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Endodontic Management of a Mandibular First Molar with Unusual Canal Morphology

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ABSTRACT

A comprehensive knowledge and understanding of root canal anatomical variations are essential for successful root canal treatment. Mandibular molar teeth show considerable variations in their external and internal radicular morphology that require special attention from dental practitioners to provide the best clinical outcomes to the patients. This report aims to present root canal treatment of a mandibular first molar that has six separate root canals (three root canals in the mesial roots and three in the distal roots [^{2}36 M^{3} D^{3}]). This report points out the importance of proper exploration for identifying additional canals in mandibular molars.
Key words: Cone beam computed tomography, mandibular molar, middle mesial canal, middle distal canal

INTRODUCTION

Sufficient knowledge on root canal morphology and absolute clinical thoroughness are essential for successful root canal treatment (1). Mandibular molars present a clinical challenge due to its wide variation in root canal morphology. Mandibular first molars are commonly double-rooted; and generally, there are two or three canals in the mesial root and one or two canals in the distal root (1, 2). Nevertheless, the occurrence of three canals in the distal root has been reported and can reach up to 3% (3). A recent micro-computed tomography micro-CT study demonstrated the existence of more complex root canal configurations in the distal root of mandibular first molars (4).

Literature demonstrates the existence of mandibular first molars with six root canals in which the mesial root encases two, three, or four canals, and the distal root encases four, three, or two canals, respectively (5-17) (Table 1). Such accessory root canals can often join nearby main canals, and only two reports documented the occurrence of six-canalled mandibular first molar, in which all canals have separate foramina (8, 14). Six canals have also been reported in three- and four-rooted mandibular first molars (15, 18).

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HIGHLIGHTS

- This report presents a successful root canal treatment of a double-rooted mandibular first molar that has six separate root canals.
- Careful exploration between canal orifices is essential to prevent the occasion of missed canals and subsequent undesirable clinical outcomes.

This report aims to present the endodontic management of unusual canal morphology of a double-rooted mandibular left first molar with six canals, three separate canals in the mesial root, and three separate canals in the distal root confirmed by post-obturation cone beam CT (CBCT).

CASE PRESENTATION

A 56-year-old female patient was referred to the endodontic department for root canal treatment of her mandibular left first molar. Medical history showed a diagnosis of rheumatoid arthritis 9 years ago and reg-

TABLE 1. Summary of reports for mandibular molars having six root canals [according to the classification presented by Ahmed et al (19)].

Authors/s	Year	Root and root canal morphology
Martínez-Berná and Badanelli (5)	1985	1-Double rooted mandibular first molar: Mesial (3-3), Distal (3-2) [^{2}**46 M^{3} D$^{3-2}$**] 2-Double rooted mandibular first molar: Mesial (3-3), Distal (3-1) [^{2}**36 M^{3} D$^{3-1}$**]
Ghoddusi et al (18)	2007	Four rooted mandibular first molar: Mesio-buccal (1-1), Mesio-lingual (1-1) Disto-buccal (2-2), Disto-lingual (2-2) [^{4}**46 MB^{1} ML^{1} DB^{2} DL^{2}**]
Kontakiotis and Tzanetakis (6)	2007	Double rooted mandibular first molar: Mesial (4-1), Distal (2-1) [^{2}**46 M$^{4-1}$ D$^{2-1}$**]
Aminsobhani et al (7)	2010	Double rooted mandibular first molar: Mesial (4-2), Distal (2-1) [^{2}**36 M$^{4-2}$ D$^{2-1}$**]
Ryan et al (8)	2011	Double rooted mandibular first molar: Mesial (3-3), Distal (3-3) [^{2}**46 M^{3} D^{3}**]
Gupta et al (9)	2012	Double rooted mandibular first molar: Mesial (3-2), Distal (3-2) [^{2}**46 M$^{3-2}$ D$^{3-2}$**]
Baziar et al (10)	2014	Double rooted mandibular first molar: Mesial (2-2), Distal (4-2) [^{2}**46 M^{2} D$^{4-2}$**]
Hasan et al (11)	2014	Double rooted mandibular first molar: Mesial (3-2), Distal (3-2) [^{2}**36 M$^{3-2}$ D$^{3-2}$**]
Sinha et al (12)	2014	Double rooted mandibular first molar: Mesial (4-2), Distal (2-2) [^{2}**36 M$^{4-2}$ D^{2}**]
Jain et al (13)	2015	Double rooted mandibular first molar: Mesial (4-2), Distal (2-1) [^{2}**46 M$^{4-2}$ D$^{2-1}$**]
Maniglia-Ferreira et al (14)	2015	Double rooted mandibular first molar: Mesial (3-3), Distal (3-3) [^{2}**46 M^{3} D^{3}**]
Martins and Anderson (15)	2015	1- Three rooted mandibular first molar: Mesial (3-1), Distobuccal (1-1), Distolingual (2-1) [^{3}**46 M$^{3-1}$ DB^{1} DL$^{2-1}$**] 2- Double rooted mandibular first molar: Mesial (4-2), Distal (2-2) [^{2}**46 M$^{4-2}$ D^{2}**]
Alenezi (16)	2016	Double rooted mandibular first molar: Mesial (3-2), Distal (3-1) [^{2}**36 M$^{3-2}$ D$^{3-1}$**]
Çiçek et al (17)	2016	Double rooted mandibular first molar: Mesial (4-2), Distal (2-1) [^{2}**46 M$^{4-2}$ D$^{2-1}$**]

ular intake of corticosteroids. Dental history revealed previous pain response to cold and hot temperatures and episodes of spontaneous pain attacks in the lower left jaw. A report from the referring dentist indicated that a previous attempt for an access cavity preparation has been performed with failure to locate the canals, and it was stated that the canals were calcified. A mandibular arch CBCT (field of view 5 × 8 cm, Voxel size 125 um, Veraviewepocs R100, J Morita, Osaka, Japan) was performed. CBCT axial images showed that canals encased in the mesial and distal roots were narrow, especially in the middle and apical thirds of the roots (Figure 1).

After administration of a nerve block anesthesia, rubber dam application and field disinfection using NaOCl 5.25% were performed, the temporary restoration was removed,

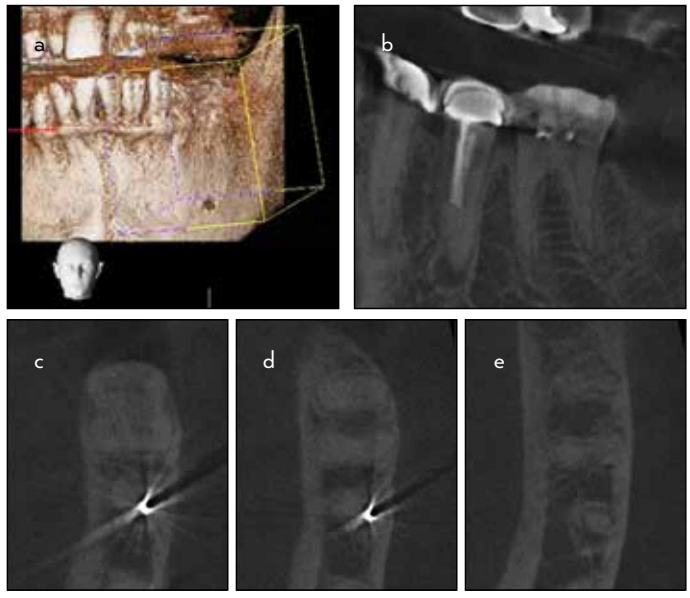

Figure 1. a-e. Reconstructed image showing the area of interest (a) Preoperative CBCT image [sagittal] (b) Preoperative CBCT image [axial section - coronal] (c) Preoperative CBCT image [axial section - middle] (d) Preoperative CBCT image [axial section - apical] (e)

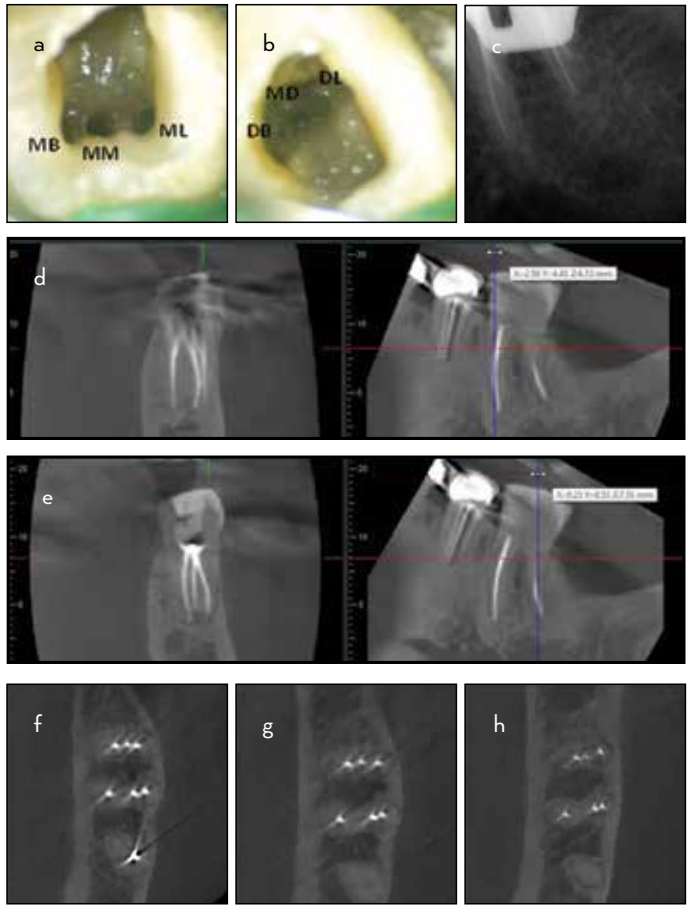

Figure 2. a-h. A photograph showing the 3 orifices of the mesial canals (a) A photograph showing the 3 orifices of the distal canals (b) Confirmation periapical radiograph for the master GP (c) Postoperative CBCT scan (coronal and sagittal sections - mesial root) (d) Postoperative CBCT scan (coronal and sagittal sections - distal root) (e) Postoperative CBCT image [axial section – coronal] (f) Postoperative CBCT image [axial section – middle] (g) Postoperative CBCT image [axial section – apical] (h)

and the access cavity was refined using a tapered diamond stone under 8× magnification using a Leica M320 surgical microscope (Leica Microsystems, Wetzlar, Germany). Guided by the CBCT and recessional lines of pulpal floor, a search for the mesial and distal canals was performed using ET20 ultrasonic tip operating at power 8 (Satelec, Acteon, France) under 20× magnification. MB and ML canals were identified and negotiated with K file #10 (Mani, Japan). Troughing through the isthmus between the MB and ML revealed a third middle mesial (MM) canal (Figure 2a). Two distal canals (DB and DL) were initially identified. Tooth length was determined using electronic apex locator (Root ZX, J Morita, Japan). Root canal preparation was performed using iRace system (FKG, Switzerland). NaOCl (2.6%) irrigation was used after each file. Careful inspection revealed a shadow of a third canal in the distal root (middle distal [MD] canal) (Figure 2b). The canal was negotiated under magnification, and then instrumented. Simultaneous placement of different files inside the mesial canals showed that all of them reached the working length, indicating that they have separate apical foramina. This was also evident with the distal canals. This was reconfirmed during master gutta-percha cone placements (Figure 2c). Therefore, the tooth was classified as $^{2}36\ M^{3}\ D^{3}$ (19). Final irrigation was performed using Qmix (Tulsa, Dentsply, Switzerland). After drying the canals, master gutta-percha cones (#35/4% for mesial canals and #40/4% for distal canals) and Topseal root canal sealer (Dentsply) were inserted inside the canals. Continuous wave of condensation (System B, Kerr Endo, USA) and thermoplasticized gutta-percha injection (Obtura II, Spartan, USA) techniques were used for obturation. Glass ionomer cement (ShangHai International, Hamburg, Germany) was placed as a temporary restoration. Limited field of view postoperative CBCT was performed to confirm proper three-dimensional (3D) obturation of the canals, especially that the six separate canals and foramina may not be clearly identified using periapical radiographs due to the potential overlap of images with mesial and distal shifts (Figure 2d-h). The patient was then referred back to the referring dentist.

DISCUSSION

Proper identification, complete debridement followed by 3D obturation of the root canal system are the main objectives of root canal treatment (20). The root canal anatomy shows considerable variations that require special attention to prevent the occasion of missed root canals that can reach as much as 42% (21). This report presents the endodontic management of a mandibular left first molar with a rare anatomical variation, in which the mesial and distal roots encase three separate root canals each.

The last decade has shown numerous reports on the identification of internal radicular variations in mandibular molars. For many years, the prevalence of MM root canals in mandibular molars has been reported to range from <1% to 19% (22); however, a recent clinical study reported that the prevalence of MM canals can reach up to 46.2% (2). It is worth noting that separate MM canals remain the least frequent anatomical variation (2, 22).

The occasion of MD canals in the mandibular molars has also been reported in the literature. Previous reports demonstrated distal roots with complex root canal configurations such as type (3-1) (3, 23), type (3-2) (5, 9) as well as type (3-3) (24, 25). The occurrence of four distal canals has also been reported (10).

A review on the literature shows that only two reports have documented the occurrence of six-canalled mandibular first molar in which all canals have separate foramina. One report described a case of a mandibular first molar with six separate canals instrumented with conventional hand and profile rotary files and obturated using a warm vertical compaction technique (8). Another report presented a mandibular first molar with a similar morphology instrumented with a reciprocating file system and obturated using a warm compaction technique (14).

In addition to the formation of tertiary dentine as a response to injury, drugs have the potential to induce pulp canal calcification (26, 27). In this case, it is believed that the long-term administration of systemic corticosteroids was another potential cause for the calcification of the mesial and distal root canals and probably the subsequent complex canal anatomy (26). Long-term systemic corticosteroids are used in the treatment of chronic autoimmune diseases such as rheumatoid arthritis. While these drugs may be considered essential for the patient's health, adverse reactions, such as disturbances in mineralized tissue metabolism, increased risk of infection, and disturbances in wound healing, do occur, which depend upon the dose level and the treatment duration (26).

Current knowledge on root canal morphology is based on research findings and individual case reports (28). This case describes the concurrent existence of two rare anatomical variations (separate MM and MD canals) in the mesial and distal roots of a mandibular first molar, which can be clearly seen in the coronal and axial sections of the postoperative CBCT. This emphasizes the importance of careful exploration between canal orifices to prevent overlooking canals and subsequent undesirable clinical outcomes.

CONCLUSION

The root canal morphology in mandibular molars is variable and complex. Adequate knowledge and absolute clinical thoroughness are essential for successful root canal treatment procedures.

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