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Endodontic management of a maxillary premolar with a rare anatomical variation: Case report

Abordagem endodôntica de pré-molar superior com variação anatômica rara: Relato de caso

Abordaje endodóntico de un premolar superior con una variación anatómica rara: Reporte de un caso

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Abstract
The success of endodontic treatment depends on the quality of cleaning and obturation of the Root Canal System (RCS), which are challenged by morphological variations such as isthmuses, polar areas, and accessory canals. Failure to locate all root canals can result in persistent infections or reinfections, significantly contributing to treatment failure. Upper premolars with three roots represent a rare anatomical variation, requiring a meticulous approach to achieve therapeutic success. This study aims to report the endodontic treatment of a left upper premolar with three roots and three canals, with independent foraminal exits. A 38-year-old male, Caucasian patient, was referred for endodontic treatment of the left second upper premolar. Upon clinical examination, tooth 25 showed an exaggerated response to the vitality test, and the radiographic examination revealed an atypical anatomy with three roots and three canals. The first session was dedicated to locating and performing complete chemical-mechanical preparation of the three canals using stainless steel files (C-pilot®), rotary instruments (Bondent Platinum®). An intracanal medication containing calcium hydroxide combined with 2% chlorhexidine gel was placed for 21 days. In the second visit, the root canal system was obturated with Endofill® sealer. The endodontic treatment of teeth with complex anatomy, such as tooth 25 with three independent canals, emphasizes the need for meticulous planning and the use of advanced technologies for clinical success.
Keywords: Tooth Abnormalities; Endodontics; Bicuspid; Tooth Root; Root Canal Therapy.

Resumo
O sucesso do tratamento endodôntico depende da qualidade da limpeza e obturação do Sistema de Canais Radiculares (SCR), especialmente diante das variações morfológicas, como istmos, áreas polares e canais acessórios. A falha em localizar todos os canais radiculares pode resultar em infecções persistentes ou reinfecções, contribuindo significativamente para o insucesso do tratamento. Os pré-molares superiores com três raízes representam uma variação anatômica rara, exigindo uma abordagem meticulosa para alcançar o êxito terapêutico. Este trabalho tem como objetivo relatar o tratamento endodôntico de um pré-molar superior esquerdo com três raízes e três canais,

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apresentando saídas foraminais independentes. Paciente do sexo masculino, 38 anos, leucoderma, foi encaminhado para o tratamento endodôntico do segundo pré-molar superior esquerdo. Ao exame clínico, o dente 25 apresentou resposta exacerbada ao teste de vitalidade, e o exame radiográfico revelou uma anatomia atípica, com três raízes e três canais. A primeira sessão foi dedicada à localização e ao preparo químico-mecânico completo dos três canais, utilizando instrumentos manuais (C-pilot®) e mecanizados (Bondent Platinum®). Foi realizado medicação intracanal à base de hidróxido de cálcio associado com gel de clorexidina 2% por 21 dias. Na segunda sessão, foi realizada a obturação do sistema de canais radiculares com cimento obturador Endofill®. O tratamento endodôntico de dentes com anatomia complexa, como o dente 25 com três canais independentes, destaca a necessidade de um planejamento meticuloso e do uso de tecnologias avançadas para o sucesso clínico.
Palavras-chave: Anormalidades Dentárias; Endodontia; Dente Pré-Molar; Raiz Dentária; Tratamento do Canal Radicular.

Resumen
El éxito del tratamiento endodóntico depende de la calidad de la limpieza y obturación del Sistema de Canales Radiculares (SCR), especialmente frente a las variaciones morfológicas, como istmos, áreas polares y canales accesorios. El fracaso en localizar todos los canales radiculares puede resultar en infecciones persistentes o reinfecciones, lo que contribuye significativamente al fracaso del tratamiento. Los premolares superiores con tres raíces representan una variación anatómica rara, lo que requiere un enfoque meticuloso para lograr el éxito terapéutico. Este trabajo tiene como objetivo reportar el tratamiento endodóntico de un premolar superior izquierdo con tres raíces y tres canales, presentando salidas foraminales independientes. Un paciente masculino de 38 años, de piel clara, fue referido para el tratamiento endodóntico del segundo premolar superior izquierdo. En el examen clínico, el diente 25 presentó una respuesta exacerbada al test de vitalidad, y el examen radiográfico reveló una anatomía atípica, con tres raíces y tres canales. La primera sesión se dedicó a la localización y al preparado químico-mecánico completo de los tres canales, utilizando instrumentos manuales (C-pilot®) y mecanizados (Bondent Platinum®). Se realizó una medicación intracanal a base de hidróxido de calcio asociado con gel de clorhexidina al 2% durante 21 días. En la segunda sesión, se llevó a cabo la obturación del sistema de canales radiculares con el cemento obturador Endofill®. El tratamiento endodóntico de dientes con anatomía compleja, como el diente 25 con tres canales independientes, resalta la necesidad de una planificación meticulosa y el uso de tecnologías avanzadas para el éxito clínico.
Palabras clave: Anomalías Dentarias; Endodoncia; Diente Premolar; Raíz Dental; Tratamiento del Canal Radicular.

1. Introduction

The success of endodontic treatment is directly influenced by the quality of pulp tissue and biofilm removal, as well as the three-dimensional sealing of the root canal system (Siqueira & Rôças, 2008; Iandolo et al., 2021). However, the internal anatomy of teeth can present morphological variations-such as isthmuses, flattenings, and accessory canals-that may hinder the thorough treatment of the root canal system. (Versiani; Martins; Ordinola-Zapata, 2023; Martins et al., 2024)

Studies indicate that unlocated canals in infected teeth may harbor bacteria in sufficient quantities to sustain the periapical pathological process (Costa et al., 2019). Similarly, the failure to identify all canals during primary endodontic treatment in non-infected teeth may lead to reinfection and the development of apical periodontitis (Baruwa et al., 2020; Pessotti et al., 2023). Therefore, failing to locate all root canals is a significant risk factor for endodontic treatment failure (Baruwa et al., 2020; Pessotti et al., 2023; Alotaibi et al., 2024; Ebrahimi et al., 2024).

Periapical radiographs can be valuable in detecting atypical anatomies and mitigating the limitations of two-dimensional imaging when dealing with three-dimensional structures is necessary. To enhance diagnostic accuracy, the clinician must take radiographs at various angulations-both horizontally and vertically (De Moor & Calberson, 2005). Two radiographic features may suggest the presence of three root canals. The first involves the mesiodistal distance of the middle third of the root, which is equal to or greater than that of the coronal third. This may indicate either the presence of two buccal roots, resembling the root anatomy of an upper molar, or two buccal root canals within a single, larger buccal root (Barros et al., 2009). The second radiographic sign is the abrupt disappearance of the root canal, which can make it difficult to accurately determine the number and orientation of the present canals (Gesi et al., 2006)

Additionally, Cone Beam Computed Tomography (CBCT) has proven to be crucial for assessing the complex

anatomy of root canals (Chan; Brown; Parashos, 2023) CBCT provides detailed three-dimensional visualization of dental and periapical structures, allowing for precise identification of anatomical variations, such as accessory canals and extra roots, which may not be visible in two-dimensional radiographs (Alfadley et al., 2024). Moreover, CBCT is particularly useful in cases where conventional radiographs are inconclusive, contributing to more accurate diagnoses and better therapeutic planning (Asgary, 2025)

Given these challenges, clinicians must be well versed in the potential anatomical variations of the targeted tooth group and utilize advanced technologies, such as magnification (operating microscopes or dental loupes) and ultrasonic inserts, for a comprehensive approach-from coronal access to endodontic reintervention. (Del Fabbro et al., 2009; Camacho-Aparicio et al., 2022).

Upper premolars, in particular, exhibit significant anatomical variations in both the number of roots and the configuration of the canals (Buchanan et al., 2020; Erkan et al., 2023). Vertucci, Seelig and Gillis (1974), classified premolars based on the number of foraminal exits, canal configurations, and branching patterns. These classifications include: Type I-III (single foramen), Type IV-VII (two foraminal exits), and Type VIII, which is characterized by three distinct canals with independent foraminal exits-a rare configuration with a prevalence ranging from 0.3% to 4.3% (Erkan et al., 2023; Martins et al., 2024; Xu et al., 2024). This study aims to report the endodontic treatment of a left upper premolar with three roots and three canals, with independent foraminal exits.

2. Methodology

The present study is a descriptive one of qualitative nature and that is a clinical case report (Toassi & Petry, 2021; Pereira et al., 2018; Chaves et al., 2022) on the endodontic treatment of a maxillary premolar with atypical internal anatomy. The research followed ethical criteria with the patient signing the free and informed consent form (TCLE) allowing the disclosure of data from his case for scientific purposes, and the study also underwent approval by the institutional ethics committee.

In compliance with legal and ethical standards, all stages were conducted in accordance with the Declaration of Helsinki and Resolution 466/12 of the Brazilian National Health Council (CNS). The study participant was included after signing the Informed Consent Form (ICF), declaring their willingness to participate in the study and authorizing the use of their image for academic purposes.

3. Case report

Male patient, leukoderma, 38 years old, sought dental care due to intense, long-lasting pain upon exposure to cold stimuli on tooth 25, which had a mesio-occluso-distal silver amalgam restoration. During the medical history inquiry, the patient reported not taking any medications and having no health issues.

A pulp sensitivity test was conducted using refrigerant gas (Tetrafluoroethane) Endo-Ice® (Maquira Dental, Maringá, Paraná, Brazil), applied with a cotton swab to the tooth surface. An intense, prolonged painful response was observed, consistent with a diagnosis of irreversible pulpitis.

The tooth presented no symptoms to horizontal and vertical percussion, as well as apical palpation. Additionally, no mobility was observed. The clinical examination revealed the patient's blood pressure to be within acceptable parameters set by the World Health Organization (130/80 mmHg).

The preoperative radiograph revealed radiolucency on the proximal surfaces of tooth 25, suggestive of secondary caries and an unsatisfactory restoration. A visible root pulp was noted in the cervical third, which abruptly disappears in the middle and apical thirds, indicating a possible bi- or trifurcation of the root canals (Figure 1).

Figure 1 - Pre-operative periapical Radiography.

Source: Authors.

During the patient's first visit, under local anesthesia with 2.0% Lidocaine Hydrochloride with Epinephrine 1:100,000 (Alphacaine 100, DFL, Rio de Janeiro, RJ, Brazil), the silver amalgam restoration and the underlying carious tissue were completely removed, and access to the root canals was made using 1014 and 3082 diamond burs (Microdont, São Paulo, SP, Brazil). Subsequently, rubber dam isolation was installed using the Madeitex® rubber dam (Indústria de Artefatos de Borracha Inovatex LTDA, São José dos Campos, SP, Brazil). The root canals were located using an endodontic probe #47 (Golgran, São Caetano do Sul, SP, Brazil). The operator used 2.5x magnification loupes (Bioart Equipamentos Odontológicos, São Carlos, SP, Brazil).

After analyzing the preoperative radiograph, the treatment proceeded with the exploration of the canals using a C-Pilot #15 file (VDW GmbH, Munich, Germany). Then, the preparation of the middle and cervical thirds of the vestibular (V) and palatal (P) canals was performed with a 17.12 instrument (Bondent Group, GbmH, Germany) to remove interferences in the middle and cervical thirds (Figure 2a).

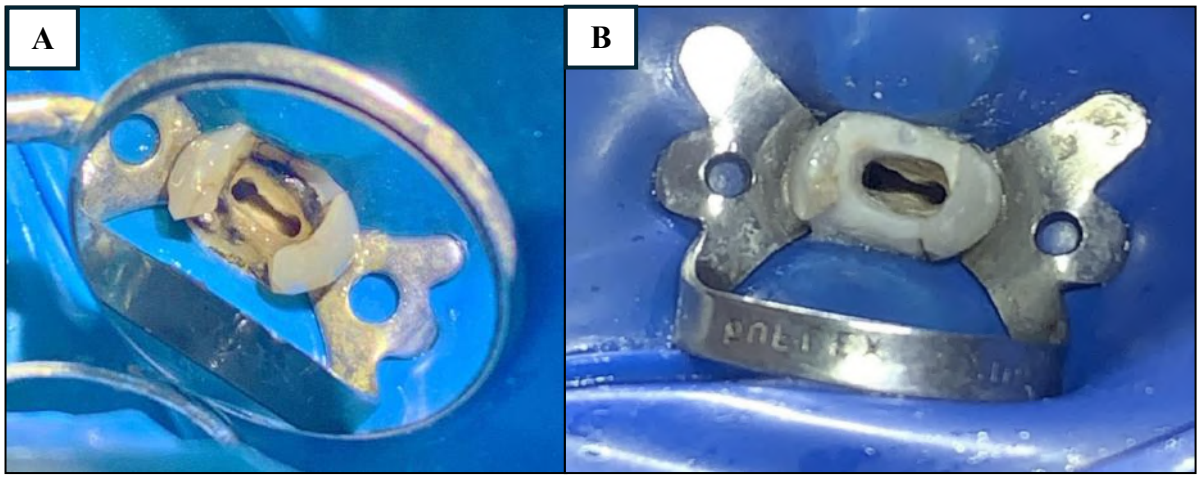
The working length was established with an electronic apex locator (Dpex-III, Guilin Woodpecker Medical Instrument Co., LTDA, Guilin, China), and patency was achieved at 23 mm. The instrumentation was performed 1 mm beyond the foramen, using the Platinum V.EU and CC-One Blue systems (Bondent Group, GbmH, Germany), with the #17.04, #20.04, #25.06, #30.04, and #40.06 files (Figure 2a). Root canal disinfection was carried out with 2% chlorhexidine (Lenza Farm, Belo Horizonte, Brazil), which was the chosen Auxiliary Chemical Substance (ACS), and sterile 0.9% saline solution (SS) (Eurofarma, São Paulo, SP, Brazil) was used as the irrigating solution.

Following the instrumentation of the vestibular and palatal canals, compensatory dentine removal was performed using a size 2 Müller bur (Ceptiom Acessórios Odontológicos, Tijucas, SC, Brazil), distal to the already located vestibular canal, aiming to explore the possible existence of an extra vestibular canal (Figure 2b). After the removal of debris, the third canal was located using a C-Pilot #10 file (VDW GmbH, Munich, Germany). Apex measurement and all root preparation were conducted in the same manner as for the other canals.

After completing the chemical-mechanical preparation, a final irrigation was performed, which preceded the intracanal dressing. During this final step, 5 ml of SS was used, followed by 2 ml Endogel 2% in the root canal system, and

then 5 ml of SS. The canal was then irrigated with 5 ml of 17% ethylenediaminetetraacetic acid (EDTA) (Lenza Farm, Belo Horizonte, MG, Brazil) and agitated with Easy Clean (Easy Equipamentos Odontológicos, Belo Horizonte, MG, Brazil) in six 20-second cycles per canal.

Figure 2 - Initial photos from the start of treatment.



Legende: A. Tooth aspect after complete removal of failed amalgam restoration, caries, pulp chamber acess and preflating of the root canals; B: Tooth aspect after location and instrumentation of all three canals. Source: Authors.

The canals were dried using DiadentCell Pack absorbent paper points (Diamond Dental Industrial Co. Ltd, South Korea). A calcium hydroxide and 2% chlorhexidine-based intracanal dressing was used. For the temporary restoration of the tooth, the lost proximal walls were restored with Forma composite resin (Ultradent, Indaiatuba, SP, Brazil), and Meron® glass ionomer cement (VOCO, Porto Alegre, RS, Brazil) was used for the occlusal restoration.

After 21 days, the patient returned asymptomatic, and the intracanal dressing was removed using 0.9% SS and Easy Clean. Absorbent paper points (MK Life, Porto Alegre, RS, Brazil) were used with the aid of a calibrated measuring ruler (MK Life, Porto Alegre, RS, Brazil). Gutta-percha cones size FM (Odous de Deus, Belo Horizonte, MG, Brazil) were calibrated 1 mm short of the total canal length, in accordance with the final apical file size, and inserted into the canal to observe the cone's fit. The root canals were obturated with zinc oxide and eugenol-based cement Endofill® (Dentsply, São Paulo, SP, Brazil) using the lateral condensation technique (Figure 3).

The orifices were sealed with flowable resin Master Flow (Biodinâmica, Ibiporã, PR, Brazil), and a provisional restoration was made with Meron® glass ionomer cement. Upon completion of the endodontic treatment, a postoperative radiograph was taken, and the tooth was referred for prosthetic treatment.

Figure 3 - Post-operative radiograph.

Legenda: (M): Mesial incidence; Distal incidence; (O) parallel incidence. Source: Authors.

4. Discussion

Before starting any endodontic treatment, a detailed understanding of root anatomy and its possible variations is essential for effective planning (Barros et al., 2009). In the case of tooth #25, the preoperative periapical radiographs raised suspicions about complex root anatomy, emphasizing the importance of accurate diagnosis. The literature highlights that the use of CBCT may be indispensable in these cases, as it provides a detailed three-dimensional view that aids in the identification of anatomical variations and the detection of accessory canals, isthmuses, and curvatures (Asgary, 2025)

Alrahabi and Gabbani (2019) reported the endodontic treatment of an upper premolar with similar anatomy to the present case, emphasizing the importance of tomography in mapping internal anatomy and highlighting the role of CBCT in providing more predictable outcomes in treating premolars with atypical anatomies.

Studies such as those by Vertucci (1974) emphasize the anatomical variations in upper premolars, often associated with additional roots or extra canals, which can be influenced by demographic factors, including ethnicity and gender, as observed in other articles (Buchanan et al., 2020; Erkan et al., 2023; Martins et al., 2024; Xu et al., 2024). In the present case report, the presence of three independent canals and root trifurcation represents a rare and challenging anatomical variation, underscoring the need for advanced instrumentation techniques.

The use of the stainless steel C-Pilot file was crucial for instrumenting and maintaining patency in calcified canals. This choice is supported by studies that highlight the superior resistance of this material to deformation in calcified or severely constricted canals (Lopes et al., 2012a, b)

Regarding the preparation of the root canal system (RCS), the choice of a hybridization strategy was fundamental for efficient cleaning and shaping. The literature suggests that a combination of manual and rotary instruments, particularly those with cross-sections that allow for better evacuation of debris and optimized irrigation, significantly contributes to the disinfection of the RCS (Butcher; Mansour; Ibrahim, 2019; Duque et al., 2019). Increasing the apical constriction diameter and taper of the canal, such as to a 40.06 instrument, provides better penetration of irrigants into apical ramifications, better removal of the smear layer, and overall better flow of irrigants in the canal, improving the predictability of endodontic success (De Gregorio et al., 2013)

The intracanal medication approach, even when facing a vital pulp, was justified due to the need for multiple sessions, which could allow recontamination of the RCS. The combination of calcium hydroxide with 2% chlorhexidine was chosen for its synergistic, long-lasting antimicrobial properties and ability to neutralize endotoxins, as demonstrated in several studies (Saatchi et al., 2014; Arruda et al., 2018). Recent studies also validate the use of Easy Clean as an efficient tool for intracanal medication removal, promoting more effective cleaning of the canal walls (Oliveira et al., 2019).

Kapoor & Paul (2012) reported using the combination of 2% chlorhexidine and calcium hydroxide as intracanal

medication in a necrotic tooth with a periapical lesion approximately 1.5 cm in diameter and observed a reduction in lesion size after six months of follow-up, indicating the intracanal medication's capacity to reduce microbial content. Furthermore, a randomized clinical trial comparing the efficacy of calcium hydroxide combined with saline and 2% chlorhexidine gel in resolving periapical lesions when used as intracanal medication showed similar success rates between the two groups, supporting the use of chlorhexidine as a vehicle (Riaz et al., 2018)

In the obturation phase, the lateral condensation technique, combined with zinc oxide-eugenol-based cement (ZOE), was effective in achieving adequate three-dimensional sealing. Comparative research indicates that, despite the growing popularity of bioceramic cements, ZOE-based cements continue to offer predictable and satisfactory results in endodontic obturation (Amoroso-Silva et al., 2023; Bardini et al., 2025).

Magnification, provided by magnification loupes, was a critical resource for detecting and treating fine anatomical details, such as isthmuses and additional canals, which are often overlooked in traditional approaches (Del Fabbro et al., 2009) The use of magnification has been widely recommended to improve the accuracy and effectiveness of complex endodontic procedures (Camacho-Aparicio et al., 2022)

Finally, clinical and radiographic follow-up will be essential to monitor periapical bone healing and the functionality of the treated tooth, ensuring the long-term success of the procedure. Follow-up will assess the integrity of the obturation and the tissue response to treatment, both crucial factors for endodontic success.

5. Conclusion

Endodontic treatment of teeth with complex anatomy, such as tooth 25 with three independent canals, underscores the need for meticulous planning and the use of advanced technologies for clinical success. The discussion of this case demonstrates that the combination of CBCT, dental operative microscope, and biocompatible materials represents an effective approach to maximize results and minimize risks associated with atypical root anatomies.

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Conflicts of interest

The authors declare no financial interests nor personal relationships that could have influence the work reported in this article.

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