Original Article

Prevalence of Apical Periodontitis by Cone Beam Computed Tomography: A Cross Sectional Study

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Abstract

Objectives: This study aimed to assess the prevalence of apical periodontics (AP) from a sample of the Iraqi adult population using cone-beam computed tomography (CBCT) images.

Methods: Two hundred and fifty-one CBCT images (116 male and 135 female) were obtained, 6738 teeth were examined of these patients who attended for dental treatment from January 2017 to June 2018 in the B&R private dental clinic in Sulaimani, Kurdistan Region/Iraq. Apical periodontitis was divided according to tooth types (anatomical) in both upper and lower jaw, root canal treatment (RCT) and non-root canal treatment (Non-RCT), affected root by AP, and quality of RCT. Pearson's chi-square test was used to determine the level of significance ($p<0.05$).

Results: Apical periodontitis was found in 294 teeth from 6738 examined teeth; of these, 59.9% of AP incidence was linked to RCT. The percentage of periapical lesions was not significantly different between male and female patients. Among RCT teeth, maxillary teeth were most susceptible to AP (61.92%) than mandibular teeth (38.07%). The mesiobuccal root of upper first molar and mesial root of lower first molar were most commonly affected with AP (12.4%). The most-reported defects were underfilling, followed by a missed canal and pulpotomy, 32%, 20%, and 18 %. The missed upper second mesiobuccal canal presented with a higher percentage of AP (40.6%), and palatal roots of maxillary molars showed the least AP (2.7%).

Conclusion: The prevalence of AP was low on the population level; however, the prevalence of AP was high in inadequate endodontically treated teeth and increased in teeth with complex anatomy.

Keywords: *Apical periodontitis; Cone Beam Computed Tomography; Root canal treatment.*

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Introduction

Apical periodontitis is a periradicular inflammatory lesion of the tooth. It is a host defense response against microbial infection that originates from untreated necrotic dental pulp or improper root canal treatment[1]. RCT aims to seal the root canal space, reduce root infection to a minimal level, and achieve the absence of post-treatment apical periodontitis[2].

Endodontic failure has been defined in some studies as a recurrence of clinical symptoms along with the presence of a periapical radiolucency[3].

Epidemiologically, AP is widely spread in the adult population. One study concluded that around 27-80% of patients had at least one of their teeth affected with AP[4].

Upon successfully treating AP by root canal therapy, it is essential to monitor the outcome through radiological assessment. The unfavorable outcome of root canal treatment can be determined by persistence, or the new appearance, of periapical radiolucency, while the re-establishment or the appearance of a normal periodontal ligament space is a highly desirable outcome[5,6].

Moreover, many endodontically treated teeth have been found with lesions around the root's apex. Still, non-surgical root canal treatment is regarded as the treatment of choice for a restorable tooth with AP[7,8].

Radiographs are essential in the diagnosis, planning, and execution of the endodontic treatment, as well as for following up on the success of therapy. Until recent years, periapical radiography (PA) and orthopantomography (OPG) were the main radiographic investigations used in root canal treatment. Nowadays, CBCT is more frequently used for endodontic treatment, which is largely due to the limitations of conventional two-dimensional radiographic techniques. It has demonstrated advantages in evaluating complex dental lesions, malformed teeth, and differentiation of periapical lesions, root fractures, and root resorption. In addition, CBCT gives a detailed three-dimensional assessment of the region of interest that allows a detailed evaluation of a tooth and its surrounding anatomy[9,10]. However, the use of CBCT is limited by its higher radiation doses and additional costs. Thus, CBCT should be limited to indicated patients[11].

This study aimed to investigate the prevalence of apical periodontitis among dental patients who had taken CBCT for different purposes, correlating this information to gender, most affected teeth and roots, and relative causes of endodontic failure therapy.

Patients and methods

The scientific committee approved this research protocol of Sulaimani Technical Institute/ Sulaimani Polytechnic University (Issue No. 2131 on 16/09/2019).

A two hundred fifty-one CBCT of an adult Iraqi population in Sulaimani/Kurdistan Region of Iraq who attended B & R Dental Center from January 2017 to June 2018 was obtained. The age of participants ranged from 17 to 76 (mean, 40.75) years. The periapical status of 6738 teeth was examined.

Radiographic examination

All the CBCT images were acquired with a GALILEOS Sirona comfort PLUS unit (Sirona Dental Systems GmbH, Bensheim, Germany). Technical specifications are 15.4cm spherical imaging volume, 0.25/0.125mm isotropic voxel size, and field of view of 15×15 cm; all radiographs were taken according to the following parameters: 98 kVp, 3-5mA, and exposure time of 14s. The CBCT was opened and examined by the Sidex XG/Galileos implant.

Each scan was assessed on-site using the same step-by-step screening protocol by two examiners. The screening protocol included an initial tooth/root selection, followed by a mandatory root alignment in the three planes (coronal, sagittal, and axial) in order to have a centered view in the three planes, which was followed by the tooth/root classification.

Subjects younger than 17 years and those with ten or less remaining teeth and poor-quality or blurred radiographs were excluded from this study. For each case, the following data were recorded: age and gender, number of available teeth, number and location of teeth and roots with AP.

Apical periodontitis

Apical periodontitis was defined as a radiolucency connected with the apical part of the root, exceeding at least two times the width of the lateral part of the periodontal ligament[12]. Multirooted teeth were classified according to the root exhibiting the most severe periapical condition. Apical periodontitis was recorded in endodontically and non-endodontically treated teeth[9].

Root filled teeth

A tooth with a radiopaque material in the pulp chamber and root canals was considered root filled or endodontically treated. A tooth with radiopaque material in the pulp chamber is defined as (pulpotomy). A root filling more than 2 mm short of the radiographic

apex is defined as inadequate (underfilling). While RCT extruded beyond the apical foramen was considered inadequate (overfilling). Density defect (voids or lack of homogeneity of root canal materials). The root categorized Multirooted teeth with the most inadequate root filling[4,13].

Coronal leakage restoration

A coronal restoration was defined as a restoration of the coronal part of the tooth. Crowns or partial restorations such as inlays and onlays were considered indirect restorations or direct tooth-colored or non-colored direct tooth restoration. The restoration quality was also assessed radiographically and classified inadequate if the restoration was lost or no restoration were detectable or if open margins or fracture of the restoration were found[14].

Missed canal

Maxillary and mandibular teeth with the possibility of extra canals undergo RCT was assessed using an axial plane to check the correlation between the missed canal and the presence of AP[15].

Statistical analysis

IBM SPSS statistical software (version 23, Armonk, NY: IBM Corp. 2016) was used to perform statistical analysis. The Shapiro-Wilk normality test determined the distribution of the data. Results were expressed as mean ± standard deviation. The statistical significance of the correlation was determined using Pearson's correlation test. P values of less than 0.05 were regarded as having statistical significance in all analyses.

Results

A total of 251 CBCT images were selected. The study included 116 (46.21%) male and 135 (53.78%), female patients. Their ages ranged from 17 to 76 (mean, 40.75) years.

A total of 6738 teeth (3167 (47%) male and 3571 (53%) female) were examined, and among them, 6444 (95.6%) did not present with AP, and only 294 (4.4%) were diagnosed with AP. The differences between males and females in association with AP prevalence are not significant (Table 1). From the examined teeth with AP, 59.9% of AP teeth had undergone RCT, and 40.1% had not, as shown in (Figure 1).

The prevalence of AP was higher in the maxilla (61.92%) compared to the mandible (38.07%). The mandibular anterior single roots were found less prone to AP than maxillary anterior teeth. The single-rooted maxillary second premolars recorded the highest AP percentage (9.6%) compared to other single-rooted teeth. Maxillary and mandibular first molars were the teeth most commonly diagnosed with AP. The mesiobuccal root of maxillary first molar and mesial root of mand first molar was most commonly affected (12.4%) for each, compared to other roots of multi-rooted posterior teeth (Table 2).

There was a significant relation ($P<0.05$) between the occurrence of AP and type of teeth, with the highest percentage of AP found in molars and the lowest percentage in anterior teeth (Table 3).

Among RCT failures associated with AP, underfilling was identified as the most common (32%). Meanwhile, missed canal and pulpotomy accounted for 20% and 18%, respectively, of failures related to the presence of AP in endodontically treated teeth. Overfilling of RCT showed the least relation to the failure of RCT associated with AP (4%), and the defect in root canal filling materials density represent (17%) among related failures associated with AP. (Figure 2).

Prevalence of AP in RCTs with missed canals was found in 37 of 187 (20%) cases. Among teeth with missed canals (n=37), AP was present in (89.2%) of them. The prevalence of missed canals per tooth was highest in the second mesiobuccal of maxillary molars (40.6%), followed by the mesiolingual canal of mandibular molars and palatal canal of maxillary premolars (16.2%). The prevalence of missed canals was lowest in the palatal canals of maxillary molars (2.7%) (Figure 3). The correlated causes of RCT failure was shown in figure 4.

Table 1: Distribution of AP by gender.

Gender	Total teeth examined	Teeth without apical periodontitis	Teeth with apical periodontitis	Pearson's Chi-Square (p-value)
Male	3167 (47)	3012 (44.7)	155 (2.3)	X^2= 3.8
Female	3571 (53)	3432 (50.9)	139 (2.1)	*P*=0.0513
Total	6738 (100)	6444 (95.6)	294 (4.4)	

Table 2: Distribution of Apical Periodontitis in RCT by tooth types and affected roots.

Tooth type and affected root			Apical Periodontitis (%)
Maxilla	Central incisors		11 (3.9%)
	Lateral incisors		17 (6.1%)
	Canines		9 (3.2%)
	First premolars	Single root	3 (1.1%)
		Buccal roots	4 (1.4%)
		Palatal roots	25 (8.9%)
	Second premolars	Single root	27 (9.6%)
		Buccal roots	1 (0.35%)
		Palatal roots	5 (1.8%)
	First molars	Mesiobuccal roots	35 (12.45%)
		Distobuccal roots	4 (1.4%)
		Palatal roots	4 (1.4%)
	Second molars	Mesiobuccal roots	14 (4.98%)
		Distobuccal roots	2 (0.71%)
		Palatal roots	3 (1.1%)
	Third molars	Single root	2 (0.7%)
		Mesiobuccal root	4 (1.4%)
		Distobuccal root	2 (0.71%)
		Palatal root	2 (0.71%)
	Subtotal		172 (61.65%)
Mandible	Central incisors		6 (2.1%)
	Lateral incisors		5 (1.77%)
	Canines		5 (1.77%)
	First premolars		5 (1.77%)
	Second premolars		14 (4.98%)
	First molars	Mesial roots	35 (12.45%)
		Distal roots	8 (2.8%)
	Second molars	Mesial roots	17 (6.05%)
		Distal roots	3 (1.07%)
	Third molars	Single root	1 (0.45%)
		Mesial roots	5 (1.8%)
		Distal roots	3 (1.1%)
	Subtotal		107 (38.35%)
Total	281		

*Some root canal treated teeth with AP have more than one lesion.

Table 3: Distribution of different tooth categories in relation to the presence/absence of AP and RCT.

Teeth group	RCT teeth	RCT teeth without AP	RCT teeth with AP	Pearson's Chi-square (p-value)
Maxillary and mandibular anterior teeth	91 (25.8)	55 (15.6)	36 (10.2)	X^2= 8.69 *P*=0.013
Maxillary and mandibular premolar teeth	120 (34.1)	63 (17.9)	57 (16.2)	
Maxillary and mandibular molar teeth	141 (40.1)	58 (16.5)	83 (23.6)	
Total	352 (100)	176 (50)	176 (50)	

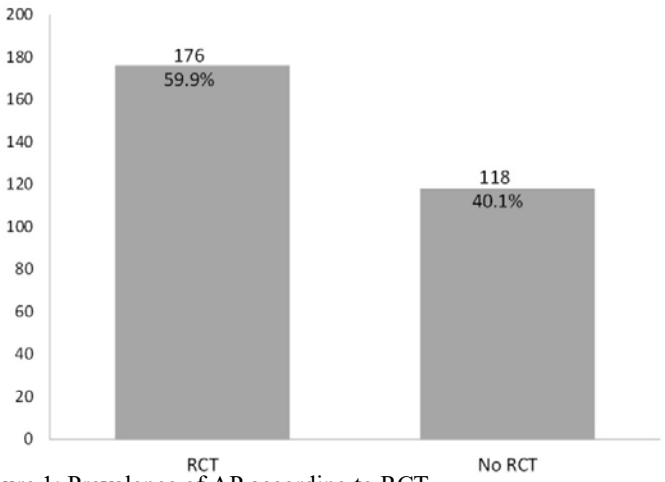

Figure 1: Prevalence of AP according to RCT.

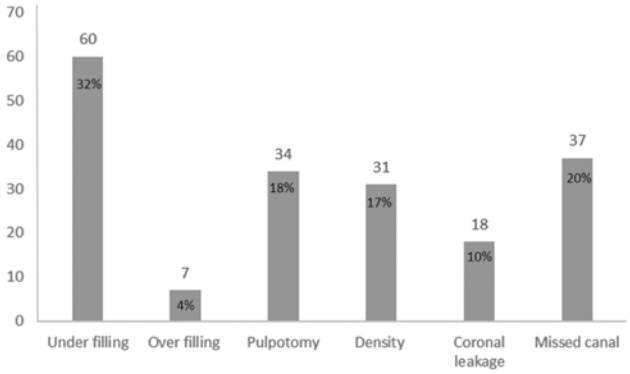

Figure 2: Correlation between causes of failure of RCT according to the number of effects roots and radiographic signs of AP.

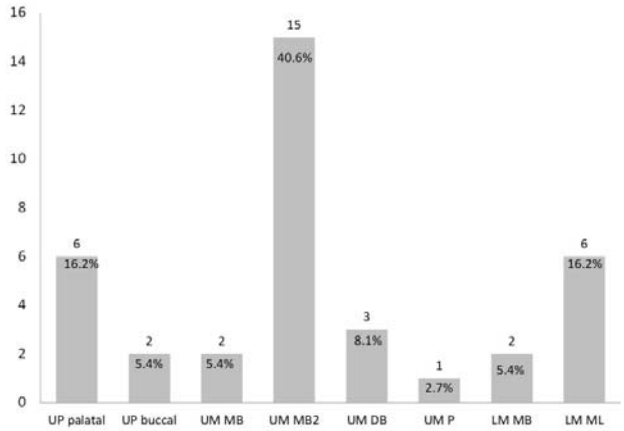

Figure 3: Apical periodontitis and untreated canals per root in RCT teeth (UP: upper premolars; UM: upper molars; LM: lower molars).

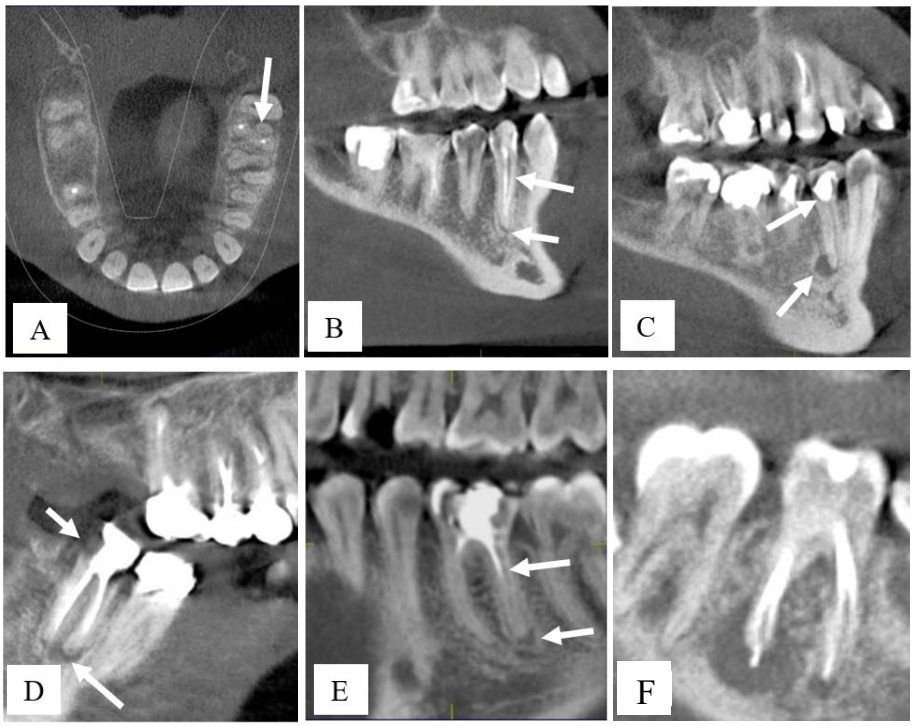

Figure 4: The possible causes of RCT failure: A. Axial view of CBCT showing missed canal, B. Tangential view of CBCT showing a defect in the density of root canal filling materials, C. Tangential view of CBCT showing root canal filling material limited to the pulp chamber, D. Tangential view of CBCT showing coronal leakage, E. Tangential view of CBCT showing underfilling RCT, F. Tangential view of CBCT showing overfilling RCT.

Discussions

The current study has a cross-sectional design based on available CBCT scans; therefore, this study would have been conducted in a randomized manner in a general Iraqi population to study the prevalence and AP and its failures related factors.

The prognosis/outcome of RCT depends on the obturation length, density, tooth type, and quality of coronal restoration[16]. The clinical significance of the current study is its determination of the roots most affected by AP. Additionally, this study has indicated a possible relation between the missed canals and the presence of AP.

Patients with ten or fewer remaining teeth were excluded because they often had periodontal disease and extensive dental caries lesion. It was impossible to determine RCT's role in the occurrence of their AP[17].

The number of females was more than males in this study, with no significant effect identified on the presence of AP and with similar gender proportions to

Those found in other studies[18,19] which may reflect some sociological aspect of the Iraqi population.

In the present study, CBCT has double the capacity to diagnose periapical lesions in endodotically treated teeth compared to a two-dimensional analog X-ray (PA and OPG) and allows the earlier detection of small periapical alterations[20]. A clinical study done by Patel et al. (2012) compared the alterations in the periapical status one year post endodontic treatment in a follow-up of 123 teeth, concluding that 14 times more AP was detected with CBCT than by digital periapical radiography[21].

In this study, CBCT images were selected of both the maxilla and the mandible, as in panoramic or full-mouth periapical radiographs, to observe AP prevalence in patients. However, a CBCT scan is not a simple and routine examination since it exposes the patient to higher radiation; therefore, clinicians prefer localized region CBCT (also known as focused, small field or, limited field) in RCT. In our study, CBCT images were taken for different purposes, not only for referral cases.

In the present study, the prevalence of AP was 4.4% and was higher in teeth that had undergone RCT compared to non-RCT teeth, falling within the same range (40%-65%) as observed by other studies[22,23]. Studies done by Gulsahi et al. (2008) and Dolci et al. (2016) reported the prevalence of AP as detected using OPG and digital periapical radiograph at 18.2% and 17.04%, respectively. These differences may be attributed to three-dimension CBCT examinations, which provide

more accurate information about the extension and dimensions of AP[24,25]. Furthermore, studies by Vandenberghe et al. (2007) and Bagis et al. (2015), comparing the use of 3D and 2D images in artificial bone defects, have shown CBCT to have a sensitivity of 80–100 % in the detection and classification of bone defects, while intraoral radiographs offer a sensitivity of 63-67 %[26,27]. CBCT has also shown an absence of distortion and overlapping, and the dimensions it presents are compatible with the actual size. Some dependent variables such as root filling length or crown and intra-coronal restorations can be more accurately evaluated with a 3-dimensional assessment compared to 2-dimensional analysis[28].

Concerning AP location, posterior multi-rooted molars presented a higher percentage, and the maxilla was affected more than the mandible, a result similar to those produced by other studies[29,30]. This fact can be related to these teeth' complex anatomy and difficulty in proper cleaning, shaping, and filling during RCT[31].

The results revealed a greater prevalence of AP in teeth and roots with underfilling, and this is again in accordance with several other studies[32,33]. Possible reasons for this finding might include inadequate negotiation, debridement, and disinfection of the apical portion of the root canal system and the lack of an adequate apical seal, allowing for the proliferation of apical bacteria and increasing the prevalence of AP.

The mesiobuccal root of the maxillary first molar presented with a greater percentage of AP. This might be related to two important factors: the inherent anatomical complexity and high possibility of a missed second mesiobuccal canal. In the present study, the missed second mesiobuccal canal represented the most common missed canal of RCT associated with AP. This study's findings regarding the most affected root and missed canal associated with AP are in agreement with other studies[34,35].

Coronal leakage plays an important role in the long-term success of root canal treatment. The quality of coronal restorations can assess CBCT scans. The most reliable methods of evaluating the quality of coronal restorations are clinical examination and intraoral radiographs because of the different types of image artifacts of filling materials found on CBCT radiographs[36]. The present study identified coronal leakage as the third most common cause of AP in RCT, which agrees with previous research[37,38].

In the present study, overfilling presented with the least AP among the relative causes of endodontic failures. A possible explanation might be the biocompatibility and bioactivity of most of the root canal filling materials and their easy integration with the biological environment, as found in other studies[9,39].

A limitation of cross-sectional studies is the lesion's size. In the early stages, AP cannot be detected in radiography. Another limitation is the impossibility of determining whether an AP is in the healing or progressing stage. Moreover, this type of data analysis, using a one-point-in-time assessment, does not take into account all causal factors that may affect the outcome or progression of periapical healing. Such factors may include the treatment date and specific clinical procedures[35], as well as the clinician's skills and qualifications[40].

Conclusions

The prevalence of AP was low in the studied population; however, the prevalence of AP in root-filled teeth with inadequate treatment was high and increased in molar teeth compared to other teeth.

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