Reasons for replacement and the age of failed restorations in posterior teeth of young Finnish adults

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Using dentist characteristics, our aim was to evaluate the reasons for replacements of fillings, the age of failed restorations in the posterior teeth of young adults, and replacement rates. Altogether 205 patient records from the Public Oral Health Service of the City of Vantaa, Finland were evaluated. Patient age was restricted to between 25 and 30 years and type of tooth to posterior teeth only (third molars excluded). Information collected from the records included the patient's date of birth, latest DMFS and DMF, and the code for background data on the dentist. Details of each filled premolar and molar included the restorative material, location, and surface coverage of filling(s). The age of replacement of filling in premolar(s) or molar(s) was screened retrospectively from patient records. The total number of filled premolars and molars was 1873, with 1969 fillings. Forty percent of the patients had undergone replacement of filling in premolar(s) or molar(s). In all, 140 replacements had been made, accounting for 6.9% of amalgam fillings and 8.5% of tooth-colored fillings. Secondary caries, along with fractures, overhangs, and marginal discrepancy, was the most common reason for replacement. The mean age of failed amalgam fillings was 8.9 years (SD 5.2) and of failed tooth-colored fillings 2.4 years (SD 1.6). In the public sector, female dentists form the majority and their replacement rate for amalgam fillings was twice that of male dentists (7.6% vs 3.2%; $P = 0.01$). □ *Amalgam; replacements; restoration; tooth-colored fillings*

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Replacement of failed restorations is one of the most common procedures in dental care, accounting for a larger proportion of operative dentistry in adult patients than primary caries (1–4). A recent survey in England has shown that more than half (56%) of fillings in adult patients attending National Health Service dentists were placed for reasons other than primary caries (5). The same study showed that 10% of all fillings were re-treated within 1 year and 23% during the subsequent 4 years.

Since the share of amalgam fillings is continuously decreasing, it could be asked what impact this is having on replacement of restorations. Reasons for replacement of restorations have mostly been studied by inquiry of dentists (1–3, 6–14). The predominant reason for replacement, both for amalgam and composite resin restorations, is secondary caries, followed by fracture of restoration and marginal discrepancies for amalgam, discoloration, and loss of retention for composite resins (1, 3, 6, 7, 15, 16).

A large variation in dentists' treatment decisions on re-treatment of fillings has been reported by Elderton (17), but the reasons behind these decisions are unclear. In the present study, we hypothesize that the characteristics of dentists have no impact on their replacement practices. We evaluated the replacement of posterior fillings in young adults attending the Public Oral Health Service. The reasons for replacement, the restorative materials used, and the age of failed restorations were ascertained. Furthermore, differences in dentists' clinical practices were evaluated in relation to replacement rates by dentists' characteristics.

Materials and methods

Data were collected from patient records in the Public Oral Health Service of the City of Vantaa, Finland. In contrast to most other Finnish cities, Vantaa has a long tradition of delivering public dental services to young adults, who today account for approximately one-third of all visits annually (18). About 40,000 patients attend Public Dental Clinics each year, i.e. a total of approximately 140,000 visits. Patients in the age group 19 to 32 years account for 32% of these visits (19). The service, which includes examination and preventive and operative treatment, is free for all patients under 19 years of age. For adults aged under 40 years, the treatment is highly subsidized, fees being about half of those in the private sector.

A total of 64 dentists work in the 37 clinics, assisted by dental hygienists and chair-side dental assistants. Dentists receive a fixed salary with supplementary payments according to procedures performed on patients. Education sessions for dentists are held monthly during working hours. The treatment strategy of the Public Dental Clinics is the same everywhere in Finland; it includes unified instructions, standardized dental records, and a strictly followed policy of comprehensive dental care (20). Detailed records are kept of each visit. Finland has a standardized system for codes of diagnoses and treatments both in Public Dental Clinics and the private sector. All patients have individual treatment intervals.

The patients in the present study are young adults

Table 1. Distribution of patients by number of replacements of fillings in premolars or molars by number of teeth at risk, i.e. with fillings.
Number of replacements made. Number of premolars and molars at risk

	1–3 teeth *n* (%)	4–9 teeth *n* (%)	10–16 teeth *n* (%)	All *n* (%)
None	12 (100)	66 (70)	45 (46)	123 (60)
1–6	–	28 (30)	54 (54)	82 (40)
All patients	12 (100)	94 (100)	99 (100)	205 (100)

Statistical evaluation by χ^2 test: $\chi^2 = 20.81$, df = 2, $P < 0.001$.

seeking comprehensive dental care on a regular basis in Vantaa. The basic population comprised all patients ($n = 3,248$) born in 1966–71 and clinically examined in 1994 with recordings in the ADP file, including identification of each patient by social security number and of dentist by code given by the authorities. For each dentist code, 4 to 5 patients were randomly selected, resulting in 239 patients whose original oral health records were requested from public dental clinics. Records which included one or more treatment courses during the preceding 3 years were available for 208 (87%) patients (71 men and 137 women). Data from the most recent treatment course were used. At the time of clinical examination, patient ages ranged from 22.2 to 30.4 years (mean 26.9; SD 2.0).

The information collected from each record included the patient's gender and date of birth, date of visit, most recent dental status by tooth and surface, and the code of the dentist in question. The public authorities of the City of Vantaa supplied the background data, consisting of gender, year of birth, and year of graduation of each dentist.

DMFT and DMFS indices were calculated from dental status recordings. A premolar or molar with filling was taken as a tooth at risk of replacement. Only patients with one or more such teeth were included, resulting in 205 patients with a total of 1,873 teeth and 1,969 fillings at risk of replacement.

Details of each filled premolar or molar at risk of replacement included material, location, and surface coverage of the fillings. The surface coverage of replacement filling(s) in premolars or molars was coded as occlusal only (oc), mesial and/or buccal (mb), mesial and/or buccal and occlusal (mo), distal and/or oral (dl), distal and/or oral and occlusal (do), MOD or crown. Types of fillings were categorized according to Black, and grouped within either Class I or Class II, but MODs were grouped separately. Fillings with a buccal or mesial surface were taken as visibles. For each replacement of filling in premolars or molars the number of occasions, the dates of initial restoration, and replacement and use of local anesthesia were collected. The age of a failed restoration was retrospectively screened from patient records with an accuracy of 1 month. For the 21% of patients for whom an exact date was not found from patient records, the first sign of the filling in dental records was taken as the approximate date. Reasons for replacement were coded as (1) secondary caries, (2) open margin, marginal ridge discrepancy, (3) filling or tooth fracture, (4) poor anatomical form, (5) overhang, (6) discoloration, (7) patient's request/poor esthetics, (8) caries on another surface involving removal of the existing restoration.

Statistical evaluation of differences between the subgroups was performed by chi-square test for comparison of frequencies and by *t* test and ANOVA for comparison of mean values. *P*-values of 0.05 and below were taken as statistically significant. Associations between variables were shown by Pearson's correlation coefficient.

Results

A total of 205 patients had one or more filled premolar or molar. Patients' mean DMFT was 11.9 (SD 5.2, med 12) and mean DMFS 24.1 (SD 14.2, med 20) with no noticeable gender difference ($P > 0.05$). The number of dentists involved was 51, of whom 86% were female. The number of patients per dentist was 4.0 (SD 1.9, med 4). No difference in patients' DMFT, DMFS, and filled premolar or molar by dentist gender was found ($P > 0.05$). Mean DMFS for the patients of female dentists was 23.8; for the patients of male dentists this was 23.9.

Thirty-five percent of premolars had fillings and 82% of molars. Of the 1,969 fillings at risk of replacement, 70% were in molars. The mean number of premolars and molars with fillings was 9.1 (SD 3.6, med 9), the mean number of fillings in these teeth being 9.6 (SD 4.0, med 10), with no difference found by gender.

Forty percent of patients (36% men and 42% women; $P = 0.38$) had undergone replacement of filling(s) in premolars or molars. Receiving a replacement filling in premolars or molars was not correlated with patient age ($r = 0.12$) or gender ($r = 0.06$).

For the 40% of patients receiving any replacement of filling during the most recent treatment course, the mean number of replacements was 1.7 (SD 1.0), and more than half had received just one. The more teeth at risk of replacement one had, the more ($r = 0.39$) replacements of fillings had been done. Table 1 gives the distribution of replacements of fillings in premolars or molars by number of teeth at risk of replacement. Those with 1 to 3 teeth at risk had received no replacement of fillings, whereas 54% of those with 10 to 16 teeth at risk had undergone replacement of filling.

In total, 140 replacements of filling had been made in premolars or molars, the replacement rate being 7.1% for all posterior fillings, for 6.3% of fillings in premolars and 7.5% in molars. The respective replacement rates for amalgam were 6.9% and 8.5% for tooth-colored fillings. From among the 140 replacements, 26% were located in premolars and 74% in molars; 84% were amalgam fillings and 16% tooth-colored; 27% were Class I fillings, 57% Class II, and 16% MOD or larger. The majority of the

Table 2. Distribution of reasons for replacement of fillings by material and visibility

Categories of failed filling	Reason for replacement: Secondary caries *n* (%)	Fracture, overhang, marginal discrepancy *n* (%)	Caries on adjacent surface *n* (%)	Reasons not given *n* (%)	Total *n* (%)
Material					
Amalgam	34 (29)	38 (32)	30 (26)	15 (13)	117 (100)
Tooth-colored	9 (39)	9 (39)	0 (0)	5 (22)	23 (100)
Visibility					
Occlusal only	7 (19)	10 (27)	19 (51)	1 (3)	37 (100)
Mes. visible	23 (37)	22 (35)	4 (7)	13 (21)	62 (100)
Not visible	13 (32)	15 (37)	7 (17)	6 (15)	41 (100)
All	43 (31)	47 (34)	30 (21)	20 (14)	140 (100)

Statistical evaluation by χ^2 test: difference by material $\chi^2 = 7.86$, d.f. = 3, $P = 0.049$; by visibility of filling $\chi^2 = 30.89$, d.f. = 6, $P < 0.001$.

replaced Class I fillings were in the second molars (57%), whereas from among the replaced Class II and MOD fillings, half (48%) were in the first molars. When replaced, the filling material was changed from amalgam to tooth-colored in 50%, but vice versa in only 18% of replacements.

The reasons for replacement by material and visibility of filling are given in Table 2. In general, secondary caries, fractures, overhangs, and marginal discrepancy were dominant reasons, except for occlusal fillings, where one of two replacements was due to caries on an adjacent surface. No reason had been given for 14% of replacements, consisting of 22% of tooth-colored fillings and 13% of amalgam. Poor esthetics had been recorded as the reason for one filling only.

The mean age of failed restorations was 7.9 years (SD 5.4), ranging from 1 month to 21 years. The mean age for failed amalgam fillings was 8.9 years (SD 5.2, med 9), the life span in molars being longer than in premolars ($P = 0.02$), as can be seen from Table 3. The mean age of failed tooth-colored fillings was 2.4 years (SD 1.6, med 1.9), the maximum being 6.3 years. For replaced amalgam fillings, a longer life span was found for those carried out without local anesthesia and those done when the patient was no older than 15 years of age (Table 3). These differences were seen for all types of amalgam fillings, but for no tooth-colored fillings.

Female dentists' replacement rate for amalgam fillings was twice that of male dentists (7.6% vs 3.2%, $\chi^2 = 7.12$, d.f. = 1, $P = 0.01$). Dentists who had graduated before 1980 tended to replace amalgam fillings at a lower rate than those who graduated in 1980 and later (5.8% vs 7.9%, $\chi^2 = 3.04$, d.f. = 1, $P = 0.08$). These differences were not seen for tooth-colored fillings.

Discussion

Reasons for replacement and age of failed fillings form a complex research subject which can be investigated and reported in numerous ways, as recently thoroughly discussed by Burke et al. (21). Questioning dentists about their treatments with regard to replacement of fillings over a fixed period is one of the most frequently used methods. The data in the present study were, by contrast, based on individual detailed record-keeping required for each patient. To control one possible confounder, namely the service sector, the public sector alone was included because of its highly subsidized fees, allowing access to all Finnish citizens, its use of a structured oral health record form, and its strictly followed policy of comprehensive dental care.

To control further underlying confounders, such as patient age and type of tooth, restrictions were imposed: adults between 25 and 30 years of age and posterior teeth, but no third molars. Since adult patients attend Public Dental Clinics at individual treatment intervals, we scrutinized the preceding 3 years and included the most recent treatment course in the data, which explains patient age ranging from 22 to 30 years. On the other hand, restriction of the study population to young adults only

Table 3. Mean age (years) of failed posterior fillings according to characteristics of the filling

Characteristics of failed filling	Material of failed filling: Amalgam *n*	Amalgam Mean (SD)	Tooth-colored *n*	Tooth-colored Mean (SD)
Type of tooth				
Premolars	30	7.1 (4.6)*	6	2.9 (1.6)
Molars	87	9.6 (5.2)	17	2.2 (1.6)
Type of filling				
Class I	34	10.3 (4.7)	3	2.2 (1.7)
Class II	66	8.5 (5.5)	14	2.4 (1.7)
MOD or larger	17	7.8 (4.3)	6	2.4 (1.7)
Local anesthetics				
Not used	62	10.8 (4.6)†	10	2.3 (1.5)
Used	31	7.2 (4.7)	9	2.6 (2.1)
Data missing	24		4	
Patient's age when the initial filling made				
15 years or younger	37	14.4 (3.2)†	0	– –
Over 15 years	80	6.4 (3.8)	23	2.4 (1.6)
All fillings	117	8.9 (5.2)	23	2.4 (1.6)

Statistical evaluation by ANOVA for differences within the 4 groups by characteristics of failed fillings, separately for amalgam and tooth-colored fillings: * $P < 0.05$; † $P < 0.001$; all others NS.

causes limitations for the maximum age of fillings. For comparability of reports on the age of restorations, the results should always be given taking patient age into account.

Drop-out (13%) can be considered tolerable and is a consequence of patients moving to other parts of Finland and sending their dental records to the new dentist. Our results can be considered as representative of the everyday clinical practice of public dental service, since the dentists did not know about the coming evaluation while performing treatment. Despite inadequacies found in record-keeping (22), recordings in patient charts on placement and on restorative material, as well as on teeth and surfaces filled, have previously been found to be highly reliable (23). Despite the failure of the authorities to demand writing down the reasons for replacements, these were available in patient files in 86% of cases in the present study, indicating an acceptable standard of record-keeping.

In public oral health care, most patients continue regular dental visits after advancing from the free-service age (up to 19 years) to the subsidized one. Retrospective information of the age of failed fillings at the time of replacement could therefore be obtained for 79% of cases. For the remainder of the replacements, our method of recording the date when the filling first occurred in dental records as its initial placement time led to an underestimation, which should be kept in mind when comparing our results with those of others. Also noteworthy is that many studies reporting the age of failed fillings have been based on information available for around 60% of cases (10, 13), or even less, for 1 of 4 fillings replaced (9).

The present results are in line with numerous previous studies showing secondary caries and fractures of a filling or tooth as the most frequent reasons for replacement of amalgam fillings in adults (1–3, 6–10, 13, 21, 24). The age of failed amalgam fillings corresponds fairly well with earlier findings in Sweden (9), Denmark (7), and Norway (10), but is longer than in a recent German study (13). Since patient age was 22–30 years, it is hardly surprising that a shorter age was found for those failed fillings initially placed after 15 years of age. The unexpected finding of a longer age for initial fillings made without local anesthesia may be explained by the fact that its use in children's dental care is rare and may be used in very demanding cases and for uncooperative patients only (25, 26).

The replacement rate and the age of failed fillings indicate a longer life span of fillings than was reported for adults regularly attending general dental practice in NHS in England (5). In that material, 10% of the teeth restored in the first year of the study were re-treated within 1 year compared with an overall rate of 7% during the most recent treatment course in our study.

Dentist characteristics revealed some differences in their replacement rates. The gender difference indicates either an overtreatment by female dentists or an undertreatment by males, since their patients' dental states were similar. This calls for further research on the reasoning behind replacement of amalgam fillings in order to reach a uniform standard in these treatments in the public sector, where female dentists form the vast majority (27). In addition, dentists with longer professional experience tended to replace fillings at a lower rate, which may sound logical but is contrary to a 15-year follow-up in Iceland (15). In their study, however, only three dentists were compared.

The present results are in line with previous reports on reasons for replacement of fillings. A new finding, however, is a higher filling replacement rate by female dentists despite a homogeneous group of patients. More education sessions to calibrate treatment decisions on replacement of fillings are needed to diminish the possible overtreatment by female dentists.

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