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# A review on significance of second mesio-buccal canal in maxillary molars

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**Abstract**
Maxillary molars present a wide range of root canal configurations ranging from three canals to seven canals. Very few authors have found maxillary molars with seven canals but the incidence of the fourth canal is considered very common now. Therefore, second mesiobuccal canal is no longer considered an accessory canal. This review article describes the anatomy of the maxillary first molar, prevalence, and incidence of MB2 canals, ways to negotiate the hidden MB2, and its significance.

**Keywords:** second mesiobuccal canal, maxillary molars, accessory canal, locating second mesiobuccal canal

## Introduction
Successful root canal treatment is dependent on various factors. An accurate diagnosis, appropriate treatment planning, and a sound knowledge of tooth anatomy is therefore necessary. Further, a thorough the debridement, sterilization, obturation, and a well-fitting coronal restoration completes the treatment [1]. To avoid any mishaps during the procedure, before undertaking any endodontic therapy it is very important to visualize and have an adequate knowledge of internal anatomy relationships [2]. A higher occurrence of unsuccessful endodontic treatment has been reported in maxillary molars owing to its anatomic variations [3].

## Maxillary Molars
Maxillary molars usually have three roots but may also occasionally exhibit three mesial canals, three distal canals, and two palatal canals. Among these, the mesiobuccal root of the maxillary molar has generated more research and clinical investigation than any other root within the oral cavity. It generally has two canals but a third canal has also been reported. When there are two canals in the maxillary molars, they are called mesiobuccal (MB1) and second mesiobuccal (MB2), thus making the third canal the third mesiobuccal canal (MB3) [2]. According to Weine, MB2 is a poor and inappropriate name. Instead, mesiolingual (ML) is the term that best describes the canal and its location [4].
For almost a century now, we have known about the existence of a fourth canal in maxillary molars. Nevertheless, many ignore this fact. In 1925, Professor Walter Hess injected vulcanized rubber into maxillary root canals. Later, by removing the hard tissue through decalcification, he clearly showed the presence of MB2 [5].

## Classification
Weine *et al*. were one of the first to acknowledge that the failure of endodontic treatment of maxillary molars is likely due to the failure to locate, instrument, and fill the MB2 canal. They conducted an *in vitro* study on mesiobuccal roots of 208 extracted maxillary first molars. When possible, the root canal or canals were revealed, from the roof of the pulp chamber to the apex, and the typical configurations were classified and tabulated.

- Type I: From the pulp chamber to the apex a solitary canal.
- Type II: A larger buccal canal and a smaller canal located lingual to the previous which consolidates from 1 to 4mm from the apex.

- Type III: Two separate canals and two separate apical foramina, with the buccal canal being larger and usually longer from the roof of the chamber to its apical foramen.
- Of the 208 teeth sectioned,
- 48.5% exhibited the Type I (solitary canal) configuration
- 37.5% showed the Type II (bifurcated canal but common apical foramen) appearance
- 14.0% were classified as Type III (two separate canals) [6].

Along with these, Weine *et al*. added one more type of configuration, Type IV (with a single coronal canal that bifurcated to exit the root in two separate foramina [4]. (figure:1 Types of mesiobuccal canal)

**Incidence**

Regardless of race, age, sex, or nationality, the incidence of second mesiobuccal (MB2) canal in maxillary first permanent molar has been adequately reported in literature. *In vivo* and *in vitro* studies have reported a high incidence of the second canal in the mesiobuccal root of the maxillary molar tooth, ranging from about 15.1% and 78%, and even reaches to 95% in one *in vitro* study, making it important to take into consideration the high probability of finding an MB2 canal during the treatment planning phase [7].

**Prevalence**

Till date the prevalence of the MB2 canal has been published in studies done clinically, radiographically, and by using microscopes or other types of magnification [7]. Numerous authors have conducted in-vitro studies to discern the prevalence of occurrence of MB2. In 1925, Hess conducted a study on 513 teeth and found that 53% of them had the MB2 canal. Out of 208 roots, Weine in 1969 found 51.5% showing the MB2 canal. In 1974, Vertucci found 55% of teeth showing the presence of an MB2 canal, and later in 1984, out of 100 tooth samples he found 55% showing MB2 canal. Thus, all authors have found that more than half of the samples showed the presence of a fourth canal, which is the MB2 [8].

**Factors affecting the locating MB2 canal**

Clinically, several factors may impact the location of MB2 canals.

**1. Operator Experience**

Locating and negotiating difficult canals and including additional canals in the mesio buccal root of maxillary molars depends on the operator's experience, knowledge on tooth anatomy and variations as well as his/her clinical skills. Depending on this an operator may take more or less time during an appointment to search for additional canals [9].

**2. Age and Sex**

In an in-vitro study by Reis *et al* in 2013 it was found that, as age advances, as a result of dentin apposition on the root canal walls the chances of identifying an MB2 canal decreases. However, no association with sex was observed [10].

**3. Medication**

3-Hydroxy-3-methylglutaryl-coenzyme A reductase inhibitors (statins) are the first-line pharmaceuticals for the prevention and treatment of dyslipidemia. A recent investigation conducted by Pettiette, MT. *et al*. (2013) has shown that statins induced odontoblastic differentiation of dental pulp stem cells. Thus, it can be added that this medication is another factor that can impact root canal location [11].

**4. Access Cavity Shape**

Endodontic access should be completed with caution in order to preserve as much sound dentin as possible. Presently, a minimally invasive trend has garnered the attention of the endodontic community to save as much tooth structure as possible. But several *in vitro* studies reported that, after a definite restoration, tooth resistance is not affected by the size of the access preparation. Moreover, both location and instrumentation of canals will be difficult when very small access is made [12].

**Strategies used for Detection**

With the advancement of technology like magnification, ultrasonic tips, and CBCT, it became easiest to detect missed canals.

**Certain factors make negotiation of MB2 very difficult. These include [13]:**

- Debris and sealer that can accumulate in type II configuration of MB2 during the cleaning and shaping and obturation procedure of principal canals.
- Presence of diffuse calcifications, pulp stones, transverse anastomoses, cul de sac
- Type IV anatomy
- Dentinal mud that gets accumulated in an attempt to negotiate smaller MB 2 canals
- Debris in type II canals
- Anatomical variations
- Separated instrument

**Locating the Mesiobuccal Canal**

For the successful treatment of maxillary molars, it is very important to find the location of the extra canal. Based on prior studies it is shown that the majority of maxillary molars show the presence of MB2. Hence a clinician should search for MB2 preserving the available tooth structure. Several clinical steps might help to locate this canal, such as the recognition of the pulp chamber floor, magnification, ultrasonic tips, and dyeing [12].

The first step is preparing an adequate access opening. Rather than a triangular shape, a rhomboidal access cavity is adequate for locating and proper instrumentation of MB2 canal [8, 12]. A wide canal with a flat, flared and finished axial wall is recommended.

Compared to the pulp chamber roof and walls the pulpal floor is darker. In the floor, small grey colored lines are seen connecting the orifices. These lines are called "Dentinal Maps", "Rostrum Canalis" or "Pulpal Road Maps". Following these lines with a sharp endodontic explorer-like DG-16 or CK-17 will lead to a missed MB2 canal[12]. Based on previous researches, the geometric location of the MB2 suggests using the center of the MB1 channel as a reference parameter and from this point explore 2.68mm (+ -0.49) in a palatal direction and 1.25 (+ - 0.34) in the mesial direction [14].

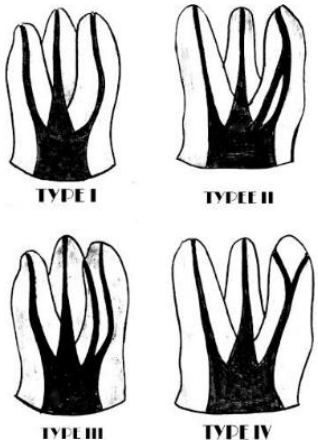
Dyes like Methylene blue, Sable seek, or ophthalmic dyes (e.g. Fluorescein Sodium, Rose Bengal) can be used to locate the orifices. 1% sodium fluorescein is an ophthalmic solution that binds to the connective tissue and shines when exposed to blue light. Nalapatti *et al*. in 2004, proposed the use of this solution by applying it in the pulp chamber for 2 minutes, and then exposing it to a blue curing light to observe the canals under a microscope. The remaining area with pulp tissue will be seen as green stained [15].

Trans-illumination, White line test, Red line test, and Champagne bubble test can be done to evaluate the orifice location. The white line test shows the dust formed by the use of ultrasonics without water accumulating in the area of orifices, fins, and isthmus area. The entrance to the small orifice of the MB2 canal is often hidden under a dentin shoulder or calcifications in a small groove. In the red line test, blood from the vital pulp moves along the dentinal map revealing the hidden canal. For Champagne bubble test sodium hypochlorite is flooded into the cavity. Free oxygen released after the reaction with pulpal tissue shows air bubbles in the area of the orifice [8, 16].

The use of magnification to find an extra canal is paramount for successful endodontic treatment. 3.5x loupes, joining magnification and illumination can be used for this purpose. Along with a proper visualization, a clinician with good handling capability can easily work with proper ergonomics, and document the cases, simultaneously improving communication with the patient regarding the treatment outcome as well [12].

Selective dentin removal is often required to expose the orifice for instrumentation. When MB2 is calcified or tortuous, troughing depths of 4mm or more may be necessary using ultrasonic tips (CPR, ProUltra, CKT), micro-openers, Gates Glidden drills, or with burs (Munce, LN, Moller burs). Also, ¼, ½, #1, #2 round burs, and composite finishing burs can be used [8, 16]. EDTA (chelating agent) can be used to remove the smear layer and softening calcifications inside the pulp chamber.

Newer diagnostic methods like computerized axial tomography (CT), spiral computerized tomography (SCT), and cone-beam computed tomography (CBCT) scanning have facilitated easy access to the location and anatomy of MB2.




**Clinical Significance of MB2**

Amongst the reasons for unsuccessful root canal treatment, one of the commonest reasons is an untreated root canal or a missed canal. A study was conducted at the University of Pennsylvania by Karabucak *et al*. to evaluate the prevalence of untreated/missed canals in endodontically treated teeth and their association with periapical lesions. It was found that out of 1137 samples overall, the incidence of missed canals was 23.04% and this was highest in the maxillary molars (40.1%) [17]. Successful endodontic treatment is dependent upon two factors, to remove the bacteria from infected root canals and to control the occurrence of secondary infection [18]. Missed canal pave the way for a sound habitat for active bacteria to reside and multiply leading to pathosis. This may result in symptoms like acute responses to hot and cold stimuli, slight sensitivity to percussion and/or palpation, or acute abscesses, or may also remain asymptomatic. These variations in symptoms along with diagnostic and therapeutic difficulties make the treatment of missed anatomy a challenge for the general dentist. Subsequently, treatment of these difficult cases should be managed by dentists with advanced training in endodontics [19]. Location and treatment of missed anatomy typically leads to complete clinical and radiographic healing [18].

**Conclusion**

It can be concluded that identifying the presence of the MB2 canal is indispensable in endodontic treatment so as to avoid recurrent pathosis and failure. Advanced technologies and techniques should be employed to achieve skilful navigation and exploration of endodontic space. For this, one should have a well-framed knowledge of canal anatomy and patience to explore these hidden canals.

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