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CASE REPORT

Endodontic management of mesial middle canal in mandibular molars with symptomatic irreversible pulpitis

ABSTRACT

Aim: *This article aims to present three endodontic treatment cases of mandibular molars with three mesial canals and two distal canals.*
Summary: *Three patients were admitted in our clinic with a description of toothache while having hot and cold drinks. Clinical examinations revealed deep decay of teeth, but no pain to percussion. Radiographic images confirmed an intact periapical tissue with deep decay in each tooth, and teeth were diagnosed as symptomatic irreversible pulpitis. Root canal treatments were completed in single appointments. Studies suggest that mandibular molars with MMCs could be recognized more precisely with CBCT. Endodontic treatment of mandibular molars with mesial middle canal (MMC) can cause various challenges for every clinician, thus a proper understanding of root canal anatomical variations is a cornerstone in reaching endodontic success.*
Key Learning Points:

- *To identify the presence of an MMC, the isthmus between the ML and MB canal should be probed with a straight endodontic probe. In case of engagement of the probe at a specific point, it may be legitimate to look for the presence of the MMC.*
- *In root treatments, it is important not only to recognize the shape of the root canals, but also the variations of their course and possible fusion, respectively.*
- *It is of great importance to pay attention to the possible existence of an isthmus between the root canals, which must be completely cleaned and filled.*

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Introduction

Endodontic treatment of mandibular molars with mesial middle canal (MMC) can cause various challenges for every clinician, thus a proper understanding of root canal anatomical variations is a cornerstone in reaching endodontic success. Root canal treatment procedures of mandibular molars with complex anatomical variations is a difficult task, and can lead to complications if not properly conducted (1). The knowledge of the root canal anatomy configuration is essential for the diagnosis and execution of endodontic treatment (2). In most cases, the lower molars have two roots: mesial with two canals in mesial root and distal with one canal in the distal root (3). A high degree of morphological variability, ranging from 20%-46%, can be found in mesial root of lower molars, including the presence of mesial middle canals (MMCs) (4, 5). The description of the MMCs include having a small orifice deep within the isthmus or a developmental groove between the orifices of the mesiobuccal (MB) and mesiolingual (ML) canals (6, 7). Pomeranz has categorized the MMC's into three types - fin, confluent and independent (8). Even though the fin-type lacks a separate orifice, the file is able to move freely between the MB or ML canal and MMC. The confluent type is characterized by a separate orifice which joins apically at the MB or ML canal. The independent type presents with a separate orifice and separate apical foramen (8). Root canal therapy includes localizations of all canal orifices, debriding the root canals chemically and mechanically, and creating the final shape for three-dimensionally obturation and prevent its reinfection (9, 10). The consistent pattern is not necessarily present in the MMCs of lower molars (11). MMC with a generally disclosed orifice, is occasionally situated in the developmental groove in a form of intermediate canal connecting an MB and ML canals (9). The most commonly endodontically treated tooth is the mandibular first molar (12). Several morphological variabilities, can be found in the lower first molar, including: MMC, isthmus, middle distal canal (MDC), radix entomolaris, taurodontism and radix paramolaris. To achieve success in endodontic treatment and therapy, the clinician should have an expanded knowledge of the possible anatomical variations (13). Various authors have concluded that MMC is more common in mandibular first molar with two distal canals (45.4%) than cases that have one distal canal (14). However, Nosrat et al. described no connection between MMCs and the incidence of the second distal canal (5). The most frequent detection of MMC happens in the tooth with an isthmus. The existence of the isthmus in a tooth, can increase the occurrence of MMC. MMCs were found approximately fivefold in mandibular first molar with an isthmus in-between MB and ML canals (5). The study conducted by Azim et al, the MMC was located in 46.2% instances, out of which 6.6% were found following a predictable access preparation and 39.6% following consistent troughing (4). The pervasiveness of the MMCs differs related to ethnicity and varies from 0.26 to 45.8% (15). Age is also related with the occurrence of MMCs and small accessory canals (16). Different literature reported the occurrence of an accessory canal in the mesial root between the MB and ML root canals, with different names such as middle mesial canal (MMC), mesiocentral canal (MCC) or accessory mesial canal (AMC) (4). The mesial middle canal system intricacies present difficulties during shaping and obturation procedures. Usually, they are recognized during the preparation of the access cavity. Adequate knowledge of anatomical variations of root canal (RC), their cavity preparation and 3D obturation, represent an important factor for success in endodontic therapy. The aim of this case report is to present and discuss three clinical cases with mesial middle canal root canal configuration. Thanks to the knowledge of the root canal anatomical variations associated with the use of modern technologies, it is possible to increase the degree of chemico-mechanical debridement and to achieve a successful treatment. RC treatments of lower molars with MMC may represent a difficulty to every clinician, and an understanding of anatomical variations of root canals are essential for achieving successful endodontic treatment outcomes.

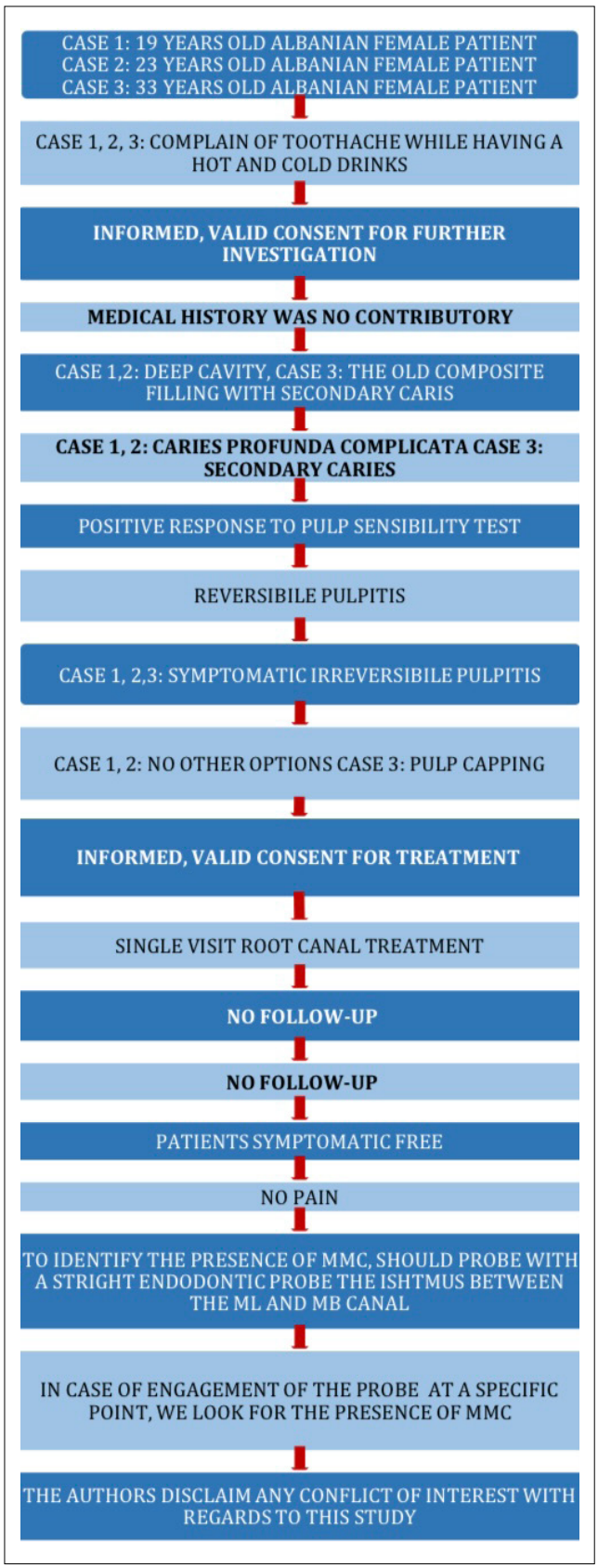

Figure 1 PRICE (Preferred Reporting Items for Case reports in Endodontics) 2020-Flow chart (17).

Case Reports

This case reports have been written according to Preferred Reporting Items for Case reports in Endodontics (PRICE) 2020 guidelines (Figure 1) (17). Prior to intervention, the patients were informed that their radiographic images may be used in a dental magazine, and ensured that their personal identifiable information will be protected. The patients gave signed consent, and signed the informed consent as well.

Case 1
An Albanian female patient, 19 years old, was admitted in our clinic with a description that she has a toothache in lower right side of the face for the last 3 weeks, getting worse when having cold drinks. Clinical examinations revealed deep decay of tooth 47, but no pain to percussion. Positive response to pulp sensibility test. Radiographs confirmed an intact periapical tissue with deep decay in tooth 47 (Figures 2, 3). The determined diagnosis was symptomatic irreversible pulpitis (SIP).

Case 2
An Albanian female patient, 23 years old admitted in our clinic with a description that she had a toothache, and the referred pain frequency increased during the night. Clinical examinations revealed deep decay of tooth 36, but no pain to percussion. Positive response to pulp sensibility test (Figure 4).
The determined diagnosis was symptomatic irreversible pulpitis (SIP).

Case 3
An Albanian female patient, 33 years old admitted in our clinic with a description of toothache while having hot and cold drinks. The patient consumed analgesics to relieve pain. Clinical examinations discovered the old composite filling in tooth 46 with deep decay lesion on the mesial wall of the tooth, but no pain to percussion. Positive response to pulp sensibility test (Figures 5, 6).
The determined diagnosis was symptomatic irreversible pulpitis (SIP).

After administration of nerve block anesthesia Septanest (4% Articaine hydrochloride with 1:100000 Epinephrine), (Septodont, Saint-Maur-des-Fosses Cedex, France) and application of

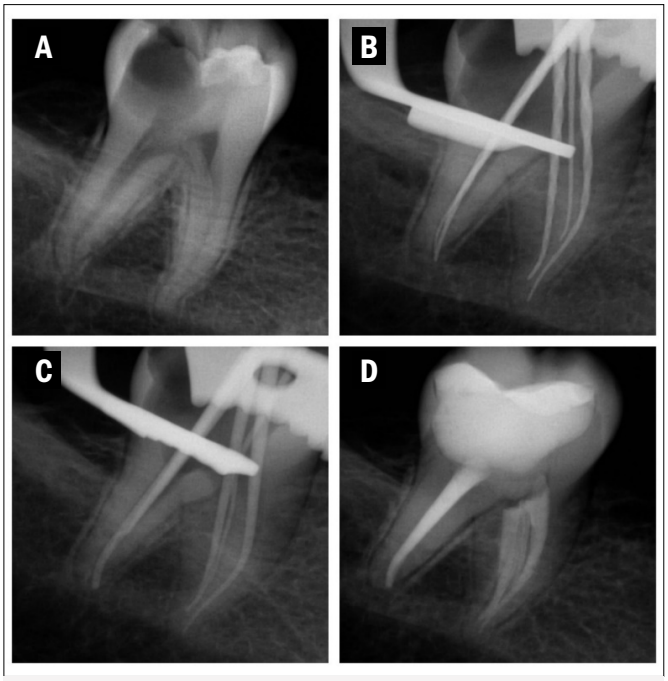

Figure 2
(A) Initial radiographic image; **(B)** measuring the length of canals; **(C)** confirmation length of the canals with gutta-percha cone; **(D)** final radiographic image.

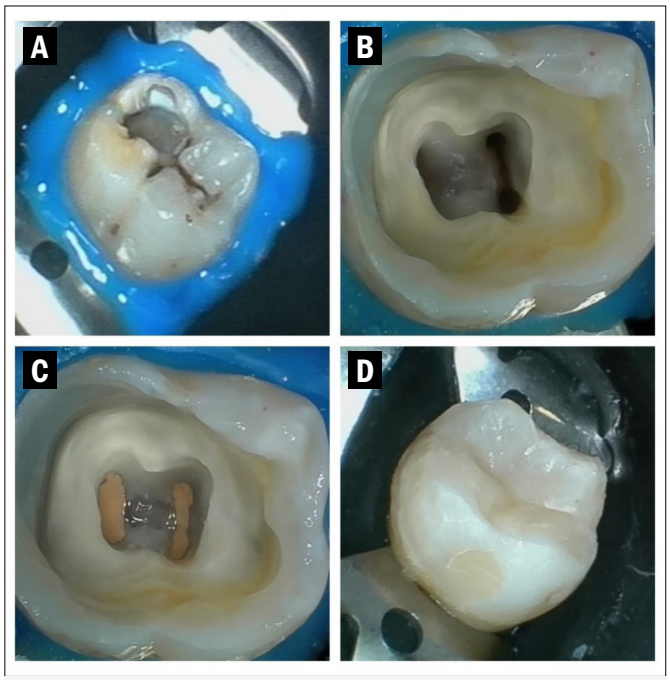

Figure 3
(A) Clinical view before endodontic treatment; **(B)** cavity after shaping and cleaning; **(C)** clinical view of the cavity after obturation; **(D)** clinical view after composite restoration.

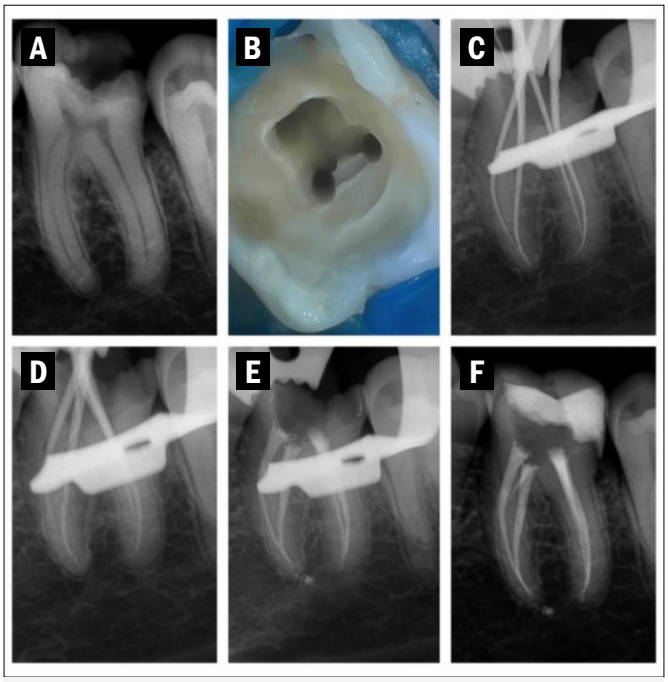

Figure 4
(A) Initial radiographic image; **(B)** clinical view after cleaning and shaping; **(C)** measuring the length of canals; **(D)** confirmation length of the canals with gutta-percha cone; **(E)** obturation-radiographic image; **(F)** final radiographic image.

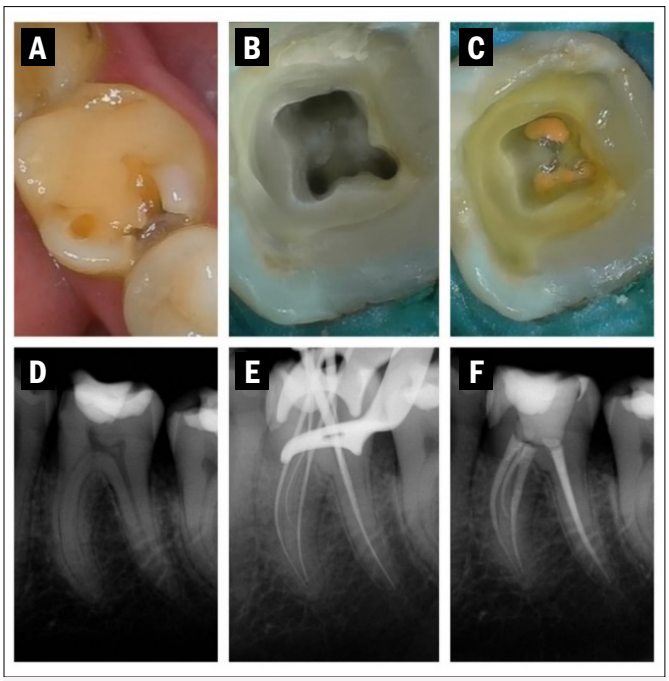

Figure 5
(A) Initial clinical view; **(B)** clinical view after cleaning and shaping; **(C)** clinical view after obturation; **(D)** first diagnostic radiography; **(E)** controlling of working length; **(F)** final radiographic image.

the rubber dam, the access cavity preparation was refined using a round diamond burs and improved with Endo 1 ultrasonic tips (Dentspy Maillefer, Baillagues, Switzerland). The clinician located five RC orifices - three mesial canals and two distal canals.

During the negotiation of canals, the use of magnification (Univet Loupes 3.0 Spa, Rezzato, Italy) proved helpful. MB and ML canals were negotiated and identified with size 06 and 08 K-files (DiaDent Group international, South Korea) and the working length determination was performed with an electronic apex locator FindPex (Changzhou Sifary Medical Technology Co.,Ltd, Eighteeth, China Eighteeth). The presence of MMC was identified with a straight endodontic probe, through the isthmus between the ML and MB canal. After the engagement of the probe at a specific point, we looked for the presence of the MMC. Ultrasonic tips (Endo 1 Dentspy Maillefer, Baillagues, Switzerland) were used for cleaning the area between MB and ML orifices, the coronal isthmus is prepared and use of smaller K-files provided for a careful negotiation of the canal. Irrigation with 5.25% NaOCl was used and the rest of pulpal tissue within the MMC released a stream of bubbles - champagne effect. Irrigation with 5.25% NaOCl and 17% EDTA was used after each file and was activated with an ultrasonic device (Changzhou Sifary Medical Technology Co.,Ltd, Ultrax, Eighteeth, China).

Slow up and down movements have been made during this stage, inserting the needle 2 mm below the working length, and extruding the irrigation solutions drop by drop. Root canal preparation was completed with E flex gold rotary file size 25/04 (Changzhou Sifary Medical Technology Co.,Ltd, Eighteeth, China Eighteeth), using manufacturer recommendations. The canals were cleaned and the length of each root canal was determined using an electronic apex locator FindPex (Changzhou Sifary Medical Technology Co.,Ltd, Eighteeth, China Eighteeth) and confirmed radiographically (Figures 2B, 4B, 5E, 6B). Marcus Haapasalo protocol (18) of irrigation was performed with 5.25% NaOCl and 17% EDTA, by introducing the irrigation solution in each canal and activating it with an ultrasonic device (Changzhou Sifary Medical Technology Co.,Ltd, Ultrax, Eighteeth, China). Irrigation was performed by using Irriflex needle (PD Dental, Vevey, Switzerland). Paper points (DiaDent Group international, South Korea) were used for drying the canals. Gutta-percha cones 25/04 (DiaDent Group international, South Korea) were inserted inside the canals and working length was controlled with radiography (Figures 2C, 4D, 6C). Sealapex sealer (Kerr Endodontics, CA, USA) is inserted inside the canals with gutta-percha cones. Obturation technique was warm vertical condensation (WVC) and thermoplastic gutta-percha injection (Fast fill & Fast pack pro obturation system combo, Changzhou Sifary Medical Technology Co.,Ltd. Eighteeth, China). The hand plugger was used to compact thermoplastic gutta-percha in the canal with the controlled working length. Radiograph was taken with Xios XG Supreme intraoral sensor size 2 (Dentsply Sirona, Charlotte, NC 28277 USA). The postoperative radiograph showed complete obturation of all the five root canals (Figures 2D, 4F, 5F, 6F). Photos of clinical view were taken by an intraoral camera (Figures 3A-D, 4B, 5A-C). Root canal treatments were completed in single appointments. Teeth have been restored by composite filling materials Tetric Prime (Ivoclar Tetric Prime, Ivoclar Vivadent, Liechtenstein). The patients did not report any signs of discomfort or pain after the endodontic treatment.

Discussion

Diagnostic and endodontic therapeutic procedure of MMC due to anatomical and morphological variabilities, require certain knowledge as well as clinical skills. To achieve success, one of the most fundamental steps is the preparation of coronal isthmus. To simplify the endodontic procedure and avoid missing canals, it is important to conduct the radiological examination and establish the clinical diagnosis of an MMC before the endodontic treatment. Practitioners must have a detailed knowledge and understanding of anatomical variations to conduct a successful treatment. To reach the radiological diagnosis, the clinician must perform two preoperative radiographs with using varying horizontal angulations, resulting in defining the roots bucco-lingual width which will display the presence of mesial middle

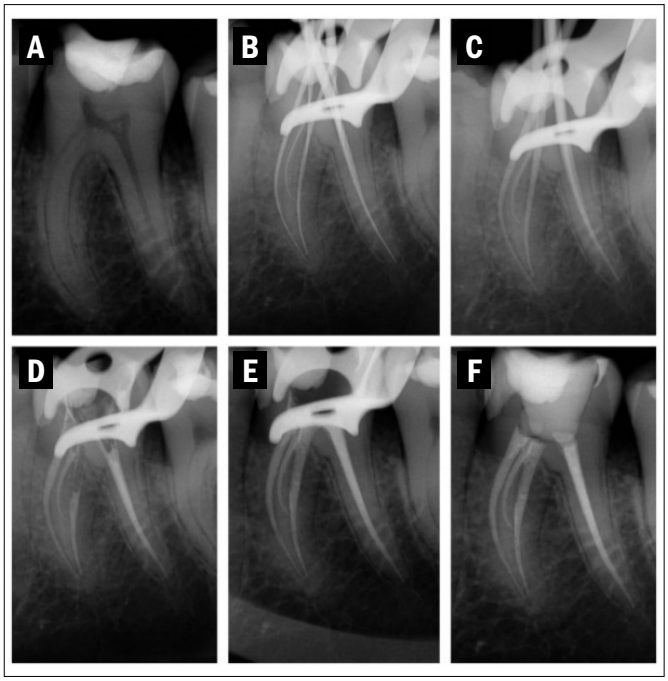

Figure 6 **(A)** Initial radiographic image; **(B)** measuring the length of canals; **(C)** confirmation length of the canals with gutta-percha cone; **(D)** down packing radiographic image; **(E)** obturation-radiographic image; **(F)** final radiographic image.

canal (19). To find the exact position and depth for accessing the obvious portion of canals, the clinician should use CBCT scanned images and conduct a correct treatment.

A better visualization of the cavity, enhanced diagnostic and straight-line access to the orifice, is made possible by the proper access cavity preparation (20). In various cases the orifice of MMC can be differently positioned – adjacent to ML or MB canal or halfway from MB and ML canals. It is noticeable from the available literature, that the orifice of the MMC presents itself closer to the ML canal than to the MB canal, followed by the frequency of the orifice in-between the two main canals, even though it is quite unusual to find the existence of the orifice close the MB canal (5, 8, 14). When the mesial middle canal is adjacent to MB or ML, the reach in-between them is around 3.21 mm, while the tooth lacking MMC presented an inter-orifice medium distance of around 3.7 mm (21). Several authors described an inter-orifice distance of about 3.6 mm in roots with MMC and 3.8 mm in roots without MMC (21, 22). To locate the canal orifice the most commonly used dye is the 1% methylene blue. The dye is directly applied into the cavity and visualized after rinsing with water and drying. The absorption of the dye into the orifices, aids the identification of the RT orifices and is called a Dye test (23). Further, the prepared cavity was rinsed with 5.25% NaOCl to check for the orifice of MMC. If the MMC is present, the sodium hypochlorite will react with the rest of pulpal tissue within the MMC and release a stream of bubbles creating the champagne effect. The presence of the canal orifice is indicated by the bubble originating area (24). To detect the originating place of the bubbles, the clinician needs to observe the access cavity under a dental operative microscope (DOM).

Using the higher magnification of the DOM allows us to identify the very thin MMCs which can present themselves deeply into the isthmus (16). Based on the overall observations, it can be concluded that the dimensions of MMCs are 2-3 times smaller than the main canals (23). Considering that most MMCs are thin, twisted, curved, or joined to ML or MB canals, the clinician ought to meticulously clean and shape MMCs so to avoid practical mistakes (25). A more efficient canal preparation can be achieved with rotary glide files than with K-files. However, in cases when the practitioner choses to prepare a glide path using K-files, the usage of intermediate files, such as 08 and 10, is much more advantageous in reaching a flatter conversion between the files and easing the penetration through canal constrictions (26).

The chosen instrumentation technique for cleaning and shaping the MMCs is carefully applied crown-down technique (27). Avoiding the procedural errors and efficiently cleaning and shaping the MMCs can be achieved by an appropriate glide path preparation, the correct choice of rotary files (28). It is suitable to use ultrasonic tips when cleaning the area between MB and ML orifices and use of smaller files provides for a careful negotiation of the canal (29). Syringe irrigation is effective when cleaning the main root canals but not so effective when used for RC abbreviations and anatomic irregularities which are quite common in MMCs (28). To obtain clean canals, it is recommended to use ultrasonic and negative apical pressure supplementary irrigation techniques, since these techniques proved more successful than conventional techniques in debris removal (30). Choosing the right instrument to clean and shape the root canal space is as important as

any other step (31). Chosen obturation technique depends on the skills of the clinician, configuration of the root canal, as well as available materials and equipment. It is important to always choose the best technique for each individual case in order to achieve an optimal canal obturation.

Conclusion

Detection of MMC, followed by careful and proper root canal treatment and finished by exact obturation, improves the outcome of demanding therapeutic procedures. For proper detection, it is of utmost importance to know the morphology of the canal, have a radiological finding and perform scouting with a manual k-file. When processing the canal manually, it is necessary to use a certain technique with adequate irrigation and removal of debris from the canal (rinsing, ultrasonic activation). For the final filling of the canal, it is of great importance to use the appropriate technique, with which an adequate three-dimensional filling of a certain canal can be carried out. The clinician needs to be aware of the existence of this root canal anatomical variations in order to reach the best possible results.

Clinical Relevance

Root canals treatments of lower molars with MMC may represent a difficulty to every clinician, and an understanding of anatomical variations of root canals are essential for achieving successful endodontic treatment outcomes.

Conflict of Interest

The author disclaims any conflict of interest in regard to this study.

Acknowledgements

The authors deny any financial affiliation.

Patients Consent Statement

Written informed consent was obtained from the patients when the patient registered at the private dental clinic for future publication of the case report and any accompanying images.

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