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ORIGINAL RESEARCH

An *In Vivo* Study: Location and Instrumentation of the Second Mesiobuccal Canal of the Maxillary Second Molar

[1]Naji Kharouf, [2]Davide Mancino

ABSTRACT

Aim: The first purpose of this retrospective observational in vivo study was to determine the incidence of the second mesiobuccal canal (MB2) in maxillary second molars. The second purpose was to propose a modern shaping procedure able to transform a difficult canal, like MB2, into a normal canal.

Materials and methods: This study was led from September 2016 to December 2017, for 15 months. It was conducted on fifty-seven successive cases of root canal therapy on maxillary second molars. All procedures were done in conformity with the current state of the art practices in endodontics. These included rigorous clinical and radiographic pre-access analysis, appropriate tooth restoration to ensure watertight rubber dam installation, surgical microscopic manipulations for precision, the systematic use of ultrasonic endodontic tips to manage the access cavity preparation, and a modern step down technique to shape MB2.

Results: Fifty-seven maxillary second molars were treated: 3.5% had one canal, 7.0% two canals, 24.6% three canals; 64.9% four canals (MB2 presence). Weine's method was used to classify mesiobuccal root canal morphology: 27.4% had a type I canal configuration, 35.3% type II, 37.2% type III canal configuration.

Conclusion: The perfect knowledge of endodontic anatomy, a painstaking pre-access analysis of the preoperative radiographs, the systematic identification of the CEJ, using a periodontal probe, the use of surgical microscope coupled with the use of specific endodontic ultrasonic tips and the use of a modern step-down technique allows a high accuracy of the access cavity preparation, canal localization and instrumentation.

Clinical significance: The rate of MB2 localization and instrumentation on maxillary second molars by our surgical protocol is high. The clinician should take the necessary time to locate and negotiate the MB2. The lack of its location can provoke the failure of endodontic treatment.

Keywords: Endodontic anatomy, Maxillary second molars, Second mesiobuccal canal.

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[1]Faculty of Dental Medicine, Department of Endodontics, Strasbourg University, Strasbourg, France

[2]INSERM UMR_S 1121, Biomaterials and Bioengineering, Strasbourg, France

Corresponding Author: Naji Kharouf, Faculty of Dental Medicine, Department of Endodontics, Strasbourg University, Strasbourg, France, Phone: 0033667522841, e-mail: dentistenajikharouf@gmail.com

INTRODUCTION

The first purpose of this retrospective observational *in vivo* study was to determine the incidence of the second mesiobuccal canal (MB2) in maxillary second molars, to demonstrate that it is imperative for a dentist performing a canal therapy on this tooth to examine carefully the pulp floor to detect the orifice of the MB2. The second purpose of this study was to propose a modern shaping procedure able to transform a difficult canal, like MB2, into a normal canal.

A root canal therapy can be unsuccessful for the failure in the treatment of few millimeters of pulp tissue, so it is easy to understand how the failure in finding a whole canal system can negatively influence the prognosis of endodontic treatment.

For correct endodontic therapy, the knowledge of the endodontic anatomy and its frequent variations and complexities it is an essential prerogative. Back in 1925, Hess and Zurcher pointed out the complexity of the mesiobuccal root of maxillary molars.[1]

Later on, many articles have been published concerning the canal configurations of the maxillary first molars and of maxillary molars in general. Yet, just a few articles have dealt exclusively with the maxillary

second molar. Today literature considers the maxillary first molars as a four-canal tooth, but it is not the same for the second molar.[2-8] Even though the few studies have been performed on second molars, they clearly show that it is a four-canal tooth.[7,9-11]

Indeed, in an *in vitro* study, Kulid and Peters[10] located the MB2 in 93.7% of the analyzed second molars.[10] While Pecora et al.[7] in their *in vitro* "morphologic study of the maxillary molars" concluded that the incidence of two canals in the mesiobuccal root was higher in the maxillary second than in first molars.[7]

The inability to locate the MB2 canal could be considered as one of the main causes of the failure of endodontic therapy on maxillary second molars.

MATERIALS AND METHODS

This study was led from September 2016 to December 2017, for 15 months. It was conducted on 57 successive cases of root canal therapy on maxillary second molars.

All procedures were done in conformity with the current state of the art practices in endodontics. These included effective local anesthesia, rigorous clinical and radiographic pre-access analysis, appropriate tooth restoration to ensure watertight rubber dam installation, and surgical microscopic manipulations for precision (Leika M320).

For each maxillary second molar, two preoperating radiographs were taken, with different angulations. The cementoenamel junction was identified by using a periodontal probe.[5] This allowed us to have a three-dimensional view of the pulp canal system before starting the treatment.

After rubber dam placement, the endodontic access cavity preparation was started with a # 012 cylindrical diamond drill and enlarged with a Start X1 (Dentsply-Sirona) ultrasonic tip.

Canal orifices were localized and enlarged with the same tip. When the MB2 was not immediately detected, for the removal of the dentinal layer in the portion of the pulp floor, lingual to the mesiobuccal canal an endodontic probe and, if necessary, a Start X 3 (Dentsply- Sirona) was used without exceeding 3 mm of depth to avoid any risk of perforation.

The access cavity resulted as an anatomic projection of the coronal pulp chamber onto the occlusal surface, in order to help the MB2 detection.

Then, keeping the pulp chamber constantly flooded with 6% sodium hypochlorite, MB2 root canal shaping was performed, using a modern step down technique without initial manual scouting.

The initial mechanical preflaring was always performed with proglider (Dentsply-Sirona) until to 2/3 of estimated radiographic working length or the first impediment applying an in and out movement, using an endodontic engine (300 rpm/5 Ncm).

After the initial preflaring, using a #10 stainless steel (SS) K-file or, in very difficult cases, # 08 SS K file (Dentsply-Sirona) the canal was scouted up to working length (WL) + 0.5 mm. Length determination was taken using an electronic apex locator (root ZX; J Morita Co, Kyoto, Japan).

Then a mechanical glide-path with the proglider at working length was performed.

The MB2 was shaped in a very conservative way, usually with a taper of 4%, sometimes 6%, to avoid some procedural errors, leading to incomplete shaping of the root canal system, and to a possible failure of the root canal treatment.

Therefore in most cases, the MB2 canal was shaped using ProTaper Next X1 until to the WL, Pro Taper Next X2 (300 rpm/5 Ncm) 2 mm shorter from the WL and Profile 25/04 (Dentsply-Sirona) (300 rpm/3 Ncm) until to the WL. In the cases where the MB2 was larger, we shaped the canal until to WL with ProTaper Next X1 and ProTaper Next X2.

After the shaping procedure, to assure a three-dimensionally cleaning of the root canal system, an aqueous 17% solution of EDTA was flooded into the pulp chamber. The solution was then activated using EndoActivator (Dentsply-Sirona) for 120 seconds. After rinsing with physiological saline, a solution 6% of NaOCl flooded into the pulp chamber was activated using EndoActivator for 120 seconds.

Then the canal was dried using sterile paper points. After having applied a drop of Ah Plus root canal sealer (Dentsply-Sirona) with a coated paper point at the entrance of the canal, MB2 was filled with Thermafil 25 or, in the case of very narrow anatomies, with Thermafil 20. The canal therapy was always performed in a single session.

RESULTS

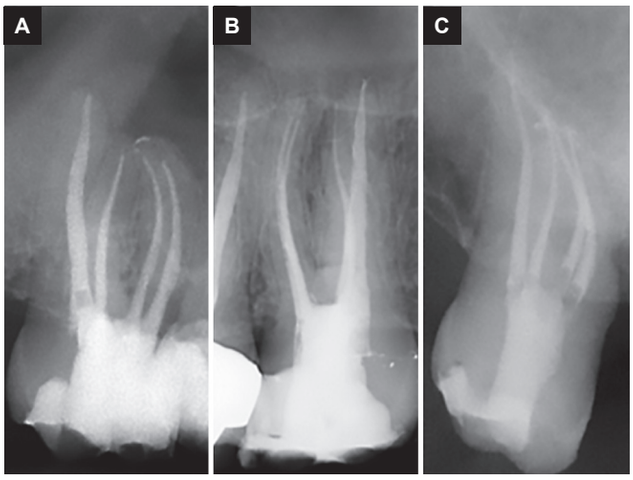
Fifty-seven maxillary second molars were treated:

- 3.5% had one single canal
- 7.0% had two canals
- 24.6% had three canals
- 64.9% had four canals (MB2 presence).

Weine's method was used to classify mesiobuccal root canal morphology (Fig. 1):

- 27.4% had a type I canal configuration
- 35.3% had a type II canal configuration
- 37.2% had a type III canal configuration.

Seven of the fifty-seven molars retreated, and in five of them, the MB2 undetected during the first endodontic



Figs 1A to C: MB root classified as type III of Weine's configuration in maxillary second molars

treatment was located and negotiated. This shows that the more the clinician is concentrated, as during retreatment, the more the chances to locate the MB2.

DISCUSSION

For a correct endodontic therapy, the knowledge of the endodontic anatomy and its frequent variations and complexities it is an essential prerogative.[12-14] Whereas in vitro studies show the MB2 presence in almost all maxillary second molars, in vivo conditions of poor visibility and the risk of perforation could explain the low rate location of the MB2 (Tables 1 and 2).

Actually, the location of the MB2, a tooth placed far in the back of the oral cavity, is a challenge, because after accessing the cavity, the canal orifice is often invisible, since it is secondary covered with dentin, or too small to be seen without magnification.[3,4,10,15,16]

Another factor to complicate the MB2 search is that the mesial zone of the maxillary second molar is often a site of considerable conservative restoration procedures including caries. These could create a chronic irritation of the pulp tissue that can cause intra-chamber calcifications.[17] To treat maxillary second molars correctly, an understanding of the morphogenesis of the mesiobuccal canal system is quite important. At first, the canal in the mesial buccal root is kidney-shaped, with a bigger pole, the MB1, and a smaller one, the MB2. With a continued deposition of secondary dentin, the isthmus between the two poles becomes narrower and finally might even close, forming two canals. All this could also happen in the apical region, forming two foramina. At the same time, as the mesiolingual segment of the kidney canal is in the smaller pole, it will narrow leaving a small canal orifice. Therefore, it would be more difficult to locate.[8,9]

Our protocol allows us to facilitate and standardize the access cavity preparation, MB2 localization, and instrumentation. It consists of eleven main points:

- Analysis phase: Clinical and radiographic pre-access analysis
- Penetration phase: It is performed using a cylindric diamond bur # C 801L 012 round diamond bur (NTI, Kahla, Germany)
- Enlargement phase: It is performed with an endodontic ultrasonic tip (Start X1)[18]
- Locating phase: It is performed with an endodontic ultrasonic tip to locate the canal orifices (Start X1, Start X3)[18]
- Finishing phase: Sculpting a veritable rail with an ultrasonic tip to have more direct access with a rotary instrument
- Preflaring phase: Initial rotary preflaring until to 2/3rd of estimated root canal length or until to the first impediment
- Apical scouting phase: Apical scouting until to electronic working length (EWT)

Table 1: *In vitro* studies: percentage of MB2 in maxillary second molars

Author	*Method*	*MB2 location (%)*
Gilles and Reader[3]	Scanning electron microscope	70
Kulid and Peters[11]	Microscope and histology	93.7
Pecora et al.[8]	Decalcification and ink	42
Singh et al.[17]	Radiography and Decalcification	78
Imura et al.[18]	Decalcification and ink	66.6
Alavi et al.[19]	Decalcification and ink	55

Table 2: *In vivo* studies: percentage of MB2 in the maxillary second molar

Author	*Method*	*MB2 location (%)*
Storpko[9]	Microscope	60
Sempira and Hartwell[20]	Microscope	24
Burlhey[12]	Microscope	36,1
Burlhey[12]	Dental loupes	40.5
Wolcott [21]	Microscope	34
Onay et al.[7]	Microscope	31.7
Mancino	Microscope and ultrasonic tips	64.9

- Glide-path phase: Rotary glide-path until to EWT.
- Shaping phase
- Irrigation phase
- Filling phase.

Clinicians often underestimate the importance of diagnostic radiographs and pre-access analysis to plane the access cavity preparation and the shaping sequence.[5]

As our results show the systematic use of the surgical microscope coupled with endodontic probes and specific endodontic ultrasonic tips, like start X1 and 3, allows a high accuracy of the access cavity preparation. Moreover, it facilitates the removal of intrachamber calcifications, and the location of MB2.

It is important to consider that once the MB2 is found, it should be treated, but its treatment is not easy, on account of its strong mesial bend in the coronal one third. This bend can prevent the rigid #10 SS K file from advancing in the apical direction.[4,15,19]

In difficult anatomies, like in most cases of MB2, manual canal scouting step might cause some procedural errors such as a ledge, apical zipping, canal straightening, elbow, blockage, fracture, leading to incomplete shaping of the root canal system, and to a possible failure of the root canal treatment. To avoid these procedural errors we propose a modern step down technique[20] using at first a proglider, that goes up to the 2/3 of root canal length or until to the first impediment. This procedure allows easy apical scouting of the last millimeters of the canal system and increases the volume of the irrigants in the apical region starting from the initial stages of the canal instrumentation. Hence, the 10 K file can work without any coronal interference, giving better control during the apical scouting, decreasing apical extrusion of debris, and reducing post-operative pain. After the preflaring step, we can scout the very difficult canals in an easy way, reaching quickly into the apex and assessing the whole instrumentation steps as appearing faster and safer.

MB2 need a specific instrumental sequence in order to more quickly eliminate the interference at the coronal and middle tiers of the canal root system. In the preflaring step, the use of a classic opener, with deep taper and large tip, is less effective, considering that the opener is made to relocate and negotiate the first 2 mm of the root canal.

We propose a modern step-down technique able to transform a difficult canal into a normal canal, with an initial rotary preflaring of the 2/3rd of the root canal system, apical scouting, usually with 10 K-file, rotary glide path, and shaping.

It is important to remember that the mesiodistal thickness of mesiobuccal root lowers in the buccal–lingual direction. As the orifices of MB1 and MB2 are not centered in the mesiodistal direction, but nearer to the furcation zone, clinicians need to be very careful not to weaken the distal wall, during the shaping phase of the MB2.[15,19,21]

Therefore, in most cases of MB2 treatment, we must reduce the taper of final shaping also for anatomical reasons.

Concerning the filling step, considering canal curvature and the small taper, in our opinion, the better technique, in these cases, would be to use a carrier-based technique using the Thermafil system.

Today, thanks to the perfect knowledge of endodontic anatomy, the available techniques, and specific instruments, it is possible to locate and negotiate the MB2 in a maxillary second molar in a reproducible way as our results show.

The systematic use of the surgical microscope, ultrasonic endodontic tips and a modern step down technique which facilitates and standardizes cavity access during preparation, MB2 localization, and instrumentation.

CLINICAL SIGNIFICANCE

The rate of MB2 localization and instrumentation on maxillary second molars by our surgical protocol is high, but maybe, still away from the anatomical reality. Of course, it is important to consider that once the MB2 is located, it should be shaped, avoiding procedural errors such as ledges, blockage, fracture, leading to incomplete shaping of the MB2 canal. To avoid these procedural errors we propose a modern step down technique. It allows eliminating more quickly the interference at the coronal and middle tiers of the canal root system. Hence, after the preflaring step, 10 K file worked without any coronal interference in the lasts 2 or 3 mm of the canal, giving better control during the apical scouting. In this way, difficult canals were scouted easily, reaching into the apex and assessing the whole shaping faster and safer.

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