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C-shaped palatal canal in maxillary first molar with two palatal canals evaluated with cone – beam computed tomography

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Abstract*: Introduction: The aim of this article was to emphasize the importance of variations in root canal anatomy.*
Methods: *This case report presents the endodontic management of a maxillary first molar with c-shaped palatal canal bifurcating into two canals at the middle third and exiting from a single apical foramen. The canal morphology was confirmed with the aid of cone beam computerized tomography.*
Results: *CBCT axial images showed that the palatal root had a Vertucci type III canal pattern.*
Conclusion: *This report describes and discusses the variation in canal morphology of maxillary first molar and the use of latest adjuncts in successfully diagnosing and negotiating them.*
Keywords: *C-shaped, CBCT, Palatal Root.*

I. Introduction:

Successful endodontics depends upon knowledge, respect, and appreciation for root canal anatomyand careful, thoughtful, meticulously performed cleaningand shaping procedures. Knowledge of pulpal anatomy and thepossible variations is critical for success in endodontics and lack ofit may lead to treatment failure.

One such variation is the C-shaped canal system. The high frequency of transverse anastomoses, apical deltas, and lateral canals in such casescompels the clinician to use every resource at his disposalto achieve an adequately debrided canal.

C shaped canal is so named becausethe pulp chamber of the canal has a single ribbon shaped orifice with 180º arc. Typically, this canal configuration is found in teeth with fusion of the roots either on buccal or lingual aspect. The main anatomic feature of C-shaped canals is the presence of a fin or a web connecting the individual root canals[1].

Melton et al.[2],proposed classification of C-shaped canals based ontheir cross-sectional shape:
1. Category I: Continuous C-shaped canal running from the pulp chamberto the apex: it defines a C-shaped outlinewithout any separation (i.e., C1 inFigure 1A).
2. Category II: It shows a semicolon-shaped (;) orifice in which dentine separates a main C-shaped canal from one mesial distinct canal (i.e., C2 in Figure 1A) and
3. Category III: Refers to those with two or more discrete and separate canals.

Fan et al.[3], modified Melton's classification intothe following categories:
1. Category I (C1): Depicts an uninterrupted "C" with no separation or division
[Figure 1A(a)].
2. Category II (C2): Canal shape resembles a semicolon resulting from a discontinuation of the "C" outline [Figure 1A(b)], but either angle a or ß [Figure 1B] should be no less than 60°.
3. Category III (C3): 2 or 3 separate canals [Figure 1A (c and d)] and both angles, a and ß are less than 60° [Figure 1C].
4. Category IV (C4): Only one round or oval canal is seen in the cross-section [Figure 1A(e)].
5. Category V (C5): No canal lumen can be observed (which is usually seen near the apex only) [Figure 1A(f)].

According to radiological appearance Fan et al.[4],classified C-shaped roots into three types:
1. Type I: Conical or square root with a vague, radiolucent longitudinal line separating the root into distal and mesial parts. They show a mesial anda distal canal that merge into one before exiting at the apical foramen [Figure 1D].

2. Type II: Conical or square root with a vague, radiolucent longitudinal line separating the root intodistal and mesial parts. They also show a mesial and adistal canal, but the two canals appear to continueon their own pathway to the apex [Figure 1D].
3. Type III: Conical or square root with a vague, radiolucent longitudinal line separating the root into distal and mesial parts. They show a mesial and a distal canal, where one canal curves to and superimposes on this radiolucent line when running toward the apex, and the other canal appears to continue on its own pathway to the apex [Figure 1D].

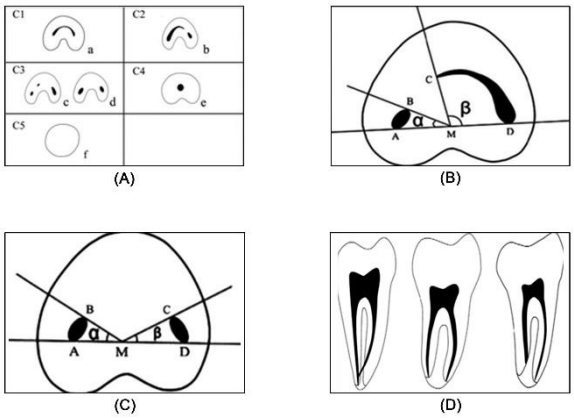

Fig.1 A. Melton's classification for C shaped canal. B. Measurement of angles for C2 canal. C. Measurement of angles or C3 canal. D. Radiographic classification of C shaped canals.

II. Case Report:

A 23-year-old woman presented to our department with history of spontaneous pain on the left side of her face since past several days. The patient's medical history was insignificant. Clinically, the left maxillary first molar had a deep carious lesion along with tenderness on percussion.

Electric pulp testing was indicative of irreversible pulp damage. After extensive clinical and radiographic examination, the left maxillary first molar was prepared for nonsurgical endodontic therapy. A preoperative radiograph was obtained[Figure 2A]. 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.

Clinical examination of the internal anatomy revealed 3 principal root canal systems: mesiobuccal (MB), distobuccal (DB), and palatal. On probing with a DG 16 endodontic explorer, a small hemorrhagic point was seen in a groove 2-3 mm mesial to the palatal orifice. A small amount of dentin occluding the orifice of the second palatal canal was removed with the help of Endo Access bur no. A0164 (DentsplyMaillefer, Ballaigues, Switzerland). The conventional triangular access was modified to a trapezoidal shape to improve access to the additional canals.

Examination of the pulp chamber floor with the explorer revealed C-shaped canal orifice of palatal canal. Radiograph showed two separate palatal canals merging in the apical third [Figure 2B]. CBCT was used to trulydetermine the canal morphology.

Axial images were reconstructed in CS3D software. There was C-Shaped canal orifice for the palatal canal [Figure 2D], but in the middle third the canals separated [Figure 2E]. In the apical third the canals again merged to exit from a single apical foramen [Figure 2F].It was evident that in the present case, the palatal canal system assumed a C-shaped anatomy.

At the next visit, the working lengths of each canal were estimated by means of an electronic apex locator (Root ZX; Morita, Tokyo, Japan). The canals were initially instrumented with #15 K files (DentsplyMaillefer) under irrigation with 3% sodium hypochlorite. All canals were cleaned and shaped by hand nickel titanium files in a circumferential manner using crown-down technique.

One week later, all canals were obturatedwith laterally condensed gutta-percha points. A final radiograph was taken [Figure 2C]. After completion of root canal treatment, the tooth was sealed with a posterior composite filling.

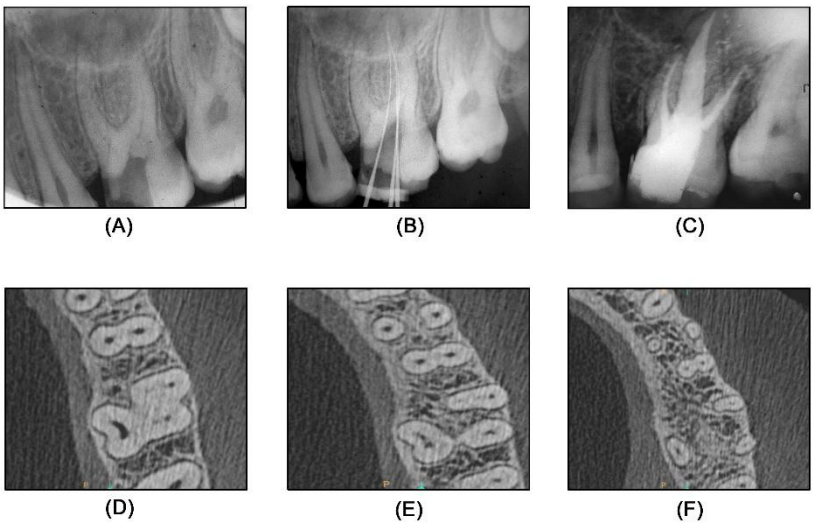

Fig. 2 A. Pre-operative radiograph B. Diagnostic raadiograph C. Post-obturation radiograph D. CBCT image for coronal third E. CBCT image for middle third F. CBCT image for apical third

III. Discussion:

C- shaped canal morphology is most commonly seen in mandibular second molars but has also been documented in mandibular first molars, maxillary molars,mandiular first premolars and in maxillary lateral incisors.

Palatal root of maxillary first molars mostly have Vertucci Type I configuration, and the most common variation is the presence of a second palatal root canal canal[5]. The incidence of 2 root canals in the palatal root in maxillary molars has been reported to be between 2% and 5.1%[6]. Other variations such as palatal root canal bifurcation or a trifurcation, fused distobuccal and palatal roots, and 2 distinct palatal roots have also been seen.

Various authors have described C-shaped canal in maxillary molars[7,8]. The probabilityof observing C-shaped canals in maxillary firstmolars has been reported to range between 0.091% and 0.12%[9,10], which is a rare occurrence.

De Moor[10]stated that the C shape in maxillary molars results from the fusion of the distobuccaland palatal roots, which might extend to the apical thirdof the fused roots. The lack of division ofthe roots leads to an intercommunication betweenthe root canals, resulting in a C-shaped canal pattern.However, in the present case the palatal root itselfcontained the C-shaped canal system, with a root bifurcationin the middle third. This could imply that 2palatal roots were possibly present that failed to divideat the junction of the coronal and middle third, resultingin the C-shaped canal system.

Recently, Singla and Aggarwal[11]diagnosed a Cshapedcanal in the palatal root of a maxillary secondmolar using spiral computerized tomography (SCT).They reported 2 different root canal orifices for thepalatal root that fused in the middle third to form aC-shaped ribbon-like pattern and exited as 2 separateapical foramens.

In the present case, CBCT axial imagesshowed a semicircular ribbon-shaped canal orifice until the junction of the coronal and middle third. Additionally, in the apical third the canals fused to exit from a single foramen.

Conventional 2-dimensional radiographs do not yield sufficient diagnostic information in cases of complicated morphology of the root canal system, such as in the present case. These problems can be overcomed by using newer diagnostic methods, such as SCT and CBCT, which can produce 3-dimensional images of individual teeth and the surrounding tissues. However, the radiation dose should be kept "as low as reasonably achievable" when exposing patients to ionizing radiation. In our case, CBCT was used over SCT because of its low effective radiation dose.

C-shaped canals are definitely an endodontic challenge. The access cavity for teeth with a C-shaped root canal system can vary considerably and requires modifications based on the pulpal morphology. In present case, a modified trapezoidal access cavity was prepared to locate the C-shaped canal and allow for its subsequent instrumentation. Irregular areas in C-shaped configuration house soft-tissue remnants and infected

debris that may escape regular cleaning and shaping procedures, necessitating supplementary efforts to accomplish a successful root canal treatment.

The connecting fin or isthmus is a thin area susceptible to rupture during canal preparation, resulting in a strip perforation. Recent studies done on mandibular molars with
C-shaped roots, NiTi rotary instrumentation was associated with a higher percentage (59.6%) ofuninstrumented canal areas than the manual K-file group (41.6%) with more dentine removed from the convex aspect of the C-shaped canal[12,13]. The CBCT images also provided valuable information regarding the critical remaining dentin thickness in the isthmus area of the palatal root canal system. Thus, observant use of circumferential filing was done to thoroughly debride the narrow canal isthmus in the palatal root.

An increased volume of irrigant and deeper penetration with small instruments using ultrasonics allows for more cleansibility in fan-shaped areas of the C-shaped canal.Lateral condensation technique used here obturated the c- shaped canal system adequately although, thermoplasticized gutta-percha technique has been recommended by many clinicians to fill in canal irregularities.

IV. Conclusion:

This case report highlights 2 important anatomicvariations in the palatal roots of maxillary first molars.The first is the presence of a palatal root bifurcation atthe junction of the coronal and middle third, and thesecond is the presence of a C-shaped root canal withinthe palatal root. Careful location and negotiation of thecanals and the meticulous mechanical and chemical debridement of the pulp tissue should be carried out to successfully manage a C-shaped root canal.

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