Endodontic Management of Mandibular Second Premolar with Type IX Canal Configuration Using Cone-Beam Computed Tomography as a Diagnostic Aid: A Rare Case Report

Abstract

Successful endodontic treatment requires knowledge of the root canal anatomy, cleaning, and shaping followed by three-dimensional filling of the root canals. With the advent of newer diagnostic aids such as cone-beam computed tomography (CBCT) and magnifying tools such as dental operating microscope and loupes, it has become easier for an operator to identify the root canal anatomy of teeth and reduce the risk of procedural accidents and failures. Variations in root canal configuration require modification in access cavity preparation, disinfection, and obturation of the canals. Mandibular premolars are identified to have unusual root and canal anatomy which increases the risk of endodontic failure when additional canals remain undiagnosed. The present case report elaborates successful endodontic management of a mandibular second premolar with Type IX root canal configuration using CBCT as a diagnostic tool.

Keywords: *Cone-beam computed tomography, mandibular second premolars, Type IX root canal configuration*

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Introduction

Successful endodontic therapy mandates knowledge of root canal anatomy,[1] good-quality angulated radiographs,[2] thorough disinfection of entire root canal system, and three-dimensional obturation of the canals. In a majority of cases, the root canal anatomy dictates modification of the steps in endodontic treatment and is the only factor which is beyond the control of an operating dentist. Failure to follow the basic protocol of endodontic treatment may result in the inability to identify and prepare additional canal, leading to failure.[3] Other identified causes of endodontic failure include incorrect canal instrumentation, incomplete obturation, and untreated primary canals.[4]

Mandibular premolars have earned their reputation to have aberrant root and root canal configuration and thus designated as enigma to the endodontist.[5] Their narrow mesiodistal dimensions allow narrow access to canals and limited visibility. The apical third bifurcation or trifurcation and apical deltas further add the difficulties for the clinician.[6] In a study carried out by the University of Washington, it was observed that mandibular first premolars have the highest rate of failure in about 11.45% in nonsurgical endodontic treatment.[7] The literature reveals a wide variation in the root canal morphology of mandibular premolars, showing only small percentage of such teeth with three roots. Vertucci found two canals at the apex in 25.5% and three canals at the apex in 0.5% of the cases of 400 investigated premolars. He suggested that the sudden narrowing or disappearance of the radiographic image of the canal indicates bifurcation or trifurcation of the canal.[8] Based on the observations from various studies, it was stated that mandibular second premolars exhibit a single canal in 65.7%–100%, two root canals in 1.2%7–11.7%,[1] and three root canals in 0.4% cases.[1,9-11] Furthermore, a number of factors contribute to the variations found in the root canal morphology of permanent teeth such as ethnic background, age, and gender of the population.[12,13]

Over the years, various classifications of the root canal anatomy have been put forth by

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various authors. In 1969, a clinical classification of multiple root canal system in a single-rooted tooth was given by Weine *et al*., who studied the mesiobuccal root of a maxillary first molar as a reference.[14] This classification has four types of root canal configuration. Pineda and Kuttler as well as Vertucci further developed a system for canal anatomy classification and designated them as Type I–VIII. Gulabivala *et al*. studied the root canal morphology of mandibular molars and identified seven additional canal configurations, according to the number of orifices, canals, and apical foramina.[15] Sert and Bayirli reported additional 14 new canal configurations (Type IX–XXIII), taking reference of Vertucci's classification.[16] The present case reports successful endodontic management of mandibular second premolar with Type IX (1–3) configuration using cone-beam computed tomography (CBCT) as a diagnostic tool.

Case Report

A 48-year-old healthy male patient with a noncontributory medical history reported to the Department of Conservative Dentistry and Endodontics, with a chief complaint of spontaneous pain in tooth #45 for 15–20 days. Clinical examination showed deep distal caries in tooth #45. Intraoral periapical (IOPA) radiograph revealed caries involving pulp in tooth #45 with diffuse apical radiolucency at the distal aspect of the root [Figure 1]. Interestingly, the radiograph showed a sudden disappearance of the canal, giving rise to suspicion of bifurcation or trifurcation of the root canal. Electric pulp test showed delayed response, confirming the diagnosis of irreversible pulpitis with diffuse apical radiolucency in tooth #45. To understand the root and canal anatomy, CBCT scan was advised after obtaining informed consent of the patient [Figure 2]. The CBCT image showed single canal with trifurcation at the middle third of the tooth exiting as three separate canals. Root canal treatment was advised in tooth #45, and the treatment plan was explained to the patient.

After obtaining his informed consent for the treatment, local anesthesia was administered and tooth #45 was isolated under rubber dam. Access cavity was prepared under ×3.5 magnification loupe to explore additional canal. To locate the trifurcation, the access cavity was modified to a triangular shape. The pulpal floor was explored with a DG 16 (Dentsply, Maillefer) endodontic explorer, and three root canal orifices were found: mesiobuccal, distobuccal and lingual [Figure 3]. The canals were explored with No.10 K-file (Mani Inc., Japan), and working length radiographs with two angulations, i.e., straight-on [Figure 4] and mesial angulations [Figure 5], were made which confirmed three canals. Working length was measured using Ingle's radiographic method and confirmed with an electronic apex locator as an adjunct (Root ZX, Morita, Tokyo, Japan) for all the three canals.

After establishing glide path with file size #10 and #15, using crown-down technique, coronal flaring was done with ProTaper SX file (Dentsply, Maillefer). The root canals were prepared with size 20 K-files (Mani Inc., Japan) apically with continuous copious irrigation using 3% warm sodium hypochlorite solution (Prime Dental, India). The irrigating solution was agitated using EndoActivator (Dentsply, Tulsa Dental Specialities) agitation tip. The final apical preparation was done with Flexicon X3 file (20/04) (Flexicon, Johnson City, Tennessee, USA). Root canals were irrigated with 17% ethylenediaminetetraacetic acid solution followed by rinsing with saline and canals were dried with paper points. Calcium hydroxide paste (Avuecal, Dental Avenue, India) as intracanal medicament was placed in the canals, and the access cavity was sealed coronally with Cavit (3M ESPE AG Seefeld, Germany). The patient was scheduled after 2 weeks for evaluation.

Figure 1: Preoperative intraoral periapical of tooth #45 showing a sudden disappearance of the root canal with diffuse periapical radiolucency on the distal aspect

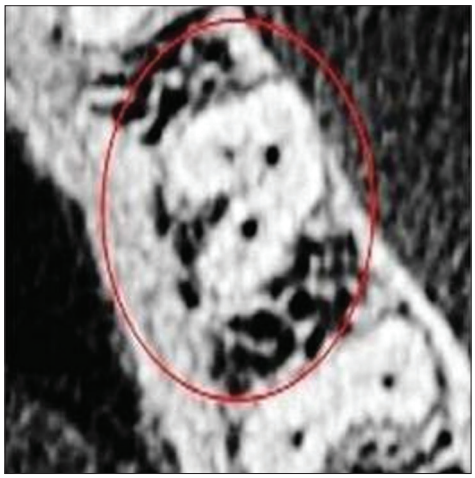

Figure 2: A cone-beam computed tomography image of tooth #45 at middle third showing trifurcation of the canal

In the next visit, the patient was reported to be asymptomatic. The canals were rinsed with 3% sodium hypochlorite solution and finally rinsed with normal saline. After drying with absorbent paper points (Diadent), IOPA radiograph was taken to check proper fit and extension of gutta-percha master cones [Figure 6]. Warm vertical compaction was done with size 20, 4% gutta-percha points (Diadent), and AH Plus sealer (Dentsply International Inc.). Due to lack of accessibility, the gutta-percha cones were placed in one canal at a time. The gutta-percha cone coated with AH Plus sealer was first placed in the mesiobuccal canal. A heated plugger was then placed at the orifice of the canal; the remaining coronal gutta-percha was removed, followed by vertical compaction of the gutta-percha in the canal with the heated plugger. This was followed by the obturation of the distobuccal and finally the lingual canal. A postoperative IOPA radiograph was taken [Figure 7]. The patient was recalled for postendodontic permanent restoration after a week and advised a full coverage restoration in tooth #45.

Discussion

Knowledge of root canal configuration with their variation is important for successful nonsurgical root canal treatment. This is followed by negotiation, cleaning, shaping, and obturation of the entire canal system in three dimensions. Mandibular premolars are known for their aberrant anatomy and known as enigma to the endodontist. Various root canal configurations have been evaluated in different studies. The earliest clinical classifications of more than one canal system in a single root were given by Weine and Vertucci. These classifications were further elaborated by Gulabivala *et al*., who studied the root canal morphology of mandibular molars and identified seven additional canal types. In addition to Vertucci classification, a new classification was given by Sert and Bayirli, explaining 14 new canal types (Type IX–Type XXIII). The presented case report highlights the management of one of such cases of mandibular second premolar, showing Type IX configuration of the root canal.

Figure 3: Access cavity preparation of tooth #45 showing three canal orifices

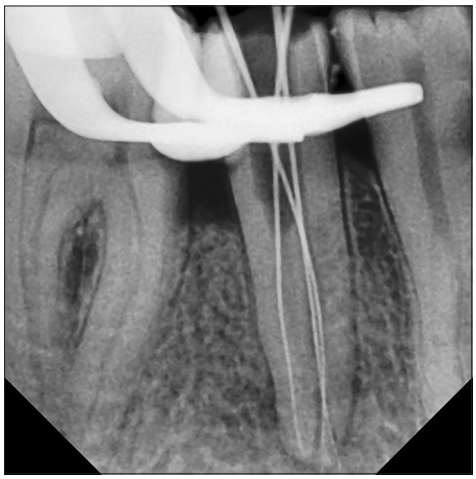

Figure 4: Working length straight – on intraoral periapical radiograph of tooth #45, showing three separate root canals from middle third

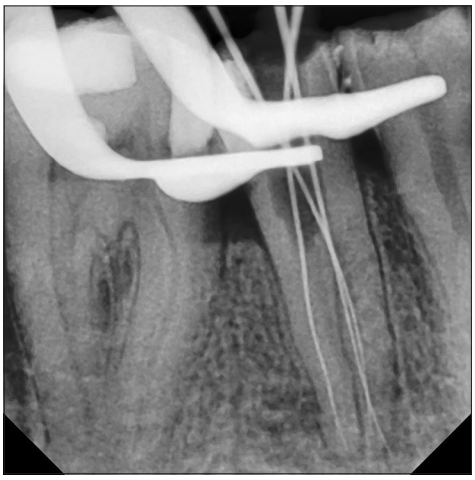

Figure 5: Working length mesial angulation intraoral periapical radiograph of tooth #45, showing three separate root canals from middle third

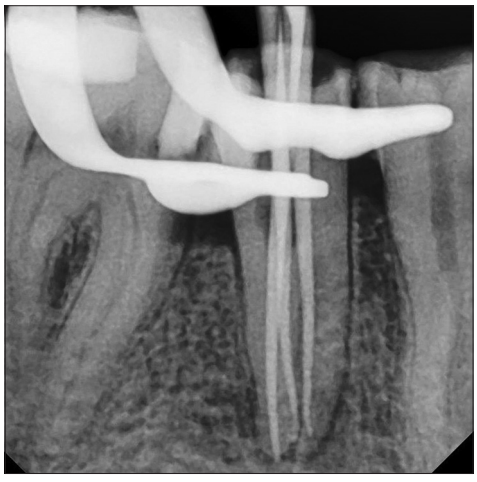

Figure 6: Master cone intraoral periapical radiograph of tooth #45 confirming proper apical fit and extension

Figure 7: Postoperative intraoral periapical radiograph of tooth #45 showing obturation of the root canal system

The Hertwig epithelial root sheath (HERS) is responsible for the development of root and root canal system. The HERS extends horizontally and may grow as a single collar-shaped diaphragm or two-three tongue-like extensions. A single collar-shaped diaphragm of the HERS gives rise to a single-rooted tooth, whereas two to three extensions of the HERS give rise to a multirooted tooth. The roots in a multirooted tooth may remain fused or separate and the root canal anatomy is determined by the HERS.

The variations found in the root canal anatomy of permanent teeth are influenced by a number of factors such as ethnic background, age, and gender of the population.[17] Mandibular second premolars usually have a single root with a single root canal. A systematic review of the root canal configuration of mandibular premolars has observed that Caucasian, Indian, and Middle Eastern populations showed a higher prevalence of multiple canals (14%–17%).[11] Based on the results from various studies, it was observed that mandibular second premolars show a single canal in 65.7%–100%, two root canals in 1.2%–11.7%, and three root canals in 0.4% cases.[9-11] Mandibular second premolars with unusual anatomy having four and five canals have also been reported in the literature.[18,19] From the above studies, it is evident that mandibular second premolars with three canals is a rare occurrence and needs to be managed strategically.

Gulabiwala *et al*. concluded from the observations in their study that broad, flat roots are much more likely to contain multiple canals and intercanal ramifications.[15] To rule out extra root and root canal, preoperative as well as intraoperative radiographs with different angulations are mandatory.[20] Fast break principle is a term used to describe a situation when a canal suddenly disappears on a radiograph as proceeding apically. This usually happens when the main canal divides into two or more smaller canals that are not discernible on a radiograph. Advance imaging technique such as CBCT has proved to be an additional diagnostic tool in revealing the internal and external anatomy of teeth.[21-23] Other uses of CBCT scan in endodontics include diagnosis and management of endodontic treatment complications, dentoalveolar trauma, identification of external and internal resorption, pathology of nonendodontic origin, and presurgical case planning.[24] In addition, a conservative access can be prepared to the root canals, when the operator has a prior knowledge of its anatomy with the help of CBCT.

Root canal system of premolars with three root canals is usually characterized by one large lingual or palatal canal and two smaller canals in the mesiobuccal and distobuccal root.[25] A third canal should be suspected if the pulp chamber does not lie in its expected buccal–lingual relationship. If only one eccentric orifice is found, at least one more canal should be suspected and searched for on the opposite side.[26] Furthermore, the dentinal map on the pulp chamber floor guides the operator to the precise location of root canal orifices. The small size of mandibular premolars limits the coronal access to the complex root canal system. Magnification in endodontics not only facilitates better vision but also facilitates the access for ease of preparation and obturation of root canals. It also provides less stress to eyes, improves ergonomics of the operator, and concomitantly prevents any procedural errors.

Conclusion

Detailed knowledge of the root canal system is imperative for a successful root canal treatment. A single canal in a tooth is not considered as a rule but rather an exception. Additional diagnostic aids such as CBCT and magnifying loupe may help in reducing the risk of procedural accidents and endodontic failure. Although the incidence of three root canals in the mandibular second premolars is relatively low, such teeth should be carefully investigated and strategically managed.

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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Nil.

Conflicts of interest

There are no conflicts of interest.

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