The Radix Entomolaris and Paramolaris: Clinical Approach in Endodontics

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Abstract

Mandibular molars can have an additional root located lingually (the radix entomolaris) or buccally (the radix paramolaris). If present, an awareness and understanding of this unusual root and its root canal morphology can contribute to the successful outcome of root canal treatment. This report discusses endodontic treatment of three mandibular molars with a radix entomolaris or paramolaris, both of which are rare macrostructures in the Caucasian population. The prevalence, the external morphological variations and internal anatomy of the radix entomolaris and paramolaris are described. Avoiding procedural errors during endodontic therapy demand an adapted clinical approach to diagnosis and root canal treatment. *(J Endod 2007;33:58–63)*

Key Words

Anatomical variations, endodontic treatment, mandibular molar, radix entomolaris, radix paramolaris

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The prevention or healing of endodontic pathology depends on a thorough chemomechanical cleansing and shaping of the root canals before a dense root canal filling with a hermetic seal. An awareness and understanding of the presence of unusual root canal morphology can thus contribute to the successful outcome of root canal treatment.

It is known that the mandibular first molar can display several anatomical variations. The majority of Caucasian first molars are two-rooted with two mesial and one distal canal (1, 2). In most cases the mesial root has two root canals, ending in two distinct apical foramina. Or, sometimes, these merge together at the root tip to end in one foramen. The distal root typically has one kidney-shaped root canal, although if the orifice is particularly narrow and round, a second distal canal may be present (3). A number of anatomical variations have been described in the mandibular first molar: Fabra-Campos (4, 5) and Bond (6) reported the presence of three mesial canals and Stroner (7) noted the presence of three distal canals.

Like the number of root canals, the number of roots may also vary. An additional third root, first mentioned in the literature by Carabelli (8), is called the radix entomolaris (RE) (9). This supernumerary root is located distolingually in mandibular molars, mainly first molars (Fig. 1*A*, *B*). An additional root at the mesiobuccal side is called the radix paramolaris (RP) (Fig. 1*C*, *D*). The identification and external morphology of these root complexes, containing a lingual or buccal supernumerary root, are described by Carlsen and Alexandersen (10, 11).

Although both macrostructures are rare in the Caucasian population, knowledge of their occurrence and location are important. In this report three such cases are presented. The prevalence, external morphological variations and internal anatomy of the radix entomolaris and paramolaris are described. The clinical approach to diagnosis and endodontic treatment are also discussed and illustrated.

Case Reports

Case 1

A 34-year-old Caucasian male was referred for endodontic treatment of the mandibular right first molar before the replacement of a large amalgam restoration with a ceramic crown. The tooth was free of symptoms and radiographical examination showed no signs of apical periodontitis. The pulp chamber was opened, and one distal and two mesial canal orifices were located using an endodontic explorer (DG-16 Endodontic Explorer, Ash Instruments, Dentsply, Gloucester, United Kingdom). The root canals were explored with a K-file ISO 15 (Dentsply Maillefer, Ballaigues, Switzerland) and radiographical length measurement was performed with the Rinn set (Dentsply Rinn, Elgin, IL) (Fig. 2*C*).

Upon visual inspection with a microscope (OPMI Pico, Zeiss, Zaventem, Belgium), a dark line was observed between the distal canal orifice and the distolingual corner of the pulp chamber floor. At this corner overlying dentin was removed with a diamond bur with a noncutting tip (Diamendo, Dentsply Maillefer) and a second distal canal orifice was detected (Fig. 2*A*, *B*). The canal length was determined electronically using an AFA Apexfinder (EIE Analytic Technology, Orange, CA) and the root canals were shaped with ProTaper rotary instruments (Dentsply Maillefer). During preparation, File Eze (Ultradent Products Inc., South Jordan, UT) was used as a lubricant and the root canals were disinfected with a sodium hypochlorite solution (2.5%).

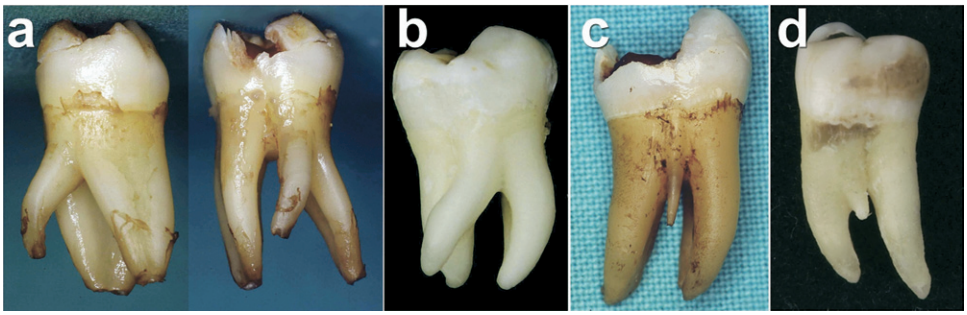

Figure 1. Clinical images of extracted mandibular molars with a radix entomolaris or paramolaris. (*A*) first molar with a radix entomolaris [distolingual view (left), lingual view (right)]. (*B*) radix entomolaris on a third molar (lingual view). (*C*) first molar with a separate radix paramolaris (buccal view). (*D*) first molar with a fused radix paramolaris (buccal view).

Initially, the distolingual root canal was thought to be a second canal in one distal root. Radiographically the outlines of the distal root(s) were unclear; however, the unusual location of the orifice far to the disto-lingual indicated a supernumerary root, and the presence of an RE was confirmed on the postoperative radiograph (Fig. 2d). The root canals were filled with gutta-percha and AH26 (De Trey Dentsply, Konstanz, Germany) using hybrid condensation with gutta-percha condensers (Dentsply Maillefer) according to De Moor and Hommez (12). The opening cavity was sealed with glass ionomer cement (Ketac Fil, 3M ESPE, Seefeld, Germany) and the patient was referred to his general dental practitioner for the permanent coronal restoration.

Case 2

A 35-year-old Caucasian male was referred for endodontic treatment of the mandibular right first molar. An initial opening of the pulp chamber had already been performed by the referring dentist to relieve acute throbbing pain (acute pulpitis). Radiographical examination showed no signs of apical periodontitis. No distinct distal root was visible, but tiny projection lines of the periodontal ligament indicated a strong curvature of (one of) the distal root(s) to the mesial (Fig. 3*D*). On adjusting the opening cavity, four distinct canal orifices were found (Fig. 3*A*, *B*), and were coronally enlarged with Gates Glidden drills. Initial negotiation of the root canals was performed with a K-file ISO 15. Although the coronal enlargement and relocation of the canal orifices allowed straight-line access in three canals, insertion of the file in the fourth, distolingual canal showed a more lingually oriented access inclination. Upon removal of the file, the tip was deformed with a strong curvature to the mesial. This, together with the different access inclinations between the two distal canals, indicated the presence of two separate distal roots.

The lengths of these canals were measured electronically. The canals were cleaned with sodium hypochlorite solution (5.25%) and EDTA (Salvizol, Ravens, Konstanz, Germany), and shaped with ProTaper instruments. A second distal canal was found (Fig. 3*C*) and prepared. The two distal canals merged at the mid-root level. Ultrasonic tips (ProUltra, Dentsply Maillefer) were used to remove the isthmus between the distal canals. The gutta cone fit, with radiographical exposure 30 degrees from the mesial, confirmed the presence of an RE (Fig. 3*E*). All canals were filled with gutta-percha and AH26 sealer (hybrid condensation) (Fig. 3*F*, *G*) and the opening cavity was sealed with Fuji IX (GC Corp., Tokyo, Japan). The patient was then referred to the general practitioner for restoration of the crown.

Case 3

A 50-year-old Caucasian male was referred for endodontic treatment of the lower left second molar before restoration of the crown. The tooth was sensitive to percussion and extensive tooth decay had caused fracture of the distal part of the crown. A temporary coronal filling was placed by the referring dentist. An extra cusp was present on the buccal side of the crown (Fig. 4*A*). Radiographically, no signs of periapical pathosis were observed (Fig. 4*D*). Upon opening the pulp chamber, three root canals were found; these were enlarged coronally with Gates Glidden burs. The distal part of the temporary filling was left in place, to allow proper rubberdam clamp placement and to prevent leakage during endodontic treatment.

Inspection of the pulp chamber wall with a microscope and an angled probe revealed an overlying edge of the pulp chamber roof on the mesiobuccal. The opening cavity was enlarged and another root canal orifice was found (Fig. 4*B*, *C*). Radiographical length determina-

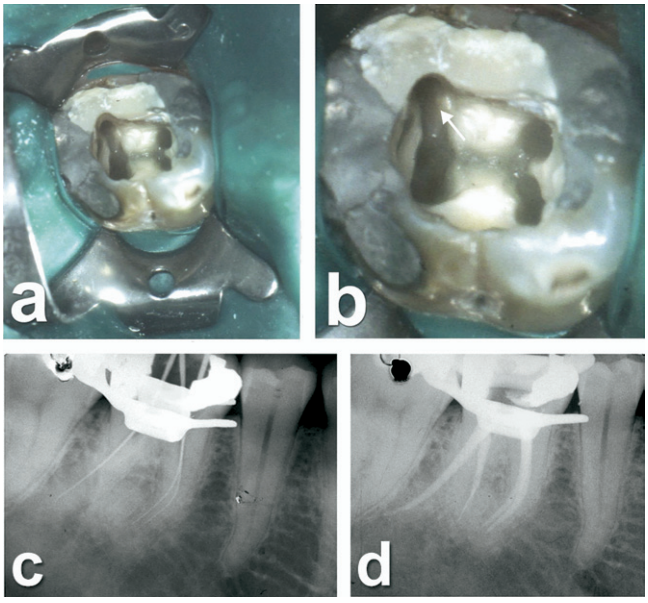

Figure 2. (*a*, *b*) occlusal view of the pulp chamber floor with the orifice of the radix entomolaris (arrow). A distolingual extension of the opening cavity is made for better access and vision of the additional canal. (*c*) Length determination radiograph. The radix entomolaris is invisible because of superposition of bone. (*d*) Postoperative radiograph with the radix entomolaris in the middle.

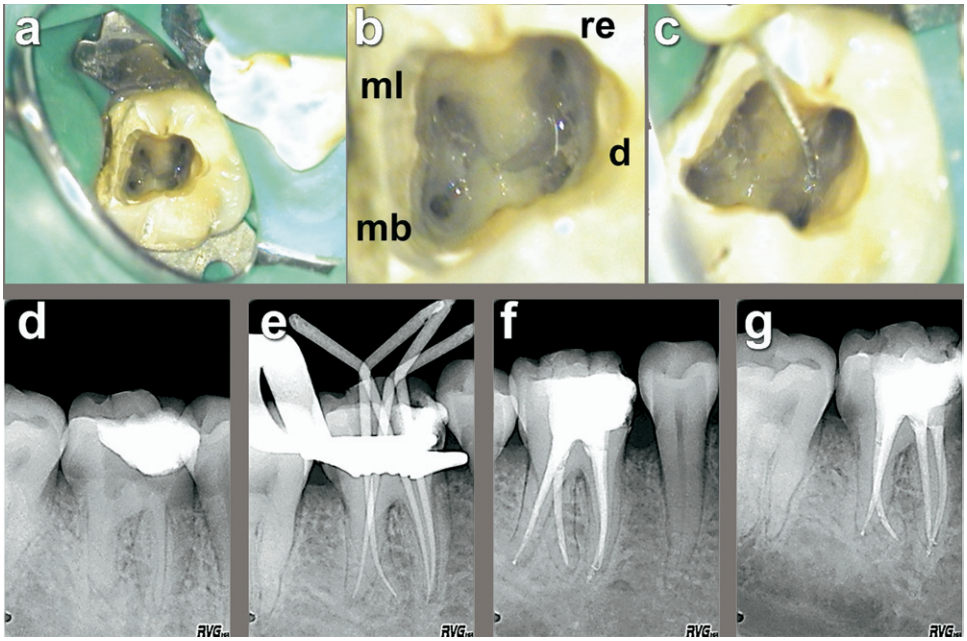

Figure 3. (*A*) Clinical image of the opening cavity. (*B*) Orifice location of the radix entomolaris (ml, mesiolingual; mb, mesiobuccal; d, distal; re, radix entomolaris). (*C*) A second distal canal orifice is located between the distobuccal and radix entomolaris canal orifices. (*D*) Preoperative radiograph. (*E*) Gutta cone fit; two separate distal roots can be distinguished when a radiograph is exposed 30 degrees from the mesial. (*F*) Postoperative radiograph. (*G*) Radiograph 6 months postoperatively.

tion showed a separate buccal root, identified as an RP (Fig. 4*E*). The four root canals were disinfected with sodium hypochlorite solution (5.25%) and EDTA (Salvizol) and shaped with K-files and ProTaper instruments. A temporary calcium hydroxide paste (UltraCal XS, Ultradent) and temporary filling (Ketac Fil) were put in place. Symptoms of pain disappeared and two weeks later the root canals were filled with gutta percha and AH-Plus sealer (thermomechanical condensation) (Fig. 4*F*, *G*). The pulp chamber was sealed with Ketac Fil glass ionomer

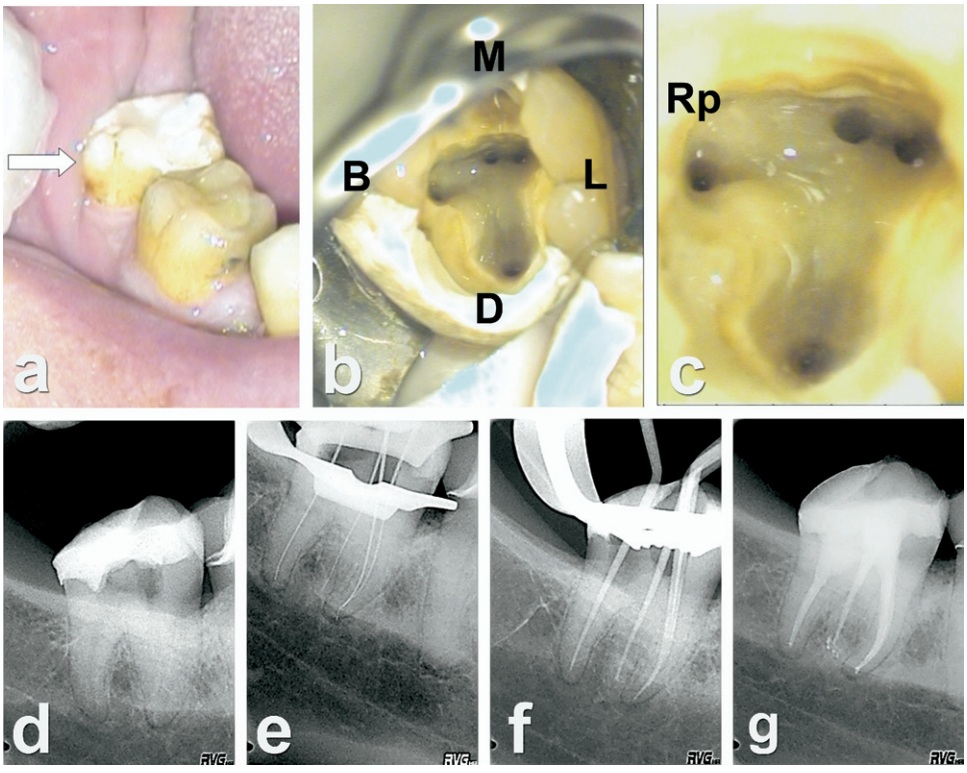

Figure 4. (*A*) An extra cusp on the buccal side of the crown (arrow) could indicate the possible presence of a supernumerary root. (*B*, *C*) clinical images of the opening cavity with extension to the mesiobuccal to reveal the orifice of the radix paramolaris (M, mesial; D, distal; B, buccal; L, lingual; Rp, radix paramolaris). (*D*) Preoperative radiograph. (*E*) Length determination. (*F*) Gutta cone fit. (*G*) Postoperative radiograph.

cement. The patient was referred to his dentist for the permanent restoration of the crown.

Discussion

Prevalence of Radix Paramolaris and Entomolaris

The presence of a separate RE in the first mandibular molar is associated with certain ethnic groups. In African populations a maximum frequency of 3% is found (13), while in Eurasian and Indian populations the frequency is less than 5% (14). In populations with Mongoloid traits (such as the Chinese, Eskimo and American Indians) reports have noted that the RE occurs with a frequency that ranges from 5% to more than 30% (14–20). Because of its high frequency in these populations, the RE is considered to be a normal morphological variant (eumorphic root morphology). In Caucasians the RE is not very common and, with a maximum frequency of 3.4 to 4.2% (21, 22), is considered to be an unusual or dysmorphic root morphology.

The etiology behind the formation of the RE is still unclear. In dysmorphic, supernumerary roots, its formation could be related to external factors during odontogenesis, or to penetrance of an atavistic gene or polygenetic system (atavism is the reappearance of a trait after several generations of absence). In eumorphic roots, racial genetic factors influence the more profound expression of a particular gene that results in the more pronounced phenotypic manifestation (19, 23). Curzon suggested that the 'three-rooted molar' trait has a high degree of genetic penetrance as its dominance was reflected in the fact that the prevalence of the trait was similar in both pure Eskimo and Eskimo/Caucasian mixes (24).

An RE can be found on the first, second and third mandibular molar, occurring least frequently on the second molar (25). Some studies report a bilateral occurrence of the RE from 50 to 67% (26, 18).

Bolk (27) reported the occurrence of a buccally located additional root: the RP. This macrostructure is very rare and occurs less frequently than the RE. The prevalence of RP, as observed by Visser (25), was found to be 0% for the first mandibular molar, 0.5% for the second and 2% for the third molar. Other studies have, however, reported RP in first mandibular molars (11, 13).

Morphology of the Radix Entomolaris and Paramolaris

The RE is located distolingually, with its coronal third completely or partially fixed to the distal root. The dimensions of the RE can vary from a short conical extension to a 'mature' root with normal length and root canal. In most cases the pulpal extension is radiographically visible. In general, the RE is smaller than the distobuccal and mesial roots and can be separate from, or partially fused with, the other roots. A classification by Carlsen and Alexandersen (10) describes four different types of RE according to the location of the cervical part of the RE: types A, B, C and AC. Types A and B refer to a distally located cervical part of the RE with two normal and one normal distal root components, respectively. Type C refers to a mesially located cervical part, while type AC refers to a central location, between the distal and mesial root components. This classification allows for the identification of separate and nonseparate RE.

In the apical two thirds of the RE, a moderate to severe mesially or distally orientated inclination can be present (Fig. 1*A*, *B*). In addition to this inclination, the root can be straight or curved to the lingual. According to the classification of De Moor et al. (28), based on the curvature of the separate RE variants in bucco-lingual orientation, three types can be identified. Type I refers to a straight root/root canal, while type II refers to an initially curved entrance which continues as a straight root/root canal. Type III refers to an initial curve in the coronal third of the root canal and a second curve beginning in the middle and continuing to the apical third.

The RP is located (mesio) buccally. As with the RE, the dimensions of the RP can vary from a 'mature' root with a root canal, to a short conical extension. This additional root can be separate or nonseparate (Fig. 1*C*, *D*). Carlsen and Alexandersen (11) describe two different types: types A and B. Type A refers to an RP in which the cervical part is located on the mesial root complex; type B refers to an RP in which the cervical part is located centrally, between the mesial and distal root complexes. As can be seen in Fig. 4*A*, an additional cusp was present on the buccal side. A similar observation has been made in other reports, i.e. an increased number of cusps is not necessarily related to an increased number of roots; however, an additional root is nearly always associated with an increased number of cusps, and with an increased number of root canals (13, 29, 30).

Clinical Approach

The presence of an RE or an RP has clinical implications in endodontic treatment. An accurate diagnosis of these supernumerary roots can avoid complications or a 'missed canal' during root canal treatment. Because the (separate) RE is mostly situated in the same buccolingual plane as the distobuccal root, a superimposition of both roots can appear on the preoperative radiograph, resulting in an inaccurate diagnosis. A thorough inspection of the preoperative radiograph and interpretation of particular marks or characteristics, such as an unclear view or outline of the distal root contour or the root canal, can indicate the presence of a 'hidden' RE. To reveal the RE, a second radiograph should be taken from a more mesial or distal angle (30 degrees). This way an accurate diagnosis can be made in the majority of cases.

Apart from a radiographical diagnosis, clinical inspection of the tooth crown and analysis of the cervical morphology of the roots by means of periodontal probing can facilitate identification of an additional root. An extra cusp (tuberculum paramolare) or more prominent occlusal distal or distolingual lobe, in combination with a cervical prominence or convexity, can indicate the presence of an additional root. If an RE or RP is diagnosed before endodontic treatment, one knows what to expect or where to look once the pulp chamber has been opened.

The location of the orifice of the root canal of an RE has implications for the opening cavity (Fig. 5). The orifice of the RE is located disto- to mesiolingually from the main canal or canals in the distal root. An extension of the triangular opening cavity to the (disto) lingual results in a more rectangular or trapezoidal outline form. If the RE canal entrance is not clearly visible after removal of the pulp chamber roof, a more thorough inspection of the pulp chamber floor and wall, especially in the distolingual region, is necessary. Visual aids such as a loupe, intra-oral camera or dental microscope can, in this respect, be useful. A dark line on the pulp chamber floor can indicate the precise location of the RE canal orifice. The distal and lingual pulp chamber wall can be explored with an angled probe to reveal overlying dentin or pulp roof remnants masking the root canal entrance. The calcification, which is often situated above the orifice of the RE, has to be removed for a better view and access to the RE. An initial relocation of the orifice to the lingual is indicated to achieve straight-line access. However, to avoid perforation or stripping in the coronal third of a severe curved root, care should be taken not to remove an excessive amount of dentin on the lingual side of the cavity and orifice of the RE.

A severe root inclination or canal curvature, particularly in the apical third of the root (as in a type III RE), can cause shaping aberrations such as straightening of the root canal or a ledge, with root canal transportation and loss of working length resulting. The use of flexible nickel-titanium rotary files allows a more centered preparation shape with restricted enlargement of the coronal canal third and orifice relocation. Nevertheless, unexpected complications such as instrument sep-

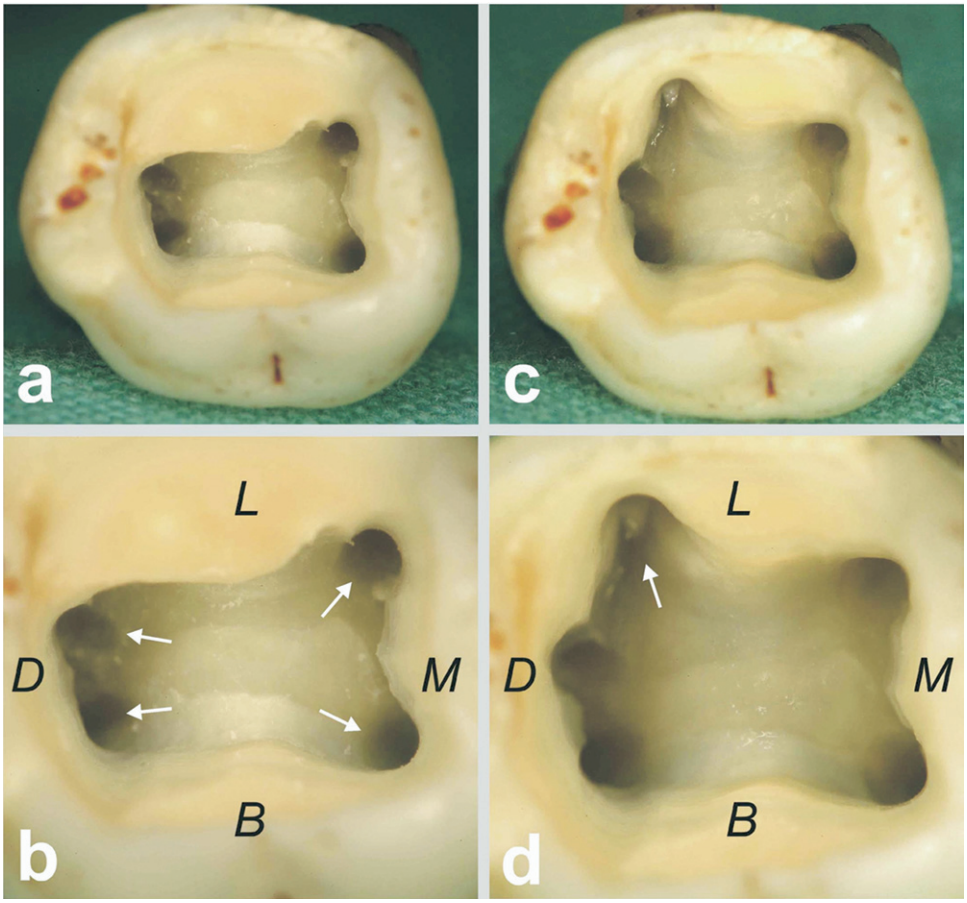

Figure 5. (*A*, *B*) Clinical view of the opening cavity after caries removal and initial opening of the pulp cavity (M, mesial; D, distal; B, buccal; L, Lingual). (*C*, *D*) a distolingual extension of the cavity reveals the orifice of the RE (arrow).

aration do occur, and are more likely to happen in an RE with severe curvature or narrow root canals. Therefore, after relocation and enlargement of the orifice of the RE, initial root canal exploration with small files (size 10 or less) together with radiographical root canal length and curvature determination, and the creation of a glide path before preparation, are step-by-step actions that should be taken to avoid procedural errors.

Conclusion

Clinicians should be aware of these unusual root morphologies in the mandibular first molars in Caucasian people. The initial diagnosis of a radix entomolaris or paramolaris before root canal treatment is important to facilitate the endodontic procedure, and to avoid 'missed' canals. Preoperative periapical radiographs exposed at two different horizontal angles are required to identify these additional roots. Knowledge of the location of the additional root and its root canal orifice will result in a modified opening cavity with extension to the distolingual. The morphological variations of the RE in terms of root inclination and root canal curvature demand a careful and adapted clinical approach to avoid or overcome procedural errors during endodontic therapy.

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