ISSN: 2581-5989
PubMed - National Library of Medicine - ID: 101738774

International Journal of Dental Science and Innovative Research (IJDSIR)

IJDSIR : Dental Publication Service

Available Online at: www.ijdsir.com

Volume – 3, Issue – 3, May - 2020, Page No. : 284 - 288

Variability of root canal system in mandibular first and second molars – A case series

[1]Dr Pragya Pandey, Assistant Professor, Department of Conservative Dentistry & Endodontics, Faculty of Dental Sciences, King Georges Medical University, Chowk, Lucknow, Uttar Pradesh, India

[2]Dr A.P Tikku, Professor and Head, Department of Conservative Dentistry & Endodontics, Faculty of Dental Sciences, King Georges Medical University, Chowk, Lucknow, Uttar Pradesh, India.

Corresponding author: Dr Pragya Pandey, Assistant Professor, Department of Conservative Dentistry & Endodontics, Faculty of Dental Sciences, King Georges Medical University, Chowk, Lucknow, Uttar Pradesh, India

Citation of this Article: Dr Pragya Pandey, Dr A.P Tikku, "Variability of root canal system in mandibular first and second molars – A case series ", IJDSIR- May - 2020, Vol. – 3, Issue -3, P. No. 284 – 288.

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Type of Publication: Case Report

Conflicts of Interest: Nil

Abstract

Success of endodontic treatment depends upon accurate diagnosis, comprehensive knowledge of normal as well as aberrant root canal morphology and precise execution of the treatment. No matter, how much an endodontist is sure about the root canal anatomy, nature never fails to surprise, especially in case of mandibular posterior teeth, where one might encounter extra root canals apart from the three main canals-mesiobuccal, mesiolingual and distal. Several variations such as an additional distolingual or mesiobuccal root, third canal in the isthmus between mesiobuccal and mesiolingual canal known as middle mesial canal or between distobuccal and distolingual canal known as middle distal canal, C-shaped root canal system, and isthmuses connecting the canals may be present in these teeth. Exploration and cleaning of all the canals and isthmi is important for endodontic success. Technological advancements like cone beam computed tomography, magnification and ultrasonics have made such aberrant anatomy far more common in todays' practice, as in the present report. This case series presents varied anatomic configurations in first and second mandibular molars and points to the importance of anticipating and looking for additional canals in these teeth.

Keywords: middle mesial canal, mandibular first molar, middle distal canal, mandibular second molar, missed canal, extra canals.

Introduction

As a dental professional, one should be aware of all the probable nooks and crannies of complex root canal system, its protean permutations and combinations, to render the finest possible treatment. The incidence of teeth requiring endodontic retreatment due to missed roots or canals has been reported to be as high as 42% making it a major cause of endodontic treatment failure.[1] Mandibular first molar with an endodontic success rate of 81.48%, considerably lower than the usual success rate of 87.79% in other teeth, has reported a high incidence of missed canals in both distal and mesial roots.[2] The middle mesial canal (MMC) is, also, often missed in mandibular second molars.[3] The objective of this case series is to report anatomic variations in terms of different root canal configurations in mandibular first and second molars, the role of comprehensive knowledge and meticulous exploration of the pulpal floor anatomy and assistance of pre-operative radiographs and cone beam computed tomography in locating root canals. This article presents the successful management of three unique cases of mandibular molars having more than the usual canals.

Case Presentation

Case 1: A 19-year-old female presented to the Department of Conservative Dentistry and Endodontics, with severe pain in lower left posterior jaw region. Clinical examination revealed a carious left mandibular first molar. Radiographic examination confirmed pulpal involvement in left mandibular first molar and hence endodontic

therapy was initiated the same day. The patients' medical history was noncontributory. Anesthesia in the involved area was achieved by administration of inferior alveolar nerve block using 2% lignocaine. Four canals were straightforwardly located- Mesiobuccal, Mesiolingual Distobuccal and Distolingual following the dentinal map on the pulpal floor. Careful exploration of the pulpal floor with an endodontic explorer revealed two distinct additional canals – middle mesial canal and mid-distal canal apart from the four main canals (figure 1). Transverse section images of CBCT scan validated the presence of six canals (figure 2). After working length determination (figure 3), biomechanical preparation was done using protaper rotary instruments (Densply-Mallifer, Switzerland), along with copious irrigation with 3% NaOCl. Finally, the canals were obturated after a week with gutta-percha cones of size corresponding to the master apical file, by cold lateral compaction technique (figure 4) followed by post endodontic restoration. The patient experienced no postoperative sequelae and was referred for appropriate coronal restoration.

Case 2: A 20-year-old male reported to the Department of Conservative Dentistry and Endodontics, King Georges Medical University (KGMU) with a chief complaint of pain in his lower right back region of jaw since past one week. The medical history was non-contributory. Clinical examination revealed a prosthetic crown on mandibular right first molar. Past dental history revealed root canal treatment last month. Tooth was found to be tender on percussion. Radiographic examination revealed faulty root canal treatment in 46. The crown was removed with the help of a crown removal kit (Waldent Automatic Crown Remover Instruments Kit) and the gutta percha root canal filling was retrieved. Calcium hydroxide dressing was given and the tooth was sealed with a cotton pellet and temporary material. The patient returned the next day with pain. After removing the temporary restoration, the pulpal floor was carefully examined to look for any defects, extra canals or fracture. Aberrancy in developmental root fusion line joining the two mesial canals was seen. Careful exploration under illumination and magnification (4x dental loupes; neitz surgical loupes) revealed a missed middle mesial canal (Figure 5) with independent configuration. The canal originated as a separate orifice and ended in a separate foramen. The canal was cleaned, shaped and subsequently obturated with laterally condensed with AH Plus epoxy resin- based root canal sealer (Dentsply, Maillefer) and gutta percha (figure 6 and 7). The patient was asymptomatic after a follow up of two months; thereafter a final fixed prosthesis was given.

Case 3: A 17-year-old male patient presented to the Department of Conservative Dentistry and Endodontics, KGMU, Lucknow with a chief complaint of hot and cold sensitivity and spontaneous pain in left lower jaw region. After clinical and radiographic examination, diagnosis of symptomatic irreversible pulpitis was made and root canal treatment of #37 was initiated. Clinical examination with a DG 16 (Hu-Freidy, USA) endodontic explorer revealed three mesial orifices and one distal canal (figure 8 & 9). Confirmation of the presence of independent type of middle mesial canal was done with the help of CBCT (figure 10). Cleaning and shaping of the canals was performed by crown-down technique. Inter-appointment calcium hydroxide intra-canal medicament was placed and obturation was done after a week, using AH Plus sealer by cold lateral compaction technique (figure 11). The case was followed for two months with no postoperative discomfort.

Discussion

It is not unknown that anatomy of root canal system is very complex and inspite of having knowledge about the same, it is challenging to recognize and treat tooth with aberrant root canal configuration. [4] Mandibular first and second molars exhibit considerable anatomical variation regarding the number of roots and root canals. [5] The article reports three cases with a third canal in mesial root, the MMC and one case with a third canal in distal root-mid distal canal in mandibular molars.

The presence of a third canal in the mesial root of mandibular molars has been reported to have an incidence rate of 1-15%. [6] According to Pomeraz, the MMC can be classified as (1) fin, when at any stage of debridement the instrument could pass freely between mesiobuccal or mesiolingual canal and the middle mesial canal, (2) independent, wherein the MMC originated as a separate canal orifice and ended in a separate foramen and (3) confluent type, wherein the additional canal may have a separate orifice and join apically with either the mesiobuccal or mesiolingual root. [5] Many authors have reported the presence of three foramina in mesial root of mandibular molars, however only few have reported the presence of three independent type of MMC. [7] In the present case series all cases reported an independent type of MMC, making the cases rare and unique. Pomeranz et

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al. studied hundred mandibular molars- 61 first molars and 39 second molars that were successively endodontically treated. He reported twelve cases MMC of which five were in second molars. In his study he recounted- eight fins, two confluent canals, and only two independent canals. [5] The presence of MMC is more common in mandibular first molars in comparison to mandibular second molars. [8] Contrarily, in a study by Ahmed *et al.* in Sudanese population, the prevalence of MMC was 4% in mandibular first molars and 10% in mandibular second molars. [9] Reuben et. al. reported the incidence of middle mesial in mandibular molars in Indian population to be in range of 0.95–15%. [10] Baugh and Wallace did a review of literature and also reported a similar incidence of 1-15%. [11] The first case of this case series also reports the successful treatment of an additional case of a mandibular first molar with six canals-three mesial and three distal canals. The incidence of middle distal canal in mandibular first molar is a rare entity with an incidence in the range of 0.2%-3%. [12] Berthiaume was the first to report existence of three distal canals in mandibular first molar and the three distal canals ended in two apical foramina. [13] Reuben et al., examined one twenty five mandibular first molars in an Indian population, using spiral computerized tomography, and none of the teeth had three distal canals. [10] The first case of this series describes the rare occurrence of mandibular first molar of Indian origin, having three distal canals. All three canals had a common apical opening that could be described as Type XVIII (3-1) canal configuration according to Sert and Bayirli classification. [14] Type XVIII canal pattern in distal root of mandibular first molar has previously been reported in only few cases. [15, 16]. Witherspoon et al identified 64 cases of missed canal of the 133 previously treated teeth. He found that of the total missed canals, in the mandibular second molars, 29% of missed canals were identified in the distal and 71% were identified in the mesial root. [8] In the mandibular first molars, 86% of missed canals were identified in the distal and 14% were identified in the mesial root. [8] Our second case report also shows the unsuccessful endodontic treatment due to the missing of the middle mesial canal in mandibular first molar. Clinician should consider all measures available to maximize canal identification. Modification of coronal access, use of magnification and ultrasonic tips and removal of cervical stenosis, if any, by clinically troughing the pulpal groove in proper direction help in negotiating and managing middle canals in mesial/distal roots. [17] These aberrant root canal anatomies need to be dealt with extreme patience, precaution, expertise, precise visualization of dentinal map and preoperative radiographs (straight and angled) as suggested by Weine.[18] Radiographic analysis may not be confirmatory, necessitating the use of more advanced methods like CBCT as a diagnostic tool to confirm the presence of extra canals. [19]

Conclusion

Identifications of the aberrant canal systems and their cleaning and shaping is one of the most important criteria for success of endodontic treatment. A thorough knowledge about the incidence of the aberrant anatomies of the root canal along with the prudent use of diagnostic modalities can help in better negotiation of such unusual types of canal configurations paving a way for longevity of the endodontically treated teeth.

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Legends Figure

Case 1

Figure 1: clinical occlusal view showing 6 distinct canal orifices in #36 : MB, mesiobuccal; MM, middle mesial; ML, mesiolingual; DB, distobuccal; MD, middle distal; DL, distal lingual.

Figure 2: CBCT –axial view with 6 distinct canals in #36: MB, mesiobuccal; MM, middle mesial; ML, mesiolingual; DB, distobuccal; MD, middle distal; DL, distal lingual.

Figure 3: working length intraoral periapical image #36: MB, mesiobuccal; MM, middle mesial; ML, mesiolingual; DB, distobuccal; MD, middle distal; DL, distal lingual.

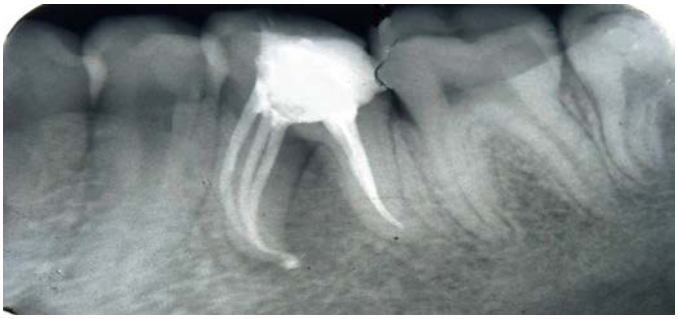

Figure 4: obturation intraoral periapical images #36: MB, mesiobuccal; MM, middle mesial; ML, mesiolingual; DB, distobuccal; MD, middle distal; DL, distal lingual.

Case 2

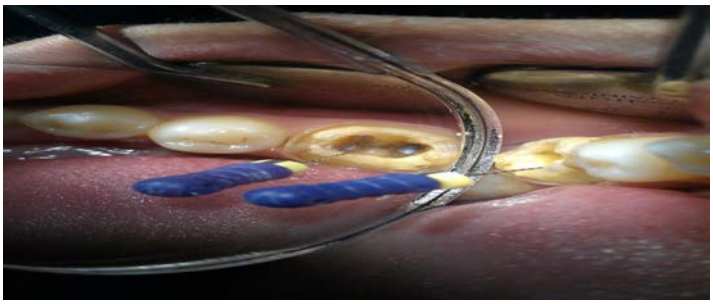

Figure 5: clinical occlusal view showing missed middle

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mesial during retreatment #46: MB, mesiobuccal; MM, middle mesial; ML, mesiolingual; D, distal.

Figure 6: obturation intraoral periapical image #46: MB,mesiobuccal; MM, middle mesial; ML, mesiolingual; D, distal.

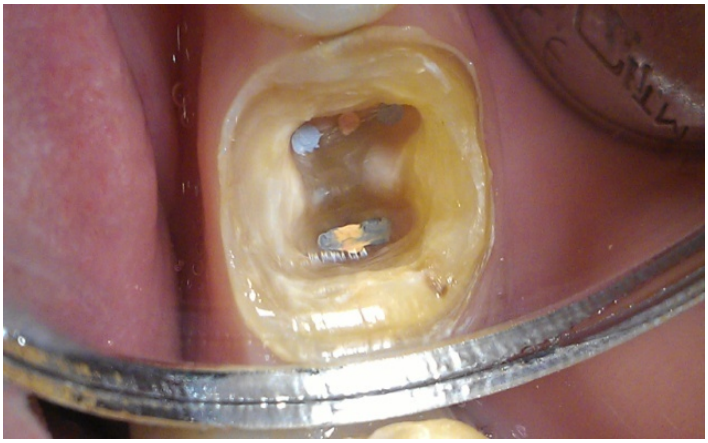

Figure 7- clinical occlusal view with obturation #46: MB, mesiobuccal; MM, middle mesial; ML, mesiolingual; D, distal.

Case 3

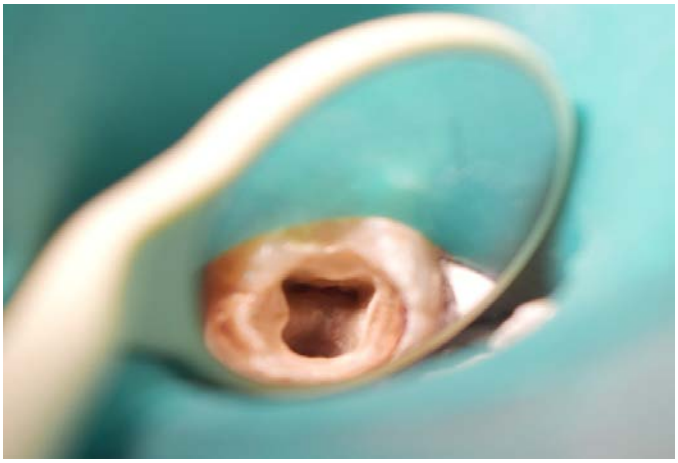

Figure 8- clinical occlusal view showing 4 distinct canal orifices #37: MB,mesiobuccal; MM, middle mesial; ML, mesiolingual; D, distal.

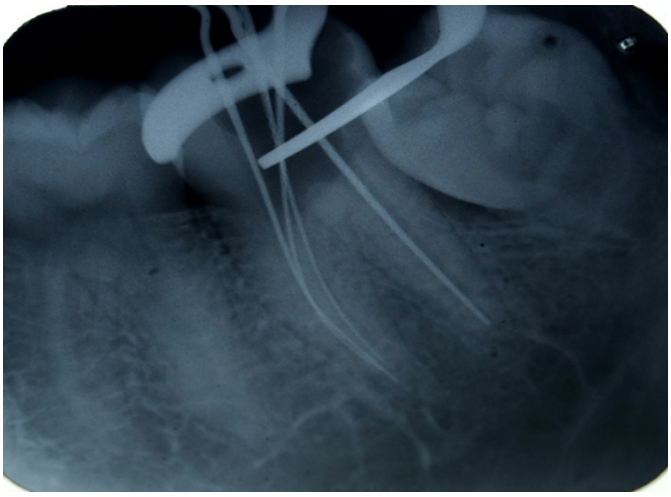

Figure 9: working length intraoral periapical image #37: MB,mesiobuccal; MM, middle mesial; ML, mesiolingual; D, distal.

Figure 10: CBCT –axial view with 4 distinct canals in #37: MB,mesiobuccal; MM, middle mesial; ML, mesiolingual; D, distal.

Figure 11: obturation intraoral periapical image #37: MB,mesiobuccal; MM, middle mesial; ML, mesiolingual; D, distal.

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