

**Radix entomolaris, an anatomical variation of mandibular molars:  
clinically relevant considerations**

**Radix entomolaris, uma variação anatômica em molares inferiores:  
considerações de relevância clínica**

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**Caroline Felipe Magalhães Girelli**

Doutora em Odontologia

Institution: Pontifícia Universidade Católica de Minas Gerais

Address: Av. Dr. Sérvulo Teixeira, 412, Alto Esplanada, Gov. Valadares - MG,

CEP: 35064-004

E-mail: carolfmagalhaes3@hotmail.com

**Carolina Oliveira de Lima**

Doutora em Endodontia

Institution: Universidade Federal de Juiz de Fora - Campus Governador Valadares

Address: R. São Paulo, 745, Centro, Governador Valadares - MG

E-mail: c.oliveiradelima@yahoo.com.br

**Marilia Marceliano-Alves**

Doutora em Endodontia

Institution: Universidade Iguazu

Address: Av. Abílio Augusto Távora, 2134, Luz, Nova Iguaçu - RJ, CEP: 26260-045

E-mail: mmarceliano@hotmail.com

**Renato Girelli Coelho**

Doutor em Odontologia

Institution: Universidade Vale do Rio Doce

Address: R. Israel Pinheiro, 2000, Universitário, Gov. Valadares - MG,

CEP: 35020-220

E-mail: renatogirellicoelho@hotmail.com

**Gabriel Pinheiro Lacerda**

Mestre em Clínica Odontológica

Institution: Universidade Federal de Juiz de Fora

Address: Rua José Lourenço Kelmer, S/N, São Pedro, Juiz de Fora - MG,

CEP: 36036-900

E-mail: gl.jf@hotmail.com

**Mariane Floriano Lopes Santos Lacerda**

Doutora em Endodontia

Institution: Universidade Federal de Juiz de Fora, Campus Governador Valadares

Address: R. São Paulo, 745, Centro, Governador Valadares - MG

E-mail: mariane.lopes.santos@gmail.com

## ABSTRACT

Knowledge about both the external and internal anatomy of teeth is essential for the success of endodontic treatment. The mandibular molars are prone to anatomical variations such as the presence of an additional root located lingual to the tooth which is named *Radix Entomolaris* (RE). The aim of the present study was to describe the internal and external morphology of RE, as well as evaluate the prevalence, etiology, and clinical protocol of this atypical anatomy by means of a literature review. The knowledge of these anatomical variations as well as clinical guidelines for the diagnosis and endodontic treatment of RE can minimize procedural errors during root canal preparation, and provide an adapted clinical approach for the dentists, thus culminating in the success of endodontic treatment.

**Keywords:** Radix entomolaris, root canal therapy, anatomy.

## RESUMO

O conhecimento sobre a anatomia externa e interna dos dentes é essencial para o sucesso da prática endodôntica. Os molares inferiores são propensos a variações anatômicas como a presença de uma raiz extra localizada lingualmente, sendo esta raiz chamada de *Radix entomolaris* (RE). O presente artigo tem como objetivo descrever a morfologia interna e externa, bem como, abordar a prevalência, etiologia e a conduta clínica do RE por meio de uma revisão de literatura. O conhecimento sobre prevalência, as variações morfológicas internas e externas encontradas nos molares inferiores, bem como as diretrizes clínicas para diagnóstico e tratamento endodôntico do RE irão minimizar iatrogenias e condutas serão adotadas para o correto manejo desta variação anatômica, proporcionando ao profissional uma abordagem clínica adaptada, culminando na excelência do tratamento endodôntico.

**Palavras-chave:** Radix entomolaris, tratamento do canal radicular, anatomia.

## 1 INTRODUCTION

The goal of the endodontic treatment is to reach a proper chemical-mechanic preparation, followed by tridimensional filling of the root canal system (RCS).<sup>1</sup> The first step to reach this objective is the comprehension of the anatomy and anatomical variations of the RCS.<sup>2</sup> A lack of knowledge about these variations can lead to the non-identification of additional root canals, and therefore, the maintenance of microorganisms and pulp tissue remains, which can lead to, the failure of the endodontic treatment.<sup>3,4</sup>

The mandibular first molars usually have one mesial and one distal root, and three root canals, however, in some situations, an additional third root can be found, mostly lingual.<sup>5,6</sup> This anatomical variation was first described by Carabelli<sup>7</sup> (1844), and is known as *Radix Entomolaris* (RE).<sup>8</sup> The dimensions of these canals can vary from a short and conical extension to a completely formed root, with length similar to the other roots,

with a buccolingual curvature. This diversity of anatomical configurations of the RE can be an endodontic challenge to the dentists.<sup>3</sup>

Although it cannot be used clinically, the micro-computed tomography (micro-CT) imaging is a technique that allows the accurate quantitative and qualitative 3D data acquisition for assessing RCS anatomy in experimental endodontic studies, providing valuable information about internal anatomy of root canals that could increase the safety and efficiency of root canal preparation procedures, especially in teeth with peculiar anatomy, and even support the implementation of new treatment protocols.<sup>9,10</sup>

Furthermore, the anatomical variation of the number of canals and roots can be related to the ethnicity and gender of different populations.<sup>11,12</sup> Many studies have reported that the prevalence of RE is related to certain origins, ranging from 3 to 5% on African, Caucasian and indigenous populations,<sup>11-14</sup> and up to 30% on populations with Mongol traits, such as Chinese, Eskimos and Americans.<sup>13</sup>

Since the Brazilian population is miscegenetic, with ancestries from Europe, Africa, indigenous tribes, and many other ethnicities, it is believed that the frequency of RE on the Brazilian population may be higher than in other countries. Therefore, it is important for the clinicians the knowledge of the occurrence, localization, identification, morphology, canal configuration and clinical approach of the RE before the endodontic treatment. Thus, the present study aims to describe the internal and external morphology of RE as well as evaluate the prevalence, etiology and clinical conduct of this atypical root by means of a literature review.

## 2 MATERIALS AND METHODS

To guide the achievement of the present study, the following question was performed: what are the morphological and clinical characteristics of the *Radix entomolaris*?

Thus, an online search was carried out in the following databases: Medical Literature Analysis and Retrieval System Online (Medline/PubMed), Scopus, Web of Science, Latin American and Caribbean Literature in Health Sciences (Lilacs) and Scientific Electronic Library Online (SciELO), using as descriptors: *Radix entomolaris*; distolingual root; mandibular molar; anatomical variation. A manual search by four reviewers was also performed, after reading the titles, abstracts and keywords. When the information contained in these topics was insufficient, articles were read entirely. The

references of possible studies to be used, as well as the cross search of author's database, served as a guide for the selection of other relevant articles.

As inclusion criteria for both electronic and manual research, articles of literature review or systematic review, studies of cases reports and in vitro research were considered. Such articles should only address the prevalence, morphological and clinical characteristics of the RE.

Studies involving deciduous teeth and other anatomical variations in mandibular molar were discarded. The final synthesis was developed in a literature review, regarding the results and conclusions obtained from each of the studies.

### 3 RESULTS

The literature review was carried out after the conference of the articles in full and the pre-established eligibility criteria. A total of 417 articles were identified in Web of Science and 17 were selected. After removing duplicates, 31 articles were included in the present review about RE. Of the total articles researched, 90,4% were written in the English language.

## 4 DISCUSSION

### 4.1 CLASSIFICATION AND MORPHOLOGY OF RE

The Latin expression, *Radix entomolaris* (RE), was used to describe the supernumerary root in the lingual surface of mandibular molars.<sup>8</sup> Since then, few studies reported the morphology of RE with details (Figure 1).<sup>3,15</sup>

Firstly, four types of RE were described, according to the location of its cervical part, by direct observation with a stereomicroscope. In types A and B, the cervical portion is located distally, and there are 2 and 1 normal distal root components respectively; in type C, the cervical portion is located mesially; while in type AC it is located centrally, between the distal and mesial roots.<sup>15</sup>

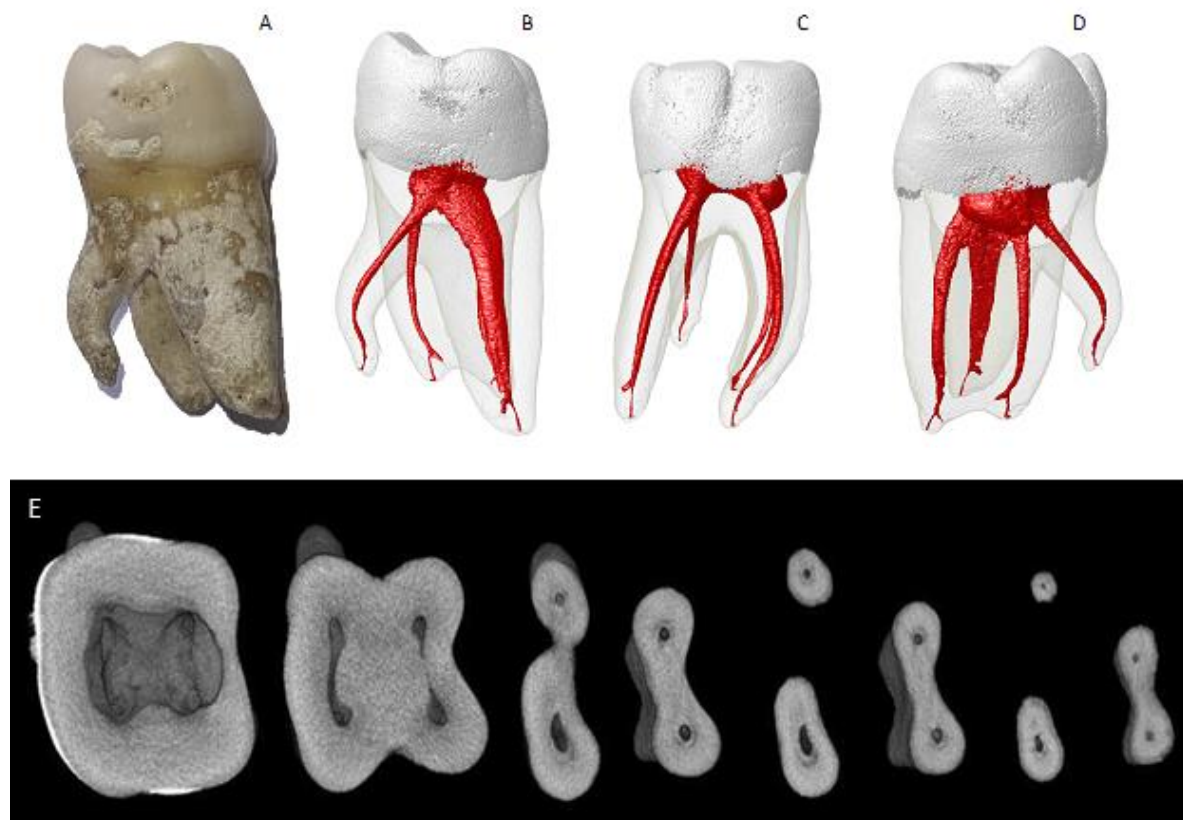
Then, De Moor<sup>3</sup> et al. (2004) classified REs into types I–III based on the curvature of the separate RE variants in buccolingual orientation. Type I, with a straight root canal; type II, with an initially curved entrance which continues as a straight root canal; and type III, with an initial curve in the coronal third of the root canal and a second curve starting in the middle and continuing to the apical third. Type III is found more frequently than the other anatomical types.<sup>16</sup>

Recently, in addition to the I-III types already classified, RE was categorized into 5 types according to their morphologic features by using three-dimensional images reconstructed from cross-sectional computed tomography images. The new types of RE were named ‘small type’, when its length is half of the distobuccal root’s, and ‘conical type’, which is even tinier than the small type and has no root canal.<sup>17,18</sup>

Regarding root canal morphological variations, the RE is typically rounder and is classified as Vertucci<sup>19</sup> type I configuration, the simplest canal anatomy of all types.<sup>19,20</sup>

The use of micro-CT provides the tridimensional analysis of root canals *in vitro*, which, allows to establish the distance between the distal canal and RE, and thus may also serve as a useful guideline when locating and treating a RE.<sup>21,22</sup> To facilitate the location of RE, it be found 2.7 mm from the distobuccal canal orifice, 4.4 mm from the mesio buccal canal orifice, and 3.5 mm from the mesiolingual canal orifice.<sup>21</sup>

Figure 1: (A) Extracted tooth #46, showing *Radix Entomolaris*. (B, C, D) Three-dimensional image, using micro-CT (E) cross-sections from cervical to apical third, showing the anatomy of the *Radix entomolares*. Note the distance between the root canals and the RE.



Clinically, a more prominent occlusal distal or distolingual lobe, in combination with a cervical prominence or convexity, forms a complex external contour of the root canal furcation, which can indicate the presence of an additional root. A similar

observation has been reported by an anterior study that shows that an increased number of cusps is not necessarily related to a higher number of roots; however, an additional root is nearly always associated with an increased number of cusps.<sup>23,24</sup>

#### 4.2 PREVALENCE AND ETIOLOGY

Many studies have reported that the prevalence of RE is related to certain ethnicities, ranging from 3 to 5% on African, Caucasian and indigenous populations,<sup>12,13,14,15</sup> and up to 30% on populations with Mongol traits, such as Chinese, Eskimos and Americans.<sup>13</sup> Populations from American countries such as the United States and Brazil show a prevalence of 2.2% and 4.2% respectively.<sup>24,25</sup> However, since the Brazilian population is miscegenetic, with ancestries from Europe, Africa, indigenous tribes, and many other ethnicities, it is believed that the frequency of RE on the Brazilian population may be higher than in other countries.

However, the etiology of RE is still unclear. In populations with high frequency of RE, it is considered to be a normal morphological variant (eumorphic root morphology), that is, ethnical genetic factors influence a deeper expression of a specific gene which reflects in a more pronounced phenotypic trait. In caucasians, RE is considered unusual or as a dysmorphic root morphology. The dysmorphic roots may be related to either external factors during the odontogenesis, atavism, or to the polygenetic system.<sup>13,23,26</sup>

RE can be found on the first, second and third mandibular molar, occurring with lower frequency on the second molar.<sup>27</sup> Some studies reported a bilateral occurrence, between 50 to 67%,<sup>28</sup> however others have reported only unilateral occurrences.<sup>21</sup> No significant difference was found in the side of occurrence, despite some studies describing it to be more to the right while others more to the left side. Regarding gender predilection, no significant difference was found in the prevalence of RE.<sup>14</sup>

This variety of results can be attributed to the different methodologies applied in the identification of RE. Some previous studies used extracted teeth<sup>11,12,29</sup> to identify permanent three-rooted mandibular molars, which might have led to an underestimation of their frequency, as teeth with slender roots can easily be fractured during an extraction.<sup>21</sup>



### 4.3 CLINICAL APPROACH

If this RE is not located, the root canal preparation may lead incomplete and consequently provide the endodontic failure, which can cause postoperative pain and propagation of radicular infection. Thus, careful visualization of the periapical preoperative radiography and attention to details, such as unclear outlines of the distal root and double vision of the periodontal ligament, are both essential for the identification of RE.<sup>16</sup> Furthermore, previous studies<sup>12,14,23,30,31,32</sup> suggest a variation of the horizontal angle of 30° to mesial on radiographies, to improve the visualization of the additional distal root (Figure 2). In an anterior study it was reported that on more than 90% of cases, RE can be visualized on the radiography.<sup>12</sup>

Figure 2: (A) Initial radiograph of tooth (#46) with extensive caries. Note the suggestive image of *Radix entomolaris*; (B) Location of root canal orifices. RE with independent path and root canal; (C) Final radiograph with all root canal filled; (D) Clinical aspect after trapezoidal access to enable RE preparation.

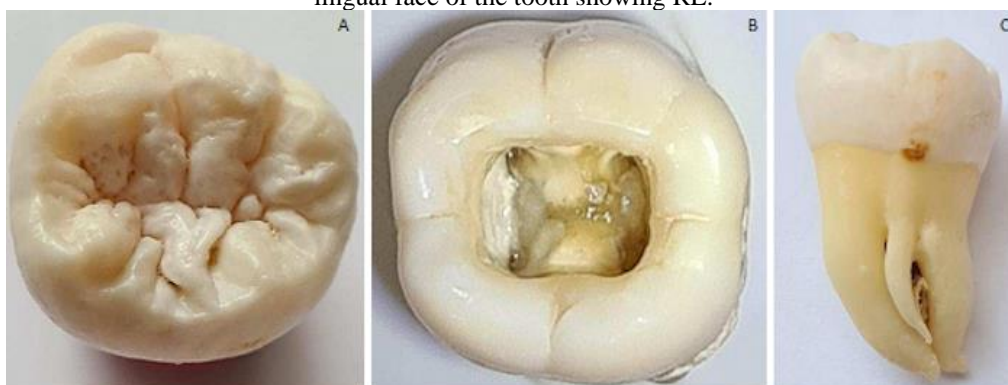


The location of root canals, previously identified with the use of periapical radiographies solely, is now widely used to proper planning of endodontic treatments, for that, the introduction of cone beam computed tomography (CBCT) in endodontics.<sup>34</sup> Aside from presenting high resolution tridimensional images of teeth, CBCT allows the visualization of different slices, which can be useful in the detection of additional canals, anatomical deviations, perforations, radicular reabsorptions and pathologies that can affect hard tissues.<sup>35</sup> However, considering the ALADA (as low as diagnostically acceptable) principle and aligning with the literature, every radiation exposure should be clinically justified, and principles should be followed to minimize the patient's exposure to ionizing radiation while maximizing the diagnostic benefit.<sup>36</sup> Therefore, although CBCT imaging accurately displays complex dental anatomy, it should not be routinely used simply to search for a supernumerary root in mandibular first molars given that the frequency of this variation is of <5% in several populations.<sup>10</sup>

As such, there are some limitations in the morphologic study in the root canal system of teeth when using CBCT *in vivo*. If the diameter of the root canals is smaller

than 0.25 mm, it is impossible to get a clear view in the LCD monitor.<sup>21</sup> In view of these limitations imposed by radiographic and CBCT images, the importance of clinical diagnosis and especially knowledge about these anatomical variations is evident. The clinic inspection of the tooth crown and analysis of the cervical morphology of the roots with a periodontal probing can both also facilitate the identification of an additional root. A greater prominence of the distolingual cusp, in combination with a cervical prominence or convexity, can indicate the presence of an extra root.<sup>37</sup> In relation to access, a quadrangular or trapezoidal opening can be chosen instead of the traditional triangular (Figures 2,3,4). According to the symmetry law, there is an equidistance between the orifice of the canal and the line traced from mesial to distal through the floor of the pulp chamber, so the use of another access would allow a greater field of view.<sup>14</sup>

Figure 3: (A) Initial clinical aspect of the occlusal surface of the tooth with prominence on the lingual cusp, suggesting RE; (B) Modification of the access to the trapezoidal shape due to the presence of the extra root. Greater compensatory wear in order to allow preparation and filling; (C) Clinical aspect of the lingual face of the tooth showing RE.



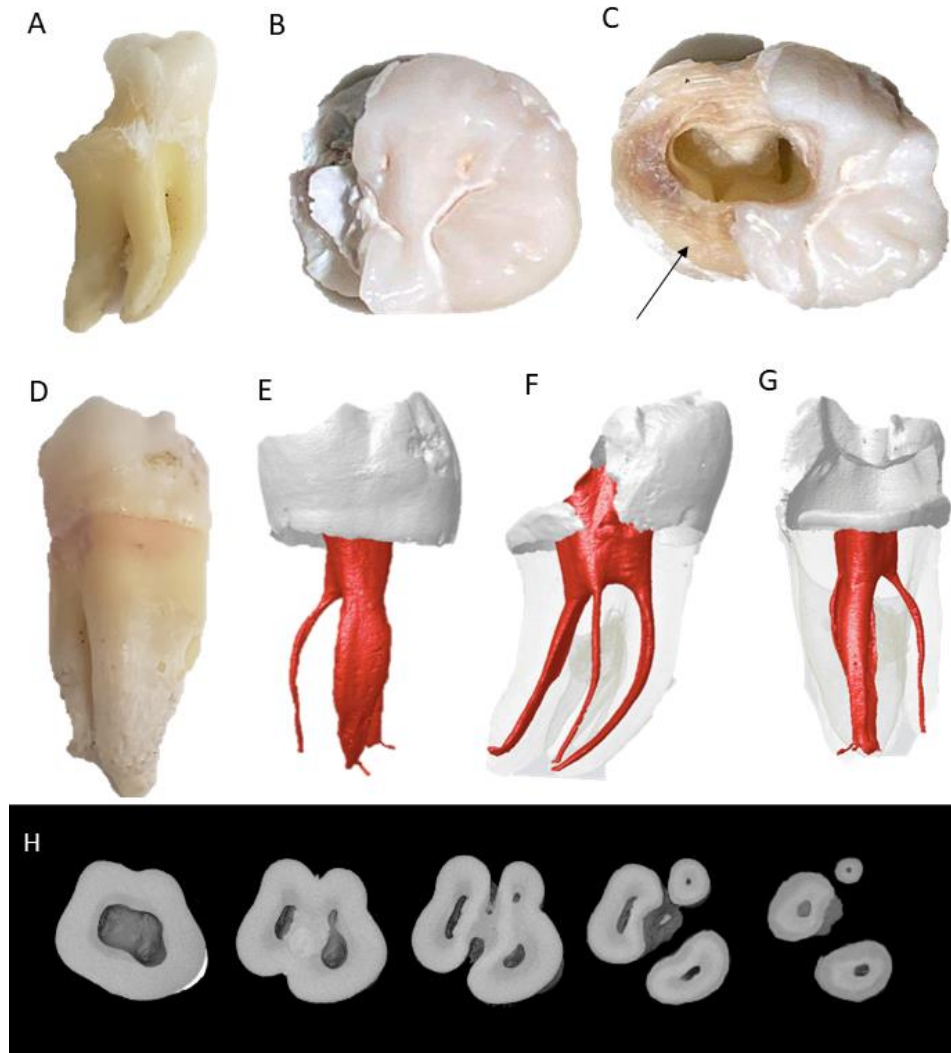
The RE canal orifice could be occluded by secondary or calcified dentine, thus, it is suggested to also observe the floor of the pulp chamber and look for a dark line, that leads to the entrance to the orifices.<sup>6,23,38</sup> Therefore, the ultrasonic cutting tips provide during access procedures make them a convenient tool in such cases.<sup>14</sup> Periodontal probing can also facilitate the identification of RE, just like magnifying glasses, microscopes, coloration of the floor of the pulpar chamber with 1% methylene blue and the “bubbling” effect of hypochlorite when in contact with pupal remains from the distolingual canal.<sup>5,18,39</sup>

Generally, RE presents a shorter root than disto- and mesiobuccal roots, lingual bends, and have thinner and narrower canals (Figure 4). These quirks can be taken into account during endodontic treatment, by opting for the use of, for example, a thinner



instrument, in order to avoid iatrogenesis such as perforations and failure of the endodontic treatment.<sup>15,16,32</sup>

Figure 4: (A) Clinical and micro-CT aspect of tooth (#37), with RE (B, C) Coronary access modified to the quadrangular shape due to the presence of the RE (black arrow). (D) lingual surface of the tooth with RE. (E,F,G) Three-dimensional image, using micro-CT. (H) Cross-sections from cervical to apical third, showing the anatomy of the *Radix entomolares*



## 5 CONCLUSION

Dentists should have knowledge of the morphology prevalence, etiology, and therapeutic conduct in face of the presence of *Radix Entomolaris*, to achieve a proper endodontic treatment.

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