Case Study

Endodontic Management of Three-Rooted Maxillary Premolars: A Clinical Case Series

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Abstract

Background: Anatomical variations in maxillary premolars can significantly influence the outcome of endodontic treatment. Although these teeth typically present with one or two roots, the occurrence of three distinct roots and canals is uncommon and may remain undetected when conventional diagnostic methods are relied upon. Missed canals continue to represent a major cause of post-treatment disease, underscoring the need for accurate assessment of root canal morphology before and during treatment.

Case Presentation: This case series reports three patients—two maxillary first premolars and one maxillary second premolar—with three separate roots and canals. Clinical examination was supplemented by multiple angulated periapical radiographs and 5 × magnification to confirm the canal anatomy. All teeth underwent non-surgical root canal treatment following standardised clinical protocols. Canal preparation was performed using nickel–titanium rotary instruments, with irrigation using sodium hypochlorite and ethylenediaminetetraacetic acid for smear layer removal. Obturation was completed using a single-cone technique with gutta-percha and a bioceramic sealer. Definitive coronal restorations were placed in all cases. At clinical and radiographic follow-up, all treated teeth were asymptomatic and demonstrated favourable outcomes.

Conclusion: This case series highlights the importance of systematic radiographic evaluation, magnification, and contemporary endodontic techniques in the successful management of three-rooted maxillary premolars.

Keywords: Maxillary premolar, Three-rooted premolar, Root canal morphology, Anatomical variation; Case series

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Introduction

A comprehensive knowledge of root canal anatomy and its variations is fundamental to the success of endodontic therapy. Maxillary premolars most commonly present with one or two roots; however, anatomical deviations such as three distinct roots and canals, though rare, have been increasingly reported in clinical literature[1,2]. These variations can complicate diagnosis, access cavity design, and canal preparation, thereby increasing the risk of missed canals and subsequent treatment failure[3].

The reported prevalence of three-rooted maxillary first premolars ranges between 0.5% and 6%, depending on the population studied and the diagnostic methods employed[1,2]. Maxillary second premolars demonstrate an even lower incidence of this configuration[1]. Conventional periapical radiographs may fail to reveal additional roots due to superimposition, necessitating the use of angled radiographs, magnification, and, in selected cases, cone-beam computed tomography (CBCT) for accurate identification[4,5].

Advances in nickel–titanium rotary instrumentation, irrigant activation, and bioceramic sealers have significantly improved the predictability of managing complex canal anatomies[6,7]. This case series highlights the endodontic management of three-rooted maxillary premolars and underscores the importance of systematic diagnostic evaluation and contemporary clinical techniques in achieving successful outcomes.

Case Presentation

Case 1

A 35-year-old male patient presented with pain and swelling in the upper left posterior palatal region. Intra-oral examination revealed a diffuse palatal swelling adjacent to the maxillary left first premolar (tooth 24), with expression of purulent discharge on palpation. The tooth exhibited extensive coronal destruction, with loss of more than two-thirds of the crown structure, and was tender to percussion. No abnormal mobility was noted. Pulp sensibility testing yielded no response, indicating pulpal non-vitality.

A pre-operative periapical radiograph demonstrated a well-defined periapical radiolucency associated with tooth 24 and an unusual root configuration suggestive of three distinct roots (Figure 1). Based on the clinical and radiographic findings, a diagnosis of necrotic pulp with chronic apical abscess was established. Written informed consent was obtained prior to initiating treatment.

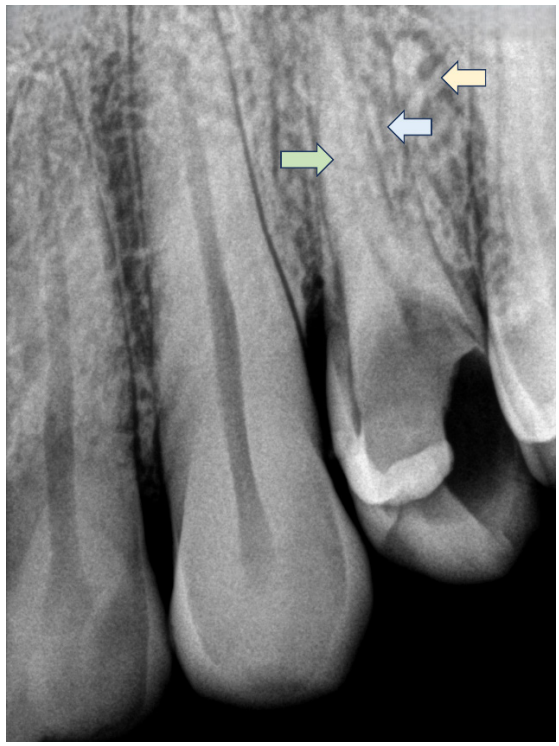

Figure 1: Pre-operative radiograph showing extensive coronal loss and periapical radiolucency associated with tooth 24. (green arrow- mesiobuccal root, blue arrow- distobuccal root, yellow arrow- palatal root)

Local anaesthesia was administered using 2% lignocaine with 1:80,000 adrenaline (Lignox, Indoco Remedies Ltd., India), and rubber dam isolation was achieved. Endodontic access cavity preparation was performed under 5 × magnification using dental loupes (Admetec, Israel), allowing enhanced visualisation of the pulpal floor. Three distinct canal orifices—mesiobuccal, distobuccal, and palatal—were identified, confirming the presence of a three-rooted maxillary first premolar.

Initial canal negotiation was performed using #10 K-files (MANI Inc., Japan) until apical patency was achieved in all canals. Working length determination was carried out using an electronic apex locator (Eighteeth Medical, China) and confirmed radiographically (Figure 2).

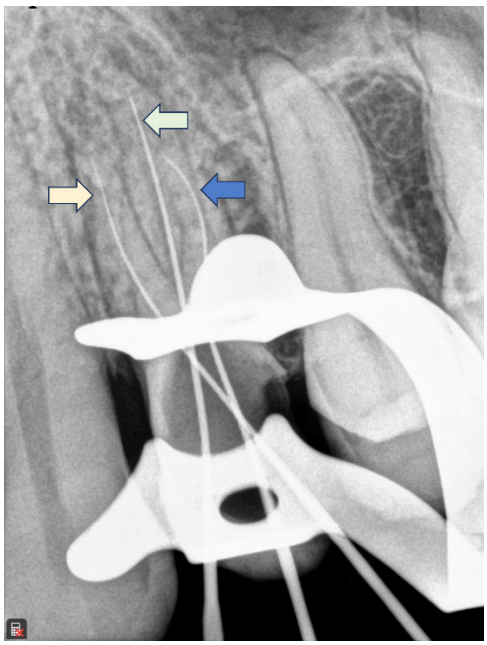

Figure 2: Working length radiograph confirming three separate canals — mesiobuccal, distobuccal, and palatal. (peach arrow- mesiobuccal canal, blue arrow- distobuccal canal, green arrow- palatal canal)

Biomechanical preparation was completed using nickel–titanium rotary instruments (VDW, Munich, Germany) up to size 25 with a 4% taper. Throughout instrumentation, copious irrigation was performed using 5.25% sodium hypochlorite (SafeEndoHypochlor Forte, Safe Endo Dental India Pvt. Ltd., India) delivered through a 30-gauge side-vented irrigation needle (NaviTip, Ultradent, USA).

Smear layer removal was achieved using 17% EDTA (RC-Prep, Premier Dental Products Co., USA) for one minute, followed by a final rinse with sterile saline. Irrigant activation was performed using a sonic activation device (Dentsply Sirona, USA) for 30 seconds in each canal. Calcium hydroxide paste (UltraCal XS, Ultradent, USA) was placed as an intracanal medicament using a lentulo spiral, and the access cavity was temporarily sealed with Cavit-G (3M ESPE, USA).

At the two-week recall visit, the patient was asymptomatic, and the palatal swelling had completely resolved. The intracanal medicament was removed using sodium hypochlorite and saline irrigation with sonic activation. The canals were dried with sterile paper points and obturated using the single-cone technique with gutta-percha (Dentsply Sirona, USA) and a bioceramic sealer (CeraSeal, Meta Biomed, Korea) (Figure 3).

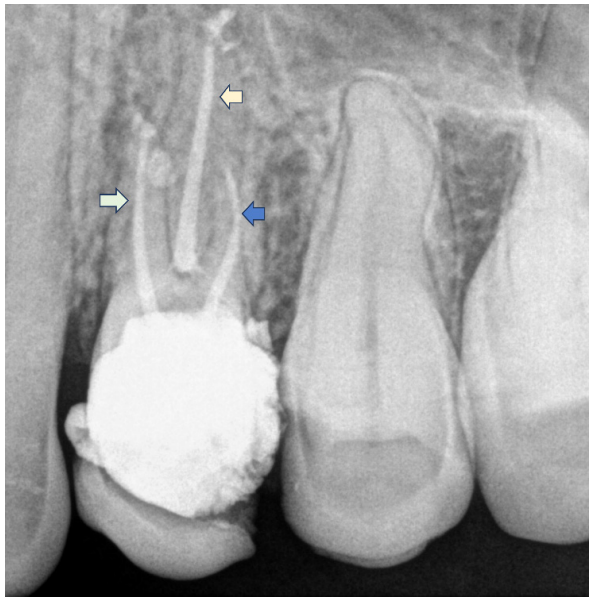

Figure 3: Post-obturation radiograph showing single-cone obturation. (green arrow- mesiobuccal canal, blue arrow- distobuccal canal, peach arrow- palatal canal)

Given the extensive loss of coronal tooth structure, a glass fibre post (Reforpost, Angelus, Brazil) was placed in the palatal canal to reinforce the tooth. The access cavity was restored using a light-cured nano-hybrid composite resin (Filtek Z350 XT, 3M ESPE, USA), and definitive rehabilitation was completed with a porcelain-fused-to-metal crown cemented using resin-modified glass ionomer luting cement (RelyX Luting 2, 3M ESPE, USA).

At the four-month follow-up, the patient remained asymptomatic. Radiographic evaluation revealed

dense and homogeneous obturation, a well-adapted fibre post, and evidence of progressive periapical healing (Figure 4).

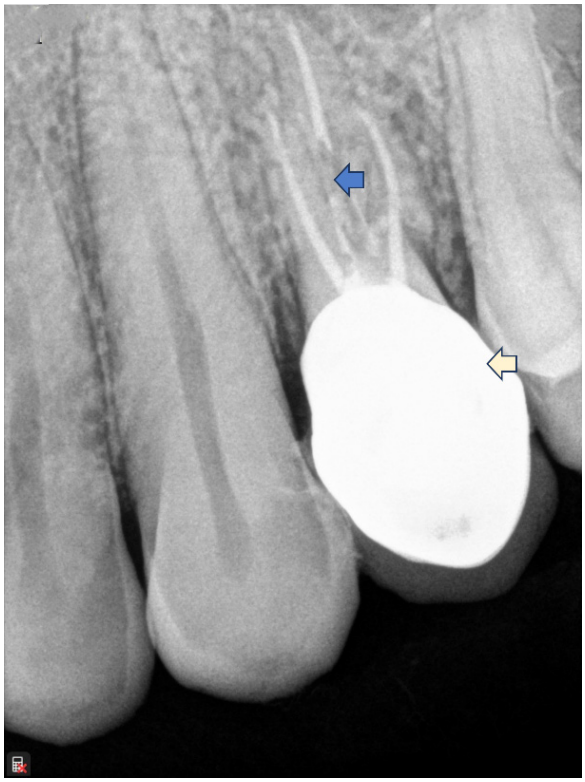

Figure 4: Fibre post and post-endodontic restoration at four month follow-up. (blue arrow- fibre post, yellow arrow- porcelain fused to metal crown).

Case 2

A 22-year-old female patient presented with intermittent pain during mastication in the upper left posterior region. Clinical examination revealed a deep disto-occlusal carious lesion involving the maxillary left first premolar (tooth 24). The tooth was tender to percussion, with no associated swelling, sinus tract, or abnormal mobility. Pulp sensibility testing elicited no response, indicating pulpal necrosis.

A pre-operative periapical radiograph demonstrated a periapical radiolucency and an atypical root morphology suggestive of three distinct roots (Figure 5).

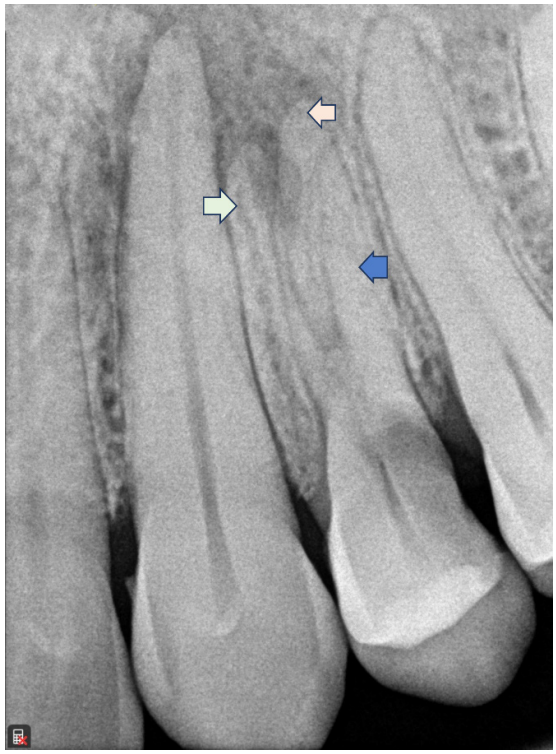

Figure 5: Pre-operative periapical radiograph showing deep carious lesion and periapical radiolucency in tooth 24. (green arrow- mesiobuccal root, blue arrow- distobuccal root, peach arrow- palatal root)

Based on the clinical and radiographic findings, a diagnosis of necrotic pulp with symptomatic apical periodontitis was established. Written informed consent was obtained prior to treatment.

Local anaesthesia was administered using 2% lignocaine with 1:80,000 adrenaline (Lignox, Indoco Remedies Ltd., India), and rubber dam isolation was achieved. An endodontic access cavity was prepared under 5× magnification using dental loupes (Admetec, Israel). Careful exploration of the pulpal floor revealed three distinct canal orifices—mesiobuccal, distobuccal, and palatal.

Initial canal negotiation was performed using #10 K-files (MANI Inc., Japan) until apical patency was achieved in all canals. Working length determination was carried out using an electronic apex locator (Eighteeth Apex Locator, Eighteeth Medical, China) and confirmed radiographically (Figure 6).

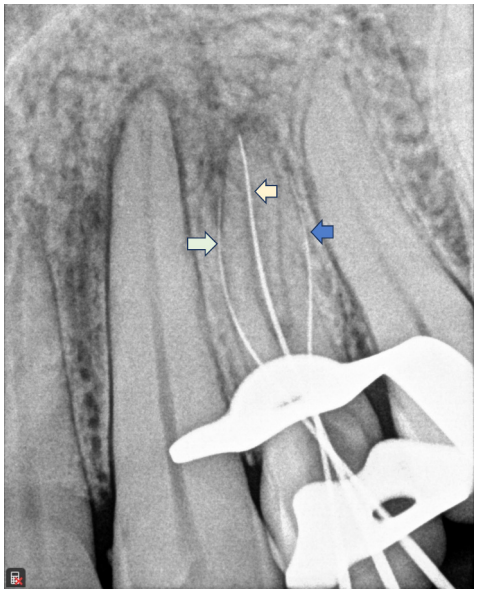

Figure 6: Working length radiograph confirming three separate canals — mesiobuccal, distobuccal, and palatal. (green arrow- mesiobuccal canal, blue arrow- distobuccal canal, peach arrow- palatal canal)

Biomechanical preparation was completed using nickel–titanium rotary instruments (VDW.ROTATE, VDW, Munich, Germany) up to size 25 with a 4% taper.

The irrigation protocol consisted of 5.25% sodium hypochlorite (SafeEndoHypochlor Forte, Safe Endo Dental India Pvt. Ltd., India) delivered after each instrument using a 30-gauge side-vented irrigation needle (NaviTip, Ultradent, USA). Smear layer removal was achieved using 17% EDTA (RC-Prep, Premier Dental Products Co., USA) for one minute, followed by a final rinse with 5 mL of sterile saline. Irrigant activation was performed using the EndoActivator system (Dentsply Sirona, USA) for 30 seconds in each canal.

As the canals were dry and free of exudate, obturation was completed in the same visit using the single-cone technique with gutta-percha cones (Dentsply Sirona, USA) and a bioceramic sealer (CeraSeal, Meta Biomed, Korea). The access cavity was restored with a light-cured nano-hybrid composite resin (Filtek Z350 XT, 3M ESPE, USA) to ensure an adequate coronal seal (Figure 7). As sufficient coronal tooth structure remained, post placement and full-coverage restoration were not indicated.

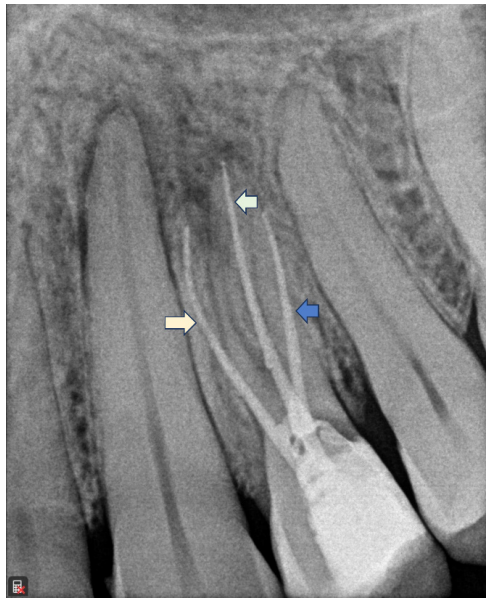

Figure 7: Post-obturation radiograph showing single-cone obturation.mesiobuccal, distobuccal, and palatal. (peach arrow- mesiobuccal canal, blue arrow- distobuccal canal, green arrow- palatal canal)

At the three-month follow-up, the patient was asymptomatic, and radiographic evaluation demonstrated well-condensed obturation with early evidence of periapical healing (Figure 8).

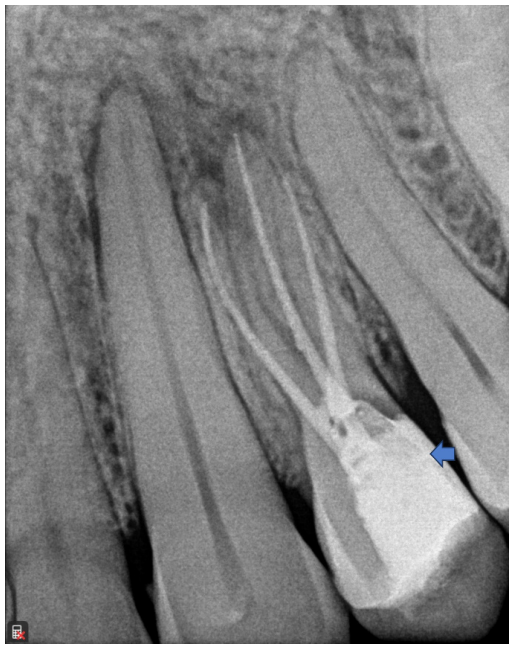

Figure 8: Three month follow-up (blue arrow- definitive coronal restoration)

Case 3

A 27-year-old female patient presented with lingering pain on exposure to cold stimulus in the upper right posterior region. Intra-oral examination revealed a deep occlusal carious lesion involving the maxillary right second premolar (tooth 15). The tooth was tender to percussion, with no associated swelling, sinus tract, or abnormal mobility.

A pre-operative periapical radiograph revealed an unusual root morphology suggestive of three distinct roots and canals, with no evidence of periapical radiolucency or periodontal ligament widening (Figure 9).

Figure 9: Pre-operative periapical radiograph showing deep occlusal caries and normal periapical architecture in tooth 15. (green arrow- distobuccal root, blue arrow- mesiobuccal root, yellow arrow- palatal root)

Based on the clinical and radiographic findings, a diagnosis of symptomatic irreversible pulpitis with normal apical tissues was made. Written informed consent was obtained prior to treatment.

Local anaesthesia was administered using 2% lignocaine with 1:80,000 adrenaline (Lignox, Indoco Remedies Ltd., India), and rubber dam isolation was achieved. An endodontic access cavity was prepared under 5× magnification using dental loupes (Admetec, Israel). Careful inspection of the pulpal floor revealed three separate canal orifices—mesiobuccal, distobuccal, and palatal.

Canal negotiation was performed using #10 K-files (MANI Inc., Japan) until apical patency was achieved in all canals. Working length determination was carried out using an electronic apex locator (Eighteeth Apex Locator, Eighteeth Medical, China) and confirmed radiographically (Figure 10).

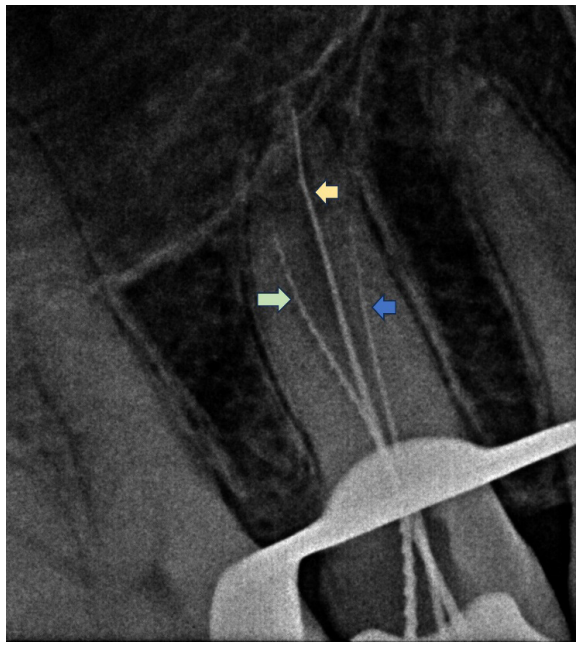

Figure 10: Working length radiograph confirming three separate canals — mesiobuccal, distobuccal, and palatal. (green arrow- distobuccal canal, blue arrow- mesiobuccal canal, yellow arrow- palatal canal)

Cleaning and shaping were completed using nickel–titanium rotary instruments (VDW.ROTATE, VDW, Munich, Germany) up to size 25 with a 4% taper.

Throughout instrumentation, irrigation was performed using 5.25% sodium hypochlorite (SafeEndoHypochlor Forte, Safe Endo Dental India Pvt. Ltd., India) delivered after each file with a 30-gauge side-vented irrigation needle (NaviTip,

Ultradent, USA). Smear layer removal was achieved using 17% EDTA (RC-Prep, Premier Dental Products Co., USA) for one minute, followed by a final rinse with sterile saline. Irrigant activation was performed using the EndoActivator system (Dentsply Sirona, USA) for 30 seconds in each canal.

The canals were dried using sterile paper points and obturated using the single-cone technique with gutta-percha cones (Dentsply Sirona, USA) and a bioceramic sealer (CeraSeal, Meta Biomed, Korea). The access cavity was restored using a light-cured nano-hybrid composite resin (Filtek Z350 XT, 3M ESPE, USA). As adequate coronal tooth structure was retained, post placement or full-coverage restoration was not required (Figure 11).

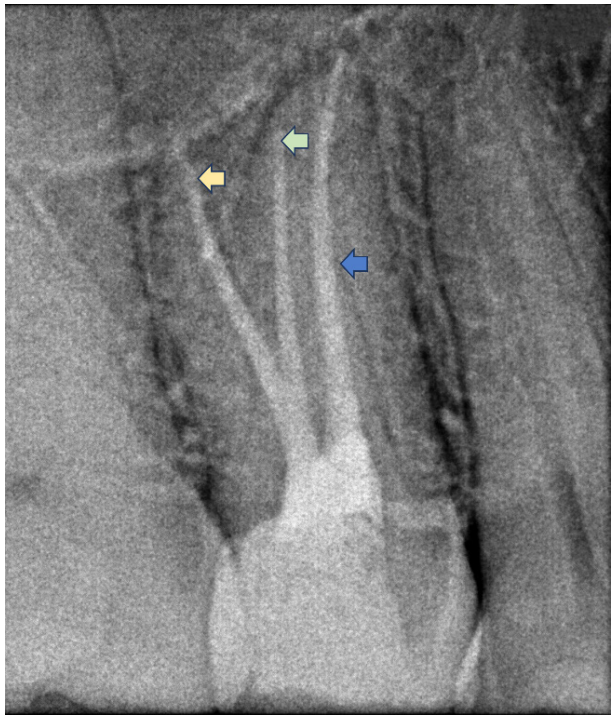

Figure 11: Post-obturation radiograph showing single-cone obturation. (yellow arrow- distobuccal canal, green arrow- mesiobuccal canal, blue arrow-palatal canal)

At the three-month follow-up, the patient was asymptomatic, and radiographic assessment demonstrated intact periapical architecture with no evidence of pathological change (Figure 12).

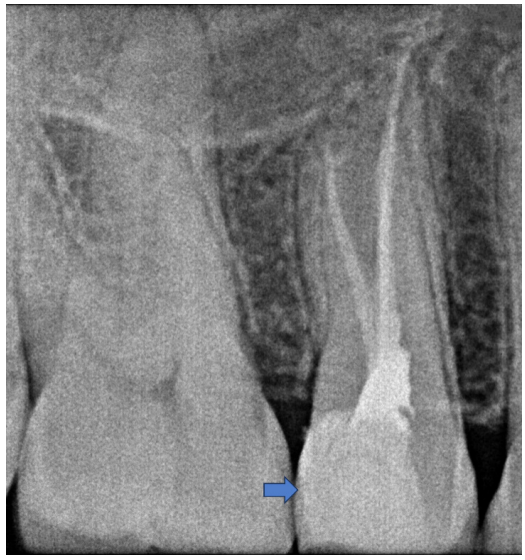

Figure 12: Three month follow-up. (blue arrow-definitive coronal restoration)

Discussion

Endodontic success is closely linked to the clinician's ability to identify and treat all canals within a tooth. Anatomical variations such as three-rooted maxillary premolars, although uncommon, present unique challenges due to their molar-like configuration with two buccal roots and one palatal root[1,2]. Failure to detect these additional canals remains a leading cause of persistent periapical pathology and retreatment[3].

Radiographic interpretation plays a pivotal role in recognising such anomalies. Multiple angulated periapical radiographs, particularly with horizontal shifts of 20°–40°, can help separate overlapping root structures and reveal hidden canals[5]. The SLOB (Same-Lingual-Opposite-Buccal) principle continues to be a reliable adjunct for confirming canal positions. While CBCT provides superior three-dimensional assessment, its routine use must be balanced against radiation exposure, with magnification via dental loupes or operating microscopes offering a practical alternative[4,5].

Access cavity modification is often necessary to achieve straight-line access to all canals in three-rooted premolars. Contemporary irrigation protocols employing sodium hypochlorite and

ethylenediaminetetraacetic acid, supplemented by sonic or ultrasonic activation, enhance debridement and smear layer removal[7]. The use of calcium hydroxide as an intracanal medicament remains beneficial in cases with persistent exudation, whereas single-visit obturation may be appropriate in dry, asymptomatic canals[8].

Bioceramic sealers, used in conjunction with gutta-percha in single-cone techniques, have demonstrated favourable sealing ability, dimensional stability, and biocompatibility, contributing to predictable outcomes[6]. Equally important is the placement of a definitive coronal restoration, as coronal leakage has been shown to significantly influence long-term success[9].

This case series reinforces that successful management of three-rooted maxillary premolars is achievable when clinicians maintain a high index of suspicion, employ systematic diagnostic strategies, and utilise contemporary endodontic techniques. Awareness of such anatomical variations, combined with meticulous execution, minimises the risk of missed canals and enhances treatment prognosis.

Conclusion

The presence of three roots in maxillary premolars represents a rare but clinically significant anatomical variation that can compromise endodontic outcomes if unrecognized. This case series demonstrates that predictable non-surgical management of three-rooted maxillary premolars is achievable when clinicians maintain a high index of suspicion and adopt a systematic diagnostic approach. Careful interpretation of angulated periapical radiographs, supplemented by magnification, is essential for accurate identification of all canals. Appropriate access cavity modification, effective chemo-mechanical preparation, and the use of contemporary obturation materials contribute to thorough disinfection and reliable sealing of complex canal systems. Furthermore, definitive coronal restoration plays a crucial role in ensuring long-term success. Awareness of such anatomical variations and adherence to sound endodontic principles allow even anatomically challenging premolars to be managed successfully, minimizing the risk of missed canals and post-treatment disease.

Declaration of Patient Consent

The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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