

Prevalence of apical periodontitis and quality of root canal treatment in an adult Saudi population

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ABSTRACT

الأهداف: تحديد الحالة الصحية للانسجة المحيطة بجذور الأسنان ونوعية حشوات قناة الجذر بين السكان السعوديين البالغين الذين يحضرون إلى عيادات الأسنان لأول مرة.

الطريقة: تم تقييم 926 من الصور الشعاعية البانورامية ذات النوعية الجيدة من للمرضى السعوديين (540 من الذكور و 386 من الإناث) الذين يحضرون عيادات طب الأسنان بجامعة الملك سعود، الرياض، وغيرها من مراكز طب الأسنان الأخرى في مدينة جدة و نجران و الباحة في المملكة العربية السعودية. تم تسجيل عمر المريض ونوع الجنس والحالة الصحية (مصاب السكري أم لا)، عادات التدخين وعدد ومكان الأسنان المعالجة جذورها (لبيا) المصابة وغير المصابة بأفات ذروية، والجودة التقنية لحشوة تاج السن. تم معايرة البيانات وأجريت التحليلات الإحصائية باستخدام برنامج SPSS.

النتائج: كان العدد الإجمالي للأسنان التي تم تقييمها في هذه الدراسة 25,028 سن. وكان عدد الأسنان المصابة بآفة ذروية 1,556 (6.2%). الذكور بعمر أكثر من 55 سنة والإناث بين 36-45 سنة لديهم آفات ذروية أكثر من المجموعات الأخرى. وجد أن 36 من المصابين بالسكري و 87 من المدخنين لديهم آفات ذروية. تم اكتشاف التهاب ذروة السن في الذكور المصابين بالسكري أكثر من الإناث ($p=0.383$) والمدخنين من الإناث أكثر من الذكور ($p=0.44$). بالنسبة لجودة حشوات قنوات جذور الاسنان فالنسبة لم تتجاوز 42.2% للذكور و 57.7% للإناث.

الخاتمة: هناك ارتباط كبير بين التهاب ذروة السن والسكري والتدخين وعدم كفاية المعالجة اللبية. الفحص السريري هو أفضل لتحقق نتائج أفضل.

Objectives: To determine the health status of periradicular tissue and the quality of root canal fillings in an adult Saudi population attending dental clinics for the first time.

Methods: This cross sectional study was conducted in the dental clinics at King Saud University, Riyadh and other dental centers (Jeddah, Najran, and Albaha

City), Kingdom of Saudi Arabia between year 2010 and 2012. Good-quality panoramic radiographs of 926 Saudi subjects (540 males and 386 females) were analyzed based on the gender, age, health status, smoking habits, periapical status of the endodontically treated teeth, technical quality of the root canal fillings, and the presence or absence of coronal restoration. Data were calibrated and statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL, USA) version 17.

Results: Of the 25,028 teeth examined, 1,556 teeth (6.2%) had apical periodontitis (AP). Male subjects aged over 55 years and females between 36 and 45 years had higher AP. A total of 36 diabetic and 87 smokers subjects had AP. The AP was more common in male diabetics than female ($p=0.383$), and in female smokers more than male ($p=0.44$). Only 42.2% of male and 57.7% of female teeth had adequate root canal treatment.

Conclusions: Apical periodontitis was significantly related to diabetes, smoking, and inadequate endodontic treatment.

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Apical periodontitis (AP) is an inflammatory disorder of periradicular tissues caused by microbial infection within the root canal system of the affected tooth, similar to periodontal disease. The infection is limited to the area near the root apex and is detected on a routine radiographic examination. In addition, low-quality endodontic treatment may be associated with the persistence of AP infection.¹⁻³ The prevalence of AP associated with root-filled teeth is relatively high.⁴⁻⁷ Several risk factors related to AP have been reported, including poorly controlled diabetes and smoking.⁸⁻¹¹ Diabetes mellitus (DM) is a metabolic disorder of insufficient insulin secretion that causes serious and debilitating complications. A community-based national epidemiological health survey conducted in Saudi Arabia by Al-Nozha et al¹² found that 4,004 (23.7%) of 16,917 subjects (30-70 years old) were diagnosed as having DM. Diabetes mellitus was more prevalent among those living in urban areas compared with rural areas. The International Diabetes Federation reported that 17.6% (3.4 million cases) of Saudi adults (20-79 years old) had diabetes in the year 2015.¹³ Smoking can cause serious health problems over the long term. It was reported to be associated with various complications of diabetes.¹⁴ Published epidemiological studies related to smoking habits in Saudi Arabia, reviewed by Bassiony et al¹⁵ showed that the prevalence of smoking ranged from 2.4 - 52.3%, and it was higher in males than females. A review of endodontic literature revealed 2 studies that evaluated the quality of root canal treatment and the health of periradicular tissue of adult Saudi populations.^{7,16} The number of evaluated subjects was small and no consideration was given to the health and smoking habits of the subjects. The aim of the present study was to determine the health status of periradicular tissue and quality of root canal fillings among an adult Saudi population attending dental clinics at King Saud University (KSU), College of Dentistry, Riyadh, Kingdom of Saudi Arabia (KSA) and other dental centers.

Methods. *Study sample.* A random sample of 926

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Saudi subjects (540 males and 386 females) attending the dental clinics at KSU, Riyadh and other dental centers (Jeddah, Najran, and Albaha City), KSA for the first time between 2010 and 2012 were evaluated. This cross-sectional study was approved by the ethics committee of KSU, College of Dentistry. It has been conducted in full accordance with the World Medical Association Declaration of Helsinki.

The samples were randomly selected according to the following inclusions criteria: subjects over 16 years of age with more than 10 teeth (excluding third molars) who required the panoramic radiograph as part of dental diagnosis and treatment plan were included in the study. A written consent form approved by the ethical committee was signed by each patient including those under 18 years of age. The parents/guardians signed the consent form of all participants under 18 years of age. Panoramic radiographs of good quality and showing the periapical status of the present teeth were evaluated. All teeth were recorded according to the FDI nomenclature. The following data were recorded on a structured form for each subject: patient's age and gender, health status (diabetic or not), smoking habits, teeth present, number and location of non-root-filled teeth with periapical lesions, number and location of root-filled teeth with and without apical periodontitis, the technical quality of the root canal fillings, and the presence or absence of coronal restoration. Multi-root teeth were evaluated as a single unit. Data calibration was performed by 2 observers, an endodontist and a radiologist. It was carried out using 20 panoramic films prior to evaluation. In case of disagreement regarding the periapical status, a third observer was consulted to reach a consensus.

Evaluation criteria. The radiographic scoring criteria proposed by De Moor et al⁴ were applied as follows:

Quality of root canal fillings. Root canal filling 0-2 mm short of the radiographic apex (adequate). a) Root canal filling <2 mm short of the radiographic apex (inadequate). b) Root canal filling extruded beyond the radiographic apex (inadequate). c) Root canal filling limited to the pulp chamber as pulpotomy (inadequate)

Periapical status. a) Healthy periodontal ligament: an intact periodontal ligament with no signs of periapical pathosis. b) Apical periodontitis: widening of the periodontal ligament (widening of the apical part of the periodontal ligament not exceeding 2 times the width of the lateral periodontal ligament space) or periapical radiolucency (radiolucency in connection

with the apical part of the root, exceeding at least 2 times the width of the lateral part of the periodontal ligament).

Coronal restoration. Coronal restoration of the evaluated teeth was scored as yes or no. Teeth with detectable recurrent caries or open margins were considered as having no restoration. All radiographs were examined systematically using an illuminated viewer box with magnification of 2.5x. Digital radiographs were viewed on a larger screen. Statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL, USA) version 17. The *p*-values less than 0.05 were considered statistically significant.

Results. The total number of evaluated teeth in this study was 25,028; 15,745 (62.9%) belonged to males

and 9,283 (37.1%) to females. Patients from Riyadh included 260 males and 44 females with 7,939 teeth; from Jeddah, 97 males and 176 females with 5,860 teeth; from Al-Baha, 67 males and 107 females with 4,551 teeth; and from Najran, 299 males and 59 females with 6,678 teeth. The number of endodontically treated teeth was 1,541 (6.16%) (Riyadh 479, Jeddah 377, Al-Baha 348, and Najran 337), and 1,556 teeth were seen with AP (6.2%) (Table 1). There was no significant difference between males and females (*p*=0.000). The most common root canal-treated tooth was the mandibular molar (23.2%) followed by the maxillary premolar (21.7%) in both male and female subjects (Table 2). A total of 54.4% of males (98 of 177) had endodontically treated mandibular molar teeth with AP, which was significantly higher (*p*=0.009) than the proportion of treated mandibular molar teeth in females (40.7%; 72 of 177). The least common treated teeth were the mandibular anterior teeth, which showed the highest percentages of AP in both males and females (*p*=0.431). Male subjects over 55 years and females between 36 and 45 years experienced AP more often than other groups (Table 3). Among 43 subjects with diabetes 36 (83.7%) had AP and 115 smokers 87 (75.7%) had AP. Apical periodontitis was more common in male than in female diabetics (*p*=0.383) and more common in female than in male smokers (*p*=0.44) (Table 4). Only 42.2% of male and 57.7% of female teeth had adequate root canal treatment. Generally, males and females were significantly different in the frequency

Table 1 - Distribution of assessed teeth, root canal treated teeth (RCT), and teeth with apical periodontitis (AP) by gender.

Gender	Number of teeth	RCT teeth n (%)	AP n (%)
Male	15745	748 (4.8)	910 (5.8)
Female	9283	793 (8.5)	649 (7.0)
Total	25028	1541 (6.2)	1559 (6.2)
<i>P</i> -value		0.000	0.000
Proportion t-test <i>p</i> -value			

Table 2 - Frequency of apical periodontitis (AP) for teeth with root canal treatment (RCT) according to tooth type.

Tooth Type	Teeth with RCT (Male)				Teeth with RCT (Female)				Proportion t-test*
	No AP	With AP	Total n	(%)	No AP	With AP	Total n	(%)	
Maxillary incisors	80	30	110	27.3	46	36	82	43.9	0.016
Maxillary canines	25	17	42	40.5	28	10	38	26.3	0.402
Maxillary premolars	101	56	157	35.7	113	64	177	36.2	0.926
Maxillary molars	87	60	147	40.8	90	51	141	36.2	0.417
Total	293	163	456	35.7	277	161	438	36.8	0.731
Mandibular incisors	5	8	13	61.5	12	11	23	47.8	0.431
Mandibular canines	9	9	18	50.0	13	10	23	43.5	0.677
Mandibular Premolars	46	35	81	43.2	82	50	132	37.9	0.442
Mandibular molars	82	98	180	54.4	105	72	177	40.7	0.009
Total	142	150	292	51.4	212	143	355	40.3	0.003
Over all total	435	313	748	41.8	489	304	793	38.3	0.168

**P*-value for comparing gender with AP and with RCT teeth for Tooth type.

and quality of root canal treatments for all tooth types (Chi-square, $p=0.000$) (Table 5). Coronal restoration was found in 1,437 (93.3%) endodontically treated teeth; 560 (36.3%) of these had AP ($p=0.08$). There was no significant difference between males and females ($p=0.7203$) (Table 6). Comparing the restoration with and without AP, males with root canal-treated maxillary incisors with restoration and AP (28.2%) were less common than males treated with restoration without AP (71.8%, $p=0.000$). Similarly, females with root canal-treated maxillary incisors with restoration and AP (40.2%) were less common than females with root canal-treated teeth with restoration and without AP (56.1%, $p=0.042$). Males with root canal-treated mandibular incisors with restoration and AP (61.5%) were more common than males with canal treatment with restoration without AP (38.5%, $p=0.239$). There were significantly fewer females with root canal-treated mandibular incisors with restoration and AP (47.8%) than with root canal treatment with restoration and without AP (52.2%, $p=0.768$).

Discussion. A cross-sectional study is a systemic investigation of collected information of a well-defined population where a prevalence of disease is described.¹⁷ This type of data collection lacks information regarding the evaluated cases that may affect the outcome of root canal therapy, such as time and quality of treatment, the skills of the treating doctor, and the quality of the restoration. The current cross-sectional study evaluated panoramic films obtained from 4 dental centers located in different cities in Saudi Arabia with various socioeconomic and cultural characteristics. This study evaluated a large number of teeth representing a convenience sample of the adult Saudi population, whereas studies by Alfouzan et al⁷ and Alrahabi and Younes¹⁶ each evaluated only one city. Studies dealing with the prevalence of AP are often based on radiographic images. The examined samples in the current study consisted of good-quality images of panoramic radiographs (OPG) of patients who visited the Dental Department for the first time seeking treatment for numerous issues. It is rare to use

Table 3 - Distribution of root canal treated teeth with apical periodontitis (AP) by age groups.

Age	Number of male subjects		Number of female subjects		Proportion t-test [†]
	Total	With AP n (%)	Total	With AP n (%)	
16-25	229	137 (59.8)	121	80 (66.1)	0.248
26-35	137	83 (60.6)	110	66 (60.0)	0.926
36-45	78	54 (69.2)	64	45 (70.3)	0.889
46-55	57	40 (70.2)	56	38 (67.9)	0.79
>55	39	30 (76.9)	35	19 (54.3)	0.036*
Total	540	344 (63.7)	386	248 (64.2)	0.456

* P -value < 0.05 significant, [†] P -value for comparing gender within each age group

Table 4 - Distribution of root canal treated teeth in diabetic / smoker subjects with AP by age group.

Age	Total	Male n (%)				Total	Female n (%)			
		Diabetic		Smoker			Diabetic		Smoker	
		n	With AP	n	With AP		n	With AP	n	With AP
16-25	229	1	1	35	25	121	1	1	1	1
26-35	137	4	3	31	24	110	0	0	2	2
36-45	78	6	3	18	13	64	2	2	1	0
46-55	57	8	8	15	11	56	5	5	2	2
>55	39	12	12	9	7	35	4	2	1	1
Total	540	31	27	108	81	386	12	9	7	6
Percentage	100	5.7	87.1	20.0	75.0	100.0	3.1	75.0	1.8	85.7

n - number of patients

Table 5 - Quality of root canal treatment (RCT) according to the tooth type (male and female).

Tooth type	Gender	Quality of root canal treatment n (%)				Total	P-value for RCT quality
		Adequate	Inadequate (<2mm Short)	RCT extruded	RCT in pulp chamber		
Maxillary Incisors	Male	75 (68.2)	34 (30.9)	1 (0.9)	0 (0)	110	0.000
	Female	61 (74.4)	17 (20.7)	4 (4.9)	0 (0)	82	0.000
Maxillary Canines	Male	18 (42.9)	24 (57.1)	0 (0)	0 (0)	42	0.000
	Female	29 (76.3)	8 (21.1)	1 (2.6)	0 (0)	38	0.000
Maxillary Premolars	Male	84 (53.5)	70 (44.6)	1 (0.6)	2 (1.3)	157	0.000
	Female	108 (61.0)	68 (38.4)	1 (0.6)	0 (0)	177	0.000
Maxillary Molars	Male	50 (34.0)	86 (58.5)	1 (0.7)	10 (6.8)	147	0.000
	Female	69 (48.9)	69 (48.9)	3 (2.1)	0 (0)	141	0.000
Total	Male	227 (49.8)	214 (46.9)	3 (0.7)	12 (2.6)	456	0.000
	Female	267 (61.0)	162 (37.0)	9 (2.1)	0 (0%)	438	0.000
Mandibular Incisors	Male	4 (30.8)	9 (69.2)	0 (0)	0 (0)	13	0.000
	Female	7 (30.4)	12 (52.2)	1 (4.3)	3 (13.0)	23	0.000
Mandibular Canines	Male	12 (66.7)	5 (27.8)	1 (5.6)	0 (0)	18	0.000
	Female	13 (56.5)	8 (34.8)	0 (0)	2 (8.7)	23	0.000
Mandibular Premolars	Male	34 (42.0)	44 (54.3)	2 (2.5)	1 (1.2)	81	0.000
	Female	74 (56.1)	54 (41.0)	3 (2.3)	1 (0.8)	132	0.000
Mandibular Molars	Male	46 (25.6)	117 (65.0)	3 (1.7)	14 (7.8)	180	0.000
	Female	81 (45.8)	91 (51.4)	3 (1.7)	2 (1.1)	177	0.000
Total	Male	96 (32.9)	175 (59.9)	6 (2.1)	15 (5.1)	292	0.000
	Female	175 (49.3)	165 (46.5)	7 (2.0)	8 (2.3)	355	0.000

P-value between gender

Table 6 - Periapical status of root canal treated teeth as related to the coronal restoration (Ch-square test).

Tooth status / gender	No AP		Total	With AP		Total	Over all total
	Coronal restoration			Coronal restoration			
	Yes	No	Yes	No			
Male	408 (95.8%)	19	427	282 (87.9%)	39	321	748
Female	469 (95.51%)	22	491	278 (92.1%)	24	302	793
Total	877	41	918	560	63	623	1541
P-value	0.982		0.08				

the intraoral periapical full-mouth images for studies of this sort. In addition, the availability of OPG in all dental departments involved in the current study, which allows for all teeth to be examined on a single film, resulting in a relatively low radiation dose, makes it use an acceptable. Previous epidemiological studies found no significant difference in detection of periapical radiolucency between OPG and intraoral periapical film, although the intraoral periapical film revealed more radiolucency.^{17,18} In contrast, Ahlqwist et al.¹⁷ found that OPG detected PA in approximately 86-96% of patients compared with full mouth surveys. Cone beam computed tomography (CBCT) has been used in endodontics with different goals, including detection of periapical lesions.^{19,20} Estrela et al.²¹ compared the accuracy of CBCT imaging for detecting AP with panoramic periapical radiographs. The detection of AP was found to be significantly higher with CBCT. Similar findings were reported by Lofthag-Hansen et al.¹⁹ and Stavropoulos and Wenzel.²² Regardless of its accuracy however, CBCT is not available in every dental office due to its high cost and relatively high radiation dose. In addition, the scatter and beam hardening caused by coronal, intracanal, and apical retrofill radiopaque materials may lead to uncertainties in the interpretation of the CBCT images due to artifact formation.¹⁹ Thus, the current study did not use CBCT images.

Properly defined criteria must be used when performing an epidemiological study. The radiographic scoring criteria for periapical radiolucency employed in the current study were proposed by De Moor et al.⁴ Their approach is valid and improves the reliability of OPG evaluation of the periapical conditions. This is confirmed based on the findings of Molander et al.¹⁸ and De Moor et al.⁴ The scoring criteria of De Moore et al.⁴ are simple and easy to follow. In addition, the inter- and intra-examiner agreement in the current study was high due to prior calibration. Multi-root teeth were evaluated as having apical pathosis if one or more roots were involved. Only 2 similar studies on a Saudi population have been published. The prevalence of AP ranged from 53.5%¹⁶ to 58.6%⁷ for all subjects, whereas we observed AP in 63.9% of patients (Table 3). This difference could be related to the large sample size and the number of representative cities. The sample size used in this study was very high (1,541 root canal-treated teeth of 25,028). In the present study, we evaluated more compared with study of did Alfouzan et al.⁷ and Alrahabi and Younes.¹⁶ Thus, these data will provide adequate information to assess AP prevalence as well as the quality of endodontic treatment. Most of evaluated patients were young,

between 16 and 25 years of age (37.8%). It seems that younger patients seek dental treatment more often than older patients do. This finding is in contrast with other studies of Saudi populations,^{7,16} in which middle-aged subjects accounted for the majority of participants. This difference could be due to the total number of evaluated samples. The number of evaluated teeth decreased with age, and the percentage of root-filled teeth increased. This is probably due to caries and periodontal diseases as a result of long use, which is reflected in greater tooth loss among older subjects. The frequency of AP did not vary significantly with age, but the older subjects (>55 years old) showed a low number of teeth and a high ratio of AP compared with other groups, especially among male subjects. This finding is similar to those of Alfouzan et al.,⁷ Ericksen et al.,¹⁷ and Frisk and Hakeberg.²³ AP prevalence was similar in males and females in the present study ($p=0.456$), as shown in Table 3. This was consistent with the findings of previously reported studies.^{6,24} Of the 1,541 root-filled teeth in the current study, 617 teeth (40.0%) showed radiographic signs of periapical radiolucency. These findings fall between the findings of Alfouzan et al.⁷ (48.5%), and Alrahabi and Younes 16 (34.7%). The relationship between the type of tooth and AP was significant ($p=0.000$) for maxillary teeth, but not ($p=0.130$) for mandibular teeth. It is difficult to achieve an absolute diagnostic value (failure or success of treatment) based on one radiographic view of an endodontically treated tooth. In addition, no information regarding the time of endodontic treatment was available. Petersson et al.²⁵ found that the number of endodontically treated teeth with healed periapical lesions that were followed up to 11 years were comparable to the number of those that developed periapical lesions during the same period.

The frequency of AP was reported to range from 1-21%, using the tooth as a unit.^{6,26} In the current study, 6.2% of evaluated teeth had AP, which is similar to values in previous studies. This is slightly higher than the value from a previously reported study of a Saudi population.¹⁶ Diabetes is a disorder of elderly subjects, and its prevalence in Saudi Arabia has been reported to increase with advancing age.^{12,27} It was thought to serve as a disease modulator of AP.¹⁰

The results of the current study revealed a higher prevalence of AP in diabetic subjects. The prevalence of AP in the total diabetic samples was 87.1% in males and 75% in females of old age. This finding agrees with Marotta et al.¹⁰ Regardless of the small number of evaluated subjects with diabetes in this study, the results were comparable with previous

reports.^{8,9,11} Rudranaik et al²⁸ reported that healing of periapical lesions will be delayed in the infected teeth of subjects with uncontrolled diabetes, despite root canal treatment. This was supported by Fouad and Burlison,²⁹ who recommended the use of an effective antimicrobial root canal regimen in cases with AP. However, Britto et al⁸ observed no significant increase in AP prevalence in diabetics compared with controls.

Smoking is known to be significantly associated with the frequency of endodontic treatment and with an increased prevalence of AP.^{11,30} Nicotine decreases bone healing due to a reduction in the amount of oxygen reaching the area as a result of decreased blood flow, as well as stimulation of osteoclast cells.³¹ This, in turn, suppresses inflammatory cells, antibodies, and immunoglobulins.³² In addition, it increases serum C-reactive protein levels, leading to an increase in the size of the AP as a result of bone destruction.^{33,34} In the current study, the prevalence of AP was greater in females than males, with young males (16-25 years) representing a large number of cases. This finding is in agreement with previously published Saudi reports.^{35,36} The number of smoking subjects in the present cross-sectional study was small (108 males and 7 females), similar to previously reported studies.^{30,37} Therefore, these results may not represent the true prevalence of AP. Although it is important, the smoking history was not addressed in the current study. This inclusion question has been used in previous studies related to prevalence of AP as “smoker or none”.^{11,38} The frequency and history of smoking and its relation to presence of PA should be deeply investigated using biochemical measurements such as serum cotinine concentration “a predominant metabolite of nicotine” Serum cotinine concentration measurement was reported to provide an estimation of the smoking prevalence.³⁹

The prevalence of root canal-treated teeth was significantly higher in females (8.54%) than in males (4.75%) in this study ($p=0.000$), similar to Alrahabi and Younes.¹⁶ In the current study, the number of root canal-treated teeth was greater in the maxilla ($n= 894$, 48.0%) compared with the mandible ($n= 647$, 42.0%). This is consistent with other reports.^{2,5,7,11,16} The mandibular molar teeth were the most common root canal-treated teeth (23.2%), perhaps due to their early eruption and the anatomical complexity of the occlusal surfaces of their crowns. These findings were in contrast to Alfouzan et al,⁷ who found that the maxillary posterior teeth had more root canal treatments, which agrees with Alrahabi and Younes.¹⁶ The number of teeth that had root fillings

that extruded beyond the radiographic apex, or was limited to the pulp chamber of the treated tooth was very low, and these were considered as having inadequate root filling. These teeth usually have a poorer prognosis. In addition, teeth with root fillings of 2 mm short of the radiographic apex were considered inadequate in the current study. More than 85% of male and female teeth had root canal treatments assessed as less than adequate. Only 42.2% of male and 57.7% of female teeth had adequate root canal treatment. These results were better than those of Al-Omari et al⁶ and Alrahabi and Younes,¹⁶ but were consistent with Alfouzan et al.⁷ In fact, poorly performed root canal treatment often results in the development, persistence, or recurrence of periapical pathology.^{7,40} However, this was not evaluated in the current study. Root-filled mandibular incisor teeth were associated with a greater prevalence of AP in both male and females. Similar findings were reported by Alfouzan et al.⁷ This could be related to a failure to treat the second canal of mandibular incisor. The percentage of having 2 canals in the mandibular incisor of Saudi was 30% although teeth has one root.⁴¹ The low number of root-filled mandibular incisor teeth in the current study should be evaluated with caution. The association of the type of tooth and quality of RCT with AP in this study was significant ($p=0.000$ for maxillary and 0.000 for mandibular teeth). In the current study, root canal-treated teeth with good coronal restoration often had no AP (54.5% for males and 59.1% for females; $p=0.6985$). Similar findings were reported by Alfouzan et al,⁷ and Nur et al.⁴² Comparing restoration with and without AP, males with root canal-treated maxillary incisors with restoration and AP (28.2%) were less common than males treated with restoration without AP (71.8%), $p=0.000$. Similarly, females with root canal-treated maxillary incisors with restoration and AP (40.2%) were significantly less common than females with root canal-treated teeth with restoration and without AP (56.1%, $p=0.042$). Furthermore, males with root canal-treated mandibular incisors with restoration and AP (61.5%) were more common than males with canal treatment and restoration without AP (38.5%, $p=0.239$), whereas females with root canal-treated mandibular incisors with restoration and AP (47.8%) were significantly less common than females with root canal-treated teeth with restoration and without AP (52.2%, $p=0.768$).

A prospective epidemiological study is further needed to deeply evaluate the relationship between smokings, DM and periapical inflammation in diabetic

and smoker samples only. In addition, CBCT images should be used to provide a 3-dimensional views of the affected teeth.

In conclusion, AP was significantly associated with diabetes, smoking, and inadequate endodontic treatment. This study only assessed periapical condition using panoramic radiographs, and a clinical examination should be performed for better results using CBCT images.

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 - **The following are the typical headings:**
 - Objectives (background, why the study was done, specific aims)
 - Methods (setting, date of study, design, subjects, intervention and analysis)
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