doi: 10.1111/j.1365-2591.2006.01129.x

Endodontic status amongst 35-year-old Oslo citizens and changes over a 30-year period

R. Skudutyte-Rysstad[1] & H. M. Eriksen[2]

[1]Faculty of Dentistry, University of Oslo, Oslo, Norway; and [2]Faculty of Medicine, University of Tromsø, Tromsø, Norway

Abstract

Skudutyte-Rysstad R, Eriksen HM. Endodontic status amongst 35-year-old Oslo citizens and changes over a 30-year period. *International Endodontic Journal*, **39**, 637–642, 2006.

Aim To determine the prevalence of apical periodontitis and quality of root fillings in 35-year-old citizens of Oslo, Norway in 2003, and to compare the results with data from the same age cohort collected by repetitive cross-sectional studies in 1973, 1984 and 1993.

Methodology A random sample of 250 35-year-old Oslo inhabitants was drawn from The National Bureau of Statistics Recordings. Attendance rate was 64%. Root filled teeth and teeth with periapical pathology were detected from panoramic radiographs and additional periapical radiographs of affected teeth were processed. The preriapical status was evaluated by applying the periapical index system (PAI). Chi-square and Student's *t*-tests were used for the evaluation of differences between the groups.

Results Twenty-three per cent of the individuals examined had root filled teeth and 16% had at least one tooth with apical periodontitis. Root filled teeth were associated with PAI values of 1 and 2 (health) in 57% of cases. Prevalence of root filled teeth and apical periodontitis remained unchanged during the past 10 years. An increase in the proportion of root filled teeth with apical periodontitis from 18% in 1973 to 43% in 2003 was observed.

Conclusions Despite continuous improvement in dental health (reduced DMF-values) compared with the previous Oslo studies; there was no improvement in endodontic status from 1993 to 2003.

Keywords: apical periodontitis, endodontics, epidemiology, treatment outcome.

Received 12 December 2005; accepted 6 February 2006

Introduction

In the past, the prevalence and severity of apical periodontitis was known primarily from Scandinavian countries. However, more recently such information has been collected also from other parts of the world (Hülsmann 1995, Eriksen *et al.* 2002, Friedman 2002, Dugas *et al.* 2003, Georgopoulou *et al.* 2005). A general trend is that the prevalence of apical periodontitis amongst 35–45-year-olds is 30–40% and increasing with increasing age (Eriksen *et al.* 2002, Friedman 2002). A majority of apical periodontal lesions seem to be located in previously root filled teeth (Bergström *et al.* 1987, Eriksen & Bjertness 1991, Petersson 1993, Hülsmann 1995, Sidaravicius *et al.* 1999, Kirkevang *et al.* 2001b). On the basis of a comparison of results of studies from several European countries, it seems that apical periodontitis is more prevalent than severe marginal periodontitis (Eriksen *et al.* 2002). The disease should therefore be of concern both for the individual, for society and for the dental profession.

There are a few longitudinal or repetitive cross-sectional studies within endodontology reporting time-trends in prevalence of apical periodontitis and other endodontic conditions (Bergenholtz *et al.* 1979, Eriksen & Bjertness 1991, Petersson *et al.* 1991, Petersson 1993, Kirkevang *et al.* 2001a). These studies indicate a reduced prevalence of apical periodontitis and of the number of root filled teeth, particularly amongst the younger section of the populations investigated. There also seems to be an improvement in technical quality of

Correspondence: Rasa Skudutyte-Rysstad, Institute of Clinical Dentistry, Faculty of Dentistry, P.b.1109 Blindern, 0317 Oslo, Norway (Tel.: +47 22852128; fax: +47 22852344; e-mail: rasas@odont.uio.no).

the endodontic treatment performed during the last decades. However, a concomitant improvement in results of endodontic treatment is not documented (Kirkevang *et al.* 2001a).

Both root filled teeth and apical periodontitis remain to be highly prevalent conditions amongst adults (Eriksen *et al.* 2002). Repeated cross-sectional studies amongst 35-year-olds in Oslo from 1973 to 1993 indicated, however, a decreasing prevalence of root filled teeth and apical periodontitis over this 20-year period (Eriksen *et al.* 1995). On the basis of the probable benefit of the general improvement in dental health in Norway during the last 30 years (von der Fehr 1994, Berset *et al.* 1996, Schuller & Holst 1998), it has been assumed that a continuing improvement in endodontic status is likely to occur.

The aim of the present study was primarily to describe the endodontic condition amongst 35-year-olds in Oslo in 2003 and to investigate possible changes in endodontic status in a 30-year perspective in this age cohort. Furthermore, an analysis of factors related to apical periodontitis, including the quality of root canal treatment, was performed.

Materials and methods

A random sample of 250 35-year-old Oslo inhabitants was drawn from the National Bureau of Statistics Recordings. Approval for performing the study was obtained from the Regional Ethics Committee. After adjusting for 18 of the individuals that were excluded from the initial sample due to address change or temporary residence abroad, the final sample comprised 232 individuals. Of these, 149 (64%) attended the clinical examination. Data collection included self-administered questionnaires and clinical and radiographic examination of participants at the Faculty of Dentistry, University of Oslo.

Radiographs from three of the participants were not available (due to pregnancy, lack of time) and the final sample therefore comprised 146 individuals. Telephone interviews with 56 (68%) of in total 83 nonattenders showed that the main reasons for nonattendance amongst 20 interviewed men were lack of time (60%) and lack of interest (30%). Thirty-six interviewed women reported pregnancy/maternity (31%), lack of time (31%) and dental fear (11%) as the main reasons for nonattendance. Comparison of the study participants and nonattenders showed that 73% of the participants visited their dentist regularly compared with 66% of the nonattenders. However, 73% of the nonattenders visited a dentist during last year compared with 56% of the study participants.

Root filled teeth and teeth with periapical pathosis were identified in panoramic radiographs [15 × 30 cm HR-E30 (Fuji Film Co., Tokyo, Japan), Orthophoss, Siemens AG, Erlangen, Germany], and periapical radiographs (Insight, Kodak, Rochester, NY, USA) of the respective teeth were then taken using the paralleling technique. The periapical status was evaluated using the periapical index system (PAI) (Ørstavik *et al.* 1986), where PAI scores 3, 4 and 5 were taken to indicate presence of apical periodontitis. In addition, the quality of the root fillings was evaluated based on distance from termination of the root filling to the radiographic apex and an evaluation of homogeneity as complete or incomplete seal of the root canal (presence of voids and/or porosities) described in previous studies (Eriksen *et al.* 1988, 1995). For multi-rooted teeth, the root presenting the highest PAI-score and the quality of the corresponding root filling was used. Evaluation of the periapical status was made independently by two examiners (R.S.R. and H.M.E.) using the same examination conditions after a calibration session applying the PAI system. Kappa value for inter-examiner agreement of PAI-values for all scored teeth was 0.81. For cases of disagreement, the final score was established based on consensus.

For comparisons with previous studies on endodontic status amongst 35-year-olds in Oslo, data from available publications were used (Hansen & Johansen 1976, Eriksen *et al.* 1988, 1995).

Data were computerized and analysed by the SPSS statistical program package (SPSS for Windows 11.0, SPSS Inc., Chicago, IL, USA). Chi-square test and Student's *t*-test were used for comparing differences between the groups. Differences were considered significant for P-values < 0.05.

Results

The results indicate that 33 (23%) of all individuals examined in 2003 had root filled teeth and 23 (16%) had at least one tooth with apical periodontitis.

Frequency distribution according to numbers of affected teeth per person is presented in Fig. 1. Only six persons had more than two root filled teeth. There were three persons who had from four to nine teeth with apical periodontitis, which constituted 40% of all the cases of apical periodontitis observed. Seventeen (39%) of a total of 43 teeth had primary apical periodontitis, i.e. they were not previously root filled.

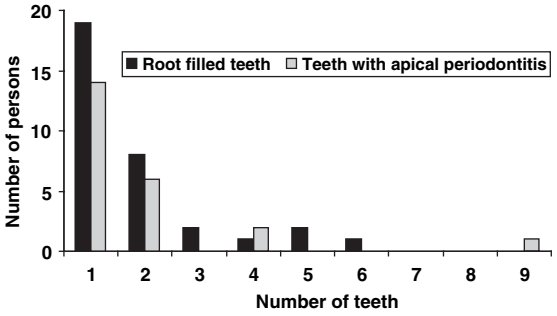

Figure 1 Frequency distributions of subjects in relation to number of root filled teeth and teeth with apical periodontitis per person in 2003.

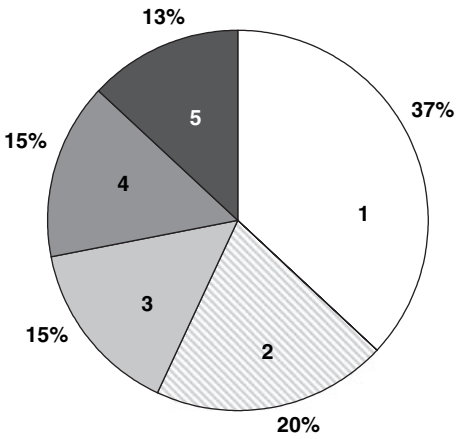

Figure 2 Distribution of root filled teeth ($n = 61$) according to periapical index (PAI) scores amongst 35-year-olds in 2003.

Since study participants that were not born in Norway (median residence time in Oslo 6.5 years) comprised a relatively large proportion (25%) of the total study sample compared with earlier Oslo studies performed from 1973 to 1993, comparisons were made to see if this could have impact on the results. As presented in Table 1, it seems that participants not born in Norway had slightly lower prevalence of both root filled teeth and teeth with apical periodontitis. In contrast, the number of affected teeth was higher amongst non-Norwegians, and so were the proportion of root filled teeth with apical periodontitis, but none of the differences observed was statistically significant. There was no difference between these groups when treatment quality was considered. Due to absence of systematic differences, data from all the participants in the 2003 study independent of country of origin were therefore pooled and used for comparisons with previous studies.

Bivariate analyses showed that irregular dental attenders had significantly higher prevalence of apical periodontitis than regular ones ($P = 0.013$). Persons with apical periodontitis had significantly higher mean decayed ($P = 0.009$), missing ($P = 0.027$) and filled ($P = 0.016$) surfaces.

Overall, 37 (61%) of 61 root filled teeth presented with root fillings terminating 1–2 mm from the radiographic apex and 45 (74%) had a complete filling of the root canal. When both length and homogeneity were considered, adequate root fillings (homogeneous root fillings terminating 1–2 mm from the radiographic apex) were present in 56% of the cases.

When root filled teeth were dichotomized according to PAI scores into health (PAI 1–2) and disease (PAI 3–5), the overall prevalence of post-treated disease was 43% (Fig. 2). More disease was observed when obturation of root canal was <1 mm (63% scored PAI 3–5) or >5 mm (75% scored PAI 3–5) from the radiographic apex.

A comparison of data from the present study and data from 1973, 1984 and 1993 (Hansen & Johansen 1976, Eriksen *et al.* 1988, 1995) is presented in Table 2. Despite a substantial decrease in the proportion of individuals with one or more root filled teeth from 53% in 1984 to 24% in 1993, no further decrease was observed from 1993 to 2003. In the same way, the prevalence of apical periodontitis also decreased from

Table 1 Comparison of endodontic conditions amongst participants born in Norway compared with other countries in 2003

	Country of birth		
	Norway	Other	Total
Number of subjects examined	109	37	146
Individuals with root filled teeth (%)	26 (24)	7 (19)	33 (23)
Individuals with apical periodontitis (%)	18 (17)	5 (14)	23 (16)
Number of teeth examined	2966	1005	3971
Number of root filled teeth (%)	42 (1.4)	19 (1.8)	61 (1.5)
Number of teeth with apical periodontitis (%)	27 (0.9)	16 (1.6)	43 (1.1)
Root filled teeth with apical periodontitis (%)	17 (40)	9 (47)	26 (43)

Table 2 Prevalence of root filled teeth and teeth with apical periodontitis amongst 35-year-olds in Oslo, 1973–2003

	Year of examination			
	1973*	1984*	1993*	2003
Number of subjects examined	111	141	118	146
Individuals with root filled teeth (%)	55 (50)	75 (53)	28 (24)	33 (23)
Individuals with apical periodontitis (%)	33 (30)	42 (30)	17 (14)	23 (16)
Number of teeth examined	2981	3917	3282	3971
Number of root filled teeth (%)	100 (3.4)	133 (3.4)	42 (1.3)	61 (1.5)
Number of teeth with apical periodontitis (%)	43 (1.5)	54 (1.4)	18 (0.6)	43 (1.1)
Root filled teeth with apical periodontitis (%)	18 (18)	34 (26)	16 (38)	26 (43)

*Numbers based on orthophantomograms.

Table 3 Quality of root fillings 1984–2003. Data from 1973 investigation was not available

		Distance from apex (%)		Seal (%)	
Year of examination	Number of root filled teeth	1–2 mm	Over/underfilling	Complete	Incomplete
1984	79	32 (41)	47 (59)	54 (68)	25 (32)
1993	42	19 (45)	23 (55)	36 (86)	6 (14)
2003	61	37 (61)	24 (39)	45 (74)	16 (26)

30% in 1984 to 14% in 1993 with no further changes in 2003.

Similar trends were observed when comparing proportions of root filled teeth: a reduction from 3.4% in 1984 to 1.3% in 1993, with a slight increase in 2003. The number of teeth with apical periodontitis also decreased from 1984 to 1993; however, this number increased again in 2003. The proportion of root filled teeth with apical periodontitis had gradually increased from 18% in 1973 to 26% in 1984, then to 38% in 1993 and to 43% in 2003 ($P = 0.003$).

Comparisons of available data on treatment quality during the period 1984–2003 are presented in Table 3. The proportion of root fillings terminating 1–2 mm from the radiographic apex had increased from 41% to 61%, but this increase was not statistically significant ($P = 0.055$). There was no difference in the proportion of homogeneous root fillings during this period.

Discussion

The present study is the fourth 10-year repetitive cross-sectional study amongst 35-year-olds in Oslo. Due to the randomly selected study population and registration methods used, it may be considered relevant for documenting changes in endodontic conditions in a 30-year perspective. The proportion of individuals not born in Norway was larger in the present study compared with earlier studies (25% in 2003, 13% in 1993 and 1984, and 5% in 1973). Since the differences observed in relation to endodontic conditions between the indigenous and immigrant participants were found to be relatively small and statistically nonsignificant, it was decided to include all participants in one observation group for comparisons. Nevertheless, there is a possibility that the differences in demographic structure might have an effect on the differences observed over time.

A comparison of nonattenders with the study participants demonstrated that a slightly higher number of the study participants visited their dentist regularly. However, there were more nonattenders that visited the dentist during the previous year. Since irregular dental attenders in the study had higher prevalence of apical periodontitis, there is a possibility that this could affect the results and prevalence of apical periodontitis was under-estimated in the study.

Studies performed amongst 35-year-olds in Oslo in 1973 and 1984 recorded endodontic conditions based on panoramic radiographs (treatment quality and PAI in 1984 was assessed from periapical radiographs that were taken 2 years later from 62% of participants from the initial sample). In 1993 and 2003, panoramic radiographs were taken and supplied with periapical pictures. Although studies comparing panoramic and periapical radiographs for detecting periapical lesions indicate similar overall diagnostic accuracy (Rohlin *et al.* 1989, Molander *et al.* 1993), panoramic radiographs are claimed to show lower sensitivity when detecting periapical lesions of the anterior teeth and mandibular molars compared with periapical radiographs (Molander *et al.* 1995). Thus, there is a

possibility for loss of information when endodontic conditions are recorded based on OPG only.

The PAI system was used for evaluation of the periapical status in 1984–2003 studies but not in the 1973 study. The possible differences in registration criteria used could have influenced results and differences observed from 1973 to 1984.

Due to the cross-sectional nature of the study, the number of teeth having apical periodontitis that were undergoing a healing process was impossible to estimate. However, data from longitudinal studies indicate that cross-sectional data give a valid estimate of the prevalence since it has been shown that number of teeth that undergo a healing process or develop apical periodontitis are approximately the same (Eriksen & Bjertness 1991, Petersson *et al.* 1991, Petersson 1993).

The results of the present study indicate that prevalence of root filled teeth and apical periodontitis amongst 35-year-olds in Oslo remained unchanged during the past 10 years. It seems that the substantial improvement in endodontic conditions observed from 1984 to 1993 did not continue further to 2003 even if the mean caries experience dropped from 41 to 25 DMFS (decayed, missing and filled surfaces) during this period. This is in agreement with data from Denmark, where no decrease in endodontic treatment frequency was observed despite reduced caries experience (Bjørndal & Reit 2004).

Prevalence of apical periodontitis in root filled teeth recorded in the present study was 43%, compared with 13–61% reported in other studies (for review see Kirkevang & Hørsted-Bindslev 2002). However, many of the studies on endodontic conditions are performed on nonrandom populations, and with different scoring systems; the results may therefore not be directly comparable.

When comparing results with earlier studies performed amongst 35-year-olds in Oslo, an increase in proportion of root filled teeth with apical periodontitis from 1973 to 2003 was observed. A similar trend has been reported amongst 30-year-olds in Sweden, where the proportion of apical periodontitis in root filled teeth increased from 22% in 1973 to 28% in 1993 (Hugoson *et al.* 1995) and in Denmark (Kirkevang *et al.* 2001a). A change in the treatment strategy of dentists towards more conservative treatment approaches instead of extraction for endodontically diseased teeth could be one of the possible explanations for this, supported by the fact that number of teeth present amongst 35-year-olds in Oslo had increased during the period 1973–2003.

There are many factors that may influence the outcome of root canal treatment (Friedman 1998): the preoperative periapical status (Sjögren *et al.* 1990), the endodontic treatment procedures and materials used, as well as quality of root filling and coronal restoration (Sjögren *et al.* 1990, Ray & Trope 1995, Tronstad *et al.* 2000, Hommez *et al.* 2002). In the present study, 56% of all root fillings had an acceptable technical quality when length and homogeneity was considered. However, 38% of them were diagnosed with apical periodontitis. In addition, there were no significant changes in the radiographic quality of root fillings during the period 1984–2003 either in relation to apical termination of the root filling or in its homogeneity.

The technical quality of root fillings is one of the factors most commonly used to evaluate quality and outcome of root canal treatment in endodontic epidemiology (Eriksen *et al.* 2002). In the present study, no change in quality of root fillings, which could be related to an increased prevalence of apical periodontitis in endodontically treated teeth, was detected. It can only be speculated, whether the increased prevalence of apical periodontitis in root filled teeth could be due to preoperative factors, procedures or materials used during endodontic treatment or the final restoration. Whatever the reasons might be, increased prevalence of apical periodontitis in root filled teeth is a challenge.

Conclusions

Despite a continuing improvement in dental health amongst 35-year-olds in Oslo, no substantial changes in endodontic conditions have occurred during the past 10 years. Prevalence of root filled teeth and teeth with apical periodontitis remained unchanged compared to 1993. In addition, a gradual increase in root filled teeth with apical periodontitis from 1973 to 2003 was observed.

Acknowledgements

We are grateful to Dr Dag Ørstavik, Department of Endodontics, University of Oslo for his comments to the manuscript.

References

Bergenholtz G, Lekholm U, Milthon R, Heden G, Ödesjö B, Engström B (1979) Retreatment of endodontic fillings. *Scandinavian Journal of Dental Research* **87**, 217–24.

Bergström J, Eliasson S, Ahlberg KF (1987) Periapical status in subjects with regular dental care habits. *Community Dentistry and Oral Epidemiology* **15**, 236–9.

Berset GP, Eriksen HM, Bjertness E, Hansen BF (1996) Caries experience of 35-year-old Oslo residents and changes over a 20-year period. *Community Dental Health* **13**, 238–44.

Bjørndal L, Reit C (2004) The annual frequency of root fillings, tooth extractions and pulp-related procedures in Danish adults during 1977–2003. *International Endodontic Journal* **37**, 782–8.

Dugas NN, Lawrence HP, Teplitsky PE, Pharoah MJ, Friedman S (2003) Periapical health and treatment quality assessment of root-filled teeth in two Canadian populations. *International Endodontic Journal* **36**, 181–92.

Eriksen HM, Bjertness E (1991) Prevalence of apical periodontitis and results of endodontic treatment in middle-aged adults in Norway. *Endodontics & Dental Traumatology* **7**, 1–4.

Eriksen HM, Bjertness E, Ørstavik D (1988) Prevalence and quality of endodontic treatment in an urban adult population in Norway. *Endodontics and Dental Traumatology* **4**, 122–6.

Eriksen HM, Berset GP, Hansen BF, Bjertness E (1995) Changes in endodontic status 1973–1993 among 35-year-olds in Oslo, Norway. *International Endodontic Journal* **28**, 129–32.

Eriksen HM, Kirkevang LL, Petersson K (2002) Endodontic epidemiology and treatment outcome: general considerations. *Endodontic Topics* **2**, 1–9.

von der Fehr FR (1994) Caries prevalence in the Nordic countries. *International Dental Journal* **44**, 371–8.

Friedman S (1998) Treatment outcome and prognosis of endodontic therapy. In: Ørstavik D, Pitt Ford TR, eds. *Essential Endodontology*, Oxford: Blackwell Science, pp. 367–401.

Friedman S (2002) Prognosis of initial endodontic therapy. *Endodontic Topics* **2**, 59–88.

Georgopoulou MK, Spanaki-Voreadi AP, Pantazis N, Kontakiotis EG (2005) Frequency and distribution of root filled teeth and apical periodontitis in a Greek population. *International Endodontic Journal* **38**, 105–11.

Hansen BF, Johansen JR (1976) Oral roentgenologic findings in a Norwegian urban population. *Oral Surgery, Oral Medicine, Oral Pathology* **41**, 261–6.

Hommez GM, Coppens CR, De Moor RJ (2002) Periapical health related to the quality of coronal restorations and root fillings. *International Endodontic Journal* **35**, 680–9.

Hugoson A, Koch G, Bergendal T et al. (1995) Oral health of individuals aged 3–80 years in Jonkoping, Sweden in 1973, 1983, and 1993. II. Review of clinical and radiographic findings. *Swedish Dental Journal* **19**, 243–60.

Hülsmann M (1995) Epidemiologische Daten zur Endodontie (I). *Endodontie* **3**, 193–203.

Kirkevang LL, Hørsted-Bindslev P (2002) Technical aspects of treatment in relation to treatment outcome. *Endodontic Topics* **2**, 89–102.

Kirkevang LL, Hörsted-Bindslev P, Ørstavik D, Wenzel A (2001a) A comparison of the quality of root canal treatment in two Danish subpopulations examined 1974–75 and 1997–98. *International Endodontic Journal* **34**, 607–12.

Kirkevang LL, Hörsted-Bindslev P, Ørstavik D, Wenzel A (2001b) Frequency and distribution of endodontically treated teeth and apical periodontitis in an urban Danish population. *International Endodontic Journal* **34**, 198–205.

Molander B, Ahlqwist M, Gröndahl HG, Hollender L (1993) Comparison of panoramic and intraoral radiography for the diagnosis of caries and periapical pathology. *Dentomaxillofacial Radiology* **22**, 28–32.

Molander B, Ahlqwist M, Gröndahl HG (1995) Panoramic and restrictive intraoral radiography in comprehensive oral radiographic diagnosis. *European Journal of Oral Sciences* **103**, 191–8.

Ørstavik D, Kerekes K, Eriksen HM (1986) The periapical index: a scoring system for radiographic assessment of apical periodontitis. *Endodontics and Dental Traumatology* **2**, 20–34.

Petersson K (1993) Endodontic status of mandibular premolars and molars in an adult Swedish population. A longitudinal study 1974–1985. *Endodontics and Dental Traumatology* **9**, 13–8.

Petersson K, Hakansson R, Hakansson J, Olsson B, Wennberg A (1991) Follow-up study of endodontic status in an adult Swedish population. *Endodontics and Dental Traumatology* **7**, 221–5.

Ray HA, Trope M (1995) Periapical status of endodontically treated teeth in relation to the technical quality of the root filling and the coronal restoration. *International Endodontic Journal* **28**, 12–8.

Rohlin M, Kullendorff B, Ahlqwist M, Henrikson CO, Hollender L, Stenström B (1989) Comparison between panoramic and periapical radiography in the diagnosis of periapical bone lesions. *Dentomaxillofacial Radiology* **18**, 151–5.

Schuller AA, Holst D (1998) Changes in the oral health of adults from Trøndelag, Norway, 1973–1983–1994. *Community Dentistry and Oral Epidemiology* **26**, 201–8.

Sidaravicius B, Aleksejuniene J, Eriksen HM (1999) Endodontic treatment and prevalence of apical periodontitis in an adult population of Vilnius, Lithuania. *Endodontics and Dental Traumatology* **15**, 210–5.

Sjögren J, Hagglund B, Sundqvist G, Wing K (1990) Factors affecting the long-term results of endodontic treatment. *Journal of Endodontics* **16**, 498–504.

Tronstad L, Asbjørnsen K, Døving L, Pedersen I, Eriksen HM (2000) Influence of coronal restorations on the periapical health of endodontically treated teeth. *Endodontics and Dental Traumatology* **16**, 218–21.