

ORIGINAL ARTICLE

Prevalence of apical periodontitis and frequency of root-filled teeth in an adult Sudanese population

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Abstract

The aim of this study was to estimate the prevalence of teeth with apical periodontitis (AP) and root-filled (RF) teeth in an adult Sudanese population. Panoramic and periapical radiographs were obtained for 200 patients over 18 years of age seeking routine dental care and attending the dental clinics (University of Khartoum) and the dental hospital (University of Science and Technology) for the first time. The periapical status of all teeth (except third molars) was categorized on the basis of the presence or absence of radiographic signs of AP. In addition, the frequency of RF teeth was recorded. Data were analyzed using the chi-square test and odds ratio (OR).

The periapical status of 4,967 teeth was assessed. AP in one or several teeth was identified in 95 (47%) patients and in 3.3% of the teeth. The prevalence of AP was higher in molar teeth (7.3%) than in premolar (3.5%) and anterior teeth (0.9%, $p \leq .001$). There were 80 (1.6%) RF teeth in 42 (21%) patients. The probability of root-filling in molar and premolar teeth was almost twice that of anterior teeth (OR with 95% confidence intervals: $1.06 < 1.91 < 3.44$, $p \leq .05$).

The prevalence of RF teeth increased with age (OR of $48 \pm \text{year} = 3.06$, $p \leq .001$). Statistical analysis showed that the probability of radiological detection of AP in RF teeth was 17-fold higher than in nonfilled ones (OR with 95% confidence intervals: $9.87 < 16.83 < 28.25$, $p \leq .001$).

Therefore, the probability of AP, RF teeth with or without AP, and missing teeth was high in molar teeth than in anterior or premolar teeth. The frequency of RF teeth was low compared to that demonstrated in most other epidemiological studies. This highlights the need to focus on improving the quality of restorations and the procedure by which root canal is shaped and disinfected.

KEYWORDS

apical periodontitis, root-filled teeth, prevalence

1 | INTRODUCTION

Apical periodontitis (AP) is the inflammatory reaction in the apical periodontal ligament; it is mostly a consequence of dental caries caused by infection of the root canal system. AP has been estimated to be a prevalent disease among adult populations of a number of countries in Europe, Australia, North America, and Asia (Boucher, Matossian, Rilliard, & Machtou, 2002; Buckley & Spangberg, 1995; Dugas, Lawrence, Teplitsky, Pharoah, & Friedman, 2003; Kabak & Abbott, 2005; Tsuneishi, Yamamoto, Yamanaka, & Tamaki, 2005).

Numerous epidemiological studies have investigated the prevalence of AP and its association with root-filled (RF) teeth in different populations. Wide range of AP prevalence was found (from 0.6% to 16%; Table 1). In addition, a high prevalence of AP has been associated with RF teeth.

“Endodontic and periapical status are important measures that can predict tooth survival and the need for dental treatment in the growing dental population” (Kirkevang, Horsted-Bindslev, Orstavik, & Wenzel, 2001). It may also be a useful tool in the assessment and improvement of future undergraduate and postgraduate dental education. In Sudan,

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TABLE 1 Prevalence studies of apical periodontitis (AP) and root-filled (RF) teeth in populations from different parts of the world

Author (year)	Country	Age (years)	No. of individuals (teeth)	Prevalence of AP (%)		Prevalence of RF teeth (%)
				In all teeth	In RF teeth	
Eriksen et al. (1995)	Norway	35	118 (3,282)	0.6	38.1	1.3
Soikkonen (1995)	Finland	76–86	169 (2,355)	7.1	16.7	21.5
Marques et al. (1998)	Portugal	30–39	179 (4,446)	2.0	22.0	1.5
Sidaravicius et al. (1999)	Lithuania	35–44	147 (3,892)	7.2	35.6	8.2
De Moor et al. (2000)	Belgium	>18	206 (4,617)	6.6	40.4	6.8
Kirkevang et al. (2001)	Denmark	22–63	614 (15,984)	3.4	52.2	4.8
Lupi-Pegurier et al. (2002)	France	^a	344 (7,561)	7.4	31.5	18.9
Boucher et al. (2002)	France	>21	208 (5,373)	7.3	29.7	19.1
Dugas et al. (2003)	Canada	25–40	400 (10,474)	3.4	44.3	3.0
Jimenez-Pinzon et al. (2004)	Spain	>18	180 (4,453)	4.2	64.5	2.1
Kabak and Abbott (2005)	Australia	>15	1,423 (31,212)	12	45	20
Boltacz-Rzepakowska and Laszkiewicz (2005)	Lodz	>18	174 (10,054)	6.2	36.4	9.7
Tsuneishi et al. (2005)	Japan	^a	672 (16,232)	7.2	40	21
Kirkevang et al. (2006)	Denmark	>18	301 (8,159)	7.6	20	12.6
Skudutyte-Rysstad and Eriksen (2006)	Norway	35	250 (6,250)	16	43	23
Chen et al. (2007)	USA	76	244 (35,226)	5.1	37.5	4.8
Sunay et al. (2007)	Turkey	>18	375 (8,863)	4.2	53.5	5.3
Gulsahi et al. (2008)	Turkey	>15	1,000 (24,433)	1.4	18.2	3.3

^aGeneral population (no specific age).

studies on the prevalence of AP and frequency of root canal treatment are lacking. This study aims to estimate the prevalence of AP and the frequency of RF teeth in an adult Sudanese population in Khartoum state.

2 | PATIENTS AND METHODS

2.1 | Study population

The study sample consisted of 200 patients (153 female, 47 male), aged 34 ± 12.9 years. Those patients attended the dental clinics at the Faculty of Dentistry (University of Khartoum) and the dental hospital at the Faculty of Dentistry (University of Science and Technology) during the period of the study (3 months) and fulfilled the inclusion requirements.

The criteria for inclusion in the study implied that the patients of more than 18 years of age should agree to participate in the study during the study period, attend for the first time, and have more than 7 remaining teeth. Pregnant ladies were excluded to avoid radiation hazards. The scientific committee of the dental faculties approved the study and all patients signed a written informed consent.

2.2 | Radiographic examination

A combination of panoramic and periapical radiographs were taken by an experienced dental radiologist, using a Cranex 3⁺ Ceph (Sore dex orion corporation, Finland) X-ray unit and Kodak (MXG and Dental Intra oral E-speed) films (Estman Kodak Company, Rochester, New York, USA). A periapical radiograph was taken whenever the tooth apical area was not clear on the panoramic view. The paralleling technique was used for taking the periapical radiographs (using Endo Ray II film

holder, Dentsply Rinn Corporation, USA). An experienced dental assistant processed the films manually.

2.3 | Radiographic evaluation

From the radiographic survey, all teeth excluding third molars were recorded according to the FDI nomenclature. Teeth have been categorized as Normal (no periapical radiolucency and normal width of periodontal ligament space), Endodontically treated (a tooth containing a radio-opaque material in the root canal and/or the pulp chamber), and Apical Periodontitis (a tooth with distinct periapical radiolucency or widening of the periodontal ligament space exceeding twice the normal width). Multirrooted teeth were classified according to the root exhibiting the most severe periapical radiolucency. For each patient, the number and location of teeth with or without filling and with identifiable AP were recorded in a structured form. In the same form, the number and location of RF teeth were also recorded.

2.4 | The observer

The radiographs were examined by one observer assisted by an experienced radiologist, under standardized conditions using dark room and uniformly illuminated viewing box. The intraobserver reproducibility was evaluated by a double scoring of randomly selected 50 patients 3 months after the first examination. The intraobserver agreement test produced a Cohen's Kappa value of 0.951.

2.5 | Statistical analysis

The Statistical Package for Social Sciences (SPSS) version 15 was used for data management. The data were then transferred to the software: the Epidemiologic Perspectives and Innovation program (PEPI-for-

Windows). The data were analysed using the chi-square test and odds ratio (OR) at confidence level of 95% and significant level of 5%. *P* value less than .05 was considered as significant.

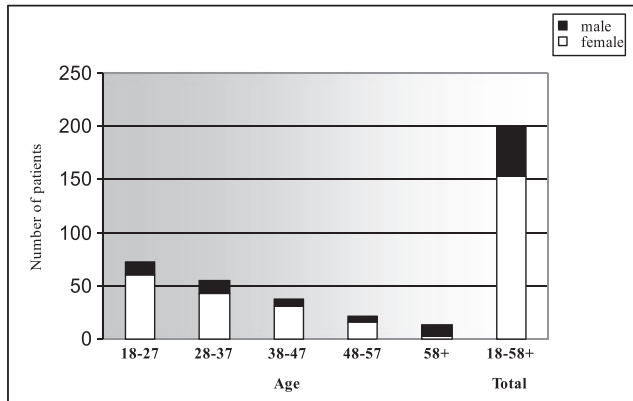


FIGURE 1 Distribution of the patients' sample according to age and gender

3 | RESULTS

The age of the 200 patients in the study ranged from 18 to 75 years with a mean ± SD age of 34.0 ± 12.9 years. Females comprised 76.5% of the study population (Figure 1).

Excluding the third molar teeth, 624 (12.5%) teeth were missing (48.7% in the maxilla; 51.3% in the mandible). The number of missing teeth varied from 1 to 16 per patient, with an average of 1–2 teeth per patient. Mandibular first molar was missing more often than any other tooth; 53.8% of the mandibular left first molar and 48.1% of the mandibular right first molar were missing. The mandibular right second molar was the third most commonly missing tooth (36.1%). The mandibular canine and first premolar were the least often extracted teeth (2% of the mandibular left canine, 2.6% of the right canine, 2% of the left first premolar, and 2.6% for the right first premolar; Table 2). The prevalence of missing molar teeth was higher (28.31%) than that of premolar teeth (9.51%) and anterior teeth (5.82%; *p* < .001). The probability of missing a molar tooth was almost five times that of an anterior tooth (OR = 4.85; Table 3).

TABLE 2 Distribution of apical periodontitis, root-filled and missing teeth according to the tooth type

Tooth	Normal periapex		Apical periodontitis		Endodontically treated		Missing		Total
	n	%	n	%	n	%	n	%	
11	170	98.8	2	1.2	3	1.7	28	16.3	172
12	185	97.9	4	2.1	3	1.6	11	5.8	189
13	190	99.5	1	0.5	1	0.5	9	4.7	191
14	173	97.7	4	2.3	3	1.7	23	13.0	177
15	169	97.1	5	2.9	2	1.1	26	14.9	174
16	154	95.1	8	4.9	8	4.9	38	19.8	162
17	170	95.5	8	4.5	0	0	22	12.4	178
21	179	98.4	3	1.6	5	2.7	18	9.9	182
22	184	98.4	3	1.6	3	1.6	13	7.0	187
23	188	98.4	3	1.6	5	2.6	9	4.7	191
24	167	92.8	13	7.2	8	4.4	20	11.1	180
25	164	94.3	10	5.7	6	3.4	26	14.9	174
26	153	93.9	10	6.1	5	3.1	37	22.7	163
27	170	96.6	6	3.4	2	1.1	24	13.6	176
All maxillary teeth	2,416	96.8	80	3.2	54	2.2	304	12.2	2,496
31	190	100	0	0	0	0	10	5.3	190
32	192	99.5	1	0.5	1	0.5	7	3.6	193
33	193	98.5	3	1.5	3	1.5	4	2.0	196
34	192	98.0	4	2.0	3	1.5	4	2.0	196
35	179	96.8	6	3.2	3	1.6	15	8.1	185
36	112	86.2	18	13.8	5	3.8	70	53.8	130
37	141	90.4	15	9.6	1	0.6	44	28.2	156
41	191	100	0	0	0	0	9	4.7	191
42	191	100	0	0	1	0.5	9	4.7	191
43	194	99.5	1	0.5	4	2.1	5	2.6	195
44	192	98.5	3	1.5	2	1.0	5	2.6	195
45	174	96.7	6	3.3	0	0	20	11.1	180
46	122	90.4	13	9.6	2	1.5	65	48.1	135
47	134	91.2	13	8.8	1	0.7	53	36.1	147
All mandibular teeth	2,397	96.7	83	3.3	26	1.0	320	12.9	2,480
Total	4,813	96.7	163	3.3	80	1.6	624	12.5	4,976

TABLE 3 Number and percentage of apical periodontitis (AP), root-filled (RF) and missing teeth, and RF teeth with AP as related to tooth type

	Number of teeth	AP teeth (%)	RF teeth (%)	Missing teeth (%)	RF teeth with AP (%)
Anterior	2,268	21 (0.9)	25 (1.1)	132 (5.82)	3 (12.0)
Premolar	1,461	51 (3.5)	29 (2.0)	139 (9.51)	11 (37.9)
Molar	1,247	91 (7.3)	26 (2.1)	353 (28.31)	12 (46.2)
Total	4,976	163 (3.3)	80 (1.6)	624 (12.54)	26 (32.5)
OR anterior	-	1.0	1.0	1.0	1.0
OR premolar	-	3.82	1.81	1.63	4.00
95% CI (p value)	-	2.26-6.68 ($<.001$)	1.03-3.22 (.039)	1.27-2.11 ($<.001$)	0.94-24.14 (.063)
OR molar	-	8.27	1.91	4.85	5.54
95% CI (p value)	-	5.10-14.03 ($<.001$)	1.06-3.44 (.029)	3.92-6.04 ($<.001$)	1.29-34.51 (.018)

Note. Adjusted odds ratio (OR) with 95% confidence intervals (CI) and p values.

3.1 | Periapical status

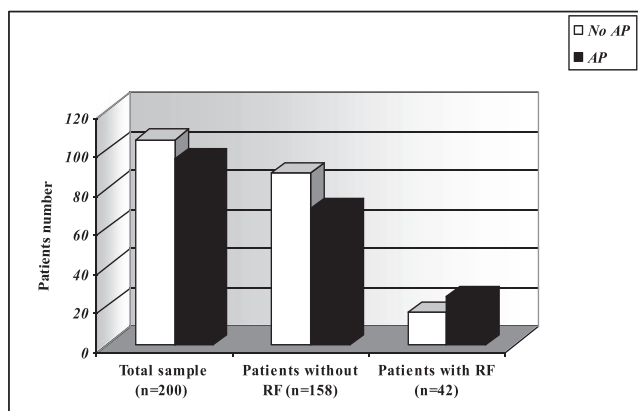
The periapical status of 4,976 teeth was assessed, with a range of 12–28 teeth per patient. Ninety-five (47.5%) patients had AP in one or more teeth (range 1–7). One hundred sixty-three (3.3%) teeth had AP (Table 2). The highest prevalence of AP occurred in mandibular second molar (21.5%) followed by mandibular first molar (15.5%) and maxillary first molar (9%). The difference in the frequency of AP between different types of teeth was statistically significant; premolar and molar teeth had AP more often than anterior teeth ($p < .001$; Table 3).

The probability of AP occurring in molar teeth was eight times that of anterior teeth (OR = 8.27; Table 3).

3.2 | Endodontic treatment

Seventy-nine percent of the patients had no root fillings, whereas 21% had ≥ 1 RF teeth (range 1–6). Of the patients with root fillings, 25 (59.5%) had AP, whereas 70 (44.3%) of the patients without root fillings had AP (Figure 2).

Eighty (1.6%) teeth had been root filled. Of these RF teeth, 26 (32.5%) teeth had AP. No statistically significant difference was found between male and female for presence of RF teeth or RF teeth with AP ($p > .05$; Table 4).

**FIGURE 2** Distribution of apical periodontitis (AP) and root-filled (RF) teeth in the study population**TABLE 4** Number and percentage of teeth with apical periodontitis (AP), root-filled (RF), and RF with AP as related to gender

	Number of teeth	AP teeth (%)	RF teeth (%)	RF teeth with AP (%)
Females	3,874	105 (2.7)	62 (1.6)	18 (29.0)
Males	1,102	58 (5.3)	18 (1.6)	8 (44.4)
Total	4,976	163 (3.3)	80 (1.6)	26 (32.5)
OR females	-	1.0	1.0	1.0
OR males	-	2.0	1.04	1.95
95% CI (p value)	-	1.42-2.80 ($<.001$)	0.58-1.78 (1.000)	0.58-6.55 (.346)

Note. Adjusted odds ratio (OR) with 95% confidence intervals (CI) and p values.

The prevalence of endodontically treated teeth increased with age (Table 5). The probability of RF teeth in older groups (≥ 48 years old) was three times that in younger groups (18–47 years old).

The highest prevalence of endodontically treated teeth occurred in maxillary first molar (6.5%) followed by maxillary first premolar (5.5%), maxillary second premolar (4%), and mandibular first molar (3.5%; Table 1). More premolar and molar teeth were root filled (2%) than anterior teeth (1%), ($p < .05$). The probability of root-filling in

TABLE 5 Number and percentage of teeth with apical periodontitis (AP), root-filled (RF), and RF teeth with AP as related to age

Age (years)	Number of teeth	AP (%)	RF teeth (%)	RF teeth with AP (%)
18–27	1,939	49 (2.5)	13 (0.7)	6 (64.1)
28–37	1,416	28 (2.0)	26 (1.8)	5 (19.2)
38–47	890	39 (4.4)	14 (1.6)	7 (50.0)
48–57	467	29 (6.2)	19 (4.1)	5 (26.3)
58+	264	18 (6.8)	8 (3.0)	3 (37.5)
Total	4,976	163 (3.3)	80 (1.6)	26 (32.5)
OR 18–47	-	1.0	1.0	1.0
OR 48+	-	2.46	3.06	0.84
95% CI (p value)	-	1.70-3.51 ($<.001$)	1.84-4.97 ($<.001$)	0.27-2.48 (.890)

Note. Adjusted odds ratio (OR) with 95% confidence intervals (CI) and p values.

molar and premolar teeth was almost twice than that of anterior teeth (Table 3).

4 | DISCUSSION

The candidates included in this study were adult patients attending the dental clinics at the Faculty of Dentistry, University of Khartoum, and the Dental Hospital at the Faculty of Dentistry, University of Science and Technology, seeking routine dental care for the first time. The criteria used to select those patients were the same as those used by other studies (Boltacz-Rzepkowska & Laszkiewicz, 2005; Boucher et al., 2002; Buckley & Spangberg, 1995; De Moor, Hommez, De Boever, Delme, & Martens, 2000; Dugas et al., 2003; Jimenez-Pinzon, Segura-Egea, Poyato-Ferrera, Velasco-Ortega, & Rios-Santos, 2004; Lupi-Pegurier, Bertrand, Muller-Bolla, Rocca, & Bolla, 2002; Saunders, Saunders, Sadiq, & Cruickshank, 1997; Sunay, Tanalp, Dikbas, & Bayirli, 2007). Obviously, the sample does not represent a random sample of the Sudanese population. Extrapolation of this study results to the general population must be done with caution. Nevertheless, no survey on the periapical health or the endodontic needs of a Sudanese population has been published at the time of preparing this paper. Therefore, the results of this study may provide useful data on the prevalence of AP and assessment of endodontic treatment needs in Sudan.

Patients with seven or fewer remaining teeth were excluded because they often have severe periodontal disease and it was impossible, in such patients, to determine the possible effects of the endodontic treatment in the occurrence of periapical radiolucency. On the other hand, excluding those patients would underestimate the effects of marginal periodontal disease on the periapical health (Bahrami, Vaeth, Kirkevang, Wenzel, & Isidor, 2008; Gerald, David, & William, 2000; Stassen, Hommez, De-Bruyn, & De-Moor, 2006).

OPG has been used for the detection of AP by several studies (Chen et al., 2007; De Moor et al., 2000; Hansen & Johansen, 1976; Kabak & Abbott, 2005; Marques, Moreira, & Eriksen, 1998; Schulte, Pieper, Charalabidou, Stoll, & Stachniss, 1998; Vago, Deak, Bruncsics, & Szabo, 2000). This technique is more convenient to the patients and exposes them to less radiation as compared with full-mouth sets of periapical radiographs. "OPG and full-mouth radiographic series were compared, using full-mouth radiographic series as the gold standard with respect to osteolytic periapical lesions; the sensitivity was 82–95%" (Ahlqwist, Halling, & Hollender, 1986). Other investigations found that an underestimation of lesions occurred when OPG was used (Eriksen & Bjertness, 1991). In this study, a combination of OPG and periapical views were used and the intra-examiner agreement was high. The Kappa value of 50 radiographs was 0.95.

Young adult patients (18–37 years) were the majority of our sample (64%). Other investigators have reported a similar skewed distribution (De Cleen, Schuurs, Wesselink, & Wu, 1993; De Moor et al., 2000; Eckerbom, Andersson, & Magnusson, 1987; Jimenez-Pinzon et al., 2004; Kirkevang, Vaeth, & Wenzel, 2006). A possible explanation for such findings is that younger patients seek dental treatment more frequently than older ones. The sample also consisted of 76.5% females, a matter that may reflect the greater interest of

women in receiving dental care. Other studies with the same recruitment also found similar gender proportions (Boucher et al., 2002; Jimenez-Pinzon et al., 2004).

The prevalence of teeth with AP in previous studies varies from 0.6% (Eriksen, Berset, Hansen, & Bjertness, 1995) to 16% (Skudutyte-Rysstad & Eriksen, 2006). This wide range is probably due to the variations in sampling procedures, type of radiographs examined, disease definitions, and so forth. Therefore, comparison of findings from different studies should be made only with caution. In this study, the prevalence of teeth with AP (3.3%) was similar to other studies that used similar methodologies and radiographs (De Cleen et al., 1993; De Moor et al., 2000; Dugas et al., 2003; Gulsahi, Gulsahi, & Ungor, 2008; Lupi-Pegurier et al., 2002; Sunay et al., 2007).

The frequency of RF teeth in our group of patients was 1.6%, which is low compared to the results of other studies in different populations from different parts of the world, where a range of 5.5–23% RF teeth was found (Boltacz-Rzepkowska & Laszkiewicz, 2005; Boucher et al., 2002; Buckley & Spangberg, 1995; De Moor et al., 2000; Eckerbom et al., 1987; Eriksen & Bjertness, 1991; Hollanda, de Alencar, Estrela, Bueno, & Estrela, 2008; Imfeld, 1991; Kabak & Abbott, 2005; Kirkevang et al., 2006; Lupi-Pegurier et al., 2002; Odesjo, Hellden, Salonen, & Langeland, 1990; Petersson, Lewin, Hakansson, Olsson, & Wennberg, 1989; Petersson, Petersson, Olsson, Hakansson, & Wennberg, 1986; Saunders et al., 1997; Sidaravicius, Aleksejuniene, & Eriksen, 1999; Skudutyte-Rysstad & Eriksen, 2006; Soikkonen, 1995; Tsuneishi et al., 2005). This low percentage of RF teeth in our sample could be explained by the conditions of the country health care services and the variations in age distribution of the patient's sample. Older patients usually have more RF teeth (Imfeld, 1991), probably because of the accumulative exposure to caries and subsequent operative procedures provided. In Sudan, endodontic treatment is relatively expensive; that is why patients prefer to extract their diseased teeth. On the other hand, other studies found similar results that range between 1.3% and 4.8% (Chen et al., 2007; De Cleen et al., 1993; Dugas et al., 2003; Eriksen, Bjertness, & Orstavik, 1988; Eriksen et al., 1995; Jimenez-Pinzon et al., 2004; Kirkevang et al., 2001; Marques et al., 1998; Sunay et al., 2007)

5 | CONCLUSIONS

Within the limitation of this study, the following conclusions can be drawn:

- The prevalence of AP in RF and untreated teeth was comparable to those reported in previous similar studies.
- The frequency of RF teeth was low compared to that demonstrated in most other epidemiological studies.
- The probability of AP, RF teeth with or without AP and missing teeth was high in molar teeth than in anterior or premolar teeth.

CONFLICT OF INTEREST

The authors have declared that no competing interests exist.

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