Endodontic Management of Maxillary Second Molar with Vertucci Type VI Root Canal Morphology Diagnosed Using Cone-beam Computed Tomography

Abstract
The objective of this article is to highlight the importance of having a thorough knowledge about the root canal anatomy and the possible anatomical variations in maxillary second molar. This case report presents the endodontic management of the left maxillary second molar with four roots and four canals. A cone-beam computed tomography (CBCT) imaging was performed to ascertain this complex root canal anatomy. The CBCT findings revealed that the distobuccal canal and the distopalatal canal of the left maxillary second molar exhibits Vertucci Type VI root canal anatomy. This case report demonstrates the usefulness of CBCT in the understanding of complex root canal anatomy of maxillary second molar and its potential use as an endodontic diagnostic tool.

Keywords: Anatomical variations, cone-beam computed tomography, maxillary second molar, root canal anatomy

Introduction
The success of nonsurgical root canal treatment is dependent on a thorough knowledge of the external root and internal root canal morphology to locate all root canals and properly clean, shape, and obturate the root canal space in three dimensions.[1]

The maxillary second molar has shown to exhibit variations in root canal number and configurations. Variations reported in the in vitro studies include four rooted teeth with two palatal roots having a single canal in each root, with its occurrence ranging from 0.4% to 1.4%.[2,3] Peikoff et al.[3] carried out a retrospective study in 520 completed endodontic treatments of maxillary second molar teeth. They classified the anatomical root and canal variations into six categories: (i) Three separate roots and three separate canals; (ii) three separate roots and four canals (two in the mesiobuccal [MB] root); (iii) three roots and canals whose MB and distobuccal (DB) canals combine to form a common buccal with a separate palatal canal; (iv) two separate roots with a single canal in each root; (v) one main root and canal; and (vi) four separate roots and four separate canals including two palatal canals.

Cone-beam computed tomography (CBCT) has been used successfully in endodontics for the diagnosis of endodontic pathosis and canal morphology, assessment of pathosis of nonendodontic origin, evaluation of root fractures and trauma, analysis of external and internal root resorption, invasive cervical resorption, and presurgical planning.[3] This case report describes the endodontic management of the left maxillary second molar with unusual root canal morphology diagnosed using CBCT.

Case Report
A 27-year-old Indian male patient reported to our clinic with a chief complaint of tooth decay and pain in his maxillary left back tooth for the past 1 week. History revealed intermittent pain in the same tooth during mastication. The patient’s medical history was noncontributory. Clinical examination revealed a decayed left maxillary second molar (tooth #27) with tenderness to vertical percussion. The tooth mobility was within physiological limits, and the gingival attachment apparatus was normal. Thermal and electric pulp testing...
elicited a negative response. The preoperative radiograph showed widening of the periapical periodontal ligament space in relation to the mesial root apex of tooth #27. From the clinical and radiographic findings, a diagnosis of symptomatic apical periodontitis of left maxillary second molar was made, and nonsurgical endodontic treatment was initiated.

Radiographic evaluation of the involved tooth revealed a superimposed roots of left maxillary second molar [Figure 1a]. The superimposition of the roots in the radiograph made the accurate assessment of the root canal anatomy unclear. The tooth was anaesthetized by using 1.8 ml (30 mg) of 2% lidocaine containing 1:200,000 epinephrine (Xylocaine; AstraZeneca Pharma India Ltd., Bengaluru, India). A rubber dam was placed, and a conventional endodontic access opening was made using an endo access bur and an endo Z bur (Dentsply Tulsa, Tulsa). Examination of the pulp chamber floor with a DG-16 endodontic explorer (Hu-Friedy, Chicago, IL, USA) revealed four distinct root canal orifices, 1 MB canal, 2 palatal canals (mesiopalatal canal and distopalatal (DP) canal), and 1 DB canal connected by the developmental root fusion lines [Figure 1b]. Clinical examination of the pulp chamber floor revealed the DB canal was close to the DP canal. However, the intraoral periapical radiograph did not reveal the number and morphology of the roots clearly.

Therefore, to ascertain this rare and complex root canal anatomy of the tooth in a three-dimensional manner, it was decided to perform CBCT imaging of the tooth. Informed consent was obtained from the patient, and a multislice CBCT of the maxilla was performed (Simulix Evolution; Nucletron Pvt., Ltd., Chennai, India), with a tube voltage of 100 kV and tube current of 8 mA. The involved tooth was focused, and the morphology was obtained in transverse, axial, and sagittal sections of 0.5 mm thickness. The axial images revealed that the left maxillary second molar had four roots and four root canals. The CBCT images showed that the DB canal and DP canal exhibit Vertucci Type VI (2-1-2) root canal system [Figure 2a-h].

After exploring the four root canals with #10 K-files (Mani, Inc., Tochigi, Japan), the working lengths were determined with the help of an electronic apex locator (Root ZX; Morita, Tokyo, Japan) and radiographic method [Figure 1c]. Coronal enlargement was performed with a Nickel-Titanium ProTaper SX rotary file (Dentsply Maillefer, Ballaigues, Switzerland) to improve the straight-line access to root canals [Figure 1b]. Cleaning and shaping were performed using ProTaper nickel-titanium rotary instruments (Dentsply Maillefer) with a crown-down technique. The MB and DB canals were enlarged to ProTaper F2; whereas, the two palatal canals were enlarged until ProTaper F3. During root canal preparation, irrigation was performed using 2.5% sodium hypochlorite solution and 17% Ethylene Diamine Tetra Acidic acid (EDTA). Final rinsing of the canals was performed using 2% chlorhexidine digluconate. After completion of cleaning and shaping, the root canals were dried with absorbent points (Dentsply Maillefer). Calcium hydroxide (Calciure, VOCO, Cuxhaven, Germany) was placed as an intracanal
medicament with a lentulo spiral (Dentsply Mailfefer), and the access cavity was sealed with Cavit (3M ESPE Dental Products, St Paul, MN). The next appointment was scheduled after 2 weeks; the patient was asymptomatic. The root canals were dried, and obturation was done by using cold lateral compaction of Gutta-percha (Dentsply Mailfefer) and AH plus resin sealer (Dentsply Mailfefer, Konstanz, Germany). A final radiograph was taken to establish the quality of the obturation [Figure 1d]. After completion of root canal treatment, the tooth was restored with a composite resin core [Figure 1e] (Z-100; 3M ESPE Dental Products, St Paul, MN). The patient was reviewed for 2 years’ follow-up and was subsequently referred for appropriate coronal restoration [Figure 1f].

Discussion
The important aspect in contemporary endodontics is to possess a thorough knowledge of the internal and external root anatomy. This aspect, coupled with a correct diagnosis and appropriate cleaning and shaping of the root canal system, would improve the overall treatment outcome.[1] Anatomic characteristics of permanent maxillary molars were described as a group of teeth with three roots, one palatal and two buccal, each root with one root canal. The occurrence of second MB canal when there are four canals also is common. The number of roots in maxillary molars can also vary.

Christie et al.[3] reported 16 cases of maxillary molars with two palatal roots and it was classified according to the shape and root separation as Type I, II, and III. Type I maxillary molars have two widely divergent palatal roots, which often are long and tortuous. Type II maxillary molars have four separate roots, but the roots often are shorter, run parallel, and have blunt root apices. Type III maxillary molars are constricted in root morphology with the MB, mesiopatalal, and DP canals engaged in a web of root dentin. The DB root in these cases seems to stand alone and may be distinctly divergent.

The main disadvantage with a conventional film-based radiograph is that it is only a two-dimensional image of a three-dimensional object, resulting in superimposition of images. Existing newer diagnostic methods such as computerized transverse axial scanning greatly facilitates access to the internal canal morphology. Volumetric computerized tomography or CBCT is a newer diagnostic imaging modality that has been used in endodontics for effective evaluation of root canal morphology.[8-9] In maxillary second molar, the DB canal is usually detected more mesially when compared with the first molar. However, in this case, the DB canal is located more distally from the MB canal, and it is present close to the DP canal. Vertucci found the proximity of the canal orifices to each other as indicative of whether they joined or remained as separate canals. If the separation of the orifices was > 3 mm, the canals tend to remain separate throughout their entire length. In contrast, the canals usually joined together if the orifices were <3 mm apart.[9]

In this case, the DB and DP canals were located close to each other, and they were <3 mm apart. Both the DB and DP canals had separate root canal orifice at the cervical third of the root canal system. They joined together into one root canal at the middle third, and again they got divided into two separate root canals at the apical third, thereby exhibiting Vertucci Type VI root canal system (2-1-2).

In this case, the CBCT was used for better understanding of the complex root canal anatomy. The CBCT axial images clearly showed the maxillary left second molar had four roots and four root canals. They also revealed that the DB canal and DP canal exhibit Vertucci Type VI root canal system (2-1-2).

Any attempt to perform endodontic therapy must be preceded with a thorough understanding of the anatomy of both the pulp chamber and the root canal system. The use of magnification (surgical loupes and dental operating microscope) and additional lighting (fiber optic illumination) are recommended for successful management of complex root canal system.

Conclusion
An accurate knowledge of root canal morphology with its anatomical variations is required for successful root canal treatment. Access cavity refinements and newer diagnostic aids such as CBCT are required for the identification and negotiation of the complex root canal anatomy of maxillary second molars.

Declaration of patient consent
The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest
There are no conflicts of interest.

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