Endodontic Management Of C-shaped Root Canal Followed By a Post Less Core and Crown-a Case Report

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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. In this case report we have discussed the successful management of C-shaped canal (Melton’s category II) in mandibular second molar diagnosed by using cone-beam computed tomography and operating microscope and also used self-adjusting file (SAF), sonic irrigation and thermoplasticized gutta percha obturating technique. Endocrown-type restorations are single prostheses fabricated from reinforced ceramics that can be acid etched, indicated for endodontically treated molar teeth that have significant loss of coronal structure. Endocrowns are formed from a monoblock containing the coronal portion integrated into the apical projection that fills the pulp chamber space, and possibly the root canal entrances. A endocrown-type restoration was fabricated from lithium disilicate ceramic (IPS e.Max) in a mandibular second molar with extensive lingual destruction.

Keywords: C-shaped canal, Cone-beam computed tomography (CBCT), Endoactivator, Endocrown, Melton’s Classification, self-adjusting file (SAF), Rely X Unicem resin cement, Thermoplasticized gutta percha technique.
Introduction
The essence of successful endodontics rotates around knowledge and appreciation for root canal anatomy and careful, thoughtful, meticulously performed cleaning and shaping procedures. A thorough knowledge of root canal morphology 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 root canal system.

The C-shaped canal, 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. This results from the failure of Hertwig’s epithelial sheath to develop or merge in the furcation area in the developing stage of the teeth. Failure on the buccal side results in a lingual groove and failure on both sides results in the formation of a conical or prism-shaped root. C-shaped anatomy 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%).

It is currently accepted that the amount of residual tissue is probably the most important predictor of clinical success. Many adhesive techniques that do not require root anchoring are currently indicated to restore the depilated tooth. Endocrowns are a viable option for the restoration of endodontically treated posterior teeth. Pissis in 1995 was the first to introduce the heat-pressed ceramic monoblock technique, which utilized the pulp chamber to increase the macro-mechanical retention of the crown. In 1999 Bindl and Mörmann evolved Pissis concept and used the terminology ‘endocrown’ to describe a CAD/CAM all ceramic crown that is anchored to the interior portion of the pulp chamber and adhesively cemented to the remaining tooth structure, gaining micromechanical retention. The main objective is to achieve a bonded biomimetic reconstruction, i.e., minimally invasive of root canals.

This article highlights a case report of endodontic treatment of a C-shaped root canal followed by prosthodontic management by means of endocrown-type restoration.

Case Report
A 26-year old male patient reported to the Department of Conservative Dentistry and Endodontics with a chief complaint of pain in lower left back tooth region. Medical history of the patient was not contributory. Clinical examination showed deep caries on occlusal surface of mandibular left second molar which was sensitive to palpation and 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. To confirm the root canal morphology and to rule out the presence of any additional roots/canals, it was proposed to perform CBCT scan (FOV 5X5) of the tooth in concern i.e 37. The CBCT scan revealed fusion of mesial and distal roots with the presence of one large canal and a smaller one suggesting of Melton’s category II (figure1). Further a root canal procedure was planned.

The patient received local anesthesia of 2% lidocaine. Rubber dam (GDC) isolation was done. The access cavity preparation was performed with endo access burs (Dentsply, Mallifer, Switzerland) and pulp chamber was observed carefully under the dental operating microscope (GLOBAL). 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). Canals were enlarged with hand files from 10 # K file further 15, 20, 25, 0.02%. However, circumferential filing was done in the isthmus region not more than no. 25 K files; otherwise, strip perforation is likely. Further
cleaning and shaping was performed using self-adjusting file system (SAF) (Renodent Nova). During instrumentation, the canals were irrigated with 3% sodium hypochlorite followed by 17% liquid EDTA (Smear Clear, Sybron Endo) and further 1 min agitation with endoactivator (Dentsply). The canals were dried with sterile paper points. Obturation was done using combination of lateral compaction and thermoplasticized gutta-percha (Elements Obturation System, Sybron Endo, CA, USA) along with AH Plus root canal sealer (Dentsply, Maillefer) (figure 2).

![Image](image_url)

**Figure 1:** a) Pre-operative radiograph revealing an unusual root canal morphology with 37 b) CBCT axial sections at coronal, middle, apical levels respectively suggestive of Melton’s category II c) C-shaped anatomy nser dental operating microscope (GLOBAL)

**Tooth preparation for Endocrown**
Prior to tooth preparation, shade was selected using VITA master shade guide considering the adjacent and opposing teeth. The key areas of the preparation were the cervical margin i.e. cervical sidewalk and the cameral cavity. The preparation of the cervical sidewalk was made using a “wheel bur” WR-13C (ISO 068/042).
The reduction of 2mm was done as to support cusps and guiding cusps, in order allow sufficient space for the ceramic. Enamel walls less than 2 mm thick should be removed. The cameral cavity was prepared using a flat end-tapered diamond point TF- 13C (ISO 173/018). A total convergence of 7° was established to make the coronal pulp chamber and endodontic access cavity continuous. These values were identical to those described by Jorgensen as a minimum stump which promotes retention and stabilization. The depth of the cavity should be minimum 3mm. The entrance of the root canals was sealed with a conventional two-step adhesive system (Excite DS, Ivoclar Vivadent) and flowable resin composite (Tetric Flow, Ivoclar Vivadent, Liechtenstein, Germany). Finally the walls and margins of the preparation were smoothed with a fine-grained tapered-trunk diamond point TF12EF (ISO 173/016) in order to remove any irr-regularities and create a flat polished surface.

![Figure2: showing a) Working length radiograph using electronic apex locator (Dentaport ZX, J Morita corp) b) Final Obturation done using Elements Obturation System, (Sybron Endo, CA, USA)](image)

Impression procedure: Polyvinyl siloxane impression material (Hidroxtreme, Coltène/Whaledent, Cuyahoga Falls, OH, USA) was used with a putty-wash impression technique together with a retraction cord 000 (Ultrapak, Ultradent). Finally temporary restoration (Protemp) was placed. A lithium disilicate-based ceramic (IPS e.Max Press, Ivoclar Vivadent) endocrown in shade A2 was planned. Cementation procedure: The provisional restoration was removed, and the pulp cavity and cavity margins were cleaned with pumice-water slurry. The endocrown was tried-in, and small proximal adjustments were made. The intaglio surface of endocrown was treated with 9.6% hydrofluoric acid (Pulpdent) for 10 seconds, washed with water for 30 seconds followed by application of the silane coupling agent (MonobondS) for 1 minute. Since the lingual margin was located at the gingival level, a less technique-sensitive resin luting cement (Rely-X Unicem, 3M ESPE, St. Paul, MN, USA) was used (figure 3). After bonding procedure both static and dynamic occlusion were checked.

**DISCUSSION**

Successful endodontic treatment of a tooth with a C-shaped configuration is difficult and a real challenge considering decontamination and successful filling of the root canal system. In general, a C-shaped root canal is defined as a root canal that in transverse section is shaped like the letter C. However, such root canals are not always continuously C-shaped from orifice to apical foramen. 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 the middle Asia
upto 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.\textsuperscript{3,10,11}

Figure 3: a) Tooth preparation done for endocrown b) Impression taken with poly vinyl siloxane (Aquasil, putty/light body, Dentsply) c) Fabrication of lithium disilicate endocrown in shade A2 d) intaglio surface treatment with 9.6% hydrofluoric acid gel (pulpdent) e) application of Monobond S silane coupling agent (Angelus) f) cementation of endocrown using Rely X Unicem resin cement (3M ESPE)
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\textsuperscript{2,12} divided the C-shaped canals into 3 types:

Type I: The continuous C-shaped canal; type II: The semicolon shaped canal and type III: Two discrete and separate canals. Fan et al in 2004\textsuperscript{2} 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 radiograph might not provide adequate diagnostic information for the clinicians to appreciate intricate morphology of root canal system. These problems might be overcome by newer diagnostic methods like cone beam computerized tomography (CBCT), which can provide 3- dimensional images of individual teeth and the surrounding tissues.\textsuperscript{11}

An increased volume of irrigant and deeper penetration with small instruments using sonics or ultrasonics may allow for more cleanliness in fan-shaped areas of the C-shaped canal.\textsuperscript{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 irrigant into the more inaccessible regions of the root canal system.\textsuperscript{13} In general, 10,000 cycles per minute (cpm) has been shown to optimize debridement and promote disruption of the smear and biofilm.\textsuperscript{13, 14} Obturation of ‘C’ shaped canal requires technique modification. The sealing of the buccal isthmus is difficult if lateral condensation is the only method used; hence thermoplasticized gutta-percha is more appropriate.\textsuperscript{2}

Although endocrowns are desirable for all the teeth in the dental arch, they are especially indicated in cases of molars with short, obliterated, dilacerated, or fragile roots. They may also be used in situations of excessive loss of coronal dental tissue and limited inter-occlusal space, in which it is not possible to acquire adequate thickness of the ceramic covering on the metal or ceramic substructures.\textsuperscript{15}

Some authors consider that the essential parameter for the indication of this technique, is the depth of the cameral cavity, which must have a minimum depth of 4 to 5mm. The cameral anchorage must be utilized to the maximum by preventing weakening the rest of the roots.\textsuperscript{7} The butt joint, or cervical sidewalk, is the base of the restoration — with a band of peripheral enamel that maximizes bonding. The goal is to achieve a wide, even, stable surface that resists the compressive stresses that are most common on molars. The prepared surface is parallel to the occlusal plane to ensure stress resistance along the long axis of the tooth.\textsuperscript{16}

The lithium disilicate-reinforced ceramic was used in the present case as it serves a good restorative material for fabrication of endocrowns. Considering Weibull parameters, bonding seems to be more promising in lithium disilicate endocrowns, for both axial and lateral loading, than for those fabricated with multiphase resin composite. Compared to feldspathic porcelain, this material presented higher fracture strength. Lithium disilicate endocrowns have also exhibited better bonding to tooth structure and higher compressive strength in comparison to endodontically treated teeth restored with metal-ceramic or all ceramic full coverage crowns, with or without the presence of a post.\textsuperscript{17}
Rely X Unicem (3M ESPE) was used for luting the lithium disilicate endocrowns. This self-adhesive resin cement is based on a new monomer, filler, and initiation technology. The manufacturer claims that the organic matrix consists of newly developed multifunctional phosphoric acid methacrylates. The phosphoric acid methacrylates can act with the basic fillers in the luting cement and the hydroxyapatite of the hard tooth tissue.\textsuperscript{18,19} Self-adhesive cements eliminate the procedure of etching and bonding adhesive application. Phosphate monomers and silane coupling agents are added in the cement base to enhance the bond strength to the root dentin, ceramic or metal substrate.\textsuperscript{20}

In 2012, Biacchi and Basting, observed greater resistance to compression forces of endocrown restorations, compared with traditional crowns supported on fiber-posts, when these restorations were made with lithium disilicate ceramic.\textsuperscript{21}

**Conclusion**

Management of C shaped canal represents a great challenge with respect to diagnosis and treatment. A thorough knowledge of the internal anatomy, with a keen eye for variations is necessary for the success of therapy. Four main factors account for the success and longevity of endocrowns: correct preparation of the tooth, precise selection of bonding materials, and careful selection of cases including strategic importance of the tooth, margin locations, and residual sound dental structure. Nevertheless, long term clinical trials to evaluate the performance of endocrowns using monolithic IPS e.max are of utmost importance in order to establish their mechanical and aesthetic modality in restoration of endodontically treated posterior teeth.

**References:**

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