

CASE REPORT

Endodontic management of elusive middle mesial canal: Case report

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Abstract

The middle mesial canal (MMC) in mandibular first molar presents a significant anatomical variation that can impact the success of endodontic treatment. Accurate identification and effective management of this canal is critical for achieving complete debridement and obturation. This case report focuses on the challenges and strategies for managing the MMC during endodontic therapy. Advanced diagnostic tools such as cone-beam computed tomography (CBCT) and magnification aids, including the dental operating microscope, play a pivotal role in identifying and accessing the MMC. Techniques such as troughing with ultrasonic tips and modified access cavity designs enhance canal localization. Proper shaping and cleaning protocols are essential to address the anatomical complexity of the MMC. The integration of advanced bioactive sealing materials such as bioceramic sealer improves obturation outcome. This case report underscores the importance of a meticulous and evidence-based approach to managing the MMC in the mandibular first molar to ensure long-term endodontic success.

KEYWORDS

Middle mesial canal, Retreatment, Sonic activation, Ultrasonic tips

1 | INTRODUCTION

In-depth awareness of the root canal system is crucial to ensure the success of non-surgical and surgical root canal procedures, and to reduce or prevent potential mishaps and failures.¹ Identifying all the portals of exit, debriding the entire root canal system, and sealing all exits with a three-dimensional filling material is the key to success.² Clinically, the mandibular first molar shows many anatomical variations, such as C-shaped canals, taurodontism, radix entomolaris, radix paramolaris, middle distal canal, and middle mesial canal.³ The middle mesial canal, also referred to as the “intermediate canal,” “accessory mesial canal,” “mesio-central canal,” or “third mesial canal,” may be defined as a narrow, partial, or complete communication between the mesiobuccal (MB) and mesiolingual (ML) canals (American Association of Endodontists [AAE]).⁴ It is located in the sub-pulpal groove of the mesial root, connecting to the main mesial canals.⁵ The presence of an independent MMC with a separate orifice and apical foramen was first reported in 1974 by Barker et al. and Vertucci.³ A detailed study identifying the incidence and clinical detection of the MMC was subsequently reported by Pomeranz et al. in 1981.³ According to Sundus et al., the overall prevalence of the MMC in the mandibular molar is 5.09%.⁶ The global prevalence of the MMC

in the mandibular first molar is 4.4%, significantly higher than in the mandibular second molar, at 1.3%.⁷ In a systematic review and meta-analysis, Mahamood et al. reported a worldwide prevalence of 4.15% in the mandibular first molar, with wide geographic variation ranging from 0% to 29.7%.⁸ A meta-analysis by Fatma Pertek et al. reported a prevalence ranging from 1% to 23%.⁹ Bharatiya et al. (2024) evaluated the prevalence of the MMC in the Indian sub-population and observed the highest rate in the West zone (11%), followed by the South zone (10%), North zone (8.9%), East zone (6.6%), and Central zone (6%), although the difference was not statistically significant ($p > 0.05$).⁵ The development of the MMC is attributed to the apposition of secondary dentin throughout tooth development, which results in a vertical partition within the root (Srivastava et al., 2018), the diameter of which is age-related.³ The incidence was 32.1% in patients ≤ 30 years old, 23.8% in patients 30–40 years old, and only 3.8% in patients > 40 years.¹⁰ This age-related reduction is attributed to continued secondary dentin formation causing canal obliteration, which makes clinical identification increasingly difficult (Solomonov et al., 2020). In an Indian population, Sherwani et al. found that 67% of MM orifices were located between the MB and ML orifices, 20% closer to the ML orifice, and 12% closer to the MB orifice.¹¹ MMCs have also been shown to exhibit a bilateral incidence

(Pertek Hatipoğlu et al., 2023). In 1981, Pomeranz was the first to classify the MMC into three categories: Independent, where the MMC runs independently from orifice to apex; Fin, where an isthmus is present between the MMC and the MB or ML canal at any point along its course; and Confluent, where the MMC joins the MB or ML canal before exiting at the apex.¹² Shuaimi et al. classified the MMC as Type I (Independent) – three independent canals detectable to the apex; Type II (Confluent) – the MM canal joins either the ML or MB canal en route to the apex; and Type III (Fin) – the MM canal orifice communicates with the MB or ML orifice but terminates in a separate foramen.¹³ According to Mahajan et al. (2023), the prevalence of the independent type was 4.7%, the confluent type 14.6%, and the fin type 8.7%.⁴ Given this anatomical complexity and the high likelihood of the MMC being missed on routine clinical and radiographic examination, the following two cases illustrate its detection and systematic management using a combination of clinical, magnification-aided, and CBCT-based diagnostic strategies.

2 | CASE REPORT 01

A 34-year-old male patient reported to the Department of Conservative Dentistry and Endodontics with the chief complaint of pain in the lower left back tooth region for the preceding two weeks. The pain was continuous and throbbing in nature, aggravated on eating food and relieved on taking medication. The patient gave a history of root canal treatment performed on the same tooth nine months earlier. Clinical examination revealed an occlusodistal cavity in relation to 36, and the tooth was tender on percussion. Radiographic examination revealed radiolucency involving enamel, dentin, and pulp occlusodistally, with radiopacity in the canals suggestive of gutta-percha. Periodontal ligament (PDL) widening, loss of lamina dura, and a periapical lesion in relation to the mesial root of 36 were noted

. Based on the clinical and radiographic findings, 36 was diagnosed as a previously root canal treated tooth with symptomatic apical periodontitis. Non-surgical root canal retreatment followed by post-endodontic restoration was recommended. The tooth was isolated using a rubber dam, and the canals were instrumented with D1 and D2 ProTaper retreatment files to the coronal and middle third along with gutta-percha (GP) solvent. All canals were then instrumented using D-finders (Mani D-Finders) #10 and #15 to the full working length, followed by instrumentation using D3 up to the working length. Clinically, four root canal orifices – mesiobuccal, mesiolingual, distobuccal, and distolingual – were located under the dental operating microscope

. On the confirmatory periapical radiograph taken during GP removal, it was noticed that GP from the mesiolingual canal was still present and that the retreatment file had tracked into a separate, previously unidentified canal space – the middle mesial canal

. The residual GP was removed from the mesiolingual canal using #15 and #20 H-files, and the patient was referred for a CBCT scan to confirm the anatomy before proceeding further, in keeping with the principle that a suspected additional canal should be verified radiographically



FIGURE 1 Pre-operative intraoral periapical radiograph of tooth 36 showing the existing gutta-percha filled canals, with periapical radiolucency in relation to the mesial root, widening of the periodontal ligament space, and loss of lamina dura.

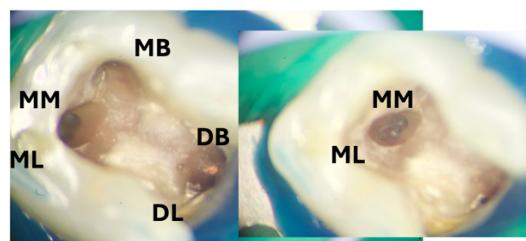


FIGURE 2 Clinical photograph under the dental operating microscope showing the five canal orifices – mesiobuccal, mesiolingual, midmesial, distobuccal, and distolingual – following access refinement and coronal/middle-third gutta-percha removal.

before shaping. The CBCT report confirmed the presence of a middle mesial canal, located 13.4 mm from the occlusal surface and confluent with the mesiolingual canal

. According to Ahmed's nomenclature, the tooth was represented as 236M2-3D2; according to Pomeranz et al., the MMC was classified as the fin type; and according to Shuaimi et al., it was classified as Type III. Working length

was established using a #15 K-file (DB: 19 mm, DL: 19 mm, MB: 21 mm, MM: 20 mm, ML: 20 mm), and biomechanical preparation was completed up to ProTaper Gold F2, followed by calcium hydroxide (RC Cal) as an intracanal medicament. The working irrigant used was 3% NaOCl with intermittent saline irrigation. The final irrigation protocol consisted of 3% NaOCl for 1 minute, saline irrigation, 17% EDTA for 1 minute, saline irrigation, and 2% chlorhexidine (CHX) solution, with irrigants activated sonically (Superendo Sonic Endo Irrigator) to improve penetration into the fin-type isthmus connecting the MMC to the mesiolingual canal. The patient was recalled after one week; at the second appointment the intracanal medicament was removed using sonically

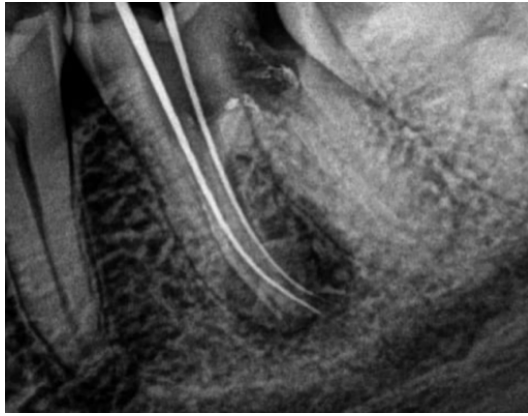


FIGURE 3 Confirmatory intraoral periapical radiograph taken during gutta-percha removal, showing residual gutta-percha in the mesiolingual canal and a retreatment file tracking into a previously unidentified canal space, subsequently confirmed as the middle mesial canal.

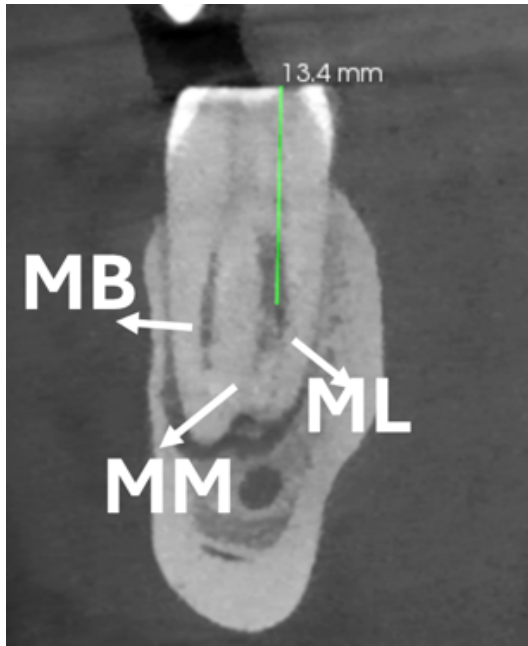


FIGURE 4 CBCT sections confirming the presence of a middle mesial canal located 13.4 mm from the occlusal surface, confluent with the mesiolingual canal (fin-type configuration).

activated 17% EDTA, followed by saline irrigation and a final irrigation with 3% NaOCl for 30 seconds. Obturation was performed using the single-cone technique (ProTaper Gold F2 GP) with Ceraseal bioceramic sealer

. At a subsequent visit, access closure was completed and the tooth was prepared to receive an all-ceramic crown, cemented using RelyX U200 self-adhesive resin cement. The entire procedure was performed under magnification.

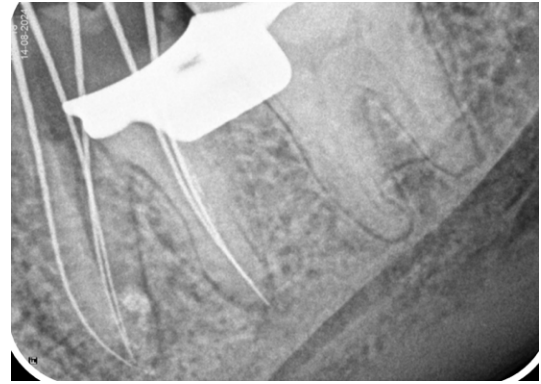


FIGURE 5 Working length.



FIGURE 6 Obturation.

3 | CASE REPORT 02

A 28-year-old female patient reported to the Department of Conservative Dentistry and Endodontics with the chief complaint of spontaneous pain in the lower right back tooth region for the preceding four weeks. Clinical examination revealed an occlusodistal cavity in relation to 46, and the tooth gave a lingering response on the cold test. Radiographic examination revealed radiolucency involving enamel, dentin, and pulp occlusodistally. Based on the clinical and radiographic findings, 46 was diagnosed as symptomatic irreversible pulpitis with normal apical tissue. Non-surgical root canal treatment followed by post-endodontic restoration was recommended. An inferior alveolar nerve (IAN) block was administered, followed by rubber dam isolation. Access opening was performed using an endo-access bur, and canals were negotiated with a #8 K-file followed by a #10 K-file. Clinically, four root canal orifices – mesiobuccal, mesiolingual, middle mesial, and distal – were located under magnification

. Working length was determined using a Root ZX Mini apex locator and confirmed radiographically

. According to Pomeranz et al., the MMC in this case was classified as the confluent type; according to Ahmed's nomenclature, the tooth was represented as 246M3-2D1; and according to Shuaimi et al., it was

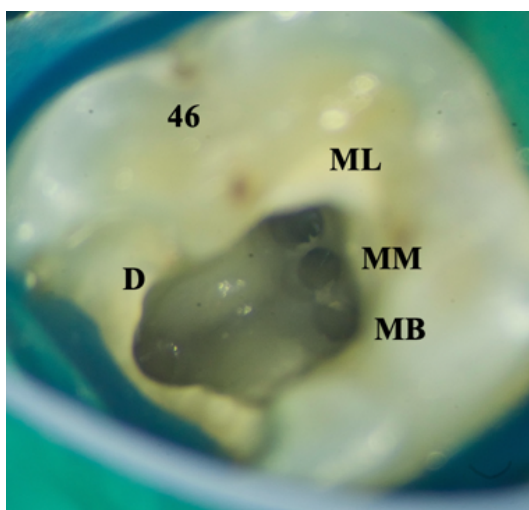


FIGURE 7 Clinical photograph under the dental operating microscope showing the four canal orifices – mesiobuccal, mesiolingual, midmesial, and distolingual

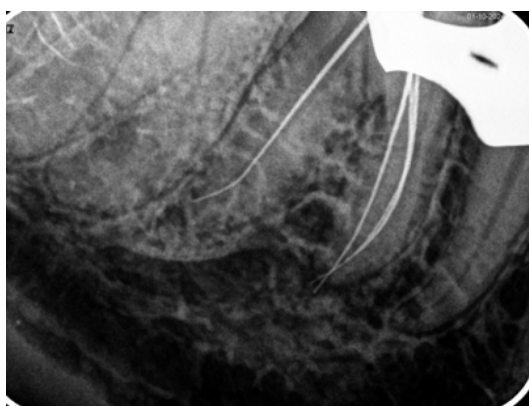


FIGURE 8 Working length.

classified as Type II. Canals were prepared up to ProTaper Gold F2 rotary files. Obturation was performed using the single-cone technique (ProTaper Gold F2 GP) with Ceraseal bioceramic sealer

. At a subsequent visit, access closure was completed and the tooth was prepared to receive an all-ceramic crown, cemented using RelyX U200 self-adhesive resin cement. The entire procedure was performed under magnification.

4 | DISCUSSION

Clinical significance of missed canals in endodontic failure: Post-treatment endodontic disease manifesting as pain, swelling, or difficulty in chewing is most often the result of inadequate cleaning and shaping of the root canal system, missed canals, or insufficient/over-obturation. A missed canal remains one of the most common causes of root canal



FIGURE 9 Obturation.

failure.¹⁴ RCT failure attributable to missed canals ranges from 12% to 42% across different populations.¹⁵ Apical periodontitis in root canal treated teeth with missed canals has been reported to be as high as 90%, with the mandibular and maxillary first molars being the teeth most frequently affected (Mohammed et al., 2021).¹⁵ Teeth with missed canals have been shown to carry 4.4 times higher odds of being associated with a periapical lesion.¹⁶ In a study by Tartuk et al. (2023) on the incidence of missed middle mesial canals in endodontically treated mandibular molars, 97.53% of MMCs were undetected by clinicians.¹⁷ Case 1 in the present report is a direct illustration of this: the MMC had been missed during the initial root canal treatment nine months earlier, and it was only identified during retreatment when the retreatment file was found to have entered an unexplored canal space on the confirmatory radiograph. This underlines why persistent or recurrent symptoms in a previously treated molar should always prompt a deliberate search for missed anatomy, rather than being attributed solely to reinfection of the already-treated canals. Detection strategies for the middle mesial canal: Methods for detecting the MMC can be broadly classified into technology-based and clinical methods.³ Technology-based methods include periapical radiography, CBCT, and the dental operating microscope. Clinical methods include adequate access cavity preparation and the red-line test; exploration and negotiation of the canal floor using a DG-16 explorer or micro-openers; use of small, stiff stainless-steel K-files; guided troughing using ultrasonic tips (CPR 2D, E2D, ET18, ENDO 2, E6D, StartX 2); a small-headed Munce discovery bur (#2); the champagne-bubble test with 3–5.25% NaOCl, in which a stream of bubbles is generated by oxygenation of residual pulp tissue; and the 1% methylene blue dye test. In the present cases, a combination of these strategies was used sequentially rather than in isolation. In Case 1, the MMC was first suspected clinically – an instrument tracking outside the four previously identified orifices on the confirmatory radiograph – and this clinical suspicion was then confirmed and precisely localized using CBCT, which additionally defined its distance from the occlusal surface and its confluence with the mesiolingual canal. In Case 2, careful troughing of the pulpal floor under magnification between the mesiobuccal and mesiolingual orifices was sufficient to directly visualize

the MMC orifice at the outset, without the need for CBCT, illustrating that systematic floor exploration under the operating microscope remains the first and most cost-effective step, with CBCT reserved for cases of diagnostic uncertainty or complex canal confluence as in Case 1. Justification of the treatment protocol: The treatment protocol adopted in both cases was deliberately tailored to the anatomical challenge posed by the MMC. In Case 1, ProTaper retreatment files (D1–D3) combined with a GP solvent were used to remove the existing filling material efficiently while minimizing unnecessary removal of sound dentin from the already-treated canals, and D-finders were used to negotiate the narrow, previously unfilled MMC without ledging or transportation. Working length was verified using a K-file and radiographic confirmation for each of the five canals individually, reflecting the fact that a fin-type MMC (Case 1) and a confluent-type MMC (Case 2) can present with markedly different lengths and points of confluence, so length determination could not safely be assumed from the adjacent MB or ML canal. The final irrigation protocol – 3% NaOCl, 17% EDTA, saline, and 2% CHX, activated sonically – was selected to maximize disinfection within an anatomically restricted, fin-shaped isthmus that is difficult to instrument mechanically. Sonic/ultrasonic activation improves irrigant penetration and debris removal in narrow, curved, or accessory canal spaces such as the MMC, which is precisely the anatomy encountered in Case 1; the addition of 17% EDTA served to remove the smear layer and enhance sealer penetration, while 2% CHX was used as a substantive final rinse given the extended treatment interval since the original filling. Calcium hydroxide was placed as an interappointment medicament to allow further disinfection of the fin/isthmus area before obturation, and the patient was recalled only once the tooth was asymptomatic, consistent with the principle of achieving a dry, symptom-free canal before sealing. Obturation with the single-cone technique using a bioceramic sealer (Ceraseal) was chosen for both cases because bioceramic sealers exhibit dimensional stability, bioactivity, and superior sealing ability along irregular canal walls and fins compared with conventional sealers, making them well suited to the additional, often irregular canal space created by the MMC. Canal preparation was intentionally limited to a moderate taper (ProTaper Gold F2) rather than aggressive enlargement of the MMC. This is consistent with finite element analysis data showing that progressive mechanical enlargement of the MMC is associated with a reduction in the fracture resistance of the mesial root, with a 25/.04 preparation size being the advocated upper limit for conservative shaping.¹⁸ This finding is corroborated by Keles et al. and Kiliç et al., who similarly demonstrated an increased risk of mesial root fracture with over-instrumentation of the MMC.¹⁹ Full-coverage all-ceramic crowns were subsequently planned for both teeth, in view of the additional loss of dentinal structure from access refinement, canal fin instrumentation, and the pre-existing occlusodistal cavity, all of which increase the risk of cuspal fracture in a posterior tooth with compromised remaining tooth structure. Comparative learning points from the two cases: Taken together, the two cases represent complementary learning points. Case 1 demonstrates the fin-type MMC being missed at the

time of primary treatment and subsequently identified only during retreatment, reinforcing the need for CBCT as a confirmatory tool when instrumentation reveals a canal trajectory inconsistent with the pre-operative radiograph. Case 2 demonstrates the confluent-type MMC being successfully identified and managed during the primary treatment visit itself through careful clinical floor exploration alone, without recourse to CBCT, showing that a high index of suspicion and systematic troughing can prevent this anatomy from being missed in the first instance. Both cases were managed using the same conservative shaping philosophy and bioceramic obturation strategy, and both received a full-coverage restoration – illustrating a consistent, anatomy-driven treatment protocol that can be applied regardless of whether the MMC is discovered at initial treatment or at retreatment.

5 | CLINICAL RELEVANCE

Recognition and management of the middle mesial canal are essential for complete debridement and obturation in mandibular molars, preventing missed anatomy, persistent infection, and treatment failure, and thereby improving long-term endodontic success. A systematic diagnostic approach – beginning with careful clinical floor exploration under magnification and escalating to CBCT when clinical findings are equivocal or instrumentation suggests unexplored anatomy – combined with anatomy-conserving shaping and bioceramic obturation, offers a reproducible protocol for managing this frequently missed canal.

REFERENCES

1. AL-Rammahi HM, Chai WL, Nabhan MS, et al. Root and canal anatomy of mandibular first molars using micro-computed tomography: a systematic review. *BMC Oral Health*. 2023;23:339.
2. Solete P, Antony DP, Govindaraju L, et al. Endodontic Management of Middle Mesial Canal in Mandibular Molars: A Report of Three Cases. *Cureus*. 2023;15(3):e35826.
3. Penukonda R, Pattar H, Nambiar P, Al-Haddad A. Middle mesial canal in mandibular first molar: A narrative review. *Saudi Dent J*. 2023;35(5):468-475.
4. Mahajan S, Meena N, Rangappa A, Mashood AM, Murthy C, Lokapriya M. Evaluation of interorifice distance in permanent mandibular first molar with middle mesial canal in Bengaluru city, Karnataka: A cone-beam computed tomography study. *Endodontology*. 2023;35(2):100-106.
5. Bharatiya RP, Ujariya UM, Kothari AK, Shah VY, Naik MH. Prevalence and morphology of middle mesial canal in mandibular first molars in an Indian sub-population: A cone-beam computed tomographic analysis. *Endodontology*. 2024;36(1):54-60.
6. Bukhary S, et al. Prevalence of middle mesial canal using cone beam computed tomography: A systematic review and meta-analysis. *Saudi Dent J*. 2023;35(8):904-915.

7. Al-Maswary AA, et al. The Global Prevalence of Middle Mesial Canal in Mandibular First and Second Molars Assessed by Cone Beam Computed Tomography: A Systematic Review and Meta-Analysis. *J Endod.* 2023;49(6):638-656.
8. Motamedi MRK, et al. A systematic review and meta-analysis of the prevalence and global distribution of middle mesial canals in mandibular molars identified by CBCT. *Clin Oral Investig.* 2024;28(6):310.
9. Pertek Hatipoğlu F, et al. Assessment of the Prevalence of Middle Mesial Canal in Mandibular First Molar: A Multinational Cross-sectional Study with Meta-analysis. *J Endod.* 2023;49(5):549-558.
10. Nosrat A, Deschenes R, Tordik P, Hicks M, Fouad A. Middle Mesial Canals in Mandibular Molars: Incidence and Related Factors. *J Endod.* 2014;41.
11. Bansal R, Hegde S, Astekar M. Morphology and prevalence of middle canals in the mandibular molars: A systematic review. *J Oral Maxillofac Pathol.* 2018;22(2):216-226.
12. Yang Y, Wu B, Zeng J, Chen M. Classification and morphology of middle mesial canals of mandibular first molars in a southern Chinese subpopulation: a cone-beam computed tomographic study. *BMC Oral Health.* 2020;20(1):358.
13. Xu S, Dao J, Liu Z, et al. Cone-beam computed tomography investigation of middle mesial canals and isthmuses in mandibular first molars in a Chinese population. *BMC Oral Health.* 2020;20:135.
14. Tabassum S, Khan FR. Failure of endodontic treatment: The usual suspects. *Eur J Dent.* 2016;10(1):144-147.
15. Mashyakhy M, Hadi FA, Alhazmi HA, Alfaifi RA, Alabsi FS, Bajawi H, Alkahtany M, Abu Melha A. Prevalence of Missed Canals and Their Association with Apical Periodontitis in Posterior Endodontically Treated Teeth: A CBCT Study. *Int J Dent.* 2021;2021:9962429.
16. Baruwā AO, et al. The Influence of Missed Canals on the Prevalence of Periapical Lesions in Endodontically Treated Teeth: A Cross-sectional Study. *J Endod.* 2020;46(1):34-39.e1.
17. Tartuk GA, Kaya S. Incidence of missed middle mesial canal in endodontically treated mandibular molar teeth: A cone-beam computed tomography study. *Niger J Clin Pract.* 2023;26(6):756-759.
18. Nawar NN, et al. Optimum Shaping Parameters of the Middle Mesial Canal in Mandibular First Molars: A Finite Element Analysis Study. *J Endod.* 2023;49(5):567-574.
19. Keleş A, et al. Middle Mesial Canal Preparation Enhances the Risk of Fracture in Mesial Root of Mandibular Molars. *J Endod.* 2020;46(9):1323-1329.

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