Frequency and distribution of root filled teeth and apical periodontitis in a Greek population

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Abstract

Georgopoulou MK, Spanaki-Voreadi AP, Pantazis N, Kontakiotis EG. Frequency and distribution of root filled teeth and apical periodontitis in a Greek population. *International Endodontic Journal*, **38**, 105–111, 2005.

Aim To investigate the prevalence of root filled teeth and apical periodontitis (AP) in a Greek population.

Methodology A random sample of 320 patients who required full mouth periapical radiographic examination as a part of diagnostic and planning procedures were included. The age of the patients ranged from 16 to 77 years. A total of 7664 teeth were assessed and the frequency of root filled teeth and periapical status was recorded. Two observers evaluated the radiographs under standardized conditions. AP was defined as distinct periapical radiolucency or widening of the periodontal ligament space exceeding two times the normal width. Statistical evaluation of differences in proportions between groups was performed using random effects logistic regression models.

Results The periapical status of 286 (3.7%) teeth was impossible to evaluate because of radiographic faults; these teeth were excluded from further analysis. A total of 1040 (13.6%) teeth had radiographic signs of AP and 680 (9.2%) teeth had been root filled. Of the root filled teeth, 408 (60.0%) had AP. There was no difference in the number of root filled teeth between males and females; the prevalence of root filled teeth increased with age. Significantly more molars (13.1%) and premolars (11.9%) than anterior teeth (5.8%) had been root filled ($P < 0.001$). The prevalence of AP was significantly higher ($P < 0.001$) in molars (23.9%) and premolars (14.0%) than anterior teeth (9.4%).

Conclusions The prevalence of AP and the frequency of root filled teeth with AP in this Greek population were higher than those found in many other European countries. The frequency of root filled teeth was comparable with findings in other epidemiological studies.

Keywords: apical periodontitis, endodontic epidemiology, endodontically treated teeth.

Received 13 November 2003; accepted 14 October 2004

Introduction

Several epidemiological studies have investigated the prevalence of apical periodontitis (AP) in different populations and found a range of prevalence (Table 1). Furthermore, a high prevalence of AP has been associated with root filled teeth. Prevalence of AP is a disease rate, which indicates that treatment is needed to restore periapical tissues to health, usually by root canal treatment or occasionally in combination with endodontic surgery (European Society of Endodontology 1994). In Greece no epidemiological studies of periapical and endodontic status have been published.

The purpose of the present study was to evaluate the prevalence of root filled teeth and AP in a Greek population as well as to investigate some factors that may influence these variables.

Materials and methods

Study population

The sample consisted of 320 randomly selected individuals living in Athens. Patients who required a full

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Table 1 Epidemiological studies of root filled teeth and prevalence of apical periodontitis in different populations. (R = radiographs; RT = root canal treatment)

Country	Author	Number of individuals	Number of teeth	Radiographs	AP/total (%)	RT/total (%)	RT with AP/RT (%)	Population
Greece	Georgopoulou *et al.*	320	7664	Full mouth periapical radiographs	13.6	9.2	60.0	Dental patients living in Athens
Spain	Jiménez-Pinzón *et al.* (2004)	180	4453	Full mouth periapical radiographs	4.2	2.0	64.5	Dental school patients of Seville
Canada	Dugas *et al.* (2003)	610	16 148	Full mouth or panoramic and periapical R. of RT	3.1	2.5	45.4	Patients from two different dental schools 25–40 years old
France	Lupi-Pegurier *et al.* (2002)	344	7561	Panoramic R.	7.3	18.9	31.5	Adult patients of dental school in Nice >20 years old, ≥10 teeth
France	Boucher *et al.* (2002)	208	5373	Full mouth periapical radiographs	7.4	19.1	29.7	Adult dental patients of the Hotel Dieu, in Paris
Denmark	Kirkevang *et al.* (2001)	614	15 984	Full mouth periapical radiographs	3.4	4.8	52.2	Adults living in Aarhus
Belgium	De Moor *et al.* (2000)	206	4617	Panoramic R.	6.6	6.8	40.4	University hospital patients >18 years old, ≥10 teeth
Lithuania	Sidaravicius *et al.* (1999)	147	3892	OPGs and intraoral R. of R.T. teeth	7.2	8.2	35.0	35–44-year-old from Vilnius region
Portugal	Marques *et al.* (1998)	179	4446	OPGs and bite wings	2.0	1.5	21.7	30–39-year-old from Porto area
Germany	Weiger *et al.* (1997)	323	7987	Periapical R. in some, panoramic R. in some	3.0	2.7	61.0	Individuals visiting a general practice in Stuttgart
United Kingdom	Saunders *et al.* (1997)	340	8420	Full mouth periapical radiographs	4.9	5.6	58.1	≥20 years old dental hospital patients
USA	Buckley & Spangberg (1995)	208	5272	Full mouth periapical radiographs	4.1	5.5	31.3	Dental school patients (initial examination)
The Netherlands	De Cleen *et al.* (1993)	184	4196	Panoramic R.	6.0	2.3	39.2	Dental school patients
Switzerland	Imfeld (1991)	143	2004	OPGs and intraoral R. of single teeth	8.4	20.3	30.5	66-year-old living in Zurich
Finland	Soikkonen (1995)	169	2355	Panoramic R. and intraoral R. of poorly visible areas	7.1	21.5	16.8	>76-year-old living at home in Helsinki
Norway	Eriksen *et al.* (1995)	118	3282	OPGs and intraoral R. of RT teeth	0.6	1.3	38.1	35-year-old in Oslo (1993 sample)
Norway	Eriksen *et al.* (1995)	141	3917	OPGs	1.4	3.4	25.6	35-year-old in Oslo (1984 sample)
Norway	Eriksen *et al.* (1995)	111	2981	OPGs	1.5	3.4	18.0	35-year-old in Oslo (1973 sample)
Norway	Eriksen & Bjertness (1991)	119	2940	OPGs and intraoral R. of RT teeth	3.5	6.0	44.7	50-year-old in Oslo
Sweden	Ödesjö *et al.* (1990)	743	17 430	Full mouth periapical radiographs	2.9	8.6	24.5	General Swedish population ≥20 years old
Sweden	Eckerbom *et al.* (1987)	200	4889	Full mouth periapical radiographs	5.2	13.0	26.4	Patients from general practices
Sweden	Eckerbom *et al.* (1989)	200	4672	Full mouth periapical radiographs	5.6	14.7	21.5	The same sample as above, 5–7 years after
Sweden	Bergström *et al.* (1987)	250	6593	Full mouth periapical radiographs	3.5	6.5	28.8 (roots)	Patients with regular dental care habits, 21–60-year-old
Sweden	Petersson *et al.* (1989)	567	11 497	Full mouth periapical radiographs	8.9	22.8	26.5	Swedish population needing high-cost treatment
Sweden	Petersson *et al.* (1986)	861	4985	Intraoral R. only of the premolar-molar	6.6	13.0	34.6	General Swedish population
Sweden	Allard & Palmqvist (1986)	183	2567	Full mouth periapical radiographs	9.8	17.6	27.0	≥65-year-old in Örebro country

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mouth periapical radiographic examination as a part of diagnostic and planning procedures were included. The series of radiographs were collected from private dental offices between 1999 and 2001. The exact conditions under which the radiographs were taken and processed were not known, however, in most cases the patients were referred to an experienced radiologist.

Two observers, one experienced endodontist and one general dentist evaluated the radiographs at twofold magnification under standardized conditions using a uniformly illuminated viewing box masked to obtain an illuminated area the same size as the radiograph.

For each patient age, gender, number of remaining teeth excluding third molars and number of root filled teeth were recorded. For each tooth the following data were surveyed: the periapical status, the presence of root fillings and the presence of coronal restorations.

Radiographic evaluation

The radiographic criteria for categorization were as follows:

Periapical status
Normal: no periapical radiolucency and normal width of periodontal ligament space.
Abnormal: distinct periapical radiolucency or widening of the periodontal ligament space exceeding two times the normal width.
Not assessable: periapical status of at least one root (in multirooted teeth) not clear.

Multirooted teeth were classified according to the root exhibiting the most severe periapical condition.

Endodontically treated teeth
Pulpotomy: tooth with radiopaque material only in the pulp chamber.
Root filling: tooth with radiopaque material in the root canal(s).
Surgically treated: tooth with apicectomy or apicectomy and root-end filling.

Coronal status
Intact: intact tooth with no radiographic signs of caries or restoration.
Caries: tooth with caries without restoration.
Intracoronal restoration: tooth with restoration, with/without caries.
Extracoronal restoration: tooth with crown, with/without caries.
Lost restoration: tooth with cavity or crown preparation but with missing restoration.

Seven full mouth radiographic series (112 periapical radiographs) were assessed to calibrate the two examiners. Inter-examiner agreement with regard to the classification of periapical status was determined by computing Cohen's κ; the intra-examiner agreement with a 6-month interval was also determined. All κ values were between 0.76 and 0.82. Because of the high inter-examiner agreement, the teeth selected were scored on each occasion by one of the examiners. The data were then pooled.

Statistical methods

Statistical evaluation was performed using random effects logistic regression models. These models are suitable for multivariate analysis and provide estimates of the magnitude of such differences via the 'odds ratio'. The random effects model was used in order to take into account the hierarchical structure of the data, where teeth are clustered within subjects.

Results

The age of the 320 subjects included in the study ranged from 16 to 77 years with a mean (SD) age of 48.0 (11.9) years. Females comprised 65.3% of the population and males 34.7%. The total number of teeth present was 7664 (85.5%) with a range from 12 to 28 per subject. The median (IQR = interquartile range) of teeth present was 25 (22–27). Of the 320 participating subjects 275 (85.9%) had at least one tooth with periapical status scored as 'abnormal'. The median (IQR) of teeth with abnormal periapical status was 3 (1–5). A total of 210 (65.6%) patients had at least one endodontically treated tooth. The number of endodontically treated teeth ranged from 0 to 26 per subject with a median (IQR) of 1 (0–3).

Periapical status

The periapical status of 286 (3.7%) teeth was impossible to determine because of radiographic errors. A total of 1040 (13.6%) teeth had AP. Teeth categorized as not assessable were excluded from further analysis. Figure 1 shows the distribution of teeth with AP between different teeth groups. The highest prevalence of AP occurred in maxillary first molars (27.0%) followed by mandibular first molars (25.4%) and mandibular second molars (24.2%). The prevalence of

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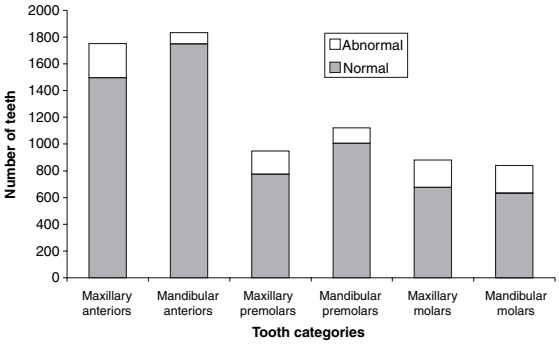

Figure 1 Periapical status of maxillary and mandibular teeth categories.

AP was significantly higher ($P < 0.001$) in molars (23.9%) and premolars (14.0%) than in anterior teeth (9.4%) (Table 2).

Endodontic treatment

A total of 680 (9.2%) teeth had been endodontically treated of which 656 (96.5%) were root filled, 15 (2.2%) were surgically treated and nine (1.3%) had received pulpotomies. Of the 680 endodontically treated 408 (60.0%) teeth had AP.

No difference in the number of root filled teeth between male and female cohorts was observed ($P = 0.508$).

The prevalence of endodontically treated teeth increased with age (Fig. 2). The highest prevalence of endodontically treated teeth occurred in mandibular first molars (16.7%) followed by maxillary first molars (16.2%) and maxillary second premolars (14.8%).

Significantly more molars (13.1%) and premolars (11.9%) than anterior teeth (5.8%) had been endodontically treated ($P < 0.001$).

The prevalence of AP was significantly higher ($P < 0.001$) in root filled (surgically treated and pulpotomized teeth excluded) than nontreated teeth. The prevalence of AP in root filled versus nontreated teeth in different jaws and tooth groups is shown in Fig. 3 and Table 3.

Coronal status

Excluding 55 teeth with missing data on coronal status, 1896 (25.9%) teeth had an intracoronal restoration, 1067 (14.6%) teeth had a crown, 454 (6.2%) had caries without restoration, 39 (0.5%) had lost restorations and 3867 (52.8%) were intact (Fig. 4). The prevalence of AP between different groups of coronal status is shown in Table 4. Because of the small number of teeth (39) in the category 'lost restoration' this category was pooled together with category 'caries'. When comparing the prevalence of AP in different groups A, B, C (A: 'intracoronal restoration', B: 'extracoronal restoration', C: 'caries + lost restoration') versus group D: 'intact' a statistically significant difference was found (A versus D, $P < 0.001$, OR = 5.89; B versus D, $P < 0.001$, OR = 15.47; C versus D, $P < 0.001$, OR = 7.86).

Discussion

This survey provides the first cross-sectional study of the periapical and endodontic status of a Greek population. Several epidemiological studies in different countries have been performed (see Table 1). Interpretation of radiographs, either periapical, panoramic or combination of panoramic and periapical, is the only method that can be used in an epidemiological study when evaluating AP. Some studies also include clinical examination and/or interview (Allard & Palmqvist 1986, Ödesjö *et al.* 1990, Imfeld 1991, Eriksen *et al.* 1995, Soikkonen 1995, Weiger *et al.* 1997, Sidaravicius *et al.* 1999, Dugas *et al.* 2003).

A full mouth series of periapical radiographs instead of panoramic radiographs was chosen to be evaluated, because the latter are considered to have lower sensitivity than periapical radiographs in detecting periapical osteolytic lesions, especially in the anterior region (Molander *et al.* 1995). In order to minimize bias only radiographs of high quality were included, all radiographs were examined under standardized light conditions, none of the examiners was involved in the therapeutic procedures of the patients included and

Table 2 Distribution of teeth in different tooth categories in relation to presence/absence, periapical status, endodontic treatment

Tooth group	Present	Absent	Present (%)	Not assessable	Abnormal	Normal	Root filled	Root filled + abnormal
Anteriors	3679	161	95.8	93	339	3247	199	114
Premolars	2114	446	82.6	43	290	1781	245	121
Molars	1871	689	73.1	150	411	1310	224	155
Total	7664	1296	85.5	286	1040	6338	668	390

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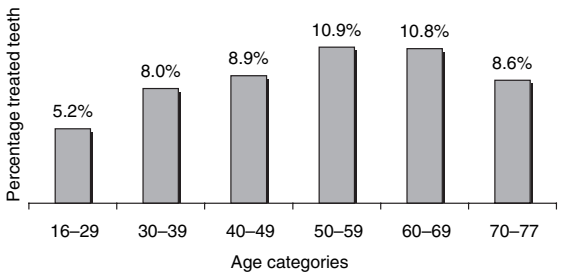

Figure 2 Distribution of endodontically treated teeth with age.

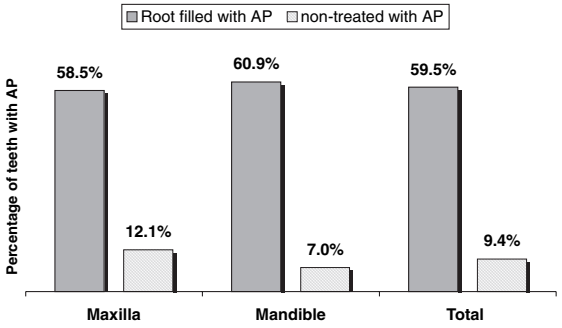

Figure 3 Prevalence of AP in root filled versus nontreated teeth.

before starting the evaluation the two examiners discussed the criteria and agreed on a strict definition of periapical disease. Kappa values of inter-examiner and intra-examiner reliability showed good to excellent agreement in all cases (Hunt 1986).

The statistical method used was a multiple regression method, which takes into account the number of teeth that belong to the same person. This makes the results more reliable.

Dental care in Greece is primarily provided by general dental practitioners. Only a small number of patients are treated by dentists within the National Health System, which originated mainly for prevention. The number of specialists in endodontics is low and centred in the major cities of Athens and Thessalonica. The results of this study might vary if another population of a provincial region of Greece was chosen, because of the lower level of dental health as well as the lower level of dental care provided. Extraction might be the prevailing treatment of choice in those regions instead of endodontic treatment.

The sample consisted of 65.3% females and 34.7% males. Although the sample is not representative of Greek population overall, this difference may reflect the greater interest of women in receiving dental care. However, similar epidemiological studies reported that gender had no effect on the number of root filled teeth or presence of AP (Kirkevang *et al.* 2001, Boucher *et al.* 2002, Jiménez-Pinzón *et al.* 2004).

The median number of remaining teeth was 25, ranging from 12 to 28 per subject, which is in accordance to a recent study in Denmark (Kirkevang *et al.* 2001). However, in the present sample the large number of remaining teeth may be due to selection bias, as it included individuals who had sufficient remaining teeth to warrant a full mouth periapical radiographic examination. No information was available on the history of the missing teeth, thus it can be assumed that a number of teeth were lost due to persistent AP. The overall number of missing teeth was 14.5% and it is not known to what extend this would affect the prevalence of AP.

A total of 286 (3.7%) teeth were excluded from the study because the apex and periapical area of one or more roots in multirooted teeth was not visible on the radiograph; this was more often the case with second molars and canines.

The prevalence of AP was 13.6% and higher than in other European countries, the USA and Canada (Table 1). The comparison of the finding from the different studies should be made with caution, because of the variations in sampling procedures, type of radiographs examined, criteria of disease, time the study was carried out, etc. As no previous study in a Greek population has been performed, it would be appropriate to compare the present study with those

Table 3 Periapical status of root filled and nontreated teeth (root filled versus nontreated: $P < 0.001$)

	Root filled			Nontreated		
	Normal (%)	Abnormal (%)	Total (%)	Normal (%)	Abnormal (%)	Total (%)
Anteriors	83	114	197 (30)	3162	215	3377 (50.4)
Premolars	121	121	242 (36.9)	1659	166	1825 (27.3)
Molars	62	155	217 (33.1)	1245	251	1496 (22.3)
Total	266 (40.5)	390 (59.5)	656	6066 (90.6)	632 (9.4)	6698

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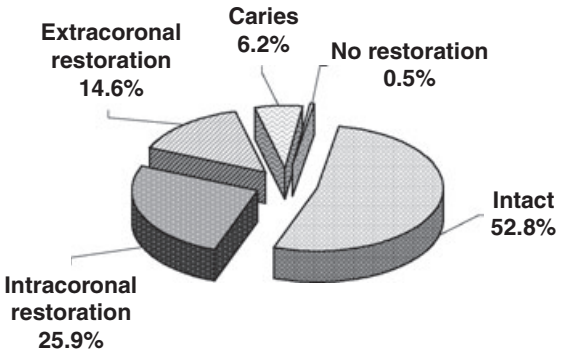

Figure 4 Coronal status of total teeth.

Table 4 Prevalence of AP in relation to coronal status

	Abnormal (%)	Normal (%)	Total (%)
Intracoronal restoration	345 (18.2)	1551 (81.8)	1896 (25.9)
Extracoronal restoration	400 (37.5)	667 (62.5)	1067 (14.6)
Caries	92 (20.3)	362 (79.7)	454 (6.2)
Lost restoration	25 (64.1)	14 (35.9)	39 (0.5)
Intact	158 (4.1)	3709 (95.9)	3867 (52.8)
Total	1020 (13.9)	6303 (86.1)	7323

that evaluated full mouth periapical radiographs (Allard & Palmqvist 1986, Bergström *et al.* 1987, Eckerbom *et al.* 1987, 1989, Petersson *et al.* 1989, Ödesjö *et al.* 1990, Buckley & Spangberg 1995, Saunders *et al.* 1997, Kirkevang *et al.* 2001, Boucher *et al.* 2002, Jiménez-Pinzón *et al.* 2004). Although discrepancies can originate from methodological differences, a lower level of dental health may explain the higher percentage of AP in a Greek population.

The number of endodontically treated teeth in comparable studies range from 2.0 to 22.8%, which is similar to the data derived from the present study. However, a noticeable percentage (60.0%) of treated teeth in this Greek population had AP compared with 21.5–64.5% in other studies with similar methodology.

The percentages of pulpotomized and surgically treated teeth were low in comparison with root filled teeth. This fact tends to indicate that Greek dentists prefer root canal treatment rather than other endodontic options.

In the present study significantly more molars and premolars than anterior teeth were root filled and moreover the number of treated teeth increased with age, except for the age groups over 60 years. These findings are in accordance with other studies (Buckley & Spangberg 1995, Kirkevang *et al.* 2001).

The prevalence of AP in root filled teeth compared with nontreated teeth was high (Boucher *et al.* 2002, Jiménez-Pinzón *et al.* 2004). Nevertheless, the prevalence of AP in the group of nontreated teeth was 9.4%. This suggests that there is a substantial need for primary endodontic treatment in this population.

It was interesting to note that teeth restored with crown, whether endodontically treated or not, had a greater association with AP (OR = 15.47, 95% CI: 12.26–19.52) than teeth with intracoronal restoration (OR = 5.89, 95% CI: 4.75–7.3) when compared with intact teeth.

Conclusions

The results of this study indicate a higher prevalence of AP in a Greek population compared with findings in other countries. The frequency of endodontically treated teeth was comparable with other epidemiological studies but the proportion of endodontically treated teeth with AP was higher. These findings, in conjunction with the considerable amount of untreated teeth with AP indicate a need for endodontic treatment in the Greek population. Further studies in other Greek populations must be carried out to confirm and supplement these results.

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