

Endodontic management of C-shaped root canal configuration - Three case reports

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Abstract

The most common anatomical variation of the root canal system is the C-shaped root canal configuration and is commonly seen in mandibular second molars. The complex configuration of these canals is due to the high incidence of anastomoses along the root length which are challenging to negotiate, debride and seal the entire canal system adequately. Failure of early recognition and thorough debridement of the C-shaped canal anatomy can lead to failure of root canal therapy. The current case report presents endodontic management of three different clinical cases of mandibular second molars with C-shaped canal configuration using advanced irrigation and three dimensional obturation techniques. Therefore, thorough knowledge of this canal configuration is very much important to diagnose this complex anatomy and also in the further management like negotiation of canals, meticulous chemo- mechanical debridement and

three-dimensional filling of the entire root canal system which should be carried out in order to successfully treat a C-shaped canal.

Keywords: C-shape, canal configuration, anatomy, debridement.

Introduction

Knowledge of different possible alterations in the internal anatomy of teeth that require root canal treatment is essential for successful outcomes. One such anatomical variation of root canal system is the C-shaped root canal configuration which involves root fusion commonly seen in mandibular second molars with a prevalence ranging from 2.7% to 45.5% in different populations.(1)This variation was first reported on endodontic literature by Cooke and Cox in 1979 and named it for the cross-sectional morphology of root and root canal (2).

The most accepted theory for the formation of this C-shaped canal configuration results from the failure of Hertwig's epithelial sheath to fuse during the root embryonic stage. Failure to fuse on the buccal side results in a lingual groove and vice versa. Failure of sheath to fuse on both sides results in the formation of a conical root (3). The C-shaped canal configuration shows racial predilection. Higher incidence reported in countries belonging to the Asian continents like Chinese (0.6-41.27%) and Koreans (31.3%-45.5%) (4). The apical anatomy of C-shaped root canal systems in mandibular second molars is extremely complex with many anatomical variations and the root canals are connected by web with varying anatomy along the root length which makes thorough debridement and obturation an obstacle for the clinician(5). This case report discusses endodontic management of three clinical cases of C-shaped canal configuration in mandibular second molars.

Case report 1

A 42 year old female patient reported to the Department of Conservative dentistry and Endodontics, Government dental college, Thiruvananthapuram with a chief complaint of pain in lower right back tooth. Her medical history was non-contributory. Clinically, temporary filling was seen in tooth 47 and was tender on percussion. Cold test and electric pulp testing gave an exaggerated response and the pain persisted after removal of stimulus. Periodontal status was within normal limits. Radiographic examination of the tooth revealed a coronal restoration closely approximating the pulp horn and fusion of roots in the apical part without any periapical changes (fig 1a). A diagnosis of symptomatic irreversible pulpitis was made and root canal treatment was advised. Local anesthesia (2% lidocaine hydrochloride with 1:80,000 epinephrine) (Lignospan

Special, Septodont, Raigad, India) was administered, and rubber dam was placed. All procedures were performed under $\times 3.2$ magnification loupe (Admetec, Israel). Access opening was done using endo access bur #1 and endo- z tapered safe end bur. The floor of the pulp chamber showed a C-shaped outline without any separation (Melton's category type 1 canal anatomy) (fig 1b). Working Length was determined using electronic apex locator (Root ZX Mini, J Morita, Kyoto, Japan) which was then confirmed using radiographs (fig 1c). Canal was prepared using rotary nickel-titanium files (Neo Endo and Orikam Healthcare India Private Limited) up to 40/04 followed by circumferential filing the isthmus areas till 25/02 hand K-files (Mani, Japan) under copious irrigation with 5.25% sodium hypochlorite and normal saline. Ultrasonic activation of irrigant was done using Ultra X (Eighteenth, Sifary Medical Tech. Co. Ltd). Calcium hydroxide was placed as an intracanal medicament. In the next appointment, master cone radiograph was taken (fig 1d) and obturation was completed with thermoplasticized gutta percha using EQ-V obturation system (Meta Biomed, Europe) and AH Plus sealer (Dentsply, York, PA, USA) (fig 1e). Post endodontic restoration was done using composite resin (Tetric N Ceram, Ivoclar).



Fig 1a

Fig 1b

Fig 1c



Fig 1d

Fig 1e

Case Report 2

A 24-year-old male patient reported to the Department of Conservative Dentistry and Endodontics, Government Dental College, Thiruvananthapuram with a chief complaint of pain in relation to lower right back tooth with a history of intermittent throbbing pain at night for past 2 months which increased in intensity in the past 3 days. He had no relevant medical or allergy history. On clinical examination, tooth 47 had deep caries which was tender on percussion. The periodontal status was within normal limits. The tooth gave positive response to cold test and electric pulp test and the pain persisted after removing the stimulus. Radiographically, occlusal radiolucency was evident involving pulp with periapical radiolucency and widening of periodontal ligament. The radiograph also showed a single conical root with two radiolucent canal outlines joining at the apical third of the root indicating a C-shaped canal anatomy (fig 2a). A diagnosis of symptomatic irreversible pulpitis with symptomatic apical periodontitis was made and root canal treatment was planned and explained to the patient. After profound Local anaesthesia (2% lidocaine hydrochloride with 1:80,000 epinephrine) (Lignospan Special, Septodont, Raigad, India), a dental dam was placed. All procedures were performed under $\times 3.2$ magnification loupe (Admetec, Israel). Access opening was done using endo access bur #1 and endo- z tapered safe end bur. On examining the floor of pulp chamber using magnifying loupe, the chamber was deep with a C shaped orifice (fig 2b). On exploration of pulp chamber with K file ISO 10 (Mani, Tochigi, Japan), Melton's type 2 canal anatomy was found in which dentine separates a C-shaped canal from one mesial distinct canal. Working Length was determined using electronic apex locator (Root ZX Mini, J Morita, Kyoto, Japan) which was then confirmed using radiographs in which

the mesial canal was seen merged with the C shaped distal canal apically (fig 2c). The C shaped distal canal was first prepared followed by mesial canal. Biomechanical preparation of both canals were completed using rotary nickel-titanium files (neo Endo and Orikam Healthcare India Private Limited) up to 40/04 followed by circumferential filing the isthmus areas till 25/02 hand K-files (Mani, Japan) under abundant irrigation with 5.25% sodium hypochlorite and normal saline. Irrigant activation was done using PATS vario (Sonic Pro Agitator Tip System). Calcium hydroxide was placed as an intracanal medicament. After 1 week, master cone radiograph was taken (fig 2d) and obturation was completed with thermoplasticized gutta percha using EQ-V obturation system (Meta Biomed, Europe) and AH Plus sealer (Dentsply, York, PA, USA) (fig 2e). Canals were seen joining in the apical third in the post obturation radiograph. Post endodontic restoration was done using composite resin (Tetric N Ceram, Ivoclar).



Fig 2a

Fig 2b

Fig 2c



Fig 2d



Fig 2e

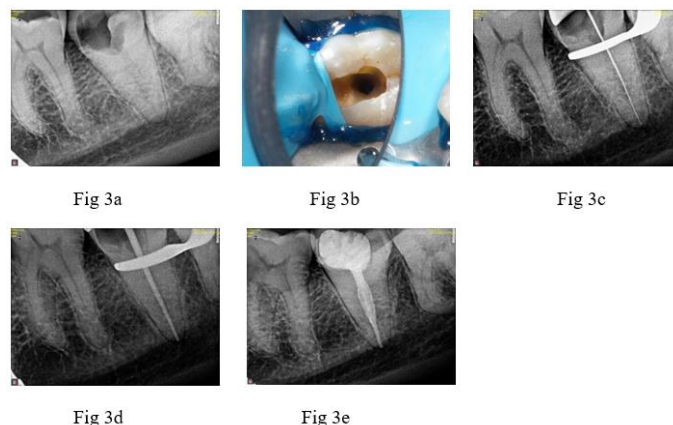
Case Report 3

A 39-year-old female patient reported to the Department of Conservative Dentistry and Endodontics, Government Dental College, Thiruvananthapuram with a chief complaint of pain in relation to lower left back tooth for

past 1 week with intermittent throbbing pain which disturbed her sleep. Her medical history was non-contributory. Clinical examination revealed that the tooth 37 had deep proximal caries which was tender on percussion. The periodontal status was within normal limits. The tooth elicited a negative response to cold test and electric pulp test. Radiographic examination revealed radiolucency involving dentin extending to pulp with periapical radiolucency and periodontal ligament widening. The radiograph also showed a single conical root with outline of single root canal (fig 3a). A diagnosis of symptomatic apical periodontitis was made and root canal treatment was advised.

Local anesthesia (2% lidocaine hydrochloride with 1:80,000 epinephrine) (Lignospan Special, Septodont, Raigad, India) was administered, and a dental dam was placed. All procedures were performed under $\times 3.2$ magnification loupe (Admetec, Israel). Access opening was done using endo access bur #1 and endo- z tapered safe end bur. A single round orifice located in the middle portion of the floor of the pulp chamber was seen (Fan's category 4) (fig 3b). Working Length was determined using electronic apex locator (Root ZX Mini, J Morita, Kyoto, Japan) which was then confirmed using radiographs (fig 3c). Cleaning and shaping was done using rotary nickel-titanium files (Neo Endo and Orikam Healthcare India Private Limited) up to 50/04 under abundant irrigation with 5.25% sodium hypochlorite and normal saline. Irrigant activation was done using Ultra X (Eighteenth, Sifary Medical Tech.Co.Ltd). Calcium hydroxide was placed as an intracanal medicament. After 1 week, mastercone radiograph was taken which confirmed the fit of the cone (fig 3d) and obturation was completed with thermoplasticized gutta percha using EQ-V obturation system (Meta Biomed, Europe) and AH Plus sealer (Dentsply, York, PA, USA) (fig 3e). Post

endodontic restoration was done using composite resin (Pal fique LX5, Tokuyama dental).



Discussion

Often variations from normal anatomy in the form of additional roots and root canals may be encountered. One of the most important anatomic variations is the “C” configuration of the canal system with presence of a fin or web connecting the individual root canals(6). This is a real challenge to the clinician as early recognition of these configurations facilitates cleaning, shaping and obturation of the entire root canal system.

Various classifications of C-shaped canals have been proposed to make the diagnosis and treatment planning easier. Fan et al analyzed the C-shaped canal system using micro-computed tomography and modified the Melton's classification of the C-shaped canal system. According to Melton et al, this type of canal system had to exhibit all of the following three features: (i) Fused roots, (ii) a longitudinal groove on the lingual or buccal surface of the root, and (iii) at least one cross-section of the canal belonging to the C1, C2, or C3 configuration (7). Clinical recognition of C-shaped canals is based on the definite observable criteria i.e., the anatomy of the floor of the pulp chamber and the persistence of hemorrhage or pain when separate canal orifices were found. The convergence of root canal instruments at the apex or being centered and appearance of furcation

perforation by instruments exiting the furcation were used as the criteria for identifying C-shaped canals.

In the first case, it is a true C-shaped canal running from the orifice to the apex and it was possible to pass files from the mesial to the distal aspect without obstruction (C1 configuration). While in the second case, we found a single conical root with C-shaped orifice in which dentine separates the mesial and distal canals and also the two canals merging at the apical third of the root (C2 configuration). In the third case, initial evaluation of the radiograph suggested the presence of single root with a wide centrally located canal space. After access preparation, only one canal with a round orifice was negotiated suggesting Fan et al C4 configuration.

In all of the three cases, there is clinical recognition and radiographic findings like appearance of orifice and the fusion of roots in the apical portion suggests the existence of a C-shaped root canal system. The C2 canal would be more likely to extend into the fused area of the root where the dentin wall may be quite thin making more difficult to clean and shape(8).

Treatment of the C-shaped canals should be accompanied by additional measures for identification and negotiation of canals, their chemo mechanical debridement and three-dimensional filling of the complex root canal anatomy. Use of diagnostic aids like Magnifying loupes, microscope and CBCT aids in better understanding the complex morphology of the canal system in the pulpal floor. Self - adjusting file system is found to be efficacious in cleaning and shaping C-shaped canals (9).Continuous circumferential ant curvature filing along the periphery of the C- shaped root canal along with copious irrigation with 5.25 % NaOCl allow for more cleans ability in the intricacies of the C-shaped canal. Irrigant should be activated using ultrasonics or sonics enhanced necrotic tissue removal. It

is challenging to obtain a three-dimensional obturation of the C-shaped canals due to its complex configuration. Thermoplasticised gutta-percha technique and warm vertical condensation was used for all the cases which is the recommended technique for canal irregularities.

C-shaped canal systems are challenging to debride and obturate because of the presence of high percentage of anatomoses. When sound principles of debridement, obturation and restoration are not followed, it will end up in endodontic failure(10).Therefore, clinicians should be thoroughly aware of the C-shaped root canal morphology and their possible variations enhances the chances of successful treatment. in order to improve the predictability of RCT.

Conclusion

This case report highlights the successful management of three different cases of C-shaped canal configuration using advanced irrigation and three dimensional obturation techniques. Knowing this anatomy of mandibular second molars with C-shaped canals and early recognition of these configurations allows one to better clean, shape, and obturate the root canal system.

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