CASE REPORT

Mandibular first molar with six root canals: a rare entity

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SUMMARY

Recently, there has been an ongoing trend of case reports that highlight the presence of more than four root canals in mandibular first molars. This tendency warns clinicians to be more prudent when dealing with mandibular first molars requiring endodontic treatment. Moreover, radiographic examination should be taken as a clue providing tool rather than as an absolute guide to anatomy and its associated aberrances. This case reports the successful non-surgical endodontic management of a mandibular first molar with six root canal systems with three canals in the mesial root and three in the distal root. The classification of root canal systems found in this case was Sert and Bayirli type XV in both the roots. After non-surgical endodontic treatment, the tooth was restored definitively with a resin composite core followed by porcelain fused to the metal crown. This case adds to the library of previously reported cases of mandibular first molars with six root canals and further emphasises on the importance of rare morphological deviations that may occur in the mandibular first molars.

BACKGROUND

The therapeutic success of endodontics depends on several factors such as diagnosis, adequate access and application of skills towards the thorough cleaning, shaping and obturation of the root canal system.^{1–3} The endodontic system of human teeth comprises several variations which range from fins, deltas, isthmuses, anastomoses, cul-de-sacs, additional canals to additional roots.^{4–10} Therefore, to accomplish thorough cleaning and shaping, it is imperative to develop a good understanding of the root canal anatomy and associated deviations such as additional root canals, as evidence suggests that a missed root canal system may lead to post-treatment disease.^{11 12}

The mandibular first molars normally have mesial and distal roots that harbour two mesial canals and one or two distal canals, respectively.¹³ One of the major variants of mandibular first molars is the radix entomolaris, which has an accessory third root present on its lingual side.¹⁴ Infrequently, there is an additional canal known as the middle mesial canal, located in the mesial root. This canal is located in the developmental groove present between the mesiolingual and mesiobuccal canals. The reported incidence of a middle mesial (MM) canal ranges from 1% to 15%.^{4 15} Another rare occurrence is the presence of three canals within the distal root. The third canal is referred to as the middle distal (MD) canal, which is located between the distolingual and distobuccal canals.

The presence of three canals in the distal root is considered extremely rare and their reported incidence is 0.2–3%.^{5–7 11 14–19} However, the presence of six or more root canals is highly exceptional and such teeth are described in a small number of case reports only with their incidence being unknown^{20–25} (table 1). The purpose of this article is to report the successful endodontic treatment of a mandibular first molar exhibiting six root canal systems (three in the mesial root and three in the distal root).

CASE PRESENTATION

A 31-year-old man presented with symptoms of food stagnation and sensitivity to hot and cold stimuli in his lower right tooth. On examination, he had a deep carious lesion on the distal surface of the lower right mandibular first molar (#30; figure 1A). Periodontal probing depths were within normal limits. The tooth was –ve to percussion and the thermal tests were +ve with lingering sensitivity to cold suggesting a hyperaemic state of pulp. Periapical radiographic examination revealed that the carious lesion was in close proximity to the dental pulp. A diagnosis of pulpal hyperaemia secondary to a deep chronic carious lesion was established. The patient was given the option of root canal treatment or an extraction followed by a fixed prosthesis; however, the patient elected for endodontic treatment. The risks and benefits of the treatment were explained to the patient and a written consent was obtained before embarking on treatment.

INVESTIGATIONS

Pulp vitality testing, periapical radiograph.

DIFFERENTIAL DIAGNOSIS

Hyperaemic pulp secondary to a deep chronic carious lesion.

TREATMENT

Treatment was initiated with the administration of local anaesthesia (4.4 mL 2% lidocaine with 1:100 000 epinephrine) and rubber dam isolation. Under magnification (EyeMag Pro F, Carl Zeiss Meditec Ag, Germany), caries were removed from the cavity by a slow speed round carbide. A carious pulpal exposure was readily visible and haemorrhage could not be controlled confirming the hyperaemic state of the pulp. The pulp tissue was excavated from the pulp chamber and the orifices identified were mesiobuccal (MB), mesiolingual (ML), distolingual (DL) and distobuccal (DB). In

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Table 1 Reported cases with six or more root canals

Author	Case	Number of canals	Mesial root configuration	Distal root configuration	Additional root
Reeh ²⁵	23-year-old man, USA Left mandibular first molar	7	4 canals MB1, MB2, ML1, ML 2	3 canals, all separate DB, MD, DL	
Ghoddusi <i>et al</i> ²⁰	30-year-old man, Iran Left mandibular first molar	6	2 canals MB, ML	4 canals DB1, DB2, MD, DL	Distolingual (RE)
Kontakiotis and Tzanetakis ²³	30-year-old man Left mandibular first molar	6	4 mesial canals Unspecified	2 distal canals DB, DL	
Aminsobhani <i>et al</i> ²²	30-year-old woman, Iran Right mandibular first molar	6	4 mesial canals Unspecified	2 distal canals DB, DL	
Ryan <i>et al</i> ²¹	52-year-old woman, USA Left mandibular first molar	6	3 canals, all separate MB, MM, ML	3 canals, all separate DB, MD, DL	
Gupta <i>et al</i> ²⁴	38-year-old man, North India Right mandibular first molar	6	3 canals MB, MM: confluent ML: independent	3 canals DB, DM: confluent DL: independent	

RE, radix entomolaris

addition, the presence of the mesiolingual canal was found to be distant to the mesiobuccal canal, which suggested that the mesial root is wider than normal. The developmental groove between the mesiolingual and mesiobuccal canals was further evaluated and an additional orifice was identified, present between the ML and MB canals, and located in close proximity to the MB canal (figure 1B).

The canal was identified as the MM canal and was successfully negotiated to full length with #8 and #10 H-type hand files. Working length was confirmed with the help of an electronic apex locator (Root ZX, J Morita Corp, Tustin, California, USA) and periapical radiographs (GXS-700 sensor, Gendex Dental System, Des Plaines, Illinois, USA) (figure 1C). It was observed that the middle mesial canal was merging with

the primary mesiobuccal canal in its apical third. The canal system was classified as confluent-type.¹⁰ The working lengths of MB, MM, ML, DB and DL were 22, 21, 21.5, 20 and 20.5 mm, respectively. Following the determination of working lengths, pulpectomy was carried out and the access was sealed with a temporary filling (Cavit, Espe, Seefeld, Germany).

The patient returned to the dental clinic for his second visit after 1 week. All the canals were prepared using the protaper rotary system (Dentsply-Maillefer, Ballaigues, Switzerland) with RC prep (Hawe Neos Dental, Bioggio, Switzerland) as the lubricant. At regular intervals, copious irrigation with 5% sodium hypochlorite was performed. The mesial and distal canals were finished with F1 and F2 protaper rotary files (Dentsply-Maillefer, Ballaigues, Switzerland), respectively. A final rinse using 95%

Figure 1 Preoperative radiograph (A), access cavity showing the middle mesial canal (black arrow) (B), working length radiograph (C), prepared canals before obturation (D).

isopropyl alcohol was given and the canals were dried with paper points (figure 1D). Following disinfection of the gutta-percha points for 1 min in 5% sodium hypochlorite, the points were cleansed with alcohol to wipe away residual sodium hypochlorite and down-packed using Buchanan pluggers (Analytic Endodontics, Sybron Dental Specialties, Glendora, California, USA) to obtain an apical cork till 4 mm. Later, all canals were sequentially backfilled in increments using the Obtura II system (Obtura Spartan, USA). Sealapex (Kerr Manufacturing Co) was used as the root canal sealer (figure 2A, B). Post-obturation radiographs were obtained at distal angulations to evaluate the three-dimensional pack in all five canals (figure 2B). Following obturation, the tooth was restored with a temporary restoration (Cavit, Espe, Seefeld, Germany) and the patient was rescheduled to receive a coronal build-up.

The patient returned to the dental clinic after a week's time for core build-up with mild symptoms of tenderness. On removing the temporary restoration, a small remnant of gutta percha was observed between the obturated distolingual and distobuccal canals (figure 2C). An evaluation of the area between the distal canals revealed a sixth canal system, the middle distal canal (MD), which initially went unnoticed. A working length radiograph confirmed the presence of this canal which was merging with the DB canal system in its apical third (confluent-type) (figure 2D).¹⁰ This canal had a length of 17.5 mm till its merging point with the DB canal. After shaping and cleaning, it was obturated and a temporary restoration was placed (Cavit,

ESPE, Seefeld, Germany) (figure 3A). On the subsequent visit, the patient was asymptomatic and a core build-up with Smart Dentin Replacement (DENTSPLY DeTrey, Konstanz, Germany) was placed. A porcelain fused-to-metal crown was provided as the definitive restoration (figure 3B).

OUTCOME AND FOLLOW-UP

At 6-month follow-up, the radiograph shows successful non-surgical root canal treatment (figure 3C). The patient is symptom free.

DISCUSSION

This report highlights a rare case of a mandibular first molar with six root canals. Three canals were located in the mesial root, while three were found within the distal root. Both the roots had canals with type XV (3-2) configuration,¹⁸ that is, the middle mesial canal merged with the mesiobuccal canal in its apical third and exited through a common foramen, and the middle distal canal joined the distobuccal canal in its apical third having a mutual exit. The mesiolingual and distolingual canals were independent-type with separate orifices and apical portal of exits (figure 4). In this case report, the tooth was right-sided and a majority of the cases reported with additional roots and canals have described right-sided mandibular first molars.²⁶⁻³⁴

In 1986, Quackenbush³⁵ found that an additional root in the mandibular molars occurred unilaterally in up to 40% of the cases, predominantly on the right side. Moreover, these teeth

Figure 2 Cone fit radiograph (A), post-obturation radiograph showing five filled canals (B), following obturation, a remnant of gutta percha was observed in the orifice of an unidentified middle distal canal (black arrow; C), working length radiograph showing the middle distal canal (white arrow; D).

Figure 3 Radiograph taken at mesial angulation demonstrating six obturated canals (A), Final restoration (B), 6-month follow-up (C).

are much likely to harbour an additional root canal due to the presence of an extra root. However, this correlation of right-sided mandibular molars to the presence of an additional root can simply be recognised as an observation. A case recently reported by Gupta *et al*²⁴ discussed the presence of six root canals in a mandibular right first molar. In their case report, it was found that the middle mesial was confluent in its apical third with the mesiobuccal canal, whereas the middle distal had a mutual exit with the distolingual canal (table 1).

It has been reported in the literature that secondary dentin deposition occurs with age due to which partitions develop leading to progressive differentiation and separation of canals as well as formation of intercanal communications. The prevalence of such intercanal communications is usually high in the middle age group while being the lowest among young and old age groups.^{36 37}

Every effort should be made to achieve a proper access cavity keeping the 'law of concentricity' in consideration.³⁸ This would help the operator to follow the outline of the tooth and make adequate sized access cavity. Once the appropriately flared access cavity is finalised, it is recommended to sequentially irrigate the access cavity with 17% aqueous solution of ethylene diamine tetra acetic acid followed by 95% ethanol to achieve adequate cleaning and drying before visual examination of the pulp cavity floor under magnification.³⁹ The canal may initially not be visible due to the overlying internal triangular dentin which often conceals the orifices. The developmental grooves between the canals should be troughed and inspected for a

potential sticky point. If a sticky point is located, it should be carefully 'pecked' towards progressive advancement following the same methods employed for negotiating fine or blocked canals.⁴⁰ It is imperative to establish a straight line access into the canal as it reduces the chances of instrument separation.⁴¹ Once a glide path is established, the clinician should then proceed with a normal rotary sequence to complete the shaping and cleaning process.

There is an increasing trend of case reports that highlight mandibular first molars with anatomical aberrances such as accessory root canals. In order to be successful in endodontic treatment, clinicians should also be aware of root canal anatomy and its associated variances. A sceptical approach when searching for additional canals may prove beneficial. Moreover, several diagnostic methods are available that can facilitate detection of additional root canal systems. These measures include radiographs at various angulations,⁴² appropriate access cavity,⁴³ good lighting and magnification using a dental operating microscope,⁴⁴ careful visualisation, inspection of the chamber floor with an endodontic explorer, use of dyes, transillumination, white line test, red line test, bubble test, ultrasonics, chamber floor troughing and advanced imaging techniques such as cone beam CT (CBCT).⁴⁵ It should be kept in mind that there are several limitations of conventional radiographs mentioned in the literature. In contrast, CBCT has proven to be a very successful modality as it is not subjected to a two-dimensional view, geometric distortion, image elongation or foreshortening, etc.⁴⁶ CBCT has been shown to be a powerful tool for evaluating the

Figure 4 Diagrammatic illustration of the mesial (A) and distal (B) root canal configuration.

extent of canal calcification and therefore helps in contributing to the proper sequence of the treatment.⁴⁷ Therefore, an intraoperative evaluation with CBCT is highly recommended while managing such atypical cases. However, CBCT imaging was not performed for this case as it is presently not available at our centre.

Learning points

- Cone beam CT imaging should ideally be performed for teeth showing additional canals on access in order to avoid left out canals postoperatively.
- Mandibular molars should be considered to have four or more canals unless proven otherwise.
- Use of magnification and adequate flaring of access walls is helpful in providing improved visualisation of the pulp cavity floor.

Contributors MH carried out the treatment on the patient mentioned in this case report and wrote the manuscript. In addition to this, all the coauthors mentioned have made a significant contribution to this case report with regard to the write-up and its correction.

Competing interests None.

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