



Two, Three, Four.....What More!!! Endodontic Management of Three Cases with Rare Root Canal Morphology

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Authors' contributions

This work was carried out in collaboration between all authors. Author NJ did the clinical cases and wrote the first draft of the manuscript. Author AG managed the literature searches, analyses of the study and authors CK and SPM managed the final completion of the manuscript. All authors read and approved the final manuscript.

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Case Study

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ABSTRACT

Aim: To describe the clinical management of three teeth with aberrant root canal morphology: a mandibular canine with two radicular canals, maxillary second premolar with three roots and root canals; and maxillary second molar with four roots and root canals, all of which are rare clinical occurrence in our environment.

Presentation of Case: This case report summarizes 3 cases with rare root canal morphology treated by non surgical endodontic treatment in which a maxillary first premolar, maxillary second molar and mandibular canine with aberrant root canal morphology.

Discussion: It is generally accepted that a major cause for the failure of root canal therapy is an inability to recognize the presence of and to adequately treat all of the canals. The clinical impact of untreated canal spaces may vary from clinical and radio graphical normalcy to severe symptoms of acute pulpitis or apical abscess. Consistent high levels of success in endodontic treatment require an understanding of root canal anatomy and morphology. To achieve endodontic success,

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the entire root canal system must be derided, disinfected and obturated. The clinician must have a thorough understanding of normal anatomy, and of common variations from the norm. Thus meticulous knowledge of tooth morphology, careful interpretation of angled radiographs, proper access cavity preparation and a detailed exploration of the interior of the tooth is needed to ensure a proper endodontic treatment.

Conclusion: The variability of symptoms diagnostic and therapeutic difficulties make the treatment of missed anatomy a challenge for the general dentist; consequently, treatment of these difficult cases should be managed by dentists with advanced training in endodontics.

Keywords: Canine; premolar; root canal morphology; molar.

1. INTRODUCTION

Knowledge of the most common anatomic characteristics and their possible variations is fundamental, because the non treatment of one canal can lead to endodontic treatment failure [1].

The main objective of endodontic therapy is to eliminate infection from the root canal and the prevention of reinfection [2]. The achievement of this goal depends on several factors: [3]

- elimination of surviving microorganisms in the root canal system through effective cleaning and shaping procedures.
- creation of a tight three-dimensional seal with an inert filling material.
- blockage of any communication between the oral cavity and the periradicular tissue through a high quality coronal restoration.

However, the variation of pulp cavity morphology, especially in multirooted teeth, is a constant challenge for diagnosis and successful endodontic therapy. Knowledge of the most common anatomic characteristics and their possible variations is fundamental, because inability to recognize the presence of and adequately treat all the canals of the root canal system may be a major cause of endodontic treatment failure [4,5] Hoen and Pink found that in teeth that needed re-treatment the incidence of missed roots or canals was 42% [6] The relative simplicity and uniformity of the external surfaces of roots often masks internal complexity [7] These clinical cases describe rare root morphological variants of the different teeth managed endodontically in the same manner.

1.1 Maxillary First Premolar

Premolars are a group of teeth exclusive of the permanent dentition, and their predecessors are the first deciduous molars. The maxillary first

premolar has highly variable root canal morphology, but it is rare to find three roots with three canals. The incidence of maxillary premolars with three root canals varies from 0.5% to 6% [8,9] and generally the three roots have separated canals [10]. A review of the literature from studies conducted in teeth from populations of Asian origin reveals that the incidence of having three canals in maxillary first premolar is between 1.2%-1.5% [11-14]. The chances of maxillary first premolar having three roots and hence three canals are very low. There seems to be a racial predisposition for the presence of two or more canals in maxillary and mandibular premolars, as well as their bilateral occurrence [15] Rozylo et al. [16] has described the presence of the third canal in 9% of the cases. Bellizzi and Hartwell [17] had classified three rooted premolars as: Group 1: the three roots are merged or there are only two buccal roots, and the palatal root is semifused or free. In Group 2 buccal roots present separate, from middle or apical third. In Group 3 the three roots are separate from the cervical third. In these cases, where three roots are present, the maxillary premolar is called "minimolar" or "ridiculous" [18]. The case presented here appears to be in Group 3 according to this classification.

1.2 Maxillary Second Molar

Slowey [19], first reported the endodontic treatment of maxillary molars with two palatal roots. Thews et al. [20], also reported the endodontic treatment of two maxillary molars with aberrations of the palatal root anatomy, first tooth had two widely divergent palatal roots, and the second one had two root canals which joined at the apex in the single palatal root. Five years after his first report, Slowey [19] again showed a second molar in which the second palatal root might have been missed due to radiograph mis-interpretation during endodontic treatment. Libfeld and Rotstein reported an incidence of

second palatal root as 0.4% on examination of 1000 radiographs and 200 maxillary second molar endodontic treatments [21] Von Weiland and Wendt described a case report that did not resolve until the extra palatal root was located [22]. Peikoff and Christie [23] studied 520 endodontically treated maxillary second molars and concluded that the incidence of four separate roots and four separate canals including two palatal roots was 1.4%.

They also proposed a classification for four rooted Maxillary second molar abnormalities: Type 1-with divergent separate palatal roots, Type 2-with short blunt and parallel roots, Type III-with three convergent roots and distinctly divergent fourth distobuccal root. The tooth treated in this case appears to be of Type 1 variety according to the Christie's classification.

1.3 Mandibular Canine

Mandibular canines are recognized as having one root and one root canal in majority of the cases; however, the literature has reported single-rooted canine with two or three root canals and canine teeth with two different roots. The occurrence of two roots and even more two root canals is rare, ranging from 1% to 5% [24] Pécora JD et al. [25] studied 830 mandibular canines, and reported that 98.3% had only one root and of these 4.9% had two canals and one orifice, 1.2% had two canals and two orifices. Two canals and two roots were present in 1.7% of the cases. Bakianian Vaziri P et al. [26] analyzed 100 canines and detected the presence of two radicular canals in 12% of the cases using stereomicroscope. His results are in accordance with those obtained by Kaffe I et al. [27] that which showed a percentage of 13.75%, in a radiological study on 400 mandibular canines. Green D [28] reported 13% in the analysis of 100 teeth. Pineda F and Kuttler Y [29] found 18.5% of the mandibular canines having two canals through a study on 187 radiological images. Caliřkan MK et al. [30] studied 100 mandibular canines and reported the incidence being 19.5%. Holtzman L [31] reported mandibular canine with three root canals.

The objective of this case report was to describe the clinical management of three teeth with aberrant root canal morphology: A mandibular canine with two radicular canals, maxillary second premolar with three roots and root canals; and maxillary second molar with four

roots and root canals, all of which are rare clinical occurrence in our environment.

2. PRESENTATION OF CASES

2.1 Case 1

A 38-year-old female patient was referred to the author's clinic, with a complaint of spontaneous pain in tooth upper left first premolar. Clinically, there was a deep carious lesion at the distal surface of the tooth. The tooth was sensitive to cold and electric pulp testing, with responses indicating irreversible pulp damage. A preoperative periapical radiograph confirmed the presence of a carious lesion on the distal surface of the maxillary first premolar (Fig. 1a). 2% Lignocaine with 1:100,000 epinephrine (Xicaine, ICPA Health Products Ltd, Gujarat, India), was administered by periapical infiltration and the tooth was isolated with rubber dam (Hygienic Dental dam, Coltene/Whaledent Inc). All caries were removed and an access cavity was completed using No. 4 round bur and Endo Z bur (Dentsply Maillefer, Switzerland). The evaluation of the periapical radiograph together with the position of the buccal and palatal canal orifices suggested the possibility of the presence of a third root and third canal. The access cavity was modified to a triangular outline (T-shape) and the pulpal floor was re-explored carefully and a second buccal canal orifice was found. After removing the coronal pulp, all three canals (mesiobuccal, distobuccal and palatal) were explored with 10 K file. The working length was measured with an apex locator (Root ZX, J. Morita Inc), confirmed with a radiograph (Fig. 1b), and glide path was achieved with pathfiles (Dentsply Maillefer, Switzerland) in rotary motion. Biomechanical preparation was completed done using Wave One Primary (25/08 red ring) reciprocating file (Dentsply Maillefer, Switzerland) and canal irrigation was done using 5.25% sodium hypochlorite and 17% EDTA. After cleaning and shaping, the canals were dried with paper points and single cone obturation was done with Wave one gutta percha cones (size primary) and AH-plus sealer (Dentsply Dentry GmbH, Germany) (Fig. 1c). Post endodontic restoration was done by composite restoration, followed by porcelain fused to metal crown.

2.2 Case 2

A 25 year old male patient with a non-contributing medical history reported to the

author's clinic with a complaint of continuous pain in the right upper back region of mouth since 15 days. History of present illness revealed pain of throbbing type, localized and with moderate intensity. The clinical examination revealed distal caries in maxillary second molar with pulpal involvement. Pulp testing revealed that the tooth responded to electric pulp testing, indicating it to be vital. Radiograph indicated the pulpal involvement (Fig. 2a). Based upon the

findings the condition was diagnosed as irreversible pulpitis and endodontic treatment was advocated. After local anesthesia administration and rubber dam application, the endodontic access was refined and the main canals were found. This fourth canal which is mostly seen close to the mesio-buccal canal was not observed; however, a small blood spot was observed very closer to and towards the palatal canal previously located. Examination of the floor

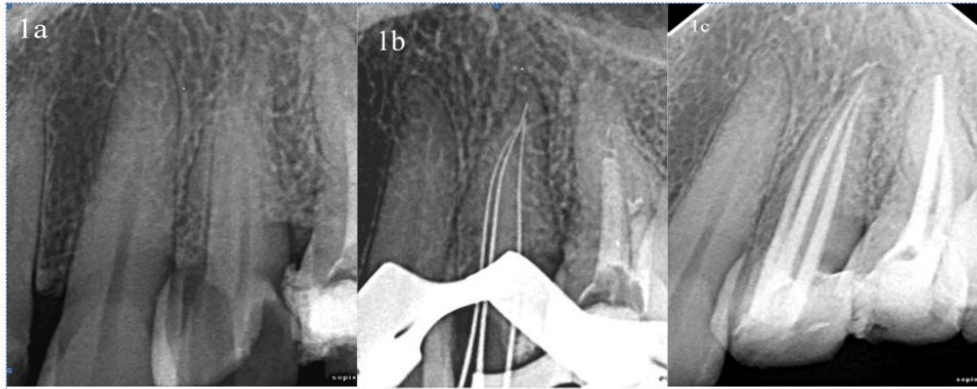


Fig. 1a. Pre-operative radiograph of maxillary left first premolar; **1b:** working length radiograph showing the presence three root canals; **1c:** Immediate post-treatment radiograph showing the obturated 3 root canals in maxillary first premolar

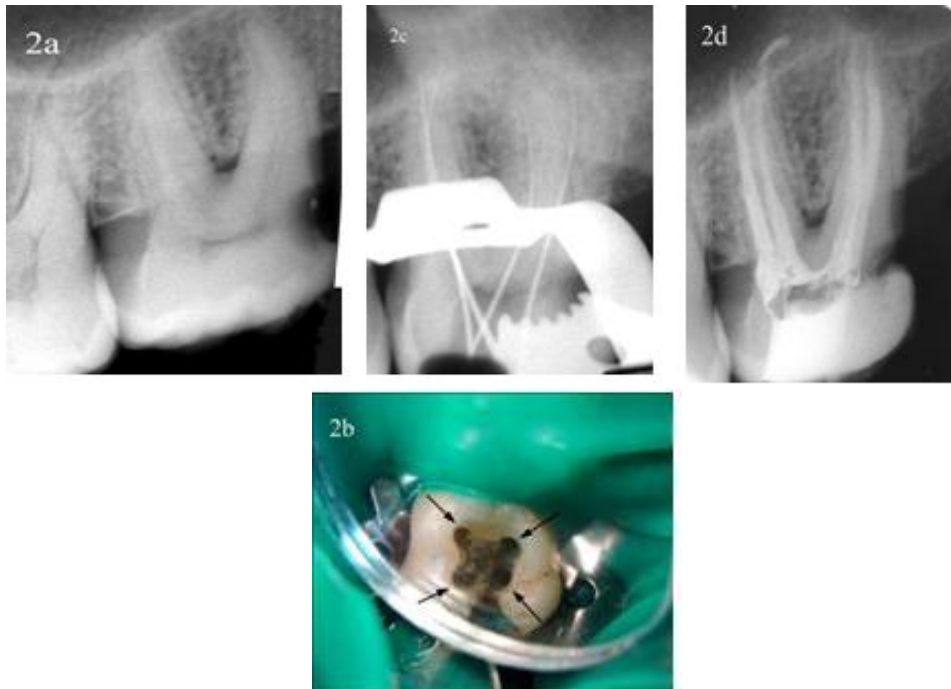


Fig. 2a. Pre-operative radiograph of maxillary right second molar; **2b:** Careful exploration of the pulp floor revealed the presence of four root canals; **2c:** Working length radiograph showing four root canals; **2d:** Immediate post-treatment radiograph showing obturated four root canals in maxillary second molar

of the pulp chamber with an endodontic explorer revealed 4 canal orifices, one mesiobuccal canal, one distobuccal canal and two palatal orifices. In the current case, to obtain a straight line access to the canals, the access cavity was prepared in trapezoidal shape and involved the oblique ridge. The pulp chamber of this tooth was broader in the palatal area and like other teeth, represented the whole crown shape (Fig. 2b). The treatment followed the same way as in case 1 and tooth was obturated. Post- obturation radiograph revealing 4 different canals was taken (Fig. 2c and Fig. 2d).

2.3 Case 3

A 54 year old female patient reported to the author's clinic with a chief complaint of pain in lower right anterior region for last six months. Pain was continuous in nature. Radiographic examination revealed severe attrition in canine with two separate root canals (Fig. 3a). After anaesthetizing the tooth and adequate isolation, access cavity preparation was initiated. After reaching the pulp chamber, the roof and

overhanging dentin from lateral walls were removed.

On attempt to negotiate the canal we found file going in different direction on every attempt, which gave a suspicion of presence of two canals. Hence size No. 10 and No. 8 K-file were placed in canal and radiograph was taken at two different angulations to confirm the presence of extra canals (Fig. 3b). Radiograph revealed the presence of two canals and two roots. Working length was estimated with an apex locator and confirmed by a radiograph. The orifices of labial and lingual canals were explored and canals were located with #8 and #10 K files (Fig. 3c). For the straight line access, GG drills were used with crown down method to enlarge the orifices. Both the canals were instrumented using wave one primary (25/08 red) reciprocating file, using for irrigation. Irrigation was done by 5.25% sodium hypochlorite and 17% EDTA and then obturated with wave one gutta percha points and A Hplus sealer (Fig. 3d). For post endodontic restoration, composite restoration followed by a metal ceramic crown was preferred.

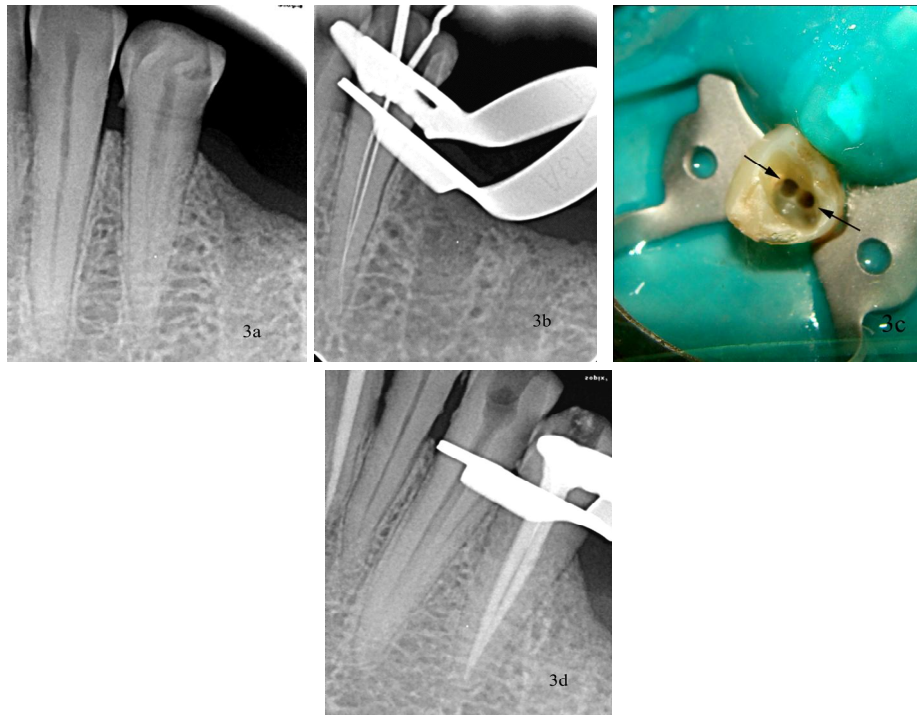


Fig. 3a. Pre-operative radiograph showing the presence of two rootcanals in mandibular canine; **3b:** Two root canals were confirmed by working length radiograph; **3c:** One Buccal canal and one lingual canal orifices were located, cleaned and shaped; **3d:** Post-treatment radiograph of right mandibular canine showing two root canals which merge in the apical third

3. DISCUSSION

Variations in type and number of root canals are probably some of the most widely described anomalies in literature. The anatomy of root canal systems dictates the condition under which root canal therapy is carried out and can directly affect this prognosis. Extra root or root canals if not detected are a major reason for failure of the treatment due to incomplete removal of all the irritants from the pulp space. The feasibility of negotiating cases with an unusual morphology depends upon a thorough knowledge of the normal anatomy and an awareness of the existence of anomalies. Diagnostic measures such as multiple pre-operative radiographs, examination of the pulp chamber floor with a sharp explorer, troughing of grooves with ultrasonic tips, staining the chamber floor with 1% methylene blue dye, performing the sodium hypochlorite 'champagne bubble' test and visualizing canal bleeding points are important aids in locating root canal orifices. Stropko recommended the use of 17% aqueous EDTA, 95% ethanol and the Stropko irrigator, fitted with a 27 gauge notched endodontic irrigating needle to clean and dry the pulp chamber floor prior to visually inspecting the canal system [32].

The initial radiograph is extremely essential because it allows for the identification of multiple roots, root canals and anatomical variations. Radiographs in different angulations reveal the anatomy of roots and root canal. Hence, it is important to take additional radiographs. Bifurcations in the cervical and middle thirds may be observed radiographically, such as a sudden root canal discontinuity. In addition, when examining the pre-operative periapical radiographs, if the outlines of roots are unclear or if the root canals show sharp density changes or if the apices cannot be well defined, then extra roots can be suspected. However, it does not always occur. Identification of the second root is even more difficult in the presence of tooth crowding. In all the present cases, identification of the extra root and root canals was evident by multiple radiographs at different angulations. Sieraski et al. [33] gave a general guideline for the identification of three rooted maxillary premolars using radiographs. He stated that, most likely, the tooth has three roots if the mesio-distal width of the mid-root image appears equal to or greater than the mesio-distal width of the crown image. A similar finding was observed in this case report.

The use of magnification and fiber optic illumination offers a tremendous advantage in locating and treating 'extra' canals. The Surgical Operating Microscope has been found to be particularly helpful. It is most important to be on the lookout for additional canals. Recently, spiral computed tomography, cone beam computed tomography and micro-computed tomography have also been advocated for use in studying root and canal system. In the present case, however, we did not feel the need for any objective analytical tool, such spiral or helical CT, to ascertain root canal morphology, because there were no doubtful circumstances in either radiographs of different angulations or examination of the floor of the pulp chamber. Furthermore, due to their high cost, such equipment may not always be present in routine clinical practice and the patient can be exposed to unwarranted radiations.

Optimum opening of the access cavity should be designed to provide direct access to the apical third of the root canal system, not merely to locate the canal orifice. Practice of extension of access cavity bucco-lingually, is mandatory to find extra and hidden canals. Efforts should be made to locate the point where the root or the canals divide. During the initial placement of scouting files (hand k files 6, 8, or 10) in the main canal, one may encounter an obstruction and the file may deflect to the buccal or lingual before it travels any further. This may indicate a canal division. It is important, thereafter, to develop a sense of tactile feel and direction with appropriately precurved scouting files to detect the trifurcation. When working with the surgical operating microscope, one can many times see the hypochlorite bubbling in the extra canal, marking its presence. On occasion, dyes or trans-illumination may be helpful in locating additional canals.

The working length may be determined using radiographs and electronic apex locators. Small, slightly pre-curved k- files or nickel titanium hand files are used to debride the canals and to establish a glide path to the working length. When anatomic variations are detected clinically, treatment can be performed with conventional or rotary preparation and root canal filling techniques respecting technical and biological principles. The use of locators can be important to determine the working length. The rotary instruments have been well indicated for these situations because of their property of flexibility and maintenance of the root canal center as well

as good shaping, even in cases of root dilaceration, diminishing the risk of elbows and perforations.

4. CONCLUSION

Failure to locate and treat extra canals in one of the major reasons of failed root canal treatment. This case report shows the presence of extra roots or root canals in mandibular canine, maxillary premolar and second molar. Although such root canal findings are rare, the practitioner should have a detailed knowledge of all possible root canal variations and never assume canals are simple. Careful interpretation of the radiograph, close clinical inspection of the floor of the chamber, and proper magnification of the chamber floor are essential for diagnosing and treating such cases.

CONSENT

All authors declare that 'written informed consent was obtained from the patient (or other approved parties) for publication of this case report and accompanying images.

ETHICAL APPROVAL

All authors hereby declare that all experiments have been examined and approved by the appropriate ethics committee and have therefore been performed in accordance with the ethical standards laid down in the 1964 Declaration of Helsinki.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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