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Endodontic Management of C-shaped Root Canal Configuration using Different Obturation Systems: Case Series

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Abstract

C-shaped canal is one of the most difficult situations with which the dentist is confronted during endodontic treatment of teeth. Recognition of unusual variation 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 rule. 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 present case series reports the successful management of C-shaped canals in mandibular second molars using cone-beam computed tomography (CBCT), sonic irrigation activation and different thermoplasticized gutta percha obturating techniques.

Keywords: C-shaped canal, Cone-beam computed tomography (CBCT), Endoactivator, Melton’s Classification, Fan’s Classification, Thermoplasticized gutta percha technique.

1. Introduction

The crux of successful endodontics revolves around knowledge, respect and appreciation for root canal anatomy and careful, thoughtful, meticulously performed cleaning and shaping procedures.[1] A thorough knowledge of both normal and abnormal anatomy of the root canal system dictates the parameters for doing root canal therapy and can directly affect the outcome of endodontic therapy. One of the important anatomic variations is the “C” configuration of the canal system.

The C-shaped canal, which was first documented in endodontic literature by Cooke and Cox in 1979, is so named for the cross sectional morphology of the root and root canal.[2] This C-shaped canal is an anatomical variation of a root fusion and a type of taurodontism. This results from the failure of Hertwig’s

epithelial sheath to develop or fuse in the furcation area in the developing stage of the teeth. Failure on the buccal side results in a lingual groove, and the opposite case is possible. Failure on both sides results in the formation of a conical or prism-shaped root.[3] C-shaped canal system is most commonly found in mandibular second molars but may rarely occur in mandibular first molars and maxillary molars too. Studies on mandibular second molars have shown a high incidence of C-shaped roots and canals (10%-31.5%).[4,5]

This case series presents the management of C-shaped mandibular molars using CBCT and different thermoplasticized obturation systems.

Case report 1

A 26-year-old male patient reported to the Department of Conservative Dentistry and Endodontics with a chief complaint of pain in the lower left back tooth region. Medical history was not contributory. Clinical examination showed a deep class 1 carious lesion on occlusal surface of tooth 37 with tenderness on percussion. Both the cold test and electric pulp test (Parkwell, digitest) showed abnormal responses indicating irreversible pulp damage. A pre-operative radiograph with 37 revealed occlusal caries involving pulp & an unusual root canal morphology. The CBCT scan (CS 9300, (Planmeca, Helsinki, Finland) having a resolution of 90 µ field of view (FOV: 5x5), revealed Fan's category C2 (canal shape resembling a semicolon resulting from a discontinuation of a "C" outline, but either angles alpha or beta should be no less than 60 degree). the root canal treatment was initiated. Working length was determined using an electronic apex locator (Dentaport ZX, J Morita corp). Canals were enlarged using hand files from 10 # K file (Dentsply) further 15, 20, 25, 0.02. However, circumferential filing was done in the isthmus region not more than #25 K files; otherwise, strip perforation is likely. Further cleaning and shaping was performed using the self-adjusting file system (SAF) (Renodent Nova). During instrumentation, the canals were irrigated with 5.25% sodium hypochlorite (Prime Dental) followed by 17% liquid EDTA (Smear Clear, Sybron Endo) and further 1 min agitation was performed with Endoactivator (Dentsply). The access cavity was temporised by a double seal with Cavit (ESPE, Seefeld, Germany) and IRM (Caulk, Dentsply DeTrey, Saint-Quentin-Yvelines, France). In the second appointment (after one week), the master cone were selected and confirmed radiographically.The canals were dried with sterile paper points (Dentsply). Obturation was performed using The Obtura III Max system (Obtura Spartan, Fenton, MO, USA) along with AH Plus root canal sealer (Dentsply, Maillefer) (figure1). The access cavity was then sealed with Cavit.

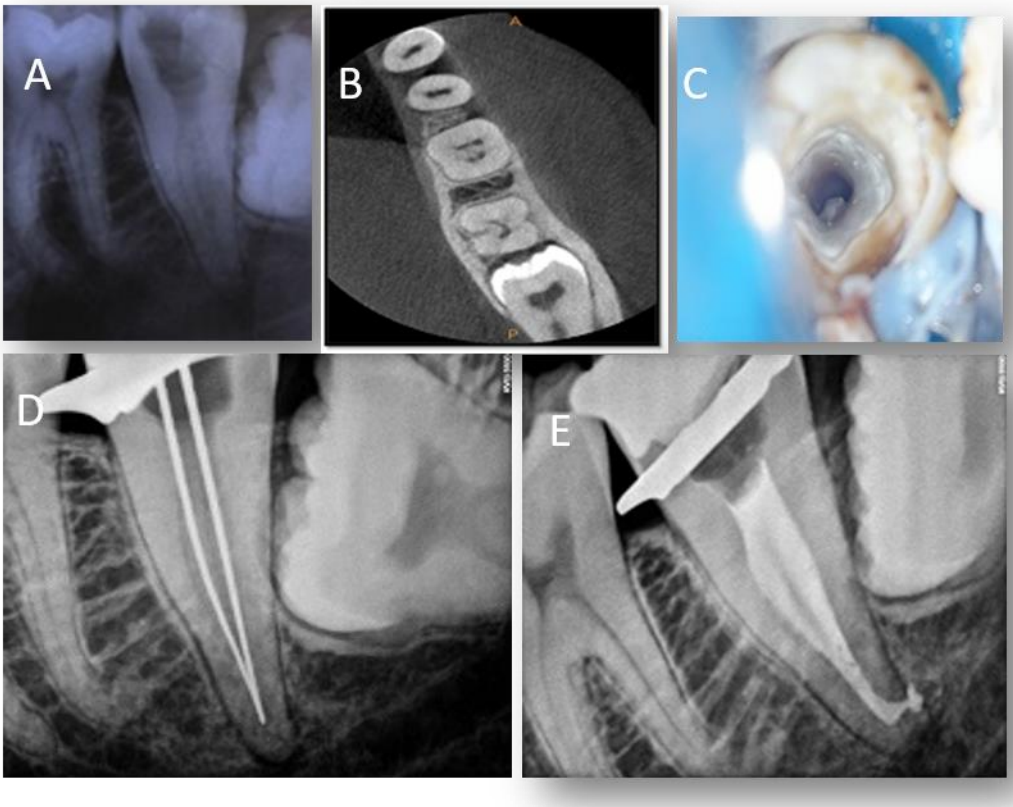

Figure 1: (A)Pre-operative IOPA with 37 (B) Pre-operative CBCT view (axial section) showing C-shaped canal anatomy (C) Access cavity (C-shaped) under Dental operating microscope (D) Working length determination (E) Root canal obturation using Obtura III system along with AH-plus root canal sealer

Case Report 2

A 33-year-old female patient reported to the Department of Conservative Dentistry with a chief complaint of pain in the lower right back tooth region. The medical history of the patient was non-contributory. Clinically, 47 showed deep occlusal carious lesion and the tooth was nonresponsive to vitality tests like Electric pulp test (Parkwell, digitest). There was presence of prolonged sensitivity to hot and cold. Radiographically, 47 showed radiolucency involving pulp with widening of the periodontal ligament (PDL) space and a single root having a single canal till the middle third followed by bizarre anatomy till the apex was noticed with 47. Based on clinical and radiographic examination diagnosis of pulp necrosis was made. To ensure the exact morphology of the root canals, (CBCT) scan (CS 9300, (Planmeca, Helsinki, Finland) having a resolution of 90 µ field of view (FOV: 5x5), was advised. It revealed a single uninterrupted "C" with no separation or division suggesting of Fan's category C1. After administration of local anesthesia and rubber dam isolation, an access cavity was performed. Cleaning and shaping was performed using a self-adjusting file system (SAF) (Renodent Nova). Continuous irrigation was done using 5.25 % sodium hypochlorite (PrimeDental), 17% EDTA (Smear Clear, Sybron Endo). Activation was done using Endoactivator (Dentsply) and the access cavity was temporised with Cavit. Master cone was selected in the second appointment and a radiograph was exposed. Obturation was done using a

combination of lateral compaction and thermoplasticized gutta-percha (Ultrafil 3D injectable gutta-percha, Coltene) along with AH Plus root canal sealer (Dentsply, Maillefer)(figure 2). Post obturation the cavity was sealed with Cavit.

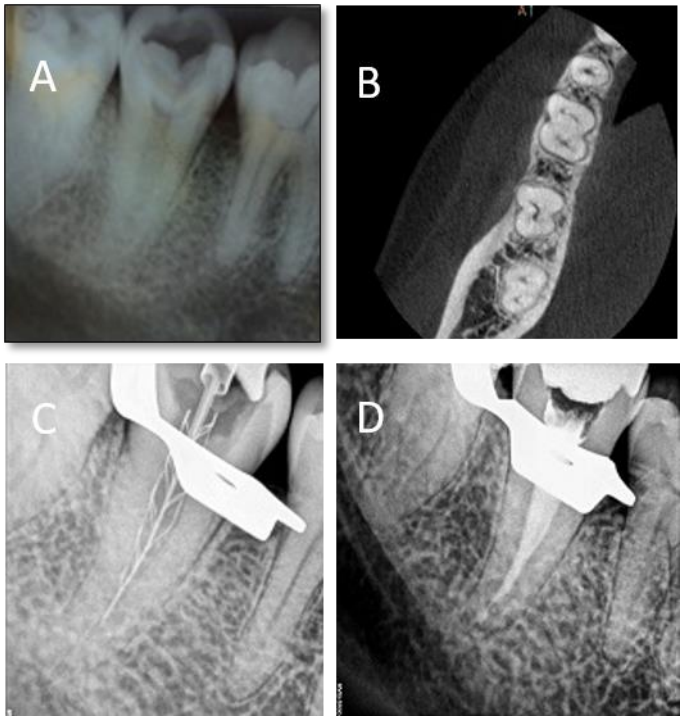

Figure 2: (A)Pre-operative IOPA with 47 (B) Pre-operative CBCT view (axial section) showing C-shaped canal anatomy(C) cleaning and shaping done using SAF system (D) Root canal obturation using Ultrafil 3D injectable gutta-percha along with AH-plus root canal sealer

Case Report 3

A 22-year-old female patient reported to the department of conservative dentistry and endodontics with a chief complaint of pain in the lower right back tooth region. On clinical examination, the tooth (47) had a dislodged restoration along with evidence of secondary caries and was tender on percussion. The radiographic examination revealed caries involving pulp & and apical periodontitis along with an unusual root canal morphology with 47. To confirm the root canal morphology and to rule out the presence of any additional roots/canals, can CBCT (Sirona, GmBH, Germany) was advised. The CBCT scan revealed two separate canals and both angles alpha and beta less than 60 degrees suggesting Fan's category III. Root canal treatment was planned, and the tooth was anesthetized using 2% lidocaine under rubber dam (Coltene) isolation. The access cavity preparation was performed with endo access burs (Dentsply, Mallifer, Switzerland) and visualized under a dental operating microscope (Carl Zeiss Surgical, Obenkochen, Germany). The pulpal floor revealed a mesiobuccal orifice and a groove that ran continuously along the buccal wall to the distal canal orifice, suggestive of C-shaped canal anatomy. Working length was determined using an electronic apex locator (Dentaport ZX, J Morita corp). Cleaning and shaping was performed using a self-adjusting file system (SAF) (Renodent Nova). During instrumentation, the canals were irrigated with 5.25% sodium hypochlorite followed by 17% liquid EDTA (Smear Clear, Sybron Endo) and further 1 min agitation with an endoactivator (Dentsply) followed by

placement of calcium hydroxide intracanal medicament for 7 days. After 1 week obturation was done using thermoplasticized gutta-percha (Elements Obturation System, Sybron Endo, CA, USA) along with AH Plus root canal sealer (Dentsply, Maillefer) (figure 3).

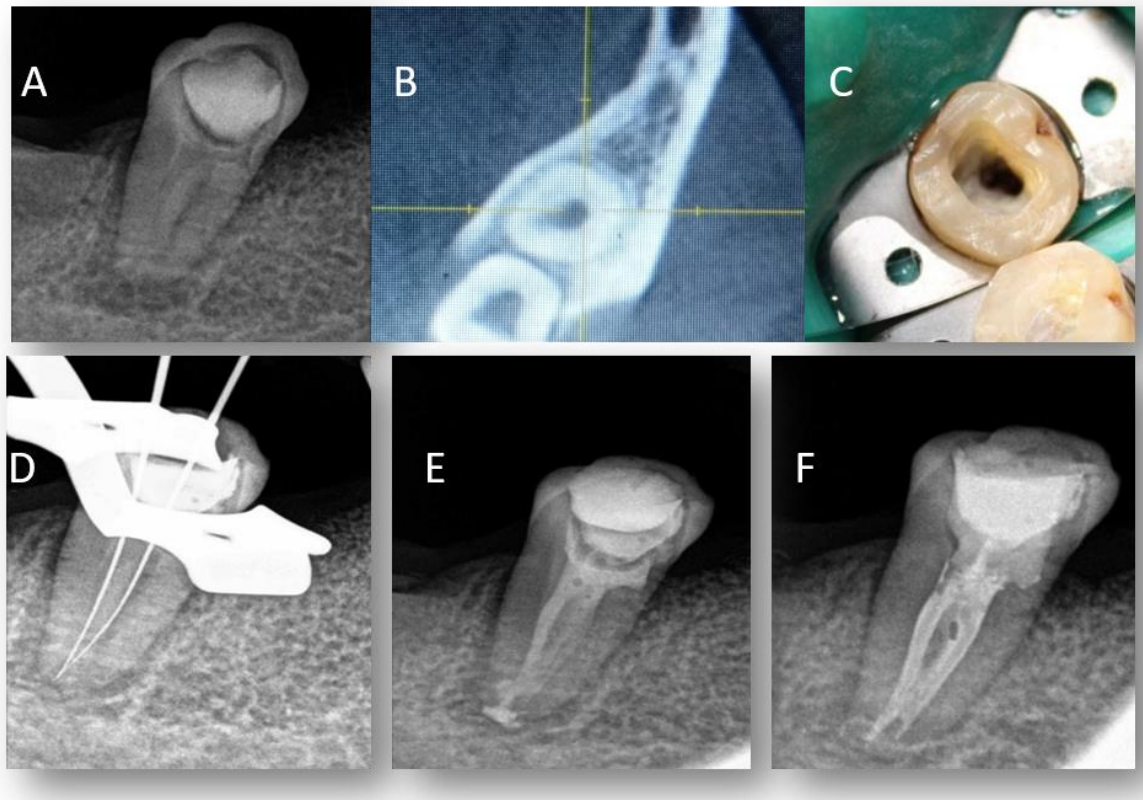

Figure 3: (A)Pre-operative IOPA with 47 (B) Pre-operative CBCT view (axial section) showing C-shaped canal anatomy (C) Access cavity (C-shaped) under Dental operating microscope (D) Working length determination (E)Placement of calcium hydroxide intracanal medicament for 7 days (F)Root canal obturation using Elements Obturation System along with AH plus root canal sealer

Case report 4

A 26-year-old male patient reported to the department of conservative dentistry and endodontics with a chief complaint of pain in the lower right back tooth region. Clinically, 47 showed deep occlusal carious lesion. The tooth showed delayed response to the electric pulp test (Parkwell, digitest). Radiographically, 47 showed radiolucency involving pulp with a widening of the periodontal ligament (PDL) space. The radiographs revealed three different canals suggesting fan's category C3. The patient received profound local anesthesia of 2% lidocaine (Cadila Pharmaceuticals). The tooth was isolated under rubber dam. Access opening was done and working length was determined using an electronic apex locator (Dentaport ZX, J Morita corp). Canals were enlarged using hand files from 10 # K file (Dentsply) further 15, 20, 25, 0.02. Further cleaning and shaping was performed using Endostar E3 Azure files. 5.25% sodium hypochlorite (Prime Dental) and 17% liquid EDTA (Smear Clear, Sybron Endo) were used for irrigation. The canals were dried with sterile paper points (Dentsply). Obturation was performed using the Denjoy Cordless Gutta Percha Obturation System- freefill along with Sealapex root canal sealer (Kerr) (figure 4) .

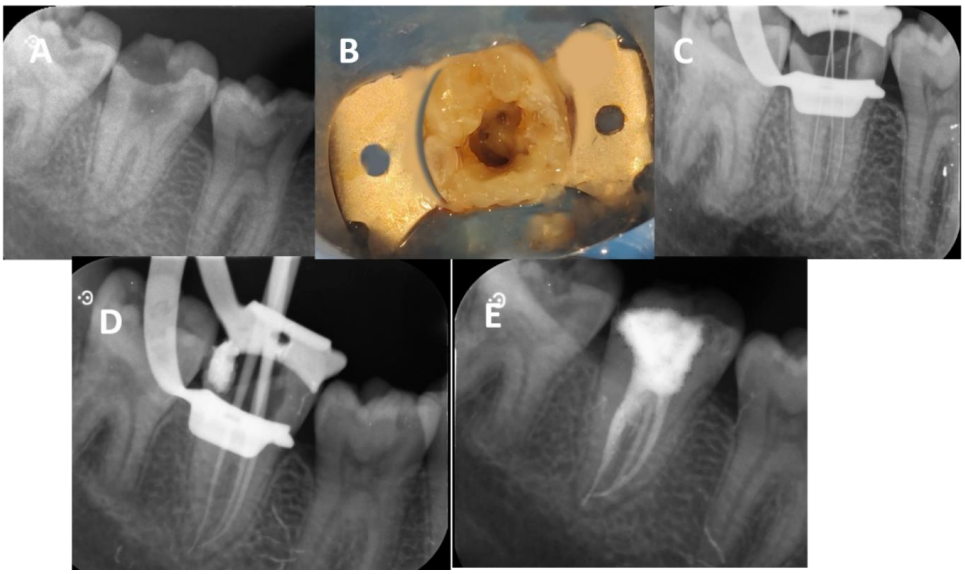

Figure 4: (A)Pre-operative IOPA with 47 (B) Clinical view of Access cavity preparation suggesting of C-shaped anatomy (C) Working length determination (D) Master cone selection IOPA (E) Root canal obturation using Denjoy Cordless Gutta Percha Obturation System along with Sealapex root canal sealer

Discussion

The root canal anatomy shows considerable variation and complexity that requires special attention while performing root canal therapy. Thorough knowledge of root canal morphology is a fundamental prerequisite to help and ensure optimal outcomes of root canal treatment. This includes preoperative awareness and intraoperative care to identify the landmarks of normal morphology as well as any unusual anatomy of the root canal system. A good understanding of external and internal root anatomy helps to reduce the number of missed roots and root canals during treatment, thus increasing the rate of favorable outcomes following root canal treatment. In the mandibular second molar usually two roots and three canals are seen similar to the first molar. Anatomical variations with one root or three roots one fused root with a limited number of canal configurations can also seen. [6]

A C-shaped root canal is defined as a root canal that in transverse section is shaped like the letter C.[7] Successful endodontic treatment of a tooth with a C- shaped configuration is difficult and a C-shaped canal configuration with the presence of narrow ribbon-like and fan-shaped areas, transverse anastomoses, lateral canals, and apical delta make the cleaning and shaping, decontamination and successful filling of these teeth challenging.[4,8]

The C-shaped canal is not uncommon and this is confirmed by studies in which frequencies ranging from 2.7% to 8% have been reported. The prevalence is higher in middle Asia up to 10.6% in Saudi Arabians and 19.14% in Lebanese. In northeast Asia, the prevalence is 31.5% in Chinese and 32.7% in Koreans.[9,10]

The C-shaped canal system can assume many variations in its configuration. So a comprehensive classification can help in diagnosis and management.

Melton and his co-authors in 1991 [2,11] divided the C-shaped canals into 3 main types :

Type I: The continuous C-shaped canal.

Type II: The semicolon-shaped canal.
Type III: Two discrete and separate canals.
Fan et al in 20042 modified Melton's method of classification into the following categories Category I (C1): The shape was an interrupted 'C' with no separation or division.
Category II (C2): The canal shape resembled a semicolon resulting from a discontinuation of the 'C' outline, but either angle or should be no less than 60°.
Category III (C3): Two or three separate canals and both angles, and were less than 60°.
Category IV (C4): Only one round or oval canal in that cross-section.
Category V (C5): No canal lumen could be observed (which is usually seen near the apex only).
Conventional 2–dimensional radiographs might not provide adequate diagnostic information for clinicians to appreciate the complicated morphology of the root canal system. These problems might be overcome by CBCT, which can provide 3- dimensional images of individual teeth and the surrounding tissues.[10] Whenever a clinician decides to acquire CBCT images, the risk and benefits of radiation should be considered. Generally, the radiation doses from CBCT are much higher than those in conventional periapical radiography. However, we used the D-mode field of view (FOV, 5 × 5 mm) of the CBCT scanner which is similar in size to a conventional periapical radiograph. Compared to other modes of the CBCT scanner, such as the I-mode (FOV, 102 × 102 mm), P-mode (FOV, 169 × 119 mm), and C-mode (FOV, 200 × 179 mm), the D-mode has the smallest FOV. Patel et al. reviewed that the effective dose of a small FOV is 2 - 3 times higher than the FOV of a periapical film. But, it is equally important that the radiation dose should be low.[12]
The Self-Adjusting File (SAF) is a patented hollow file with a unique design. It is made of a nickel-titanium lattice and is compressible. It is run by using a distinct trans-line (in-and-out) motion RDT3, ReDent-Nova handpiece head at 5,000 vibrations per minute.SAF compresses and expands at the same time but in opposite sides, when placed in a constricted canal, allowing it to adapt to the three-dimensional morphology of the root canal. This file is associated with continuous irrigation and the file's motion activates the irrigant helping in an additional scrubbing effect on the canal. These unique features may be the reason for the reported superiority of this file when used for instrumentation.[13]
An increased volume of irrigant and deeper penetration with small instruments using sonics or ultrasonics may allow for more cleansibility in fan-shaped areas of the C-shaped canal.[11] The endoactivator polymer tip of 25/04 was placed within 2 mm of working length and activated while moving up and down motion for 30 sec. During use, the action of the vibrating tip frequently produces a "cloud" of debris that can be clinically observed in a fluid-filled pulp chamber. This hydrodynamic activation serves to improve the penetration, circulation, and flow of irrigants into the more inaccessible regions of the root canal system.[14] In general, 10,000 cycles per minute (CPM) has been shown to optimize debridement and promote disruption of the smear and biofilm.[15]
Changes in obturation procedures, such as lateral and heated vertical condensation, aid in enhancing filling adaptability and density. Because a C-shaped canal is an extreme version of a long oval canal, thermoplasticised gutta-percha obturation procedures are recommended for improved adaptability and web filling. Guttmann and Rakusin suggested the use of thermoplastized gutta percha for the obturation of C–shaped canals.[16,17] The sealing of the buccal isthmus is difficult if lateral condensation is the only method used. Because the isthmus cannot be flared to allow deeper spreader insertion, sealing the buccal isthmus with lateral condensation alone is challenging. This makes the use of gutta-percha that has been thermoplasticized with electric spreaders or spreaders heated over an open flame, or delivered via

injectable devices, more suitable.[2,18,19] Walid et al recounted using two pluggers at the same time to down pack the major canals in a C-shaped canal in 2000. A large plugger is placed on one of the seared master points while the other master point is down packed with a smaller plugger. This increases the resistance towards the passage of obturating material from one canal to another. The smaller plugger is then held in place while the other point is down packed. [16,19] Proper placement of sealer with ultrasonic endodontic files is critical, regardless of the obturation technique.

Several methods were reported in the literature which investigating the root canal morphology. One of those, micro-CT which is an imaging technique used for in vitro studies, cannot be used clinically yet. Fan et al. examined the morphological characteristics of C-shaped canals with micro-CT. They observed that when a C-shaped canal orifice was observed in the pulp chamber, it may change along the length of the root. As a limitation of this study, examination of C-shaped morphology was done only at canal orifice level. Most of canal orifices (72%) demonstrated C1 canal configuration in our study. C1 and C2 configurations are much more difficult to shape and clean than the C3 and C4. Zheng et al. evaluated the mandibular second molars at four root levels including canal orifice, coronal, middle and apical third of the root. The results revealed that only 12 (5.5%) teeth did not change canal configuration from the orifice to the apical space. The frequency of C1 and C2 morphologies decreased from the orifice to the apical region, whilst that of C3 and C4 increased.[18,19]

Conclusion

The successful endodontic management needs a thorough understanding and sound knowledge about the morphology of the natural dentition. Early recognition of morphological variations can be done by using newer diagnostic techniques like CBCT. The advent of rotary and hand instrumentation assisted with ultrasonics as well as modified obturation techniques have improved the prognosis of C shaped root canals.

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