

Endodontic Treatment Failure Consecutive to Unsystematic Radiographic Examination

Oscar Alonso-Ezpeleta DDS¹, Jenifer Martín-González DDS², Milagros Martín-Jiménez DDS², Juan J Segura-Egea MD, PhD, DDS²

¹Department of Surgery, University of Zaragoza, Zaragoza, Spain. ²Department of Stomatology (Endodontics), School of Dentistry, University of Sevilla, C/Avicena S/N, 41009 Sevilla, Spain.

Abstract

This case report describes the endodontic therapy on a three-rooted mandibular first molar. The initial endodontic treatment was carried out after misreading preoperative periapical radiograph. Moreover, the working length was determined only with the apex locator. So, the additional disto-lingual root left unidentified and remained untreated, failing the treatment. A thorough radiographic examination in the initial therapy would have allowed the identification of the supernumerary root and its canal. Although the apex locators determine accurately the working length, it does not inform about the root canal morphology. It can be concluded and remarked that a systematic radiographic examination, including preoperative radiographs, is essential for success in endodontic therapy.

Key Words: Endodontics, Mandibular Molar Anatomy, Periapical Radiograph, Radiographic Examination, Radix Entomolaris, Root Canal Treatment

Introduction

The final outcome of endodontic therapy is the complete filling and sealing of root canal system, after proper chemo-mechanical debris removal and disinfection. However, sometimes root canals are left untreated because their presence is not identified, with the consequent treatment failure due to incomplete pulp extirpation and disinfection. This contingency can occur particularly in teeth that have anatomical variations or additional root canals [1].

The normal anatomical configuration of the mandibular first molar in Caucasian have two roots, one mesial, with two canals, and another distal, generally with one canal [2,3]. Despite mandibular first molar is normally two-rooted, there can be variations in the number of roots and the anatomy of root canals [4,5,6]. The presence of a third root in the first permanent mandibular molar, usually placed lingually, is the major variant in this group. This trait occurs in less than 5% of Caucasian, Eurasian, African and Indian populations, but increasing until more than 40% in people of Mongolian origin [7,8]. This feature is also rarely found in the third inferior molar, whereas the variation is not reported in the second inferior molar [7,9-14]. As first mentioned in 1844 by Carabelli, this third additional root was described as “disto-lingual root”, “extra disto-lingual root” or simply “extra third root” [15]. In 1915, Block first used the term “Radix Entomolaris” (RE) to refer this anatomical variation [16]. The RE is generally located in the same bucco-lingual plane as the other two roots, leading to a superimposition of the roots on radiographies, hindering a proper diagnose [9,17,18].

After normal access cavity preparation, the orifice of the RE canal can be hardly evidenced, remaining untreated the canal. Because this, it is so important to read radiographies carefully, identifying any variation of the root canals of the mandibular first molar. Other features, such as unclear view or outline of the distal root contour or the root canal itself, might

make suspect about a third root [18]. A thorough radiographic study is recommended, since some authors conclude that in traditional periapical radiographies the RE appears rarely [12,19]. The recommended exposure is a buccal-to-lingual projection, followed by a second projection taken at 20° from the mesial, and finally a third projection taken at 20° from the distal, in order to obtain basic information of the tooth anatomy [20,21]. A better recording of root canal anatomy is achieved with CBCT, but the new technology is not yet available for all the professional community.

This paper describes the endodontic therapy on a three-rooted mandibular first molar. The initial endodontic treatment was carried out after misreading preoperative periapical radiograph. Moreover, the working length was determined only with the apex locator. So, the additional disto-lingual root left unidentified and remained untreated, failing the treatment.

Case Presentation

A Caucasian man, 44 years old, in good health, sought treatment for the chief complaint of pain in the right mandibular region. A month earlier, the first right mandibular molar (4.6) had been endodontically treated. Patient reported pain upon mastication and around the apical area of this tooth. Clinical examination revealed a discolored molar with an occlusal resin composite restoration. The molar tooth was sensitive to percussion and palpation. A buccal sinus tract associated with the tooth was evident. Periapical radiograph, taken using Kodak RVG 6100 digital radiography system (Carestream Health, Rochester, NY, USA) (Figure 1), revealed a great radiolucent periapical lesion around the mesial root, extending to furcation and the distal root. Unexpectedly, a second distal root which canal had been left untreated was also evident. The dentist who had performed the first endodontic treatment was asked for dental radiographs (Figures 2 and 3). Shockingly,

Corresponding author: Juan Jose Segura Egea, Department of Stomatology (Endodontics), School of Dentistry, University of Sevilla, C/Avicena S/N, 41009 Sevilla, Spain, Tel: +34 954481146; Fax: +34 954481111; e-mail: segurajj@us.es



Figure 1. Periapical radiograph showing an additional disto-lingual root which canal had not been treated. A radiolucent periapical lesion is evident indicating persistent chronic apical periodontitis.



Figure 2. Pre-operative radiograph in the first endodontic therapy. The third root in the distal area was not identified).



Figure 3. Post-operative radiograph after the first endodontic therapy (Again, the third root in the distal area was not identified).

the supernumerary root had not been identified in the pre-operative or in the post-operative radiographs. Moreover, only the apex locator had been used to determine the working length.

Diagnosis was established of persistent chronic apical periodontitis because the presence of an untreated root canal. Endodontic re-treatment was indicated. Conventional endodontic access was performed after proper anesthesia and isolation with rubber dam. Three canal orifices were evident, two mesial and one disto-buccal, all them filled with gutta-percha. The cavity access was then extended disto-lingually

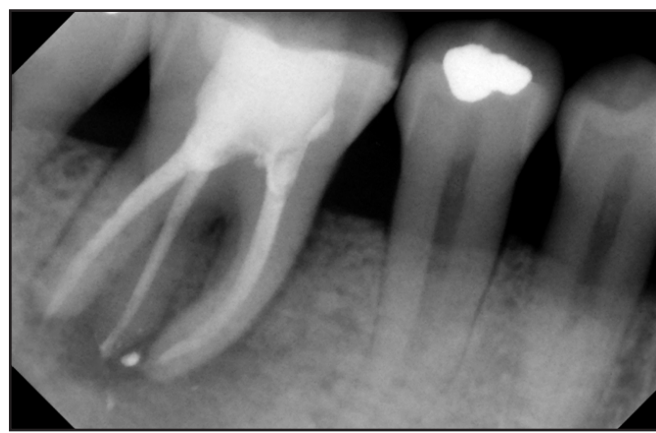


Figure 4. Post-operative radiograph after the endodontic re-treatment (Now the canal in the supernumerary disto-lingual root has been endodontically treated).

using an Endo-Z bur (Dentsply Maillefer, Ballaigues, Switzerland). Then, a thorough examination of the pulp chamber using #10 K-File (Dentsply Maillefer, Ballaigues, Switzerland) was carried out, revealing the disto-lingual orifice of the supernumerary root. After glide-path using #10 K-File (Dentsply Maillefer, Ballaigues, Switzerland), the working length was estimated using an apex locator (Root ZX, Morita, and Tokyo, Japan). The disto-lingual canal was cleaned and shaped using Protaper Universal (Dentsply Maillefer, Ballaigues, Switzerland), up to the F1 file. The root canal was irrigated during the instrumentation with 10 mL of 4.2% sodium hypochlorite (NaOCl) carried in plastic syringe with side-vented needle (31 gauge, NaviTip Sideport; Ultradent Products (Inc South Jordan, UT, USA). After cleaning and shaping, a final irrigation was performed alternating 17% ethylenediaminetetraacetic acid (EDTA) and 4.2% NaOCl solution. Then, the root canal was dried and obturated with warm gutta-percha using Calamus heat source (Dentsply Maillefer, Ballaigues, Switzerland) and with AH Plus sealer (Dentsply DeTrey, Konstanz, Germany) (Figure 4).

Discussion

This case report shows the initial failure of the endodontic treatment of a three-rooted right mandibular first molar. The fourth canal, in an additional disto-lingual root, left untreated because it was not identified in the periapical radiograph nor in the pulp chamber examination.

The fourth disto-lingual root may have several origins. In case of dysmorphic supernumerary roots, disto-lingual root formation is connected to external factors during odontogenesis [18] or penetration of atavistic gene or polygenic system [22]. In the case of eumorphic roots, racial genetic factors influence the profound expression of a particular gene that results in a more pronounced phenotypic expression [23]. To sum up, the aetiology of the disto-lingual root still remains unclear.

In the case reported here, the three-rooted mandibular first molar had one mesial root with two root canals and two distal roots with one canal each one, as stated in previous reports of three-rooted mandibular first molars [24]. The root and canal anatomy of mandibular first permanent molars have normally common characteristics, with also a great number of abnormalities. Although the presence of four canals in

the first mandibular permanent molar is relatively frequent [7], the presence of two distal roots is uncommon [25]. This feature has been demonstrated by Steelman, who studied radiographically the mandibular first permanent molars of 156 Hispanic children to determine the incidence of an accessory distal root, finding an overall incidence of 6.4% [26].

A 50% to 69% of bilateral occurrence of three-rooted lower first molars has been reported previously [26-28]. However, in a recent study all three-rooted molars occurred unilaterally in a German population [29]. Several studies have found that the additional root occurred more frequently on the right side than on the left side [28,30,31]. On the contrary, other studies found that these three-rooted mandibular first molars occurred more often on the left side [7,20,23,32]. Two other studies showed no significant differences dealing with the side in which it occurred [29,33].

The three-rooted mandibular first permanent molars morphology have been classified into five types by Song et al. [31], as follows: 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: root length less than half of the disto-buccal root; and Conical type: cone-shaped extension without root canal. In the present case report, the disto-lingual additional root seemed to be type I and smaller than its respective disto-buccal root.

In 90% of cases, the disto-lingual root anatomy is easily recognizable in radiographies [34]. In the remaining cases, a careful reading of angled periapical radiographies allows to identify this trait. This includes a thorough and complete radiographic study of the involved teeth, with three different horizontal exposures—a buccal-to-lingual projection, a 20° from the mesial projection and a 20° from the distal projection—in order to get basic information of the tooth anatomy and perform a proper endodontic treatment [21]. However, using the buccal object rule with two radiographies with different horizontal angulations may be enough to determine the position of the lingual root [35,36]. Other terms to refer this

buccal object rule are “Clark's rule: Same Lingual, Opposite Buccal (SLOB rule)” and “Walton's projection” [21]. The two-dimensional traditional radiographic images are a handicap to visualize the three-dimensional tooth. Three-dimensional imaging solves this limitation adding the fact that it allows to eliminate superimpositions [37]. Several studies have demonstrated that cone-beam computed tomography scanning is an effective method for studying external and internal dental morphology both in maxillary [38] and mandibular [39] molars. The CBCT aids to ensure the exact localization and anatomy of radix entomolaris [12,19,40].

It is absolutely necessary to locate and access the additional distal root. This goal can be achieved by modifying the traditional triangular opening cavity to a trapezoidal form, after removal of the pulp chamber roof. If this technique does not lead to a clearly visible RE opening, visual aids such as loupes or surgical operating microscope may be needed [41]. There is risk of perforating the tooth locating the RE canal orifice, because it could be occluded by secondary or calcified dentine. Accordingly, the superior control of ultrasonic cutting tips during access performance allows a good visual area, so they are a convenient tool in such cases [42].

The case presented in this report emphasizes the importance of the pre-operative radiographic examination in endodontic therapy [43]. The first endodontic treatment could have been successful if the supernumerary root would be identified. On the contrary, the misreading of the preoperative periapical radiograph provoked the treatment failure. Moreover, although the apex locators determine accurately the working length during the root canal treatment [44], it does not inform about the root canal morphology. Thus, a systematic radiographic examination, including periapical preoperative radiographs carefully interpreted, is essential for success in endodontic therapy. The use of CBCT provides new capabilities for assessment of the morphology and root anatomy of molar teeth. Considering radix entomolaris is uncommon in Caucasian population, CBCT must be used in those cases where the conventional radiographic examination is not conclusive concerning the presence or absence of a supernumerary root.

References

1. Reeh ES. Seven canals in a lower first molar. *Journal of Endodontics*. 1998; **24**: 497-499.
2. Barker BC, Parsons KC, Mills PR, Williams GL. Anatomy of root canals. III. Permanent mandibular molars. *Australian Dental Journal*. 1974; **19**: 408-413.
3. Vertucci FJ. Root canal anatomy of the human permanent teeth. *Oral Surgery, Oral Medicine, Oral Pathology*. 1984; **58**: 589-599.
4. Skidmore AE, Bjorndal AM. Root canal morphology of the human mandibular first molar. *Oral Surgery, Oral Medicine, Oral Pathology*. 1971; **32**: 778-784.
5. Sperber GH, Moreau JL. Study of the number of roots and canals in Senegalese first permanent mandibular molars. *International Endodontics Journal*. 1998; **31**: 117-122.
6. Sidow SJ, West LA, Liewehr FR, Loushine RJ. Root canal morphology of human maxillary and mandibular third molars. *Journal of Endodontics*. 2000; **26**: 675-678.
7. Gulabivala K, Aung TH, Alavi A, Ng YL. Root and canal morphology of Burmese mandibular molars. *International Endodontics Journal*. 2001; **34**: 359-70.
8. Gulabivala K, Opananon A, Ng YL, Alavi A. Root and canal morphology of Thai mandibular molars. *International Endodontics Journal*. 2002; **35**: 56-62.
9. De Moor RJ, Deroose CA, Calbertson FL. The radix entomolaris in mandibular first molars: an endodontic challenge. *International Endodontics Journal*. 2004; **37**: 789-799.
10. Tu MG, Tsai CC, Jou MJ, Chen WL, Chang YF, Chen SY, Cheng HW. Prevalence of three-rooted mandibular first molars among Taiwanese individuals. *Journal of Endodontics*. 2007; **33**: 1163-1166.
11. Chen G, Yao H, Tong C. Investigation of the root canal

configuration of mandibular first molars in a Taiwan Chinese population. *International Endodontics Journal*. 2009; **42**: 1044-1049.

12. Huang RY, Cheng WC, Chen CJ, Lin CD, Lai TM, Shen EC, Chiang CY, Chiu HC, Fu E. Three-dimensional analysis of the root morphology of mandibular first molars with distolingual roots. *International Endodontics Journal*. 2010; **43**: 478-484.

13. Nagaven NB, Umashankara KV. Radix entomolaris and paramolaris in children: a review of the literature. *Journal of Indian Society of Pedodontics and Preventive Dentistry*. 2012; **30**: 94-102.

14. Park JB, Kim N, Park S, Kim Y, Ko Y. Evaluation of root anatomy of permanent mandibular premolars and molars in a Korean population with cone-beam computed tomography. *European Journal of Dentistry*. 2013; **7**: 94-101.

15. Carabelli G. Systematisches Handbuch der Zahnheilkunde. (2nd edn.) Vienna, Austria: Braumüller and Seidel; 1884. pp. 114.

16. Bolk L. Bermerkungen über Wurzelvariationen am menschlichen unteren Molaren. *Zeitung für Morphologie und Anthropologie*. 1915; **17**: 605-610.

17. Carlsen O, Alexandersen V. Radix paramolaris in permanent mandibular molars: identification and morphology. *Scandinavian Journal of Dental Research*. 1991; **99**: 189-195.

18. Calberson FL, De Moor RJ, Deroose CA. The radix entomolaris and paramolaris: clinical approach in endodontics. *Journal of Endodontics*. 2007; **33**: 58-63.

19. Abella F, Patel S, Durán-Sindreu F, Mercadé M, Roig M. Mandibular first molars with disto-lingual roots: review and clinical management. *International Endodontics Journal*. 2012; **45**: 963-978.

20. Loh HS. Incidence and features of three-rooted permanent mandibular molars. *Australian Dental Journal*. 1990; **35**: 434-437.

21. Ingle JJ, Heithersay GS, Hartwell GR, Goerig AC, Marshall FJ, et al. Endodontic diagnostic procedures. In: Ingle JJ, Bakland LF, editors. *Endodontics*. (5th edn). Hamilton, London, UK: BC Decker Inc; 2002. pp: 203-258.

22. Reichart PA, Metah D. Three-rooted permanent mandibular first molars in the Thai. *Community Dentistry and Oral Epidemiology*. 1981; **9**: 191-192.

23. Curzon ME. Three-rooted mandibular permanent molars in English Caucasians. *Journal of Dental Research*. 1973; **52**: 181.

24. Kimura Y, Matsumoto K. Mandibular first molar with three distal root canals. *International Endodontics Journal*. 2000; **33**: 468-470.

25. Prabhu NT, Munshi AK. Additional distal root in permanent mandibular first molars: report of a case. *Quintessence International*. 1995; **26**: 567-569.

26. Steelman R. Incidence of an accessory distal root on mandibular first permanent molars in Hispanic children. *ASDC Journal of Dentistry for Children*. 1986; **53**: 122-123.

27. de Souza-Freitas JA, Lopes ES, Casati-Alvares L. Anatomic variations of lower first permanent molar roots in two ethnic groups. *Oral Surgery, Oral Medicine, Oral Pathology*. 1971; **31**: 274-278.

28. Tu MG, Huang HL, Hsue SS, Hsu JT, Chen SY, Jou MJ, Tsai CC. Detection of permanent three-rooted mandibular first molars by cone-beam computed tomography imaging in Taiwanese individuals. *Journal of Endodontics*. 2009; **35**: 503-507.

29. Schäfer E, Breuer D, Janzen S. The prevalence of three-rooted mandibular permanent first molars in a German population. *Journal of Endodontics*. 2009; **35**: 202-205.

30. Song JS, Kim SO, Choi BJ, Choi HJ, Son HK, Lee JH. Incidence and relationship of an additional root in the mandibular first permanent molar and primary molars. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontology*. 2009; **107**: e56-60.

31. Song JS, Choi HJ, Jung IY, Jung HS, Kim SO. The prevalence and morphologic classification of distolingual roots in the mandibular molars in a Korean population. *Journal of Endodontics*. 2010; **36**: 653-657.

32. Wang Q, Yu G, Zhou XD, Peters OA, Zheng QH, Huang DM. Evaluation of x-ray projection angulation for successful radix entomolaris diagnosis in mandibular first molars in vitro. *Journal of Endodontics*. 2011; **37**: 1063-1068.

33. Peiris HR, Pitakotuwage TN, Takahashi M, Sasaki K, Kanazawa E. Root canal morphology of mandibular permanent molars at different ages. *International Endodontic Journal*. 2008; **41**: 828-835.

34. Walker RT, Quackenbush LE. Three-rooted lower first permanent molars in Hong Kong Chinese. *British Dental Journal*. 1985; **159**: 298-299.

35. Walton RE. Endodontic radiographic technics. *Dental Radiography and Photography*. 1973; **46**: 51-59.

36. Goerig AC, Neaverth EJ. A simplified look at the buccal object rule in endodontics. *Journal of Endodontics*. 1987; **13**: 570-572.

37. Cohenca N, Simon JH, Marthur A, Malfaz JM. Clinical indications for digital imaging in dentoalveolar trauma. Part 2: root resorption. *Dental Traumatology*. 2007; **23**: 105-113.

38. Zheng QH, Wang Y, Zhou XD, Wang Q, Zheng GN, Huang DM. A cone-beam computed tomography study of maxillary first permanent molar root and canal morphology in a Chinese population. *Journal of Endodontics*. 2010; **36**: 1480-1484.

39. Zhang R, Wang H, Tian YY, Yu X, Hu T, Dummer PM. Use of cone-beam computed tomography to evaluate root and canal morphology of mandibular molars in Chinese individuals. *International Endodontic Journal*. 2011; **44**: 990-999.

40. Abella F, Mercadé M, Duran-Sindreu F, Roig M. Managing severe curvature of radix entomolaris: three-dimensional analysis with cone beam computed tomography. *International Endodontic Journal*. 2011; **44**: 876-885.

41. Yoshioka T, Kobayashi C, Suda H. Detection rate of root canal orifices with a microscope. *Journal of Endodontics*. 2002; **28**: 452-453.

42. Plotino G, Pameijer CH, Grande NM, Somma F. Ultrasonics in endodontics: a review of the literature. *Journal of Endodontics*. 2007; **33**: 81-95.

43. Segura-Egea JJ, Jiménez-Pinzón A, Ríos-Santos JV.

Endodontic therapy in a 3-rooted mandibular first molar: importance of a thorough radiographic examination. *Journal of Canadian Dental Association*. 2002; **68**: 541-544.

44. Miletic V, Beljic-Ivanovic K, Ivanovic V. Clinical reproducibility of three electronic apex locators. *International Endodontic Journal*. 2011; **44**: 769-776.