Second mesiobuccal canal (MB2): how to overcome the difficulties in treating it

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DOI: https://doi.org/10.14436/2358-2545.10.2.010-019.oar

ABSTRACT

When not treated, root canals may affect the predictability of endodontic treatments directly. The second mesiobuccal root canal (2MB) is the canal most often missed and left untreated during endodontic treatments. The probability of inflammatory disease in the periapical region in these cases is 4.5 to 6.5 times greater than in teeth that have all canals treated. Therefore, clinical dentists should know the anatomical complexities that may complicate root canal access and exploration. As 2MB detection and negotiation are a great challenge, they should also be familiar with the procedures that facilitate treatment. This study describes the main obstacles to the location and treatment of the 2MB canal and discusses how these obstacles may be overcome in routine endodontic practice.

Keywords: Endodontics. Second mesiobuccal canal. Ultrasound in Endodontics.

How to cite: Rodrigues EA, Rios MA, Macedo Junior F, Passinho DA. Second mesiobuccal canal (MB2): how to overcome the difficulties in treating it. Dental Press Endod. 2020 May-Aug;10(2):10-9.
DOI: https://doi.org/10.14436/2358-2545.10.2.010-019.oar

» The authors report no commercial, proprietary or financial interest in the products or companies described in this article.

» Patients displayed in this article previously approved the use of their facial and intraoral photographs.

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Submitted: June 01, 2020. Revised and accepted: June 04, 2020.

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Introduction

Maxillary molars pose the greatest clinical challenge to endodontic treatments, as their anatomy is much more complex than that of all other teeth[1]. They usually have three roots, and their mesiobuccal root has been more frequently studied than any other tooth root.[2,3] These studies have used several methods, such as ex vivo root sectioning,[4,5] radiography,[6,7] cone beam CT (CBCT),[8,9,10] operating microscope evaluations[11,12] and micro-CT.[13,14,15]

Historically, the mesiobuccal root has been studied for more than a century. As early as 1914, Hans Moral drew attention to the fact that 60% of these roots had two canals.[16] Soon after that, in 1917, Walter Hess described the substantial mesiodistal flattening of the mesiobuccal root of the maxillary molar, and the fact that more than one root might very likely be found in roots with this anatomical characteristic. A Brazilian author, professor Quintiliano De Deus, described the great anatomical complexity of this root in his doctorate thesis in 1960.[18]

Periapical radiographs are the imaging study most often used in clinical endodontic routine for treatment planning. However, as radiographs are two-dimensional, anatomical structures are superimposed, and only macro anatomical features are visualized, while microanatomical details of the pulp cavity are hidden (Fig 1).

According to Martins et al.[18] the prevalence of the second mesiobuccal canal (2MB) varies according to country and is 82.4% in Brazil.[19] Studies in the literature show that 65% to 85% of these canals are missed and not treated during endodontic treatment. When left untreated, the probability of developing inflammatory diseases is 4.5 to 6.5 greater than when all canals are treated.[8,9] This discrepancy between the high prevalence of a 2MB canal and the low percentage of cases in which they are located and treated suggests that there are clinical difficulties to treat maxillary molars endodontically. Dentists should be aware of this caveat and be prepared to deal with it.

This study describes the main obstacles found in the detection and treatment of the 2MB canal and discusses how these obstacles may be overcome in routine endodontic practice.

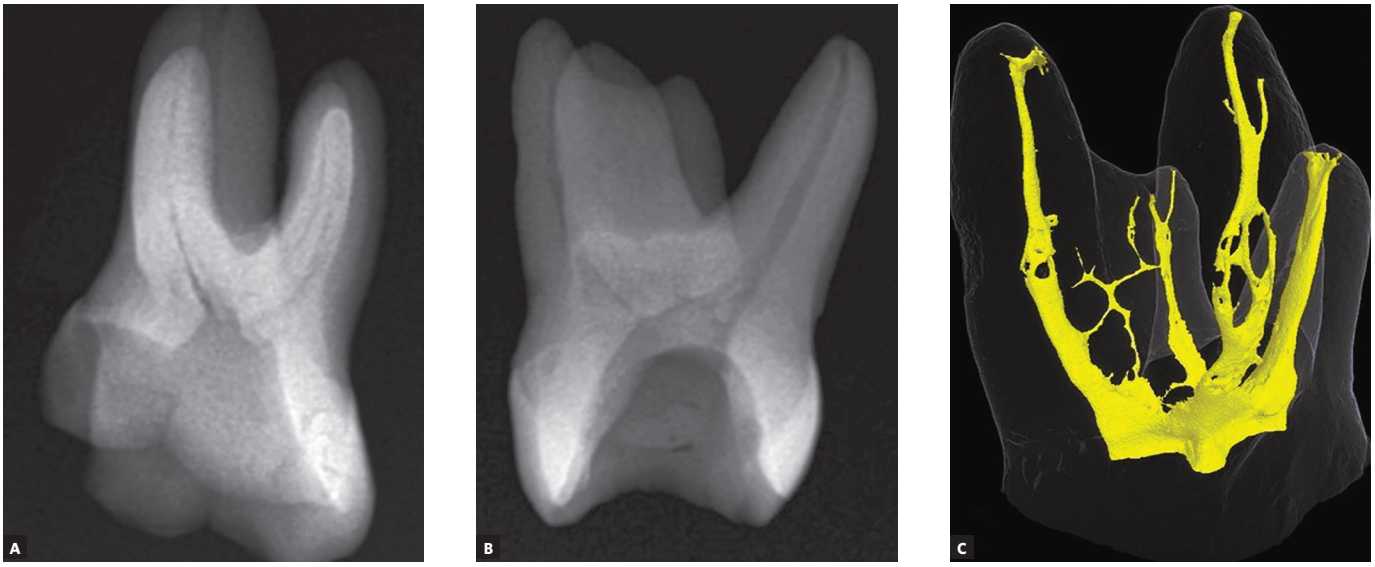

Figure 1. A) Buccolingual radiographic view; **B**) Proximal radiographic view; **C**) Micro-CT scan.

Prevalence and main configurations of 2MB canals

The existence of 2MB canals is indisputable, and not locating them may reduce the chances of long-term success.[20,21] Therefore, dentists should be aware of the extreme importance of planning, which ensures greater chances of detecting the 2MB canal during treatment. According to the literature, the prevalence of 2MB canals in maxillary molars varies substantially. This variation may be assigned to the different methods used to detect them: in vitro studies of root sections and direct visualization of the root, use of microscopes, micro-CT and CBCT[4,14] and clinical studies with or without the use of magnification tools, such as loupes and operating microscopes.[11,22,23]

In vitro studies have showed that the prevalence of 2MB canals ranges from 90% to 100%,[4,14] but clinical studies found a lower prevalence, from 50.7% to 80%.[11,22,23] This may be explained by the fact that, in in-vitro studies, teeth are examined using direct visualization or high-technology tools, such as micro-CT. A recent multicenter study using CBCT conducted by Martins et al.[19] found that the rate of 2MB canals ranged from 48.0% in Venezuela, 82.4% in Brazil and 97.6% in Belgium, with a global prevalence of 73.8%.[19]

The prevalence of 2MB canals may be affected by sex and age, as men have a greater chance of having a 2MB canal than women.[10,19] Prevalence becomes lower as age advances for both men and women, which may be assigned to the greater time of tooth exposure to external irritation, such as caries, trauma and canal calcification resulting from restorations, when secondary dentin is deposited and may occlude the canal or make its detection difficult.[24,25,26]

Knowing the prevalence of type II (merging canals) and type IV (separate canals) mesiobuccal roots of a maxillary molar may contribute to treatment planning, but no consensus about these possible configurations has been reached in the literature. Some studies found a greater prevalence of type IV,[27,28] others, of type II,[19] and some found no statistically significant differences between the prevalence of type II and IV.[13,14]

Clinical barriers to 2MB canal detection and negotiation

In fact, the detection and negotiation of the 2MB canal are true challenges, as difficulties are present since the beginning of the endodontic treatment. Therefore, dentists should pay special attention to the main obstacles to success at these treatment stages.[2,14] During a treatment, endodontists should always keep in mind what is known about the location of the 2MB canal to facilitate its detection. Moreover, dentin ledges over the canal orifice should be eliminated, and the canal inclination should be detected and negotiated, respecting its pathway.

Detection of the 2MB canal

Most authors indicate that the reference for this canal is the imaginary line that connects the mesiobuccal (1MB) to the palatine canal. This is a very useful landmark, as the 2MB canal is usually found slightly mesial to this line,[11] and its orifice is usually very close to the mesial chamber wall (Fig 2).

Ledges of dentin over the 2MB canal orifice

The 2MB canal is rarely visible and ready to be explored immediately after the endodontist removes the pulp chamber ceiling (Fig 3).

In most cases, the 2MB canal orifice is hidden by reparative dentin that accumulates on the mesial chamber wall and reaches the chamber floor. These findings are associated with the biological and chronological age of the tooth.[2,29,30] These dentin ledges have to be removed, so that the 2MB canal may be seen (Fig 4).

2MB canal inclinations

In contrast to the 1MB canal, which usually has a discrete mesial inclination when it emerges from the floor of the pulp chamber, the 2MB canal usually has one of two abrupt inclinations in its cervical third, which greatly complicates its exploration.[11,14,23] Dentin ledges on the mesial wall and the chamber floor change the pathway of the 2MB canal, which bends distally (Fig 5A, arrow 1), and then abruptly mesially (Fig 5A, arrow 2 and B, arrow 4) and again distally (Fig 5A, arrow 3, and 5B, arrow 5). This tortuous pathway, particularly in the cervical portion, often complicates the initial exploration of the 2MB canal. The file usually stops at one of these points, where a segment of the pathway ends, and the canal bends to another direction (Fig 5 - arrows 1, 2 and 4). Therefore, the file does not usually advance more than 3 mm apically.[11] To overcome these barriers and access the apical foramen of

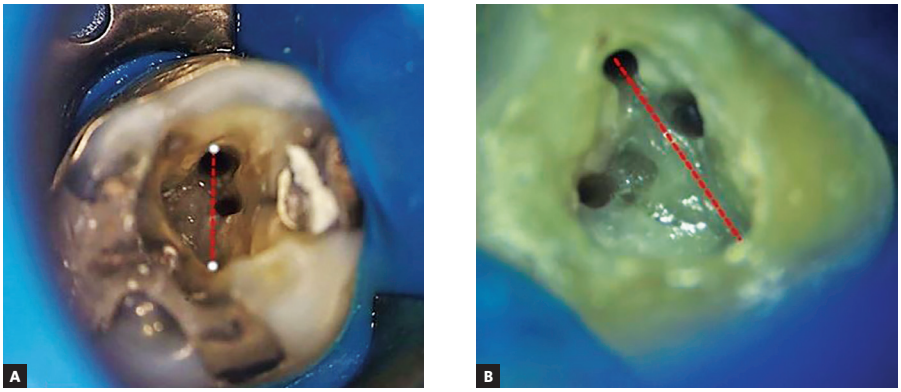

Figure 2. A) 2MB canal orifice slightly mesial to imaginary line that connects 1MB canal to palatine canal; **B**) 2MB close to mesial pulp chamber wall.

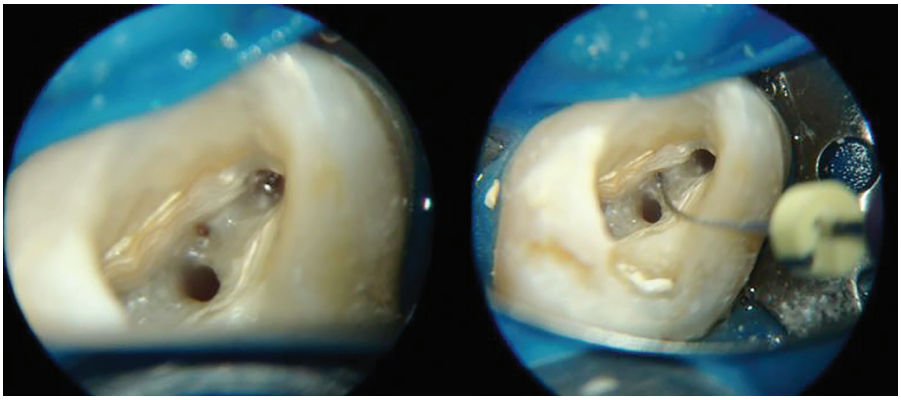

Figure 3. 2MB canal fully visible and ready to be explored after removal of pulp chamber ceiling.

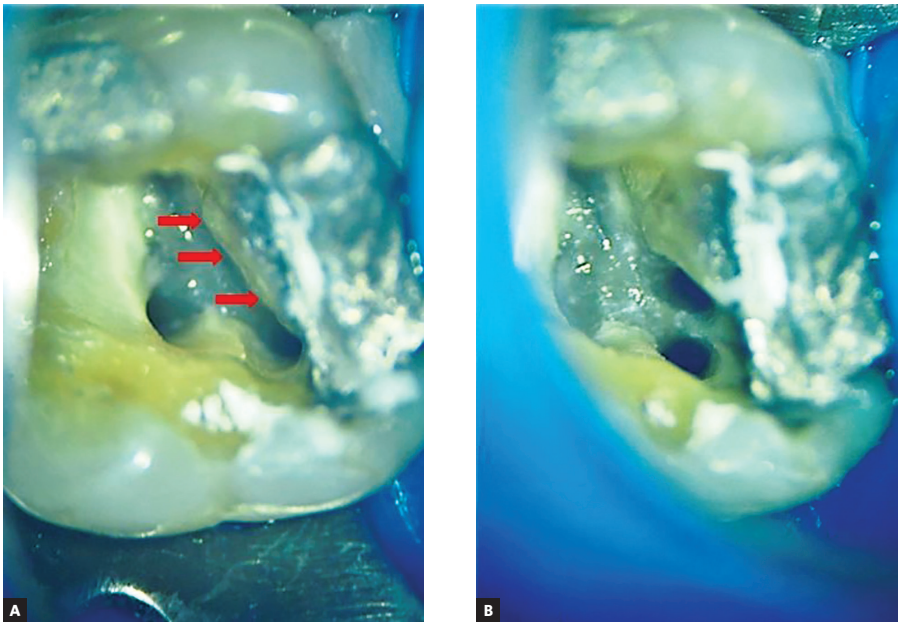

Figure 4. A) Dentin ledge on mesial wall and floor of pulp chamber covers 2MB canal orifice (red arrows); **B**) Removal of dentin ledges reveals 2MB canal orifice.

the 2MB canal, coronal inclinations should be reduced as much as possible to facilitate the advance of the file past the subsequent curves (Fig 5C, arrow 6). This may be achieved by removing the dentin ledges that cover the canal orifice. More that 0.5 mm to 3.0 mm should be removed in some cases, a process known as troughing or countersinking.[2,11]

Troughing and the importance of ideal ultrasonic inserts

Troughing, also known as countersinking, may be defined as a removal of dentin toward the mesial chamber wall and 0.55 mm to 3.0 mm apically. Its purpose is to remove the obstacles that complicate the detection and exploration of the 2MB canal. This procedure should be performed very carefully to avoid accidents, such as perforations and zips, as the mesiobuccal root becomes considerably narrower from coronal to apical. Also, there are concave areas on the mesial and distal surfaces of this root, which reduces the amount of dentin that surrounds it, particularly in the case of the so-called risk area of the 2MB canal.[4,32] Therefore, the safe selective removal of dentin requires specialized instruments, as well as a skillful and confident endodontist.[11,31]

In the past, dentin used to be removed with burs,[4,23] but after the introduction and growing acceptance of ultrasound in Endodontics, the use of ultrasonic inserts to refine access cavity, remove pulp stones and detect calcified canals, as well as the 2MB canal, has become very frequent.[33,34]

Ultrasonic inserts offer some advantages over the use of burs for troughing, or countersinking, as they do not rotate while performing it, which ensures greater control and safety. At the same time, they provide great cutting efficiency and a better visualization of the work area, particularly when using an operating microscope. Both the high- and the low-speed handpieces used with burs complicate visualization during dentin removal. This is especially important because of the risk of perforation during this phase of the treatment.[35]

Figure 5. A) Arrow 1, canal deviation to distal; arrow 2, abrupt inclination to mesial; and Arrow 3, canal curve to distal. **B**) Arrows 4 and 5, view of inclinations from a different angle. **C**) File reaching foramen after reducing coronal inclination. (A and B are reprinted by courtesy of professor Marco Versiani).

When locating the 2MB canal, selective dentin removal without damaging the chamber floor or the root as the file advances apically depends on the shape and size of the ultrasonic inserts used.[35,36]

In 2019, to ensure the safety and accuracy of these procedures, Helse Ultrasonic Br (Santa Rosa de Viterbo, Brazil), with the consultancy of professor Evaldo Rodrigues, of the State University of Feira de Santana (UEFS), launched two exclusive ultrasonic inserts for locating the 2MB canal. The two inserts are the Finder (Fig 6) and the FlatRound (Fig 7), both part of the MV2 Helse Ultrasonic Br kit.

The Finder insert (Helse Ultrasonic, Santa Rosa de Viterbo, Brazil) has an ogival diamond-coated active part and a diameter of 0.15 mm at the tip, increasing gradually to its largest diameter, 0.60 mm, at the base of the tip (Fig 6). It is used to remove dentin ledges that usually cover the 2MB canal orifice. The increasing diameter from its active tip to its base ensures that dentin is removed divergently towards the occlusal surface, which, in addition to preserving pericoronal dentin, often uncovers the 2MB canal orifice. In some cases, the 2MB canal cannot be located even after the dentin ledges have been removed from the floor to the mesial chamber wall. In these cases, troughing may be created by deeply removing dentin 0.5 mm to 3.0 mm apically. The regular, flattened shape and the size of the FlatRound insert (Helse Ultrasonic, Santa

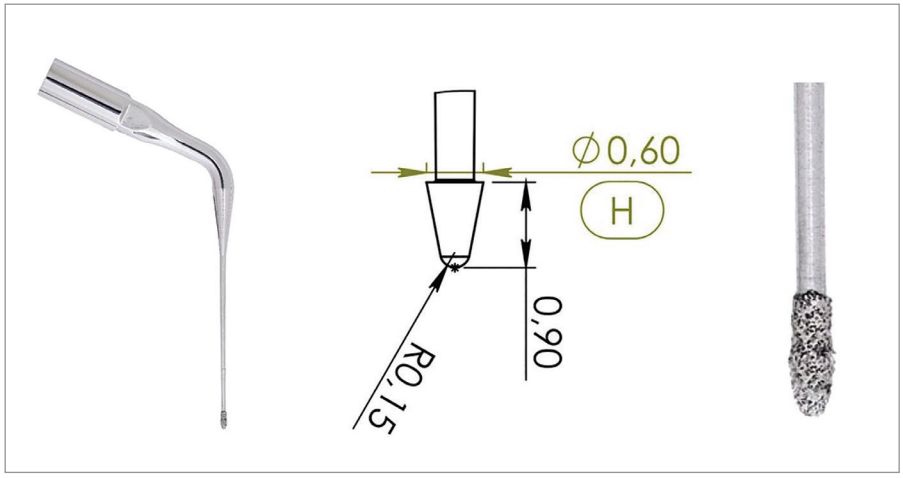

Figure 6. Shape and size of Finder insert.

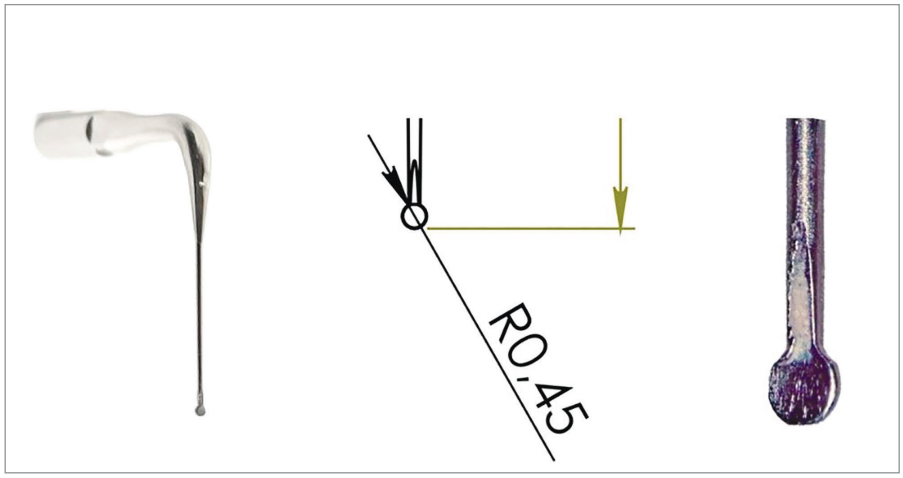

Figure 7. Shape and size of FlatRound insert.

Rosa de Viterbo, Brazil) (Fig 7) ensure the safety of this procedure, fitting the characteristics of the mesiobuccal root, which is flattened mesiodistally, has proximal concavities, and, therefore, has less dentin surrounding the 2MB canal. The FlatRound insert is smooth and not diamond-coated, which provides better control and less aggressive cutting, avoiding unnecessary removal in critical areas.

During troughing, removal should be gradual, and we should attempt to explore the 2MB canal using a pilot-tip file (C-pilot, VDW, Munich, Germany) after irrigating the pulp chamber at each 0.5-mm advance. At this point, a good straight probe may help to define the direction of the initial insertion. Although two-dimensional angulated radiographs are limited, they should be taken, because they give an idea of the direction and amount of removal necessary. When searching for the 2MB canal, we should not advance more than 3.0 mm. In case it is not located, the 1MB canal should be treated and regularly followed up radiographically to check the need of a future surgical retreatment.

Figure 8 shows a clinical case in which the use of the Finder insert to remove dentin ledges from the canal orifice was enough to locate the 2MB canal.

Figure 9 shows a clinical case in which the use of the Finder insert to remove the dentin ledge covering the 2MB canal orifice was necessary for troughing, and the FlatRound insert was used to locate the canal and reduce its inclination in the cervical third before negotiating and preparing the canal.

Figure 8. A) Finder placed on imaginary line that connects 1MB canal to palatine canal to remove dentin toward mesial chamber wall. **B**) Dentin ledge removed and 2MB canal orifice located at a mesial position in relation to 1MB. **C**) Treatment completed, tooth restored and in function.

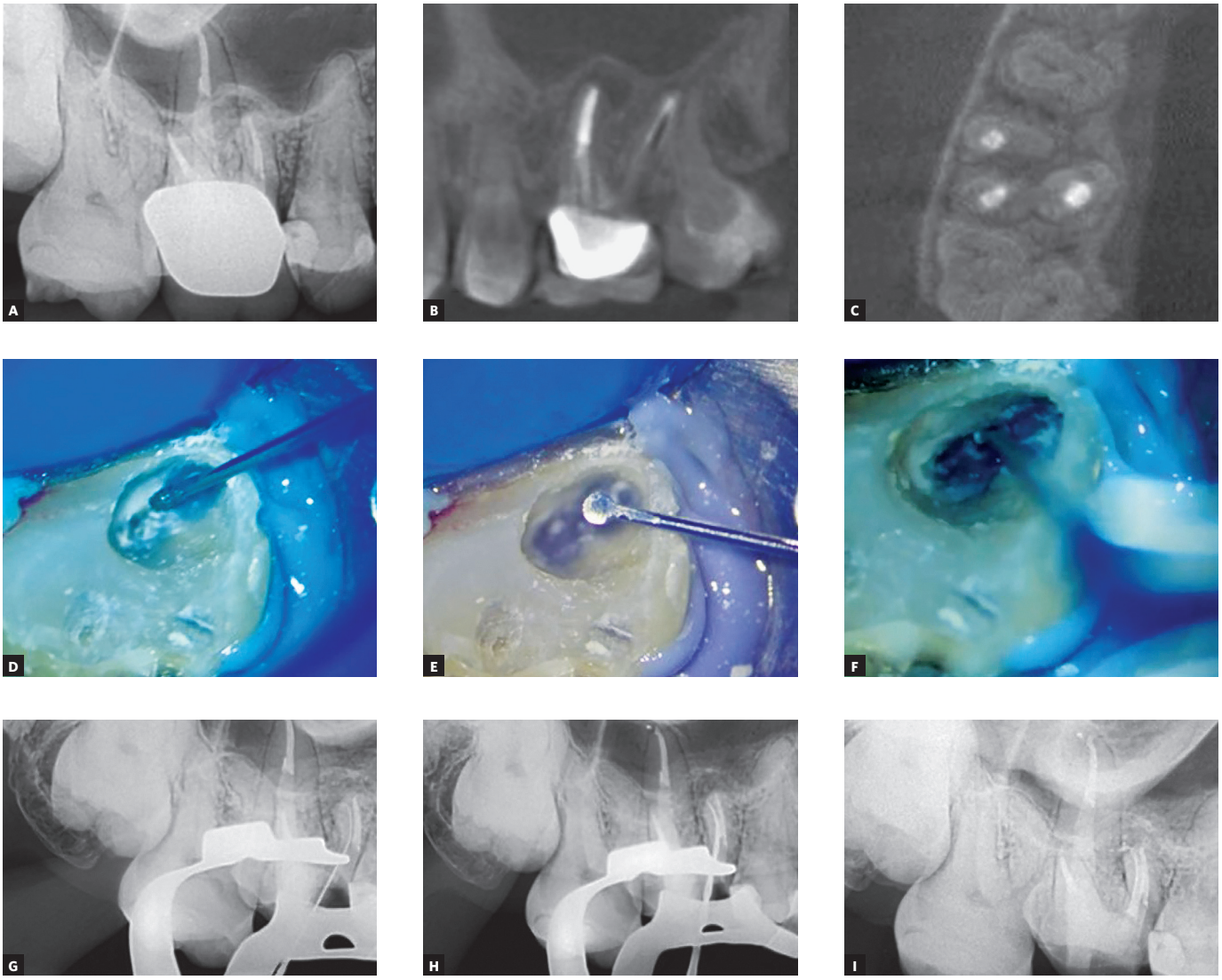

Figure 9. A) Diagnostic radiograph confirms failure of endodontic treatment of maxillary first molar. B) CBCT scan shows apical periodontitis in mesiobuccal root. **C**) Axial view shows 1MB canal in asymmetrical position, displaced buccally, which suggests presence of 2MB canal. **D**) Finder in position to remove dentin ledge on mesial chamber wall, whose color is different from that of the pulp chamber floor. **E**) Active FlatRound insert tip. **F**) Apical troughing removes obstacles to negotiate 2MB canal. **G**) C-pilot file used to explore 2MB canal after troughing. **H**) 2MB canal after preparation. **I**) 2MB canal after filling.

Discussion

In addition to diagnosis and treatment planning, knowing the anatomical features and their implications in daily clinical routine is a basic pre-requisite to achieving success in endodontic treatments. The 2MB canal has some anatomical characteristics that have not been fully described in the literature, and lack of this knowledge may be directly associated with the difference in canal prevalence and the percentage of cases in which it is located, negotiated and treated. Despite its high prevalence, already described in the literature,[4,14,19] it is clinically found at a frequency ranging from 16% to 78%, which may be explained by the difficulties that clinical dentists face when there are anatomical obstacles, such as the dentin ledges and the tortuous pathways that are characteristic of the cervical third of the 2MB canals.[11]

Missed root canals may have a direct impact on the predictability of an endodontic treatment. Studies found that teeth with untreated canals have a greater chance of developing apical periodontitis. The 2MB is the canal most often missed and left untreated.[8,9] Troughing using ultrasonic inserts with ideal size and shape may be decisive to changing this perspective. Yoshioka et al.[38] found that troughing may result in an increase of 42% in the number of 2MB canals located. These results are in agreement with those reported by Parker et al. (53%),[31] who conducted a study with 50 patients that underwent endodontic treatment. They found that the 2MB canal had not been located in 15 teeth, but was later found in eight (53%) of them after troughing. In the study conducted by Rover et al.[38] who examined cavities with a conservative access, there was an increase from 26.7% to 80% in the number of detected 2MB canals after troughing.[39]

After the ultrasonic inserts replaced burs for dentin removal when locating and negotiating the 2MB canal, some facts became established in the daily clinical routine, and these treatment procedures can now be performed safely and efficiently. As the dentin to be removed is in a region with peculiar anatomical features, more than one insert, with different designs, should be used. In addition, insert design should allow for the work in each different area to eliminate obstacles and prevent undesired accidents. The Finder and the FlatRound inserts have the characteristics necessary for a selective, conservative, efficient and safe dentin removal. They are excellent options for the detection of the 2MB canal. As these instruments have been developed a short time ago, other studies should be conducted to evaluate their clinical performance.

Conclusion

Knowledge about the complex anatomy of the 2MB canal and the main difficulties faced during an endodontic treatment, together with the correct choice of ultrasonic inserts, ensures the efficient, safe and predictable negotiation and treatment of the 2MB canal.

Acknowledgements

The authors deny any conflicts of interest in relation to this study. The authors thank professor Marco Versiani for his assistance with micro-CT images.

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