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Case Report

Unravelling the unseen 'C' with the cone-beam computed tomography: a rare case report

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ABSTRACT

Recognition of aberrant root canal configurations is critical to successfully negotiate and treat a canal and one of such aberrancies is a C shape root canal system. The fins and webs present in a C shape canal system presents a challenge to debridement and obturation. Knowledge of variations through advanced imaging modalities like CBCT, rotary and hand instruments assisted with ultrasonics and modified obturation techniques aid in effective management of C shaped root canals. This case report presents a successful endodontic management of a rare c shape canal configuration in a mandibular second premolar with the aid of the cone-beam computed tomography (CBCT) scanning imaging technique.

Keywords: C3, Mandibular second premolar, Rare, Microscope, CBCT, Ultrasonics

INTRODUCTION

Every clinician aims to achieve the best treatment outcome of endodontically treated cases. To attain the best results, one must diagnose the condition well. Therefore, a complete knowledge of root canal anatomy and its variation in morphology is important in clinical practice to reach the desired treatment goal, failure of which will adversely affect the prognosis of the tooth.

Adequate disinfection of the root canal system is one of the most important components of the endodontic triad. Outcome studies have documented several factors such as persistent bacterial infection, inadequate root filling, missed canals, improper coronal seal/restoration, and procedural errors as variables with possible associations with the persistence of apical periodontitis.[1]

An untreated canal in an endodontically treated tooth could be a result of an operator's limited knowledge of tooth anatomy, complexities in canal configuration such as apical deltas, presence of lateral and accessory canals, C shape canals, or procedural errors. Missed canals may serve to harbour a reservoir of microorganisms, which is one of the leading causes of persistent apical periodontitis and may have an impact on the treatment outcome.

Amongst these complexities, the C shape canal provides a clinical challenge to endodontic procedures because of its complex and unpredictable anatomy especially the shape which might differ along the entire length of the canal in the same tooth.[2] The high percentage of canal irregularities such as wide fins and small surface area of these canals preclude complete debridement using traditional hand instrumentation techniques, which can lead to failure of root canal therapy.[3] Therefore, careful location and negotiation of the canals and meticulous mechanical and chemical debridement of the pulp tissue should be carried out in order to successfully treat a C shaped canal.

CBCT is considered one of the most significant advances in endodontics and is recommended by the American association of endodontics (AAE) and the American academy of oral and maxillofacial radiology (AAOMR) to be used in the endodontic management of teeth presenting dental anomalies to provide insight into the anatomic variations of the root/canal morphology.[4]

Thus, this case report presents a successful endodontic management of a rare c shape canal configuration in a mandibular second premolar with the aid of the CBCT scanning imaging technique.

CASE REPORT

A 35year old male patient reported to department of conservative dentistry and endodontics with chief complaint of pain in lower right back tooth from past 1 month. The patient did not have any history of systemic disease or traumatic injury and according to the American society of anesthesiologists (ASA) classification, he falls under class ASA I. The patient started experiencing pain and sensitivity to hot and cold one month back. The pain was sharp, severe, radiating towards the auricular region, aggravated on taking hot, cold and sweet food stuff and relieved on taking medication.

On clinical diagnostic testing the tooth was tender on percussion. On cold testing the tooth gave a delayed response, on heat and electric pulp testing the tooth gave an early response. On intraoral examination, the gingiva and soft tissues were apparently healthy. Clinical examination revealed deep distoproximal caries and a dislodged restoration wrt lower right second mandibular premolar (Figure 1). There was no swelling and sinus tract associated.

Figure 1: Preoperative clinical view.

Preoperative periapical radiograph (Figure 2) revealed a radiopaque restorative material with radiolucency beneath which was encroaching the pulp. Moreover, there was a bifurcation present at the junction of middle and apical third. A diffuse periapical radiolucency was also present along one of the bifurcated roots on the mesial aspect. A diagnosis of irreversible pulpitis with symptomatic apical periodontitis according to American association of endodontist, was made wrt right mandibular second premolar.[5]

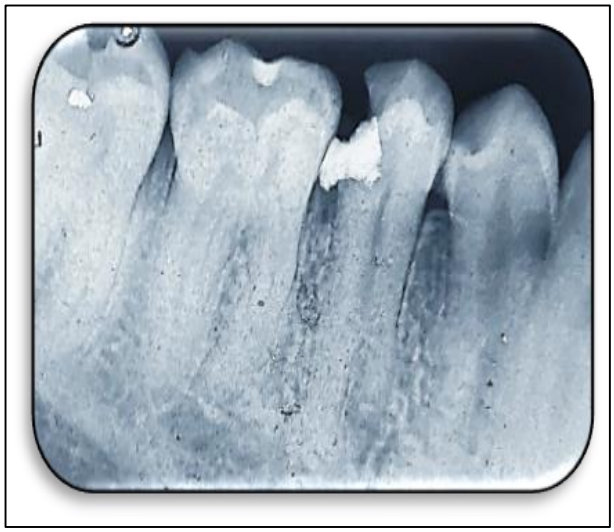

Figure 2: Preoperative radiograph.

The tooth was anesthetized with an inferior alveolar nerve block with a 1.8 mL solution of 2% lignocaine with 1:1,00,000 epinephrine and then isolated with a rubber dam. Access cavity preparation was initiated as an emergency relief to the patient under Labomed prima ENT/DNT surgical operating microscope under 14.2× (Kim et al) and two root canal orifices were located-buccal and lingual (Figure 3).

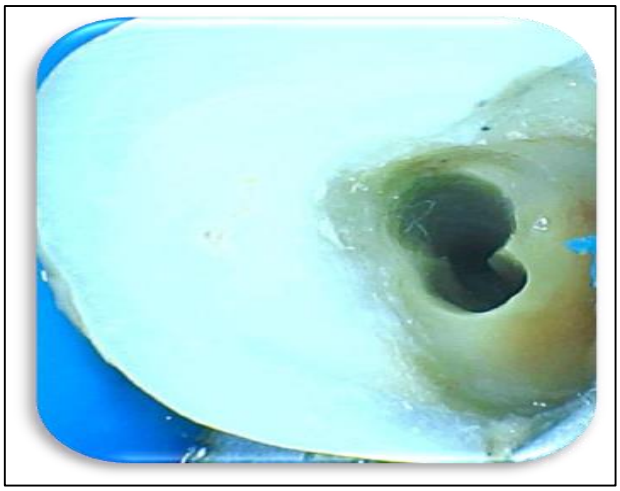

Figure 3: Access cavity under Labomed prima ENT /DNT surgical operating microscope.

After analysing a different morphological pattern on a periapical radiograph, a CBCT was planned to address

the complete anatomical configuration of the root canal system using a medium field of view (10×5 cm), at 0.075 mm voxel size at 60-90 kV and 4 Ma with exposure time of 12 sec using CS 9300 select. The coronal and sagittal slices confirmed the presence of two fused roots with one main canal that bifurcates at the middle third of the root to buccal and lingual canals.

Further evaluation of the axial slices revealed by Fan et al[14]-At the coronal one third (Figure 4) a complete uninterrupted C with no separation or division was present indicating a C1 configuration. At the middle one third (Figure 5), 2 canals were seen separated by root canal dentin. A mesially placed radicular groove was also observed in this section indicating a C3 configuration. And At the apical one third (Figure 6), 2 canals separated by root canal dentin were observed indicating a C3 configuration.

Figure 4: Axial view of CBCT: at coronal one third.

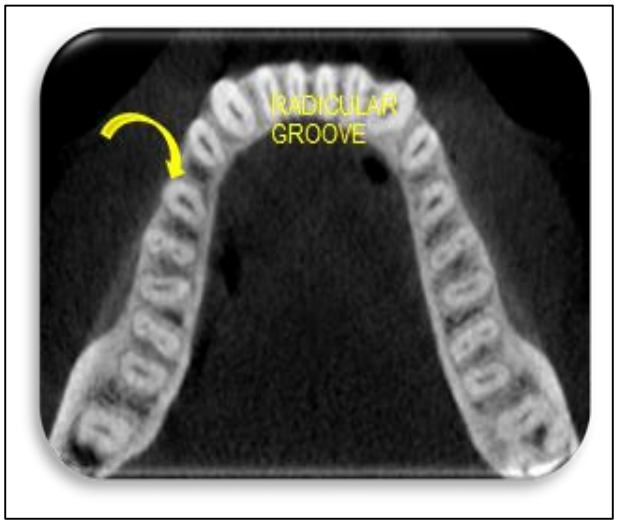

Figure 5: Axial view of CBCT: at middle one third.

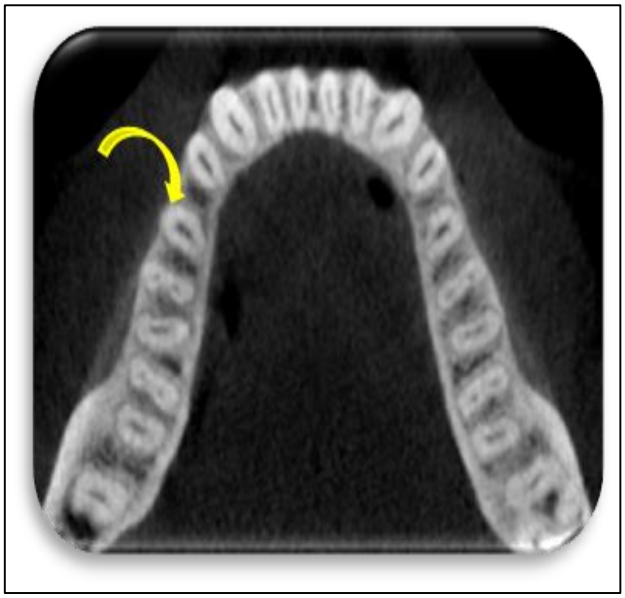

Figure 6: Axial view of CBCT at apical one third.

The working length was obtained with an electronic apex locator (Root ZX II J. Morita, Tokyo, Japan) and was confirmed radiographically (Figure 7).

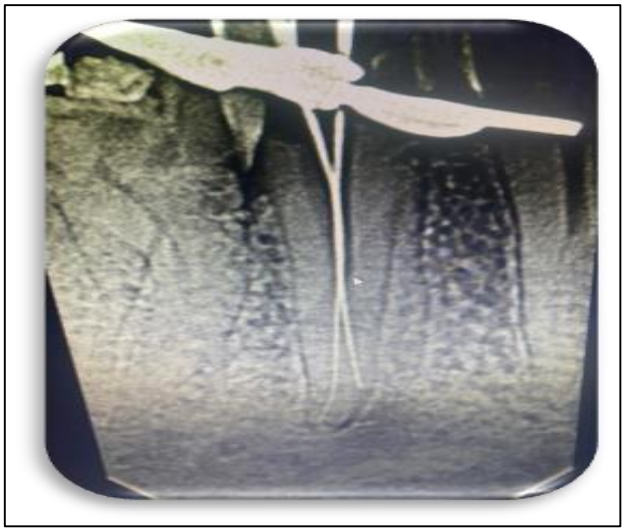

Figure 7: Working length radiograph.

The canals were cleaned and shaped manually using K-files up to size 20 to create a glide path and then finished with F2 Protaper gold file (Dentsply Maillefer, Ballaigues, Switzerland).

The canals were irrigated during the cleaning and shaping with 17% EDTA with 3 ml of saline for 1 minute followed by final irrigation protocol of 3 ml EDTA followed by saline for 1 min per canal and 3 ml of 5.25% sodium hypochlorite for 1 minute coupled with ultrasonic irrigation using Ultra X (Eighteeth, Orikam) for 30 seconds (Neelakantan 2019). The canals were dried with sterile paper points, then master gutta-percha cone radiograph was taken (Figure 8).

Figure 8: Master cone radiograph.

The canals were obturated with warm vertical condensation using AH-plus sealer (Dentsply Maillefer, Ballaigues, Switzerland).[6] The access cavity was sealed with composite core build-up material with a chamber retention and planned for a full-coverage crown (Figure 9).

Figure 9: Obturation, post obturation and full coverage crown.

DISCUSSION

Thinking of all the structures while treating a tooth and how important it is for us to see all of them, arises a query: can we see the "C"?

Also, central to the successful endodontics is the knowledge and appreciation of root canal anatomy and thorough and meticuluously performed cleaning and shaping procedure which would possibly affect the prognosis of the case.[7]

The current case report presented successful endodontic management of mandibular second premolar with a rare C shape canal configuration.

The Hertwig's epithelial root sheath (HERS) is responsible for the shape and number of roots that each tooth possesses. This HERS bends in horizontal plane below the cementoenamel junction and fuses in the centre leaving the opening for the roots.[8] The main cause for the formation of a C-shaped roots is the failure of the HERS to fuse on the lingual or buccal root surface. As said earlier, these canals contain a fin or web communication between the individual canals. It is found that C shaped roots can also be formed as a result of deposition of cementum with time. When fusion of either the buccal or lingual aspects of the mesial and distal roots occur, C shaped canals are formed. These canals remain irregular and the roots are connected by the means of inter-radicular ribbon.[9]

The C- shape canal configuration is just similar to an iceberg where 7/8 of its anatomy and shape lies below the surface of the water, the anatomy of the C-shaped root canal can display a wide range of variations over the length of the root.[2]

The presence of C-shaped root canal system is well documented in different studies with high prevalence of teeth in mandibular second molars -92.1-95.8%.[9] It is also identified in mandibular first premolars with a prevalence rate of 54.8-66.7% and mandibular first molar with a prevalence rate of 44% but it is a very rare entity which has been addressed in case of a mandibular second premolar with a prevalence rate of just 0.2-1% of the population.[10]

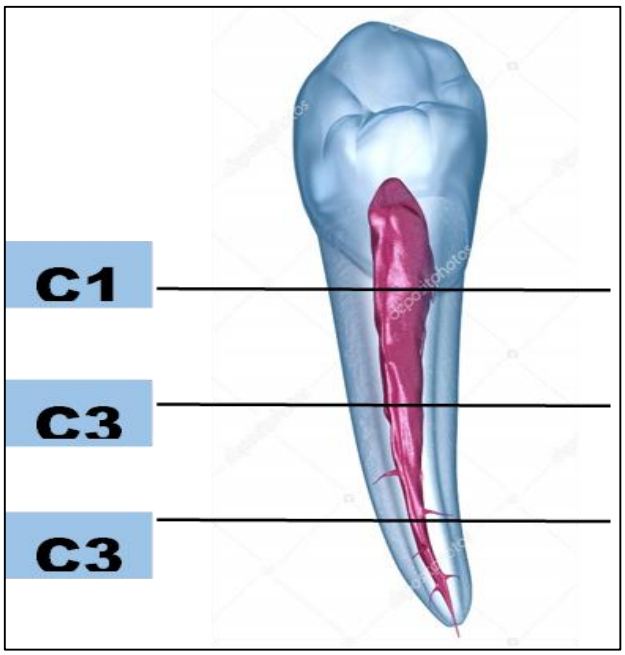

Figure 10: Different C canal configuration along entire length of the root canal.

According to joint American association of endodontists/ American academy of oral and maxillofacial radiology position statement on the use of CBCT in endodontics-2015/2016 update, limited FOV CBCT should be considered the imaging modality of choice for initial treatment of teeth with the potential for extra canals and suspected complex morphology, such as mandibular anterior teeth, and maxillary and mandibular premolars and molars, and dental anomalies.[4]

Therefore, after observing a different morphological pattern on a periapical radiograph, a CBCT was planned to address the complete anatomical configuration of the root canal system.

The saggital, coronal and axial CBCT images showed a bizarre anatomy of the fused roots that had a deep radicular groove located mesiolingually that divided the main canal, forming a c shape which a characteristic feature of this configuration.

The CBCT images also revealed a C1 configuration in the coronal one third and a C3 configuration in middle and apical one third (Figure 10) according to Fan et al.[12]

The anatomical characterization of a C shape canal in premolars is a presence of a radicular groove that extended from 3 mm below the cementoenamel junction to the root apex. These grooves may pose significant clinical concerns: (1) during root canal enlarging and shaping procedures, due to the thinness of the root wall adjacent to the groove; (2) during tooth restoration if the placement of a post is anticipated; (3) as the groove may predispose to the accumulation of dental plaque and calculus, creating a periodontal problem.[13]

However, when the groove was not identified, there was no C-shaped canal system in the tooth.[14]

The key problems encountered during cleaning and shaping C-shaped canals include difficulty in removing pulp tissue and necrotic debris, excessive hemorrhage, working length determination, and persistent discomfort during instrumentation. Because of the large volumetric capacity of the C-shaped canal system, housing transverse anastomoses, and irregularities, it becomes very cumbersome to adequately clean and debride the canal.

The necessity for deep-orifice preparation and careful probing with small files characterize the C-shaped category more accurately. In all categories, the canal spaces usually can be prepared normally. However, the isthmus should not be prepared with larger than no. 25 files; otherwise, strip perforation is likely.[15] Also, Gates-Glidden burs should not be used to prepare the isthmus areas. Due to a larger area of the pulp space, it is uncertain that intracanal instruments can thoroughly clean the pulp canal space in toto, which makes the irrigation procedures of more importance. Extravagant use of small files and 5.25% NaOCl is the key to thorough debridement of narrow canal isthmuses.[16]

Alternative canal cleaning techniques, such as those that use ultrasonics, would be more effective.[17] An increased volume of irrigant and ultrasonics may allow for more cleansibility in fan-shaped areas of the C-shaped canal.[18] Although ultrasonic preparation may effectively remove tissues from narrow C-shaped canal ramifications, aggressive instrumentation may cause perforation.[16]

Obturation of C-shaped canals may require a different approach from the traditionally used lateral compaction technique. The spaces can be prepared and obturated as standard canals. However, sealing the isthmus is difficult if lateral condensation is the only method used as this isthmus may not be prepared with a sufficient flare to permit deep placement of the spreader.

Warm vertical condensation is the method of choice for the three- dimensional obturation of the C-shaped canals. For the vertical condensation technique, the aim is to move the thermosoftened gutta-percha into narrow cross-sectional diameters of the preparation, creating a piston force on entrapped cement that produces significant sealer hydraulics.[19] The compaction of softened gutta-percha and sealer throughout a well-prepared root canal space should predictably move gutta-percha and sealer into root canal aberration.

But in C-shaped canals, conditions are different for two reasons. 1) The divergent areas are frequently unshaped and may offer resistance to the flow of obturating materials.[20] 2) Communications occur between the canals of the C-shape, through which the entrapped filling materials pass from one canal to another.

Consequently, the hydraulic forces will dramatically decrease, and this could seriously compromise the obturation quality. In this case, placing two master points and blocking canal entrance with a plugger increases the resistance toward the passage of obturating material from one canal to another. Then holding the smaller plugger in place while down packing the second canal offers a backpressure on entrapped filling materials and enhances the seal.

The use of dental operating microscope (DOM) will enhance visualization and improve the clinical performance of such challenging cases by the means of magnifications and appropriate lighting provided by the DOM. The effective use of DOM was reported by several authors in the endodontic management of complex anatomical variations.[21,22] In the present case, the DOM was used which enhanced the exploration of the floor of the pulp chamber and aid in locating and negotiating the C-shaped canal configuration orifices. Moreover, it facilitated the process of cleaning and shaping and filling the complex root canal system.

CONCLUSION

In the present case, successful nonsurgical endodontic treatment of a mandibular second premolar was performed supported by the use of CBCT imaging. The use of CBCT for comprehensive morphological analysis, illumination, and magnification for proper access preparation, pulpal floor inspection, and visualization aid during root canal system debridement and obturation is strongly emphasized for a successful treatment outcome.

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