

Prevalence of Apical Periodontitis in Endodontically Treated Premolars and Molars with Untreated Canal: A Cone-beam Computed Tomography Study

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Abstract

Introduction: The purpose of this retrospective cohort study was to evaluate the incidence of missed canals in endodontically treated teeth in the Greater Philadelphia area patient population and to evaluate the effect of untreated canals on endodontic outcome. **Methods:** A total of 1397 cone-beam computed tomography (CBCT) volumes taken from January 2013 to July 2015 were investigated. Limited view CBCT images were taken with Kodak 9000 3D System field of view at voxel size, 76 μm or Morita Veraviewpocs 3D F40 field of view at voxel size, 125 μm . All root canal-treated premolars and molars were included in the study. Unfilled canals appearing from cemento-enamel junction to apex including splitting from a main canal at coronal, mid, or apical third were defined as missed-untreated canal. A periapical lesion was diagnosed when disruption of the lamina dura was detected and the low density area associated with the radiographic apex was at least twice the width of the periodontal ligament space. **Results:** The overall incidence of missed canals was 23.04%. The incidence of missed canals per tooth was highest in tooth #14 at 46.5% and tooth #3 at 41.3%. The incidence of missed canals was highest in the upper molars at 40.1% and lowest in the upper premolars at 9.5%. There was a significant difference in lesion prevalence when a canal was missed-untreated ($P < .05$). Teeth with a missed canal were 4.38 times more likely to be associated with a lesion. **Conclusions:** Limited field-of-view CBCT should be examined before any endodontic retreatment to identify missed canals. This knowledge would not only help clinicians to locate missed canals clinically but would also help in deciding the surgical approach. (*J Endod* 2016;42:538–541)

Key Words

Apical periodontitis, CBCT, endodontic outcome, incidence of missed canals, missed canal, prevalence of apical periodontitis

Optimal prognosis for root canal treatment depends essentially on the successful reduction of microorganisms from the infected root canals and prevention of microorganisms to enter into the root canal system (1, 2). However, the cause of unsuccessful outcome for endodontic treatments is multifactorial and cannot be associated with 1 factor (3, 4). Many prognostic studies have investigated the prevalence of apical periodontitis and tried to identify the potential risk factors affecting endodontic outcome. Factors such as existence of preoperative disease, pulpal status, working length level, shaping and disinfection of the canal system, and the quality of obturation and restoration have been correlated to endodontic prognosis (1–5) and well-documented in the endodontic literature. However, it is a problem inherent in epidemiologic studies that differences in clinical practice are difficult to control, and still many prognostic factors remain unknown.

Many prognostic studies collected information on risk factors such as diagnosis, presence of apical periodontitis, cleaning-shaping procedures, and obturation techniques from well-documented treatment records and incorporated radiographic images to evaluate technical quality of root filling. However, the criteria to evaluate the risk factors should rely on measurable, reproducible, and quantifiable indicators (6, 7). The parameters defining the quality of root filling differ among investigators, and different thresholds have been adopted when categorizing root fillings as adequate or inadequate. In some studies, the quality parameter was defined as the level of final root filling in relation to the root apex, the homogenous density of filling without voids, or the combination of the 2 indicators. Sjogren et al (2) compared the quality of treatment on the level of filling with radiographic apex, whereas Ray and Trope (4) combined the level and the density of filling material to evaluate the technical quality of the root canal treatment. Chugal et al (8) incorporated in their outcome risk assessment not only radiographic images but also clinical information on loss of working length during treatment.

Limitations of two-dimensional radiographic images to display three-dimensional (3D) structures are well-established. Even though the epidemiologic studies documented extensively that the technical quality of root filling is one of the few factors that can be reliably correlated to outcome, researchers pointed out repeatedly the limitation of intraoral radiographs to diagnose apical periodontitis and to identify lateral voids in oval-shaped root canals or in multirrooted teeth (9, 10).

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Recently, limited field-of-view (FOV) cone-beam computed tomography (CBCT) has been introduced into endodontics, and its use has quickly become widespread. Accurate and 3D images obtained with CBCT provide higher sensitivity in correlating images to actual structures (11) and eliminate several limitations of conventional radiographs (12). High-resolution images help detect extra canals, anatomic deviations, perforations, root resorptions, and pathologies affecting hard tissues (13–15).

The importance of locating all existing canals within the root system to achieve optimal prognosis has been discussed by many, and potential negative effects of untreated canals on endodontic prognosis have been debated. Overwhelming evidence of missed canals in failed cases requiring endodontic retreatment has been reported previously (13, 16, 17). However, to date, the incidence of missed canals and its effect on endodontic prognosis have not been reported.

Therefore, the purpose of this retrospective cohort study was to evaluate the incidence of missed canals in endodontically treated teeth in the Greater Philadelphia area patient population and also to evaluate the effect of untreated canals on endodontic outcome.

Materials and Methods

This study included all CBCT images taken from patients referred to the University of Pennsylvania Department of Endodontics for dental treatment between January 2013 and July 2015. The investigated patient population's dental treatment needs were various, and the reasons for referral and the types of treatment requested were not included in the data analysis of this study.

Limited-view CBCT images were taken with Kodak 9000 3D System F.O.V 50 × 37 mm at voxel size 76 μm (Carestream, Rochester, NY) (n = 903) or Morita Veraviewpocs 3D F40 F.O.V 40 × 40 mm at voxel size 125 μm (Morita Mfg, Kyoto, Japan) (n = 494).

All axial, sagittal, and coronal slices of each scan were evaluated by 2 readers as a group, an endodontist experienced with reading CBCT images and a second-year endodontic resident. Scans were viewed with the software provided with the CBCT unit, and investigators had full access to each software's features to manipulate images. Scans were viewed in a clinical environment on 24-inch monitors (resolution 1920 × 1200 at 60 Hz) provided by the CBCT companies.

All root canal–treated premolars and molars were included in the study. Axial, sagittal, and coronal images of each root were aligned to the vertical (canal orifice to apex) and horizontal (mesial to distal) marking lines parallel to the long axes of each canal. Initially, axial views were investigated for unfilled canal space, and subsequently the findings were confirmed by examining sagittal and coronal views. Unfilled canals appearing from cementoenamel junction to apex including canals splitting from a main canal at coronal, mid, or apical third were defined as missed-untreated canal.

A periapical lesion was diagnosed when disruption of the lamina dura was detected and the low density area associated with the radiographic apex was at least twice the width of the periodontal ligament space (10, 18).

The Fisher exact probability and odds ratio tests were used to assess the relationship between missed canals and occurrence of apical periodontitis.

Results

A total of 1397 CBCT volumes were examined. Six hundred fifty-five scans showing 1 or multiple endodontically treated maxillary or mandibular posterior tooth/teeth were selected for further examination. Eliminated group included scans of anterior region, premolar and molars with perforation, teeth with extensive root resorption altering root

anatomy, previous periapical surgery with root-end resection, teeth with C-shape anatomy, and scans without endodontically treated teeth as well as images of unsatisfactory quality because of strong beam hardening and scattering effect of metals.

Six hundred fifty-five scans included a total of 1137 endodontically treated teeth (Tables 1 and 2). Overall prevalence of apical lesions was 59.5% (676 of 1137). The prevalence of lesions was highest in the lower molars and upper molars, 250 of 385 (64.9%) and 237 of 369 (64.2%), respectively.

The overall incidence of missed canals was 262 of 1137 or 23.04%. The incidence of missed canals per tooth was highest in tooth #14, 67 of 144 (46.5%), and tooth #3, 50 of 121 (41.3%). The incidence of missed canals was highest in the upper molars, 148 of 369 (40.1%), and lowest in the upper premolars, 25 of 262 (9.5%).

Prevalence of apical lesion in teeth with missed canal was 217 of 262 (82.8%). All lesions were around the root with a missed canal. There was a significant difference in lesion prevalence if a canal was missed (P < .05). A tooth with a missed canal was 4.38 times more likely to be associated with a lesion.

The results showed that the most frequently missed canal in maxillary molars was the mesiobuccal 2 canal (65%). Sixty-two percent of missed canals in mandibular first molars were the second distal canal. Seventy-eight percent of missed canals in mandibular second molars were in the mesial root.

Discussion

Cross-sectional studies are investigations in which information is collected in a systematic way in a well-defined population at a given point of time to describe disease prevalence and relate the disease to subjects' exposure to etiologic agents and pathogenic factors (6). The goal of this study was to capture the prevalence of apical periodontitis and correlate untreated canals identified on CBCT images to apical periodontitis. The limitation of this kind of data collection is that the data do not capture all causal factors affecting outcome or dynamic progress of healing, such as time of treatment, qualification of treating doctor, quality of obturation, treatment methodology, or quality of restoration.

TABLE 1. Distribution of Teeth Included in the Study

Tooth no.	No. of teeth included	No. of teeth without lesion	No. of teeth with lesion	Prevalence of lesion per tooth (%)	Incidence of missed canal per tooth (%)
1	1	0	1	100	0
2	51	22	29	56.9	33.3
3	121	33	88	72.7	41.3
4	65	31	34	52.3	12.3
5	58	29	29	50	5.2
12	58	27	31	53.4	10.3
13	81	41	40	49.4	9.9
14	144	51	93	64.6	46.5
15	47	23	24	51.1	27.7
16	5	3	2	40	20
17	1	0	1	100	0
18	63	30	33	52.4	20.6
19	138	51	87	63	18.1
20	37	24	13	35.1	2.7
21	17	8	9	52.9	35.3
28	22	11	11	50	18.2
29	45	23	22	48.9	4.4
30	139	36	103	74.1	20.1
31	44	18	26	59.1	22.7
32	0	0	0	0	0
Total	1137				

Tooth numbers were defined by using universal numbering system.

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