Periapical status and quality of endodontic treatment in an adult Irish population

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Abstract

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Aim To determine the prevalence of apical periodontitis and the quality of root fillings in an adult Irish population using a retrospective analysis of orthopantomograms (OPGs).

Methodology A systematic sample of clinical records and OPGs of 302 adult patients attending the Dublin Dental Hospital, Ireland, were screened by two examiners to determine the quality of root canal treatment and the prevalence of apical periodontitis. The operators who carried out the treatment were unknown. Two examiners inspected OPGs after interexaminer correlation. European Society of Endodontology (ESE) guidelines were used to determine adequacy of root treatment.

Results Of the 7427 teeth examined 2% had root fillings. Apical periodontitis was evident in 1.6% of all nonroot filled teeth whilst 33.1% of the subjects had at least one tooth with apical periodontitis. Of the root filled teeth, 25% had apical periodontitis and 52.6% were considered technically inadequate by ESE guide-lines. There was a statistically significant (P < 0.05) negative correlation between the quality of the root fillings and the prevalence of apical periodontitis. Posterior root filled teeth (premolars and molars) had a greater prevalence of apical periodontitis than anterior root filled teeth.

Conclusions The technical quality of root fillings in an adult Irish population was poor and was consistent with a high prevalence of apical periodontitis.

Keywords: dental radiography, endodontology, epidemiology.

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Introduction

As expectations of patients and costs of endodontic treatment rise it is important that quality root canal treatment is performed. There is no epidemiological data on the quality of root canal treatment or the periapical status and endodontic treatment needs of the adult Irish population. The 1989 Adult Dental Health Survey of Ireland did not include periapical pathosis as a disease entity, nor did it record root canal treatment.

Apical periodontitis is diagnosed by clinical and radiographic criteria. Clinical signs such as pain, swelling, tenderness and sinus tract formation occur to varying degrees, and are only moderately specific (Hyman & Cohen 1984). Other markers such as saliva and blood samples are not diagnostically helpful. Radiographic interpretation is therefore the prime criterion for the diagnosis of apical periodontitis (Federation Dentaire Internationale 1982).

Chronic lesions form the majority of apical periodontitis, with only 5% per year becoming symptomatic (Petersson 1993). Nevertheless, these lesions constitute an oral health risk.

Numerous studies, mainly from Scandinavian countries, have shown a high percentage of inadequately root filled teeth with concomitant apical periodontitis

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(Petersson *et al.* 1986, Eckerbom *et al.* 1987, Eriksen & Bjertness 1991, Buckley & Spangberg 1995). This investigation aims to assess the prevalence of detectable apical periodontitis as determined from orthopantomograms (OPGs) and the relationship between disease and quality of root fillings in an adult Irish population.

Materials and methods

Three hundred and two OPGs exposed for adult patients (age range 16-98 years), in 1999 were examined. The panoramic radiographs had been taken by radiographers using either a Siemens Orthoceph 10E (Siemens Plc; Siemens House, Berkshire, UK), or a Planmeca Proline 2002CC (Davis Healthcare Services, Potters Bar, UK). All films had been processed in a Kodax RPX-OMAT model M6B (Kodak Dental, Stuttgart, Germany). The patients were either symptomatic attenders in the accident and emergency clinic, had been referred to the oral medicine or oral surgery clinics, or were attending student/consultant clinics for active treatment. The operators who had carried out the individual root canal treatments were unknown. The only criterion for acceptance in the systematic sample was that the radiograph be of readable quality. Two examiners interpreted the radiographs with an illuminated light source in a darkened room using magnification $(\times 2)$. Apical periodontitis was recorded as present on the OPG if the Periapical Index (Orstavik et al. 1986) for the lesion exceeded 3 (score 1-5 for increasing size and severity). Calibration of the two examiners was carried out using 15 OPGs, which were double-scored. Signal detection theory (Green & Swets 1966), based on a periapical index score of 4 or 5 was used to indicate presence of apical periodontitis. Multirooted teeth were classified according to the root with the most severe score.

Observer calibration showed that scores 1–2 were inconsistent based on double-scoring of OPGs whereas, scores 4 and 5 yielded high inter-individual reliability.

Each tooth was classified as root filled or not. Retained roots were also included. Root fillings were either classified as adequate or inadequate on the basis of guidelines published by the European Society of Endodontology (ESE) (1994). The former category indicated a well filled root canal, without visible voids contained within the tooth and ending no less than 2 mm from the radiographic apex. An inadequate root treatment was underfilled, overfilled or poorly condensed. Where a root filling was present, the type of coronal restoration was recorded. Statistical significance was assessed by the chi-square test; *P*-values less than 0.05 were considered statistically significant.

Impacted teeth were excluded, as were wisdom teeth, giving a maximum 28 tooth dentition.

Results

The total number of teeth examined was 7424, with 3144 (42.3%) in males. One hundred and fifty-two teeth (2.0%) had root fillings and of these 80 (52.6%) were deemed inadequate by ESE guidelines (Table 1). Thirty-eight of the root filled teeth (25.0%) had apical periodontitis (PAI score 4 or 5) as compared with 2.0% of the total sample. When the root filled teeth were removed from the sample, the percentage of nonroot filled teeth with apical periodontitis was 1.6%. The 65–74-year age group had the highest prevalence of

Table 1 Prevalence of root filled teeth and teeth with apical periodontitis based on orthopantomograms within the sample population

	Total	%
Number of subjects examined	302	
(male 127; female 175)		
Number of subjects with root filled teeth	96	31.8
Number of subjects with apical periodontitis	100	33.1
Number of teeth present in the sample	7424	
Number of root filled teeth	152	2.0
(male 57; female 95)		
Number of inadequate root filled teeth ^a	80	52.6
Number of teeth with	152	2.0
apical periodontitis		
Number of root filled teeth with	38	25.0
apical periodontitis ^a		

^aBased on number of root filled teeth.

Table 2 Number of remaining teeth by age distribution in

 study population of 302 patients including root filled teeth and

 those with apical periodontitis

Age	Teeth		Root filled teeth	Ł	All teeth with apical periodontitis	
(years)	Number	%	Number	% ^a	Number	% ^a
16–24	1981	26.7	24	1.2	30	1.5
25–34	2310	31.1	37	1.6	53	2.3
35–44	1427	19.2	35	2.5	31	2.2
45–54	929	12.5	33	3.6	25	2.7
55–64	529	7.1	15	2.8	6	1.1
65–74	165	2.2	4	2.4	5	3.0
>75	83	1.2	4	4.8	2	2.4
Total	7424	100	152	2.0	152	2.0

^aBased on teeth in age group.

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Table 3 Periapical status of teeth with root filling as a function of coronal restoration (tooth is the unit)

	Root filled teeth		Root filled with apica periodonti	teeth tis	Root filled teeth without apical periodontitis	
Restoration type	Number	%	Number	%	Number	%
Amalgam	30	19.7	8	26.7	22	73.3
Composite	50	32.9	10	20.0	40	80.0
Crown	15	9.9	6	40.0	9	60.0
Post	44	28.9	7	15.9	37	84.1
Unrestored	13	8.6	7	53.8	6	46.1
Total	152	100.0	38	25.0	114	75.0

apical periodontitis in all teeth (3.0%), whereas the 45–54-year age group had the highest prevalence of apical periodontitis associated with root fillings (30.3%, Table 2). Sixty-nine per cent of the root filled teeth were in the maxilla. The incidence of disease in root filled teeth was higher in the mandible (29.8%) than the maxilla (22.9%). Root filled maxillary molars (75%), mandibular premolars (38.9%), and mandibular incisors (33.3%) were particularly associated with apical periodontitis.

Root filled teeth classified as adequately treated had apical periodontitis in 13.9% of cases compared with 35.0% in teeth classed as inadequately root filled. Teeth with poorly condensed root fillings (44.7%) had a higher incidence of apical periodontitis than teeth that had well condensed but overfilled (41.7%) or underfilled (32.6%) root fillings. Teeth were most commonly restored with materials of radiopacity similar to composite, glass-ionomer or zinc oxide and eugenol cement (32.9%). Post and core crowns were present in 28.9% of the root filled teeth. Amalgam restorations and crowns were found in 19.7 and 9.7% of the root filled teeth, respectively. Nine per cent of root filled teeth were not restored and showed the highest incidence of apical periodontitis (53.8%). Forty per cent of the root filled teeth with a crown had apical periodontitis whereas teeth with post and core restorations had a 15.0% incidence of apical periodontitis (Table 3).

Discussion

Whether this systematic sample of dental hospital patients is representative of the general Irish population is difficult to ascertain. However, the inclusion of accident and emergency patients, who typically do not have a general practitioner, or a strong dental motivation, may yield a more unbiased group than other dental school studies (Molven *et al.* 1985, Buckley & Spangberg 1995).

Such a young population sample may have affected the findings of this investigation as both apical periodontitis and root fillings are seen with greater prevalence in the elderly. The average number of teeth remaining per patient in this investigation was 24.6, excluding impacted teeth. DeCleen *et al.* (1993) reported an average of 22.8 in a Dutch adult population.

A total of 152 teeth had root fillings, accounting for 2.0% of all teeth. Other dental school-based investigations revealed a similar prevalence of root filled teeth, for example, 5.5% in American (Buckley & Spangberg 1995) and German (3.2%) populations (Hulsmann *et al.* 1991). By contrast, Scandinavian studies have reported a higher prevalence of root filled teeth (Table 4). The younger age profile of the subjects in this study may contribute to these differences.

Of the 152 root filled teeth 80 (52.6%) were deemed to have an inadequate root filling. Root fillings that end short of the apical constriction or those which extended beyond the radiographic apex of the tooth have been shown to have a poorer prognosis than those that end within 2 mm of the radiographic apex (Adenubi & Rule 1976, Jokinen et al. 1978). OPGs are often used in epidemiological studies for convenience (Eriksen & Bjertness 1991, Marques et al. 1998). For example, all teeth can be seen on a single radiograph, there is a 10-fold reduction in radiation to the patient compared with full mouth periapicals (Langland & Langlais 1997) and the speed at which OPGs can be taken and processed (Gratt 1982), are amongst the numerous advantages cited. The accuracy of OPGs in the detection of apical periodontitis has been questioned by Ahlqwist et al. (1986) who reported agreement of 76 and 90% for single and multirooted teeth, respectively, when comparing panoramic with full mouth periapicals. Muhammed & Manson-Hing (1982) found

	Country	Number of teeth	Teeth with apical periodontitis		Root filled teeth		
Study (year)			%	Per person	% Teeth	Per person	% with apical periodontitis
Petersson <i>et al.</i> (1986)	Sweden	4985	6.6	-	13.0	-	31.0
Allard & Palmqvist (1986)	Sweden	2567	9.8	-	17.6	-	27.0
Eckerbom et al. (1987)	Sweden	4889	5.2	1.28	13.0	3.18	26.0
Eriksen <i>et al.</i> (1988)	Norway	3917	1.4	-	3.4	-	34.0
Odesjo <i>et al.</i> (1990)	Sweden	17 430	2.9	0.55	8.6	1.62	25.0
Imfeld (1991)	Switzerland	2004	8.4	1.18	20.3	2.84	31.0
Eriksen & Bjertness (1991)	Norway	2940	3.5	0.87	6.0	1.47	36.6
DeCleen <i>et al.</i> (1993)	Netherlands	4196	4.5	1.03	2.3	0.53	39.0
Eriksen <i>et al.</i> (1995)	Norway	3282	0.6	0.15	1.3	0.36	38.0
Buckley & Spangberg (1995)	USA	5272	4.1	1.03	5.5	1.4	31.3
Weiger <i>et al.</i> (1997)	Germany	7897	3.0	0.75	2.7	0.67	61.0
Sidarivacius <i>et al.</i> (1999)	Lithuania	3892	7.2	1.92	8.2	2.18	35.0
Present study (2000)	Ireland	7424	2.0	0.50	2.0	0.50	25.0

Table 4 Prevalence of apical periodontitis and root filled teeth in previous studies

that when detecting periapical lesions there was no statistically significant difference between the use of OPGs and full mouth periapicals. Eriksen & Bjertness (1991) used both panoramic and intraoral radiographs in their investigation. Inter-observer variability is described by Grondahl et al. (1970) as being greater when using panoramic rather than intraoral radiographs. In this investigation inter-observer agreement in the categories, quality of root canal filling, and presence of apical periodontitis was high. This was probably due to use of stringent criteria in the examination of radiographs and prior observer calibration. OPGs of poor technical quality were excluded from this study; these included underexposed radiographs, those with superimposition of the lead apron or obvious movement of the patient.

The number of subjects with apical periodontitis was 100 or 33.1% of the total sample population with the number of teeth with disease being 2.0% (152 of a total of 7424, Table 1). This is similar to results of other European studies (see Table 4). There was no major difference in the incidence of apical periodontitis amongst the different age groups. Of the 152 root filled teeth 38 (25.0%), had evidence of apical periodontitis; 46.3% of the inadequately root filled teeth had apical periodontitis compared with 13.9% of those with adequate root fillings. This result was statistically significant (P < 0.05). In this study apical periodontitis was over 15 times more likely in root filled teeth than nonroot filled teeth. Poorly condensed root fillings and overfilled canals were strongly associated with the presence of apical periodontitis (Petersson et al. 1986, Eckerbom et al. 1987, Odesjo et al. 1990). It is important to emphasize that a periapical lesion does not always indicate failure of root canal treatment. It is possible that root filled teeth may have an associated healing periapical lesion but be scored as a failure. For this reason care should be taken when only a single radiographic view of a root filled tooth is available: its diagnostic use is of limited value in the absence of other clinical information. In contrast to other studies (Marques *et al.* 1998, Eriksen & Bjertness 1991) PAI score 3 was not used as evidence of apical periodontitis in order to prevent over-scoring of disease (Orstavik *et al.* 1986).

The percentage of root filled maxillary teeth with apical periodontitis was similar to that of root filled mandibular teeth, but posterior root filled teeth (premolars and molars) had a greater frequency of apical periodontitis compared with anterior root filled teeth; 31.7% compared with 20.7% respectively. In comparison, Buckley & Spangberg (1995) found that anterior root filled teeth had a higher prevalence of disease than posterior teeth. The greater number of endodontic specialists per capita working in the USA might explain this difference if it is assumed that specialists treat more posterior teeth.

This investigation also looked at the relationship between the type of coronal restoration within root filled teeth and the presence or absence of apical periodontitis (Table 3). Root filled teeth that had no restoration within the access cavity had the highest incidence of apical periodontitis. Root filled teeth with amalgam restorations showed less apical pathosis than crowned teeth. This is a similar result to that found by Buckley & Spangberg (1995). It is traditionally taught

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that post-placement represents a significant hazard to the root canal system, either through risk of perforation or disturbance of apical seal. Only 15.9% of postrestored root filled teeth had apical periodontitis in this study compared with 40.0% with a nonpost-retained crown restoration.

The results demonstrate that many root fillings were failing. Poorly filled canals do not necessarily indicate failure but they facilitate the introduction of microbes and their byproducts into the canals, which in turn can produce disease. In this study 52.6% of root fillings were deemed technically inadequate and of these teeth, 46.3% had apical periodontitis. This indicates a huge potential for apical periodontitis to occur in the remaining poorly filled teeth. Poor canal cleansing and shaping, use of inadequate aseptic techniques, complex canal anatomy and lack of rubber dam use all contribute to the persistence or introduction of microbes into the canal system.

Conclusion

In this study of an Irish population, the technical quality of root canal treatment was poor and the prevalence of apical periodontitis was high.

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