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(CASE REPORT)

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Unveiling the Hidden: Management of a middle mesial canal in a mandibular second molar – A case report

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Abstract

The primary objective of root canal treatment is to obtain three-dimensional obturation of the root canal space after cleaning debris from the canal. Anatomic variations are commonly observed in endodontic practice and require careful management by the clinician. A notable example of such a variation is the occurrence of a third canal in the mesial root of the mandibular second molar. Typically, mandibular second molars had two mesial canals (mesio-buccal and mesio-lingual), but the occurrence of a middle mesial canal posed a challenge for the clinician to locate and identify. This variation could influence the efficacy of cleaning and shaping procedures, as well as the overall success of endodontic therapy. The present case described tooth #37 with a chief complaint of food lodgment, pain, and tenderness on chewing. The radiograph revealed a distoproximal radiolucency involving the pulp. The mesial root appeared wider, suggestive of some anatomic variation. The diagnosis of symptomatic irreversible pulpitis with apical periodontitis was made. The treatment plan included conventional root canal therapy followed by a coronal prosthesis. A good prognosis was expected. The additional mesial canal in the second mandibular molar is a rare anatomic configuration, which emphasized that the operator had to be thorough with the expected variations, its negotiation, and the judicious preparation of the canal based on those variations.

Keywords: Canal variation; CBCT; Mandibular second molar; Middle mesial canal; Root canal anatomy

1. Introduction

Favorable endodontic prognosis can be accomplished by complete debridement of bacterial by-products and micro-organisms from the root canal. Generally, mandibular molars usually have two roots, one mesial and one distal. Typically, the mesial root contains two canals—mesiobuccal (MB) and mesiolingual (ML)—while the distal root usually

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presents with a single canal. Between the mesiobuccal and mesiolingual canal, there is a narrow isthmus that consists of pulp tissue but if a canal is present in this isthmus, then it is known as middle mesial canal[1].

Vertucci, Williams, and Barker were among the first to describe the occurrence of an extra canal in the mesial root of mandibular molars. This canal has been identified in literature by various terms such as the intermediate canal, mesio-central canal, or third mesial canal. Eventually, the middle mesial canal (MMC) found its utmost usage [2].

According to Pomeranz et al., MMC is of three types: Fin, Confluent, and Independent

In fin type, an instrument can go through freely between these canals, whereas in confluent type, canal begins with a separate orifice but eventually merges with either MB or ML canal, and in the independent type, the MMC begins with a separate orifice and terminates in its own apical foramen.[3].

However, this tooth may also exhibit other variations, such as three canals in the mesial root, two canals in the distal root, or even the presence of a supernumerary root can be present [4] also called as "Radix paramolaris"

Mandibular molars have high incidences of intercanal and intracanal connections reaching about 83% under CBCT (Cone Beam Computed Tomography) but the accomplishment of accessing and negotiating the middle mesial canal is very low (about 1 to 25%) [5].According to Vertucci's classification frequency of presence of mesial root canals in mandibular second molar is type IV (75.6% of two rooted molars) and in distal root canal configuration showed type I (77.7% of two rooted molars).

Additional canals have been identified in approximately 4% of cases. In mandibular second molars, the mesial root commonly exhibits two canals in approximately 86.1% of cases, while the distal root typically presents with a single canal in about 77.7% of instances. The predominant root morphology involves two roots in 85.3% of cases, whereas the presence of three roots is observed in only 2.6%. In terms of canal configuration, three canals are most frequently seen (87.7%), followed by two canals (12.1%) and four canals (2.6%) [4]. Anatomical variations such as C-shaped canals were identified in 7.5% of these teeth. [6].

The presence of an additional canal or root necessitates modifications to the treatment plan and requires increased clinical caution. When an extra canal is identified, the clinician must carefully evaluate its anatomical configuration and prepare it accordingly. Unlike the main (or parent) canals, the accessory canal may exhibit variations in curvature, diameter, and orientation, which demand individualized attention during cleaning, shaping, and obturation.

Thorough preclinical evaluation, combined with detailed radiographic assessment, careful inspection of the pulpal floor under magnification are the fundamentals to achieving success in endodontic treatment.

2. Case report

A 39-year-old male patient presented to the Department of Conservative Dentistry and Endodontics with a chief complaint of mild, intermittent pain, exacerbated by hot beverages in lower left back tooth region since 10 days. Medical history was non-contributory.

On Clinical examination, disto-proximal caries in tooth #37, the tooth was tender to percussion. The tooth crown exhibited an increased bucco-lingual dimension than usual, indicating a possible anatomic variation.

A Pre-operative intraoral periapical radiograph (IOPAR) revealed disto-proximal radiolucency involving the pulp space, (Figure 1), and a broader mesial root morphology was noted, with fastbreak suggestive of additional canal, confirmation was achieved through the use of the Same Lingual, Opposite Buccal (SLOB) radiographic technique. From the clinical and radiographic findings, a diagnosis of symptomatic irreversible pulpitis with symptomatic apical periodontitis in relation to tooth #37 was established (according to the glossary of endodontic terms by AAE – March 2020), and a treatment plan of Root Canal Therapy (RCT), followed by rehabilitation with a full coverage restoration was suggested to the patient.

Informed consent from the patient was obtained. During the initial appointment, local anesthesia was provided using 1.8 mL of 2% lidocaine containing 1:80,000 epinephrine [Lignox 2% ADR Inj, Indoco Remedies Ltd. (Warren, Pharma), Mumbai, MH, India] via Inferior Alveolar Nerve Block technique (IANB). Under rubber dam isolation, the caries was excavated, followed by a pre-endodontic build-up using resin-based restorative composite (Spectrum Composite, Dentsply, Weybridge, Surrey, United Kingdom). An access cavity was prepared under a dental operating microscope (DOM) at medium magnification (approximately 8x–16x) using a size 2 endo access bur (Dentsply-Sirona, Charlotte, North Carolina, USA), with the Leica M320 microscope. An Endo-Z bur (Dentsply-Sirona) was utilized to refine the access cavity. Exploration of the pulp floor was done using an endodontic explorer; three canals were located, two mesials and one distal. Using a DG16 endo explorer (Hu-Friedy, Chicago, Illinois, USA), a catch was detected between MB and ML canal orifice on the pulpal floor, a 10k file (MANI, Inc., Tochigi, Japan) was inserted in additional orifice and an IOPAR was taken at two different horizontal angulations (30°) (FIG 2) confirmed the presence of an additional canal. Coronal flaring was done using the Pro Taper SX rotary file (Dentsply Maillefer, Tulsa, Oklahoma, USA) to establish straight-line access (FIG 3). The patency was confirmed with the 10k SS hand file (Mani, Japan). Working length was determined using an apex locator (Root ZX Mini; J Morita, Japan). The cleaning and shaping was done using 20k SS hand file (MANI, Inc., Tochigi, Japan), followed by rotary instrumentation up to 25-4% in mesial canals and 20-6% in distal canal. Subsequently, the canals were irrigated using 2.5% sodium hypochlorite (NaOCl) (Prime Dental Products, India), 17% gel ethylenediaminetetraacetic acid (EDTA) (DeSmear, India) and 0.9% saline solution. The canals were dried using sterile paper points, and a calcium hydroxide dressing was placed for a duration of seven days. Cone beam computed tomography (CBCT) was also performed to evaluate any other anatomic variation other than MMC (FIG 7). The scan aided in accurately identifying the canal anatomy and improved the probability of a successful outcome. In the next sitting, dressing was removed, master cone tugback was checked and confirmed radiographically. Obturation was done with corresponding gutta-percha points using AH Plus sealer (De Trey; Dentsply, Konstanz, Germany) (FIG 4). The coronal structure was restored using resin-based restorative composite material (3M™ ESPE Filtek™ Bulk Fill, 3M, St. Paul, Minnesota, United States) (FIG 5). A full coverage metal ceramic crown was delivered to the patient (FIG 6).

3. Discussion

The root canal anatomy of mandibular molars has been widely researched, with special focus on the occurrence and anatomical configuration of the MMC. According to Karunakaran et al. (2012), the occurrence of a third canal in the mesial root of mandibular second molars range from 0.95% to 15%; however, the presence of three entirely separate and independent canals remains a rare finding. This additional canal may arise from a distinct orifice and later join either the mesio-buccal or mesio-lingual canal, or it may extend independently to exit through its own apical foramen. Understanding these morphological variations is crucial for effective endodontic treatment, as unrecognized extra canals can contribute to treatment failure [7].

According to a systematic review carried out by Bansal et al., (2018), the prevalence of different middle mesial canal configurations, like fin, confluent, and independent, has been extensively studied & are reported by 22 research articles. Earlier studies suggested a high prevalence of independent canal configurations; however, with the advent of 3D imaging techniques, fin and confluent types have been more frequently identified. Contemporary studies reported increased prevalence of confluent type compared to fin type and independent type[2] .In our case, independent configuration was present.

Nagahara et al. (2020) highlighted that the prevalence of the middle mesial canal in mandibular molars is significantly influenced by the patient's age. Their study emphasized that younger patients exhibit a higher prevalence of the MMC due to reduced pulp calcification. As individual grow older, continuous dentin deposition leads to a progressive reduction in pulp space, making the canals more confluent thin and narrow, leading to difficulty in identification and negotiation.[8].

Clinically when the presence of a MMC is suspected in a mandibular second molar, it becomes essential to alter the standard access cavity design to facilitate its detection and negotiation. Instead of the conventional triangular access, a broader, trapezoidal access is often recommended for better visibility and straight-line entry to the mesial root region. This adjustment is particularly helpful for exploring the developmental groove between the MB and ML canals, where an MMC is located. The white line test and red line test are two clinical methods that can aid in the detection of additional canal orifices. The white line test is used in non-vital teeth to find canal openings by following natural lines on the pulp chamber floor, which can be hidden by dentinal mud. The red line test, on the other hand, focuses on identifying traces of vital pulp tissue that appear as red streaks along the chamber floor or in anatomical grooves. These red lines are suggestive of remaining pulp vitality and may indicate an extra canal [9].

Test like Champagne bubble test is also great to detect accessory canals. According to Penukonda et al. (2023), it involves filling of the pulp chamber with 3-5.25% sodium hypochlorite (NaOCl) at a concentration of 3–5.25% after preparing an adequate access cavity. The interaction between NaOCl and organic tissue at the orifice of accessory canals leads to the release of oxygen, resulting in a visible stream of bubbles. This bubbling effect serves as an indicator of the presence of additional canal [10]. Endodontic explorers **like the** DG-16 **and** JW-17 have sharp, angled tips and fine points, are particularly effective in checking additional orifice on the pulpal floor [11].

Advances in endodontics like DOM offers an advantage in better visibility, proper illumination, detects color changes, improves instrumentation, enhances understanding of dentinal floor mapping and provides excellent evaluation of floor [12]. Careful troughing of the developmental groove between the mesio-buccal and mesio-lingual canals using ultrasonic tips can facilitate the detection of the MMC. MMC have very tiny orifices or they may be lying on different level within the isthmus therefore, troughing is done and then going through a developmental groove enhances the chances of canal location. The study reported an increase in the detection of middle mesial canals by 3.8% in mandibular second molars and 12.4% in mandibular first molars following the use of troughing techniques[13].

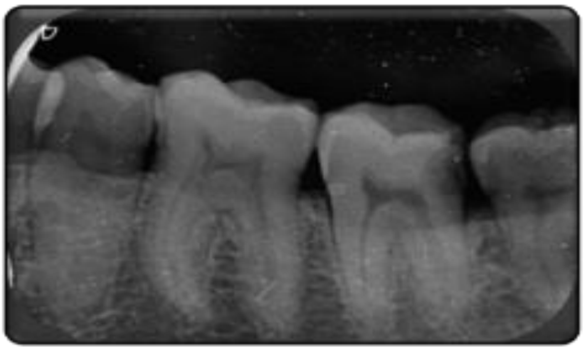

Figure 1 PRE-OPERATIVE RADIOGRAPH – revealing distoproximal caries i.r.t. 37

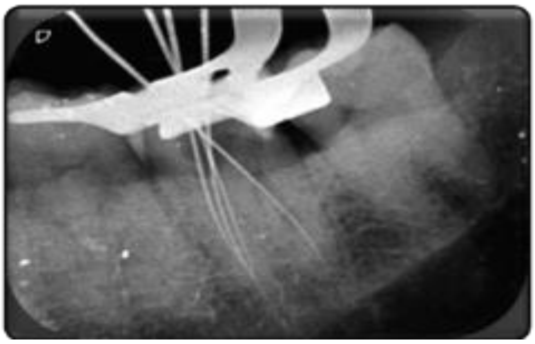

Figure 2 IOPAR REVEALING WORKING LENGTH i.r.t. 37

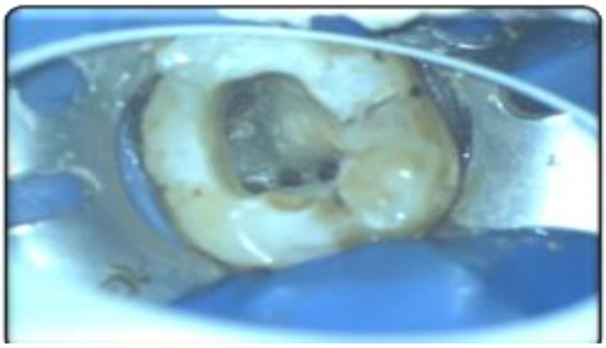

Figure 3 Clinical picture showing 4 canal orifices under 10x magnification i.r.t. 37

Figure 4 OBTURATION i.r.t. 37

Figure 5 IOPAR REVEALING POST RCF i.r.t. 37

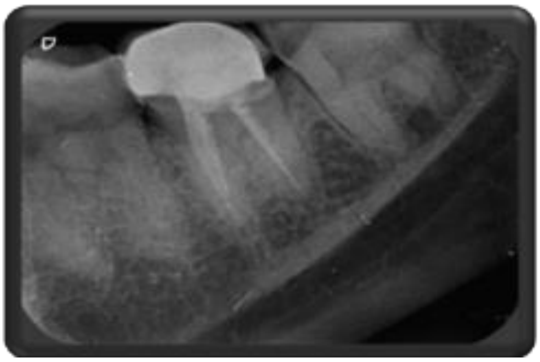

Figure 6 IOPAR revealing RC treated with coronal prosthesis irt 37

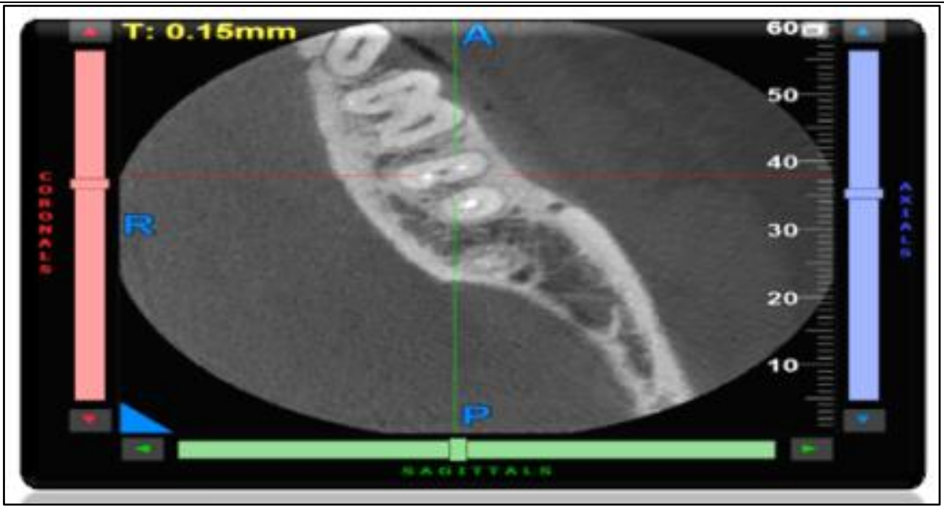

Figure 7 CBCT image showing mid-mesial canal i.r.t. 37

Shallow troughing can be performed using a long-shank bur (#2 Stainless Steel Bur Hard®, Mani)[13] to carefully remove dentin protuberances along the developmental groove. The depth of troughing was maintained at a maximum of 2mm to prevent unnecessary dentin loss[8]. However, with advancements in diagnostic techniques, detection rates have been significantly increased to 57.02% in mandibular first molars and 9.91% in mandibular second molars [1].

After canal location, canal negotiation should be performed using pre-curved K-files (#6, #8, #10). The cleaning and shaping process can then be carried out with NiTi rotary files (sizes 15/.04, 20/.04, 25/.04), depending on the canal configuration.

Due to the complex and often irregular anatomy in this region, warm vertical compaction enables precise placement of gutta-percha, promoting close adaptation to the canal walls and the isthmus. Alternatively**, thermoplasticized injectable gutta-percha systems** (such as Obtura or Calamus) can be used in combination with a **bioceramic sealer**, which offers excellent flow into accessory anatomy and dimensional stability.

Cantatore et al. [8], through several epidemiological and retrospective studies, highlighted that failure to identify and treat all the canals significantly increases the rate of apical periodontitis in teeth that have undergone endodontic therapy. Anatomical variations that go unnoticed are a primary factor in root canal treatment failure, as the complexity of the root canal system is closely linked to the occurrence of apical periodontitis. The incidence of post-treatment disease is notably higher in multirooted molars, where the likelihood of overlooking an additional canal is greater compared to single-rooted teeth like incisors [14].

Thorough cleaning, shaping, and three-dimensional obturation of all identified canals are essential to ensure long-term treatment success. Recognizing and addressing anatomical variations not only improves clinical outcomes but also underscores the importance of constant vigilance and adaptability in endodontic practice.

4. Conclusion

The presence of a middle mesial canal in the mandibular second molar is a rare but clinically significant anatomic variation that can influence the success of endodontic treatment. Accurate identification and management of this additional canal are crucial to ensure thorough cleaning, shaping, and obturation, ultimately leading to favorable treatment outcomes. This case highlights the importance of careful radiographic evaluation, magnification, and the use of advanced techniques to detect and treat such variations effectively. Awareness and clinical expertise in managing these complexities can enhance the prognosis of root canal therapy, ensuring long-term success for the patient.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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