Periapical changes following root-canal treatment observed 20–27 years postoperatively

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Abstract

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Aim The aim of the present study was to identify periapical changes 20–27 years after root-canal treatment.
Methodology The periapical condition of 265 roots filled by undergraduate students was evaluated in two series of intraoral radiographs taken 10–17 and 20–27 years after treatment. Roots (72) not recorded with a normal periapical situation on both occasions by two observers, were re-evaluated by other two examiners, separately and jointly. Final decisions about diagnoses were made by all four examiners. A strict definition was used for the identification of cases with an unfavourable outcome.

Results Favourable outcomes were observed in 6.4% of the roots that had radiolucencies at the 10–17-year follow-up. Periapical radiolucencies after 20–27 years appeared in 1.5% of all other roots. The radiographic failure frequency for the total material was 4.9%. The percentage of cases with normal periapical findings at the final follow-up was 86.4%, whilst 8.7% were recorded with increased width of the apical periodontal space. Delayed healing owing to surplus root-filling material explained nearly all of the cases with favourable outcome assessed many years after treatment.
Conclusions Late periapical changes, with more successes than failures, were recorded when a 10–17-year follow-up period after root-canal treatment was extended for another 10 years.

Keywords: prognosis, root-canal treatment.

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Introduction

Success rates after root-canal treatment of adult teeth depend, amongst many other factors, on the preoperative diagnosis and the types of treatment, with the greatest success for pulpectomy cases and the lowest for re-treatment of endodontically treated teeth with periapical radiolucencies (Engström *et al.* 1964, Molven & Halse 1988, Sjögren *et al.* 1990). Although success or failure may seem clear a short time after root-canal filling, a follow-up period of at least 4 years is regarded as necessary for the conclusions on treatment results in most cases (Strindberg 1956, Reit 1987, Hepworth & Friedman 1997, Weiger *et al.* 1998). However, extended observation periods are needed to reveal the long-term outcome of treatment. Strindberg (1956) found that 16% of the roots with periapical radiolucencies at the start of treatment and 4% of the roots without rarefaction initially differed in diagnoses at the 4-year and final follow-up examinations, 5–10 years after treatment. There were more successes than failures evident at the later follow-up times. He questioned if there was a definite observation period after which cases could be considered as being stable.

During the last decade, attention has been drawn to the importance of the quality of coronal restorations in establishing and maintaining periapical health (Torabinejad *et al.* 1990, Saunders & Saunders 1994, Tronstad *et al.* 2000). Therefore, it is possible that initially successful cases may later be recorded as failures owing to the recontamination of the root-canal system through defective temporary or permanent restorations (Siqueira 2001).

It is clear that more information is required on long-term results after endodontic treatment. The outcome

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of endodontic treatment over an observation period of 10–17 years has been previously presented (Molven & Halse 1988). A smaller patient sample from this group has been followed for an additional 10 years. The aim of the present study was to identify further periapical changes when comparing observations made 10–17 years after root-canal treatment with the findings recorded 10 years later.

Materials and methods

One hundred and seventy-five individuals (70%) of a selected patient group who had received treatment in the School of Dentistry, University of Bergen, and had appeared for radiographic examination at a 10–17-year follow-up were traced 10 years later. They were invited to be re-examined 20–27 years after root-canal treatment. A series of intraoral exposures was obtained for 131 of these patients. Three patients were edentulous and 41 were unable to attend for various reasons. The material comprised 275 root fillings performed by undergraduate students 20–27 years earlier.

The follow-up group

The present follow-up group of 275 roots represents some 25% of the material originally analysed at the time of treatment (Molven 1976) and 48% of the material studied 10–17 years later (Halse & Molven 1987, Molven & Halse 1988). The group was classified with regard to the condition at the time of root filling, the type of treatment and the technical standard of the treatment in earlier papers (Molven 1976, Halse & Molven 1987, Molven & Halse 1988).

Radiographic findings

The evaluation and classification of the periapical conditions were performed by two examiners (O.M. and A.H.) after calibration. The periapical status was first assessed separately by each examiner and classified into one of the following three groups; no disease, increased width of the periodontal space and obvious disease (Figs 1–3). Cases that had been interpreted differently by the two observers were subjected to joint re-evaluation before a

Figure 1 Normal periapical findings after endodontic treatment illustrated schematically (left) and as observed in different regions of the jaws.

Figure 2 Widened periodontal spaces illustrated schematically (left) and as observed in different regions of the jaws. Note: The structure of the bone around the apex in the left radiograph was judged to be part of the normal trabecular system.

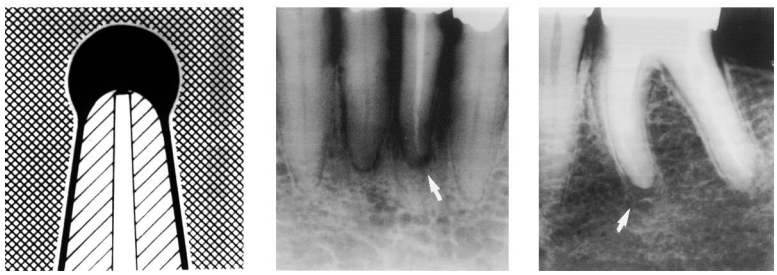

Figure 3 Pathological findings (periapical radiolucency) illustrated schematically (left) and as observed in different regions of the jaws.

decision was made. A diagnosis was not obtained for 10 roots, which were rejected for technical reasons (five), surgical endodontics (four), or because the observers did not agree about the diagnosis (one). A more detailed survey of this system for the diagnosis of apical periodontitis has been given in separate papers (Halse & Molven 1986, Molven *et al.* 2002).

Re-evaluation of critical cases

The 265 roots left for re-evaluation were separated into two groups. One hundred and ninety-three roots, recorded with normal periapical findings on both follow-up occasions, were not subjected to further evaluation. The rest, 72 roots (27% of the material), were presented to an endodontist (I.F.) and a radiologist (D.M.), who were asked to judge the status of the cases in the series of radiographs taken 10–17 and 20–27 years after treatment. A number of these cases, 58 roots in 22 individuals, had been recorded by the original observers (O.M. and A.H.) with a favourable or unfavourable change in diagnoses from 10–17 to 20–27 years, postoperatively. The rest, 14 roots in 12 individuals, had been diagnosed either with periapical disease (eleven) or increased width of the periodontal membrane (three) by the same observers (O.M. and A.H.) at the two follow-up occasions.

The 72 roots were randomly grouped into two equal sets. Each set was first judged separately by each of the two additional observers and then subjected to joint discussion by the same examiners to obtain agreement about diagnosis. Two such joint evaluations were performed, one after evaluation of each set of radiographs. Thereafter, the results were compared with the findings made by the two original examiners (O.M. and A.H.). All cases judged differently by the original and additional examiners were critically re-evaluated by all four examiners during two joint meetings. The aim was concensus.

Finally, roots recorded with periapical changes at the 20–27-year follow-up were subjected to an extra joint evaluation. Direct comparisons were made between radiographs taken at the two follow-up examinations. The aim was to exclude differences in the technical standard of the images as a possible explanation of the recorded changes.

The examiners used a strict definition of periapical disease whereby only roots with periapical radiolucencies were regarded as cases with unfavourable outcome or as failures (Kvist & Reit 1999, Kvist 2001). Roots exhibiting increased width of the periodontal space, often classified as uncertain cases, were therefore not included amongst the failures.

Table 1 Diagnostic grouping of periapical findings in 265 roots treated endodontically by undergraduate students as evaluated by the two initial observers (percentage distribution)

Radiographic diagnoses	At the time of root filling	Follow-up (years)	
		10–17	20–27
Normal findings	39.8	77.4	88.7
Increased width of periodontal space	10.4	6.0	4.9
Periapical radiolucency	49.8	16.6	6.4

Cases with periapical changes evident at the 20–27-year follow-up were especially examined for possible explanatory variables related to the endodontic treatment.

Results

Initial observations

The radiographic findings, originally recorded by observers O.M. and A.H. and later at the last follow-up, are given in Table 1. The percentage of roots with periapical radiolucencies was reduced from 49.8% at the time of root filling to 16.6% observed 10–17 years later, and further to 6.4% 10 years later. Corresponding increases were observed in the percentage of roots with normal periapical findings, whilst the number of roots with widening of the periodontal ligament space had reduced slightly on both follow-up occasions.

Final diagnostic grouping

All of the 72 roots recorded by the original observers (O.M. and A.H.) to be without periapical radiolucencies, either at the first or second follow-up, were classified in the same category by the new observers (I.F. and D.M.). Furthermore, the findings of the latter observers indicated lower numbers of roots with radiolucencies on both follow-up occasions. Successive and final joint evaluations by all four observers are presented in Fig. 4 and Table 2.

There were 1.5% of the cases classified as having developed radiolucencies after 20–27 years (Fig. 5). The percentage of roots diagnosed as having radiolucencies on both follow-up occasions was 3.4% (Fig. 6), adding up to a failure frequency of 4.9%. There were 6.4% of cases recorded as having radiographic evidence of periapical repair after 20–27 years (Fig. 7). The total recorded percentage of successful cases was 95.1% including roots

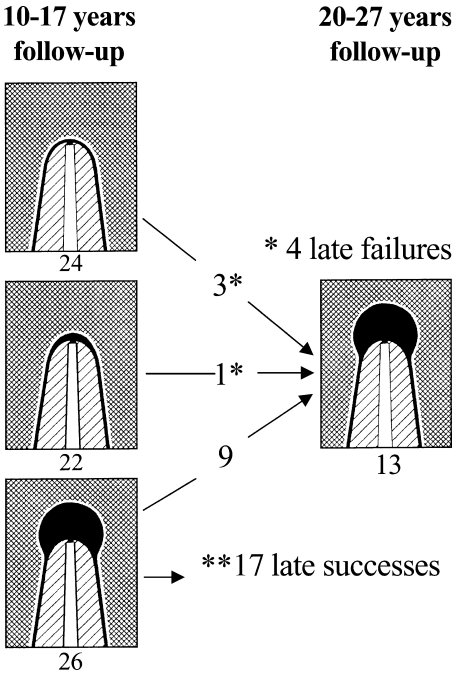

Figure 4 The origin of failures after root-canal treatment. The periapical findings recorded after separate and joint evaluation of 72 roots by four observers are given to the left. The origin of the 13 roots with radiolucencies recorded by the same observers at the 20–27-year follow-up is indicated by the numbers in the arrows. The number and origin of roots with late changes, classified as late failures* (in arrows) and late successes** (arrow), are given separately.

with no periapical radiolucencies both at the final follow-up and 10 years earlier and 5.3% of the material finally classified with an increased width of the periodontal space. Typical cases are illustrated in Figs 5–7.

Table 2 The final results after re-evaluation and joint discussion of 72 critical cases (Fig. 1) by all four observers

	Roots	%
No periapical radiolucency	235	88.7
Late successes	17[a]	6.4
Late failures	4	1.5
Failures – unchanged cases	9	3.4
Total periapical radiolucencies	13	4.9
Total no periapical radiolucencies	252[b]	95.1

Roots (193) originally judged by the initial observers to show normal periapical findings on both follow-up occasions were not subjected to re-evaluation.

[a]The technical standard of the radiographs introduced some uncertainty in one case.

[b]Includes roots (23) classified with an increased width of the periodontal space (8.7%).

Additional analysis – treatment variables

The 17 cases with late signs of healing were characterized by a high number (fourteen) of over-extended root fillings in cases recorded with periapical radiolucencies when they were root filled (Fig. 7). The rest (three) consisted of two pulpectomy cases with root fillings ending at a substantial distance from the apex and one re-treatment case filled just short of the radiographic apex.

The four cases with late signs of failure consisted of two pulpectomy cases, one with over-extension of the root filling and one with a deviating preparation in the apical part of the root (Fig. 5). The remaining two cases were an over-extended root filling after treatment of a necrotic pulp and a re-treatment case with a root filling ending 7.5 mm short of the apex.

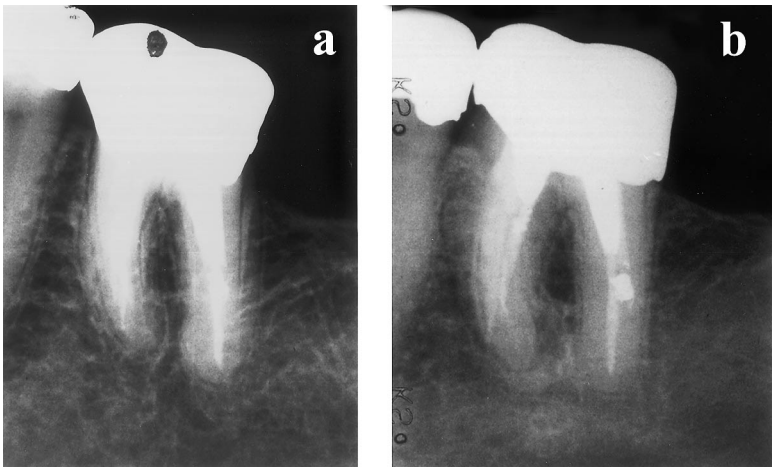

Figure 5 Late development of a radiolucency, failure in a mesial root of a mandibular molar with technically deficient root-canal filling. (a) No lesion 11 years after treatment. (b) Periapical lesion after 21 years.

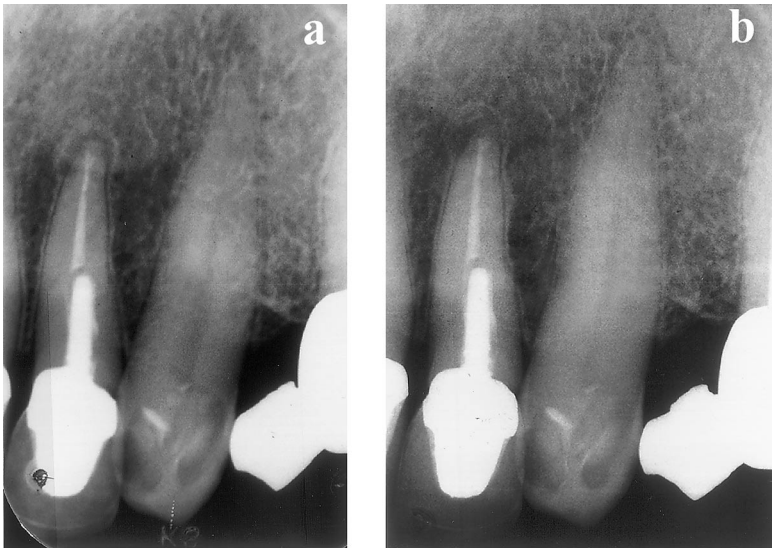

Figure 6 Tooth with a radiolucency classified as a failure on two follow-up occasions in a maxillary lateral incisor. (a) Periapical lesion after 13.5 years. (b) Periapical lesion after 24 years.

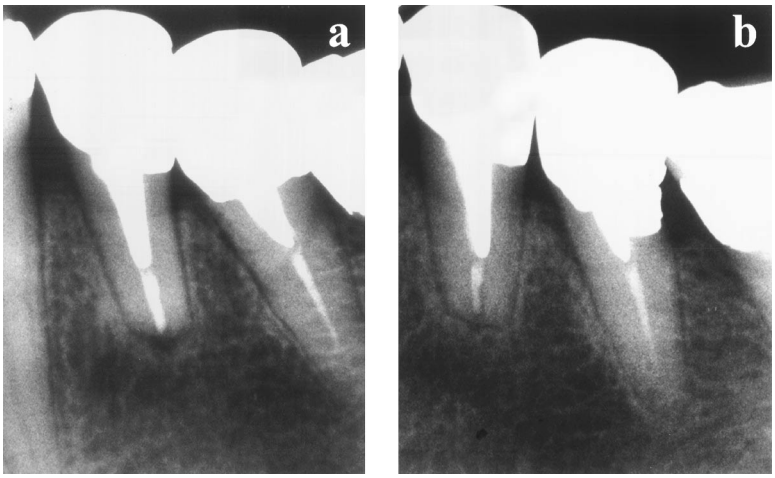

Figure 7 A mandibular premolar that originally had root-filling material extended through the apical foramen. (a) Periapical radiolucency 13 years after treatment. (b) Normal periapical condition after 23 years. Note: Disappearance of filling material within the root canal.

Discussion

This study revealed radiographic periapical alterations in endodontically treated roots occurring more than 10 years after treatment. It confirms observations of radiographic changes in the periapical status made earlier by Strindberg (1956). However, the material, methods and findings must be analysed and discussed before conclusions are made regarding the validity of the findings and their clinical implications.

The material – the observation period

The endodontic treatments and the final coronal restorations, either by fillings or artificial crowns, had been done by undergraduate students in a dental school. Root fillings were completed in teeth with and without periapical radiolucencies, as primary treatments of inflamed and necrotic pulps or as re-treatments of root fillings made before the patients attended the dental school. The basic principles and working rules adhered to, and the technical results obtained, reflect a high standard of endodontic treatment during the period when the root-filling materials used were gutta-percha/chloro-percha (Molven 1976, Molven & Halse 1988). Changes in periapical status, as observed by radiographs, could therefore be studied in well-restored teeth with good root fillings. Success frequencies in such samples, presented in several investigations, are usually in the range 70–90% within a 4-year control period (for review, see Friedman 1998).

Strindberg (1956) ended his observations with 13% of his material followed for 9–10 years, whilst the cases

in this study were first examined 10–17 years after treatment and then again 10 years later. Strindberg concluded that 9% of the total material presented different results at the 4-year follow-up and the final follow-up examinations. In the present material changes were seen in 8% of the roots after more than 10 years. The latter observations support Strindberg (1956) when he doubted whether it was possible to establish an upper, definite limit for the follow-up period beyond which radiographic changes should be regarded as unlikely. The recording of later changes, both successes and failures, implies that the treatment methods were adequate and that such changes can be explained as part of the progression of events over time.

The methods – the observers

In the follow-up studies when few transitions between the diagnostic groups are expected, the quality of the diagnostic procedure is of the utmost importance (Koran 1976, WHO 1997, Wulff & Götzsche 2000). A procedure based on an earlier suggested strategy (Halse & Molven 1986, Molven *et al.* 2002) was, therefore, established to minimize false recordings.

Changes were initially recorded by two observers (O.M. and A.H.) in 72 roots, which became the critical cases for assessing the reliability and validity of the recordings. With reference to the radiographic classifications (Molven *et al.* 2002), these cases were presented to another two experienced observers, an endodontist (I.F.) and a radiologist (D.M.). This treatment of the material should reduce the risk of error with respect to individual observations and increase the chances of obtaining correct conclusions. The supplementary recordings by I.F. and D.M. indicated a different cut-off point for disease with fewer periapical radiolucencies on both follow-up occasions. Then re-evaluation was performed by the original observers, and thereafter there were joint discussions between all four observers of all cases with disagreement. The observers knew, of course, that technical differences between radiographs increased the risk of small radiolucencies being hidden or remaining undetected, and hence they tried to avoid such pitfalls. First, the use of more than one exposure in each series would increase the chances of obtaining more reliable findings. Also a final joint evaluation of the diagnostic quality/standard of the images for cases recorded with periapical changes would be expected to reduce false diagnoses. The approach to critical cases, first separately and then jointly by experienced examiners through discussions before consensus, satisfies reasonable methodological requirements (Koran 1976, WHO 1997). The identification of changes in the present radiographic follow-up series, therefore, should be regarded as valid.

Late periapical changes – successes and failures

The occurrence of changes after such long periods needs a biological explanation. It is recognized that microbial infection is the major factor in the prognosis of root-canal treatment (Sundqvist & Figdor 1998). Foreign material, however, may be involved in the persistence and/or development of long-lasting lesions after conventional root-canal treatment. Filling material protruding into the periapical tissues may cause immediate tissue destruction and inflammation. A resulting asymptomatic foreign body reaction may explain some of the radiolucencies recorded after the end of the normal follow-up period (Nair *et al.* 1990, Ricucci & Langeland 1998, Sundqvist & Figdor 1998).

In the present study, 14 of the 17 roots with late signs of periapical healing had been filled with surplus material extruding into the periapical area in necrotic cases. These cases can, therefore, be explained as healing processes disturbed by a foreign-body reaction. It is reasonable to also expect that infection and damage through over-instrumentation and extension of debris, including dentine chips into the periapical tissues, may contribute to the delay of the healing in such cases (Sundqvist & Figdor 1998). The additional three successes may be explained as infected cases with a reduction over time of the irritative effect of microorganisms and their final disappearance.

The later development of periapical radiolucencies may indicate either re-establishment of bacteria that for some time had been dormant or reduced in numbers, or contamination through coronal leakage, or both (Siqueira 2001).

Clinical implications

The clinical relevance of the present findings must be made clear, otherwise misinterpretations may easily occur regarding the relationship between over-extension of root fillings and the prognosis of root-canal treatment.

It is generally accepted that root-canal treatment should be considered as the clinical management of a microbiological problem (Sundqvist & Figdor 1998). Follow-up studies have, without exception and irrespective of the treatment and the diagnosis, shown that the best results are obtained for fillings ending at a short distance (0–2 mm) from the radiographic root apex. They have

also revealed a negative influence on the prognosis from over-extension of the filling material through the apical foramen (for review, see Friedman 1998). These observations are not contradicted in the present study, which is not a controlled investigation into prognostic factors, but a search for and a confirmation of the existence of late periapical changes as observed radiographically. More successes than failures were found with the long-term follow-up, thus increasing the percentage of successful cases in a selected group of roots by about 6% after more than 10 years. This increase was directly related to a number of over-extended root fillings with delayed healing – that is late disappearance of periapical areas – and underlines that tissue irritation during and after treatment should be avoided or reduced to a minimum.

Conclusions

Late periapical changes in roots treated endodontically, with more successes than failures, were observed radiographically more than 10 years after treatment. The healing processes in most of the successful cases appeared to be disturbed and delayed by extension of root-filling material into the periapical area. Small radiolucencies around surplus material should not be misinterpreted as failures. Failures many years after treatment are most likely to be due to infection.

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