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Case Study

Endodontic Management of Non-single Root Canal Mandibular Premolars

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Abstract

Mandibular premolars and more often the first mandibular premolar, have some of the most complex endodontic configurations. With 1, 2 or 3 roots or root canals, C-shaped configurations, narrow endodontic space and bifurcations in the middle and apical thirds, all these are factors that make endodontic treatment of these teeth challenging. In order to endodontically treat these teeth, we need to know their anatomical variations and their prevalence, as some of them are quite frequent. Moreover, periapical radiograph does not always succeed in exposing aspects that suggest these multiple canal configurations. Current diagnostic means such as Cone-Beam Computed Tomography (CBCT), but also clinical endodontic armamentarium (operating microscope, ultrasound and the new nickel titanium files), are important resources when dealing with these teeth. Along with clinical expertise and sound knowledge of endodontic anatomy they play a crucial role to prevent endodontic errors. The purpose of this paper is to outline clinical management of these teeth, that would be beneficial to achieve a successful endodontic treatment.

Keywords: Mandibular Premolars; Endodontic Treatment; Anatomy; Root Canals; CBCT

Introduction

Mandibular premolars and particularly the first mandibular premolars, represent a group of teeth, which are from the point of view of endodontic treatment often underestimated in terms of difficulty, when, in fact, they have a complex endodontic system [1].

For a successful endodontic treatment, it is essential to approach all the canals of the endodontic system. They have to be mechanically and chemically debrided and then tightly sealed with a root canal filling. To this end, it is obvious that a good knowledge of the internal endodontic anatomy is crucial, as well as its possible variants.

From this point of view, mandibular premolars show an endodontic anatomy with more than one canal, sometimes two or even three canals in a single root, with various emergence configurations, either from the level of the pulp chamber or bifurcated deep apical.

Non-single root canal configurations show different frequencies in morphological studies, thus for the first mandibular premolar, 12.9–34.8%, and for the second mandibular premolar, 2–9.9% and their variations are caused by study methodology, ethnicity, age and sex [2-5].

The C-shaped configurations are rarer, they are found more frequently in first mandibular premolars, from 0.25% [6-10], to the highest frequency being reported in the Chinese population (29.7%) [11].

The 53.36% canal bifurcation in mandibular first premolars and 50.09% in mandibular second premolars are in the middle third [12].

Unfortunately, the preoperative analysis of the periapical radiograph does not always highlight such a situation, not even through indirect details that could lead the operator to detect and consider it. As for the C-shaped configurations, they can only be highlighted by CBCT axial sections. CBCT is an imaging tool that provides an accurate endodontic anatomical diagnosis, is non-invasive and in addition to the number of canals, provides information about the location of canal openings, depth of bifurcation, and angle of emergence [2,3].

The endodontic management of this anatomy is dependent on the magnification and illumination provided by the dental operating microscope, the use of ultrasound devices and the prebending of the endodontic files to access the lingual canal, in particular. All these treatment issues are demonstrated by the clinical cases reported in this article.

Clinical Case 1

A 47-year-old female patient was referred to our clinic for endodontic treatment of tooth 35, second left mandibular premolar. She reported that the tooth became painful shortly after the preparation for a fixed prosthetic restauration. Clinical examination revealed high sensitivity at cold test of tooth 35. Vertical percussion was negative. Periodontal probing was within normal limits. Periapical radiograph showed normal periradicular tissues around the tooth 35 (Figure 1a). Also, it reaveled the bifurcation in the middle third of the root canal, so we decided to scan the tooth. CBCT showed a C-shaped configuration with 3 root canals (Figure 1b,c). As the diagnosis was irreversible pulpitis, we decided to perform endodontic treatment. After local anesthesia, we isolated the tooth with the rubber-dam and created an access cavity under the microscope. With the diamond coated ultrasonic tips we were able to expose all three root canal orifices. With prebended #10 Kerr-File (Mani, Japan), we reached the apex and established the working length. The working length was determined using Root ZX electronic apex locator (J Morita, Kyoto, Japan). Afterwards, we performed the shaping with ProTaper Next system (Dentsply) in the presence of 5.25% sodium hypochlorite. We also used EDTA 17%. The irrigants were sonically activated with Endoactivator (Dentsply). We dried the canals with sterile paper points and then we filled them with resin based AhPlus sealer (Dentsply) and gutta-percha cones and warm vertical compaction of gutta-percha with B&L Biotech (Figure 1d). the final radiograph shows the conservative access cavity and preservation of the dentinal walls for a better resistance of the tooth to occlusal loads, especially as this tooth is also a mesial abutment for a fixed restauration. We advised the patient to return for the follow-up.

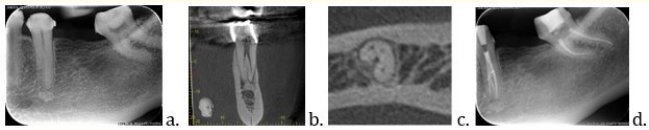

Figure 1: a. preoperative radiograph b. preoperative CBCT coronal section c. preoperative CBCT axial section d. postoperative radiograph.

Clinical Case 2

A 57-year-old male patient was referred to our clinic for retreatment of tooth 34, first left mandibular premolar. His dentist told us that he endodontically treated this tooth 6 years ago and send us the initial radiograph (figure 2a) and the one taken 6

years later (figure 2b), when the patient returned for treatment of a buccal abscess in relation to this tooth. The first radiograph showed large coronal caries, but no peripical lesion. Also, the root canal aspect was not suggestive of a multiple canal configuration. The last X-ray showed tooth 34 prosthetically restored with crown and cast post, with a homogeneous canal filling and extended to the radiological apex. Apically the tooth shows a periapical lesion, which did not exist 6 years ago, when primary endodontic treatment was performed. This periapical lesion could be seen when the patient came back for the abcess and his dentist took a radiograph. His dentist removed the crown and the cast post, drained the abcess, recommended a CBCT scan and sent the patient to us. We examined the patient and the tooth was no longer painful and there was no swelling around the tooth. CBCT scan revealed a C-shaped configuration (figure 2c) of this first mandibular premolar, with a missed lingual canal, barely visible on the coronal section (figure 2d). We followed the same clinical protocol as in the first case; we retreated the buccal canal, we removed the previous filling and searched for the lingual canal and then filled both canals with the same obturation technique (figure 2e). 1 year later, the patient returned for the follow-up. The tooth was completely asymptomatic and the radiograph showed the healed periapical bone (figure 2f).

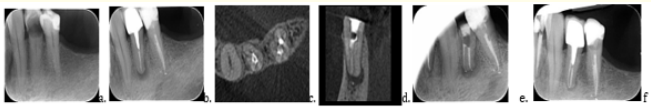

Figure 2: a. first preoperative radiograph b. second preoperative radiograph, 6 years later c. preoperative CBCT, axial section d. preoperative CBCT, coronal section e. postoperative radiograph f. 1 year-follow-up radiograph.

Discussion

The internal endodontic anatomy of the mandibular premolars was analyzed over the years by various methods: radiographs, staining and clearing, sectioning, CBCT, and micro-CT [13].

Although micro-CT has a much higher resolution than other imaging methods, from a clinical point of view, CBCT is the one that can be used at any stage of treatment, preoperatively, intraoperatively and postoperatively. It is clearly superior to periapical radiographs, allows a more precise determination of the anatomy of the root canal system, by its three-dimensional rendering, is non-invasive and can be used both *in vivo* and *in vitro*.

In the case of mandibular premolars having more than one canal, when there are two canals, they are located buccally and lingually. On the off-centric radiograph, depending on the placement of the radiation cone, they will appear mesially and distally, but the canals are never located mesially and distally, except in the situation when the tooth is rotated 90°. When there are 3 canals, they are located similar to a maxillary molar, disto-buccal, mesio-buccal and lingual.

The preoperative radiograph may expose several important aspects for the multiple-canal configuration. The most obvious is the radiolucency of the root canal well represented coronally, most of the time having the appearance of a wide canal, but which at various distances towards the apex, suddenly disappears, on the radiograph there is the typical radiopacity of a calcified canal [14].

Taking into account that the determining factors for pulpal calcification act most of the time coronally, either through caries, acute or chronic occlusal trauma or periodontal diseases, this aspect should be immediately correlated with an endodontic configuration of a canal that bifurcates and opens through at least two apical foramina.

Off-centric radiographs may also show the bifurcated appearance of the root, with two radiographic apexes, which may not be present on a centric radiograph, due to their superimposition.

Of course the best anatomical diagnostic tool is CBCT. By exposing the three planes, this particular anatomy is clearly highlighted [15-18].

Horizontal and coronal sections are useful for this purpose. Axial section may even reveal C-shaped configurations of these premolars. Coronal sections are extremely useful for establishing the level of bifurcation, and equally importantly, the angle of emergence. The latter is a crucial factor to assess preoperatively not only for identifying the canal orifices, but also for establishing an efficient treatment plan for negotiating the entire canal, avoiding the formation of ledges and consequently, the inability to access the entire root canal.

A common scenario for these teeth when they have two canals, buccal and lingual, is the lingual canal which is omitted when the primary treatment is performed. As a result, apical pathology appears after a while and these teeth end up in the situation of being retreated [19,20].

Although the maxillary molars show the highest frequency of missed canals, the mandibular premolars having 8% omitted canals, however in teeth with missed canals, the most periapical lesions were observed in the first premolars of both jaws [21-24].

Establishing the cause of apical periodontitis is sometimes difficult at this stage only on a periapical radiograph, since the aspects mentioned above are no longer evident. However, off-centric incidences may indicate either a second apex or the off-root appearance of the existing root canal filling. Occasionally, obturation material is visible at the entrance to the missed channel. Another hint for the missed canal, would be that sometimes the periapical lesion is not centered on the radiological apex, but slightly off-centric, towards the missed canal.

All stages of endodontic treatment must be carried out using the dental operating microscope, from identification of canal orifices, to mechanical treatment, endodontic irrigation and root canal filling.

The use of ultrasound is of paramount importance [1], as it creates progressive, non-invasive, targeted access to even significant depths in the canal and allows the work under the microscope, with the operator having visibility beyond the ultrasound tip. We can thus perform minimally invasive endodontic treatments in these complex situations as well, preventing vertical root fractures.

Conclusions

Knowledge of endodontic anatomy and its variations is one of the keys to successful endodontic treatment. Missed canals are one of the reasons why endodontic treatment fails and endodontic retreatment is needed.

The high frequency of multiple canals in mandibular premolars should always raise suspicion when such a tooth is to be treated endodontically, as periapical radiograph does not always provide this information, even indirectly.

The endodontic clinical approach to this anatomy often involves the use of dental operating microscope and ultrasound on the one hand, and experience and skill on the other.

Endodontic treatment of these complex tooth configurations is difficult, challenging, because the internal space is narrow, and the access is sometimes difficult from the buccal or lingual, depending on the tooth axis and the patient's mouth opening.

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