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Clinical management of C-shaped canals in mandibular molars: A case series.

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Summary

The presence of C-shaped canals indicates a histological aberration, although it is not a clinical rarity. Its occurrence has been documented usually in mandibular molars, but its prevalence extends to mandibular premolars, maxillary molars and sometimes even to maxillary anterior teeth. Even when the occurrence of these C- configuration canals is to be expected, the clinical management of these canals poses unique challenges due to their aberrant anatomy. This case series focuses on the clinical techniques that may be adopted to successfully counter the difficulties that may be encountered during endodontic therapy of these C-configuration canals.

Keywords: *C-shaped root canal configuration, apical periodontitis, endodontic therapy, thermoplasticized obturation*

Introduction

The C-shaped canals are an anatomical distinction that are found commonly in second mandibular molars, although its' occurrence is seen in other mandibular posterior teeth and even in maxillary molars. The unique anatomical deviation found in C-shaped canals happens to be the existence of a fin-akin structure which connects separate canals, with the orifice appearing to be the shape of a ribbon with an arc of 180° communicating and connecting the two major canals[1].

The C-shape configuration is usually identified in teeth with roots' fusion occurring on the lingual or buccal side. In these scenarios, tooth's pulp chambers' floor is located quite deep, demonstrating a rather atypical anatomical occurrence.

The radicular structure in tooth with C-shaped canals harbour diverse anatomic variations, which may be of two kinds:

(1) An isolated, ribbon-akin, C-shape canal system extending from orifice until the apical region, and the other type being

(2) teeth presenting 3 or more recognizable canals found beneath the C- orifice[1].

Cooke and Cox first identified, described the importance of C- configuration canals occurring in clinical scenario, because it presents with unique difficulties with regard to their chemico-mechanical debridement and 3-D filling of these canals. That's usually the case if the clinician is divided whether the C-canal's orifice is present on the pulp chambers' floor or if it extends to the apical one- third of the radicular portion.

According to a study by Haddad, it was found that the radiographs of teeth with C-configuration canal system showed a few comparable features. These features include:
1.Fusion found in the radicular region or the proximity of these structures,
2. Mesial canal being narrow
3. Large distal canal,
4. Obscure evidence of a third canal being present[2].
Clinically, C-shape canals are recognized on the basis of a few definitive criteria (the unusual pulp chamber floor anatomy and haemorrhage or pain that persists after canal orifices have been identified). In teeth with C-configuration canals, the pulp chambers have a larger occluso-apical dimension with bifurcation being lower than usual. C- shaped canals may also be identified under operating microscope/loupes.
In recent years, Cone Beam Computed Tomography (CBCT) has been instrumental in unearthing the cross section, canal morphological features before initiating endodontic therapy to ensure its success[3].
Melton classified C-type canals with the cross-sectional shape being the preliminary basis. However, it does not clearly describe the variations that occur in categories II and III and their significance when put into clinical application. Furthermore, 3 arbitrary root levels have been used as landmarks, and there is a lack of information on how the canal shape changes from the cervical to apical region.
Melton's method modified by Fan is used in contemporary clinical practice. In addition, Fan's classification gave a description of the C-shaped roots as per their radiographic appearance. Four types of pulpal floors were discovered in second mandibular molars which possessed C-shaped canals. Gao gave a three-dimensional classification of C- shaped canal configurations[4].

Case Presentation

Case Report 1

A 23-year-old female patient reported with pain in the right mandibular posterior region for 3 months. She provided a history of pain during chewing in the same region for the past 1 month. Her medical history did not reveal any significant information. On Clinical examination a carious permanent mandibular right second molar (47) with tenderness on percussion was discovered. Intra-oral periapical radiographs revealed caries extending to the pulp with ill-defined periapical radiolucency evident. The clinical and radiographical findings along with history led to a diagnosis of symptomatic irreversible pulpitis with apical periodontitis of the right mandibular second molar. The treatment options were discussed with the patient, and she agreed to undergo endodontic therapy in the affected tooth.

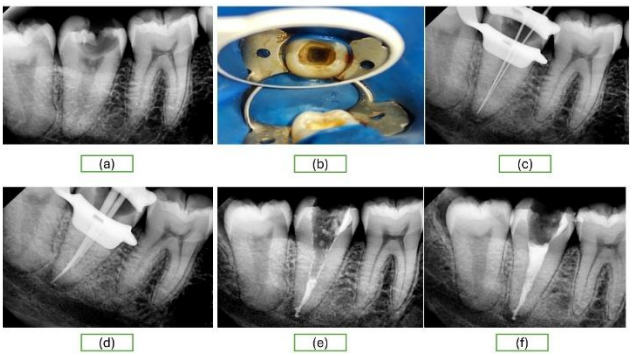

Figure 1: (a) pre-operative radiograph irt 47 for clinical case report 1. (b) Access cavity preparation performed in 47 revealing the presence of C_1 configuration C-type canal. (c) Working length estimation confirmed with radiograph irt 47. (d) Master cone radiograph taken irt 47 (e) Sectional obturation performed in the apical 5mm (f)Thermoplastic Obturation carried out to fill the aberrant morphology in 47.

2% Lignocaine with 1:100,000 adrenaline was used for anesthesia and isolation was achieved using rubber dam. Access cavity preparation was carried out with the help of round bur and carbide fissure burs with safe-end tips. The pulp chamber was flooded with 3% sodium hypochlorite to eliminate debris. Final troughing using burs with non-end safety cutting tips revealed it to be C_1 configuration, which was identified by DG-16 explorer. Patency was established with number 10 K-file. Working length was estimated using Canalpro CL2i apex locator (Coltene Whaledent, USA), along with radiographic verification and C-shaped canal's presence was confirmed. Cleaning

and shaping were carried out using standardized technique with Hyflex CM files (Coltene Whaledent, USA) according to manufacturers' instructions up to 25/.06 under abundant irrigation and ultrasonic activation (UltraX, Eighteeth, China) with 3% sodium hypochlorite Solution and 17% EDTA solution and 2% Chlorhexidine.The canals were then dried using paper points, optimal size master-cone was selected and verified with radiograph.

Obturation of the cleaned canals were done with gutta-percha and epoxy resin-based sealer (RC seal, Prime dental, India) in the apical 5mm. The rest of the canal space was obturated by means of thermoplasticized gutta percha technique. Post obturation radiograph was taken to confirm the full-length canal obturation. Follow up evaluation was done at time intervals of 3 and 6 months. The

Figure 2: (a) post-operative radiograph irt 47 for clinical case report 1 (b) Follow-up radiograph taken irt 47 after 6 months

patient remained asymptomatic, and healing of the periapical region was seen.

Case Report 2

A 23-year-old female patient reported with complaint of pain in the mandibular left posterior region for 3 months. She provided a history of pain during chewing in the same region for the past 1 month. Her medical history did not reveal any significant data. On Clinical examination a carious permanent mandibular left second molar (37) with tenderness on percussion was discovered. Intra-oral periapical radiographs revealed caries extending to the pulp with ill-defined periapical radiolucency evident. The clinical and radiographical findings along with history led to a diagnosis of symptomatic irreversible pulpitis with apical periodontitis of the left mandibular second molar. The treatment options were discussed with the patient, and she agreed to undergo endodontic therapy in the affected tooth.

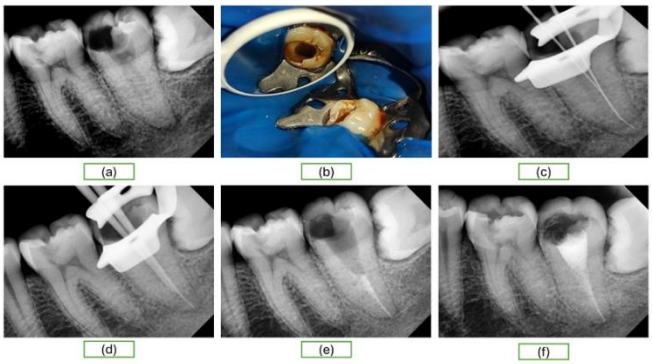

Figure 3: (a) pre-operative radiograph irt 37 for clinical case report 2 (b) Access cavity preparation performed in 37 revealing the evidence of C_1 configuration C-type canal. (c) Working length estimation confirmed with radiograph irt 37 (d) Master cone radiograph taken irt 37 (e) Sectional obturation performed in the apical 5mm (f) Thermoplastic obturation carried out to fill the aberrant morphology in 37

2% Lignocaine with 1:100,000 adrenaline was used for anesthesia and isolation was achieved using rubber dam. Access cavity preparation was carried out with the help of round bur and carbide fissure burs with safe-end tips. The pulp chamber was flooded with 3% sodium hypochlorite to eliminate debris. Final troughing using burs with non-end safety cutting tips revealed it to be C_1 configuration, which was identified by DG-16 explorer. Patency was established with number 10 K-file. Working length was estimated using Canalpro CL2i apex locator (Coltene Whaledent, USA), along with radiographic verification and C-shaped canal's presence was confirmed. Cleaning and shaping were carried out using standardized technique with Hyflex CM files (Coltene Whaledent, USA) according to manufacturers' instructions upto 25/.06 under abundant irrigation and ultrasonic activation (UltraX, Eighteeth, China) with 3% sodium hypochlorite Solution and 17% EDTA solution and 2% Chlorhexidine.

The canals were then dried using paper points, optimal size master-cone was selected and verified with radiograph. Obturation of the cleaned canals were done with gutta-percha and epoxy resin-based sealer (RC seal, Prime dental, India) in the apical 5mm. The rest of the canal space was obturated by means of thermoplasticized gutta percha technique. Post obturation radiograph was taken to confirm the full-length canal obturation. Follow up evaluation was done at time intervals of 3 and 6

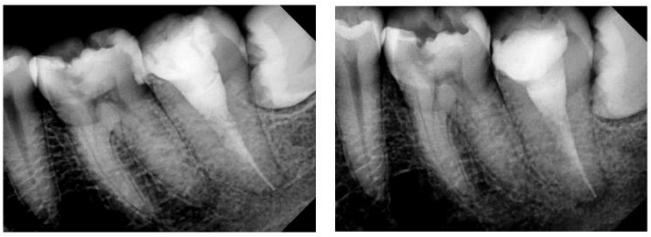

Figure 4: (a) post-operative radiograph irt 37 for clinical case report 2 (b)Follow-up radiograph taken after 6 months irt 37

months. The patient remained asymptomatic, and healing of the periapical region was seen.

Case Report 3

A 22-year-old female reported with complaint of pain in the mandibular left posterior region for 3 months. She provided a history of pain during chewing in the same region for the past 2 weeks. Her medical history was found to be non-contributory. Clinical examination revealed a restored permanent mandibular left first molar (37) with tenderness on percussion. Intra-oral periapical radiograph revealed the presence of restoration and secondary caries involving pulp, with ill-defined periapical radiolucency. The clinical findings, radiographical findings along with history led to a diagnosis of symptomatic irreversible pulpitis with apical periodontitis of the mandibular left second molar. The treatment options were discussed with the patient, and she agreed to undergo endodontic therapy in the affected tooth.

2% Lignocaine with 1:100,000 adrenaline was used for anesthesia and isolation was achieved using rubber dam. Access cavity preparation was carried out with the help of round bur and carbide fissure burs with safe-end tips. The pulp chamber was flooded with 3% sodium hypochlorite to eliminate debris. Final troughing using burs with non-end safety cutting tips revealed it to be C_2 configuration, which was identified by DG-16

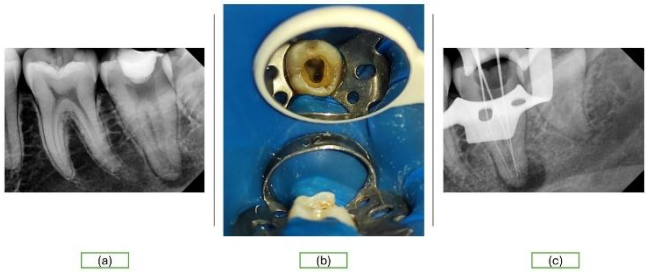

Figure 5: (a) pre-operative radiograph taken irt 37 for clinical case report 3 (b) Access cavity preparation performed in 37 revealing the evidence of C_2 configuration of C-type canal (c) Working length estimation confirmed with radiograph irt 37

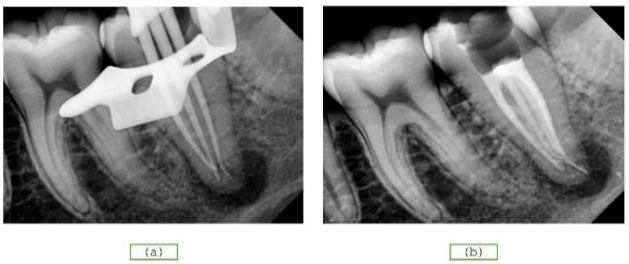

Figure 6: (a) Master cone radiograph taken irt 37 (b) Obturation done by lateral compaction technique in 37

Figure 7: (a) post-operative radiograph irt 37 for clinical case report 3 (b) Follow-up radiograph taken after 6 months

explorer. Patency was established with number 10 K-file. Working length was estimated using Canalpro CL2i apex locator (Coltene Whaledent, USA), along with radiographic verification and C-shaped canal's presence was confirmed. Cleaning and shaping were carried out using standardized technique with Hyflex CM files (Coltene

Whaledent, USA) according to manufacturers' instructions upto 25/.06 under abundant irrigation and ultrasonic activation (UltraX, Eighteeth, China) with 3% sodium hypochlorite Solution and 17% EDTA solution and 2% Chlorhexidine.
The canals were then dried using paper points, optimal size master-cone was selected and verified with radiograph. Obturation of the cleaned canals were done with gutta-percha and epoxy resin-based sealer (RC seal, Prime dental, India) by cold lateral condensation technique with the use of size 25, 20 accessory cones. Post obturation radiograph was taken to confirm the full-length canal obturation. Follow up evaluation was done at time intervals of 3 and 6 months. The patient remained asymptomatic, and healing of the periapical region was seen.

Discussion

The studies point out that it is not uncommon to come across the presence of C- configuration and its frequency of occurrence ranges between 2.7% to 8%. It is seldom found in white people; whilst it's observed that Asian population have a high relative prevalence Thereby it can be safely reported that the occurrence of C-type configuration shows an ethnic predilection.
This variation occurs not only in second mandibular molars, but may also be seen in other mandibular molars, premolars. Sometimes, their incidence has also been reported in maxillary incisors and molars. In around 70% of individuals, the C-type configuration is seen to be present bilaterally. This is demonstrated in first and second cases of this case series.
According to a systematic review and meta-analysis by JNR Martins, it was found that the C-shaped canals' prevalence was common in second mandibular molar (12%), followed by first mandibular molar (0.3%). It was commonly seen more in female population (20.5%), than the male counterpart (13.5%)[5].
Pre-operative radiographic interpretation along with supplementary radiographs taken with angulation of 20° distal/mesial projections are the only non-invasive methods that provide a few clues to the canal morphology. Pre-operative radiographic images may display fusion of the roots or two distinct roots. The aforementioned scenario especially occurs if the fin is thin relatively and thereby, is not seen on the radiograph, making identification of the C-shaped configuration difficult which may be confirmed only after the optimal accessibility to the pulp chamber has been achieved[6].
Fiberoptic transillumination can aid in enhancing the canal variance and anatomy identification. The canal system appears as a dark line or area in an illuminated field thereby enabling the clinician to identify the configuration of the C-canal present.
Optimal preparation deeper close to the orifice and carefully implementing probing techniques with specifically designed files will aid in characterizing the C-shaped configuration present. A generous utilization of irrigant solution and deeper cleansing with aid of sonics or ultrasonics allows superior debridement in fan-akin regions of the C-type canals.
Even though utilization of ultrasonics may result in efficacious removal of tissues from narrower spatial ramifications C-type canal. The obturation carried out in C-shaped configuration canals requires technical modifications. In the distal and mesio-lingual canal spaces shaping and obturation can be carried out by standard techniques. But sealing of the buccal isthmus will be challenging in case lateral compaction is the only method used. This difficulty is faced because the isthmus may not permit the deep placement of the spreader. In such a scenario, implementation of thermoplasticized gutta-percha enables 3-Dimensional filling of the isthmus[7].
When compacting softened gutta-percha and suitable sealer in a optimally prepared canal space is done, the contents will move smoothly into the aberrations present in the canal system. But in C-type configuration, the scenario is slightly variable due to:
(1) Unshaped and underprepared areas which are divergent would impede the flow of the obturating material and

(2) There exists communicating areas between the main canals of the C-shaped configuration, which would possess entrapped obturating materials extending to the apical tug-back area affecting the level of condensation.

Conclusion

When the triad of bio-mechanical cleaning and shaping, along with obturation, and restoration being performed optimally, teeth possessing C-shaped configuration exhibit long-term prognosis. But caution is warranted as lot of factors are in play that decide the longevity of the teeth with C-shaped canal system.

In the present case series, biomechanical preparation combined with chemicomechanical debridement was utilized during endodontic therapy. Both Thermoplasticized gutta percha and cold lateral condensation techniques were employed for obturating the canal with the cases demonstrating optimal success.

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