

# Radix Entomolaris and Radix Paramolaris: A Review and Case Report

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## Abstract

The majority of anatomic variations are found in the roots of the mandibular first molar. One such is radix entomolaris (RE) and radix paramolaris (RP). RE has been reported to occur with a frequency of 0.2–32% and RP 0–1.2% in different populations. A thorough understanding of root canal morphology, prevalence, and canal configuration of RE and RP ensures successful treatment outcomes and also eliminates endodontic failure in the future. This paper includes a review and case description of three rare cases of RE. The majority of patients reported with a chief complaint of pain in their lower back tooth region. Based on diagnosis, endodontic treatment was planned. Investigations revealed the presence of an extra root in all these cases. To know complex root anatomies, the use of cone-beam computed tomography is helpful to a great extent. Cases such as RE and RP once diagnosed, management of the extra canal can be done using equipment such as magnification aids, orifice locators, and flexible files. A common clinical problem posed by the three-rooted molar is the possible fracture of the distolingual root during extraction. Meticulous care should be taken from diagnosis till the completion of the treatment procedure, especially in cases of root canal therapy.

**Keywords:** Anatomic variation, Permanent mandibular molar, Radix entomolaris, Radix paramolaris.

## INTRODUCTION

The first and foremost aim of endodontic treatment is the elimination of micro-organism from the infected root canal and the prevention of subsequent reinfection. This is mostly accomplished by proper cleaning and shaping of all the root canals. Along with this a three-dimensional filling and impervious fluid-tight seal of the canal is required to prevent further contamination. To achieve good results of endodontic treatment, the clinician must have comprehensive knowledge of root canal morphology and must know its anatomic variations such as extra roots, extra canals, webs, fins, and isthmuses which may intricate the endodontic procedures.

Due to root canal complexity, mandibular first molars have a significantly lower success rate compared with other teeth.<sup>[1]</sup> In general, permanent mandibular first molars have two roots and three root canals but the number of roots for the mandibular first molar teeth may also vary due to external factors during odontogenesis or could be related to polygenetic system or penetrance of an atavistic gene. In the case of eumorphic roots, the expression of a particular gene is thought to be enhanced

by racial genetic factors resulting in a more pronounced phenotypic character.<sup>[2]</sup>

Mandibular first molars were the first to report with supernumerary roots. This additional third root was present on the disto-lingual side and was called radix entomolaris (RE). This Latin term RE was coined by Mihaly Lenhossek, Carabelli (1844) was the first to provide a short description of this root, but without naming it.<sup>[3]</sup> Bolk (1915) called it radix praemolarica, as he considered it the last manifestation of the third premolar which was obsolete during the evolution of primates and thought that it occurred only on a permanent first mandibular molar. Later, contradicting Bolk's idea, this additional root was also seen in the second and third permanent mandibular molars and even on the first and second primary

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mandibular molars.<sup>[4]</sup> When extra root is seen on the buccal side, then it is called as radix paramolaris (RP) as suggested by Bolk.<sup>[5,6]</sup>

For successful root canal treatment of the tooth, careful radiographic diagnosis plays a critical role. Radiographs taken at different angulations provide the primary information concerning the tooth anatomy. A notable limitation in conventional radiography is that it produces a 2-D image of a 3-D object. To overcome these restrictions of conventional radiographs, cone-beam computed tomography (CBCT) has come into view as an advantageous tool to aid in the diagnosis of teeth with complicated root anatomies. The edge of CBCT imaging is that it entirely removes the superimposition of structural images outside the area of interest and yields a high-contrast resolution from a single CBCT imaging process. In addition, CBCT data are amenable to reformation in a volume, rather than a slice, providing three-dimensional images in the axial, coronal, or sagittal planes<sup>[7]</sup>. Hence, it facilitates the tracking the curvature and averts iatrogenic errors such as perforation, ledge formation, instrument separation, and so forth.

The purpose of this article is to discuss the prevalence, morphology, classification, clinical diagnosis, and significance of supernumerary roots in contemporary clinical pediatric dentistry, along with it a case series of successful endodontic management of five cases with RE of first mandibular permanent molars has been discussed.

### Prevalence of RE and RP

In populations with Mongoloid traits (for example, Chinese, Eskimo, and American Indians), the frequency can range from 5% to 30%.<sup>[8-12]</sup> However, in Eurasian and Indian populations, it is <5%, and in African populations, it is <3%.<sup>[13,14]</sup> The maximum frequency of occurrence of RE has been observed in the first mandibular permanent molar (7.4%), followed by third molars (3.7%) with the least frequency reported on the second molar (0%).<sup>[13]</sup> Studies have also reported a bilateral occurrence with a frequency of 50–67%.<sup>[15]</sup>

### Classification of RE and RP

RE a distolingual root exhibits different morphologic features. De Moore *et al.* 2004 classified RE based on the curvature of the root or root canal in bucco-lingual orientation into three types<sup>[16]</sup>: Type I – a straight root and canal; Type II – initial entrance is curved but the root is straight; and Type III – the coronal third of the root canal is curved, in addition, there is a second buccally oriented curve from the middle to the apical third (Figure 1a).

Carlson and Alexandersen in 1990 classified four types of RE (A, B, C, and AC), on the basis of the location of the cervical portion of the root<sup>[17]</sup>: Type A – located distally, with two normal distal root components; Type B – located distally, with one normal distal root component; Type C – a mesially located cervical part; and Type AC – a central location, between the mesial and distal root components (Figure 1b).

The classification of REs is based on the location of the cervical part on axial slices of CBCT images. (a) Type A, (b) Type B, (c) Type C, and (d) Type AC<sup>[18]</sup> (Figure 2a).

Song *et al.* in 2010 suggested a new classification based on morphologic characteristics assessed from coronal sectional computed tomography technique<sup>[19]</sup>: Type I – no curvature; Type II – curvature in the coronal third and straight continuation to the apex; Type III – curvature in the coronal third and additional buccal curvature from the middle third to the apical third of the root; SMALL TYPE – length of the root is less than half that of the distobuccal root; CONICAL TYPE – cone-shaped extension with no root canal (Figure 2b).

By examining 203 permanent mandibular molars with root complexes containing RP, Carlsen and Alexandersen classified RP into two types<sup>[17]</sup>: Type A – cervical part is located at the mesial root complex and Type B – cervical part is located centrally, between the mesial and distal root complexes (Figure 1c).

## CASE DESCRIPTION

### Case no. 1

A 12-year-old female patient reported with a chief complaint of sharp shooting pain in the right lower back tooth region for 10 days which aggravated with lying down position. Furthermore, complaint of food lodgment in the lower left back tooth region for 2 months. Following case history, clinical evaluation, and radiographic investigations, final diagnosis was made as symptomatic irreversible pulpitis and asymptomatic apical periodontitis in relation to the lower right and left first molar, respectively. Bilaterally, an additional root was present distally.

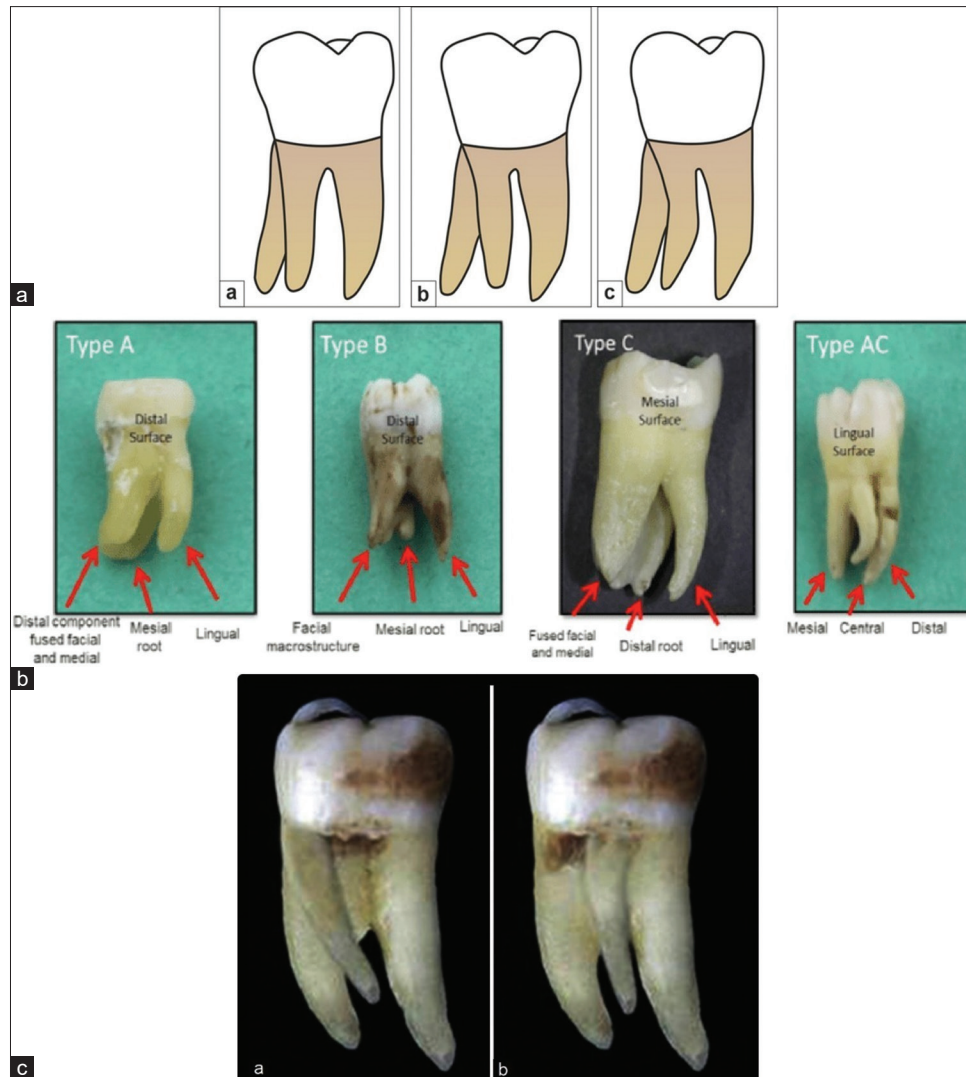
### Case no. 2

A 13-year-old male patient presented with pain and swelling in the right lower back tooth region for 1 month. He also reported dull aching pain while chewing in the left lower back tooth region for 1 month. On the basis of thorough case history, clinical examination, and radiographic investigations, final diagnosis of chronic alveolar abscess was made in relation to both the right and left mandibular first permanent molar.

### Case no. 3

A 13-year-old male patient complained of pain in the left lower back tooth region for 1 week. Clinical examination revealed deep occlusal caries. Along with it, radiolucency was appreciated in the furcation area when seen radiographically. The tooth was unresponsive on electric pulp testing. A diagnosis of chronic alveolar abscess in relation to the lower left first molar was made. CBCT scan of the lower left side of the mandible revealed that the presence of an extra distal root in relation to the first permanent molar suggests RE (Figure 3).

Based on the final diagnosis, all the patients were advised to undergo root canal treatment.



**Figure 1:** (a) classification of radix entomolaris (RE), based on its curvature; (b) classification of RE, based on the location of its cervical portion; (c) classification of radix paramolaris

### Treatment procedure

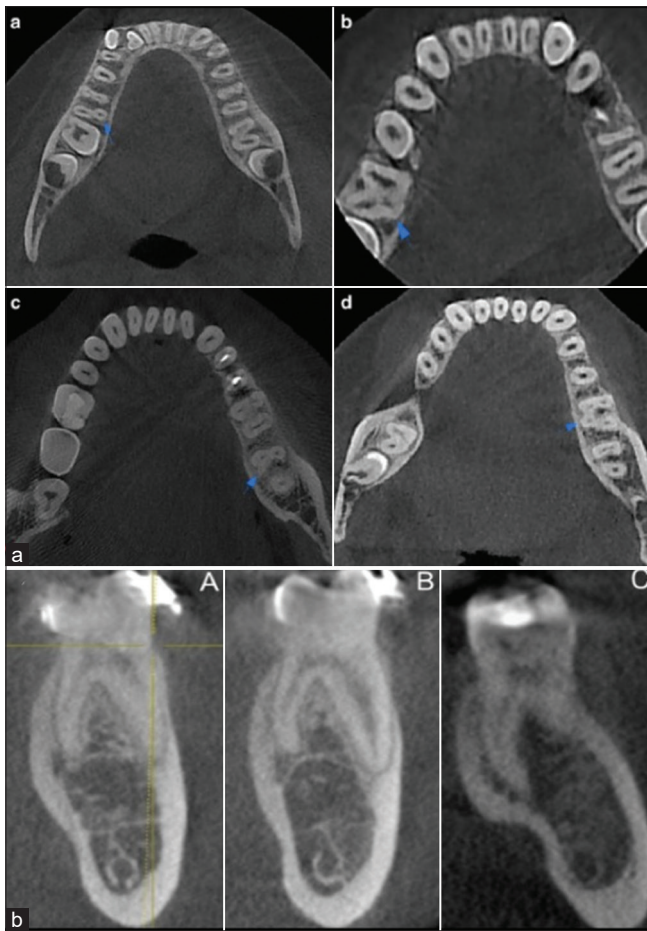
The endodontic procedure was performed under magnification Zamax TTL 3× loupes (Zamax Medical Co., Ltd.). The conventional access cavity was modified into more trapezoidal cavity into distolingual direction rather than classic triangular shape. In the case of RP, the access cavity shape is modified by extending the cavity in mesiobuccal direction; the precautions and procedure for RP remain the same as in RE during endodontic intervention. A dye (Reveal, Prevest DenPro limited) was used to detect the canal orifice. Along with it, the use of ultrasonic (Dr Talal's endo tip T3-woodpecker) troughing provided a good approach to explore all anatomic variations of the pulp chamber to locate and open the orifice of the distolingually located RE. The canal lengths were determined and cleaning and shaping were performed practicing the conventional method. Biomechanical preparation was supplemented with irrigation (3% sodium hypochlorite, normal saline, and 0.2% chlorhexidine) using a side-vented needle. Irrigation activation was performed with

the help of Dr. Talal's endo tip T2 (Woodpecker). Technical difficulties during cleaning and shaping, such as ledge formation, perforation, and instrument separation are more common in RE and RP owing to slender root canals or severe curvature. Therefore, the preparation of this curved canal has been done with lesser tapered files.

Following calcium hydroxide, dressing patient was recalled after 1 week, tooth was asymptomatic. The root canals were obturated using Protaper Gutta percha cone and Bioceramic sealer by single cone technique in all the canals. Post-endodontic restoration was performed. Moreover, finally, post-obturation radiograph was taken (Figure 4).

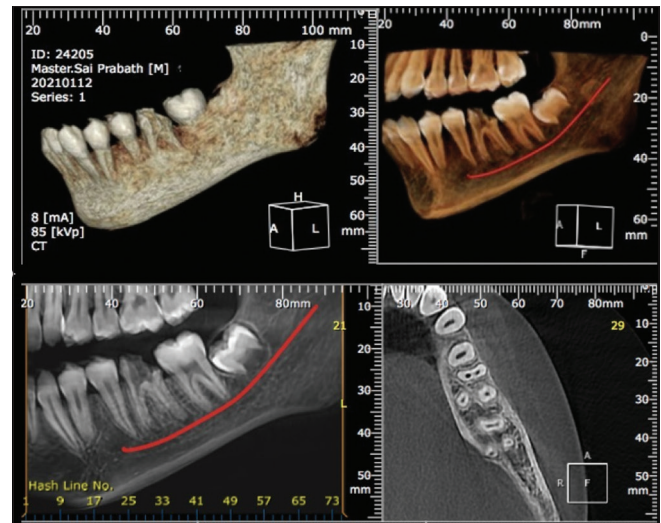
### DISCUSSION

RE, is an anatomical variant in the first permanent mandibular molar, characterized by an additional third root located distolingually. Some authors consider a RE as a genetic trait rather than a developmental anomaly.<sup>[8,20]</sup> It was first described



**Figure 2:** (a) The classification of radix entomolaris (REs) based on the location of the cervical part on axial slices of cone-beam computed tomography (CBCT) images. (a) Type A, (b) Type B, (c) Type C, and (d) Type AC<sup>[18]</sup>; (b) coronal section of a CBCT image indicating the three variants of RE according to Song *et al.*: (A) type I, (B) type II, (C) type III

by Carabelli. The crown outline of the tooth is more bulbous, the presence of an extra cusp (tuberculum paramolare) and a more prominent distolingual lobe is likely to be seen when examined clinically. In addition to the above, a cervical prominence can indicate the presence of an additional root. Understanding the complexity of these anatomical variants proves to be invaluable in the clinical approach when managing these cases endodontically. Endodontic treatment should aim more toward chemical rather than mechanical debridement of the pulpal tissue, followed by a fluid-imperious obturation to obtain a hermetic seal. RE and RP are often missed during diagnosis because of overlapping by other roots with orthograde radiographs. Magnifying loupes, an intraoral camera, or a dental microscope prove to be very useful in this respect. According to Ingle *et al.*, a meticulous radiographic assessment of the involved tooth is recommended. Initial exposure should be from the standard buccal-to-lingual projection. The second projection from the mesial at 20° angulation and the third one should be 20° from the distal.<sup>[21]</sup>



**Figure 3:** Cone-beam computed tomography scan showing radix entomolaris in relation to left mandibular molar

The complexity of the anatomical variations found in the mandibular first permanent molar is considered to be difficult when treating these cases endodontically. Magnification and illumination can significantly improve the visualisation of root canal orifices. De Carvalho and Zuolo *et al* (2000), proved in their study that the use of the Dental Operating Microscope (DOM) could increase the number of root canal orifices located in mandibular molars. They examined 11,193 first and second molars with the naked eye followed by DOM examination (8-13x magnification). A total of 641 canals were located with the naked eye and an additional 50 canals (7.8%) were located using digital operating microscope examination.<sup>[22]</sup>

Matherne *et al.* in 2008 showed that CBCT images result in the identification of a greater amount of root canal systems in teeth compared to conventional radiography.<sup>[23]</sup> The study also concluded that the combination of CBCT scanning with the dental operating microscope was important diagnostic tool for locating and identifying root canals.<sup>[23]</sup> These 3D images not only provide clinicians with anatomical detail but also diagnostic possibilities in the fields of endodontics, implantology and oral maxillofacial surgery, periodontics, general dentistry, forensic dentistry, and orthodontics. The use of CBCT in endodontics is not just confined to determining root canal morphology but also be used to establish the appropriate working length, assessment of existing obturations, and determine the exact position of separated instruments.

The current paper reports the presence of one extra root in relation to the mandibular first permanent molar which was an incidental finding on periapical radiograph. There have been many documents showing the occurrence of supernumerary roots in both permanent and primary mandibular molars of different populations. However, only a handful of studies are present reporting the prevalence of extra root variants in the Indian population.

Nagaveni *et al.* concluded in their study that the prevalence of RE was 4.5% in permanent mandibular first molars.



**Figure 4:** (a-c) diagnostic, WL, and obturation IOPA radix entomolaris cases. (a) Case 1 (diagnostic, WL and obturation IOPA radix Entomolaris w.r.t. 36 nd 46). (b) Case 2 (diagnostic, WL and obturation IOPA radix Entomolaris w.r.t. 46 and 36). (c) Case 3 (diagnostic, WL and obturation IOPA Radix Entomolaris w.r.t. 36)

They also performed a study in Davangere among pediatric population and documented that the total occurrence of three-rooted primary mandibular first molars was 1.3% with no bilateral occurrence<sup>[3]</sup> whereas in their another study, the total occurrence was 6.5% of three-rooted primary mandibular second molars among the study participants with bilateral occurrence of 2.6%.<sup>[4]</sup>

According to research by Tu *et al.*, the ethical and racial association of RE has been seen and found a prevalence of 21.1% using IOPAs and 33.33% using CBCT imaging in Taiwanese subjects.<sup>[24]</sup>

Ultrasonic tips help in careful removal of dentin and thus prevent the weakening of tooth structure.<sup>[25]</sup> The usage of flexible Ni-Ti rotary files has been recommended by Calberson *et al.* to achieve a more centered drawing-up shape of the canal with minimal enlargement of the coronal one-third and orifice relocation.<sup>[26]</sup> CBCT of the corresponding tooth should be studied carefully to estimate correct the root length and curvature. To confirm the root length, electronic apex locators can be used in such cases. Unexpected complications (such as instrument separation) are more common in RE owing to slender root canals or severe curvature. Therefore, after relocating and enlarging the canal orifice of RE, the use of small-sized files (size 10 or less) is recommended for initial exploration of the root canal before determination of working length of the curved root, as stated by Calberson *et al.* in (2007).

In-depth knowledge of root curvatures helps in the selection of NiTi rotary files and accurate planning of root canal

instrumentation. NiTi rotary files undergo hundreds of cycles of alternating compression and flexure when placed in a curved canal. The most important factor influencing cyclic fatigue is the radius of curvature. The more severe the angle of curvature with a small radius of curvature, the greater the cyclic fatigue and thus, lower its life expectancy.<sup>[27]</sup> Instrument separation is inversely proportional to the radius of curvature. Therefore, file design features including cross-sectional shape, NiTi core diameter, and flute depth should be considered while choosing the NiTi rotary instrument for curved canals.

Other straight canals were prepared using the Protaper universal system. The key features of the Protaper universal system are excellent cutting efficiency, progressively tapered design, and predictable final canal shape to allow for good cone fit. The design ensures that there is reduced contact between the cutting flutes of the instrument and the dentine wall and a reduced chance for taper lock (screw effect).<sup>[28]</sup>

A thorough inspection of the diagnostic radiographs and interpretation of certain characteristics, such as an unclear view or the distal root outline, can indicate the presence of a “hidden” RE.

### Clinical consideration

During endodontic therapy, RE/RP poses a great endodontic challenge, as incomplete pulp extirpation due to a missed canal can result in treatment failure. A common clinical problem posed by the three-rooted molar is the possible fracture of the distolingual root during extraction.

Other clinical difficulties resulting from distolingual roots would relate to orthodontic procedures, where the extra root would render

movement difficult. It is also hypothesized that the presence of extra root (RE) adds to the stability of molars by providing an increased surface area of attachment to the alveolus.<sup>[26,29]</sup>

## CONCLUSION

The successful result of endodontic treatment depends largely on biomechanical preparation and three-dimensional obturation of the entire root canal system. CBCT technology as well as proper angulation of radiographic techniques proves to be helpful in locating canal orifices, especially in first mandibular molars with a high incidence of anatomical variations. A thorough understanding of the prevalence of RE, its anatomical variations as well as radiographic and clinical diagnosis will provide the clinician with a better understanding of its complexity to ensure successful treatment outcomes.

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## CONFLICT OF INTEREST

No conflict of interest.

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