Atypical anatomy of maxillary second premolar with three roots and four canals

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Abstract
Knowledge and understanding the anatomical configuration of individual tooth play a significant role in success of endodontic treatment, in addition to through debridement and obturation of the canals. The canal anatomy of maxillary second premolar has been studied extensively, and the presence of a significant variety of multirooted canals is relatively rare in it. A 27-year-old female reported with a chief complaint of pain in her upper right posterior region for 10 days. On intraoral hard tissue examination, ill-defined access preparation was seen in maxillary right second premolar with exposed pulp. An intraoral periapical radiograph reveals radiolucency involving the pulp space and varied morphology in the same tooth. The occurrence of three roots with four canals in the maxillary second premolar is rare and not documented in the literature so far. This case report describes the nonsurgical endodontic management of such varied anatomical configuration using cone beam computed tomography as an evaluating diagnostic tool.

Keywords: Anatomical variations; cone beam computed tomography; four canals; maxillary second premolar

INTRODUCTION
Thorough knowledge of internal and external anatomy of a tooth is of utmost importance to ensure successful endodontic outcome.[1] Unusual anatomical configurations of the tooth may hinder the achievement of proper access cavity preparation, thorough cleaning and shaping, disinfection and obturating the root canal space three dimensionally. Root canal morphology can show infinite variations, and a competent clinician should be able to detect these variations and act accordingly to achieve flawless outcome.[2] Omitting such anatomical variations during root canal treatment invite postoperative pain and discomfort which lead to failure of endodontic treatment.[3]

Conventional imaging is one of the useful aids in visualizing such varied morphologies; however, it is just a simplification of a three dimensional image two dimensionally, which disables the clinician to identify the appropriate morphology. Hence, advanced three-dimensional imaging like cone beam computed tomography (CBCT) is being widely used to address the drawbacks of conventional imaging.[4]

Maxillary second premolar usually has one root with one or two root canals. As reported by Vertucci, the occurrence of one canal with one apex is 75% and two canals at the apex are 24%. The presence of three canals at apex was found to be only 1%.[3] Quite a few case reports were published in the endodontic literature reported that a wide range of canals configuration in maxillary second premolars.[3,6-8] To the best of our knowledge, the occurrence of three roots with four canals in maxillary second premolar is so far not reported. This case report presents a successful, nonsurgical endodontic management of maxillary right second premolar with three roots and four distinct root canals with the help of CBCT as confirmatory diagnostic tool.
CASE REPORT

A 27-year-old female reported to the Department of Conservative Dentistry and Endodontics with a chief complaint of pain in her upper right posterior back tooth region for 10 days. Medical history of the patient was noncontributory. She had undergone root canal treatment of the tooth in the same region one month back. No relevant findings were noted during the extra- and intraoral soft-tissue examination. On intraoral hard tissue examination, multiple decayed teeth were present, temporary restoration was seen on the maxillary right molar (tooth #16) and an ill-defined access preparation was done in maxillary right premolar (tooth #15). The second premolar and the first molar were tender to percussion. An intraoral periapical radiograph (IOPAR) was advised and it revealed complete root canal treatment with temporary restoration in tooth #16 and radiolucency involving enamel, dentin, and the pulp in tooth #15. Multiple IOPAR was taken in Clark’s tube shift technique as the premolar showed a varied morphology [Figure 1a and b]. The patient reported discomfort associated with intake of hot and cold drinks and lingering pain in the right posterior maxillary teeth which was later confirmed by clinical and radiographic examination due to exposed pulp in relation to #15. Pulp vitality test with electric pulp tester test (Ashoo Sons API Pulp Tester, Delhi, India) showed a vague response in tooth #15. As the clinical examination disclosed the pain from tooth #15, a diagnosis of irreversible pulpitis was made, and endodontic treatment was initiated. Nonsurgical endodontic treatment was planned in both #15 and #16 in two visits with the use of calcium hydroxide as interappointment intracanal medicament.

Anesthesia was achieved by means of buccal and palatal infiltration with 1.6 ml 2% lignocaine with 1:80,000 adrenaline. Teeth were isolated using rubber dam (Hygenic Dental Dam, Coltene Whaledent, Switzerland) and coronal access prepared using Endo Access Bur (Dentsply, Maillefer) in tooth #15. The unusual anatomy made it difficult to precisely discern, whether the roots were located on the buccal, palatal, or mesial aspect. The prepared access cavity was modified with EZ bur (Dentsply, Maillefer) at the distal side to deroof the pulp chamber resulting in a cavity with a T-shaped outline. On careful examination of the pulp chamber floor under ×3.5 loupes (Seiler instrument Inc., St. Louis, MO) in tooth #15, three separate root canal orifices were identified (buccal, palatal, and distal) and located with DG 16 explorer (Hu Friedy, USA), then negotiated with ISO size 10 k-files. All three canals were thoroughly debrided and working length was established with IOPA radiograph in Ingles technique and confirmed with apex locator (Propex Pixi, Dentsply). Cleaning and shaping of all the canals were done till ISO size 20 k-files under irrigation with 3% sodium hypochlorite (NaOCl) (prime dental product, Mumbai, India) and 17% ethylenediaminetetraacetic acid (EDTA) (SmearClear Kerr Corporation Orange, CA, USA). After debridement of these canals, a bleeding point was noticed just beneath the mesial canal which gave an indication for the presence of the fourth canal. Access cavity was extended toward the bleeding spot using #2 long shaft round bur to a depth of 2 mm which uncovered the fourth canal. Working length was established for all the four canal with radiograph [Figure 1c] and confirmed using an apex locator (Propex Pixi, Dentsply). All the canals were prepared manually with a balanced force crown-down technique using k-flexofiles (Dentsply, Maillefer) frequently irrigating with 0.9% normal saline (Baxter India Pvt Ltd., Alathur, India), 5% NaOCl (prime dental product, Mumbai, India), and 17% EDTA (SmearClear, Kerr Corporation Orange, CA, USA). Calcium hydroxide was used as an intracanal medicament, and the access cavity was sealed with Cavit (3M ESPE, Germany).

The treatment was adjourned due to the morphological discrepancy which was confirmed by magnification loupes clinically as well as radiographically evident fourth canal. To prospect the tortuosity of this rare and complex root canal anatomy of tooth three dimensionally, an intraoperative CBCT was taken to confirm the presence of four canals. Three-dimensional (3D) image of tooth #15 was obtained using CS 3D Imaging Software (Carestream Dental LLC-North America).

The involved tooth was focused and the morphology was obtained in axial, sagittal, and coronal views. The CBCT images revealed that tooth #15 had three separate roots and four distinct root canals (mesiobuccal 1, mesiobuccal 2, palatal and distal) [Figure 2a and b].

At the second visit, the patient was asymptomatic. Rubber dam isolation was done. Temporary restoration was removed and canals were irrigated using saline with 30-gauge side vented needle. Biomechanical preparation was done using 04/20, 06/20 size HyFlex controlled
memory (CM) rotary instruments (Coltene Whaledent, Switzerland) according to manufacturer instructions. During canal preparation, Glyde (Dentsply, Maillefer) was used as a lubricant and the root canals were copiously irrigated with 3% NaOCl (prime dental product, Mumbai, India) and 0.9% normal saline (Baxter India Pvt Ltd., Alathur, India) after the use of each instrument. At the end of biomechanical preparation, 17% EDTA (SmearClear, Kerr Corporation Orange, CA, USA) was used for 1 min to remove the smear layer and the final washing was performed with 5.25% NaOCl (prime dental product, Mumbai, India) and saline. Afterward, the root canals were dried with sterile absorbent paper cones (Hygenic Paper Points, Coltene). Obturation was done with warm vertical compaction technique using Apexit plus sealer and gutta-percha (Dentsply, Maillefer) and restored with intermediate restorative material. After which root canal therapy of tooth #16 was completed. The obturation of all canals was sighted in a postoperative IOPAR [Figure 2c].

A month later, under asymptomatic conditions porcelain fused to metal crowns were placed [Figure 2d]. The patient was asymptomatic and healing was satisfactory in the follow-up visit after 1 year [Figure 2e].

**DISCUSSION**

Endodontic treatment with least consideration to anatomic configuration may end up in failure and continuous discomfort to the patient. Hence, it is the responsibility of an endodontist to devote time in root canal treatment especially to understand the varied morphology of the teeth and locate the canals which are the crucial factors influencing the success of root canal therapy. A literature review showed a higher variation in the root canal morphology of the maxillary second premolar.\[6-10\] Various case reports and ex vivo studies reported the morphological variations of the teeth and difference in the incidence of these variations can attributed to the examination methods, classification systems, sample sizes, racial, and genetic factors that were considered for the particular study.\[11\]

Till date, single-, two-, and three-rooted maxillary second premolars have been identified, with the number of canals ranging from one to three according to different grades of classifications. The occurrence of four canals in the maxillary second premolar is rare and not so far reported. Leonardo and Leal reported that the ability to detect, locate, negotiate and instrument the canals in multirooted teeth is the crucial part and failure to execute any of the above-said factors will lead to endodontic failure.\[12\] Sometimes, even on keen examination of the preoperative radiographs reveals anatomical variations in the root. Features such as sudden disappearance of pulp space, abruptly straightening, broadening, or difficulty in tracing the continuity of canal indicate the presence of extra canal in the same root overlapping the first one. The presence of wider mesiodistal mid root width when compared to that of the crown in maxillary premolars may hint for the presence of added canals.\[13\] Based on such principles and modified access cavity preparation, one can have the ease of identification of extra canal anatomy.

Recently, numerous nickel–titanium instruments are available in market that differ in their design, shaping characteristics, breakage potential, and clinical performance.\[14\] In the present case report, HyFlex CM instruments with shape control memory are used. They are claimed to be manufactured by an innovative methodology which uses a sequential heating and cooling treatment. These files are known to show improved flexibility and better cutting ability that allows the clinicians to use in narrow, tortuous tapered canals without fear of canal transportation and instrument separation.\[15\]

Magnification with loupes or microscope is an indispensable tool to locate the extra canals. The American Association of Endodontics have reported the benefits of magnification in locating hidden canals, tracing the cracks or fracture lines, removal of canal obstructions, refinement of the access preparations, and all aspects of endodontic microsurgery.\[16\] Various ranges of magnification levels are available, but typically ×2.5 to ×4.5 is appropriate to visualize the extra canal with increased depth of field.\[17\]

Conventional periapical radiographs captured in different angulations are helpful in detection of extra roots or canals,
but a confirmatory visualization can only be obtained by a three dimensional CBCT. The advantages of CBCT imaging over the conventional imaging is higher resolution volumetric records, low scan time, geometric accuracy, and low radiation exposure. Most common application of CBCT in endodontic is identifying and diagnosing the presence of extra canals. It allows for visualization of the canals in the middle and apical thirds of the roots which are possibly not appreciated when viewed under dental operating microscope. This advanced imaging system and its application in endodontic diagnosis provide an insight into morphological and structural variations of root canal which leads to overall improvement in the prognosis of endodontic procedures.

CONCLUSION

The canal morphology of the maxillary second premolar in the present case showed a varied morphological pattern which rarely exists in the literature. Thereby, an endodontist should be prepared for the variations and thoroughly scrutinize the root canals. The triumph of nonsurgical endodontic procedures is greatly influenced by negotiating the highly variable anatomic structures.

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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