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CASE SERIES

Nonsurgical management of maxillary first molars with 5 root canals

ABSTRACT

Aim: *This case series reports the nonsurgical management of five maxillary first molars with five root canals in different ethnic groups and geographic locations.*
Summary: *Diagnosis and management of complex root canal anatomy, especially of the maxillary first molar, can be frustrating and challenging and also may increase the risk of failure if not managed with appropriate tools. In this case series the primary endodontic treatment of four, and a nonsurgical retreatment of one maxillary first molar with five root canals treated by three different endodontists from India, Spain, and Portugal has been described. None of the cases presented in the paper were performed without magnification and troughing of the pulp chamber floor using ultrasonic tips. Although CBCT wasn't used in all cases, its prudent use respecting the ALARA principle is highlighted in the paper. This paper also highlights the importance of anatomical variations in different ethnic groups with the maxillary first molar.*
Key-learning points

- *Operator should consider the ethnicity of the patient and thoroughly study pre-operative radiographs to carry out successful endodontic treatment.*
- *Use of magnification and ultrasonic tips are fundamental especially in treating unusual canal anatomies.*
- *The prudent use of CBCT should be performed respecting the ALARA principle in all given situations.*

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Introduction

The failure of endodontic treatment has often been accused of the anatomical complexities and variations that exist in the root canal system (1). Maxillary first molars have been shown to have an extra canal in the mesial root, ranging from 48% up to 97.6% of the time, which is one of the most common variations of this tooth (2-4). Variations of palatal root having 2 canals and/or 2 roots have also been reported in some case reports (5, 6). Nonetheless, distal root has also variations reported with the presence of 2 (7) and even up to a 3 canals configuration (6, 8).
Technological advancements in dentistry, especially in endodontics regarding detection, improved cleaning & shaping, and obturation of the root canal space, have noticeably improved in the last decade. CBCT has proved to be an invaluable tool in endodontics for the detection of extra canals and also has been demonstrated to have higher sensitivity and specificity compared to traditional radiographs (9-12). Periapical radiographs have also been demonstrated to detect extra canals specifically when a different beam angulation is used (13). It helps to spot superimposed roots, better visualize buccal roots for the maxillary molars, and makes it easier to visualize the apices of the roots usually covered by the zygomatic process (14). Considering the ALARA (As low as reasonably achievable) principle (15), and according to the latest guidelines, it is wise to use a CBCT only in cases where clinical examination and conventional radiography don't provide sufficient information to perform the correct treatment (16).
The dental operating microscope has demonstrated to detect more missed canals when compared to naked eyes and is found to detect MB2 canals ranging from 71-83% in the maxillary first molars when compared to other magnification aids (4, 17, 18). A study even demonstrated that with the increase in operator experience with the operating microscope, the detection of additional canals can reach up to 93% (4). The use of magnification with the addition of ultrasonic troughing also has been proven to help find missed canals (19, 20).
The presence of root canal variations of teeth is dependent on the population being studied. In a worldwide analysis, it was found that the highest prevalence of an extra mesiobuccal (MB2) canal in the first maxillary molars was in the Belgian population. Also, other countries like India (64.8%), China (76.4%), Spain (68%), and Portugal (72.8%) had a high prevalence regarding its presence (3). Publications of maxillary first molars with five, six, seven, and even up to an eight canal configuration have also been reported in different populations including the Indian, American, and Brazilian population (7, 21-25).
This case series reports the endodontic management of five maxillary first molars with the presence of 5 canals from different dental centers of India, Spain and Portugal.

Case report

This paper presents the endodontic treatment of five maxillary first molars, out of which three were treated in 3 different private dental offices in Pune, India, one tooth treated in a private dental office in Lisbon, Portugal, and one tooth in Barcelona, Spain. A detailed clinical and radiographic examination was performed for all the cases. None of the patients had any relevant medical history. All patients signed informed consent before starting any treatment. Vitality tests were carried out using a cold test and heated gutta-percha. Local anaesthesia was administered in all the cases and treatments were carried out under absolute rubber dam isolation with either loupes or dental operating microscope used for magnification.

#Case 1
A 40-year-old male of Indian origin was referred to a private office in Pune, India due to pain in the upper right region of the jaw. The referring dentist had made an access opening on the tooth 16 as an emergency treatment. Probing depth of 5mm was noted in the distobuccal and distopalatal areas of the tooth and mobility were within physiologic limits. The tooth was

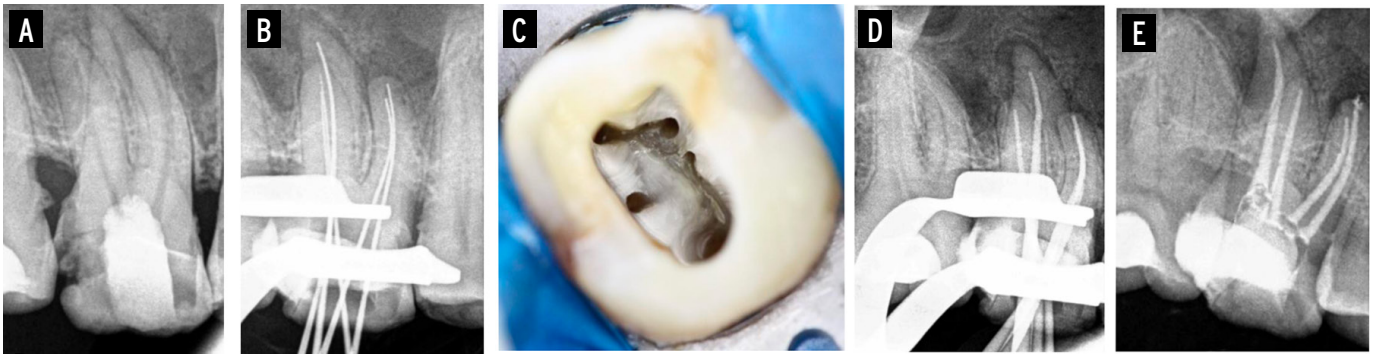

Figure 1
A) Pre-operative radiograph. **B)** Working length radiograph. **C)** Dried pulp chamber. **D)** Cone-fit radiograph. **E)** Post-operative radiograph
CBCT images exemplifying the different anatomic relationship between maxillary sinuses and molars.

tender on vertical percussion and negative to palpation. Radiographic examination revealed deep distal caries and previous access cavity filled with a temporary restoration and periapical lesions associated with palatal and mesial roots (Figure 1A). The tooth 16 was therefore diagnosed as "Previously initiated therapy with symptomatic apical periodontitis".
After removal of temporary restoration and caries, a pre-endo build-up was performed with composite resin (Filtex Z250, 3M ESPE, St. Paul, MN, USA) using Automatrix (Dentsply Maillefer, Ballaigues, Switzerland). After pulp chamber debridement and irrigation, pinpoint bleeding was noted beside the distal canal. The access cavity was then modified using No. 3, Start-X (Dentsply Maillefer, Ballaigues, Switzerland) ultrasonic tips, and the pulpal floor was explored using a DG-16 explorer (Hu-Friedy, Chicago, IL) under a dental microscope (Extaro 300, Carl Zeiss, Oberkochen, Germany). The tooth presented with 2 mesiobuccal canals (MB1, MB2), 2 distal canals (DB1, DB2), and 1 palatal canal. A 10 ISO K-file (Mani, Inc., Tochigi, Japan) was introduced into the canals which revealed that the mesial root canals (MB1, MB2) were completely independent, demonstrating a Vertucci's type IV canal configuration, and the distal canals (DB1, DB2) joining at the apical third, demonstrating a Vertucci's Type II canal configuration. The WL was determined using 15 ISO K-Files and an apex locator (VDW Gold, VDW, Munich, Germany) and then confirmed with a periapical radiograph (Figure 1B). A proglider (Dentsply Maillefer, Ballaigues, Switzerland) glide path file was used and Edge File X3 files (EdgeEndo, Albuquerque, NM, USA) were used to finish the cleaning and shaping of the root canals using 5.25% sodium hypochlorite and citric acid 10% alternatively. Sonic activation of the irrigants was performed intermittently using an EndoActivator system (Dentsply Maillefer, Ballaigues, Switzerland) for 1min in each canal. After confirming cone fit and drying the canals with paper points (Figure 1C, 1D), the canals were obturated using a warm vertical compaction technique with AH Plus sealer (Dentsply Maillefer, Ballaigues, Switzerland) (Figure 1E) and referred back to the referring dentist to complete the restorative procedure.

#Case 2
A 54-year-old male of Indian origin reported to our private practice with the chief complaint of pain on biting in the upper left back tooth. The clinical and radiographic examination revealed deep distal caries with tooth 26 with an exaggerated response to cold test and positive vertical percussion (Figure 2A). Probing and mobility were within physiologic limits. A diagnosis of "Irreversible pulpitis with symptomatic apical tissues" was made. After profound anaesthesia, removal of caries and raising of the mesial wall with a composite resin was performed. A conventional access opening was then made and modified using Start-X ultrasonic tips (Dentsply Maillefer, Ballaigues, Switzerland). After scouting the canals the tooth revealed 2 palatal canals (P1, P2), 2 mesial canals (MB1, MB2), and a single distal canal (MDB1). An attempt was made to search for the second distobuccal canal but it was concluded not to be present

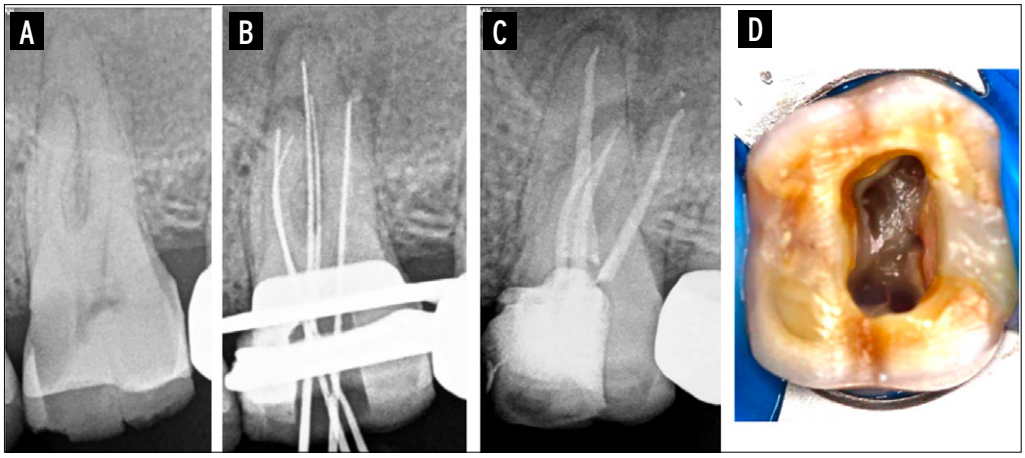

Figure 2
A) Pre-operative radiograph. **B)** Working length radiograph. **C)** Final periapical radiograph. **D)** Dried pulp chamber.

(Figure 2D). The mesial root canals (MB1, MB2) were completely separate demonstrating Vertucci's Type IV canal configuration and the palatal root (P1, P2) revealed a Vertucci's Type II canal configuration (Figure 2B). The canals were then instrumented, irrigated, and obturated similarly to case 1 and then sealed with a temporary filling (Cavit, 3M ESPE, St Paul, MN) (Figure 2C).

#Case 3

A 36-year-old Indian female came to our dental office as an emergency with a chief complaint of immense pain and sensitivity to cold in her upper right back region of the jaw. Radiographic examination revealed deep mesial caries close to the pulp chamber. Clinical examination only revealed an exaggerated response to the cold test. Percussion, Palpation were negative and mobility and probing were within physiologic limits. A diagnosis of "Irreversible pulpitis with normal apical tissues" with tooth 16 was made. After caries excavation and an adequate rubber dam isolation, an access cavity was prepared taking advantage of the excavated caries. Removal of the pulp from the chamber and provisional instrumentation of the palatal canal was performed before the placement of calcium hydroxide (VOCO, Germany) and a provisional dressing (Cavit, 3M ESPE, St Paul, MN). A limited field of view CBCT was performed to confirm the anatomy of the tooth (Figure 3A). In the second visit, a 10 ISO k-file (Mani, Inc., Tochigi, Japan) was used to scout the canals and a 15 ISO

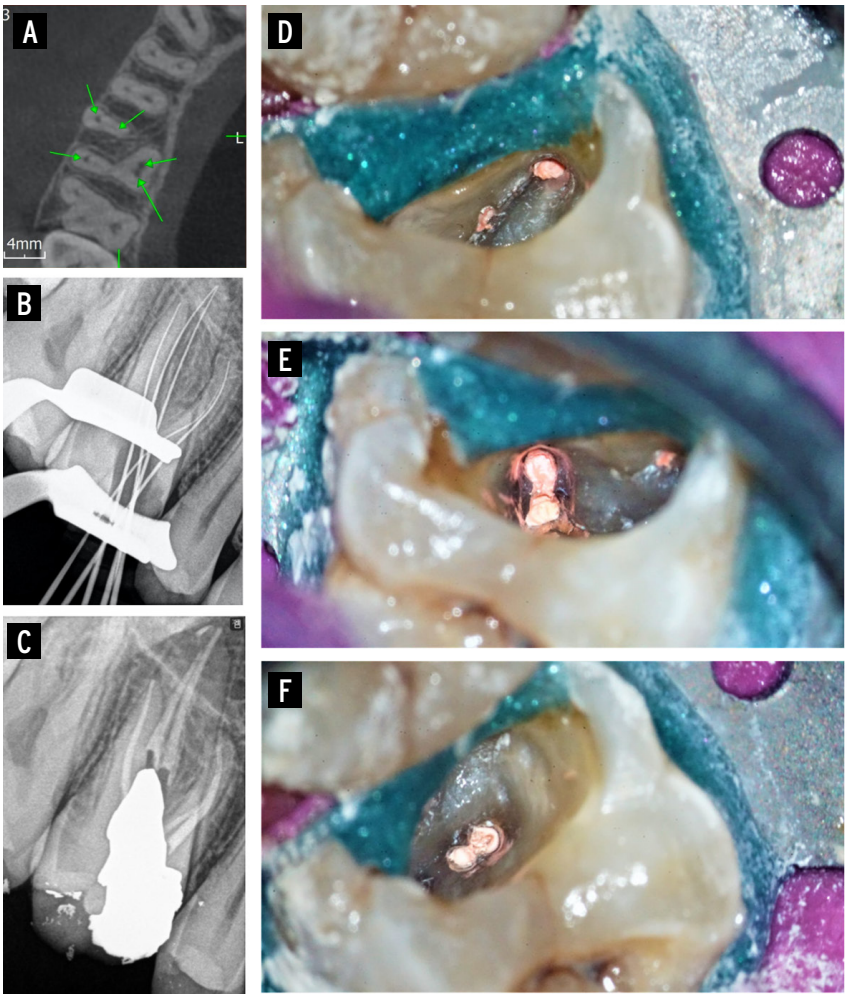

Figure 3
A) CBCT slice showing 5 root canals. **B)** Working length radiograph. **C)** Post-operative radiograph. **D, E, F**) Pulp chamber showing canal orifice obturated with gutta-percha.

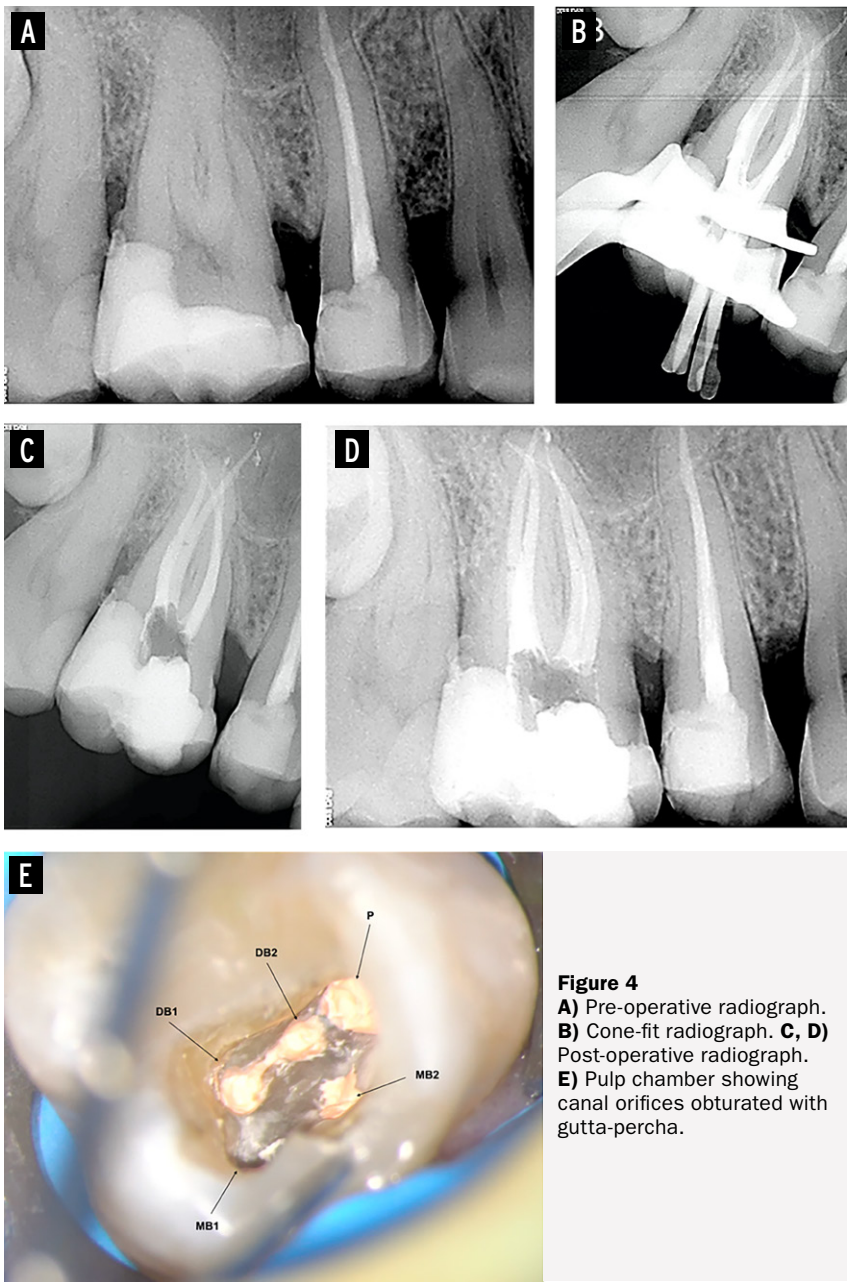

Figure 4
A) Pre-operative radiograph. **B)** Cone-fit radiograph. **C, D)** Post-operative radiograph. **E)** Pulp chamber showing canal orifices obturated with gutta-percha.

k-file was used to determine the working length similar to the previous cases (Figure 3B). The CBCT and working length radiograph revealed a Vertucci's Type II canal configuration of the palatal root (P1, P2), and mesial root (MB1, MB2), and a single canal in the distal root (D1). Instrumentation was performed using a combination of Edge File X3 and X5 file systems (EdgeEndo, Albuquerque, NM, USA) with continuous intermittent irrigation. Final irrigation was then performed, canals were dried, and obturated using a warm vertical condensation technique similarly to case 1 (Figure 3C, D, E, F).

#*Case 4*
A 42-year-old Portuguese male came to our private practice in Lisbon, Portugal with a chief complaint of "I feel some discomfort in my upper back teeth". Clinical and radiographic examination revealed a huge disto-occlusal composite restoration on tooth 16 (Figure 4A). There was no response to the cold test, but a low response when heated gutta-percha was applied. Probing and mobility were within physiologic limits. A diagnosis of "Asymptomatic irreversible pulpitis with normal apical tissues" was made for tooth 16. After profound anesthesia and isolation, the tooth was accessed with a round bur (Mani, Inc., Tochigi, Japan) under an operating microscope (OMS2380, Zumax Medical Co, Ltd, Suzhou, China). Using a DG-16 explorer (Hu-Friedy, Chicago, IL) a huge pulp stone from the pulp chamber was dislodged and removed. The access cavity was then refined using Start-X (Dentsply Maillefer, Ballaigues, Switzerland) ultrasonic tips, and pre-flaring of canals up to the middle third was performed using Reciproc Blue 25 (VDW Gold, VDW, Munich, Germany) without any predetermined WL or glide path (Supplementary Video 1). Multiple 15 ISO K-Files were used to check the type of anatomy of the canals, which revealed mesial root with 2 individual canals (MB1, MB2), distal with 2 canals (DB1, DB2) with Vertucci's Type II configuration, and a single palatal canal. An R-Pilot (VDW Gold, VDW, Munich, Germany) in reciprocating motion was then used to create a glide path, and Reciproc Blue was used until the WL to complete the instrumentation (Supplementary Video 1). Continuous irrigation with 4.25% sodium hypochlorite was carried out between each instrument change. Sonic activation was performed using the Eddy activation tip (VDW, Munich, Germany). Calibration and cone fit radiograph were made, (Figure 4B) and a warm vertical condensation was used with AH plus sealer to obturate the canals (Figure 4C, D, E).

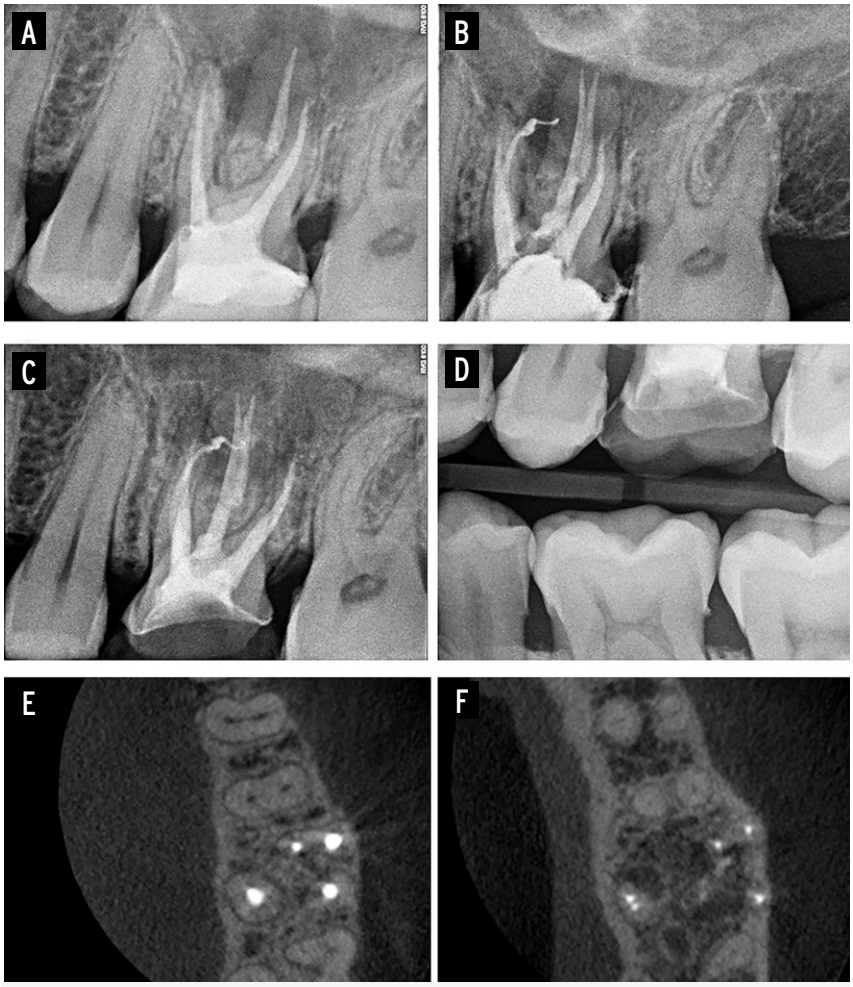

Figure 5
A) Pre-operative radiograph. **B)** Post-operative radiograph showing all 5 canals. **C)** Post-operative periapical radiograph and **D)** bite-wing radiograph demonstrating adaptation of indirect restoration. **E, F)** CBCT slices showing all 5 canals and reduction in the furcal and periapical radiolucencies.

#Case 5

A 42-year-old Spanish male was referred due to a vestibular abscess with tooth 16 which was endodontically treated a year ago. Clinical examination showed that the tooth was positive to vertical percussion with grade II furcation involvement and grade I mobility. Slight buccal and palatal swelling was evident. Radiographic examination revealed a previously treated tooth with periapical radiolucency and a fiber post placed in the palatal root canal (Figure 5A). A periapical radiograph suggested an uncentered palatal and mesial root obturation and a probable Vertucci's Type V canal anatomy, missed in the palatal root (Figure 5A). A diagnosis of "Previously treated tooth with chronic apical abscess" with tooth 16 was determined. An orthograde retreatment was chosen as the treatment of choice. After profound anesthesia and removal of all old restoration, access was made with a careful approach towards the palatal root. The fiber post was distinguished due to its more translucent shade and was removed using ultrasonics (Start-X, Dentsply Maillefer, Ballaigues, Switzerland). The gutta-percha was removed using a Reciproc R25 (VDW Gold, VDW, Munich, Germany), and both the missed MB2 and the second palatal canal were negotiated using ISO 10 K-Files and then instrumented. Continuous irrigation with 4.25% sodium hypochlorite and 10% citric acid, and a final rinse with alcohol 96% was performed. The canals were then calibrated and obturated using a warm vertical condensation technique (Figure 5B). Following the retreatment, an overlay was then placed over the tooth (Figure 5C, D). A 6-month radiograph and CBCT, taken for implant placement purposes, revealed the true anatomy of the tooth and reduction in the furcal and periapical radiolucency (Figure 5E, 5F).

Discussion

Different case report papers of upper first molars with five root canals have been published in the literature (22, 24, 26). One of the first, maxillary first molar with five root canals was reported by Cecic et al. in 1982 (26). In this case report, the molar had two mesiobuccal, two palatals, and an individual distal root canal. Later a case report by Beatty in 1984 (24), showed the presence of three mesiobuccal root canal configuration. Reports of the maxillary first molar with four roots and different canal configurations have also been published (27, 28).

In the cases presented, all the five teeth had 2 mesiobuccal canals out of which three of the teeth had 2 canals in the palatal root, and two of the teeth had 2 distal canals. Apart from demonstrating the prevalence of MB2 canal in geographically different population, this case series

also emphasizes on the uncommon variations found with this tooth. Most case reports of maxillary first molars with more than five, even up to an eight canal configuration have been reported from the Indian subcontinent (6, 7, 23). Cases reported in this case series are specifically from regions where the incidence of anatomical variations in their population is reported to be high, affirming the published findings.

Complete knowledge of the morphologic variations and anatomy with appropriate tools is essential especially for endodontically treating rare variations in tooth anatomy (29). None of the cases reported were performed without magnification. Magnification has been proven to be an essential tool in endodontics. A study by Buhrley et al. (4) showed detection of MB2 canals was almost three times higher when microscopes were used in comparison to the naked eye, while dental loupes also performed equally well. All of the cases in this series needed some kind of modification of the access cavity with ultrasonic troughing to address these extra canals.

Following the ALARA principle, CBCT was not used in each case in this series, although it has been demonstrated to detect more missed mesiobuccal (MB2) canals in the maxillary first molar especially in cases of retreatments, where one might suspect it to be present more often (30). Vasundhara et al. (31) also showed that CBCT performed significantly better in the detection of missed canals when compared with magnification. With its higher sensitivity and specificity and the advantages over the shortcomings of conventional radiographs, CBCT has proven to be a vital tool in endodontics.

Conclusions

This case series demonstrates the incidence of maxillary first molars with 5 canals and its different variations. It also validates the fundamental role of magnification, ultrasonic, and CBCT in the endodontic management of such complex root canal anatomy.

Clinical Relevance

The cases presented in this paper highlight the inevitable use of technology like magnification, ultrasonic, and especially the prudent use of CBCT in the management of complex anatomies of the maxillary first molar in different ethnic groups.

Conflicts of Interest

The authors declare that there are no conflicts of interest.

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