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Periapical status of root-filled teeth in Norwegian children and adolescents

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Abstract

Objective. To study the periapical status of root-filled permanent teeth of 9–17-year-olds in Møre & Romsdal county, Norway. ***Materials and methods.*** All permanent teeth with endodontic treatment in patients born in 1994–2001 were identified in the dental records of the Public Dental Service. The data collected consisted of chart entries and radiographs. Of 1182 teeth, 174 teeth in 155 patients met further inclusion criteria, i.e. completed endodontic treatment and a follow-up with a readable radiograph of at least 1 year. Periapical status was assessed with the Periapical Index (PAI) and the technical quality of the root fillings was also quantified on a 4-grade visual scale. ***Results.*** Apical periodontitis was found on follow-up radiographs in 25% of all teeth and in 48% of the teeth with pre-operative apical periodontitis. Forty-two per cent of root fillings were of adequate technical quality. Adequate technical quality of the root filling was significantly correlated with radiographic success. ***Conclusions.*** About one fourth of all root-filled teeth and almost half of the teeth with pre-operative apical periodontitis showed clear signs of the disease at recall.

Key Words: *endodontics, periapical status, PAI index, children, adolescents*

Introduction

Endodontic treatment is considered predictable with good prognosis: in follow-up studies on vital teeth without apical periodontitis, a success rate of some 95% is routinely reported [1]. However, a lower proportion of teeth with apical periodontitis are cured (42–91% [1]). These data have been collected from cases of endodontic treatment in adults [2] and are mostly from institutions or specialty practices. In epidemiologic studies only some 2/3 of teeth with root fillings are without radiographic clear signs of apical periodontitis [2].

There are few outcome studies of endodontic treatment in young individuals. Case series of traumatized front teeth in children can indicate good results [3], but, according to Hugosson et al. [4], 29% of root-filled teeth among 20-year-olds in Sweden have apical periodontitis. A larger survey by Ridell et al. [5] in Malmö, Sweden, found apical periodontitis in about half of root-filled teeth in adolescents in Malmö.

There are no known field studies on the outcome of root canal treatment in Norwegian children and adolescents. It is probable that the teaching of principles and practices in endodontic treatment is similar in Norway and Sweden. If the results of endodontic treatment are comparable, then there is obviously a need of improvements in endodontic practice for this age group. The present study investigates endodontic treatment on 9–17-year-olds in the county Møre og Romsdal in western Norway. We have looked at the volume of, indications for and results of endodontic treatment and sought for associations of treatment outcome with clinical and demographic variables.

Materials and methods

Sample

The basic population was all individuals born in 1994–2001 who were treated by the Public Dental Services (PDS) in Møre og Romsdal County in Western Norway (258 000 inhabitants). In all,

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1182 teeth had some kind of endodontic treatment before October 24, 2011, and clinical and radiographic data were extracted from information in files from the PDS. The study design was reviewed without comment by the Regional Ethics Committee.

Inclusion criteria were: endodontic treatment on a permanent tooth, treatment performed by a general practitioner, follow-up time more than 1 year and radiographs interpretable for PAI scoring (see below). By these criteria, the sample was reduced from 1182 to 174 teeth for first-level analysis.

All radiographs of endodontically-treated teeth were assembled and information about gender, age of the individuals at the time of root filling, follow-up time, type of tooth and reason for endodontic treatment (trauma; pulpal and periapical diagnosis) was gathered. Seventeen individuals had two and one had three endodontically-treated teeth. Only one of their teeth were included for further analysis: a dice was thrown to decide which tooth to include in the study. This further reduced the number of teeth for second-level analysis to 155.

The material was also split into teeth with or without apical periodontitis at the start of treatment. Twenty-one cases either lacked a pre-operative radiograph or it was of too poor quality to be valid for PAI scoring, giving a total of 134, 33 with and 101 without a pre-operative lesion, for final, third-level analysis (see Figure 1).

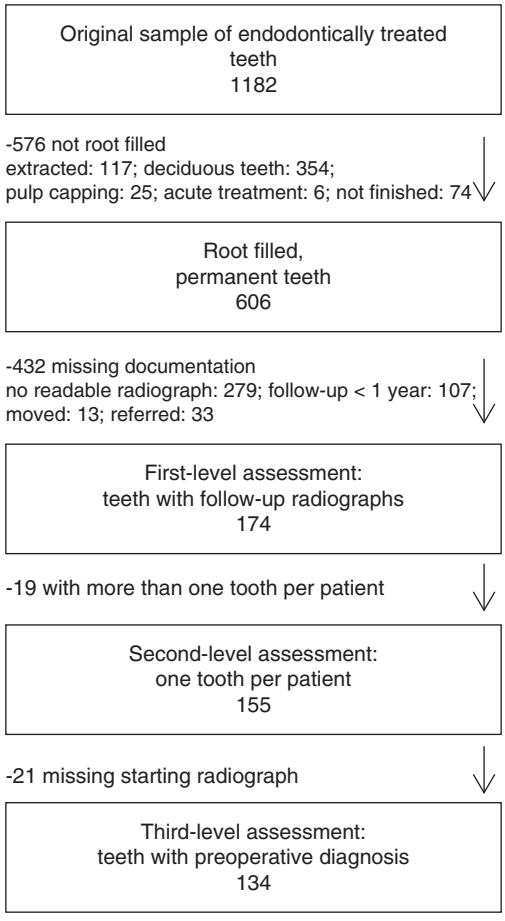

Figure 1. Pathway of tooth inclusion and exclusion for sample selection.

Radiologic evaluation

The periapical status was assessed in the radiographs with the Periapical Index (PAI) [6]. One observer (KJ) was calibrated against a standard set of 100 radiographs with or without apical periodontitis to a kappa value of 0.74. For the actual scoring of the radiographs in the study, each radiograph was coded independently and blindly assigned a PAI score. For any given tooth, the radiograph at the last follow-up was scored (PAIend). When available, a pre-operative or immediate-post-operative radiograph was also scored (PAIstart).

Root filling quality

The final radiograph in each series was used for assessment of root filling and coronal filling quality. Twenty radiographs of root filled central incisors were distributed in groups of five to represent four successive stages of decreasing root filling quality (Figure 2). For assigning a score (1–4) to a given root, its radiograph was compared with the references and given the

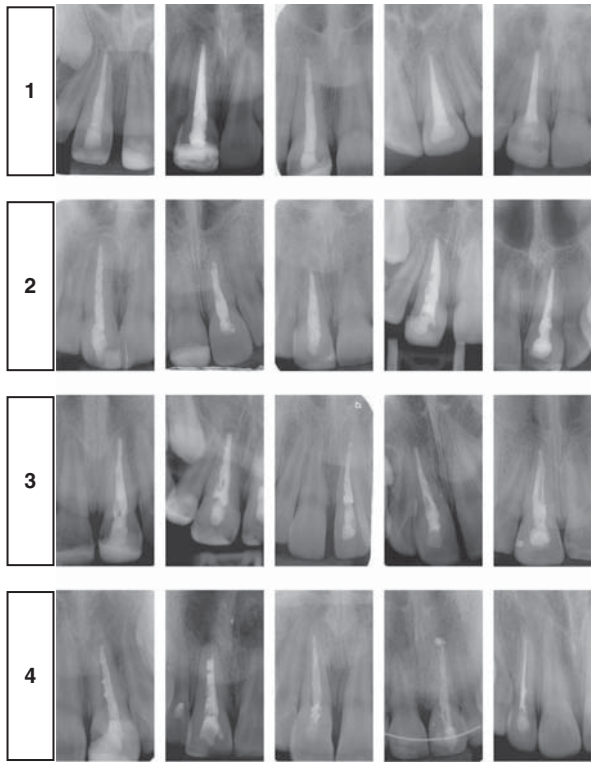

Figure 2. Scoring system for root filling quality. The experimental radiograph is compared with those of the references and assigned the score of the reference which it resembles the most.

score of the reference which it resembled the most. Multi-rooted teeth were given the score of the root with the worst individual score.

Data analysis

The PAIend scores were dichotomized with PAIend 1 and 2 scored as normal periapical status (*success*) and PAIend 3, 4, and 5 as apical periodontitis (*failure*). If the last control was at 1 year and the PAI score had moved from 4 or 5 to 3, it would be included as success. PAIstart scores were similarly dichotomized with PAIstart 1 and 2 called *healthy* or *healed* and PAIstart 3, 4 and 5 (clear signs of apical periodontitis) called *diseased*.

Root filling quality scores 2–4 were pooled to a category of *unsatisfactory* vs score 1, which was considered *satisfactory*.

Chi-square analyses were performed on stratifications of the material according to gender, age of the individuals at the time of root filling, type of tooth, periapical diagnosis before treatment and reason for endodontic treatment (trauma vs other).

Results

For 48% of the 174 teeth examined, the 1-year recall radiograph was the last one in the series. For 22%, the 2-year recall was the last, 17% came after 3 years, 8% after 4 years and 5% had their last recall at 5 years.

The majority of treated teeth were upper front teeth (68%), molars were 21% and premolars 11%. A preclinical diagnosis was lacking in 22%; a pulpal diagnosis ('vital', 'pulpitis', 'necrotic') was given for 54% and a diagnosis of apical periodontitis ('AP', 'AP with abscess', 'AP with sinus tract') in the remaining 24%. There was no apparent association between clinical diagnosis and radiographic periodontal status.

Thirty-eight per cent of fillings were of best quality (score 1, Figure 2), 41% had score 2, 16% score 3 and 5% of the root fillings had quality score 4.

The results of pairwise analysis by Chi-square that resulted in significant influences on outcome are summarized in Table I. The overall 'success rate' (PAIend <3) was 75%. (No tooth had a PAIend score of 3 coupled with a PAIstart of 4 or 5 when the last control was at 1 year, which would have indicated healing.) Whereas teeth without lesion (PAIstart 1 or 2) had 84% of cases with PAIend <3, only 52% of teeth with lesions (PAIstart 3, 4 or 5) had healed (PAIend <3). In this latter sub-group, only 11 of 27 teeth (41%) had healed in males, significantly fewer than in females (11 of 15; 73%). For the total material, molars healed less frequently than front and premolar teeth. No significant impact on treatment outcome was found for age at treatment (up to vs older than 12 years of age) or trauma (yes/no). Good

Table I. Outcome of treatment dichotomized by PAIend scores as successes (PAIend 1 or 2) or failures (PAIend 3, 4 or 5) and chi-square analyses of associations of outcome with registered variables. Factors exerting a statistically significant influence on outcome are listed in the table. No other cross-tabulations of other variables or combination of variables with outcome showed any significant interactions.

		PAIend 1,2	Total	Pearson
		% success	*n*	*p* by ^{2}
Total material				
	All	75.29	174	
	One tooth per subject	74.84	155	
	Initial Xray available	75.37	134	
Tooth type				
	Front or premolar tooth	78.57	140	
	Molar tooth	61.76	34	0.042*
Initial periapical status				
	PAIstart <3	85.87	92	
	PAIstart >2	52.38	42	0.000
Gender and PAIstart >2 (pre-op lesion)				
	Male	40.74	27	
	Female	73.33	15	0.043†
Root filling quality				
	Adequate	85.19	54	
	Inadequate	69.31	101	0.030*

*Significance lost on smaller sub-sets.
†No influence by gender in other sub-groups.

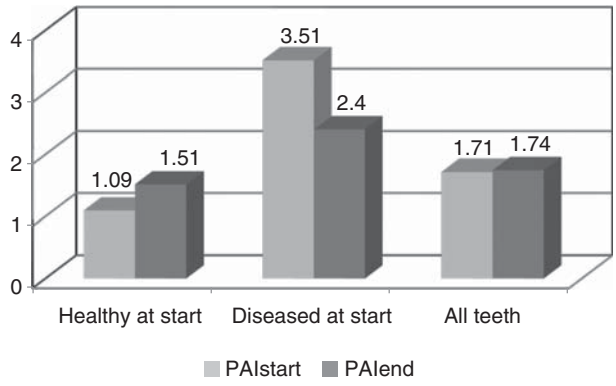

Figure 3. Average PAI scores from start to final control for sub-groups of teeth defined as healthy (PAIstart 1 or 2) or diseased (PAIstart 3, 4 or 5) at start and for the total material.

root filling quality (score 1 in Figure 2) was significantly correlated with good periapical status at final follow-up (PAIend <3).

Average PAI start and end scores were computed and used to illustrate the changes in periapical health over time and the results are shown in Figure 3. Overall, periapical health did not improve for the group of teeth treated and followed for at least 1 year.

Discussion

A total of 1182 teeth had had some endodontic procedure, i.e. on average 148 procedures per year. Deducting extractions and endodontic treatment of deciduous teeth, some 90 endodontic procedures would be done per year, of which ~76 would be root fillings. Endodontic procedures are, therefore, seldom performed for this age group, but remain important tools for the preservation also of young permanent teeth diagnosed with pulpitis or apical periodontitis.

Chart entries were poorly suited for retrieval of initial diagnoses of the teeth treated. The entries were often insufficiently precise or absent and at times the pulpal and periodontal diagnoses contradicted each other. Therefore, it was decided early in the investigation to use radiographs, taken either pre-operatively or immediately post-operatively, as a basis for diagnostic characterizations. This was warranted also by the likelihood that variations in pulpal diagnosis do not influence prognosis *per se* and that radiographic assessment of apical periodontitis does [7].

The frequent lack of chart data led to a significant reduction in the number of teeth available for study: only some 30% of the teeth that had received a root filling could be assessed for outcome. The status of the remaining 432 teeth is unknown. The pre- and per-operative factors that have the greatest impact on prognosis (periapical status and root filling quality) could not be ascertained for this group; therefore, further characterization of these patients and teeth did not seem meaningful. On the other hand, the majority of the excluded cases were either caused by poor-quality radiographs or by too short observation times. The latter category may include some early failures with clinical symptoms; otherwise this exclusion criterion should not influence the findings.

The PAI scoring system was used for assessment of periapical health. It is based on a quantitative rather than a qualitative approach to treatment outcome, but may easily be transformed into conventional, success/failure-criteria. This was done also in the present study with the purpose of comparison with other studies that have not made use of this scoring system. However, using the PAI index facilitates direct and valid comparison with other clinical and epidemiological studies utilizing the index [5,8].

Our study confirmed the striking effect of a pre-operative lesion on the prognosis of treatment: whereas one tooth in six developed a lesion where none existed, half of the teeth with pre-operative, apical periodontitis were not healed at the last time of recall.

It is generally agreed that a high success rate can be achieved when root canals are adequately sealed after appropriate infection control [9]. However, epidemiological data in adult populations indicate that the good results obtained in controlled environments at dental schools or in specialist clinics are not achieved in general dental practice [2]. The present results demonstrate that this may be true also of young permanent teeth, since ~25% of all root fillings showed clear radiographic signs of apical periodontitis. In cases with pre-operative apical periodontitis, disease persisted in 48%. The relatively high failure rate in the present material may be compared with Ridell et al.'s [5] findings in Malmö. They found apical periodontitis in 52%, including teeth with as well as without apical periodontitis at the start of treatment. While a difference may be constructed in the direction of better results in the Norwegian cohort, the most striking finding in both these investigations is the overall poor results of endodontic treatment, particularly of apical periodontitis. In the absence of similar data from other geographical areas, there seems to be no reason to believe that other districts in Norway provide better services.

There is a conspicuous lack of data on the outcome of endodontic treatment of permanent teeth in these age groups, with the exception of follow-up studies on trauma cases. The mean age of the individuals at the time of root filling was 12.3 years in this study and 16.2 years in the study by Ridell et al. [5], resulting in relatively more molars and premolars being treated in their study compared to ours. The frequency of apical periodontitis in incisors root-filled due to a traumatic injury was 12/54 (22%) in this study, about half of what was found in the Ridell et al. study (18/42; 43%).

However, the charts were frequently incomplete with regard to dental history and pre-operative pulpal and periapical diagnosis, so trauma cases may have been missed. Kerekes et al. [10] followed 166 traumatized incisors of 9–18-year-old patients after endodontic treatment and found a 95% success rate in the apexification treatment group. The data collected in the present study did not permit direct comparison with the methods in the study by Kerekes et al. [10]. If anything, a comparison may be seen as another confirmation of the improved success rates in institutional studies.

Albeit the numbers were small, we found a significantly poorer outcome for treatment of teeth with apical periodontitis in boys compared with girls. One possible explanation could be that boys in this age group have less patience and poorer compliance during treatment, but this is highly speculative.

The association of technical quality and pre-operative periapical diagnosis with treatment outcome was confirmed in the present study. The discrepancy between institutional follow-up studies and field surveys like the present has also been established in previous investigations. The present results extend these insights to the group of children and adolescents and supplements the findings by Ridell et al. [5]. It may be seen as a matter of some concern that the overall effect of treatment on periapical health is negligible (Figure 3).

It is a challenge to transfer the high success rates produced in institutions to general practice. A survey of Norwegian general dentists revealed that their practice differed from specialists with regard to microscope usage, instrumentation and length measuring techniques and rubber dam usage [11], which reflects the situation in other European countries and the US [12,13]. It would seem that a systematic approach is needed for the transfer of better clinical practices. Dental schools in Scandinavia, Western Europe and the US have promoted diagnostic and therapeutic quality measures in endodontics for decades. These efforts have had only limited success in changing and improving practices outside of institutions. Therefore, it would seem that further improvement is dependent on structured initiatives by dental organizations and government agencies.

Conclusions

The periapical status of root-filled permanent teeth among 9–17-year-olds in Møre og Romsdal, Norway, showed clear signs of apical periodontitis in about one fourth of the teeth in general and in half of the teeth with pre-operative apical periodontitis. In recognition of the association between technical quality and treatment outcome, public measures to improve endodontic therapy and thereby periapical health for this age group should be undertaken.

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