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Root Canal Treatment of Mandibular First Premolar with 3 Canals: A Case Report

Tratamiento Endodóntico de Primer Premolar Mandibular con 3 Canales: Reporte de un Caso

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SUMMARY: The mandibular first premolar is commonly a single-rooted tooth with occasional presentation of radicular variations. This tooth usually has one root with only one canal (97.9 %). Presence of three canals is very rare. Anomalies may appear during odontogenesis which can lead to anatomical variations in teeth. Similarly, these variations may be associated with characteristics that can be attributed to specific population groups. Due to their low frequency, these additional canals can easily be missed. For this reason, a meticulous knowledge of tooth morphology and their possible anatomical variations are necessary, and the presence of extra roots and canals should be always considered before initiation of root canal treatment. Additionally, different radiographs and appropriated access cavity preparation is needed to ensure a success endodontic treatment. This article reports a diagnosis and endodontic treatment of a mandibular first premolar with three canals.

KEY WORDS: Endodontic treatment; Mandibular first premolar; Root canal morphology.

INTRODUCTION

The success of endodontic treatment is contingent upon a comprehensive understanding of dental anatomy and root canal morphology (Ahmed & Dummer, 2017; Alqedairi *et al*., 2018). Adequate cleaning, shaping, and filling of the entire root canal system require the identification of all root canals. Thus, clinicians must possess knowledge of both the normal root anatomy as well as possible variations (Nallapati, 2005). If at least one canal is left untreated during endodontic treatment, the risk of post-treatment apical periodontitis is high due to the potential persistence of microorganisms and necrotic tissue (Costa *et al*., 2019).

Mandibular premolars pose significant challenges in endodontic treatment due to the complex anatomical variations in their root morphology (Baisden *et al*., 1992; Pedemonte *et al*., 2018). While they typically have a single canal, studies have shown that the incidence of two or more canals can vary significantly, ranging from 2.7 % to 62.7 % in mandibular first premolars (MFP) and 0 % to 34.3 % in mandibular second premolars, according to Vertucci *et al*. (1984). Additionally, C-shaped root canals have been observed in the MFP of Chinese individuals, with a prevalence of 24 %. Despite these documented variations in the literature, information on the prevalence of specific anatomical variations in different populations is still lacking (Pedemonte *et al*., 2018). Understanding these prevalence rates is crucial, as aberrant anatomy in teeth can be influenced by racial or ethnic factors (Awawdeh & Al-Qudah, 2008).

When considering root canals, it is crucial to examine their arrangement, path, and shape. To gain a comprehensive understanding of the root canal system's configuration, the use of Vertucci's score is recommended. This classification system analyzes anatomic variations and categorizes the configuration of root canals (Sierra-Cristancho *et al*., 2021). Although this classification system does not account for all root details, it remains applicable for determining the number and general configuration of root canals in MFP (Table I, Fig. 1). To identify any deviations from typical dental anatomy, various methods have been employed to assess

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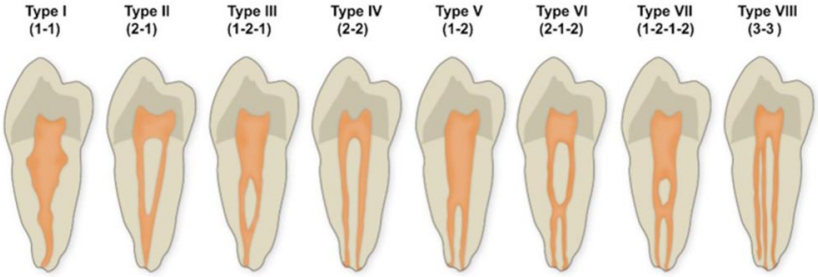

Fig. 1. Illustration of the configuration types of the root canal system by Vertucci`s classification (extracted to Sierra-Cristancho *et al*., 2021).

root canal anatomy, including conventional radiography (utilizing retro-alveolar radiographs with varying angles) and cone-beam computed radiography (CBCT), which provides a three-dimensional image of the entire root canal system's morphology. In both cases, it is essential to thoroughly evaluate radiological images to detect any potential abnormalities.

The current clinical report details a case of non-surgical endodontic treatment, where the use of periapical radiographs and CBCT images revealed a unique instance of three fully independent root canals in a FMP.

CASE REPORT

A 22-year-old female patient, with no prior medical history, sought care at the Post Graduate Endodontics Clinical Center of Mayor University in Temuco, Chile. The patient reported experiencing mild sensitivity, primarily to temperature changes, and discomfort while biting on the right side of the mandible. There were no spontaneous pain symptoms reported. Clinical examination revealed a significant caries lesion on the buccal surface of the first mandibular premolar (tooth 4.4). However, there were no alterations of the vestibule fundus, no evidence of a sinus tract, and no pain during palpation. The vitality tests showed a decreased response, and the tooth displayed moderate pain during percussion. Radiographic analysis showed that the root canal morphology had an abnormal anatomical configuration, suggesting the presence of more than one root canal and widening of the periodontal ligament (Fig. 2).

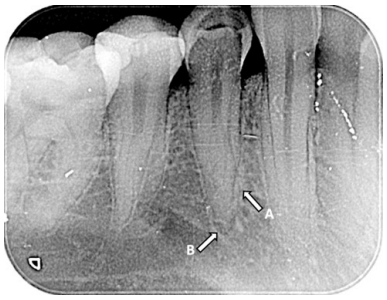

Fig. 2. Initial radiograph. Note the irregular contour of the root (suggesting the presence of 2 or more roots and canals) (A) and the thickening of the apical periodontal ligament (B).

Following a clinical and radiographic examination, symptomatic apical periodontitis was diagnosed, and the patient was informed of the prognosis and provided authorization to undergo root canal treatment. Anesthesia and a rubber dam were employed for absolute isolation. The buccal caries was removed, and partial reconstruction of the vestibular area was carried out with composite resin. An endodontic access was established using a high-velocity diamond bur and an Endo-Z bur (Dentsply-Maillefer). Following the removal of the coronal pulp, three canals were identified - two buccal canals and one lingual canal (Fig. 3). All stages of the procedure were documented.

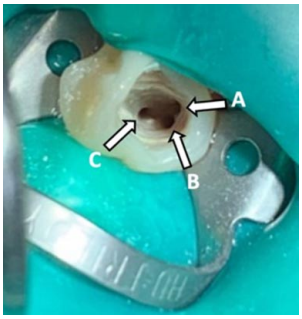

Fig. 3. Endodontic access with three canals: two buccal canals (A, B) and one lingual canal (C).

Table I. The root canal configurations in the roots of human permanent teeth according to Vertucci *et al.* (1984)

Tipo I	A single canal from the pulp chamber to the apex.
Tipo II	Two separate canals from the pulp chamber and form one canal to the apex.
Tipo III	One canal leaves the pulp chamber, divides in two, and exit as one canal.
Tipo IV	Two separate canals extend from the pulp chamber to the apex.
Tipo V	One canal leaves the pulp chamber and divides before to the apex into two canals with separate apical foramen.
Tipo VI	Two separate canals drop the pulp chamber, join in the root, and divide before the apex to exit as two distinct canals.
Tipo VII	One canal leaves the pulp chamber, divides in two, rejoins in the root, and redivides in two canals before to the apex.
Tipo VIII	Three separate canals extend from the pulp chamber to the apex.

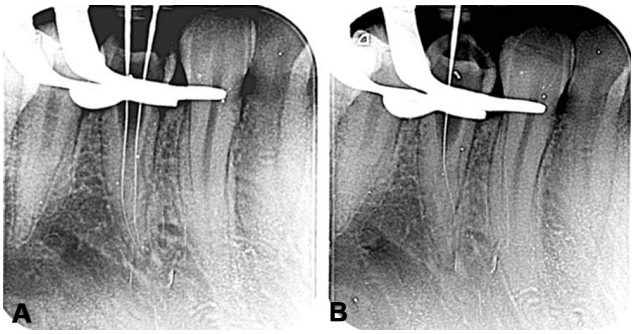

Fig. 4. Radiographic images about root canal exploration A: buccal canals, B: lingual canal.

The buccal root canals were examined with a K file nº 10 (Dentsply-Maillefer), while the lingual canal was explored using a K file nº 08 (Dentply-Maillefer) (Fig. 4). The root working length for all three canals was determined using a Propex Pixi apex locator (Dentsply-Sirona), resulting in measurements of 17 mm for the lingual canal and 21 mm for both buccal canals. All measurements were verified by periapical radiography. Furthermore, the existence of three independent root canals was definitively confirmed (Fig. 5). This case conforms to type VIII of Vertucci's root canal classification (Vertucci, 1984), indicating the presence of three separate canals.

Fig. 5. Conductometry rx with three endodontic files corresponding to three root canals.

The canals were manually instrumented using Niti files (Dentsply-Maillefer) up to size 40, and irrigated profusely with a 5.25 % sodium hypochlorite solution to eliminate pulp tissue and potential microorganisms. Subsequently, the instrumented canals were filled with calcium hydroxide paste as an inter-session medication.

A week later, the tooth exhibited no symptoms and demonstrated a normal response to percussion testing. The canals were filled manually using the cold lateral condensation technique, employing conventional gutta-percha cones nº40 and Grossman's cement. An immediate radiographic assessment was performed, confirming the complete root filling, as depicted in Figure 6.

Fig. 6. Immediate control periapical radiography.

After one week following the root filling procedure, the patient returned for a check-up and exhibited no symptoms. They were subsequently discharged and referred to a rehabilitation specialist for final tooth restoration. The oral rehabilitator recommended a cone beam computed tomography (CBCT) scan to assess the dental structure before the placement of a fiber post. The tridimensional images confirmed the root canals' proper obturation and revealed an anatomical variation present in tooth 4.4 that was also present in the contralateral first premolar (tooth 3.4), with two buccal canals and one lingual canal. Additionally, the second right premolar (tooth 4.5) displayed an unusual anatomy, seemingly possessing two roots and four canals. The bilateral nature of this anatomical variation could not be verified due to the absence of the second left premolar (tooth 3.5) (Fig. 7).

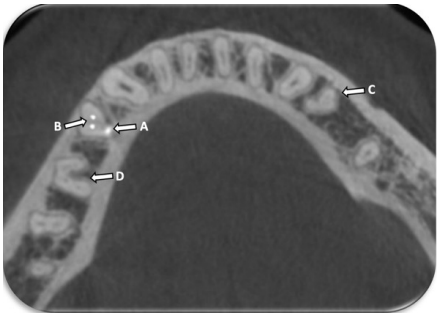

Fig. 7. CBCT axial image showing the filled canals of tooth 4.4 (A: lingual canal, B: buccal canals), tooth 3.4 with three root canals (C) and tooth 4.5 with two roots four canals (D).

DISCUSSION

Although there is extensive documentation of the typical internal and external anatomy of teeth, it is important to acknowledge the presence of anatomical variations (Paul & Dube, 2018). Such variations may require a specialized treatment approach; hence, the clinician should conduct a thorough clinical and radiological assessment of the tooth before initiating any endodontic procedure to identify possible variations that may impact the treatment's success (Costa *et al*., 2019). Understanding the internal and external anatomy of each tooth is crucial for a successful endodontic treatment, and overlooking anatomical variations can lead to untreated canals and failures in the procedure (Fava *et al*., 2000; Do Carmo *et al*., 2021). For instance, mandibular premolars with at least one unfilled canal have a high prevalence of developing apical periodontitis, which may result from persistent or secondary infections (Costa *et al*., 2019). In such cases, the untreated canal may contain a sufficient amount of bacteria to cause or sustain the infection or may create a conducive environment for bacterial growth and re-infection (Hoen & Pink, 2002; Nascimento *et al*., 2018). Clinicians should, therefore, consider all these factors when performing endodontic treatment.

Anatomical variations are influenced by various factors, such as ethnicity, geographical origin, age, and sex, as supported by several studies. In a literature review conducted by Cleghorn *et al*. (2007), it was found that the majority of mandibular first premolars (MFP) possess a single root (97.9 %), while 1.8 % have two roots, 0.2 % have three roots, and less than 0.1 % have four roots. Similarly, regarding the number of canals, 75.8 % of teeth have one canal, while 24.2 % have two or more canals (de Almeida-Gomes *et al*., 2006). Recent research in Chinese and Emirati populations has reported that the incidence of a single canal ranges from 64.04 % to 68 %. Another study utilizing CBCT on the Chilean population found that multiple root canals were present in 16.83 % of the analyzed teeth (Oporto *et al*., 2013). Despite these findings, the VIII Vertucci configuration remains uncommon, with no MFP meeting this criterion in a large-scale study of extracted teeth from Chilean individuals, even when analyzed with Micro-CT.

Studies have revealed variations in root canal anatomy according to ethnicity, with African-American individuals exhibiting a higher incidence of canals and roots compared to Caucasians (Cleghorn *et al*., 2007). Gender differences have also been noted in Turkish populations, with women showing a higher incidence of canals (Cleghorn *et al*., 2007). The evaluation of root canal anatomy typically involves conventional radiography, with preoperative radiographs of the tooth taken at different angles being essential to determine the number of roots present (Peters, 2004; Nallapati, 2005). Two radiographs are recommended for premolars, with the first being taken perpendicular to the tooth and the second being angled 20 degrees towards the proximal surfaces to visualize the vestibule-lingual anatomy (England Jr. *et al*., 1991). While conventional radiography is often sufficient for adequate diagnosis and treatment, the use of cone beam computed tomography (CBCT) is helpful for identifying additional root canals in more detail, particularly in cases where there are doubts aboutdental anatomy or loss of continuity of the root canal observed on radiographs (Salarpour *et al*., 2013; Nouroloyouni *et al*., 2021). CBCT provides three-dimensional images that offer a better understanding of the complex internal morphology of the canals, thus improving treatment outcomes.

CONCLUSION

Having a comprehensive understanding of the external anatomy of tooth roots, the internal canal system, and its morphological variations is essential in all aspects of endodontic treatment. The preservation of the tooth in the oral cavity is the primary goal of endodontics, which makes knowledge of anatomical variations vital. While radiographic images are useful for treatment planning, they may not always provide a sufficient view of the root canal system. Therefore, combining conventional images with CBCT improves the chances of a successful treatment outcome. Further research is necessary to investigate the prevalence of anatomical variations in premolars among the Latin American population. In addition, future studies should consider the ethnic and genetic origins of the populations under investigation since the morphology of root canals can vary depending on these factors, and it can affect the outcome of endodontic treatments.

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RESUMEN: El primer premolar mandibular suele ser un diente unirradicular con presentación ocasional de variaciones radiculares. Este diente suele tener una raíz con un solo conducto (97,9 %). La presencia de tres canales es muy rara. Durante la odontogénesis pueden aparecer anomalías que pueden provocar variaciones anatómicas en los dientes. De manera similar, estas variaciones pueden estar asociadas con características que pueden atribuirse a grupos de población específicos. Debido a su baja frecuencia, estos canales adicionales pueden pasar desapercibidos fácilmente. Por esta razón, es necesario un conocimiento meticuloso de la morfología dental y sus posibles variaciones anatómicas, y siempre se debe considerar la presencia de raíces y conductos

adicionales antes de iniciar el tratamiento de conducto. Además, se necesitan diferentes radiografías y una preparación adecuada de la cavidad de acceso para garantizar un tratamiento de endodoncia exitoso. Este artículo reporta un diagnóstico y tratamiento endodóntico de un primer premolar mandibular con tres canales.

PALABRAS CLAVE: Tratamiento endodóntico; Primer premolar mandibular; Morfología del canal radicular.

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