Case Report

Endodontic management of an aberrant root canal anatomy: a case report and literature review

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Background: Root canal morphology and internal anatomy shows a great variation across all the teeth. Mandibular premolars possess a great challenge to the clinicians due to its aberrant root morphology. The presence of bacteria and other microbes is the main factor in endodontic failure in missed canals. It is very essential to perform a complete debridement of the root canals including the accessory canals for a successful outcome attained using irrigants, agitation techniques and intra-canal medicaments. This article aims to provide a detailed review about the etiology, prevalence, clinical features, radiographic features & techniques, magnification, treatment choices and difficulties encountered in managing aberrant anatomies in mandibular premolar along with the presentation of a case report.

Case Description: A 19-year-old female patient presented to the department with a chief complaint of sharp shooting, lingering and continuous pain in the lower right back region of the jaw since 1 month. On digital radiographic investigation, an aberrant root canal anatomy was observed with deep disto-occlusal caries with mandibular right second premolar for which a non-surgical root canal therapy was performed using dental operating microscope (DOM) and advanced irrigation activation system. Besides, PubMed/Medline was used to find and review the pertinent literature from January 2012 to January 2023. Based on inclusion and exclusion criteria, 25 articles were included.

Conclusions: The case report and literature review come to the conclusion that cases with aberrant mandibular premolars can be successfully treated with conventional root canal therapy, good diagnostic tools, and, if necessary, surgical intervention. Our case illustrates how anatomical variations could make endodontic treatment more challenging. With an emphasis on access modifications and radiographic interpretations, the application of the DOM and essential adjustments to the standard clinical procedures and more novel diagnostic methods for difficult root canal morphologies will be essential in the future of endodontics to successfully manage such complex anatomies.

Keywords: Endodontics; root canal therapy; premolars; case report

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Introduction

The ultimate aim of successful non-surgical endodontic treatment is to obtain a root canal that is sterile, free of microorganisms and necrotic debris, restore the coronal and apical seal that prevents the ingress of microorganisms post treatment thereby limiting the incidence of reinfection. All this can be achieved by shaping the canal via mechanical debridement and cleaning through intra-canal irrigating solutions (1). Premolars are unique in that the root canal and number of roots have undergone significant anatomical alteration. Untreated canals could occur from a lack of understanding of anatomical variance, which could result in the failure of root canal therapy (2).

Literature reports various reasons for the failure of endodontic treatment with few being but not limited to inadequate cleaning and shaping, lack of apical and coronal seal due to improper obturation and faulty coronal restoration respectively, and failure to recognise accessory canals leading to incomplete treatment and high risk of reinfection (3). Variation in the morphology of root canal is believed to be the most likely reason of flare-ups. These cases typically present with remarkable symptoms like sensitivity towards hot and cold stimuli, pain on percussion and periapical abscess. About 12% of the canals are missed during the endodontic treatment, of which 82.6% demonstrate periapical lesions post treatment (4). Further, the odds for the presence of apical periodontitis post-treatment were reported to be 6.25 times higher with untreated or missed canals (5). Mandibular premolars possess a great challenge to the clinicians due to its aberrant canal morphology. Considering its complexity, these teeth are also acknowledged by the word "Endodontist's Enigma" (6).

The diagnosis of canal variation is crucial, and over time, numerous techniques have been used with varying degrees of success to meet this problem. In the medical field, improved visual aids like digital operating microscopes are a non-invasive technique that provides a magnified picture and good visualisation of the subject. Cone beam computed tomography (CBCT) has recently been included as a diagnostic tool, increasing the success of precise diagnosis to greater levels (7). When combined with 3D software imaging, micro-CT has been described as a reproducible, non-destructive, and non-invasive high-resolution *ex vivo* technique that is really thought to be the most accurate way to study root canal morphology (8).

Treatment for mandibular premolar has frequently been carried out under the general belief that these teeth have just one root and one root canal. However, reports present more than one canals and root for these teeth. Around 2.3% to 62.5% of premolars possess deviation from their normal morphology and anatomy with more than one root and one canal. Similarly, the case is no different for mandibular second premolars accounting to 0% to 34% variation from the normal morphology (9). Moreover, the variation varies across different ethnic groups.

Considering the complexity and aberrant canal morphology, the present case along with a literature review presents results of a mandibular second premolar with two roots and three canals successfully treated with conventional root canal therapy. We present this case in accordance with the CARE reporting checklist (10) (available at https://fomm.amegroups.com/article/view/10.21037/fomm-22-68/rc).

Highlight box

Key findings

- Two rooted mandibular right second premolar with three canals was successfully treated by non-surgical root canal therapy using dental operating microscope.

What is known and what is new?

- Recent diagnostic aids like cone beam computed tomography (CBCT) prove to be a promising diagnostic tool compared to conventional 2-dimensional radiography.
- This manuscript presents successful management of aberrant morphology and in brief discusses the importance of advanced diagnostic aids and treatment modalities through exhaustive literature review.

What is the implication, and what should change now?

- Dental operating microscope, advanced irrigation systems and near-perfect root canal system debridement aid in the success of the treatment.

Case presentation

A 19-year-old female patient reported to the Department of Conservative Dentistry and Endodontics of a Dental Institute in Pune with a chief complaint of pain in the lower right back region of the jaw from past 1 month. Patient gave history that she was apparently asymptomatic a month back after which she started experiencing pain during mastication. The pain was sharp shooting in intensity, lingering in nature and continuous type. It aggravated on hot and cold stimuli and relieved on taking medications. There was also a history of nocturnal pain reported by the patient. The patient visited a nearby dental clinic where

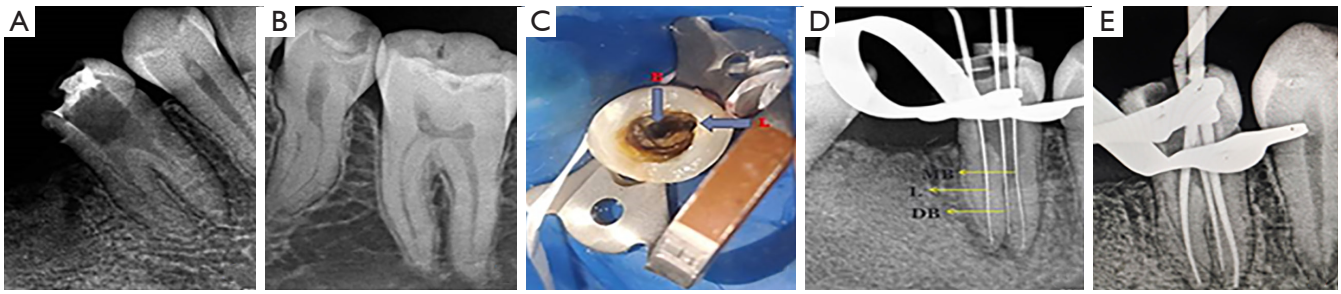

Figure 1 Digital radiography for pre-operative diagnosis and endodontic treatment. (A) Radiographic examination of mandibular right second premolar; (B) radiographic examination of contralateral tooth representing aberrant anatomy of the roots; (C) access cavity preparation revealing additional canal in mandibular right second premolar (B: buccal orifice; L: lingual orifice); (D) working length determination representing three canals (MB: mesiobuccal; DB: distobuccal; L: lingual); (E) master cone radiograph.

emergency access opening was performed and referred to the Dental Institute for further treatment. The patient was a student by occupation with no relevant medical and family history that would contribute to the present complaint. No adverse habits were reported by the patient. A detailed history revealed that, patient had undergone dental extraction with lower right back and upper left back teeth 1 year ago.

The patient was healthy with no significant medical history. On intra oral examination, labial mucosa, buccal mucosa, tongue, palate, and floor of the mouth were in normal condition. All teeth except maxillary left first molar and mandibular left first molar were present. The third molar was erupted only in fourth quadrant. There was a presence of deep Class II disto-occlusal caries with mandibular right second premolar and Class I caries with maxillary right first molar and maxillary left second molar. Stains and calculus were generalised. On inspection of the area of chief complain, the tooth mandibular right second premolar had temporary restorative material. The tooth was non-tender on palpation but presented pain during vertical percussion. The case was provisionally diagnosed with symptomatic apical periodontitis with mandibular right second premolar secondary to dental caries.

Investigation and final diagnosis

On digital radiographic investigation, a radiolucent area in distal portion of mandibular right second premolar involving enamel, dentin and approaching pulp was observed. Two roots were revealed with mandibular right second premolar along with widening of periodontal ligament, loss of lamina dura and diffuse periapical radiolucency involving roots (*Figure 1A*). Thus, the tooth was finally diagnosed with symptomatic apical periodontitis with symptomatic irreversible pulpitis secondary to dental caries. A digital radiographic examination of contralateral mandibular left second premolar also revealed aberrant anatomy of the roots (*Figure 1B*).

Treatment

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the editorial office of this journal. Treatment plan included immediately focussing on relieving pain and continuing with the incomplete treatment followed by oral prophylaxis, pre-endo build-up, cleaning and shaping, post endodontic restoration, prosthetic rehabilitation, and periodic recall. All the procedures were performed under rubber dam isolation and loupes (Galilean Loupes 3.2X Admetec™, Israel) along with dental operating microscope (DOM) was used for performing the procedures under magnified field.

In the 1st visit, dental caries was removed using round diamond bur (BR 41) and access cavity was modified with safe end bur (EX-24) (MANI™) (*Figure 1C*). Pre-endo build-up was done using composite resin (3M ESPE Filtek Z350XT) and canals were blocked using Teflon tape during this step. After build-up, canals were negotiated with size 10-K stainless steel file (Dentsply-Maillefer, Ballaigues, Switzerland). Working length of 20.5 mm for mesiobuccal

Figure 2 Radiograph representing obturation done by cold lateral compaction technique.

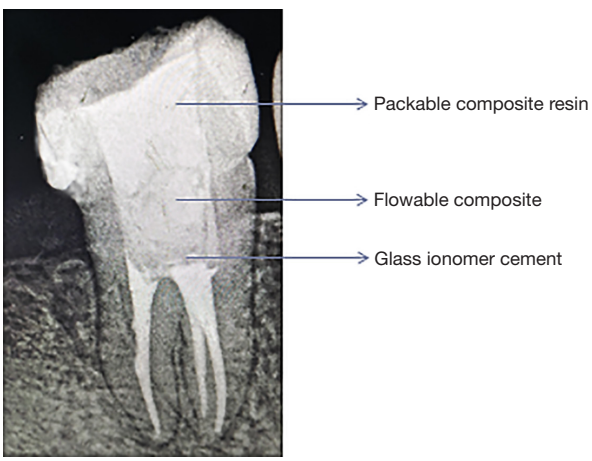

Figure 3 Radiograph representing post endodontic restoration of mandibular right second premolar.

canal, 17.5 mm for distobuccal canal and 19.5 mm for lingual canal was determined by 10-K stainless steel file using electronic apex locator (Root ZX mini) and confirmed by intraoral periapical radiograph (*Figure 1D*). Glide path was achieved using 15-K, and 20-K hand stainless steel files (Dentsply-Maillefer, Ballaigues, Switzerland). Cleaning and shaping was performed by 20, 25 and 30 4% rotary system (Micro Mega Hero Gold, France) for mesiobuccal and lingual canal while 20 4% for distobuccal canal. Smaller number files were used repeatedly for recapitulation. 17% EDTA (prime dental) and 3% NaOCl (25 mL) were used as intra-canal irrigants followed by saline for flushing the solutions. Irrigants were agitated using Endo Activator (Dentsply-Maillefer, Ballaigues, Switzerland). The root canals were dried with sterile paper points before placing calcium hydroxide dressing as an intracanal medicament and the access cavity was closed with temporary restoration (cavit).

On 2nd visit, the tooth was asymptomatic and $Ca(OH)_2$ was flushed using saline irrigation. The canals were dried with sterilized paper points. The gutta percha cones corresponding to the instrumentation performed were placed in the canals and their fit was confirmed radiographically (*Figure 1E*). Final irrigation protocol was done with 3% NaOCl followed with saline and 17% liquid EDTA (Dentwash) agitated using Endo Activator for 60 seconds and final flush with saline and gutta percha master-cones were sealed using calcium hydroxide-based sealer (Sealapex^{TM}) by cold lateral compaction technique (*Figure 2*). Post-operative restoration was done with Glass ionomer cement (GC Gold Label 2) followed by Flowable composite and finally restored with packable composite resin restoration (3M ESPE Filtek Z350XT) (*Figure 3*) and all ceramic crown (*Figure 4*) On subsequent follow ups at 1, 3 and 6 months patient had no clinical signs and symptoms.

Literature review

Literature search was conducted by screening the articles in PubMed from the year 2012 to 2023. The search terms used were 'mandibular premolar', 'aberrant roots', 'root canal therapy', 'case report', 'case series'. The inclusion criteria were case report and case series presenting data on aberrant mandibular premolars managed by conventional endodontic treatment or surgical intervention while exclusion criteria were case reports and case series presenting data on re-treatment of the aberrant mandibular premolars. A total of 25 case reports were identified from the literature with varying number of roots and canals with respect to mandibular first and second premolars. The details of the literature reporting aberrant anatomy of mandibular

Figure 4 Post-operative intraoral image after prosthesis cementation with mandibular right second premolar and missing mandibular right first molar.

premolars are presented in *Table 1* (11-35).

In the present case, the aberrant root morphology with the presence of two roots was revealed in mandibular right second premolar and the digital radiograph of the contra lateral tooth also revealed aberrant anatomy.

Etiology

The exact etiology of presence of aberrant root canal morphology is still not clear. It is believed that the extra roots are developed more commonly among the teeth that undergo development of root after birth. Other factors that can cause multiple roots and aberrant canal morphology are metabolic diseases, trauma during root development, and pressure on the developing root (36). The most commonly affected single rooted teeth are canine and the premolars (37).

Further, studies reported that C-shaped configuration of root is due to the failure of Hertwig's epithelial root sheath to fuse throughout the tooth development stage or coalescence by continuous deposition of cementum (38,39). The studies have also discussed that the presence of C-shaped canal was more commonly found among people with inherited diseases linked to X chromosome thereby suggesting this chromosome to play a contributing role (40,41).

Prevalence

Literature reports variation in prevalence with respect to aberrant root and canal morphology of mandibular 1st premolar ranging from to 1.8% to 5.73% and 2nd premolar ranging from 0% to 5.2% as reported in succeeding studies. A study by Arayasantiparb *et al.* reported a prevalence of 5.73% for multiple roots among 1st mandibular premolars whereas none of the 2nd premolar had multiple roots (42). On contrary, a lesser prevalence was observed by Dosunmu *et al.* with 1.8% to 2.1% in 1st premolar and 0.4% in 2nd premolar (43). Further, De Moor *et al.* reported 5.2% (44), Trope *et al.* as 4.4% (9), and Amos as 2.5% in mandibular 2nd premolar (45). Similarly, prevalence of C-shaped canal was reported in the range of 0.6% to 2% in the studies by Yu *et al.*, Rahimi *et al.*, and also demonstrated that the occurrence of these canals is more common in mandibular 2nd premolars (46,47). The likely reason for this variability is the diagnostic criteria used across the studies and the racial variations. Table no.1 presents the literature reporting aberrant anatomy with mandibular premolars.

Classification

Vertucci and its modifications could not be used to classify our case (48). Ahmed and Dummer conducted a study in 2018 to establish a new categorization system to classify tooth, root, and even accessory canal anomalies (49). Based on their classification it is $^{2}45\ B^{1-2}\ L^{1}$.

Clinical features

The patients with the multiple roots reported in the literature presented with a chief complaint of pain in the lower back region of the jaw also had a positive pain on percussion with a diagnosis of irreversible pulpitis, pulp necrosis or apical periodontitis. The initial observation of these cases with respect to pulp chamber floor revealed multiple orifices which were then confirmed by the radiographic examination (24,28). However, in cases where the patients do not report any complain with the aberrant morphological teeth, they accidently get diagnosed during the routine radiographic examination or due to complain of the adjacent teeth (33).

Table 1 Details of the literature reporting aberrant anatomy with mandibular premolars

Study	Tooth	Patient details	Irrigation	Roots and canals	Investigation	Treatment
Sibal *et al.*, 2022 (11)	Mandibular 2nd premolar	Male, 27 years	5.25% NaOCl, normal saline, and 0.2% chlorhexidine	2 roots, 2 canals (B, L)	POP, IOPA, pulp vitality test	Root canal treatment
Sibbal *et al.*, 2022 (12)	Mandibular 2nd premolar	Female, age not reported	5.25% NaOCl, normal saline, 0.2% chlorhexidine	1 root, 2 canals	POP, pulp vitality test, IOPA	Root canal treatment
Arroyo-Bote, 2022 (13)	Mandibular 2nd premolar	Male, 59 years	5.25% NaOCl, 10% citric acid	3 roots, 3 canals (Type I Vertucci)	Pulp vitality test, IOPA	Root canal treatment
Niavarzi *et al.*, 2022 (14)	Mandibular 2nd premolar	Male, 50 years	5.25% NaOCl, 17% EDTA	1 root, 4 canals	IOPA, CBCT, DOM	Root canal treatment
Shah, 2022 (15)	Mandibular 2nd premolar	Female, 20 years	2.5% NaOCl, 17% EDTA, normal saline	1 root, 2 canals (Type V Vertucci)	POP, IOPA, magnification loupes, endodontic explorer	Root canal treatment
Jain *et al.*, 2022 (16)	Mandibular 1st premolar	Male, 48 years	5.25% NaOCl, 17% EDTA, normal saline	1 root, 3 canals (Type VIII Vertucci)	POP, pulp vitality test, IOPA, endodontic explorer, magnification loupes	Root canal treatment
	Mandibular 1st premolar			2 roots fused, 2 canals/3 apical foramina		Root canal treatment
Penukonda *et al.*, 2021 (17)	Mandibular 1st premolar	Male, 35 years	3% NaOCl, normal saline, 17% EDTA	2 roots (M, D), 4 canals (MB, ML, DB, DL)	POP, pulp vitality test, CBCT, DOM	Root canal treatment
Nouroloyouni *et al.*, 2021 (18)	Mandibular 1st premolar	Male, 18 years	2.5% NaOCl	2 roots, 5 canals	POP, pulp vitality test, IOPA, CBCT	Root canal treatment
Moghadam and Farahi, 2021 (19)	Mandibular 1st premolar	Male, 19 years	2.5% NaOCl and 17% EDTA	1 root, 3 canals	POP, pulp vitality test, IOPA, CBCT, DOM	Root canal treatment
Zhang *et al.*, 2020 (20)	Mandibular 1st premolar	Male, 25 years	2% NaOCl and 15% EDTA	1 root, 5 canals (MB, DB-1, DB-2, DL, ML)	IOPA, CBCT, DOM,	Root canal treatment
Sagale *et al.*, 2018 (21)	Mandibular 2nd premolar	Male, 48 years	3% NaOCl, 17% EDTA, normal saline	1 root, 3 canals (MB, DB, L)	Pulp vitality test, IOPA, CBCT, magnification loupes	Root canal treatment
Izaz *et al.*, 2018 (22)	Mandibular 1st premolar	Female, 48 years	3% NaOCl, 17% EDTA	2 root, 4 canals (MB, ML, DB, DL)	IOPA, CBCT	Root canal treatment
Paul *et al.*, 2018 (23)	Mandibular 2nd premolar	Female, 17 years	5% NaOCl	2 roots, 3 canals (M, B, D)	IOPA	Root canal treatment
Bertrand *et al.*, 2016 (24)	Mandibular 2nd premolar	Female, 14 years	5.25% NaOCl and 17% EDTA	1 root, C-shaped canal with 4 canals (M, MB, DB, D)	CBCT	Root canal treatment
Praveen *et al.*, 2015 (25)	Mandibular 2nd premolar	Female. 37 years	Not reported	1 root, 3 canals (type IX root canal by Sert and Bayirli's)	IOPA, DOM	Root canal treatment
Pallavi *et al.*, 2015 (26)	Mandibular 1st premolar	Female, 19 years	3% NaOCl and 3% and H_2O_2	1 root, 3 canals	POP, pulp vitality test, IOPA	Root canal treatment

Table 1 (*continued*)

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Study	Tooth	Patient details	Irrigation	Roots and canals	Investigation	Treatment
Balakasireddy *et al.*, 2015 (27)	Mandibular 1st premolar	Male, 31 years	3% NaOCl, 17% EDTA	3 roots 3 canals	POP, pulp vitality test, CBCT	Root canal treatment
	Mandibular 2nd premolar			2 roots, 2 canals		Root canal treatment
Bhardwaj *et al.*, 2014 (28)	Mandibular 2nd premolar	Male, 27 years	Normal saline, 3% NaOCl and 17% EDTA	2 roots, 3 canals (D, MB, ML)	POP, IOPA, pulp vitality test	Root canal treatment
	Mandibular 1st premolar	Female, 32 years		2 roots, 3 canals (BL in both and BL + DB in buccal root)		Root canal treatment
	Mandibular 1st premolar	Male, 20 years		1 root, 3 canals (B, L, D)		Root canal treatment
Mittal *et al.*, 2014 (29)	Mandibular 1st premolar	Male, 24 years	5% NaOCl	1 root, 2 canals (Weine Type 3)	POP, IOPA	Root canal treatment
	Mandibular 2nd premolar	Male, 28 years	3% NaOCl and normal saline	2 roots, 2 canals		Root canal treatment
	Mandibular 1st premolar	Male, 38 years		2 roots, 2 canals		Root canal treatment
	Mandibular 1st premolar	Female, 25 years		1 root, 3 canals		Root canal treatment
	Mandibular 1st premolar	Female, 48 years		1 root, 3 canals		Root canal treatment
	Mandibular 2nd premolar			1 root, 2 canals		Root canal treatment
Fathi *et al.*, 2014 (30)	Mandibular 2nd premolar	Female, 30 years	2.5% NaOCl, 17% EDTA, normal saline	3 roots, 3 canals (MB, MidB, L)	POP, pulp vitality test, DOM	Root canal treatment
Gandhi and Patil, 2013 (31)	Mandibular 2nd premolar	Male, 34 years	3% NaOCl	3 roots, 3 canals (DB, ML, DL)	POP, pulp vitality test, IOPA	Root canal treatment
Mokhtari *et al.*, 2013 (32)	Mandibular 2nd premolar	Male, 23 years	2.5% NaOCl and 17% EDTA	1 root, 3 canals (MB, ML, D) (taurodontism)	POP, OPG, CBCT	Root canal treatment
Vaghela *et al.*, 2013 (33)	Mandibular 1st premolar	Male, 24 years	5.25% NaOCl and 17% EDTA	4 roots, 4 canals (MB, DB, ML, DL)	POP, IOPA	Root canal treatment
Kararia and Kararia, 2012 (34)	Mandibular 2nd premolar	Female, 30 years	5% NaOCl	1 root, 3 canals (joined at apical 3rd to form 1 canal)	POP, pulp vitality test, IOPA	Root canal treatment
Kararia *et al.*, 2012 (35)	Mandibular 1st premolar	Male, 32 years	5.25% NaOCl	1 canal bifurcated in 2 roots (2 canals)	POP, magnification loupes	Root canal treatment
Present case	Mandibular 2nd premolar	Female, 19 years	3% NaOCl, 17% EDTA, normal saline	2 roots, 3 canals	IOPA, DOM	Root canal treatment

NaOCl, sodium hypochlorite; B, buccal; L, lingual; POP, pain on percussion; IOPA, intraoral periapical radiograph; EDTA, ethylenediamine tetraacetic acid; CBCT, cone beam computed tomography; DOM, dental operating microscope; M, mesial; D, distal; H_2O_2, hydrogen peroxide; MB, mesiobuccal; ML, mesiolingual; DB, distobuccal; DL, distolingual; BL, buccolingual; MidB, midbuccal; OPG, orthopantogram.

Radiographic features

With respect to mandibular 2nd premolar, literature review revealed distinct variations in the root and canal morphology through radiographic examination. Sibal *et al.* (11) and Mittal *et al.* (29) reported two cases with two roots and 2 canals (buccal and lingual). One root with 2 canals (Vertucci type 1 and V) was reported in two studies (12,15). A type I Vertucci with 3 roots and 3 canals was distinguished by Arroyo-Bote (13), while a single root bifurcating into 4 canals as demonstrated by Niavarzi *et al.* (14). Further, Sagale *et al.* identified 3 canals in a single root (21). The presence of two roots with 3 root canals (mesial, buccal, distal) in Paul *et al.* (23) and with 3 canals (distal, mesiobuccal, mesiolingual) in Bhardwaj *et al.* (28) were also reported. Correspondingly, a case report by Bertrand *et al.* presented a case with a single root but also reported the presence of four canals (mesial, mesiobuccal, distobuccal, distal) in a C-shaped large canal identified through CBCT examination (24). Similarly, a case of taurodontism with mandibular 2nd premolar was demonstrated by Mokhtari *et al.* (32). Though the tooth had a single root but there were presence of three canals (mesiobuccal, mesiolingual, distal) confirmed by orthopantogram and CBCT. Additionally, cases on one root with three canals and one root with two canals were discussed by Praveen *et al.* (25) and Mittal *et al.* (29), respectively. The presence of single isolated canal with respect to root was well demonstrated by Fathi *et al.* (30) and Gandhi *et al.* (31) who reported 3 roots with 3 canals. Interestingly, one report reported presence of a single root which had 3 canals that joined at the apical 3rd to form a single canal (34).

The present literature review reporting cases on mandibular 1st premolar demonstrated two of the cases with the presence of two roots with three canals (buccolingual in both roots and additional distobuccal in buccal root) in Bhardwaj *et al.* and two canals by Mittal *et al.* (28,29). The studies also reported cases with a single root but presence of two and three canals (29,34,35). Interestingly, there was also a case reported by Vaghela *et al.* having four roots and four canals (mesiobuccal, distobuccal, mesiolingual, distolingual) (33). The presence of 2 roots with 2 canals, 4 canals and 5 canals were evident in few studies (16-18,22) while four of the studies also presented 1 root with 3 canals and 5 canals (16,19,20,26).

Radiographic technique and magnification

Though a conventional radiograph provides a two-dimensional view of a three-dimensional structure, a careful examination of two of more intra-oral periapical radiographs taken at different horizontal angulations aid in obtaining a detailed structural and anatomical morphology of the roots canals (31). These radiographs are quite useful in determining root canal shape. Furthermore, if conventional radiography techniques fail to offer evident information and more details are necessary, advanced diagnostic radiographic techniques such as CBCT can be very useful in detecting such changes (50,51).

Patient reported in the present case was treated under magnification of loupes 3.2× and dental microscope providing a better visualisation to the clinician. To find additional canals, magnification using loupes or a DOM is an essential tool. There are several magnification settings available, but 2.5× to 4.5× is usually appropriate to view the additional canal with improved depth of focus. DOM usage is advised in everyday endodontic practise because it gives great illumination and magnification to the working field and is extremely useful in detecting and treating 'extra' canals since it brings minute features into clear view (52). In the present literature review, it was observed that the DOM (14,17,19,20,25,30) and magnifying loupes (15,16,21,35) were extensively used in detecting and treating the aberrant canal morphologies on mandibular premolars thereby indicating the implementation of advanced techniques in actual practice.

Treatment choices for aberrant root canal morphology

Aberrant root canal morphology usually remains unnoticed unless the patient comes with a complaint of pain associated with that tooth due to caries of periodontal diseases or unless it gets noticed during routine examination. The choice of treatments when symptomatic is either root canal treatment or extraction. In cases where the tooth is sound and is examined during routine radiographic examination, a preventive treatment can be undertaken like pit and fissure sealant application to avoid future complex procedures. Moreover, patients should be followed routinely for oral health examination with prompt treatment for the symptomatic lesions.

It should be acknowledged that, the root canal of these cases is a complex procedure and requires a thorough irrigation. Enhancing disinfection and cleaning the uninstrumented apical bi- and trifurcations and lateral ramifications is necessary which could be achieved through use of adjuncts like passive ultrasonic irrigation, apical

negative pressure devices or dynamic modes of irrigation. In the present case report and the literature review conducted, intra-canal irrigation in all the patients was performed by NaOCl of varying concentrations with 2.5%, 3%, 5% and 5.25% along with saline to flush the canal. The use of 17% EDTA for removing the smear layer was reported with 12 cases (14,16,17,19,21,22,24,27,28,30,32,33). Few studies have also reported the use of 15% EDTA, 10% citric acid, and 0.2% chlorhexidine as an intracanal irrigant (11-13,20). Out of 25 only 2 articles mentioned volume of the irrigant used (15,20).

Gates Glidden burs help in enlarging the coronal portion of the canals thereby providing better visualisation and location of the accessory canals along with the use of magnification (53). The working length difficulty can be managed by first instrumenting the main canal followed by obtaining the working length of it and determining the curvature and the direction of file entry. Further, a proper obturation of both the canals can be performed by initially, preparing the accessory canals with smaller apical file sizes, condensing the main canal and simultaneously blocking the accessory canals with paper point (54).

Treatment difficulties encountered

Major difficulties that a clinician would encounter during the root canal treatment of mandibular aberrant root canals include; difficulty in locating the accessory canals due to narrow coronal portion, difficulty in obtaining working length for the accessory canals as the file repeatedly enter the main canal, and difficulty during obturation as the obturation of main canal blocks the introduction of gutta percha into the accessory canals as seen in our case.

Discussion

The current case report of the current study represents the successful non-surgical management of mandibular second premolar with two roots and three canals. The canals were visualized using two-dimensional digital radiographic imaging, and was subsequently verified through visual inspection under the microscope. Two orifices and three canals were identified.

Management of such anatomies can be aided by a careful analysis of two or more excellent diagnostic periapical radiographs taken at various horizontal angulations, combined with the appropriate application of the arsenal at hand. Also, if standard radiography techniques are unable to identify such abnormalities or are insufficient to offer the necessary information, sophisticated diagnostic radiographic techniques like CBCT and micro-CT might be very beneficial (7,8).

Unusual canal morphology was seen in the current case's pretreatment radiograph, which raised the possibility of additional roots and canals. Three canals were discovered during the formation of the access cavity as hazy outlines. That was in line with Rodig and Hulsmann's assertion that mandibular premolars with three root canals have a triangle-shaped pulp chamber, in which the distance between the distobuccal and lingual orifices was at its greatest (55).

Locating additional canals requires the use of loupes or a DOM, which magnifies objects. DOM was used in this clinical case, and it is advised to use it in routine endodontic practice too because it offers excellent operating field illumination and magnification as well as a significant advantage in locating and treating "extra" canals as it makes minute details clearly visible (52).

The residual dentin thickness should be at least one-third of the root diameter, as instrumentation beyond this limit may increase the risk of root fracture. Fins, isthmus areas, and other irregularities may add to the treatment's difficulties (56). Regardless of the method of instrumentation, a portion of the canal surface may still be uninstrumented. The effective debridement of canal isthmus's depends heavily on the proper use of small files and NaOCl (57). In this case report, 25 mL of 3% NaOCl was employed copiously with small hand files, and Endo Activator (Dentsply) was used to agitate the NaOCl and maximise root canal disinfection. The smear layer was removed with a final irrigation of 17% EDTA. The DOM and diagnostic radiographs were employed to facilitate accurate root canal configuration, resulting in successful endodontic therapy of this case.

Clinical relevance

Clinicians treating patients with such complex anatomy need to have a great deal of patience because it is almost certain that they will require multiple lengthy appointments. The amount of time needed to treat such complicated patients with varying tooth morphology mostly depends on the endodontist's clinical experience, expertise, and proficiency as well as the arsenal of tools available to get the best possible clinical outcome.

Limitations

Regarding the accessibility of additional diagnostic tests using CBCT, a small FOV (5 mm or less) or micro-CT, it is well known that not all processes make it possible to carry them out. They are not only expensive, but often difficult for the wider population to access. They are, however, a useful tool in these situations. Within the constraints of this study, a well-executed method still lacks great patient care because a number of post-operative care-related variables can significantly affect the outcome. Using CBCT or micro-CT will produce more accurate diagnostic outcomes. Bioceramic sealers should be employed with more advanced clinical root canal techniques. In this case, a long-term follow-up of up to 5 years will be ideal.

Conclusions

The case report and the literature review conclude that, the cases of aberrant mandibular premolars can be well managed by good diagnostic aids conventional root canal therapy and surgical intervention if required. Our case demonstrates how anatomical variances might render endodontic treatment more difficult. This complicated case was successfully treated with the help of an accurate diagnosis and treatment planning. Our assessment of the literature reveals that the future of endodontics will rely on the use of DOM, advanced irrigation systems for near-perfect root canal system debridement, and more novel techniques such as CBCT and micro-CT for challenging root canal morphologies.

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Footnote

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee(s) and with the Helsinki Declaration (as revised in 2013). Written informed consent was obtained from the patient for publication of this case report and accompanying images. A copy of the written consent is available for review by the editorial office of this journal.

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