Endodontic Management of a Maxillary First Molar with Eight Root Canal Systems Evaluated Using Cone-beam Computed Tomography Scanning: A Case Report

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Abstract

Introduction: Root canal treatment of maxillary molars presenting with complex root canal configurations can be diagnostically and technically challenging. Methods: Nonsurgical endodontic therapy of a left maxillary first molar with three roots and eight root canals was successfully performed. This unusual morphology was diagnosed using a dental operating microscope (DOM) and confirmed with the help of cone-beam computed tomography (CBCT) images. Results: CBCT axial images showed that both the mesiobuccal and distobuccal root contained a Sert and Bayirli type XV canal, whereas the palatal root showed a Vertucci type II canal configuration. Conclusions: The use of a DOM and CBCT imaging in endodontically challenging cases can facilitate a better understanding of the complex root canal anatomy, which ultimately enables the clinician to explore the root canal system and clean, shape, and obturate it more efficiently. (J Endod 2011;37:715–719)

Key Words

Cone-beam computed tomography scanning, maxillary first molar, root canal anatomy, root canals

The main objective of root canal treatment is thorough cleaning and shaping of all pulp spaces and its complete filling with an inert filling material (1). A major cause of post-treatment disease is the inability to locate, debride, or adequately fill all canals of the root canal system (2). Together with diagnosis and treatment planning, a better knowledge of the root canal system and its frequent variations is an absolute necessity for successful root canal treatment (3). The form, configuration, and number of root canals in maxillary first molars have been discussed for more than half a century (4). Maxillary first molars commonly present with three roots and three canals, with a second mesiobuccal canal (MB2) seen in 56.8% and 96.1% of the cases (5–7). Apart from these presentations, a wide variation of root and canal configurations of the maxillary first molars has been documented in the dental literature. This includes a single root canal in a single root (8), two root canals (9), five root canals (10), six root canals (11), C-shaped canals (12), and an additional palatal root (13). Recently, Kottoor et al (14) reported the endodontic management of a maxillary first molar with seven root canals. Case reports of maxillary first molars presenting with six or more root canals are summarized in Table 1. This case report presents a maxillary first molar with an unusual morphology of three roots and eight root canals, which has neither been reported in any clinical or laboratory studies nor clinical case reports so far. This unusual morphology was confirmed with the aid of cone-beam computed tomography (CBCT) scanning.

Case Report

A 30-year-old Indian male patient reported to the postgraduate clinic of the Department of Conservative Dentistry and Endodontics, Meenakshi Ammal Dental College, Chennai, India, with the chief complaint of spontaneous pain in the upper left posterior for the past 5 days. He revealed a history of intermittent pain for the last 2 months, which had increased in intensity in the preceding 5 days. The patient reported subjective symptoms of prolonged sensitivity to hot and cold and the recent heightened intensity of pain, which awakened the patient throughout the night. Clinically, the left maxillary first molar (tooth #14) had a deep mesio-occlusal carious lesion. The patient’s medical history was unremarkable. Pulpation of the buccal and palatal aspects of the tooth did not reveal any tenderness; however, the tooth was tender to vertical percussion. Periodontal probing around the tooth and mobility were within physiological limits. Thermal testing (heated gutta-percha and dry ice) caused an intense lingering pain, whereas electric pulp testing (Parkele Electronics Division, Farmingdale, NY) showed pulpal vitality on tooth #14. Preoperative radiographs revealed a mesio-occlusal radiolucency approaching the pulp space with a widened periodontal ligament adjacent to the mesiobuccal root. From the clinical and radiographic examination, a diagnosis of symptomatic irreversible pulpitis with symptomatic apical periodontitis was made, and nonsurgical endodontic treatment was recommended.

Radiographic evaluation of the involved tooth did not indicate any variation in the root canal anatomy (Fig. L4). The mesial surface of the tooth was restored with composite resin (Z100; 3M Dental Products, St Paul, MN) after caries excavation to enable optimal isolation. Local anesthesia was induced using 1.8 mL 2% lidocaine with 1:200,000 epinephrine (Xylocaine; AstraZeneca Pharma Ind Ltd, Bangalore, India). A rubber dam was placed, and a conventional endodontic access opening...
was established with an Endo Access bur and an Endo Z bur (Dentsply Tulsa, Tulsa, OK). Initially, the mesiobuccal (MB1), the distobuccal (DB1), and the two palatal canals (mesiopalatal [MP] and distopalatal [DP]) were located. While viewing the floor of the pulp chamber under a dental operating microscope (DOM) (Seiler Revelation, St Louis, MO), two additional root canal orifices were located palatally to the MB1 and DB1. However, several attempts to introduce a file into these orifices were unsuccessful. On troughing away the dentin occluding the orifices using ET 18D ultrasonic tips (Satelec/Acteon, Merignac, France), the second and third mesiobuccal (MB2 and MB3) and distobuccal (DB2 and DB3) root canal orifices were located. The conventional triangular access was modified to a trapezoidal shape to improve access to the additional canals. Coronal enlargement was performed with a nickel-titanium ProTaper SX rotary file (Dentsply Maillefer, Ballaigues, Switzerland) to improve the straight-line access (Fig. 1B). Root canals were explored with ISO #10 K-files. CBCT scan slicing was used to confirm and ascertain the unusual root canal morphology. All the root canals were dried and no medicament placed. A sterile cotton pellet was placed in the pulp chamber and Cavit G (3M ESPE Dental Products, St Paul, MN) was used to seal the access cavity.

Informed consent was obtained from the patient, and a computed tomography scan was performed with a CBCT scanner (Kodak 9500 Cone Beam 3D, Chennai, India) at a tube voltage of 60 kVp and tube current of 5 mA. All protective measures were taken to protect the patient from radiation according to As Low As Reasonably Achievable guidelines. Axial images were transmitted to a commercially available dental program (Kodak Dental Imaging Software 3D module v 2.4) to reformat panoramic and cross-sectional images in all three planes. Axial slices of the maxilla of 200-μm thickness were obtained at different levels to determine the root canal morphology (Fig. 24–C). CBCT scan slices revealed eight root canals (three mesiobuccal, three distobuccal, and two palatal) in the left maxillary first molar (Fig. 24–G). CBCT images provided valuable information regarding the canal configuration and confirmed the eight canals that were not clearly seen in the conventional radiograph. At the next appointment after 2 weeks, the patient was asymptomatic. After administering 1.8 mL 2% lidocaine with 1:200,000 epinephrine, the working lengths were determined with the help of an apex locator (Root ZX; Morita, Tokyo, Japan) under rubber dam isolation. Individual intraoral periapical radiographs for the mesiobuccal (Fig. 1C), distobuccal (Fig. 1D), and palatal root (Fig. 1E) were taken to confirm the working lengths. Cleaning and shaping were performed using ProTaper nickel-titanium rotary instruments (Dentsply Maillefer) with a crown-down technique. The MB1, DB1, MP, and DP canals were enlarged to ProTaper F3; whereas the MB2, MB3, DB2, and DB3 canals were enlarged until ProTaper F2. During root canal preparation, irrigation was performed using normal saline, 2.5% sodium hypochlorite solution, and 17% EDTA. Final rinsing of the canals was performed using 2% chlorhexidine digluconate coupled with ultrasonic agitation. The canals were dried with absorbent points (Dentsply Maillefer), and obturation was performed using cold lateral compaction of gutta-percha (Dentsply Maillefer) and AH Plus resin sealer (Maillefer Dentsply, Konstanz, Germany). 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 (Z100; 3M ESPE Dental Products, St Paul, MN) (Fig. 1F). The patient experienced no post-treatment discomfort and was subsequently referred for appropriate coronal restoration.

### Discussion

The anatomy of teeth is not always predictable. A great number of variations could occur in formation in both the roots and their shape. Hess (21) reported the wide variation and complexity of root canal systems establishing that a root with a tapering canal and a single foramen was the exception rather than the rule. Weine et al (22) divided the position of one or two canals within a root into four basic types. Vertucci (2) described a much more detailed canal system and identified eight pulp space configurations. Recently, 14 new additional canal types were reported by Sert and Bayirli highlighting the complexity of root canal systems (23).

Of the various comprehensive maxillary first molar *ex vivo* studies in the dental literature, only Baratto Filho et al (24) reported a maxillary first molar with three roots and seven root canals. Of the 140 extracted maxillary first molars evaluated, only one tooth showed seven root canals, which contained three mesiobuccal, three distobuccal, and one palatal canal. The frequency of MB2 canals in the mesiobuccal root was reported to be 92.85% (based on *ex vivo* results), 95.63% (based on clinical results), and 95.45% (based on CBCT results), whereas the corresponding figures for the distobuccal root (DB2) were 1.15% (*ex vivo*) and 3.75% (clinical) and those for the palatal

### Table 1. Summary of Case Reports of Maxillary First Molars Presenting with Six or More Root Canals

<table>
<thead>
<tr>
<th>Root configuration</th>
<th>No. of canals</th>
<th>Root canal anatomy</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 roots</td>
<td>7</td>
<td>3 MB, MP, M, P, DB</td>
<td>Present case</td>
</tr>
<tr>
<td>3 roots</td>
<td>8</td>
<td>3 MB, MP, M, P, DB</td>
<td></td>
</tr>
</tbody>
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root (second palatal canal) were 2.05% (ex vivo), 0.62% (clinical), and 4.55% (CBCT).

Traditionally, the mesiobuccal root of the maxillary first molar has generated more research and clinical investigation than the other roots (25). Most of the in vitro studies of the mesiobuccal root canal anatomy (26–30) have not reported the presence of a third canal in the mesiobuccal root. Two such studies have reported their incidence to be between 1.1% and 10% (31, 32). However, its presence has been documented in a few case reports (10, 14). The third canal in the distobuccal root of maxillary first molars is rare, with only two documented reports in the dental literature (20, 24). These reports presented a Gulabivala type III (33) and a Sert and Bayirli type XVIII root canal configuration (23) in the distobuccal root of maxillary first molars.

The maxillary first molar is predominantly a three-rooted tooth with a buccolingually broad mesiobuccal root and a rounded or ovoid distobuccal root in the cross-section (5). This anatomic difference could possibly explain for the higher incidence of multiple canals in the mesiobuccal root (25). In the present case, CBCT axial images clearly depicted that the distobuccal root was broad buccolingually, similar to the mesiobuccal root (Fig. 2B). The contralateral distobuccal root also presented with a similar anatomy (Fig. 2B and C). This variation in the external root morphology may perhaps explain for the rare internal anatomy of three root canals within the distobuccal.

Conventional intraoral periapical radiographs are an important diagnostic tool in endodontics for assessing the root canal configuration. Nevertheless, it is not completely reliable because of its inherent limitation (34). The application of further analytic diagnostic tools such as CBCT scanning for the assessment of unusual root canal morphology has been highlighted, aiding the correct endodontic management of complicated and challenging cases (14, 35). CBCT images are reconstructed using significantly lower radiation doses compared with alternative conventional computed tomography scanning. This is because with CBCT scanning the raw data are acquired in the course of a single sweep of a cone-shaped x-ray source and reciprocal detector around the patient’s head. 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.

CBCT data were particularly useful in assessing the root and canal morphology in the present case. CBCT axial images confirmed the presence of three roots and eight root canals, namely the MB1, MB2, MB3,
DB1, DB2, DB3, MP, and DP (Fig. 2A–F). The contralateral tooth appeared to have a normal root canal anatomy (Fig. 2A–C). CBCT axial images also showed that both the mesiobuccal and the distobuccal root had a Sert and Bayirli type XV canal configuration (23) (ie, the first and second canals of both roots joined at the middle third and exited through one apical foramen, whereas the third canal had a separate canal orifice and exiting foramen). The palatal root presented with a Vertucci type II canal pattern (2) (ie, two canal orifices joining together and exiting into one apical foramen) (Fig. 2B and C).

The removal of vital and necrotic remnants of pulp tissues, microorganisms, and microbial toxins from the root canal system is essential for endodontic success (36). Extensive isthmuses, anastomosis, fins, cul-de-sacs, and other parts of the canal system that are difficult to debride via mechanical instrumentation have been found to be present in all multirooted teeth (37). Therefore, chemical irrigation using sonic and ultrasonic should be an essential part of root canal debridement because it allows for cleaning beyond what might be achieved by root canal instrumentation alone (38).

The role of microscopy in endodontics should not be underestimated. Buhrley et al (7) had preformed an in vitro study to determine the practitioner’s ability to locate the MB2 canal in maxillary molars using the DOM and/or dental loupes. They concluded that when the maxillary first molars were considered separately, the frequency of MB2 canal detection for the microscope, dental loupes, and no magnification groups were 71.1%, 62.5%, and 17.2%, respectively. In the present case, success was largely dependent on the use of magnification, which allowed for the identification of the eight distinct root canal orifices with ease. Hence, clinicians should familiarize themselves with dental microscopy and new imaging technology, such as CBCT scanning, to get additional anatomic information in endodontic practice.

Conclusion

The clinical significance of the present case is that this is the first report of a case with three roots and eight root canals in a maxillary first molar. The routine use of DOM while performing endodontic treatment is suggested because it will definitely be helpful in identifying and treating all root canals successfully.

Acknowledgments

The authors deny any conflicts of interest related to this study.

References