# *In vitro* evaluation of isthmus in mandibular molars by means of optical microscopy

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### ABSTRACT

The purpose of this study was to determine the incidence of isthmus in mesial and distal root canals of mandibular molars. The study was approved by Universidade de Fortaleza Institutional Review Board under protocol #181.388 of December, 20<sup>th</sup> 2012. A total of 150 mandibular molars were selected, 50 first molars (Group 1), 50 second molars (Group 2) and 50 third molars (Group 3). The roots of all teeth were sectioned with a carborundum disk. To better visualize the area of the isthmus, optical microscope magnification and manual files were used. With the methodology used, it was found that: in Group 1, 76% of mesial root canals and 53.7% of distal root canals had isthmus; in Group 2, 86% of mesial root canals and 40.6% of distal root canals were united by isthmus; finally, in Group 3, 91% of mesial canals and 13.5% of distal root canals communicated by isthmus. Therefore, it was observed that the incidence of isthmus connecting root canals of mandibular molar roots was expressive in all three groups.

Keywords: Molar. Root canal. Anatomy.

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## Introduction

Clinical success in endodontic treatment results from various clinical and microbiological factors. The most relevant is likely to be knowledge and domain of the internal morphology of the tooth to be treated. There are several means to study the morphology of the human teeth, such as conventional radiographs, the clearing technique, optical microscopy, infiltration of dyes, tooth sectioning, and more recently computed tomography.<sup>1-5</sup>

Knowledge of external and internal morphology of the teeth, as well as their variations, allows the professional to identify and correctly manage the root canals for disinfection and shaping. Despite using the newest kind of instruments, failure will be inevitable if the focus of bacteria remains inside the root canal, which had not been properly explored or identified, thus not following the principle of "Cleaning and Shaping,"<sup>6</sup> once the root canal would be instrumented and filled incompletely.

The areas of isthmus form in strip-like shape and connect two or more root canals containing pulp tissue. Isthmuses are more frequent in mandibular molars, maxillary premolars and maxillary molars.<sup>7-10</sup> The literature reports that the presence of isthmus in mandibular molars, especially in mesiobuccal and mesiolingual root canals, varies between 50 and 89%.<sup>10-13</sup> In spite of the technological advances in Endodontics, isthmuses hardly ever suffer the mechanical action of instruments, chemical action of auxiliary irrigating solutions and intracanal medication; however, clinicians should promote the maximum disinfection and sealing of these areas in order to avoid treatment failure.

The objective of this study is to evaluate the incidence of isthmus in root canals of mandibular molars by means of root sectioning and visual inspection with optical microscopy.

#### **Material and Methods**

This research is an exploratory, descriptive, quantitative, cross-sectional study. All steps were performed in laboratory, with the use of extracted teeth, that is, *in vitro*.

These teeth were removed by therapeutic indication of aggressive periodontitis, with major loss of clinical attachment, or for orthodontic or prosthetic reasons which are part of the detailed historical records of the patients from whom they originate. The research project was submitted to Universidade de Fortaleza Institutional Review Board (Coética / UNIFOR) and was approved under protocol #181.388 of December 20<sup>th</sup>, 2012.

For this study, 150 mandibular molars were selected. They were divided into three groups of 50 teeth each: Group 1 = mandibular first molars; Group 2 = mandibular second molars; Group 3 = mandibular third molars. All teeth were stored in saline solution until the time of use. All procedures were carried out by the same operator, a general dentist previously calibrated in a pilot study using the same methods employed herein.

The following inclusion criteria were applied: healthy teeth or teeth with carious lesion, extracted from male and female patients, regardless of age or the clinical/pathological condition that justified extraction (periodontal, prosthetic or orthodontic indication). Exclusion criteria were as follows: teeth without anatomical crown due to severe destruction (regardless of the reason that caused such loss), endodontically treated teeth, incomplete root formation or external and/or internal resorption of some of the roots or the presence of root fracture.

Initially all teeth had the middle third of the roots sectioned with the aid of a carborundum disk mounted on a straight-piece mandril (Kavo 10 ABN Model), attached to a micromotor (Kavo 161 Model), with discs replaced every ten sectioned teeth . Once all roots had been sectioned, storage was carried out with plastic bags listed under the corresponding number of each tooth.

Visual magnification was conducted with the aid of an optical microscope (DF Vasconcellos, M900) which allows visualization of root canal morphology. All teeth were visualized with a microscope under 16x visual magnification, so that all canals, including narrow or calcified ones, could be identified correctly on both roots, throughout the study.

Root canals were identified with the aid of an explorer straight probe. Kerr #10 and 15 manual files (Dentsply-Maillefer, Ballaigues, Switzerland) were used to explore the root canals up to their anatomic length.

## Results

With the roots sectioned in the middle third, combined with proper root canal exploration, visual magnification revealed that all groups had a prevalence of root canals presenting isthmus areas. However, in some cases, the root canals did not communicate, or were completely independent. There were cases of root canals that, within the established



**Figure 1.** Percentage of root canal configuration in Group 1: there is a high percentage of communication among root canals present in the mesial root.



**Figure 2.** Percentage of root canal configuration in Group 2: similarly to Group 1, there is a high prevalence of communication among root canals present in the mesial root. Also, there is a high percentage of independent canals in the distal root due to a higher prevalence of single root canals.

length, showed total communication, forming only one root canal. These cases were recorded as with the presence of isthmus. When the sample had only one root canal, mostly found in the distal roots, data were recorded as independent (Figs 1, 2 and 3).

## **Discussion**

In the present study, the roots of 150 molars were sectioned in the middle third in order to have the morphology of the root canal visualized and the presence of isthmus investigated. In Group 1, consisting of 50 first molars, it was observed that mesial and distal roots had prevalent communication between root canals (76% and 53.7%, respectively); however, in the distal root, the prevalence of one root canal was also significant (46.3%). Similarly to Vertucci,<sup>14</sup> who injected dye into the pulp chamber and root canals of 100 mandibular first molars, thus visualizing the entire root canal system through decalcification, the present study found that, in the apical third of the roots, there were variations in the number of canals, with significant results for two root canals in the mesial root (59%). Distal roots had a single root canal in 95% of cases, whereas the other 5% had two canals.

Malvar and Corbacho<sup>15</sup> studied the internal anatomy of 81 mandibular second molars by means of the clearing technique, and investigated the number



**Figure 3.** Percentage of root canal configuration in Group 3: similarly to Groups 1 and 2, there is a high percentage of communication among root canals present in the mesial root.

of roots, as well as main, side and recurring root canals, intercanals and apical delta. The authors found that, for the mesial root, there was a higher incidence of two distinct and separate root canals extending from the pulp chamber to the apex. As for the distal root, it was found an increased incidence of single root canals extending from the pulp chamber to the apex. Unlike the previous study, in the present study, Group 2 (consisting of second molars) showed a higher incidence of root canals that communicate through isthmus in the mesial roots (86%). Nevertheless, the results for the distal roots were similar to those of the previous study in which 49.6% had only one root canal.

Although they are constantly indicated for extraction due to occlusal, restorative and surgical factors, we included a third group in our study, consisting of mandibular third molars. The methodology employed in our study revealed a high percentage of communication between mesial root canals (91%); while in the distal roots there was a prevalence of only one root canal (86.5%). Sert et al<sup>16</sup> conducted a comparative study of the anatomy of maxillary and mandibular third molars with the previously established anatomy of first and second maxillary and mandibular molars. The authors found that mandibular third molars showed a 69.1% prevalence of two roots, with 58.9% of teeth with one root canal in the mesial root.

Recent research proposes a new method to help identify narrow and calcified root canals, as well as isthmus areas: the use of computed tomography.<sup>17-20</sup> Despite providing a complementary examination to visualize the internal anatomy of teeth reliably, CT scans are not very suitable for clinical routine to recognize the morphology of teeth to be treated endodontically, as they are more commonly indicated in preoperative tests, diagnosis of fractures and in cases of anatomical variations difficult to diagnose. Disadvantages, such as patient's exposure to high doses of radiation and the presence of image artifacts, due to metal restorations and pins, hinder image interpretation even with modern apparatuses.<sup>18,19</sup> The latest studies using computed tomography show that, in mandibular molars, especially in mesiobuccal and mesiolingual root canals, isthmuses are present in between 50 and 85% of cases.<sup>12,19,21,22</sup> Because distal root canals are mostly unique, there are few studies on the incidence of isthmus areas; however, some studies show that the presence of this communication varies between 11 and 50% in these root canals, respectively.<sup>12,22</sup> Even though the methodology used in this research only includes serial cuts and visualization under optical microscopy, it was possible to find data that resemble those found in the literature that uses the interpretation of tridimensional images.

## Conclusion

The results of the present study show that, especially in the mesial roots, due to flattening in the mesial-distal direction, there is a prevalence of communication between mesiobuccal and mesiolingual root canals in all groups of mandibular molars (G1 = 86%; G2 = 6%; and G3 = 91%). The results are relevant because most isthmus are not accessible, mainly by mechanical action of endodontic instruments, and depend on the chemical action of irrigating solutions. As for the distal roots, there was a higher prevalence of single root canals, and, for this reason, the percentage of only one root canal was more significant in Group 2 (49.4%) and Group 3 (86.5%); whereas in Group 1, there was a prevalence of communication among root canals (53.7%). This was justified by the highest incidence of a second root canal in the distal root of mandibular first molars.

In the presence of these anatomic findings, which are not exclusive of mandibular molars, the clinician should allow maximum disinfection of these areas. Although instruments do not provide maximum cleaning of isthmus areas, they should be used in those areas. Irrigating solutions activated by ultrasound are also means to assist cleaning. If necessary, intracanal topical medication should be used, with a view to promoting greater disinfection of the root canal system.

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