The Impact of Apical Patency in the Success of Endodontic Treatment of Necrotic Teeth with Apical Periodontitis: A Brief Review

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ABSTRACT

Accumulation of soft tissue or dentinal remnants in the apical region is a common event that can cause blockage of root canals. This event can be avoided if apical patency is performed during the root canal shaping procedures. However, there is no consensus on the role of apical patency in relation to the success of endodontic treatment of necrotic teeth with apical periodontitis. Therefore, the purpose of this paper was to conduct a brief review on the role of apical patency in guaranteeing the success of endodontic treatments of necrotic teeth with apical periodontitis considering two other key points; the root canal anatomy and microbiology.

Keywords: Apical Patency; Endodontic Success; Periradicular Disease; Root Canal Therapy

Introduction

Blockage of the root canal in the apical region by remnants of dental hard and soft tissue debris, may cause procedural errors such as apical transportations, ledge and perforation. These debris may also contain bacteria capable of maintaining or inducing periradicular disease [1-4]. For these reasons, apical patency has been suggested [5-7].

The most common method for performing this procedure is to use a so-called patency file during root canal instrumentation. This file can be defined as a small flexible K-file, which is moved passively through the apical foramen without widening it [5]. In addition to avoiding the procedural errors referred above, apical patency minimizes the risk of losing working length, enhances irrigation and improves the tactile sensation of the clinician [5, 8-11]. On the other hand, according to many others studies, apical patency can promote extrusion of contaminated debris and subsequently irritate periradicular tissues [2, 12-16].

Whereas most studies are merely speculative regarding the advantages and disadvantages of performing or not apical patency [7-9], the purpose of this paper was to conduct a brief review of the literature about the role of this procedure in guaranteeing the success of endodontic treatments of necrotic teeth with apical periodontitis.

Anatomical considerations

An unchangeable high-impact factor that remains in endodontics is the root canal anatomy. The complexity of this factor has been verified by several methods over the years such as diaphonization, microscopic investigation, radiographic methods, scanning electron microscopy (SEM), cone-beam computed tomography (CBCT) and computed microtomography (micro-CT) [17-26]. This complexity is considerably higher in the apical third, regardless of the tooth type and includes apical deltas and lateral canals [22, 25, 27-30].

Morphis et al. [22] found no principal foramen in 24% of maxillary premolars and in 26% of maxillary incisors. In a study on the mesiobuccal roots of maxillary molars, Verma and Love...
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[28] found a 20% presence of two foramina and a 65% presence of three or more apical foramina. A study performed by Meder-Cowherd et al. [25] on the palatal roots of maxillary molars found a high variation of apical anatomy with apical delta in 12% of the specimens. Therefore, sometimes it is clinically impossible to reach the apical foramen, despite all the current technological advances [29, 30]. However, according to literature, there are no robust scientific evidences showing that these cases are necessarily doomed to fail. Also, achieving apical patency does not ensure the success of the treatment [31]. Even in cases where apical patency is obtained, there are other anatomical variations, such as apical deltas, lateral canals and multiple foramina, which can harbor bacteria with a potential to induce or maintain a periradicular disease [21, 22, 25, 27-32].

**Microbiological considerations**

The endodontic treatment of vital teeth is essentially a prophylactic treatment, because the pulp space is usually free of microorganisms, and the prevailing rationale for treatment is to prevent probable infection and consequent periradicular disease [33-39]. On the other hand, in cases of necrotic pulps, intraradicular infection is already established, and endodontic procedure should focus not only on preventing new microorganisms from being introduced into the root canal system, but also on reducing those located there in [40-50].

Persistence of bacteria can influence the outcome of the endodontic treatment in five possible ways: i) when they are able to survive without nutrients; ii) when they resist treatment-induced disturbances in the ecology of the bacterial community, (including disruption of quorum-sensing systems, food webs/chains and genetic exchanges, and disorganization of protective biofilm structures); iii) when they reach a climax population density (load) high enough to inflict damage on the host; iv) when they possess attributes of virulence expressed in the modified environment and reaching concentrations strong enough to directly or indirectly induce damage to the periradicular tissues and v) when they have unrestrained access to periradicular tissues through apical/lateral foramina [49].

Specifically related to the last factor mentioned above, apical patency cannot provide any advantage, because there is no real possibility of reaching microorganisms in lateral canals and apical deltas using the techniques currently known for this procedure.

**Can apical periodontitis heal after endodontic treatments without performing apical patency?**

Many investigators have retrospectively evaluated the influence of various factors that may affect the outcome of root canal treatments or retreatments [51-54]. In these studies, the limits of apical filling appear regularly as one of these factors. However, in most of these studies, the limits were measured based only on post-operative radiographs. Very likely, several cases had inaccessible root canals (without apical patency), even when the apical filling limits were observed to be within 2-mm distance from the apex.

Apical patency is not always achieved. Severe curvatures, broken instruments, miscalculation of canal length, development of ledges, obliteration and the anatomy of the root canals are among the most common reasons [55-64]. However, not all of these cases are associated with failure. Considering that the failure cannot be solely based on the absence of apical patency, there are several important factors that should not be underestimated.

Failure of nonsurgical root canal treatment or retreatment is usually related to residual bacteria (persistent infection) or reinfection of an already disinfected root canal environment (secondary infection) [11, 31, 65-70]. For surviving bacteria to maintain or induce a periradicular disease, they must adapt to the new environment represented by the filled canal, have a steady source of nutrients, have available space to multiply, and reach numbers high enough to elicit tissue damage [31, 46, 49, 65-67, 69, 70].

Therefore, the postulation of periradicular disease perpetuation simply because apical patency was not obtained, is a very questionable inference. This statement is mainly based on the following considerations: a) a high bacterial load diminishes substantially after correct instrumentation of the cervical and middle thirds; b) in several situations, even when apical patency is not achieved using files, chemical apical patency may occur using irrigating solutions, medications and sealers that are able to “disrupt microbiologically” this region; and c) only the main canal can be subjected to the effective action of apical patency files, whereas a large number of lateral and smaller canals cannot be reached. The endodontic literature confirms these statements, whereas most cases of endodontic failure, evidenced by histological findings, are associated with microorganisms in lateral canals and apical deltas and/or with extra-radicular biofilms [31, 67, 69].

**Conclusion**

This paper demonstrated that apical patency may not be strictly necessary. However, there are no robust clinical or scientific evidences showing a direct correlation between apical patency and success of endodontic treatments of necrotic teeth with apical periodontitis.

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References

1. Buchanan L. The art of endodontics: cleaning and shaping the root canal system. Part 1. Dent Today. 1993;8:46-51.

2. Cailleteau JG, Mullaney TP. Prevalence of teaching apical patency and various instrumentation and obturation techniques in United States dental schools. J Endod. 1997;23(6):394-6.

3. Siqueira JF Jr, Roças IN. Bacterial pathogenesis and mediators in apical periodontitis. Braz Dent J. 2007;18(4):267-80.

4. Sassone LM, Fidel RA, Faveri M, Guerra R, Figueiredo L, Fidel SR, Feres M. A microbiological profile of symptomatic teeth with primary endodontic infections. J Endod. 2008;34(5):541-5.

5. Buchanan L. Management of the curved root canal. J Calif Dent Assoc. 1989;17(4):18-25.

6. Tséssis I, Amador B, Tamse A, Kfir A. The effect of maintaining apical patency on canal transportation. Int Endod J. 2008;41(5):431-5.

7. Mounce R. Achieving and maintaining apical patency in endodontics: optimizing canal shaping procedures. Gen Dent. 2015;63(1):14-5.

8. Flanders D. Endodontic patency. How to get it. How to keep it. Why it is so important. N Y State Dent J. 2002;68(3):30-2.

9. Souza RA. The importance of apical patency and cleaning of the apical foramen on root canal preparation. Braz Dent J. 2006;17(1):6-9.

10. Vera J, Arias A, Romero M. Effect of maintaining apical patency on irrigant penetration into the apical third of root canals when using passive ultrasonic irrigation: An in vivo study. J Endod. 2011;37(9):1276-8.

11. Vera J, Hernández EM, Romero M, Arias A, van der Sluis LW. Effect of maintaining apical patency on irrigant penetration into the apical two millimeters of large root canals: An in vivo study. J Endod. 2012;38(10):1340-3.

12. Ricucci D, Langeland K. Apical limit of root canal instrumentation and obturation. Part 2. A histological study. Int Endod J. 1998;31(6):494-509.

13. Lambrianidis T, Tosounidou E, Tzoanopoulou M. The effect of maintaining apical patency on periapical extrusion. J Endod. 2001;27(11):696-8.

14. Holland R, Sant’Anna Junior A, Souza Vd, Dezan Junior E, Otoboni Filho JA, Bernabé PF, Nery MJ, Murata SS. Influence of apical patency and filling material on healing process of dogs’ teeth with vital pulp after root canal therapy. Braz Dent J. 2005;16(1):9-16.

15. Camões I, Salles MR, Fernando M, Freitas LF, Gomes CC. Relationship between the size of patency file and apical extrusion of sodium hypochlorite. Indian J Dent Res. 2009;20(4):426-30.

16. Deonizio MDA, Sydney GB, Batista A, Pontarolo R, Guimaraes PRB, Gavini G. Influence of apical patency and cleaning of the apical foramen on periapical extrusion in retreatment. Braz Dent J. 2013;24(5):482-6.

17. Hess W, Zürcher E, Dolamore WH. The anatomy of the root-canals of the teeth of the permanent dentition. London: J. Bale, Sons & Danielsson, Ltd.; 1925.

18. Kuttler Y. Microscopic investigation of root apexes. J Am Dent Assoc. 1955;50(5):544-52.

19. Pineda F, Kuttler Y. Mesiodistal and buccolingual roentgenographic investigation of 7275 root canals. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1972;33(1):101-10.

20. Dummer PM, McGinn J, Rees DG. The position and topography of the apical canal constriction and apical foramen. Int Endod J. 1984;17(4):192-8.

21. Vertucci FJ. Root canal anatomy of the human permanent teeth. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1984;58(5):589-99.

22. Morfis A, Sylaras S, Georgopoulou M, Kermani M, Prountzos F. Study of the apices of human permanent teeth with the use of a scanning electron microscope. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1994;77(2):172-6.

23. Peters O, Laib A, Rüegsegger P, Barbakow F. Three-dimensional analysis of root canal geometry by high-resolution computed tomography. J Dent Res. 2000;79(6):1405-9.

24. Vertucci FJ. Root canal morphology and its relationship to endodontic procedures. Endod Topics. 2005;10(1):3-29.

25. Meder-Cowherd L, Williamson AE, Johnson WT, Vasilescu D, Walton R, Qian F. Apical morphology of the palatal roots of maxillary molars by using micro-computed tomography. J Endod. 2011;37(8):1162-5.

26. Versiani MA, Pécora JD, Sousa-Neto MD. Microcomputed tomography analysis of the root canal morphology of single-rooted mandibular canines. Int Endod J. 2013;46(9):800-7.

27. Jung IY, Seo MA, Fouad AF, Spängberg LS, Lee SJ, Kim HJ, Kum KY. Apical anatomy in mesial and mesiobuccal roots of permanent first molars. J Endod. 2005;31(5):364-8.

28. Verma P, Love R. A Micro CT study of the mesiobuccal root canal morphology of the maxillary first molar tooth. Int Endod J. 2011;44(3):210-7.

29. Coutinho-Filho TS, Gurgel-Filho ED, Souza-Filho FJ, Silva EJ. Preliminary investigation to achieve patency of MB2 canal in maxillary molars. Braz J Oral Sci. 2012;11(3):373-6.

30. Abarca J, Zaror C, Monardes H, Hermosilla V, Muñoz C, Cantin M. Morphology of the physiological apical foramen in maxillary and mandibular first molars. Int J Morphol. 2014;32(6):671-7.

31. Arnold M, Ricucci D, Siqueira Jr FJ. Infection in a complex network of apical ramifications as the cause of persistent apical periodontitis: a case report. J Endod. 2013;39(9):1179-84.

32. Briseño-Marroquin B, El-Sayed MA, Willershausen-Zönchen B. Morphology of the physiological foramen: I. Maxillary and mandibular molars. J Endod. 2004;30(5):321-8.

33. Strömberg T. Pulpectomy, a review of histological studies. Sven Tandlak Tidskr. 1968;61(10):517-26.

34. Lambbjerg-Hansen H. Vital and mortal pulpectomy on permanent human teeth. Scand J Dent Res. 1974;82(4):243-332.

35. Wu MK, Wesselink PR, Walton RE. Apical terminus location of root canal treatment procedures. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2000;89(1):99-103.

36. Horsted-Bindslev T, Løvschall H. Treatment outcome of vital pulp treatment. Endod Topics. 2002;2(1):24-34.
teeth with vital and nonvital pulps. A meta-analysis. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2004;97(1):95-9.
38. Hülsmann M, Schäfer E. Apical patency: fact and fiction - a myth or a must? A contribution to the discussion. Endo. 2009;3(4):285-307.
39. Witherspoon DE. Vital pulp therapy with new materials: new directions and treatment perspectives - permanent teeth. J Endod. 2008;34(7):525-8.
40. Torabinejad M, Bakland LK. Immunopathogenesis of chronic periapical lesions: a review. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 1978;46(5):685-99.
41. Torabinejad M, Eby WC, Naidorf IJ. Inflammatory and immunological aspects of the pathogenesis of human periapical lesions. J Endod. 1985;11(11):479-88.
42. Stashenko P. The role of immune cytokines in the pathogenesis of periapical lesions. Dent Traumatol. 1990;6(3):89-96.
43. Ørstavik D, Pitt Ford T. Apical periodontitis: microbial infection and host responses. Essential endodontology: prevention and treatment of apical periodontitis. Oxford: Blackwell Science 1998:1-8.
44. Nair P. Apical periodontitis: a dynamic encounter between root canal infection and host response. Periodontol. 2000 1997;13(1):121-48.
45. Nair P. Pathogenesis of apical periodontitis and the causes of endodontic failures. Crit Rev Oral Biol Med. 2004;15(6):348-81.
46. Nair P, Henry S, Cano V, Vera J. Microbial status of apical root canal system of human mandibular first molars with primary apical periodontitis after “one-visit” endodontic treatment. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2005;99(2):231-52.
47. Kuramitsu HK, He X, Lux R, Anderson MH, Shi W. Interspecies interactions within oral microbial communities. Microbiol Mol Biol Rev. 2007;71(4):653-70.
48. Chávez de Paz LE. Redefining the persistent infection in root canals: possible role of biofilm communities. J Endod. 2007;33(6):652-62.
49. Siqueira Jr, Rôças IN. Clinical implications and microbiology of bacterial persistence after treatment procedures. J Endod. 2008;34(11):1291-301.
50. Chávez de Paz LE. Development of a multispecies biofilm community by four root canal bacteria. J Endod. 2012;38(3):318-23.
51. Swartz DB, Skidmore AE, Griffin JA Jr. Twenty years of endodontic success and failure. J Endod. 1983;9(5):198-202.
52. Sjögren U, Hägglund B, Sundqvist G, Wing K. Factors affecting the long-term results of endodontic treatment. J Endod. 1990;16(10):498-504.
53. Smith C, Setchell D, Harty F. Factors influencing the success of conventional root canal therapy - five-year retrospective study. Int Endod J. 1993;26(6):321-33.
54. Ng YL, Mann V, Rahbaran S, Lewsey J, Gulabivala K. Outcome of primary root canal treatment: systematic review of the literature - Part 2. Influence of clinical factors. Int Endod J. 2008;41(1):6-31.
55. Stroner WF, Van Cura JE. Pulpal dystrophic calcification. J Endod 1984;10(5):202-4.
56. Selden HS. Radiographic pulpal calcifications: normal or abnormal - a paradox. J Endod. 1991;17(1):34-7.
57. Knowles KI, Hammond NB, Biggs SG, Ibarrola JL. Incidence of instrument separation using LightSpeed rotary instruments. J Endod. 2006;32(1):14-6.
58. Jafarzadeh H, Abbott PV. Ledge formation: review of a great challenge. Endo. 2009;3(4):285-307.
59. Gu Y, Lu Q, Wang P, Ni L. Root canal morphology of permanent three-rooted mandibular first molars: part II-measurement of root canal curvatures. J Endod. 2010;36(8):1341-6.
60. Fu M, Zhang Z, Hou B. Removal of broken files from root canals by using ultrasonic techniques combined with dental microscope: a retrospective analysis of treatment outcome. J Endod. 2011;37(5):619-22.
61. Li X, Liu N, Liu N, Ye L, Nie X, Zhou X, Wen X, Liu R, Liu L, Deng M. A micro-computed tomography study of the location and curvature of the lingual canal in the mandibular first premolar with two canals originating from a single canal. J Endod. 2012;38(3):309-12.
62. Liang YH, Jiang L, Chen C, Gao XJ, Wesselink PR, Wu MK, Shemesh H. The validity of cone-beam computed tomography in measuring root canal length using a gold standard. J Endod. 2013;39(12):1607-10.
63. Madarati AA, Hunter MJ, Dummer PM. Management of intracanal separated instruments. J Endod. 2013;39(5):569-81.
64. Park PS, Kim KD, Perinpanayagam H, Lee JK, Chang SW, Chung SH, Kaufman B, Zhu Q, Safari KE, Kum KY. Three-dimensional analysis of root canal curvature and direction of maxillary lateral incisors by using cone-beam computed tomography. J Endod. 2013;39(9):1124-9.
65. Ricucci D, Siqueira Jr. Recurrent apical periodontitis and late endodontic treatment failure related to coronal leakage: a case report. J Endod. 2011;37(8):1171-5.
66. Vieira AR, Siqueira Jr, Ricucci D, Lopes WS. Dentinal tubule infection as the cause of recurrent disease and late endodontic treatment failure: a case report. J Endod. 2012;38(2):250-4.
67. Ricucci D, Loghin S, Siqueira Jr. Exuberant biofilm infection in a lateral canal as the cause of short-term endodontic treatment failure: report of a case. J Endod. 2013;39(5):712-8.
68. Xavier AC, Martinho FC, Chung A, Oliveira LD, Jorge AO, Valera MC, Carvalho CA. One-visit versus two-visit root canal treatment: effectiveness in the removal of endotoxins and cultivable bacteria. J Endod. 2013;39(8):959-64.
69. Ricucci D, Siqueira Jr. Apical actinomycosis as a continuum of intraradicular and extraradicular infection: case report and critical review on its involvement with treatment failure. J Endod. 2008;34(9):1124-9.
70. Ricucci D, Siqueira Jr, Bate AL, Pitt Ford TR. Histologic investigation of root canal-treated teeth with apical periodontitis: a retrospective study from twenty-four patients. J Endod. 2009;35(4):493-502.

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