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Maxillary Second Molar: An Unconventional C-shaped Canal Configuration - A Case Report

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ABSTRACT: Understanding the plethora of potential canal configurations is crucial for successful endodontic treatment, as it allows for optimal preparation of the canals by accounting for any deviations from the norm. This case highlights the rare occurrence of a C-shaped canal configuration found in a maxillary second molar, with a reported occurrence rate of only 3.8%. Although C-shaped canals are more commonly reported in mandibular second molars, recent literature has also observed such canal configurations in other teeth, including maxillary first molars, maxillary premolars, and mandibular premolars. The dental profession often faces a formidable task when dealing with the complex nature of C-shaped canal configurations during endodontic therapy; however, by anticipating and proactively managing these intricacies, dentists can avoid causing irreversible harm to the tooth.

KEYWORDS: C-shaped canal, maxillary second molar, root canal treatment

INTRODUCTION

Achieving successful endodontic therapy hinges on a multitude of factors; however, one aspect that stands out as crucial in any root canal treatment is the fastidiousness in canal preparation. The meticulous process of preparing the canal not only plays a vital role in attaining optimal control but also ensures the comprehensive elimination of root canal contents, making it indispensable for thorough debridement and infection eradication [1]. It is essential to have a comprehensive knowledge of the complex aspects of internal root structure in order to effectively plan and carry out successful endodontic procedures. The possibility of encountering different anatomical irregularities within the root canal system can potentially impact the effectiveness of root canal therapy [2].

In 1979, Cooke and Cox were the first to document the C-shaped configuration of the root canal, which is considered one of the most significant anatomical variations of the canal [3]. The discovery of C-shaped canals in the maxillary second molar is a remarkably rare find, with only a handful of scholars having documented it thus far. A breathtaking situation arises when, during the examination of the pulp chamber, a maxillary second molar reveals its enigmatic and astonishing C-shaped canal system. Although conventional radiographs do not provide meaningful insights, the clinician's knowledge of this unique canal configuration can lead to a knowledgeable suspicion when evaluating the preoperative radiographs.

There are two distinct variations of C-shaped canals: one manifests as a solitary ribbon-shaped canal stretching from the orifice to the apex, while the other reveals the possibility of multiple canals lurking beneath the C-shaped orifice [4]. It remains unclear whether an orifice in a C-shape, located on the pulp chamber floor, extends to the apical third of the root. Areas within a C-shaped canal that are irregularly shaped and could contain remnants of soft tissue or infected debris may not be completely cleaned or filled, potentially causing bleeding and intense pain [5]. Selecting the appropriate obturation system is crucial because of the existence of canal irregularities. Numerous authors have endorsed thermo-plasticized systems for their ability to effectively fill canal irregularities. The report showcases Melton category II root canal configuration in permanent maxillary second molar teeth, using a cold lateral obturation system.

CASE REPORT

A 25-year-old individual began feeling discomfort in the upper right posterior region of their jaw, accompanied by heightened and persistent sensitivity to cold, which started a few days ago. During the clinical examination, it was discovered that the patient had occlusal caries in the right second molar of the upper jaw, which extended to the pulp. The tooth exhibited significant tenderness when subjected to percussion. Furthermore, both hot and cold thermal tests, as well as electric pulp testing using the Parkel

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Electronics Division equipment from Farmingdale, NY, elicited positive responses from the patient. During the radiographic examination, it was revealed that the tooth in question had caries that extended to the pulp, indicating pulp involvement.

Through meticulous clinical scrutiny and detailed radiographic analysis, the medical experts confirmed the patient's affliction with symptomatic irreversible pulpitis, which was further compounded by the presence of apical periodontitis. consequently, the prescribed plan of action involved nonsurgical endodontic intervention. Upon careful examination, it became evident that the tooth exhibited a solitary root with a canal arrangement indicative of Weine Type II, hinting at the existence of a dual canal. After the successful application of local anesthesia, the initial phase entailed the removal of the decayed portion of the tooth. Subsequently, the entire pulp chamber was gently exposed, and the process of biomechanical preparation was commenced. During the meticulous examination, an intriguing and unique C-shaped arrangement was noted within the pulp chamber, spanning from the buccal aspect to the palatal region. The remarkable consistency of this anatomical structure was additionally discernible through the utilization of a DG 16 explorer. The biomechanical preparation of the tooth began with the insertion of an ISO#10 file to ascertain the patency of the canal. Notably, the first file utilized in the mesiobuccal canal was also #10, further supporting the suspicion of the presence of two canals as suggested by the radiographic image capturing the root canal anatomy. The subsequent step involved the insertion of a #10 file into the palatal canal. To verify the tooth's anatomy and determine the working length, an X-ray image was captured (Figure 2). A more detailed examination of the pulp chamber unveiled the presence of a C-shaped canal orifice (Figure 3). The process of achieving optimal bio-mechanical preparation was accomplished by employing a sequential technique, utilizing nickel-titanium ProTaper S1, SX shaping rotary files, and concluding with the F2 finishing file from Dentsply Maillefer in Ballaigues, Switzerland. To comprehensive preparation of all canal walls, the dental professional skillfully employed circular brushing motions. Following the meticulous cleaning, the root canals were thoroughly irrigated using a combination of 3% sodium hypochlorite and normal saline solutions. Carefully placing a calcium hydroxide intracanal medicament within the canals, the dental team ensured optimal treatment. Subsequently, to facilitate healing and protection, a temporary filling material was employed, with the additional placement of a dry cotton pellet within the pulp chamber. To mitigate any potential post-operative discomfort, occlusal reduction was performed. Finally, the patient's follow-up appointment was scheduled for one week in the future, to monitor progress and make any necessary adjustments.

After the lapse of a week, the tooth was revisited for further treatment. Once again, the intricate canal system underwent thorough irrigation and meticulous drying. To ensure comprehensive coverage of the root canal walls, a lentulo-spiral was deftly employed in a counterclockwise motion to apply a layer of root canal sealer. Employing a lateral condensation technique with the aid of spreaders, the endodontic system was effectively obturated (Figure 4). Safeguarding against potential microleakage and the risk of tooth fracture, the access cavity was meticulously sealed with a restoration (Figure 5,6).

DISCUSSION

The primary hypothesis suggests that the inability of Hertwig's epithelial root sheath to merge on either the lingual or buccal root exterior played a pivotal role in the development of a distinctive C-shaped root structure that consistently harbors a C-shaped canal [6]. Additionally, the formation of a C-shaped root might occur due to the gradual accumulation of cementum, leading to the fusion of individual canals. A notable anatomical characteristic of C-shaped canals is the presence of a connecting fin or web that unites the separate root canals. Typically, roots housing a C-shaped canal exhibit a conical or square morphology, further distinguishing them from other root configurations. Teeth containing C-shaped canals often display pulp chambers that are elongated in the occluso-apical direction, with an additional bifurcation located more apically. Previous literature reports have consistently identified the presence of C-shaped canals exclusively in teeth with two roots. However, detecting C-shaped canals on radiographs proves to be challenging, and their existence is typically confirmed only during the process of access-cavity preparation [7].

Various approaches have been proposed to gain a comprehensive understanding of the intricate C-shaped canal system, with Manning pioneering classification in 1990, which was further refined by Melton in 1991 [8,9]. Melton's classification of the C-shaped root canal configuration is based on analyzing the cross-sectional shape of the root canal:

Category I: Continuous C-shaped canal running from the pulp chamber to the apex defines a C-shaped outline without any separation.

Category II: The semicolon-shaped orifice in which dentine separates a main C-shaped canal from one mesial distinct canal.

Fan et al. revised Melton’s classification into the following types [10]:

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- Category I (C1): It looks like an interrupted “C”.
- Category II (C2): The canal shape was like a semicolon resulting from a break in the continuity of the “C” outline.
- Category III (C3): Two or three separate canals (highest incidence).
- Category IV (C4): Only one round or oval canal in that cross-section.
- Category V (C5): No canal lumen could be observed (which is usually seen near the apex only).

The occurrence rate of the C-shaped canal in the maxillary second molar stands at 3.8% globally, while for the maxillary first molar, the prevalence is estimated at 1.1% [11]. One prevailing hypothesis regarding the origin of the C-shaped canal suggests that Hertwig's epithelial root sheath fails to fuse on either the lingual or buccal surface of the root, resulting in the formation of a C-shaped root structure that typically encompasses a C-shaped canal. An alternative theory proposes that the C-shaped root may arise through the merging of cementum deposits [12]. Navigating the challenges of diagnosis, biomechanical preparation, debridement, and obturation in C-shaped canals can be highly complex; however, by possessing a thorough understanding of various root canal configurations and employing appropriate clinical expertise, one can effectively attain the desired outcome.

CONCLUSION

In order to achieve a favorable long-term prognosis, it is crucial to have a precise diagnosis, extensive understanding of atypical root canal anatomy, and meticulous chemo-mechanical preparation, accompanied by three-dimensional obturation, for successful endodontic management of C-shaped canals..

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Images:

Figure 1

Figure 2

Figure 3

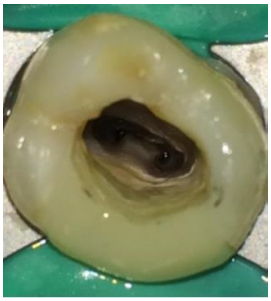

Figure 4

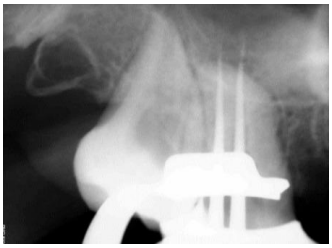

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Figure 5

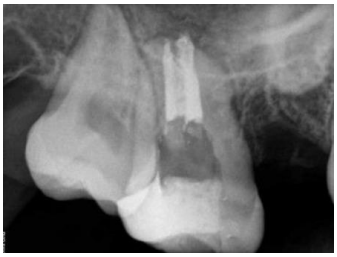

Figure 6