Failure to locate a complete canal system affects the prognosis of root canal treatment. A missed root canal is one of the most common reasons for failed root canal treatment. The prevalence of the second mesiobuccal canal in the maxillary second molar is relatively high and has a variety of configurations. Therefore, knowledge of its morphology is required in clinical endodontics. This review presented the canal in terms of its prevalence, classification, anatomical features, and the method for locating the second mesiobuccal canal in the maxillary second molar. Root canal treatment requires knowledge of tooth morphology, appropriate access preparation, and a thorough examination of the tooth's interior. Thus, clinicians should carefully employ various methods for assessing the anatomy of the entire root canal system to prevent failure in locating the second mesiobuccal canal. This canal can be located by modifying the access cavity design and utilizing specific instruments to improve the second mesiobuccal canal system visualization.

KEY WORDS: Maxillary second molar; Second mesiobuccal canal; Root canal configuration; Root canal therapy; Tooth root.

INTRODUCTION

Knowledge of tooth morphology is fundamental in root canal treatment. Clinicians should consider the configuration of the root canal and its variations before performing endodontic treatment (Tomaszewska *et al*., 2018; Baruwa *et al*., 2020). The failure to locate a complete canal system can adversely affect the prognosis of endodontic treatment because root canal therapy can fail if a few portions of pulp tissue are not successfully filled (Kharouf & Mancino, 2019). In addition, variability in anatomical structure should consistently be recognized because a lack of awareness of tooth morphology may increase the possibility of missing root canals throughout treatment, resulting in treatment failure (Baruwa *et al*., 2020).

Maxillary molars have the highest number of roots in various forms and structures, which explains why their internal canal system is complex (Betancourt *et al*., 2015). Previous studies have reported that the root canals of the maxillary second molars were more variable than the maxillary first molars (Ghoncheh *et al*., 2017; Wolf *et al*., 2017). Many studies on the anatomy of the maxillary second molar have shown the complexity of the root canal morphology. These studies were conducted based on population and demographics in vivo and ex vivo and found significant variations in root length, number of roots, root canal type, and root deviation (Wolf *et al*., 2017; Wu *et al*., 2017; Naseri *et al*., 2018; Xia *et al*., 2020; Rosaline *et al*., 2021).

The typical anatomical structure of the maxillary second molar comprises three roots (Ghasemi *et al*., 2017; Xia *et al*., 2020). In terms of canal configuration, the mesiobuccal root shows the most variation compared to the distobuccal and palatal roots (Ghoncheh *et al*., 2017; Tomaszewska *et al*., 2018). The mesiobuccal root mostly has one or additional canals, such as the second mesiobuccal (MB2) canal (Naseri *et al*., 2018; D'Souza *et al*., 2021).

The existence of the MB2 canal is one of the factors responsible for the morphological complexity of maxillary second molars (Rosaline *et al*., 2021). Numerous studies in various populations using various methods have shown considerable variation in identifying the MB2 canal in the

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Received: 2023-12-12 Accepted: 2024-02-02

maxillary second molars (Betancourt *et al*., 2015; Ghoncheh *et al*., 2017; Naseri *et al*., 2018; Kharouf & Mancino, 2019; D'Souza *et al*., 2021; Magalhães *et al*., 2022). Therefore, one of the primary reasons an endodontic treatment on maxillary second molars is incomplete might be the failure to detect the MB2 canal (Betancourt *et al*., 2015; Kharouf & Mancino, 2019).

This article aimed to present an overview of prevalence, classification, anatomical features, including the second mesiobuccal root canal characteristic, the geometric location of the orifice, and the internal architecture of the root canal. In addition, the method to locate is also described. We searched for published literature concerning the second mesiobuccal canal of the permanent maxillary second molar using the PubMed database and hand searching. The keywords searched were 'maxillary molar', 'root morphology' and 'root canal anatomy'. Titles and abstracts pertinent to the study were reviewed. This review included English papers and root canal anatomy texts published from 2011 to 2022 and relevant study of Vertucci and Weine classification published earlier.

Prevalence

Among the 47 examined studies, the prevalence of the MB2 canal represented data from 20 countries. The overall results are summarized in Table I. The MB2 canal in the maxillary second molar has been revealed frequently in Asian countries. In Iranian population studies, maxillary second molars had 14 % to 67.5 % of MB2 canals (Rouhani *et al*., 2014; Ghoncheh *et al*., 2017; Khademi *et al*., 2017; Zand *et al*., 2017; Khosravifard *et al*., 2018; Naseri *et al*., 2018; Donyavi *et al*., 2019). Investigations in Turkey reported MB2 canals frequency of 17.75 % to 47.3 % (Magat & Hakbilen, 2019; Keskin *et al*., 2021; Yanık & Nalbantog˘lu, 2022). Studies in the Indian and the Saudi Arabian population found that maxillary second molars had a wide range of MB2 canals between 8.47 % to 86 % (Singh & Pawar, 2015; Shetty *et al*., 2017; Kosaraju *et al*., 2018; Manigandan *et al*., 2020; D'Souza *et al*., 2021; Rosaline *et al*., 2021) and 17.7 % to 93 % (Al-Fouzan *et al*., 2013; Alfouzan *et al*., 2019; Alnowailaty & Alghamdi, 2022), respectively. Among Southeast Asian countries, the Thai population (Ratanajirasut *et al*., 2018) showed a much higher prevalence of MB2 canals than the Chinese in the Malaysian population (Pan *et al*., 2019). In East Asian countries, Korea (Lee *et al*., 2020), Taiwan (Lin *et al*., 2017; Su *et al*., 2019; Tzeng *et al*., 2020) and China (Tian *et al*., 2016; Wang *et al*., 2017; Wu *et al*., 2017; Martins *et al*., 2018; Xia *et al*., 2020) reported a 7.7 % to 41.3 % prevalence of MB2 canals, the lowest and the highest were identified in the Taiwanese population.

In the South American population groups, the Chilean population had a prevalence of MB2 canals in maxillary second molars of 42.48 % to 48 % (Abarca *et al*., 2015; Betancourt *et al*., 2015, 2016). However, it had a different range of 22.72 % to 83.4 % in the Brazilian population (Reis *et al*., 2013; Silva *et al*., 2014; Candeiro *et al*., 2019; Mohara *et al*., 2019). Moreover, studies on the American and Canadian populations showed 55.1 % to 73 % of MB2 canals (Domark *et al*., 2013; Park *et al*., 2014; Coelho *et al*., 2016; Parker *et al*., 2017). In the European population, the MB2 canals ranged from 23.2 % to 64.9 % (Nikoloudaki *et al*., 2015; Olczak & Pawlicka, 2017; Pérez-Heredia *et al*., 2017; Martins *et al*., 2018; Kharouf & Mancino, 2019). In Africa, the percentage of the MB2 canal was more than 50 % (Ghobashy *et al*., 2017; Fernandes *et al*., 2019).

The present study found varying percentages of MB2 canal in the mesiobuccal root of the maxillary second molar, from 7.7 % to 93 %, with a pooled mean of 32.74 %. This finding is lower than the previous result of the systematic review, which reported that the prevalence of MB2 canal in the maxillary second molar was 39 % (Martins *et al*., 2020). The MB2 canal prevalence in the mesiobuccal root of the maxillary second molar varies widely, which agrees with the previous studies, ranging from 14.0 %-83.4 % in a prevalence study consisting of data from 28 countries (Martins *et al*., 2019) and 21.8 %-83.4 % in prevalence study in Brazilian sub-populations (Silva *et al*., 2021).

Ethnic predilections and research methods can cause these wide variations. It includes different types of studies, sample selection, and equipment used. Variations may still be found using the same tool, for example, cone beam computed tomography (CBCT), due to the differences in tool specifications and techniques. In sample justification, eight studies stated the sample size calculation to provide an adequate estimate of prevalence (Reis *et al*., 2013; Park *et al*., 2014; Naseri *et al*., 2018; Fernandes *et al*., 2019; Julia Yen Yee *et al*., 2019; Manigandan *et al*., 2020; D'Souza *et al*., 2021; Alnowailaty & Alghamdi, 2022), and 4 of those studies performed power analysis for sample size (Reis *et al*., 2013; Manigandan *et al*., 2020; D'Souza *et al*., 2021; Alnowailaty & Alghamdi, 2022). Although some studies have large samples, the remaining studies only informed the sample size without verifying whether the representative addressed the target population.

Some previous studies have shown a relationship between gender and the prevalence of the MB2 canal in maxillary second molars. Studies in Chile, Poland, Chinese, India, Thailand, South Africa, Malaysia, and Taiwan have reported that MB2 canal was higher in males than in females (Abarca *et al*., 2015; Betancourt *et al*., 2015, 2016; Olczak

Table I Prevalence of MB2 canal in the maxillary second molar.

Authors	Country	Type of Study	Methods	Samples	MB2 (%)	Type of MB2 canal (%)							Gender (%)	
						II	III	IV	V	VI	VII	VIII	Male	Female
Al-Fouzan *et al.*, 2013	Saudi Arabia	*In vivo*	RCT. Magnification loupe, DOM	162	19.7	-	-	-	-	-	-	-	-	-
Domark *et al.*, 2013	USA	Cadaver	Digital radiograph, CBCT, micro-CT	14	57.0	-	-	-	-	-	-	-	-	-
Reis *et al.*, 2013	Brazil	*In vivo*	CBCT	175	83.4	-	-	-	-	-	-	-	-	-
Park *et al.*, 2014	Canada	*Ex vivo*	Simulated RCT. Magnification loupe, DOM	49	55.1	-	-	-	-	-	-	-	-	-
Rouhani *et al.*, 2014	Iran	*Ex vivo*	CBCT	125	15.2	2.4	4.0	3.2	1.6	2.4	1.6	-	-	-
Silva *et al.*, 2014	Brazil	*In vivo*	CBCT	306	34.3	-	-	-	-	-	-	-	-	-
Abarca *et al.*, 2015	Chile	*In vivo*	CBCT	572	42.5	23.1	1.2	14.7	3.2	0.4	-	-	46.7	39.0
Betancourt *et al.*, 2015	Chile	*In vivo*	CBCT	225	48.0	-	-	-	-	-	-	-	63.0	37.0
Nikoloudaki *et al.*, 2015	Greece	*In vivo*	CBCT	402	40.3	-	-	-	-	-	-	-	-	-
Singh & Pawar, 2015	India (South Asian Indian)	*Ex vivo*	Clearing technique	72	18.0	15.3	-	2.7	1.4	-	-	-	-	-
Betancourt *et al.*, 2016	Chile	*In vivo*	CBCT	550	46.9	-	-	-	-	-	-	-	59.3	40.7
Coelho *et al.*, 2016	USA	*In vivo*	RCT&/DOM	65	56.9	-	-	-	-	-	-	-	-	-
Tian *et al.*, 2016	China	*In vivo*	CBCT	1022	29.7	12.9	5.3	6.8	3.0	0.4	0.3	0.1	-	-
Ghobasy *et al.*, 2017	Egypt	*In vivo*	CBCT	610	50.8	47.1	-	8.03	1.9	0.9	-	-	46.1	53.9
Ghoncheh *et al.*, 2017	Iran	*In vivo*	CBCT	345	14.0	3.0	-	11.0	-	-	-	-	-	-
Khademi *et al.*, 2017	Iran	*In vivo*	CBCT	460	42.4	39.3	-	1.7	1.3	-	-	-	-	-
Lin *et al.*, 2017	Taiwan	*In vivo*	CBCT	143	7.7	18.0	-	55.0	18.0	1.0	-	-	-	-
Olczak & Pawlicka, 2017	Poland	*In vivo*	CBCT	207	23.2	-	-	-	-	-	-	-	34.7	17.0
Parker *et al.*, 2017	USA	*In vivo*	RCT. DOM, troughing, CBCT	11	73.0	-	-	-	-	-	-	-	-	-
Perez-Heredia *et al.*, 2017	Spain	*In vivo*	CBCT	112	46.4	33.0	-	9.8	-	2.7	-	0.9	-	-
Shetty *et al.*, 2017	India	*In vivo*	CBCT post RCT	34	29.4	50.0†	50.0†	-	-	-	-	-	-	-
Wang *et al.*, 2017	China (Southern Chinese subpopulation)	*In vivo*	CBCT	757	28.0	-	-	-	-	-	-	-	-	-
Wu *et al.*, 2017	China	*In vivo*	CBCT	1395	29.9	-	-	-	-	-	-	-	33.7	26.1
Zand *et al.*, 2017	Iran	*In vivo*	CBCT, PA radiograph	156	23.7	3.2	17.3	0.6	1.3	-	-	-	30.2	15.7
Khosravifard *et al.*, 2018	Iran	*In vivo*	CBCT	135	18.5	5.2†	12.6†	0.7†	-	-	-	-	24.0	76.0
Kosaraju *et al.*, 2018	India (Coastal Andhra population)	*In vivo*	CBCT	636	32.2	-	-	-	-	-	-	-	33.0	31.2
Naseri *et al.*, 2018	Iran	*In vivo*	CBCT	157	67.5	18.5	3.2	11.5	7.6	26.8	-	-	44.0	56.0
Martins *et al.*, 2018	China	*In vivo*	CBCT	189	18.5	6.3	-	9.5	2.1	-	-	-	-	-
	Portugal			589	43.8	26.7	0.8	7.6	3.7	4.2	0.2	-		
Ratanajirasut *et al.*, 2018	Thailand	*In vivo*	CBCT	398	29.4	14.6	2.3	7.5	3.5	1.5	-	-	31.3	28.0
Alfouzan *et al.*, 2019	Saudi Arabia	*Ex vivo*	Micro-CT	30	93.0	-	-	-	-	-	-	-	-	-
Candeiro *et al.*, 2019	Brazil (Northeast subpopulation)	*In vivo*	CBCT	801	22.7	11.9	2.4	6.0	1.4	0.1	-	0.12	30.4	16.8
Donyavi *et al.*, 2019	Iran	*In vivo*	CBCT	558	21.5	18.1	-	3.4	-	-	-	-	27.9	17.0
Fernandes *et al.*, 2019	South Africa	*In vivo*	CBCT	200	67.0	-	-	-	-	-	-	-	17:72.0 27:66.0	17:66.0 27:64.0
Kharouf & Mancino, 2019	France	*In vivo*	Surgical microscopic	57	64.9	35.3†	37.2†	-	-	-	-	-	-	-
Magat & Hakbilen, 2019	Turkey	*In vivo*	CBCT	400	17.8	-	-	-	-	-	-	-	R:21.8 L:21.8	R:13.1 L:14.1
Mohara *et al.*, 2019	Brazil	*In vivo*	CBCT	292	33.6	15.4	2.4	13.01	1.03	1.7	-	-	31.5	46.7
Pan *et al.*, 2019	Malaysia (Chinese race)	*In vivo*	CBCT	354	8.5	1.9	-	7.7	-	-	-	-	13.4	4.9
Su *et al.*, 2019	Taiwan	*In vivo*	CBCT	248	32.3	-	-	-	-	-	-	-	R:31.9 L:16.3	R:11.8 L: 5.4
Lee *et al.*, 2020	Korea	*In vivo*	CBCT	135	28.9	-	-	-	-	-	-	-	-	-
Manigandan *et al.*, 2020	India	Clinical study	Direct vision, troughing, DOM	49	86.0	83.0	-	17.0	-	-	-	-	93.0	88.0
Tzeng *et al.*, 2020	Taiwan (Mongoloid origin subpopulation)	*In vivo*	CBCT	895	41.3	-	-	-	-	-	-	-	R:48.9 L:48.0	R:32.0 L:39.5
Xia *et al.*, 2020	China (Chongqing subpopulation)	*In vivo*	CBCT	400	25.8	7.3	2.3	16.3	-	-	-	-	32.6	20.6
D'Souza *et al.*, 2021	India (South Indian Dravidian population)	*In vivo*	CBCT	236	8.5	4.7	2.3	2.3	-	-	-	-	80.0	20.0
Keskin *et al.*, 2021	Turkey	*Ex vivo*	Micro-CT	150	47.3	-	-	-	-	-	-	-	-	-
Rosaline *et al.*, 2021	India (South Indian population)	*In vivo*	CBCT	500	20.8	28.6	-	3.2	-	0.3	-	-	-	-
Alnowailaty & Alghamdi, 2022	Saudi Arabia (Jeddah population)	*In vivo*	CBCT	600	17.7	-	-	-	-	-	-	-	17.3	18.0
Yanik & Nalbantoglu, 2022	Turkey	*In vivo*	CBCT	609	39.4	34.5	0.5	1.5	-	0.5	-	-	13.3	22.2

CT: Root Canal Treatment. DOM: Dental Operating Microscope. R: right maxillary second molar tooth. L: left maxillary second molar tooth.
Classification of MB2 based on Vertucci, except with † symbol is based on Weine.

& Pawlicka, 2017; Wu *et al*., 2017; Kosaraju *et al*., 2018; Ratanajirasut *et al*., 2018; Su *et al*., 2019; Fernandes *et al*., 2019; Pan *et al*., 2019; Manigandan *et al*., 2020; Tzeng *et al*., 2020; Xia *et al*., 2020; D'Souza *et al*., 2021). In contrast, studies in Egypt and Saudi Arabia showed that the MB2 canal was higher in females than in males (Ghobashy *et al*., 2017; Alnowailaty & Alghamdi, 2022). Studies in Iran, Brazil, and Turkey have found contradictory results. Some studies have found that MB2 canal was higher in males than females, whereas others found the opposite (Khosravifard *et al*., 2018; Naseri *et al*., 2018; Mohara *et al*., 2019; Yanık & Nalbantog˘lu, 2022).

Classification

Several classifications are suggested to provide a better comprehension of root canal anatomy. The most frequently used classifications of the second mesiobuccal canals are the Weine classification and the Vertucci classification. The Weine classification was first proposed in 1969, consisting of a root canal configuration of types I, II, III, and IV (Fig. 1). Type I: One canal from the pulp chamber to the apex. Type II: A bigger buccal canal and a smaller lingual canal that unifies from 1 to 4 mm from the apex. Type III: Two different canals and two different apical foramina, with the buccal canal being bigger and generallylonger from the roof chamber to its apical foramen. Type IV: A single coronal canal splits to leave the root in two canals with two distinct foramina (Weine *et al*., 1969). According to the Weine classification, the Iranian populations have the highest prevalence of type III canal configurations in the mesiobuccal roots of maxillary second molars (Khosravifard *et al*., 2018). However, a study in France has reported that the percentage of types II and III are similar (Kharouf & Mancino, 2019). On the other hand, the Indian population had an equal proportion of types II and III, each 50 % (Shetty *et al*., 2017).

The Vertucci classification was proposed in 1974, consisting of eight types of root canal configurations (Fig. 2). Type I: One canal extends from the pulp chamber to the apex. Type II: Two distinct canals exit the pulp chamber and merge only short of the apex to create a single canal. Type III: A single canal exit the pulp chamber, separating into two within the body of the root, then uniting again to leave as a single canal. Type IV: Two different canals extend from the pulp chamber to the apex. Type V: A single canal exits the pulp chamber and separates short in the apex into two independent canals with distinct apical foramen. Type VI: Two different canals exit the pulp chamber, joining in the body of the root and dividing into two separate canals in the short of the apex. Type VII: A canal exits the pulp chamber, separating and reconnecting within the root body, and then dividing into two different canals in the short of the apex. Type VIII: Three distinct canals extend from the pulp chamber to the apex (Vertucci *et al*., 1974; Vertucci, 1984, 2005).

The Vertucci system classifies the MB2 canal configuration, except for type I, which only has one canal. Vertucci types II and IV canal configurations were the most prevalent in recent studies in Iran, Taiwan, China, Thailand, Malaysia, Egypt, India, Brazil, Spain, and Turkey (Singh & Pawar, 2015; Ghobashy *et al*., 2017; Ghoncheh *et al*., 2017; Khademi *et al*., 2017; Lin *et al*., 2017; Pérez-Heredia *et al*., 2017; Zand *et al*., 2017; Ratanajirasut *et al*., 2018; Candeiro *et al*., 2019; Donyavi *et al*., 2019; Pan *et al*., 2019; Manigandan *et al*., 2020; Xia *et al*., 2020; Yanık & Nalbantog˘lu, 2022). This result is consistent with a study and meta-analysis which reported that the most common configuration was types II and IV (Tomaszewska *et al*., 2018). However, studies in Iran discovered types III and VI as the highest prevalent (Rouhani *et al*., 2014; Zand *et al*., 2017; Naseri *et al*., 2018). On the other hand, there was a large variety of root canal configurations in some studies, the Portugal population and the Iranian population had types II to VII (Rouhani *et al*., 2014; Martins *et al*., 2018), the Chinese population had types II to VIII (Tian *et al*., 2016), and the Brazilian population had types II to VI and VIII (Candeiro *et al*., 2019; Mohara *et al*., 2019).

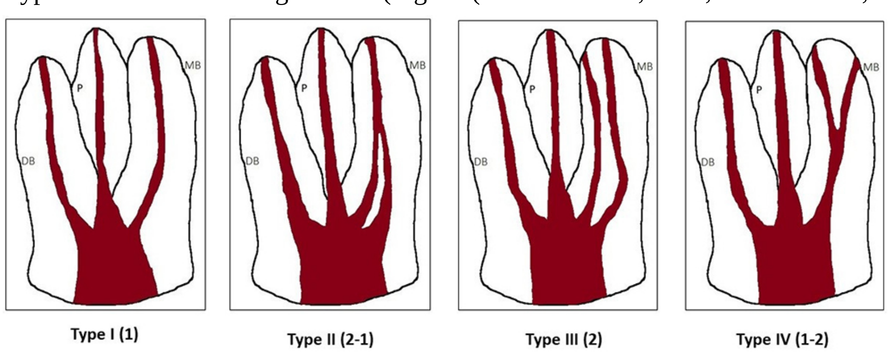

Fig. 1. Weine's root canal configurations of the MB2. MB: mesiobuccal, DB: distobuccal, P: palatal.

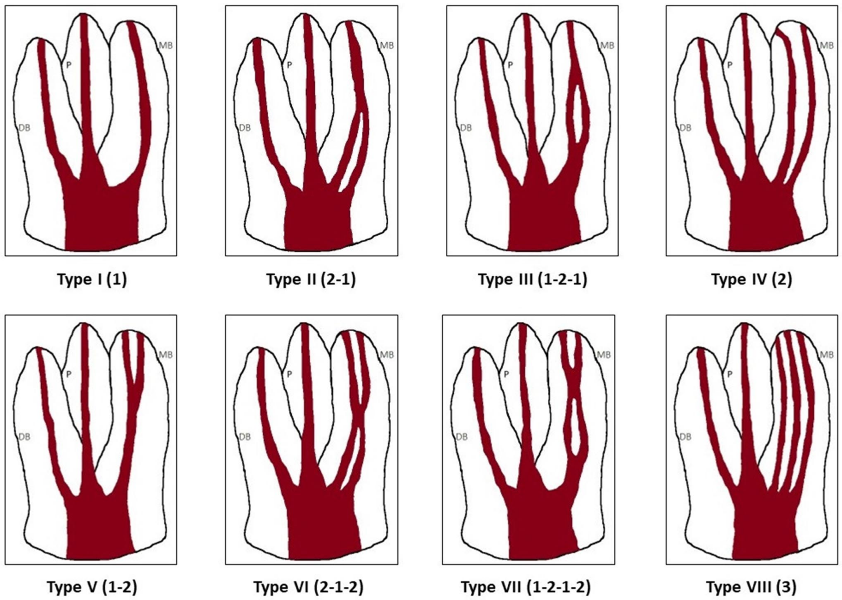

Fig. 2. Vertucci's root canal configurations of the MB2. MB: mesiobuccal, DB: distobuccal, P: palatal.

(Versiani *et al*., 2019). On the radiograph, the mesiobuccal canal is not located in the center of the mesiobuccal root, indicating more than one canal in the root (Liu *et al*., 2019). Moreover, the canal taper of MB2 is 0.05 mm/mm in the buccolingual direction. The canal diameter of MB2 is 0.19 mm (0.14–0.23 mm) in the buccolingual direction and 0.16 mm (0.15–0.16 mm) in the mesiodistal direction (Versiani *et al*., 2019).

The MB2 canal in maxillary second molars is frequently found next to the mesiobuccal canal. It could occur in a single orifice, two separate but adjacent orifices, or two somewhat distant orifices (Shah *et al*., 2014). The orifice of the MB2 canal is located approximately mesiopalatally to the orifice of the first mesiobuccal (MB1) canal (Shah *et al*., 2014; Betancourt *et al*., 2015). Figure 3 presents the orifice location. The geometric location study in Chile showed that the MB2 canal was located 2.2 ± 0.54 mm palatally and 0.98 ± 0.35 mm mesially to the MB1 canal (Betancourt *et al*., 2015). In a study with a more extensive sample, the MB2 canal was located at 2.41 ± 0.64 mm palatally and 0.98 ± 0.33 mm mesially (Betancourt *et al*., 2016). However, a study in Saudi Arabia found a lower distance; the location was 1.24 ± 0.76 mm palatally and 0.43 ± 0.18 mm mesially (Alnowailaty & Alghamdi, 2022). Two studies in Turkey reported a wide range of distances; the location was 1.39 ± 0.88 mm and 3.08 ± 0.67 mm palatally (Magat & Hakbilen, 2019; Keskin *et al*., 2021). A study in Korea found it to be 1.98 ± 0.42 mm palatally (Lee *et al*., 2020). A case report in China found that the MB2 canal was nearer to the palatal side than the buccal side; it was 3.25 mm palatally (Liu *et al*., 2019).

According to Vertucci and Weine classifications, the root canal system configuration represents various MB2 canal structures. The MB2 canal that separates from the pulp chamber to the foramen apical is found in type IV and VIII Vertucci classification and type III Weine classification. From previous studies (Table 1), the configuration of the MB2 canal in the second maxillary molar was the most in type 2-1 (two different canals leave the pulp chamber and join the apex to form a single canal) and type 2 (two different canals from the pulp chamber to apex). Since all other types of MB2 canal configuration were reported to be present, the presence of types 1-2-1, 1-2, and 1-2-1-2 should be noted. Only detecting one orifice in the pulp chamber does not mean there is only one canal in the mesiobuccal root.

Anatomical features

The morphological aspects of the mesiobuccal root of the maxillary second molar are as follows: the root length is 12.9 mm (9.0–18.2 mm), longer than the distobuccal root and shorter than the palatal root. In root grooves, there are mesial and distal depressions. Most mesiobuccal roots have a distal-buccal deviation. Apical root curvature is commonly distal (54 %), straight (22 %), and others (24 %). The mesiobuccal root's apical foramen is mostly straight in the coronal plane and deviates distally in the sagittal plane (Naseri *et al*., 2018; Versiani *et al*., 2019).

The mesiobuccal root canal has the following characteristics: the shape of the root canal cross-section is oval or flat-oval in coronal and middle and round in apical

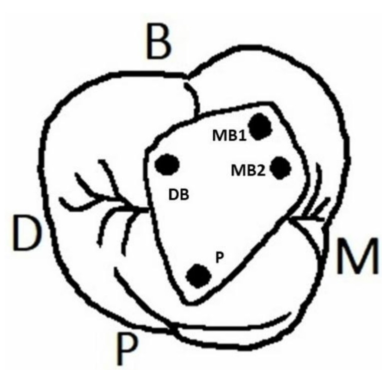

Fig. 3. Illustration of orifice location and rhomboidal access preparation. MB1: first mesiobuccal, MB2: second mesiobuccal, DB: distobuccal, P: palatal.

In maxillary second molars, the internal architecture of the mesiobuccal root, including dentin thickness, was observed to differ greatly associated with the existence of the MB2 canal (Rosado *et al*., 2022). According to recent research, the dentinal wall enclosing the MB2 root canal in maxillary second molars was thinner than the neighboring MB1 root canal (Azimi *et al*., 2020; Rosado *et al*., 2022; Yanık & Nalbantog˘lu, 2022). The dentinal wall in the distal concave region of the maxillary second molar mesiobuccal root near furcation was thinner than in the mesial convex region distant from furcation (Yanık & Nalbantog˘lu, 2022), and the palatal wall was thinner than the buccal wall (Daga *et al*., 2011).

Some studies have examined the root canal configuration by separating the roots into three-thirds: coronal, middle, and apical. The presence of the MB2 canal was checked in each third. They discovered that MB2 canals were less common in the middle and apical thirds than in the coronal third. As the root nears the apical third, the prevalence of MB2 canals decreases (Reis *et al*., 2013; Abarca *et al*., 2015; Wolf *et al*., 2017). Abarca *et al*. (2015) found that MB2 canals were present in all root thirds over 13 % of maxillary second molars. Wolf *et al*. (2017) also studied the number of main foramina, accessory canals, and connecting canals. Only 43.1 % of the samples had a main foramen in the MB2 canal. In all apical thirds, connecting and accessory canals were observable (Wolf *et al*., 2017).

Locating the second mesiobuccal canal

When locating the MB2 canal, to maximize the visibility of the MB2 canal orifice, the shape of the access cavity is suggested to be rhomboidal (Fig. 3) (Daga *et al*., 2011; Betancourt *et al*., 2015; Manigandan *et al*., 2020; Alnowailaty & Alghamdi, 2022). To achieve a sufficient access opening, a wide canal with a flat, flared, and finalized axial wall is recommended (Corneli *et al*., 2020). Direct vision, dental operating microscope (DOM), selective dentin removal, and CBCT was used to locate and negotiate the MB2 canal (Manigandan *et al*., 2020). The use of magnification, ranging from loupes and magnifying glasses to an operating microscope, has improved the detection rate of MB2 canals. In endodontics, the DOM has significantly improved magnification and illumination for the clinician. Troughing should be performed to remove the dentinal shelf that conceals the underlying orifice or to remove calcification using specially built ultrasonic tips or burs. Using multiple straights and angled radiographs both before and during surgery gives a visual representation of the existence of extra canals. CBCT, one of the contemporary diagnostic techniques, improves access to the internal root canal morphology (Daga *et al*., 2011; Manigandan *et al*., 2020). CBCT has shown to be a reliable and accurate method for locating MB2 canals (De Carlo Bello *et al*., 2018).

One study compared direct vision, DOM, selective dentin removal under DOM, and CBCT in the clinical detection of MB2 canal and showed that MB2 canal could be clinically detected in 86 % of maxillary second molars using DOM combined with selective dentin removal. Clinical detection of MB2 canals was increased successively using direct vision, DOM, selective dentin removal, and CBCT (Manigandan *et al*., 2020). Another study found 74.1 % of MB2 canals during routine pulp chamber access, with the majority of these discovered during the initial treatment. A total of 14.2 % required troughing with burs or ultrasonic tips to locate the canal orifice. A further 11.7 % were found using the aid of CBCT imaging. In this study, DOM was used in the treatment of each case. With the use of CBCT images in preoperative treatment, more MB2 canals were found in the maxillary second molar (Studebaker *et al*., 2018).

CONCLUSION

From the literature we reviewed, the prevalence of the MB2 canal in the second maxillary molar is relatively high, and the configuration is variable. Based on our investigation, the prevalence varies from 7.7 % to 93 %, averaging 32.74 %. According to gender, it mainly showed that the percentage of males was higher than that of females. Type II and IV Vertucci are the two most prevalent configurations of the second mesiobuccal canal in the maxillary second molar. Overall, the presence of the MB2 canal significantly altered the anatomical features of the mesiobuccal root canal. Moreover, to locate the MB2 canal, preparation of the tooth with a rhomboidal access outline, direct vision method, DOM, selective dentin removal, and CBCT are advisable. Therefore, understanding its internal anatomy is highly recommended for the clinician to optimally locate and negotiate the canal.

SRI, L.; YOO, Y. J.; YU, S. K. & PARK, Y. S. Morfología del segundo canal mesiovestibular en el segundo molar maxilar. *Int. J. Morphol., 42(2)*:483-490, 2024.

RESUMEN: La falta de localización de un sistema completo de canal afecta el pronóstico del tratamiento de éste. La omisión de un tratamiento de canal es uno de los motivos más frecuentes por las que el tratamiento de canal fracasa. La prevalencia del segundo canal mesiovestibular en el segundo molar superior es relativamente alta y tiene una variedad de configuraciones. Por tanto, el conocimiento de su morfología es necesario en endodoncia clínica. Esta revisión presentó el canal en términos de su prevalencia, clasificación, características anatómicas y el método para localizar el segundo canal mesiovestibular en el segundo molar superior. El tratamiento de canal requiere conocimiento de la morfología del diente, una preparación adecuada del acceso y un examen exhaustivo del interior del diente. Por lo tanto, los dentistas deben emplear cuidadosamente varios métodos para evaluar la anatomía de todo el sistema de canales radiculares para evitar fallas en la localización del segundo canal mesiovestibular. Este canal se puede localizar modificando el diseño de la cavidad de acceso y utilizando instrumentos específicos para mejorar la visualización del sistema del segundo canal mesiovestibular.

PALABRAS CLAVE: Segundo molar maxilar; Segundo canal mesiovestibular; Configuración del canal radicular; Terapia de canal; Raíz del diente.

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