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Márcia Valéria Boussada Vieira, MSc
Ingrid Pereira Oliveira, DDS
Ana Lucia Sousa, DDS
Helio Pereira Lopes, PhD

Dr. Vieira is a professor of Endodontics at São José University, Rio de Janeiro, RJ, Brazil. Dr.Lopes is a professor of the Department of Endodontics, Estácio de Sá University, Rio de Janeiro, RJ, Brazil. Dr. Sousa and Oliveira are endodontists.

Corresponding author: Márcia Valéria Boussada Vieira
mvieirabrasil@gmail.com

# C- Shaped Root Canals

# CHARACTERISTICS AND CLINICAL IMPLICATIONS

**VIEIRA, Márcia Valéria Boussada; OLIVEIRA, Ingrid Pereira; SOUSA, Ana Lúcia**

## INTRODUCTION

The definition of the C-shaped root canal system is that the morphology of its horizontal cross section is in the form of a C, with canals which may or may not be separate.[21]

It occurs mainly in mandibular second molars, but has also been reported in maxillary first molars, first and third mandibular molars, and in mandibular lower pre-molars.[4, 5, 6, 7, 8, 13, 16, 20, 21]

Molars with C-shaped root canal systems display fusion of the roots from the buccal or lingual aspect, with a radicular ridge opposite to a convex surface, and a root morphology which may be conical or square or in C-shaped.[4, 9, 12, 14, 23] When the morphology of the root canal system is C-shaped, the arrangement of the root canals can be very varied. When examining the floor of the pulp chamber of lower molars displaying this atypical configuration, normally the entrance of the canal is observed as a C-shaped orifice (an arc of 180º), in the form of a band, or a deep semilunar groove connecting the distal, mesiobuccal and mesiolingual canals. [9, 21, 23] The concavity of the C may be oriented buccally or lingually.[15] In other cases the orifice may take the form of an incomplete C, with union of the distal and mesiobuccal canals, and the presence of an isolated mesiolingual canal, giving the canals the appearance of a semicolon.[1, 21, 23] It may also present as a C-shaped canal with union of the distal and mesiolingual canals, and with a separate mesiobuccal canal. It is important to emphasize that this C-shaped variation of the anatomy can occur throughout the length of the root canal, which complicates the stages of biomechanical preparation and obturation of teeth displaying this type of internal anatomy.

## DEVELOPMENT

Variations in the number as well as the position of the canals can occur in different thirds of the root.[14, 21] A tooth with a C-shaped canal orifice may have a canal system that presents a continuous C-shape from the coronal to the apical third. In this instance, endodontic instruments of small size used to explore the canal may pass freely through the foramen. This canal type is also known as a true C-shape. Often, a true C-shaped canal will be recognized because it has a C-shaped orifice. However, a true C-shaped canal can occur while presenting separate orifices at the pulpal floor level. A C-shaped canal may commonly bifurcate at any level in the root from coronal to apical[23], and anastomoses between canals can also occur.[13, 14] MANNING (1990) examined 19 teeth with C-shaped root canal systems and found anastomoses between canals in 15 of them. [13] These areas can be extremely difficult to clean during biomechanical preparation, and they may compromise adequate sealing of the canal, thus reducing the prognosis of the root canal treatment .[4, 13]

MELTON (1991) proposed the following classification based on the different configurations of the orifices in C-shaped canal systems.

- Class I: a continuous C-shaped canal, with no separation of the canals.
- Class II: the canal orifices resemble a semicolon (;), where a C-shaped canal is present buccally or lingually, separated from another distinct canal by a dentine wall.
- Class III: two or more separate canals are present, as in a typical lower molar, with three canal orifices.[11, 14, 21]

COOKE and COX (1979) described three cases of endodontic treatments in lower molars with C-shaped canals which highlighted the difficulty of identifying C-shaped root canals based only on the pre-operative radiographic appearance, since in all three cases the radiographs gave the impression of two roots, and the anatomy of the floor of the pulp chamber suggested separate canals.[6] Similarly BARNETT (1986) commented that the radiograph can indicate the presence of distinct root canals, even when the tooth has a C-shaped canal system.[1] It is very difficult to identify this atypical configuration at the initial radiographic examination, and only after the access cavity has been made will the diagnosis become clear.[1, 2, 7, 12, 15]

JEROME (1994) believed that limited information about whether roots are fused or merely close can be obtained from evaluation of pre-operative radiographs, affirming that the radiographic appearance of two roots does not eliminate the possibility of the presence of a C-shaped canal system; in such cases the dentine isthmus that joins the roots may so be fine that it does not appear radiographically.[10, 11, 21] RICE (1980) considered the interpretation of pre-operative radiographs fundamental to the success of the endodontic treatment of C-shaped canals, since it can demonstrate the presence of atypical root configurations. The importance of good quality preliminary radiographs taken from at least two angulations cannot be overstated.

When interpeting radiographs taken for the purpose of length measurement, endodontic instruments can appear to be misplaced in the furcation, especially in Class 1 C-shaped canals. This can lead the operator to mistakenly suspect a perforation. [1, 4, 10, 11, 14]

Another factor that can cause the operator to suspect perforation is the occurence of intense hemorrhage during access to the pulp chamber. In addition, the patient may complain of constant sensitivity throughout the appointment, even after intrapulpal anesthesia, giving rise to difficulty with procedures such as pulpectomy and biomechanical preparation of the canals.[4, 6, 11, 12, 16]

Because of their atypical anatomy, C-shaped canals demand more care at all stages of the procedure. This represents a real challenge to the operator, inasmuch as the diagnosis, cleaning and shaping, three dimensional sealing and prosthodontic restoration are very difficult to complete to a high standard.[4, 6, 9, 10, 11, 13, 16, 21]

In all three classes, the "main" canals can be cleaned and shaped normally; however the instrumentation of the isthmus that connects these canals requires care, because although it may be extensive, it may also be very narrow.[1, 11, 21] These areas are prepared using small sized endodontic

instruments and copious amounts of irrigants. Gates Glidden drills cannot be used in the isthmus due to the great risk of creating a perforation to the periodontal ligament.[11] In this situation the irrigation solutions assume a very important role; sodium hypochlorite, with its capacity (amongst others) to dissolve organic material, is the solution of choice.[4, 11, 15]

Manual instrumentation can be augmented with ultrasonic devices to debride the canal more effectively[1, 4, 16, 21], since they can result in greater volumes of irrigants entering and penetrating the canal system, thus promoting more thorough cleaning of the narrow areas of the canal.

For obturation of the canal one should select a technique that facilitates the effective sealing of complex root canal systems. Thermoplasticised guttapercha is an appropriate technique, because thermoplasticisation allows better dispersal of the endodontic sealer and guttapercha, and so they are more likely to fill the irregularities of the C-shaped canal system.

**CONCLUSION**

It is evident that, for endodontic treatment of teeth with C-shaped canal systems to be successful, there must be modification of procedures at all stages of the treatment, and new resources must be used. The magnification provided by the Dental Operating Microscope is a great aid in the interpretation of the anatomy of the floor of the pulp chamber, and thus facilitating effective access to the canal system.[3] Fibre-optic transillumination can assist in the identification of the anatomy of the root canal system. Ultrasonic instrumentation and devices for thermoplasticisation of guttapercha assist greatly with debridement and obturation respectively.

Computer Aided Tomography (CAT scan) and magnetic resonance imaging (MRI) are valuable additional resources in the laboratory study of the anatomy of C-shaped canals, enabling three-dimensional reconstruction of root canal systems in high resolution. A comparison between the morphology of root canals before and after chemomechanical preparation may help to shed light on possible causes of endodontic failure.[4, 9, 10, 19]

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