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Middle Canals of Mandibular First Molar: Clinical Case Reports with Cone-Beam Computed Tomographic Evaluation

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ABSTRACT

Successful endodontic treatment depends upon the proper diagnosis, thorough cleaning, shaping and three dimensional obturation of the root canal system. Thorough knowledge of variations in root canal anatomy is vital for performing adequate root canal treatment. An accurate diagnosis of an extra root/canal facilitates the endodontic procedure and avoids procedural errors. Mandibular first molar is the first permanent posterior tooth to erupt in the oral cavity. This tooth often suffers from caries and requires endodontic treatment later on. Since the teeth exhibit considerable anatomical variations regarding the number of roots and root canals, this paper emphasizes on the utilization of magnification and spiral computed tomography for the assessment of canal configuration, along with the management of extra canals in permanent mandibular first molar.

Key Words: Extra canals, Mandibular first molar, Spiral computed tomography, Magnification

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INTRODUCTION

A thorough knowledge of root canal anatomy and morphology of human dentition is a prerequisite for successful root canal treatment. Complexity of root canal anatomy presents the clinical challenges and difficulties that often jeopardize the primary goal of such therapy. For a successful treatment outcome, careful interpretation of angled radiographs, proper access preparation and detailed exploration of the interior of the tooth are essential prerequisites.[1] Therefore, it is imperative that aberrant anatomy should be identified prior to, and during root canal treatment. Inability to locate and fill a root canal can cause post-treatment failure. Song et al.[2] reported that inability to locate the canals contributes to 19.7% failure of root canal treated cases. These missed or untreated canals contain necrotic tissue and bacteria that contribute to the chronic symptoms and non-healing periapical lesions.

Anatomical variations are more common in the molars. So the variations play an important role in root canal treatment.[3] As the earliest permanent posterior tooth to erupt, the mandibular first molar seems to be the tooth that most often requires root canal treatment. It is often extensively restored, and subjects to heavy occlusal stress.[4] The usual canal distribution of mandibular first molar is two canals in mesial root and one or two canals in distal root. The prevalence of middle mesial canal in mandibular first molar has been reported to be 2.07 – 13.3%,[5] and middle distal canal has been reported rarely with the prevalence of 0.2 – 3.0%.[6-8] The purpose of this article is to report the endodontic treatment of mandibular first molars with five root canals (one with three mesial canals and other with three distal canals) using dental operating microscope and cone-beam computed tomography (CBCT) as adjunctive aids. With increasing reports of aberrant canal

morphology, the clinician should be aware of varied morphology.

CASE REPORT 1

A 19 year-old female patient was referred to the Department of Conservative Dentistry and Endodontics, Genesis Institute of Dental Sciences and Research, Ferozepur, India with chief complaint of pain in right lower back region of mouth. The patient revealed the history of sharp, spontaneous and lingering pain for the last 2 days. Patient also reported symptoms of sensitivity to hot and cold. Tooth was tender on percussion. Clinical examination revealed carious right mandibular first molar (46). Pre-operative radiograph revealed radiolucency on mesial aspect of right mandibular first molar which extended to involve mesial and distal pulp horn. No radiographic changes evident in the apical areas of mesial and distal roots. (Figure 1a). Diagnosis of symptomatic irreversible pulpitis with symptomatic apical periodontitis was established. based on the clinical and radiographic findings.

Inferior alveolar nerve block was given using 1.8ml of 2% lignocaine containing 1:200,000 adrenaline (Lignox, Indoco Remedies Ltd, India). Tooth was isolated with rubber dam. The access cavity was prepared with Endo Access bur and Endo Z bur (Dentsply Maillefer). Initially four canals were located, two mesial canals (mesiobuccal and mesiolingual) and two distal canals (distobuccal and distolingual). After examining the chamber under operating microscope (Global Surgical corporation, St. Louis, Missouri), a groove was detected which connected distobuccal and distolingual canal orifices. Then, careful exploration with an endodontic explorer (DG16; Hu-Friedy, Chicago, IL, USA) was done and an additional canal orifice was found (Figure 1b). Coronal enlargement was performed with a nickel-titanium ProTaper SX rotary file (Dentsply Maillefer) to improve the straight-line access. Root canals were explored with ISO #10 K-files(Dentsply Maillefer). CBCT (Newton Giano) scan was done to confirm and ascertain the unusual root canal morphology. The scan revealed five canals (2 mesial canals and 3 distal canals) in the right mandibular first molar (Figure 2).

Working length of the canals was obtained using electronic apex locator (IPEX, NSK Dental equipements, Japan) and confirmed radiographically (Figure 1c). Cleaning and shaping was performed using ProTaper nickel-titanium rotary instruments (Dentsply Maillefer) with crown-down technique. During root canal preparation, irrigation was done using normal saline, 3% sodium hypochlorite solution (PreVest DenPro) and 17% EDTA (Dentsply Maillefer). 2% chlorhexidine digluconate (Vishaldentocare) was used as the final irrigant and sonic agitation was done using Endoactivator (Dentsply Maillefer). After the canal preparation was done, paper points (Dentsply Maillefer) were used to dry the canals and obturation was performed using cold lateral compaction of gutta-percha (Dentsply Maillefer) and AH Plus resin sealer (Dentsply Maillefer). A final radiograph was taken to establish the quality of the obturation. After completion of root canal treatment, the tooth was restored with a posterior composite filling material (Z100; 3M ESPE Dental Products, St Paul, MN) and a post-operative radiograph was taken (Figure 1d). The patient experienced no post-treatment discomfort and was subsequently referred for appropriate coronal restoration. Patient was recalled for a follow-up after 6 months.

CASE REPORT 2

A 54 year-old male patient was referred to the Department of Conservative Dentistry and Endodontics, Genesis Institute of Dental Sciences and Research, Ferozepur, Punjab, India with a chief complaint of slight pain at the left lower back teeth region for the past two weeks. He had a history of mild intermittent pain in the same region for the past three months. His past medical history was found to be non-contributory. Clinical examination revealed a carious left mandibular first molar (36) which was tender on percussion. The pulp sensitivity test of involved tooth gave no response to thermal tests. The pre-operative diagnostic radiograph revealed periodontal ligament widening, loss of lamina dura and ill-defined radiolucency involving mesial root of left mandibular molar. Radiolucency is evident on mesial aspect of 36 which was extending to the

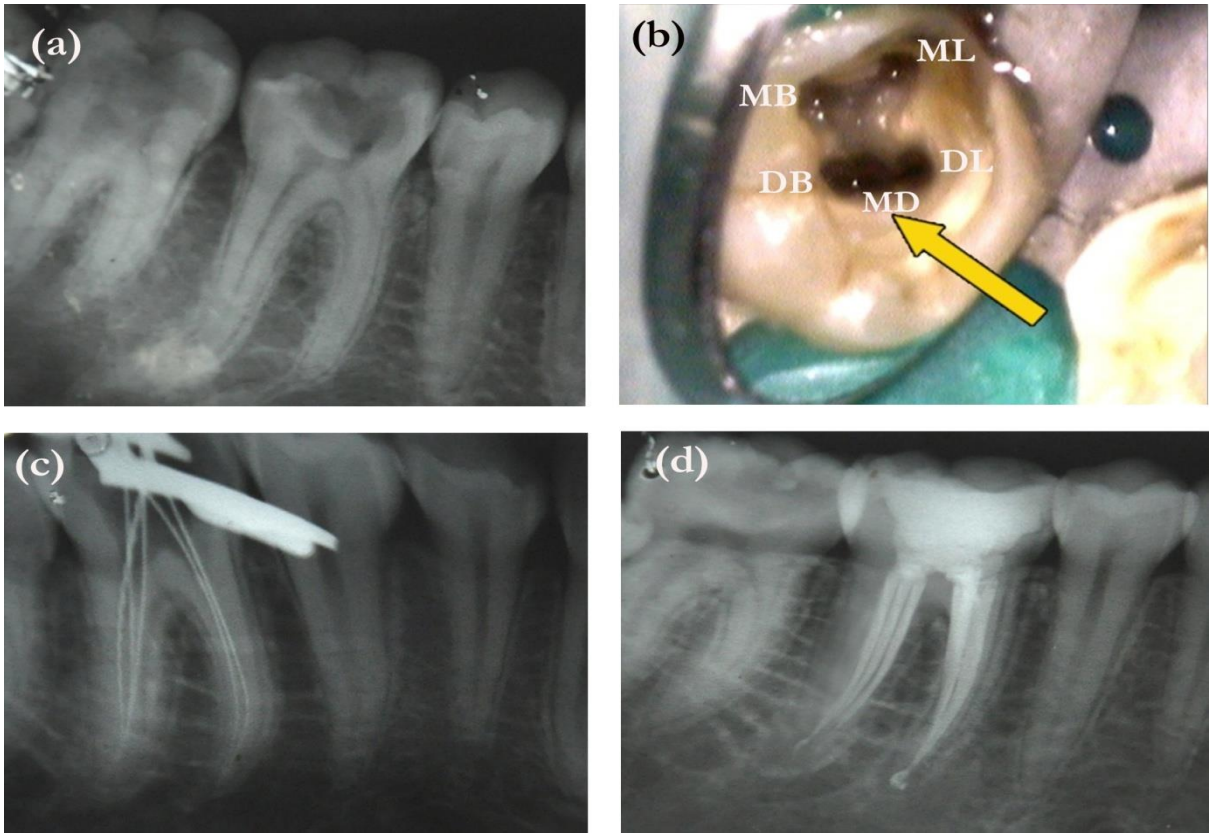

Figure 1. (a) Preoperative radiograph of tooth 46; (b) Access opening showing five canals (MB: Mesiobuccal; ML: Mesiolingual; DB: Distobuccal; MD: Middle distal; DL: Distolingual); (c) Working length radiograph of tooth 46; (d) Post-obturation radiograph of tooth 46.

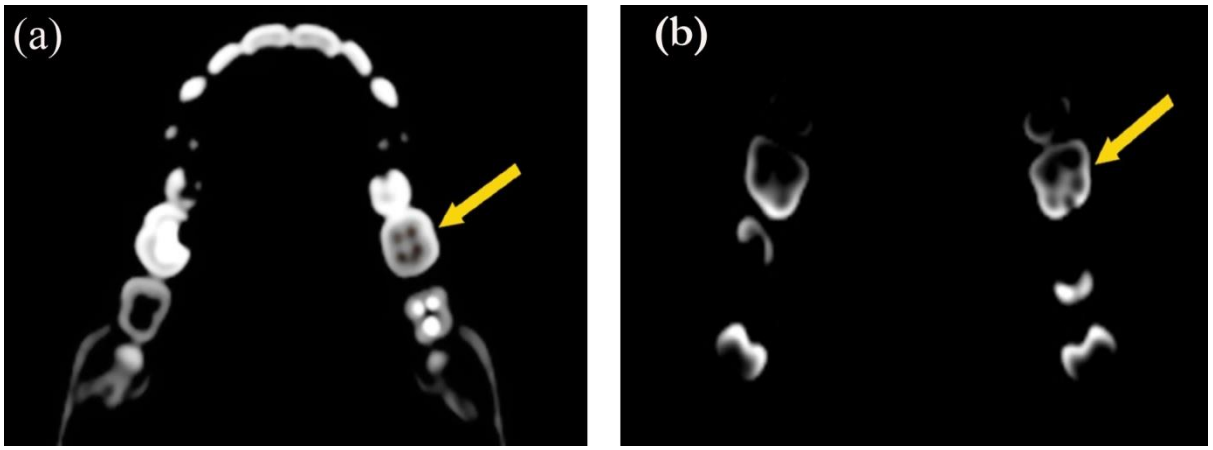

Figure 2. Axial sections of CBCT images of mandibular arch showing three distal and two mesial canals in right mandibular first molar (46).

mesial pulp horn. (Figure 3a). The clinical and radiographic findings led to a diagnosis of pulpal necrosis with symptomatic apical periodontitis.

Initial radiographic evaluation of the involved tooth indicated a normal canal configuration in the mesial and distal roots. The left inferior alveolar nerve was anesthetized using 2% Lignocaine with 1:20,000 adrenaline (Lignox, Indoco Remedies Ltd, India). The tooth was isolated using a rubber dam and an endodontic access cavity

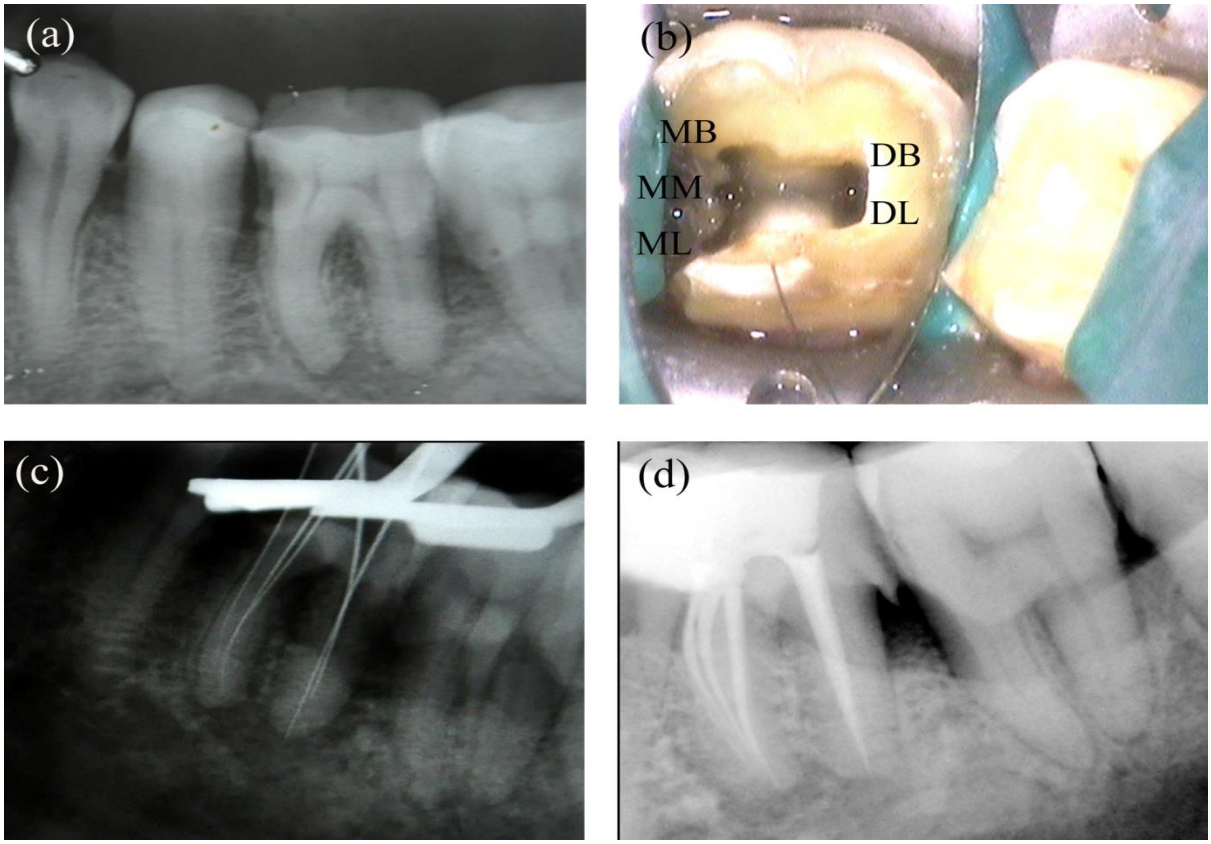

Figure 3. (a) Preoperative radiograph of tooth 36; (b) Access opening showing five canals (MB: Mesiobuccal; MM: Middle mesial; ML: Mesiolingual; DB: Distobuccal; DL: Distolingual); (c) Working length radiograph of tooth 36; (d) Post-obturation radiograph of tooth 46.

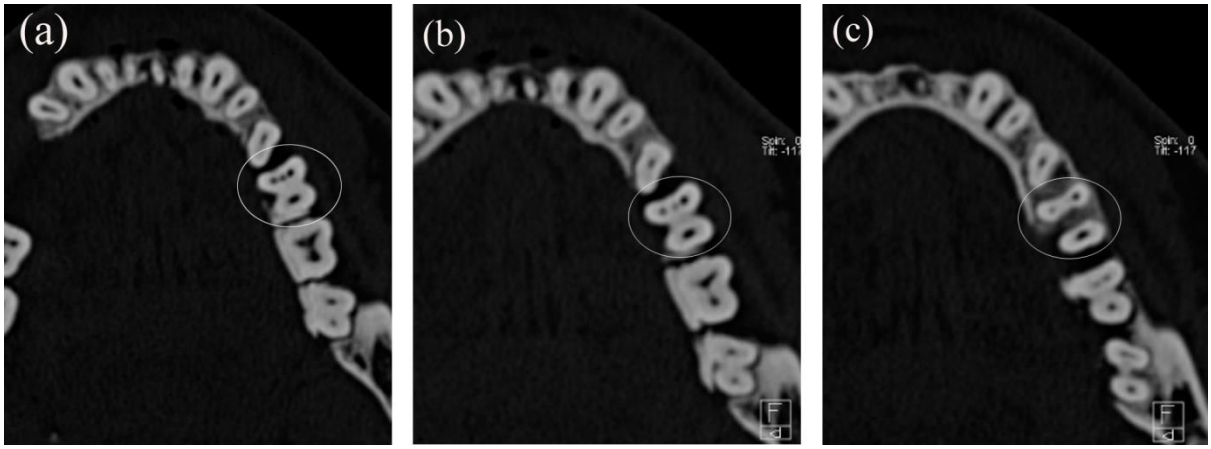

Figure 4. CBCT images of the maxillary arch showing axial sections at the (a) cervical, (b) middle, and (c) apical level.

was established. Four canals were located (mesiobuccal, mesiolingual, distibuccal and distolingual). After refinement of the access cavity using Start-X tips (Dentsply Maillifer) and examination under operating microscope (Global Surgical corporation, St. Louis, Missouri) five distinct orifices were found: three located mesially (mesiobuccal, middle mesial and mesiolingual) and two distally (distobuccal and distolingual) (Figure 3b). The canals were explored with #10 K-file (Dentsply Maillefer).

CBCT (Newton Giano) scan was planned after obtaining consent of the patient to confirm this unusual root canal morphology. Scans at three levels (cervical, middle and apical) revealed three canals (mesiobuccal, middle mesial and

mesiolingual) in mesial root and two distal canals on the left mandibular first molar (Figure 4).

Working length determination was done using apex locator (IPEX, NSK Dental equipements, Japan) and confirmed radiographically. Cleaning and shaping was performed using a crown down preparation technique with Protaper series nickel-titanium rotary instruments (Dentsply Maillefer) using copious irrigation with 3% sodium hypochlorite solution (PreVest DenPro) and EDTA (Dentsply Maillefer). The root canals were dried with paper points (Dentsply Maillefer) and obturated with cold, laterally condensed gutta-percha (Dentsply Maillefer) and AH Plus resin sealer (Dentsply Maillefer). The tooth was restored with a composite restoration (Z100; 3M ESPE Dental Products, St Paul, MN). Finally, the post-operative radiograph was taken.

DISCUSSION

Identification and treatment of extra canals is the cornerstone to successful endodontic practice. A wide variation and complexity of root canal systems exist. A root with one canal ending in a single apical foramen is a rare entity.[9] Weine et al.[10] divided the position of one or two canals within a root into four basic types. Vertucci[1] described a much more detailed canal system and identified eight pulp space configurations. In 2004, Sert and Bayirli[11] reported 14 new additional canal types highlighting the complexity of root canal systems. The mandibular first molar typically presents with 2 well-defined roots, a mesial root characterized by a flattened mesiodistal surface and widened buccolingual surface with 2 root canals, and a distal root mostly straight with a wide oval canal or 2 round canals.[12] Clinically, middle canal can be described as an intermediate canal between buccal and lingual root canals; its orifice being disclosed as a depression or a bleeding point within the developmental groove connecting the two canals.[13]

There are only few comprehensive studies reporting the incidence of three distal canals in mandibular first molar. Berthiaume[14] first reported the incidence of three distal canals which ended in two apical foramina. Quackenbush[15] reported the existence of three separate distal canals in two extracted mandibular first molar. Walker and Quackenbush[16] studied that the extra root occurred unilaterally about 40% of the time, predominantly on the right side. In previous documented case reports[17], and the present case, morphological variations have occurred in the distal root/canal of the right mandibular first molar, unlike Reeh[18] and Ghoddusi et al.[19], who have reported such variations on the left side. A previous study by Reuben et al.[20] which has examined 125 mandibular first molars in an Indian population using spiral computerized tomography concluded that none had three distal canals. However, this case report documents the three distal root canals within a single distal root in a patient of Indian origin. In the presented case report 1, canals were individually explored using K-files. However, during subsequent placement of the file in distobuccal canal, file in the middle distal canal did not reach to its full working length. Hence, it was concluded that middle distal canal joined distobuccal canal apically, describing type XV (3-2) canal configuration pattern by Sert et al.[11]

Most classic literature articles describe the presence of 2 canals in the mesial root. The first evidence of an independent third mesial canal with its own access orifice and apical foramen was described by Vertucci et al.[21] and by Barker et al.[22] Later, Pomeranz et al.[23] conducted a comprehensive in vivo study on 100 mandibular molars and found that 12 molars had middle mesial canal. He categorized them into fin, confluent and independent. Weine[24] published a case of a third independent mesial root in a mandibular first molar that was located during endodontic retreatment. Goel et al.[25] reported the incidence of middle mesial canal in 15% of the study specimens, amongst only 6.7% were independent canals. However, it was concluded that the third canal is not actually an additional mesial canal but rather the sequelae of instrumenting the isthmus between the mesiobuccal and mesiolingual canals.[26] Either way, it constitutes a distinct anatomical structure needing to be treated, otherwise treatment failure may occur. In the presented case report 2, individual canal exploration using #10 k-files reached the full working length. However, subsequent to the placement of file in mesiobuccal canal, files in middle mesial and mesiolingual canal did not reach full working length. It was concluded

that all three canals joined at the apical third, describing type XVIII canal configuration by Sert and Bayirili.[11]

Radiographic examination using conventional intraoral periapical views is important for the evaluation of the canal configuration. However, it has its inherent limitation to assess the root canal system completely. Conventional multidetector computed tomography (CT) imaging has been widely used in medicine since the 1970s and was introduced in the endodontic field in 1990.[27] The use of spiral computerized tomography (SCT) scans in dentistry has increased dramatically in the past 2 decades. With SCT scans, it is possible to reconstruct overlapping structures at arbitrary intervals, and, thus, the ability to resolve small subjects is increased.[28] CBCT is capable of providing accurate, submillimeter-resolution images in formats allowing 3D visualization of the complexity of the maxillofacial region.[29] CBCT acquires the data by a single partial or full rotational scan from an X ray source and a reciprocating area detector moves synchronously with the scan around a fixed fulcrum within the patient's head.[29] The efficient use of the radiation beam and the elimination of the need for a conventional image intensification system used in conventional computed tomography scanners result in a huge reduction in radiation exposure.[17]

Role of microscopy in dentistry should not be underestimated. Dental operating microscope (DOM) promotes an adequate visual field by providing magnification and illumination, thus increasing the number of canals observed, with a 7.8% increase in canal location in mandibular molars.[30] DOM has increased the possibilities for detection and negotiation of 'hidden anatomy' of root canal system.[31] Additionally, use of micro-openers, properly designed access cavity, champagne bubble test, transillumination, use of piezoelectric ultrasonics, looking for the rules of symmetry, red line test, white line test and perio-probing are important tools for locating root canal orifices.[32]

CONCLUSION

Treating additional aberrant canals may be challenging, but failures are caused by inability to identify the root canals.The routine use of DOM while performing endodontic treatment is suggested as it will definitely be helpful in identifying and treating all root canals successfully. The evaluation of CBCT images can resulted in better understanding of root canal anatomy, enabling the clinician to investigate the root canal system for more efficient cleaning, shaping and obturation.

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