Placement and longevity of amalgam restorations in Denmark

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A survey has been made of the reasons for placement of 4932 amalgam restorations in Denmark. In patients more than 16 years of age 39% of all restorations were made because of primary caries, and 61% were replacements of failed restorations. In children 74% of the restorations in primary teeth and 84% of those in permanent teeth were inserted because of primary caries. The reasons for replacement of restorations depended on dentition, age of the patient, and type of restoration. Secondary caries was the most frequent reason for replacement of failed restorations in permanent teeth and accounted for 38% of all failures. Marginal discrepancies and bulk fracture of fillings were the other two major reasons. In primary teeth fracture and loss of fillings were the commonest reasons, whereas secondary caries accounted for only a quarter of all restorations replaced. The age of the restorations replaced ranged from 0 to 46 years, and half of the failed restorations in permanent teeth of adults were more than 8 years old. A shorter longevity of failed restorations was noted in primary teeth and permanent teeth of children. □ *Amalgam fillings; cross-sectional study; dental materials; health care delivery; operative dentistry; questionnaire*

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The reasons for placement and replacement of restorations in children and adults in Denmark were surveyed in 1980–82 (1, 2). Since that time, efforts have been made to emphasize the treatment of initial carious lesions by non-operative intervention and active prevention of caries in general (3–7). Therefore, the gradual reduction in number of restorative treatments performed during the past decade has continued (8–11; E. Faurbye. Personal communication, 1989). Concomitant with this progress the tooth-colored restorative materials have been improved, and new restorative techniques introduced (12). Such changes have extended the field of application and use of composite resins and glass ionomer cements, possibly at the expense of amalgam restorations. On this basis the 1980–82 survey was repeated, to update our knowledge about restorative treatment patterns in Denmark.

This report focuses on information on amalgam restorations; a detailed analysis of the tooth-colored restorations will be reported on in another paper (13).

Materials and methods

The material was collected during a half-year period in 1987–88. A questionnaire was sent to 341 dentists who had registered to participate in postgraduate courses in operative dentistry. For each of the first 30 fillings they placed during a given 3-week period, the dentists were asked to record information on whether the fillings were made because of primary caries or as replacements for old fillings. The dentists were also asked to record the major reason for the replacement; this might be primary caries or one of the nine different reasons outlined in Table 3. The terms used were briefly described in the enclosed instructions. Primary caries was defined as carious lesions unrelated to fillings

but which may involve replacement of fillings as part of the treatment. Marginal discrepancies included marginal fractures, excess and deficiency of filling material, and marginal degradation ('ditching'), whereas fracture of fillings was restricted to true bulk fractures. In addition, information on patient age was recorded. This information was used in the analyses, to distinguish between patients ≤16 years of age receiving free dental treatment by salaried dentists in the Danish Public Dental Health Service and patients aged 17 years or more treated by general practitioners remunerated on the basis of a fee per item of service. These individuals will be referred to as adults.

When replacing a restoration, the dentists were asked to record information about type of old and new fillings, restorative materials used, and the age of the old restoration in years, provided this information was available from the patients' records.

Results

The placement of a total of 7454 fillings and 48 crowns was recorded by 265 dentists (78% of the participants) who responded with information on from 15 to 31 restorations inserted during the study period. The age of the patients varied from 2 to 94 years. Of the restorations, 1519 were made in primary teeth, 1664 in permanent teeth in children, and 4319 in adults. There were 4932 amalgam restorations, 2353 resin restorations, 146 glass ionomer restorations, 43 silicate cement restorations, and 28 cast restorations. Nearly all the silicate and cast restorations were made in adults, and most of the glass ionomer restorations were made in primary teeth. Only results for the amalgam restorations have been analyzed in the present paper.

Table 2. Percentage distribution of the 4932 amalgam restorations in primary and permanent teeth as a function of the age of patients and the type of restorations

Type of restoration	Primary dentition ≤16 years, n = 1332	Permanent dentition ≤16 years, n = 1283	Permanent dentition >16 years, n = 2317
Class I	23	59	17
Class II	71	27	66
Class III	2	0	2
Class V	5	13	14

The 4932 amalgam restorations represent 88% of all new restorations in primary teeth, 77% of those in permanent teeth of children, and 57% of the new restorations inserted in adults. The distribution of the restorations in relation to dentition, age of the patients, and reason for restorative treatment is given in Table 1. Most restorations were made to arrest primary caries, but variations were noted in relation to dentition and age. Thus, replacements of failed restorations accounted for almost two-thirds of the amalgam restorations in adult patients, against about one-fifth in children.

The most frequently inserted amalgam restorations in primary teeth and in permanent teeth in adults were those involving approximal surfaces of posterior teeth, whereas occlusal fillings dominated in children's permanent teeth (Table 2). One-fourth of the failed amalgam restorations in primary teeth and more than a third of those in permanent teeth were replaced because of secondary caries (Table 3). Marginal discrepancies were the second major reason for replacements in permanent teeth in children, whereas this reason was less common in the two other subgroups. Fracture of restorations was common in primary teeth and permanent teeth in adults, whereas fracture

Table 1. Distribution of the 4932 amalgam restorations in primary and permanent teeth as a function of the age of patients and the reason for treatment

Dentition	Age of patient, years	Primary caries	Replacement of failed fillings
Primary	≤16	981 (74%)	351 (26%)
Permanent	≤16	1074 (84%)	209 (16%)
Permanent	>16	904 (39%)	1413 (61%)

Table 3. Percentage distribution of the 2227 replaced, failed amalgam restorations in primary and permanent teeth as a function of the age of patients and the major reason for replacement

Reason for replacement	Primary dentition ≤16 years, n = 375	Permanent dentition ≤16 years, n = 227	Permanent dentition >16 years, n = 1625
Secondary caries	25	42	38
Discoloration	—	—	0
Marginal discoloration	—	1	0
Marginal discrepancies	3	26	12
Anatomic form	—	3	2
Fracture of filling	36	10	27
Fracture of tooth	1	3	9
Loose/lost filling	29	9	8
Other reasons	6	7	4

of teeth rarely resulted in failure of restorations in children (Table 3). Loose or lost filling was a particularly frequent reason for inserting new restorations in primary teeth.

The associations between reasons for replacement of failed restorations and type of restorations are outlined in Tables 4 and 5. The most frequently recorded reason for replacements in adults was secondary caries, especially for class-III and class-V restorations. For class-II restorations fracture of fillings also constituted a major reason for failure. Marginal discrepancies and fracture of filling were frequent reasons for replacement of class-I restorations, and many of the class-V and -III restorations had failed because of insufficient retention (Table 4). If the reasons for replacement of class-I and class-II restorations in children are tabulated separately, the difference between primary and permanent teeth is apparent (Table 5). The fracture of fillings and loose or lost fillings constituted major problems for class-II restorations in primary teeth.

Information on the age of the replaced amalgam restorations was available for 1680 (75%) of the 2227 failed restorations. Curves were prepared illustrating the accumulated percentage distribution of the age of the failed restorations (Fig. 1). In adult patients the replaced amalgam restorations had lasted for periods of up to 46 years, but only half of the failed restorations survived for more than 8 years. The age curves for

Table 4. Percentage distribution of replaced, failed amalgam restorations in adults as a function of the type of restorations and the major reason for replacement

Reason for replacement	Class I restorations, n = 214	Class II restorations, n = 1142	Class III restorations, n = 61	Class V restorations, n = 191
Secondary caries	33	35	59	56
Discoloration	—	0	7	1
Marginal discoloration	1	0	—	1
Marginal discrepancies	24	11	7	7
Anatomic form	1	2	—	1
Fracture of filling	21	33	5	5
Fracture of tooth	12	10	5	4
Loose/lost filling	5	6	15	22
Other reasons	4	3	3	5

Table 5. Percentage distribution of replaced, failed class-I and class-II restorations in children as a function of the dentition and the major reason for replacement

Reason for replacement	Primary teeth		Permanent teeth	
	Class I restorations, $n = 55$	Class II restorations, $n = 305$	Class I restorations, $n = 149$	Class II restorations, $n = 57$
Secondary caries	62	17	46	35
Discoloration	—	—	—	—
Marginal discoloration	—	—	2	—
Marginal discrepancies	4	4	32	18
Anatomic form	—	—	4	—
Fracture of filling	7	42	7	23
Fracture of tooth	—	1	—	11
Loose/lost filling	18	30	4	7
Other reasons	9	6	6	7

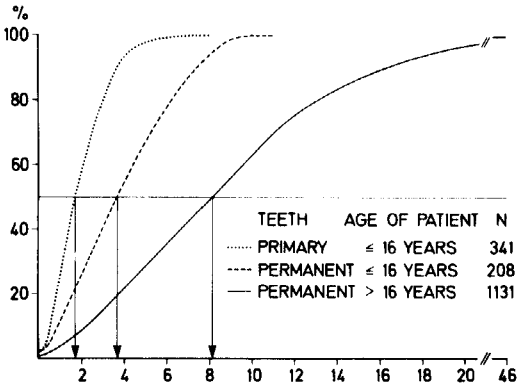

Fig. 1. Accumulated percentage distribution for the age of replaced, failed amalgam restorations in relation to dentition and the age of the patient. The points at which the horizontal 50% line crosses the curves represent the time on the abscissa when 50% of the failed fillings had been replaced.

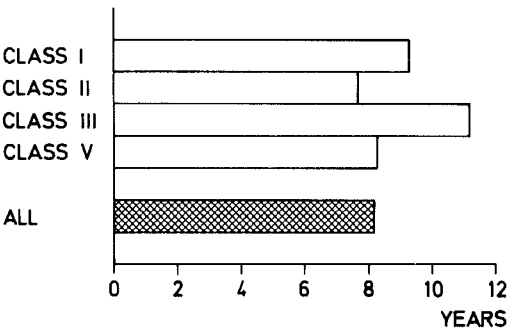

Fig. 2. Bar graph showing median recorded longevity of different types of failed amalgam restorations in adults.

replacements in primary and permanent teeth in patients 16 years of age or less were steeper, indicating a short longevity of failed restorations in children (Fig. 1).

Detailed analysis showed that the longevity of failed amalgam restorations also is influenced by the type of restoration (Fig. 2) and the major reason for replacement (Fig. 3). Class-I and class-III restorations had an increased longevity compared with class-II and class-V restorations. Loose or fractured fillings were typically replaced shortly after treatment, whereas the restorations replaced because of secondary caries and marginal discrepancies were the oldest.

Discussion

Changing treatment patterns mirror the sum of all factors affecting operative treatment. So the evaluation of the performance of restorations in general, clinical practice is important, not only for the patients and the individual dentist, but also for governmental agencies and private insurance companies. Cross-sectional surveys of restorative treatments performed by many dentists on a broad spectrum of patients are undoubtedly the most convenient method to obtain such information. However, the representativity of a cross-sectional survey is always of concern, and it is important to assess the validity of the results and the conclusions.

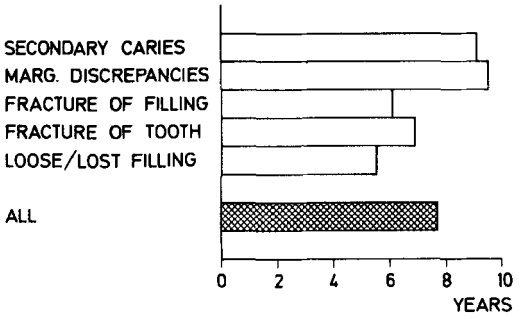

Fig. 3. Bar graph showing median recorded longevity of class-II restorations replaced for different reasons in adults.

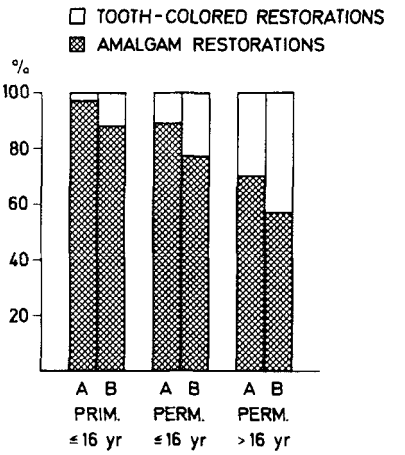

Fig. 4. Bar graph illustrating the relative frequency of amalgam and tooth-colored restorations in the 1980–82 (1, 2) (A) and the present (B) surveys. The age of the treatment groups and the dentition (prim. = primary teeth; perm. = permanent teeth) are indicated below the bars.

The present survey includes approximately 1.5‰ of the average number of restorations placed annually by Danish dentists in clinical practice in 1987–88. The dentists involved were selected from those attending postgraduate courses in operative dentistry, and 78% responded to the questionnaire. The representativity of the data collected is not considered to be adversely affected by this selection, since 95% of Danish dentists attend such courses over a 5-year period, and the age composition of the participants matched that of all dentists in Denmark (O. Buemann. Personal communication, 1989). Furthermore, the data collected, which were from 5% of all Danish dentists in clinical practice, have been compared with the treatment patterns in private practice (E. Faurbye. Personal communication, 1989) and in the Danish Public Dental Health System (10, 11) for the same time period. Only minor discrepancies were noticed; for example, the relative use of tooth-colored materials versus amalgam in adults was 1–2% higher in the present survey than in the national figures. It is concluded, therefore, that the present results reflect the actual treatment pattern in operative dentistry in Denmark, as they did in the surveys from 1980–82 (1, 2).

When the present results are compared with those in the 1980–82 survey, a 10% decrease in the relative use of amalgam is noticed (Fig. 4). This trend probably reflects a change towards a more esthetic concern by the patients, a recognition of the improved quality of the tooth-colored materials, and, possibly, also a general biologic awareness of the potential problems with mercury.

The national surveys indicate a 20% reduction in the annual number of restorations placed in adults and a 35%–40% reduction in filled surfaces in children during the past 8 years (8–11; E. Faurbye. Personal communication, 1989). Furthermore, the number of restorations placed in deciduous teeth versus permanent teeth in children has changed from 1:2 to 1:1 during the 1980s. The proportion of replacements in the primary dentition has decreased, with minimal effect on the median longevity of the failed restorations. These changes represent a major improvement and reflect the gradual decrease in the incidence and progression of caries, as shown in national surveys in the same time period.

The types of restorations placed in deciduous teeth were much the same in the two surveys. In permanent teeth, irrespective of the patient's age, the number of class-I restorations decreased 5–10%, and the proportion of class-II fillings increased by about the same percentage. The reasons for the replacements also changed, especially for permanent teeth, for which the frequency of the diagnosis secondary caries increased for all types of fillings, except class I, but was

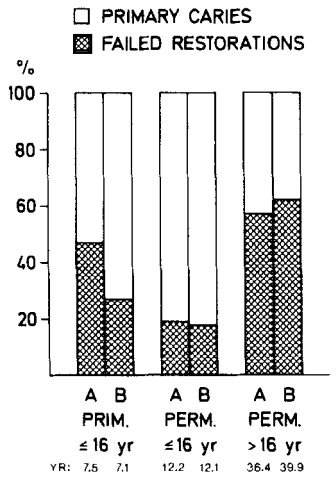

Fig. 5. Bar graph showing the relative frequency of restorations inserted owing to primary caries and failure of fillings in the 1980–82 (1, 2) (A) and the present (B) surveys. The age of the treatment groups, the dentition (prim. = primary teeth; perm. = permanent teeth), and the actual mean age in years of the patients at the time of treatment are indicated below the bars.

still lower than reported in most other cross-sectional surveys (14–22). Bulk fracture of amalgam restorations had decreased slightly in the present survey compared with the 1980–82 survey, but it still remained relatively high compared with results from other countries (14–22). The median longevity of replaced, failed amalgam restorations in adults had increased by 1 year during the past decade. The longevity data in the present survey are in conformity with those published by others (18, 20–23). However, they are probably too low, because only replaced restorations are included in the calculations, and because knowledge about the age of some restorations is deficient.

Boyd & Richardson (19) have shown a major shift in the reasons for replacement of restorations in Canada over a 12-year period; the frequency of replacements due to marginal discrepancies increased from 5% to 21%. A similar shift in clinical diagnosis of failure of restorations had not occurred in the Danish surveys. In fact, marginal discrepancies showed a slight decrease compared with the data from 1980–82, possibly reflecting the effect of the more common use of non-gamma-two amalgams in the 1980s than in the 1970s.

Surveys of the treatment patterns, including selection of materials and longevity of restorations, are important factors for an assessment of operative dentistry in any country, among groups of dentists, or even in individual dental practices. Such factors may be recorded in cross-sectional studies. The data are easily available, provided legible and accurate records are kept, including information about the materials used.

Longevity of restorations may be the most important single factor determining the success or failure of a restorative material, a particular technique, the skill of the dentist, or the efficacy of an oral hygiene regimen to prevent secondary caries. However, in populations in which the frequency of primary caries is on the decline, longevity of restorations is only a measure of the favorable outcome of the restorative treatment in adults. In children, a decrease in the longevity of restorations in deciduous teeth may in fact be due to an improved dental health, in that the need for operative treatment is postponed until late in the life cycle of the tooth. The same arguments apply to the longevity of restorations in permanent teeth of a defined age group of children.

The relationship between operative treatment of primary caries and replacement of failed restorations is considered to express the efficacy of preventive programs and restorative treatment. The data from the present survey show that fewer restorations are replaced in children's teeth—that is, a *relative* increase in the treatment of primary caries (Fig. 5). The mean age of the children at the time of restorative treatment was approximately the same in the two surveys. In adults, on the other hand, the age of the patients at the time of treatment was increased by about 3.5 years. These observations, combined with the relative decrease in primary caries treatments in adults and the increased longevity of the restorations that needed replacement, indicate a positive developmental trend in the restorative treatment pattern in Denmark. However, the relative frequency of restorations placed due to primary caries and failed fillings only

provides a part of the total developmental pattern. A combination of DMF data for different age groups, the replacement rate, and the longevity data for restorations provides an optimal overview of the achievements in the handling of dental caries in any population.

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