■ *Case Report*

C-shaped canal, an endodontic challenge

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Abstract

Recognition of unusual variations in the canal configuration is critical because it has been established that the root with a single tapering canal and apical foramen is the exception rather than the rule. C-shaped canals are anatomic features that present the clinician with both diagnostic and operational challenges. The early recognition of these configurations facilitates cleaning, shaping, and obturation of the root canal system. "C" configuration, which is an important anatomic variation, presents a thin fin connecting the root canals.The C-shaped root canal system is an anatomical variant of the root canal structure in which a continuous slit or web connects individual root canals. These C-shaped canals present a challenge to the clinician, both at the diagnostic and treatment level.

Keywords: C-shaped canal, mandibular second molar

Introduction

The failure of Hertwig's epithelial root sheath to fuse onto the buccal or lingual root surface may be the main cause of the C-shaped root formation. The prevalence of C-shaped canal systems has been reported to range from 2.7% to 44.5% in mandibular second molars, depending on the population.[1] The main anatomic feature of C-shaped canals is the presence of a finor web connecting the individual canals. The coronal orifice of these canals is usuallylocated apically to the cementoenamel junction level and may appear as a single,ribbon-shaped opening with a 180° arc linking all the main canals ora ribbon-shaped canal that includes the mesiobuccal and distal canals.[2]

On traditionalperiapical radiographic films, the recognition ofC-shaped canals is challenging because of the twodimensionalnature of the images produced, inevitablegeometric distortion and anatomical noise.[3] Manning (1990) speculated that the failure ofthe Hertwig's epithelial root sheath to fuse on thelingual or buccal root surface was the main cause of a C-shaped root, which always contains a C-shapedcanal.The C-shaped canal is most frequently found in themandibular second molar. It is a significant ethnic variation that has a high prevalence in Asians. Melton et al. (1991) firstproposed the classification of C-shaped canals basedon their cross-sectional shape.[4] There are many variations in the anatomical configurationsalong the length of the canal system in these types of teeth. The C-shapedcanal system might appear completely normal-looking at the level of the pulp chamberbut the apical anatomy can be extremely complex.[5]

The prevalence of C-shaped canals is estimated to bebetween 2.7% and 9.0% in Whites, but is as high as31.5% among Asian populations such as the Chineseand Japanese.In the Korean population, 32.7% ofsecond mandibular molars have been reported to have aC-shaped canal.[6]Cooke and Cox first described the clinical significance of C-shaped canals,which present major challenges with respect to their debridement and obturation. This is especially true when it is uncertain whether a C-shaped orifice found on the floor of the pulp chamber may continue to the apical third of the root. Irregular areas in a C-shaped canal that may house soft-tissue remnants or infected debris may escape thorough cleaning or filling and may be a source of bleeding and severe pain.[7]

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Case report

A 36-year-old woman presented with history of spontaneous pain on the left side of her face for past several days. The patient's medical history was noncontributory. Clinically, the left mandibular second molar had a deep carious lesion. Electric pulp testing (Vitality Scanner; Analytic Technology, Glendora, CA) was indicative of irreversible pulp damage. After extensive clinical and radiographic examination, the left mandibular second molar was prepared for nonsurgical endodontic therapy. A preoperativeradiograph was obtained (Fig.1). The patient received local anesthesia of 2% lidocaine with 1:100,000 epinephrine. A rubber dam was placed, and a conventional endodontic access opening was made (Fig.2). Clinical evaluation of the internal anatomy revealed a continuous canal orifice extending from the distal aspect to mesiobuccal aspect.It was evident that in the present case, the canal system of the tooth assumed a C-shaped anatomy.

Fig. 1

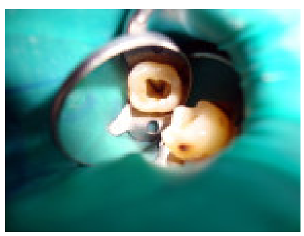

Fig. 2

At the next visit, the working length of the canal was estimated by means of an electronic apex locator (Root ZX; Morita, Tokyo, Japan), then confirmed by a radiograph (Fig.3). The canals were initially instrumented with #15 nickel titanium files (DentsplyMaillefer) under irrigation with 5% sodium hypochlorite. Coronal flaring was carried out using Gates-Glidden burs (nos. 3 and 2; DentsplyMaillefer). The canal was cleaned and prepared by hand nickel titanium files using a crown-down technique similar to that described by Saunders and Saunders. One week later, the C-shaped canal wasobturated with Pro-Taper gutta-percha points. A final radiograph was taken to establish the quality of the obturation (Fig.4). After completion of root canal treatment, the tooth was restored with a posterior composite filling (P60; 3M Dental Products, St. Paul, MN).

Fig. 3

Fig. 4

Discussion

This case report highlights the unusual anatomy of a mandibular second molar with C-shaped canal configuration. Usually, mandibular first and second molars have similar canal morphology with 2 roots with 3 or 4 root canals. Anomalous canal morphology variations can be found in any tooth, and the mandibular second molar is no exception. In the present case, the access cavity morphology and the instrument radiograph suggested a C-shaped canal configuration.

Instrumentation of the C-shaped canals was performedwith the ProTaper system and the hand instruments used with the balanced forced technique. The use of a 0.25 mm or smaller diameter instrument could have left many areas without instrumentation. Cheung et al. (2007) stated that shortest and longest diameter of the apical constriction of mesial canals in C-shaped molars were found to be 0.15–0.26 mm and 0.22 and 0.36 mm for the distal canal. If it is assumed that C-shaped canals present one or more isthmuses in the apical third, the use of smaller diameters such as 0.25 or 0.30 can make the cleaning, shaping and filling of these root canals difficult.[8]Despite the fact that radiographs provide two-dimensional images, information gleaned from them may be beneficial in determining the nature of the root canal anatomy when a C-shaped configuration is suspected. Fan et al. (2004) concluded that the transverse anatomy of a C-shaped canal system in mandibular second molar teeth might be predicted according to the radiographic appearance.New methods such as microscopy or endoscopy could be used to determine not only the existence but also the configuration of the entire C-shaped canal system in mandibular second molars. In order to establish the straight-line access and increase the illumination in root canals, the access should be extended in buccolingual directions.[9]Incomplete separation or fusion of the roots invariably occurs at the buccal aspect of teeth with a C-shaped root canal system. The canal wall facing the furca (concave aspect in cross section) is generally thinner than the outer wall, except at the apical constriction and at 1-mm level where the canal lumen appears to be centrally located. It has generally been reported that the C-shaped canal is not situated in the geometric center of the cross section of the root and that the canal wall of the mesial canals is the thinnest.[10] Identifying the potential complexity of the canal anatomy is a major prerequisite for successful canal treatment. The anatomy of C-shaped canal system in mandibular second molars is very difficult to identify not only because of its complicated morphology but also becauseof the impact of image superimposition of the hard tissues surroundingit. Recent research used a spiral computed tomography scan to diagnose the canal anatomy, but the dissolution of the image is not yet high enough to show irregular or fine canal structures, and the exposure to the relatively high dosage of x-ray radiation is also another concern.[11] Nevertheless, a keen sense of clinical acumen may go a long way in providing the correct identification and thereby instituting a better treatment.

Conclusion

It is very important for a clinician to understand the various possible canal morphologies and not stick to only a limited and standard number of canal patterns. Certain canals may not undergo detection. These undetected extra roots or root canals are a major reason forfailure. Therefore, the ability to locate all the canals in theroot canal system is an important factor in determining the eventual success of a case.

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