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Prediction of periapical status and tooth extraction

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Abstract

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Aim To describe and analyse risk factors associated with prediction of periapical status, assessed using the full-scale Periapical Index (PAI) supplemented with extraction as outcome variable.

Methodology In 1997–1998, 616 randomly selected individuals from Aarhus County, Denmark, underwent a full-mouth radiographic survey. All 616 were re-invited in 2003–2004 and in 2008–2009, when 473 and 363 persons, respectively, consented and attended a new radiographic examination. The study population of the present investigation included 330 persons who had participated in all three examinations, and 143 persons who had participated in the first and second examination only. Using the full-mouth radiographic survey and interview information, the following variables were assessed: on person level – age, gender, smoking habits and number of teeth; on tooth level – presence of tooth, PAI, root filling, caries, marginal bone level, restoration, jaw and tooth group. The outcome variable was the 5 score PAI supplemented with extraction. The observation period was 5 years. Ordered logistic regression analyses were carried out for root filled and non-root filled teeth separately. The Regional Committee of Ethics approved the study.

Results For both root filled teeth and non-root filled teeth, the baseline PAI score was the most important predictive factor of periapical status and extraction ($P < 0.0001$). Non-root filled teeth had in general a better outcome than root filled teeth. However, in non-root filled teeth, several other factors had a significant influence on the outcome, and the risk estimates were larger and showed a more pronounced variation between the different categories of predictive factors. For root filled teeth few variables, other than baseline PAI score, influenced the outcome significantly.

Conclusion The full-scale PAI was the strongest predictive factor of periapical status or extraction even when adjusted for additional factors, such as marginal bone level. A high baseline PAI score increased the risk for an impaired outcome. The large difference in risk estimates for non-root filled compared to root filled teeth documents the importance of separate analyses/studies for identification and quantification of predictive factors associated with periapical status and extraction of a tooth.

Keywords: apical periodontitis, extraction, PAI, prediction, risk factors.

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Introduction

Apical periodontitis (AP) is an inflammatory process in the periapical tissues that may develop if bacteria infect the dental pulp space. Periapical status is, however, not only a question of disease or no disease, but

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can be seen as a continuum ranging from healthy to severe disease (AP). To assess improvement or deterioration in periapical status, a more detailed assessment scale would therefore be preferable. The Periapical Index (PAI) is the only radiographic registration system that allows differentiation in severity of periapical disease. The full-scale PAI has the potential to monitor changes along a disease continuum (Ørstavik *et al.* 1986, Kirkevang *et al.* 2014). In a recent Danish study, it was demonstrated that each of the five PAI scores had a specific predictive value in relation to the future periapical status both regarding non-root filled and root filled teeth (Kirkevang *et al.* 2014).

Besides the preoperative diagnosis (initial PAI), several other factors have been investigated in relation to the outcome of a root canal treatment (Strindberg 1956, Ørstavik 1996, Chugal *et al.* 2001, Marending *et al.* 2005, Ng *et al.* 2011a, Kirkevang *et al.* 2014). The effect of different factors has, however, not previously been evaluated using a more detailed scale for assessment of outcome.

The aim of this study was to describe and analyse risk factors associated with prediction of tooth status, assessed using the full-scale Periapical Index (PAI) supplemented with extraction as outcome variable, in a randomly selected population sample. PAI scores and tooth extraction were registered in successive examinations preformed approximately 5 years apart.

Material and methods

In 1997, 616 randomly selected adults from Aarhus County, Denmark, received a full-mouth radiographic survey. In 2003 and in 2008, the 1997 cohort was contacted again and offered another full-mouth radiographic survey. In 2003, 473 persons participated in the second radiographic examination and in 2008, 363 persons attended the third radiographic examination. The latter group included 33 persons who participated only in the first and the third examination, and they were not included in this study. For further details on the study population, see Kirkevang *et al.* (2001, 2005, 2007, 2012, 2014). Thus, this study population consisted of a group 1 of 330 persons, who had participated in all three examinations, and a group 2 of 143 persons, who had participated in the first and second examination only.

For each tooth, a baseline registration and a second registration approximately 5 years later were performed. Therefore, teeth in persons who participated in three examinations (group 1) contributed with information from two periods (1997–2003 and 2003–2008). Teeth amongst persons who participated in two examinations only (group 2) contributed with information from one period (1997–2003). The Regional Committee of Ethics approved the study design in 1997, 2003 and 2008.

Radiographic recording

On each occasion, all participants underwent a full-mouth radiographic survey consisting of 14 periapical and two bitewing radiographs. The radiographs were taken by a 'GX 1000' X-ray unit (Gendex Corporation, Milwaukee, WI, USA), using the paralleling technique, 70 kV, 10 mA, a film-focus distance of 28 cm. Film processing was automated (Dürr 1330, AC 245L, Bietigheim-Bissingen, Germany).

In 1997, Kodak Ektaspeed Plus film was used (Eastman Kodak, Rochester, NY, USA), and in 2003 and 2008, Kodak Insight film (Eastman Kodak) was used. In all three studies, the fastest and most recent film on the market was chosen (Ludlow *et al.* 2001) in order to minimize the radiation dose to the participants.

Registrations

One observer examined all radiographs (LLK). All teeth were recorded according to the FDI nomenclature. Third molars were excluded. The following variables were assessed: on person level – gender, age (4 categories), number of teeth (4 categories), smoking habits, group and period; on tooth level – presence of tooth, PAI, root filling, caries, marginal bone level, restoration, jaw and tooth group (Table 1). Calibration of the observer to PAI was performed as described by Ørstavik *et al.* (1986) resulting in a Cohen's Kappa = 0.81.

Data management and statistical analysis

2The statistical analyses aimed at assessing the predictive value of a number of baseline characteristics. The outcome (dependent) variable in these analyses was the periapical status (PAI scores 1–5) and extraction of a tooth added as an ultimate sixth stage. In the analysis, the predictive value of person- and tooth-specific factors at the baseline registration was assessed by including these factors as independent variables in an ordinal logistic regression. The predictive value of

Table 1 Categorization of predictive factors

Parameters	Categories[a]
Person specific	
Gender	Female, male
Age	20–39, 40–49, 50–59, 60+
Smoking	No, yes
Group	Group 1 (three registrations), group 2 (two registrations)
Period	1997–2003, 2003–2008
Number of teeth	≤23, 24–25, 26–27, 28
Tooth specific	
Primary carious lesion	No (caries or caries in enamel), yes (caries in dentine)
Secondary carious lesion	No (caries or caries in enamel), yes (caries in dentine)
Periapical Index (PAI)	PAI 1 (normal periapical structures), PAI 2 (small changes in bone structure), PAI 3 (changes in bone structure with some mineral loss), PAI 4 (apical periodontitis with well-defined radiolucent area), PAI 5 (severe apical periodontitis with exacerbating features) (Ørstavik *et al.* 1986)
Restoration	No restoration, adequate (radiographically sealed filling or crown), inadequate (radiographic signs of overhangs or open margins of filling or crown)
Marginal bone level	<3 mm, 3–4 mm, >4 mm
Root filling	No, root filling material in the root canal
Root filling, length	≤3 mm from apex, >3 mm short or overfilling
Root filling, voidsl	No or few voids, extensive voids
Tooth group	Anterior (incisors and canines), premolars, molars
Jaw	Maxilla, mandible

[a]Categories separated by comma.

the factors was described by mutually adjusted odds ratios with 95% confidence intervals. An odds ratio larger than 1 indicates that the predictive factor was associated with an increased risk of poorer outcome (relative to the reference category) at the next examination. More specifically, if an inadequate restoration has an odds ratio of, say 3, then for all dichotomies of the outcome categories in 'good outcome' and a 'bad outcome' (5 different possibilities) the odds of a bad outcome is 3 times larger for a tooth with an inadequate restoration than for a tooth with no restoration (but otherwise identical).

The analyses applied robust standard errors, derived from a GEE estimation procedure to accommodate dependencies between teeth from the same individual. The categorization of the predictive factors used in the analyses can be seen in Table 1. The analyses were stratified according to the presence or absence of a root filling at baseline examination, because the influence of almost all of the predictive factors differed significantly between root filled and non-root filled teeth. Stata version 13 was used for all statistical analyses (StataCorp 2013, College Station, TX, USA).

Results

Group 1 consisted of 330 individuals (mean age 42.9 years, 8744 teeth). Group 2 consisted of 143 individuals (mean age 42.3 years, 3696 teeth). In total, 21133 baseline-outcome registrations were available. Of these registrations, 46 were not included in the analyses due to insufficient quality of one or both radiographs (Kirkevang *et al.* 2014).

Table 2 presents cross-tabulations of outcome by PAI scores and extractions versus PAI scores at baseline, stratified on the presence or absence of a root filling at baseline examination. The baseline distribution of the PAI scores in the non-root filled teeth showed that 98% had PAI score 1 at baseline. For the root filled teeth, the corresponding percentage was 45%.

In non-root filled teeth, the periapical status at baseline was by far the most important predictive factor for the outcome, periapical status and tooth extraction. Furthermore, evidence of either present or previous disease (caries lesions, marginal, coronal restorations) had a significant influence on the outcome. The outcome differed considerably amongst tooth groups, molars having a worse outcome than more anterior teeth (Table 3).

Person-specific factors had some predictive value for the non-root filled teeth, but not as pronounced as the tooth-specific factors. If a person had few teeth, the remaining teeth had an increased risk for a worse outcome compared to a person with all teeth, and if a person smoked, there was also a tendency that the teeth had a worse outcome compared to a non-smoker. Persons in group 1 differed from persons in group 2, who had a slightly higher risk for a worse outcome for non-root filled teeth (Table 3).

Figure 1 summarizes the results of the ordinal logistic regression analysis of the data on non-root filled teeth. For each tooth, the predicted outcome distribution at follow-up relative to that of a reference tooth (see Table 5) was described by an odds ratio. Figure 1a shows the predicted probability distribution

Table 2 Baseline PAI scores and outcome PAI scores stratified according to the absence (a) of presence (b) of a root filling

	Follow-up							
Baseline	PAI 1	PAI 2	PAI 3	PAI 4	PAI 5	ex.	non-reg.	Total
(a)								
PAI 1	19 123	166	217	37	24	85	25	19 677
PAI 2	143	19	19	1	3	6	0	191
PAI 3	21	1	64	6	5	26	0	123
PAI 4	4	0	9	6	4	6	0	29
PAI 5	2	0	5	1	3	4	0	15
Total	19 293	186	314	51	39	127	25	20 035
(b)								
PAI 1	361	17	75	14	3	16	2	488
PAI 2	51	8	24	5	0	2	0	90
PAI 3	103	14	147	35	15	35	1	350
PAI 4	16	1	30	32	9	18	0	106
PAI 5	5	0	4	12	14	11	1	47
Total	536	40	280	98	41	82	4	1081

Excluded: 17 transitions for which the PAI at baseline could not be registered.

of outcomes as a function of the odds ratio for the teeth. An odds ratio of 1 gives the predicted distribution of a reference tooth. Also shown are predictions for two additional teeth. Tooth 1 differs from a reference tooth regarding: age (50–59 years), restoration (adequate) and tooth group (maxillary premolar). Tooth 1 then has an odds ratio of 11.8 relative to a reference tooth. Tooth 2 differs from Tooth 1 regarding: PAI (PAI 3) and restoration (inadequate). The estimated odds ratio for Tooth 2 was 380.

The distribution of the tooth-specific odds ratios for non-root filled teeth is shown in Fig. 1b. More than half of the teeth (57%) had an odds ratio <10. The predicted probability of a PAI score 1 was at least 98% for these teeth. Few teeth (5%) had an odds ratio larger than 100. These teeth had a much worse outcome, the predicted probability of a PAI 1 outcome score being 86% or less.

Also for root filled teeth, the baseline PAI score influenced the outcome significantly, but apart from the PAI score few variables had a significant predictive value (Table 4). Tooth group and jaw, presence of a carious lesion and reduced marginal bone level were associated with a slightly impaired outcome of a tooth. Molars were at higher risk of a worse outcome than more anterior teeth. The risk estimates were, however, much lower compared to non-root filled teeth. Males had significantly increased risk, but the other person-specific factors seemed not relevant for assessment of outcome in relation to root filled teeth (Table 4).

Figure 2 summarizes the results of the analysis of the data on root filled teeth. The predicted probability distribution of the outcomes as a function of the odds ratio for the teeth is shown in Fig. 2a. The reference tooth, Tooth 1 and Tooth 2 shown in the figure are root filled teeth, but otherwise identical to the corresponding teeth in Fig. 1a. For root filled teeth, Tooth 1 has an odds ratio of 8.9 relative to the reference tooth, and the odds ratio for Tooth 2 is 71. Figure 2b shows the distribution of the tooth-specific odds ratios for root filled teeth. Approximately one in six of the root filled teeth had an odds ratio <10. The predicted probability of a PAI score 1 was at least 79% for these teeth. A considerable number of root filled teeth (26%) had an odds ratio larger than 100. These teeth had an increased risk of a worse outcome, the probability of a PAI 1 outcome score being at most 27%.

Table 5 compares the predicted outcome distributions for a non-root filled reference tooth and a root filled reference tooth. The non-root filled reference tooth has a much more favourable predicted outcome. Thus, for <1% of the non-root filled teeth (0.9%), the predicted risk of extraction was higher than 10%, whereas almost a quarter of the root filled teeth (22.4%) had a predicted risk of extraction that was higher than 10%.

A supplementary analysis assessed the influence of the quality of the root filling on the predicted outcome distribution. The reference categories for root filling quality were as follows: '<3 mm from apex'

Table 3 Nonroot filled teeth: Mutually adjusted associations between predictive factors and outcome

	Nonroot filled teeth			
Variable	OR	95% CI		*P*-value
Baseline PAI (ref: PAI 1)				
PAI 2	4.47	2.97	6.72	<0.0001
PAI 3	26.42	16.83	41.47	<0.0001
PAI 4	47.10	19.42	114.20	<0.0001
PAI 5	53.69	26.42	109.08	<0.0001
Primary caries (ref: no)				
Yes	4.94	3.36	7.26	<0.0001
Secondary caries (ref: no)				
Yes	2.10	1.35	3.26	0.001
Marginal bone level (ref: <3 mm)				
3–4 mm	1.38	1.07	1.79	0.013
>4 mm	4.41	3.35	5.80	<0.0001
Restoration (ref: none)				
Adequate	2.81	2.03	3.90	<0.0001
Inadequate	3.43	2.22	5.29	<0.0001
Jaw and tooth group (ref: mand. anterior)				
mand. premolar	1.08	0.60	1.95	0.804
mand. molar	5.68	3.63	8.89	<0.0001
max. anterior	1.65	1.00	2.72	0.051
max. premolar	3.29	2.04	5.31	<0.0001
max. molar	3.38	2.13	5.37	<0.0001
Gender (ref: female)				
Male	1.11	0.90	1.38	0.339
Age category (ref: 20–39)				
40–49 years	1.30	0.95	1.77	0.100
50–59 years	1.27	0.89	1.82	0.182
60 + years	1.14	0.68	1.91	0.614
Smoking (ref: no)				
Yes	1.26	0.99	1.59	0.055
Number of teeth (ref: 28 teeth)				
≤23 teeth	2.43	1.66	3.55	0.000
24–25 teeth	1.24	0.91	1.69	0.175
26–27 teeth	1.18	0.90	1.56	0.234
Group (ref: group 1)				
Group 2	1.43	1.04	1.96	0.027
Period (ref: 1997–2003)				
2003–2008	1.35	1.09	1.68	0.006

Adjusted odds ratios (OR) with 95% confidence intervals from ordered logistic regression of 19348 (96.7%) transitions.

and 'no or few voids' (Table 1). Long or short root fillings (OR = 2.37; 95% CI: 1.86–3.03) and the presence of voids (OR = 2.14; 95% CI: 1.68–2.74) had a significant association with a worse outcome than adequate root fillings, in unadjusted analyses (both $P < 0.001$). These associations weakened somewhat, but remained significant, when adjusting for all other independent variables except 'PAI score at baseline'. When the adjustment also included 'PAI score at baseline', the odds ratios decreased to 1.22 and 1.07, respectively, and root filling quality parameters were no longer significant.

Discussion

The main finding of this study was that even when adjusted for additional predictive variables, the five scores in the PAI scale were still the most decisive predictive factors for periapical status and tooth extraction over a 5-year period, both in non-root filled and in root filled teeth.

The data were derived from a longitudinal observational investigation of a general, adult Danish population and include information from questionnaires and radiographic examinations. This type of study may include information from all teeth, healthy, diseased, root filled and non-root filled. Another characteristic is that an observed treatment primarily has been performed by general practitioners and not specialists as often seen in controlled clinical studies from universities. Information deriving from the general population is relevant to describe and analyse the disease pattern and risk factors relevant for the everyday dental clinic.

The outcome was predicted using information collected from a baseline examination 5 years earlier. In the clinic, this corresponds to the fact that only information, which is available before, under or at completion of a root canal treatment, is relevant as predictor for the tooth's future status. However, other studies include current clinical observations as predictive factors of present disease (Yu *et al.* 2014). The obvious difference in approach makes comparisons of results less relevant.

In the present study, several factors, both person-related and tooth-related, were investigated to see whether they could be used to predict future tooth status assessed on a 6-point scale ranging from no periapical disease to extracted, and it was concluded that person-related factors were of less predictive value than tooth-related factors. However, it was found that smoking was a significant predictive factor for a worse outcome, in particular in relation to non-root filled teeth. The association between AP and smoking has previously been investigated in both cross-sectional and longitudinal studies, and the findings have been conflicting. Five of six cross-sectional studies found a significant positive association between AP and smoking; one longitudinal study indicated an increased risk of receiving a root canal treatment, whereas two longitudinal studies, one of which included information from a shorter follow-up of the present population, found no significant effect on development of AP (Walter *et al.* 2012).

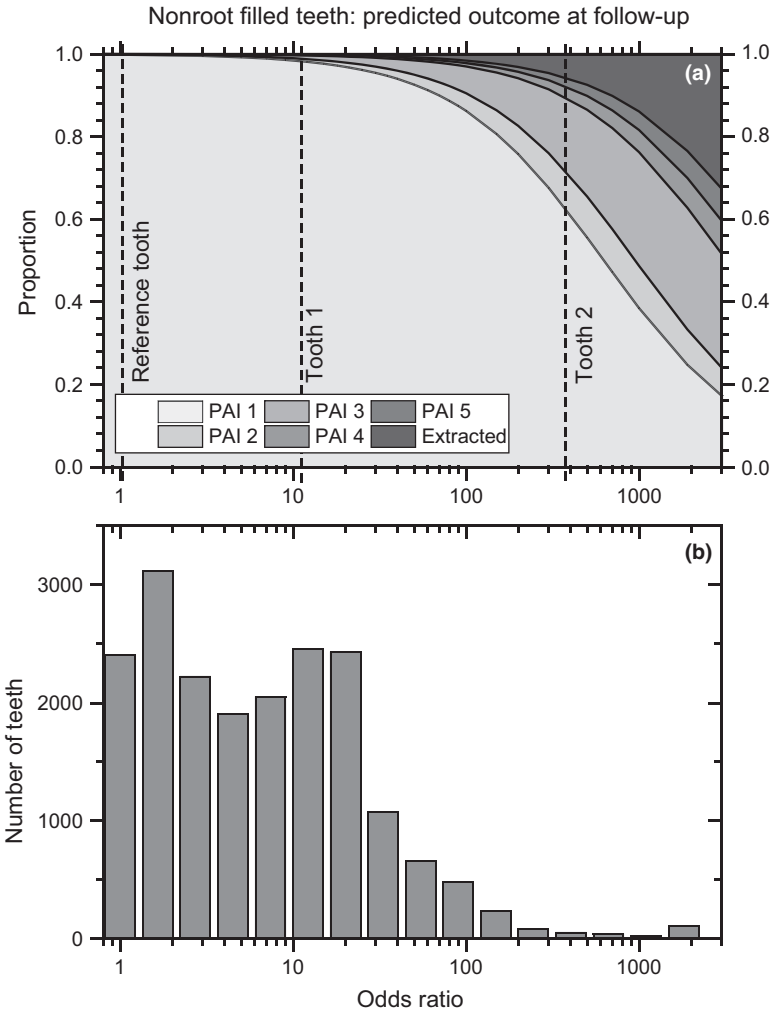

Figure 1 Non-root filled teeth. Panel a: Predicted probability distribution of outcome at follow-up as a function of the baseline prognostic index expressed as the odds ratio (OR) relative to a reference tooth. Tooth 1 is identical to a reference tooth except for age category (50–59 years), restoration (adequate) and tooth group (maxillary premolar); Tooth 2 is identical to Tooth 1 except for PAI (PAI 3) and restoration (inadequate). Panel b: Distribution of the prognostic index amongst 19348 teeth with baseline information about all predictive factors.

When observing the predictive factors and their interrelations, the overall impression is that more variables had predictive value, and the effects of the predictive variables were larger in non-root filled teeth compared with root filled teeth. Indicators of presence of other oral diseases, caries and marginal periodontitis, were associated with a worse outcome in both root filled and non-root filled teeth. It is not surprising that the presence of a carious lesion in a tooth may influence the outcome, because carious lesions are one of the main gateways for bacteria infecting the pulp space.

Teeth with a reduced marginal bone level were associated with a worse outcome than teeth with no signs of marginal periodontal disease. This was previously demonstrated in relation to extraction alone, in a subsample of the present population (Bahrami *et al.* 2008). It has been demonstrated that the relative frequency of root filled teeth with apical periodontitis is significantly higher in subjects with marginal bone loss (Jansson 2015), and other studies have demonstrated an association between AP and marginal bone loss (Ehnevid *et al.* 1993, Jansson *et al.* 1993). Possible explanations of this relationship include

Table 4 Root filled teeth: Mutually adjusted associations between predictive factors and outcome

	Root filled teeth			
Variable	OR	95% CI		*P*-value
Baseline PAI (ref: PAI 1)				
PAI 2	2.30	1.45	3.64	<0.0001
PAI 3	5.10	3.77	6.90	<0.0001
PAI 4	13.75	8.44	22.40	<0.0001
PAI 5	31.74	17.49	57.61	<0.0001
Primary caries (ref: no)				
Yes	2.09	1.37	3.19	0.001
Secondary caries (ref: no)				
Yes	0.68	0.42	1.08	0.099
Marginal bone level (ref: <3 mm)				
3–4 mm	1.00	0.72	1.39	0.990
>4 mm	1.56	1.07	2.28	0.021
Restoration (ref: none)				
Adequate	0.98	0.38	2.57	0.975
Inadequate	1.53	0.56	4.21	0.406
Jaw and tooth group (ref: mand. anterior)				
mand. premolar	2.90	0.58	14.40	0.192
mand. molar	13.22	3.06	56.99	0.001
max. anterior	5.10	1.12	23.23	0.035
max. premolar	7.40	1.66	33.07	0.009
max. molar	9.79	2.14	44.87	0.003
Gender (ref: female)				
Male	1.38	1.05	1.82	0.020
Age category (ref: 20–39)				
40–49 years	1.05	0.70	1.58	0.823
50–59 years	1.22	0.81	1.84	0.335
60 + years	1.18	0.69	2.02	0.551
Smoking (ref: no)				
Yes	1.11	0.81	1.52	0.532
Number of teeth (ref: 28 teeth)				
≤23 teeth	1.06	0.69	1.62	0.794
24–25 teeth	1.13	0.75	1.71	0.546
26–27 teeth	1.03	0.74	1.41	0.876
Group (ref: group 1)				
Group 2	1.10	0.76	1.59	0.618
Period (ref: 1997–2003)				
2003–2008	1.21	0.89	1.65	0.214

Adjusted odds ratios (OR) with 95% confidence intervals from ordered logistic regression of 1038 (96.4%) transitions.

suggestions that bacteria or metabolic substances originating from the infected pulp tissue may spread through dentinal tubules to the marginal periodontal tissue, or that marginal inflammation may progress to the apical area.

The presence and quality of a restoration was also found to be associated with a worse outcome compared to no restoration and good-quality restorations. In a British study performed in general clinical practices, it was found that the risk of pulpal breakdown was higher if the tooth had been restored with composite compared to amalgam (Whitworth *et al.* 2005). Other longitudinal studies have found that 3–10% of crowned teeth without root fillings developed AP (Ericson *et al.* 1966, Karlsson & Hedegård 1984). However, in root filled teeth, it has been demonstrated that crown therapy did not affect the periapical status (Eckerbom *et al.* 1991). Furthermore, the most frequent reason for tooth extraction in a population from Taiwan was extensive decay or an unrestorable tooth (Chen *et al.* 2007) and teeth with postoperative cast restorations had higher survival rates than teeth without (Ng *et al.* 2010, 2011b). Another large case series reported that the quality of a restoration did not influence the outcome of root canal treatment (Ricucci *et al.* 2011). Even though previous studies have somewhat conflicting findings regarding the association between restoration type and quality on tooth prognosis, an overview of current evidence suggests that high-quality coronal restorations minimize the risk of pulpal infection, AP and tooth loss.

Molars and maxillary premolars were found to have a risk of a worse outcome compared to anterior teeth and mandibular premolars. In fact, this variable was the only parameter where the odds ratios were higher for root filled teeth than for non-root filled teeth. The majority of molars and maxillary premolars have more than one root canal. When reporting on tooth level, it is obvious that multirooted teeth have a higher risk of a worse periapical status compared to teeth with only one root canal, simply because they have more roots at risk of developing disease. Similarly, when focusing on root filled teeth, healing of AP may be seen in relation to one root at the same time as AP persists in another. Moreover, a meta-analysis has revealed that molar teeth had a higher risk of being extracted after root canal treatment than other teeth (Ng *et al.* 2010), and a large case series based on root filled teeth demonstrated that the prognosis for mandibular molars was impaired (Ricucci *et al.* 2011) and that amongst maxillary premolars and mandibular molars, there was a higher frequency of extractions (Ng *et al.* 2011b).

Inadequate root filling quality was moreover associated with a worse outcome than an adequate root filling, however, when adjusted for PAI score at baseline the association disappeared. This may indicate that the association between root filling quality and the periapical status and extraction is mediated by baseline PAI score. Having an inadequate root filling increases the probability of also having a poor periapical status at baseline, and because the

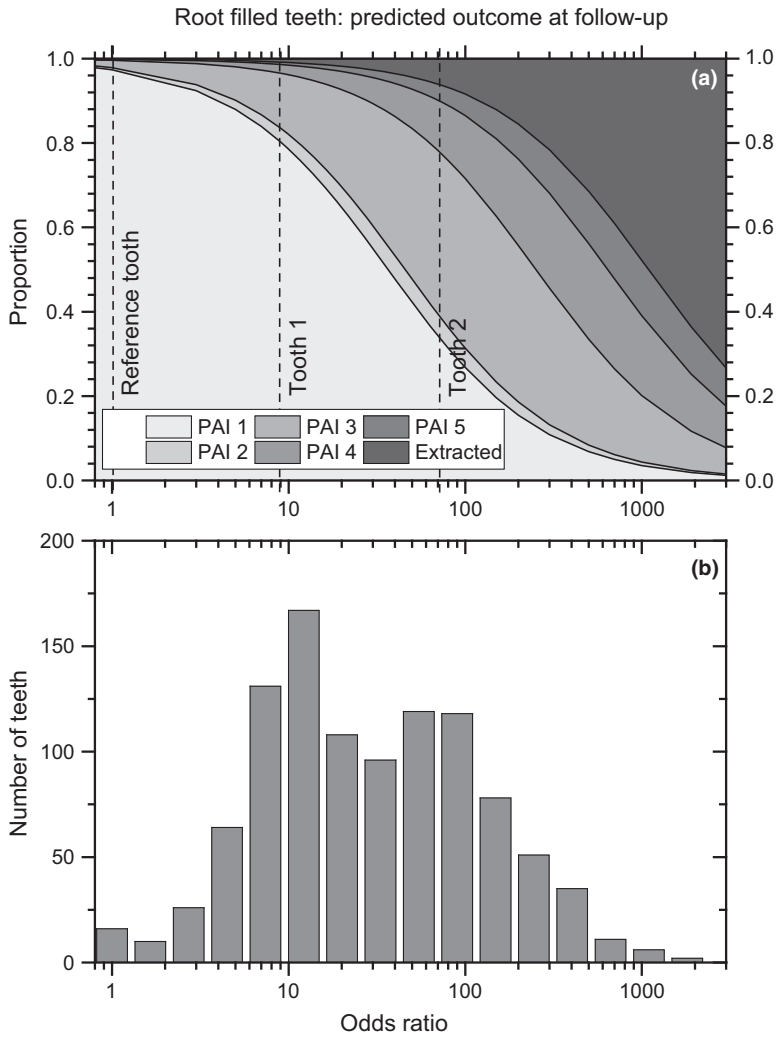

Figure 2 Root filled teeth. Panel a: Predicted probability distribution of outcome at follow-up as a function of the baseline prognostic index expressed as the odds ratio (OR) relative to a reference tooth. Tooth 1 is identical to a reference tooth except for age category (50–59 years), restoration (adequate) and tooth group (maxillary premolar); Tooth 2 is identical to Tooth 1 except for PAI (PAI 3) and restoration (inadequate). Panel b: Distribution of the prognostic index amongst 1038 teeth with baseline information about all predictive factors.

Table 5 Predicted probability distribution of the outcome for a reference tooth, which has the following baseline characteristics: PAI 1, group 1, period 1, female, no smoking, age 20–39 years, 28 teeth, no primary or secondary caries, no restoration, marginal bone level <3 mm, lower incisor

Tooth type	PAI 1	PAI 2	PAI 3	PAI 4	PAI 5	Extracted
Nonroot filled teeth	99.84%	0.05%	0.07%	0.01%	0.01%	0.02%
Root filled teeth	97.34%	0.52%	1.75%	0.24%	0.06%	0.09%

baseline PAI score is such a strong predictor, this will inevitably inflict on the probability of a poor outcome. In controlled clinical studies, inadequate technical quality of the root filling was associated with lower treatment success rates (Kirkevang & Hörsted-Bindslev 2002).

The results of the present study, in which the full-scale periapical index was used as outcome, were similar to previous results based on a dichotomized outcome, healthy/diseased or tooth present/absent. However, with the additional information derived from the increased level of detail in the reporting of the outcome, the sensitivity improves and therefore smaller sample sizes may be required. This could be of relevance in the design of future clinical studies.

Conclusion

The baseline PAI score was the strongest predictive factor for periapical status including extraction, even when adjusted for additional predictive factors. A high baseline PAI score increased the risk for an impaired outcome. The large difference in risk estimates for non-root filled compared to root filled teeth documents the importance of separate analyses/studies for identification and quantification of risk factors associated with periapical disease and tooth extraction.

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Conflict of interest

The authors have stated explicitly that there are no conflicts of interest in connection with this article.

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