Morphological variations in the root canal system of mandibular Premolars : A case series

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Abstract: The mandibular premolar may present large number of anatomic variations. The clinician should be aware of the configuration of the pulp system. Mandibular premolars usually have single root with single root canal system. The incidence of two or more canals in these teeth is quite rare. This report presents the diagnosis and clinical management of mandibular premolars with complex anatomy, drawing particular attention to tactile examination of all the canal walls.
[Youssef A. Algarni. **Morphological variations in the root canal system of mandibular Premolars: A case series .** *J Am Sci* 2014;10(12):157-162]. (ISSN: 1545-1003). http://www.jofamericanscience.org. 16

Keywords: morphological variation, mandibular premolar, complex anatomy.

1. Introduction

The ultimate goal of root canal treatment is the prevention and/or treatment of apical periodontitis through a thorough cleaning and shaping of all pulp spaces and the complete obturation of these spaces with an inert filling material. Therefore, the knowledge of root canal anatomy of each tooth is critical in order to reach this goal. The clinician must have a thorough understanding of common anatomy, appreciation of its possible variations and be capable of identifying these variant teeth.

Knowledge of the morphology of the root and root canal systems of teeth and diagnostic imaging techniques are required for successful root canal treatment, especially in mandibular premolar teeth (1).

As a group, the mandibular premolars are among the most difficult teeth to treat endodontically. A possible explanation for this difficulty may be the extreme variations in root canal morphology that occur in these teeth. Furthermore, the incidence, location, and morphology of root canal systems may vary in different ethnic or regional populations. The mandibular first premolar is typically described in textbooks as a single rooted tooth with a single root canal system and the mandibular second premolar described as a single rooted tooth with a single root canal system (2, 3). But, there are numerous case reports and anatomic studies that have reported variations in this tooth (18-23). There seems to be a racial predisposition for the presence of two or more canals in maxillary and mandibular premolars (4, 5) as well as their bilateral occurrence (6). The more rare the aberrations, the more likely it is to be bilateral in occurrence (7).

Although most mandibular first premolars have a single root, two, three, and even four-rooted forms have been reported as having 2.1% incidence when grouped together. The majority of mandibular first premolars have a single canal, though a relatively high incidence of two or more canals – 24.2% – has been reported (2). Compared to mandibular first premolars, most mandibular second premolars have a single root and in them the incidence of two or more roots is low (actually 0.4%). On the other hand, the majority of mandibular second premolars have a single canal and approximately 9.0% have two or more canals (3).

Traditional endodontics has been based on textile sensation not sight and the magnification helps the user not only to see more, but to see well. High levels of magnification increase the aggregate amount of visual information available to endodontists for diagnosing and treating the complexity.

The introduction of the dental microscope and the associated ability to inspect the root canals both orthograde and retrograde have fundamentally changed our understanding of dental morphology and its complexity (8, 9). The position of the AAE is that the microscope is an integral and important part of the performance of modern endodontic techniques (8). This huge shift in clinical accuracy from low magnification (tactile driven) endodontics to (vision-based) endodontics is bringing a revolution to the field of endodontics with greater success rate. So, utilization of magnification and illumination is essential for managing these cases.

The purpose of this article is to report, as well as discusses the successful diagnosis and endodontic treatment for mandibular premolars with complex anatomy.

Case 1

A 33-year-old female with a non-contributory medical history sought treatment at the King Abdulazize University, Faculty of Dentistry. The chief complaint was “I have sever continuous pain

with cold lasting for minutes". Clinical examination showed temporary crown in the tooth #34. After removal of temporary crown, pulp horn was exposed because of crown preparation. The tooth was sensitive in percussion. Investigations for swelling, sinus tract and periodontal involvement were negative. Preoperative radiographs of revealed slight widening of PDL space and normal apical bone. Sudden disappearance of canal space in the junction of coronal and middle third of the root (Figure 1). The pulp was diagnosed as symptomatic irreversible pulpits with normal apical periodontitis.

Root Canal Treatment

Treatment start by inferior alveolar nerve block (IANB) with 2% lidocaine one cartridge. Removal of preexisting temporary crown. Rubber dam isolation and access cavity gained obtained one orifice. Under dental operating microscope (DOM) and using micro opener (Dentsply, Maillefer, Switzerland) detection of the missed lingual canal was successful and then micro debrider (Dentsply, Maillefer, Switzerland) was used to remove the dentin triangle and create straight line access to the lingual canal. Working length determination using Root ZX apex locator (J. Morita USA). Chemomechanical preparation using proper next rotary system and irrigation by NaOCl 5.25%. Final rinse with EDTA 17% (10 ml for 1 minute) followed by NaOCl 5.25% (10 ml). Dryness using paper point. Obturation using gotta percha and zinc oxide eugenol sealer (Pulp canal sealer, SybronEndo, USA) and continuos wave compaction using Elements Obturation Unit (SybronEndo, USA). Sealed access with IRM and radiograph was taken (Figure 1). Referred patient to prosthodontist for full coverage crown. Endodontic recall in 6 months.

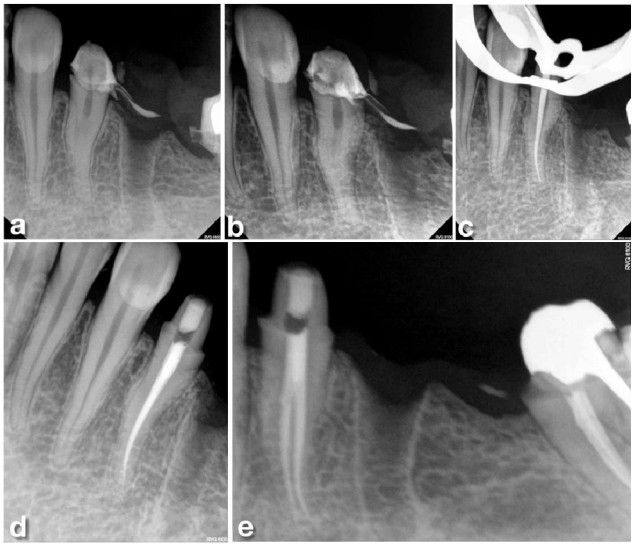

Figure 1. Case1: a,b, preoperative radiograph (straight and mesial shift). c, master cone radiograph. d,e, Postoperative radiograph (straight and mesial shift).

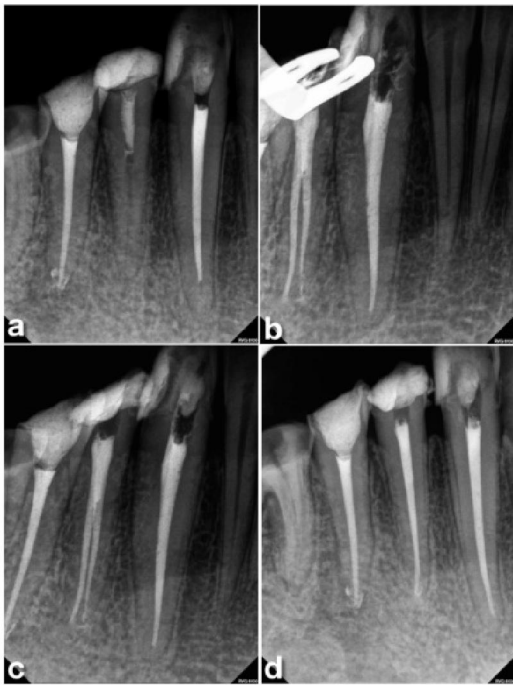

Figure 2. Case 2: a, preoperative radiograph . b, post obturation radiograph. c,d Postoperative radiograph (straight and mesial shift).

Case 2

A 39-year-old male with a non-contributory medical history sought treatment at the King Abdulazize University, Faculty of Dentistry. The chief complaint was “Referred for completion of root canal treatment". Clinical examination showed temporary restoration in the tooth #44. The tooth was sensitive in percussion. Investigations for swelling, sinus tract and periodontal involvement were negative. Preoperative radiographs of revealed slight widening of PDL space and normal apical bone. Sudden disappearance of canal space in the middle third of the root (Figure 2). The pulp was diagnosed as Previously initiated therapy with normal apical periodontitis.

Root Canal Treatment

Treatment start by inferior alveolar nerve block (IANB) with 2% lidocaine one cartridge. Rubber dam isolation and access cavity gained obtained one orifice. Under dental operating microscope (DOM) and using micro opener (Dentsply, Maillefer, Switzerland) detection of the missed lingual canal was successful and then micro debrider (Dentsply, Maillefer, Switzerland) was used to remove the dentin triangle and create straight line access to the lingual canal. Working length determination using

Root ZX apex locator (J. Morita USA). Chemomechanical preparation using proper next rotary system and irrigation by NaOCl 5.25%. Final rinse with EDTA 17% (10 ml for 1 minute) followed by NaOCl 5.25% (10 ml). Dryness using paper point. Obturation using gotta percha and zinc oxide eugenol sealer (Pulp canal sealer, SybronEndo, USA) and continuos wave compaction using Elements Obturation Unit (SybronEndo, USA). Sealed access with IRM and radiograph was taken (Figure 2). Referred patient to prosthodontist for full coverage crown. Endodontic recall in 6 months.

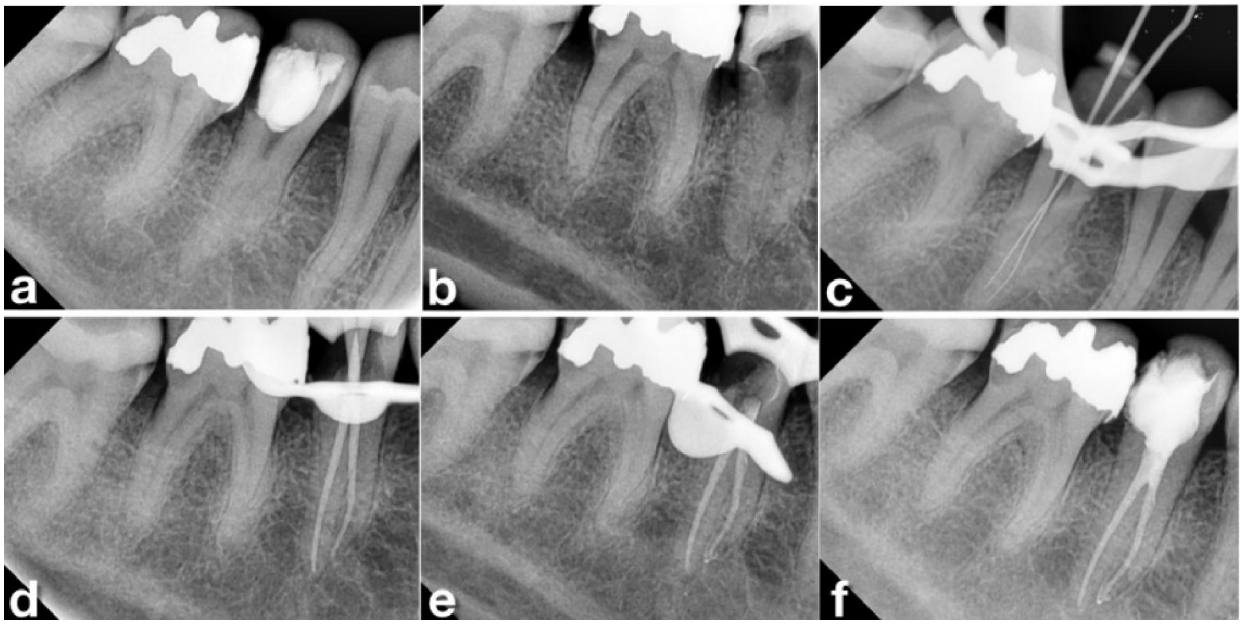

Figure 3. Case 3: a,b, preoperative radiograph (straight and mesial shift). c, working length radiograph. d, master cone radiograph. d,e, Postoperative radiograph (straight and mesial shift).

Case 3

A 22-year-old female with a non-contributory medical history sought treatment at the King Abdulazize University, Faculty of Dentistry. The chief complaint was “Referred for completion of root canal treatment". Clinical examination showed temporary restoration in the tooth #45. The tooth was sensitive in percussion. Investigations for swelling, sinus tract and periodontal involvement were negative. Preoperative radiographs of revealed slight widening of PDL space and normal apical bone. Sudden disappearance of canal space in the middle third of the root (Figure 3). In sever shift radiograph, clear distinction of two roots. The pulp was diagnosed as Previously initiated therapy with normal apical periodontitis.

Root Canal Treatment

Treatment start by inferior alveolar nerve block (IANB) with 2% lidocaine one cartridge. Rubber dam isolation and access cavity gained obtained one orifice. Under dental operating microscope (DOM) and using micro opener (Dentsply, Maillefer, Switzerland), detection of the missed lingual canal was successful and then micro debrider (Dentsply, Maillefer, Switzerland) and ultrasonic tips were used to remove the dentin triangle and create straight line access to the lingual canal. Working length determination using Root ZX apex locator (J. Morita USA). Chemomechanical preparation using proper next rotary system and irrigation by NaOCl 5.25%. Final rinse with EDTA 17% (10 ml for 1 minute) followed by NaOCl 5.25% (10 ml). Dryness using paper point. Obturation using gotta percha and zinc oxide eugenol sealer (Pulp canal sealer, SybronEndo, USA) and continuos wave compaction using Elements Obturation Unit (SybronEndo, USA) (Figure 3). Sealed access with IRM and radiograph was taken. Referred patient to prosthodontist for full coverage crown. Endodontic recall in 6 months.

Case 4

A 26-year-old female with a non-contributory medical history sought treatment at the King Abdulazize University, Faculty of Dentistry. The chief complaint was “I have pain on my lower right tooth specially on biting". Clinical examination showed occlusal amalgam restoration in the tooth #45 and large distal recurrent caries. The tooth was sensitive in percussion. Investigations for swelling, sinus tract and periodontal involvement were negative. Preoperative radiographs of revealed slight

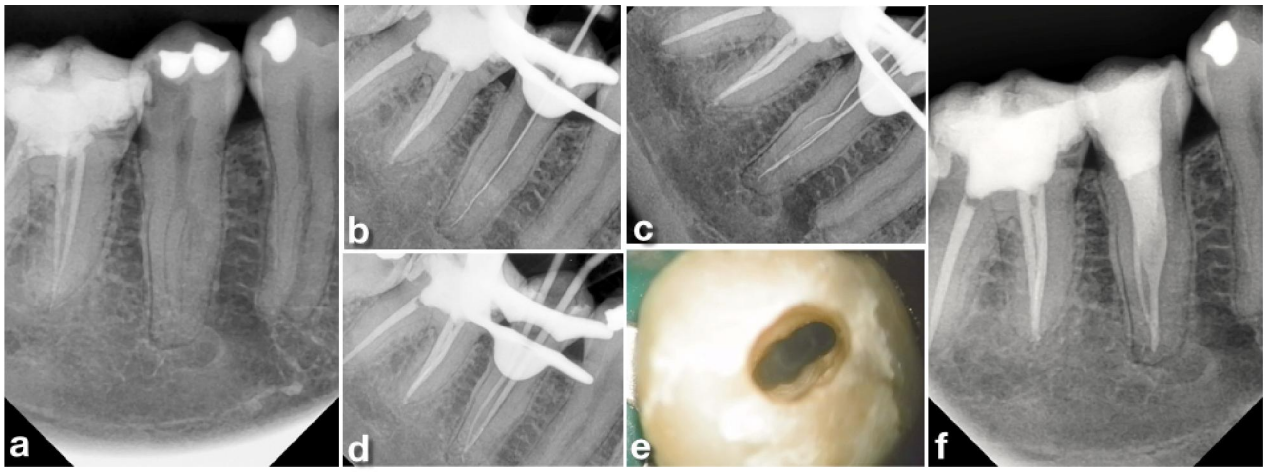

Figure 4. Case 4: a, preoperative radiograph.b, c, working length radiograph. d, master cone radiograph. e, Access cavity view. F, Postoperative radiograph.

widening of PDL space specially at apex and slightly apical radiolucency. Sudden disappearance of canal space in the middle third of the root (Figure 4). The pulp was diagnosed as Previously initiated therapy with normal apical periodontitis.

Root Canal Treatment

Treatment start by inferior alveolar nerve block (IANB) with 2% lidocaine one cartridge. Rubber dam isolation and access cavity gained obtained one orifice. Under dental operating microscope (DOM) and using micro opener (Dentsply, Maillefer, Switzerland), two canal was identified and radiograph taken (Figure 4). Radiographically, third canal was detected. The use of ultrasonic tip under DOM to remove the dentin triangle and create straight line access to the missed disco-buccal canal (Figure 4). Working length determination using Root ZX apex locator (J. Morita USA). Chemomechanical preparation using proper next rotary system and irrigation by NaOCl 5.25%. Final rinse with EDTA 17% (10 ml for 1 minute) followed by NaOCl 5.25% (10 ml). Dryness using paper point. Obturation using gatta percha and zinc oxide eugenol sealer (Pulp canal sealer, SybronEndo, USA) and continuos wave compaction using Elements Obturation Unit (SybronEndo, USA) (Figure 3). Sealed access with IRM and radiograph was taken. Referred patient to prosthodontist for full coverage crown. Endodontic recall in 6 months.

2. Discussions

Clinicians should be aware of anatomical variations in mandibular premolars and be able to apply this knowledge in radiographic and clinical interpretation. Clinically, precise three-dimensional determination of the internal structure of teeth, their form and number of root canals is a challenge. Because of the complex, varied morphology of the premolars, endodontic treatment in the premolar is a challenging task. Accurate preoperative radiographs, straight and angled, using parallel technique is essential in providing clues as to the number of roots that exist (10). Sieraski et al. (11) found that whenever the mesio-distal width of the mid-root image was equal to or greater than the mesio-distal width of the crown, the tooth most likely had three roots. Yoshioka et al. (12) have indicated that sudden

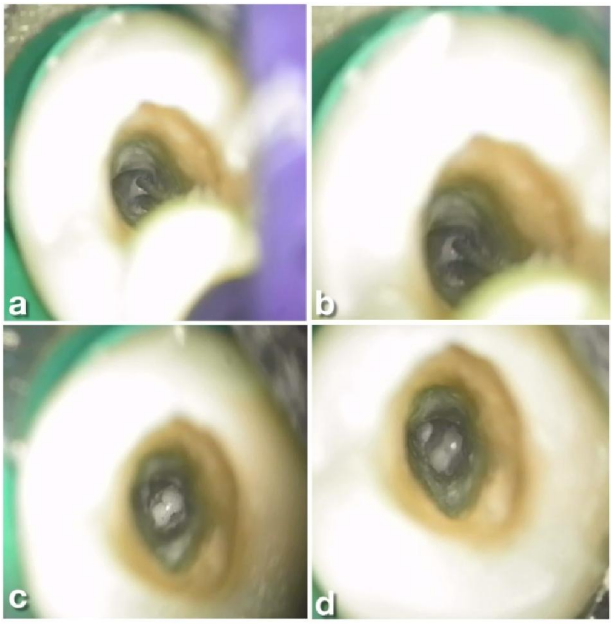

Figure 5. Case 4: a,b, Photoes under DOM with intial files in first two canals. c, prepared two canals. d, after removal of dentin triangle exposing the third canal.

narrowing of canal system (fast break rule) on a

parallel radiograph suggests canal system multiplicity. Martinez–Lozano et al. (13) have suggested a 40 degree mesial angulation of X-ray beam to identify additional canals. Sabala et al. (7) studied 501 patient records for aberrant root and root canal morphology. In the study, occurrence of the same aberration on the contralateral tooth varied according to the type of anomaly. Their study found that the rarer the anomaly, the greater the incidence of the anomaly occurring bilaterally.Those anomalies occurring less than 1% found to occur bilaterally up to 90% of the time.

Diagnostic measures also include the examination of pulp chamber floor under DOM with a sharp explorer, troughing of grooves with ultrasonic tips, staining the chamber floor with 1% methylene blue dye, performing the NaOCl 'champagne bubble' test and visualizing canal bleeding points are important aids in locating root canal orifices. The use of micro-instrument including micro-opener and micro-debrider with unique design of offset handle facilitate the detection with vision under high magnification using DOM.

The dental operating microscope (DOM) is used increasingly *in vivo* for routine endodontic procedures because of enhanced visibility and lighting (14). The reported advantages of using an operating microscope for conventional endodontics include improved the visualization of root canal anatomy that enables the operator to investigate the root canal system and to clean and shape it more efficiently (14,15). The detection rate of root canal orifices under a microscope was significantly higher than that with naked eye and that the use of surgical loupes was relatively ineffective compared with the microscopic method (16).

The use of different angled radiograph and micro-insturment under DOM will help the clinician to reach accurate diagnosis and treatment.

3. Conclusions

Reports in the literature vary greatly with respect to root canal and root morphology of mandibular premolar teeth compared with the standard description of one root, one canal found in texts on Dental Anatomy.

The mandibular premolar teeth can present with extremely complex root and canal system morphology, and if not considered during treatment can lead to difficulties when performing root canal treatment

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12/15/2014