Review Article

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Radix Entomolaris: Literature Review

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ABSTRACT

Background: Most commonly permanent mandibular first molars have two roots, one mesial, and the other distal root. In permanent mandibular first molars, anatomical variations like the number of root canals configuration and presence of a number of roots and their morphology are most common. Most complex morphological variation is the presence of supernumerary root either lingually or buccally. When the supernumerary root is located distolingually to the main distal root is known as "Radix Entomolaris (RE)". Adequate knowledge of root canal morphology and its variations are helpful for proper diagnosis, identification and treatment planning of this complexity, which leads to the successful outcome of endodontic treatment. The main goal of this article is to discuss the prevalence, morphology, classification, clinical and radiographic diagnosis and clinical significance of radix entomolaris in a permanent mandibular first molar.

Keywords: Distolingual root, radix entomolaris, mandibular molars, supernumerary root, additional root, extra root, root canal morphology.

INTRODUCTION

The primary goal of the endodontic procedure is the elimination of bacteria and their toxins from the infected root canal system and the prevention of subsequent reinfection. This is achieved by a thorough chemico-mechanical preparation of the root canal space, followed by a three-dimensional hermetic seal.

According to Swartz, Skidmore and Griffen, reported that endodontic outcome of permanent mandibular first molars has a lower success rate compared with other teeth.[1] For this reason, clinicians must have adequate knowledge of root canal morphology and its variations, for prevention of failure of the endodontic treatment. Normal anatomy of permanent mandibular first molars has mesial and distal roots with three root canals, two mesial and one distal [2,3]. Many authors have been described the variations of root canal configurations in permanent mandibular first molars. In the study of anatomical variations, Fabra-Campos documented the presence of three mesial canals, whereas Stronger reported three distal canals [4,5].

Carabelli was first reported Radix entomolaris, an anatomical variant found in a permanent mandibular molar.[6] It is characterized by the presence of supernumerary root, which is typically present disto-lingually. Radix entomolaris can be found in the first, second, and third mandibular molars, but the least frequently seen in the second molar.[7-9] Prevalence of Radix entomolaris has been found less than 5% in white Caucasian, African, Eurasian and Indian populations while it

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seems to be appeared in races of Mongoloid traits such as the Chinese, Eskimos, and Native American populations with a frequency of 5-30% [10-13]. Success of endodontic treatment also depends on careful clinical and radiographic diagnosis. Different angulations of radiographs are indicated for the diagnosis of anatomical variations like extra canals/roots [14]. However, a drawback of conventional radiography is that it gives information of three-dimensional object into two-dimensional image, resulting in the superimposition of the overlying structure.

Nowadays, cone-beam computed tomography (CBCT) has been developed as a more useful diagnostic tool to aid in the diagnosis of teeth with complex root anatomies [15, 16]. The tomographic image creates a three-dimensional view of the entire tooth at different levels. It eliminates images of superimposed structure and gives a high-contrast resolution and data from a single computed tomography imaging process, and the images can be viewed in oblique, coronal and sagittal planes. Finally, CBCT data is providing information in three-dimensional images in the axial, coronal, or sagittal planes [17].

The main goal of this article is to discuss the prevalence, morphology, classification, clinical and radiographic diagnosis and clinical significance of radix entomolaris in a permanent mandibular first molar.

Literature review

Synonyms

The term "Radix entomolaris" (RE) a supernumerary third root is located distolingually was first reported in the literature by Carabelli[6] and various terms are used for RE is "extra third root" or "distolingual root" or "extra distolingual root."[14]

Prevalence of RE

The prevalence of radix entomolaris in permanent mandibular first molar is incorporated with several ethnic and racial groups. In Mongoloid populations such as Chinese, Eskimo and American Indians, the frequency of Prevalence of RE maybe 5-30%.[12,11,13,18,19,20] Because of its high prevalence in these populations, the RE is considered to be Eumorphic root morphology. In Eurasian and Indian populations, it is less than 5% and in African populations less than 3%.[21] In Caucasians, low prevalence of 3.4–4.2% has been found and considered to be unusual or dysmorphic root morphology[21,20] RE has been reported occurring in the first (7.4%), second (0%), and third permanent mandibular molars (3.7%) occurring with the least frequency or none on the second molar.[22]

Prevalence of three roots in primary molars

Several studies on a survey of extraction of molars are reported that prevalence of extra root is higher in permanent molars compared with primary molars.[23,24,25,26,10] Due to the occurrence of physiologic or pathologic resorption and divergence of sound roots create difficulty in extraction of primary molars, which is responsible for fewer kinds of literature on the incidence of extra roots in the primary molars.

Tratman [10] reported that in primary dentition, the frequency of three-rooted mandibular first molars are less than 1% and comparatively higher in the permanent dentition. Curzon and Curzon [27] concluded that the prevalence of primary anomalies is higher in Native American than white populations. In Taiwanese (Chinese) the prevalence of permanent three-rooted mandibular molars is 21.1%, but very few literature on primary three-rooted mandibular molars in Mongolian descent is reported.[28] Jorgensen [29] documented seven cases (0.67%) of the extra root in 1041 second primary molars extracted from the Danish population. Trautman [10] described no extra root in samples collected from Europe and India but found extra root in 3 samples out of 42 samples of second primary molars (7.1%) collected from the Japanese population. On the radiographic study of the Japanese population, revealed that the occurrence of 5.6% of extra distolingual root on mandibular primary first molars.[30] According to Tu et al. [31] the prevalence of additional root in primary first molars of Taiwanese children was 5%. Song et al. [32] reported the maximum prevalence of extra root in second primary and first primary molars is 27.8% and 9.7% respectively in Korean children and Liu et al.[33] documented 18 (9%) cases of three-rooted primary second molars in the Chinese population.

In both first and second molars of the primary dentition, the extra root can be found. But there is no definitive study which gives information regarding the presence of RE in primary molars, indicates extra root in permanent molars. Recently Song et al. [32] reported the prevalence and relationship of the extra root in the permanent mandibular first molar and primary molars in 4050 children were evaluated. They appeared extra roots in 33.1%, 27.8%, and 9.7% of the first permanent, second primary, and first primary molars respectively, and concluded that when the extra root was present in a primary molar, the possibility of the occurrence of the extra root in the posterior adjacent molar was greater than 94.3%.

Gender differences

Some investigators claimed that it is a sex-linked, dominant character and other investigators reported that it has no sex predilection. Most studies give information regarding male predominance. [33,34,35,36] While, others reported that the prevalence of extra root was similar in both sexes[23,31,33] or rather more in females.[28] Tratman[10] reported that it is more common on the right for the male and bilateral for the female. Loh[23] mentioned no statistically significant difference in the predilection of RE for either sex.

Topological predilection

Many studies have reported right-side predominance of RE not only found for the permanent molars but also present for the primary molars. [28,10,36] In contrast, some investigators have reported a predilection of RE for the left side.[23] The unilateral or bilateral occurrence of RE is also controversial. Some studies reported bilateral occurrence of the RE ranging from 50–67%.[28,23,33,36]

According to Quackenbusch[37] and other reported, RE occurred unilaterally in approximately 40% of all cases and predominantly on the right side. Other reports also support this prevalence.[28,10,36] These findings have highly emphasized the fact that while treating right mandibular molars clinician must look for additional distal root to prevent failure of root canal treatment.

Etiology

According to Calberson et al. (2007) the aetiology of RE is still unclear.[38] But the literature reported that the formation of dysmorphic, supernumerary extra roots might be related to external factors during tooth formation or can be related to the penetration of an atavistic gene or polygenetic system. Whereas in eumorphic roots, racial genetic factors can influence the profound expression of a particular gene that can result in the more pronounced phenotypic manifestation.[18]

Morphology

Carlsen and Alexandersen described the identification and external morphology of RE.[39,40] RE is located distolingually with its coronal third can be fixed partially or completely to the distal root. It appears smaller and more curved in orientation than the distobuccal or mesial root. RE is ranging from a short conical extension to a mature root with normal length and root canal.[14,40] Cross-section of RE is more circular than the distal root, directed lingually about 45° to the long axis of the tooth, and has type I canal configuration.[14,40] Mostly, pulpal extension is visible on a radiograph. In some cases, root inclination of apical two-third of RE may be appeared moderate to severe mesially or distally oriented. While in others, it may be found straight or curved to the lingual direction. Clinically, the distal furcation is about 1mm lower than the furcation between mesial and distal roots.[41] Tratman[10] reported that RE is a true extra root with a separate orifice and apex.

Classification

Carlsen & Alexandersen (1990) classified radix entomolaris (RE) into four different types based on the location of its cervical part [40]:

1. Type A: the RE is located lingually to the distal root complex, which has two cone-shaped macrostructures.

2. Type B: the RE is located lingually to the distal root complex, which has one cone-shaped macrostructure.

3. Type C: the RE is located lingually to the mesial root complex.

4. Type AC: the RE is located lingually between the mesial and distal root complexes.

De Moor et al. (2004) classified radix entomolaris based on the curvature of the root or root canal [14]:

1. Type 1: a straight root or root canal.

2. Type 2: a curved coronal third which becomes straighter in the middle and apical third.

3. Type 3: an initial curve in the coronal third with a second buccally oriented curve which begins in the middle or apical third.

Song JS et al. (2010) further added two more newly defined variants of RE [42]:

1. Small type: length shorter than half of the length of the distobuccal root.

2. Conical type: smaller than the small type and having no root canal within it.

Radix Entomolaris in Association with Other Anomalies

Some kinds of literature reported [43,38] that RE is associated with the presence of additional cusp on the buccal aspect of mandibular first molars (protostylid). The presence of supernumerary root is always associated with an increased number of cusps and with an increased number of root canals.[38] But, an increased number of cusps are not always associated with an increased number of roots. George et al. [44] reported shovel-shaped incisors, three-rooted primary and permanent molars, talon cusp, and supernumerary tooth simultaneously appear in a 7-year-old Hispanic male patient. Winkler and Ahmad [45] documented, occurrence of multirooted anomalies including bifurcated maxillary primary canine, primary three-rooted first molar and bilateral primary three-rooted first and second primary molars in Native Americans.

Examination of RE

Clinical diagnosis

Morphology of mandibular molar is the crown with two normal roots with an additional distolingual/mesiobuccal root appears similar to those found in a normal molar.**[38]** So, only clinical examination of the crown for diagnosis of RE is not adequate. Literature reported that clinical examination and objective analysis of the cervical morphology of the roots by periodontal probing facilitate clinical diagnosis of RE. Clinical analysis of the presence of an extra cusp or more prominent distal cusp or distolingual cusp, in combination with a cervical prominence or convexity, can indicate the presence of an extra root.**[38]** Before starting of endodontic treatment, if RE is diagnosed. It is very helpful of the dentist for the identification of an additional canal orifice during access cavity preparation.

Several methods are used to identify the orifice of an additional root. Lists of the diagnostic methods and tools are: knowledge of law of symmetry and law of orifice location, tactile sensation with an application of hand instruments like an endodontic explorer, pathfinder, DG 16 probe and micro-opener, use of trans-illumination with fibre-optic light, dental endoscopy, intraoral camera, surgical loupes, operating endodontic microscope, microcomputed tomography (Micro CT), and magnetic resonance microscopy.[38]

Radiographic diagnosis

An accurate radiographic diagnosis of RE in mandibular molar is very important to avoid complication or failure of endodontic treatment due to missed canal during the procedure. During preoperative radiographic interpretation, if the outline of the distal or mesial root contour or the root canal appears unclear, which can be suggested the presence of an additional root.[38] Ingle et al.[46] has reported that a minimum of three radiographic exposures is required to obtain thorough basic information of the anatomy of the tooth. One radiographic exposure from the standard buccal-to-lingual projection, second taken 20° from the mesial, and the third taken 20° from the distal of the tooth. Loh[23] has reported that the RE does not normally appear in intra-oral periapical radiographs that are taken in the standard buccal-to-lingual or traditional manner. Walker and Quackenbush[19] reported that approximately 90% accuracy is achieved by panoramic radiographs.

Clinical Implications of RE

Endodontic implications

The success of endodontic treatment depends on thorough cleaning, shaping and three-dimensional hermetic seal of root canal space. Presence of RE may create an endodontic challenge, as incomplete removal of infected pulpal mass due to missed canal, which leads to failure of endodontic treatment. In case of RE, the conventional triangular endodontic access cavity preparation must be modified to a trapezoid or rectangular form for better access and identification of the distolingual orifice of an extra root.[14,38] In case of type III RE may create an endodontic challenge, such as straightening of the root canal or a ledge formation with loss of working length. Calberson et al.[38] reported that the use of nickel-titanium flexible rotary files, which increase the chance of orifice relocation and create the centring of the canal in the apical third. An endodontic mishap like instrument separation occurs due to the severe curvature or narrow root canals. Calberson et al.[38] recommended that initially negotiation of curved root canal space is achieved by small files (size ten or less), then working length determination is done and create a glide path before starting of cleaning and shaping of root canal space to avoid procedural errors.

A prevalence study was done by Tu et al.[8] in Taiwanese population using cone-beam computed tomography and measured the distance between the orifices in a mandibular first molar. He concluded that inner orifice distances from the distolingual canal to the distobuccal (DB), mesiobuccal (MB), and mesiolingual (ML) canals were 2.7, 4.4, and 3.5 mm, respectively in permanent three-rooted molars. These values might help dentists for the location of canal orifices in permanent molars with distolingual root. In the case of RE, the access cavity must be extended in the distolingual direction that requires modification in access cavity from triangular to rectangular or trapezoidal form for better location and identification of canal orifice of an additional root.[38]

Exodontic implications

During extraction procedure of three rooted primary molars, the dentist should make sure that the crown of the permanent premolar tooth bud is not entrapped in the inter-radicular space of the primary molar because it may cause the accidental removal of the developing permanent tooth bud.[45] After the extraction procedure, the dentist should evaluate the extracted anomalous three rooted primary molars to confirm that all roots have been removed from the alveolar bone.

Surgical removal of a permanent first molar with RE is more difficult compared to the molar without RE. During the extraction of three rooted molars, if rotational forces are applied, root fractures could occur. Mostly fracture of an extra distolingual root would occur due to its divergent and curved form.[14]

Orthodontic implications

During orthodontic procedures, orthodontic movement of three rooted molars is very difficult, because the presence of extra root prevents movement of the molar.[23,47] In the case of RE, the stability of molars is increased by providing an increased surface area of attachment to the alveolus.[23,47] Still, it is not clear that three rooted molars affect the normal exfoliation of the primary teeth; it is not known if these anomalous teeth present orthodontic problems.

Periodontic implications

Huang et al. [48] reported that the presence of RE might be an etiological factor in the development of localized periodontitis. In their literature, patients demonstrated the significantly greater probing depth and attachment loss at distolingual aspects than at distobuccal aspects of three rooted molars. Molars with RE manifested greater attachment loss around the distolingual root compared with molars that had only one distal root.

Forensic odontology

In primary or permanent molars, the presence of a third root may have forensic value for identifying people of the Mongoloid origin.[28,47]

CONCLUSION

The oral health care professionals should take into account the Prevalence of RE and its variations in the anatomy of permanent mandibular first molars. Before initiating routine endodontic and exodontic procedures in a mandibular first molar, proper interpretation of radiographs taken at different horizontal angulations as well as CBCT technology proves helpful in locating canals with a high incidence of anatomical variations. The clinician should have a thorough knowledge of the Prevalence of RE, its anatomical variations as well as a clinical and radiographic diagnosis will provide a better understanding of its complexity in order to ensure successful treatment outcomes.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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