

# Restorative treatment pattern and longevity of amalgam restorations in Denmark

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A survey has been made of the reasons for placement and replacement of 6052 amalgam restorations in Denmark. In patients more than 16 years of age 48% of all restorations were made because of primary caries, and 52% were replacements of failed restorations. In primary teeth 64% and in permanent teeth of children 83% of the restorations were made because of primary caries. The reasons for replacement of restorations were dependent 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, comprising a third of all replacements. Marginal discrepancies and bulk fracture of fillings were the other two major reasons. In primary teeth fracture and loss of fillings were the two major reasons for replacement of amalgam restorations, whereas secondary caries caused less than a quarter of all restorations to be replaced. The age of the restorations replaced ranged from 0 to 38 years, and half of the restorations replaced in permanent teeth of adults were less than 7 years old. A shorter longevity of failed restorations was noted in primary teeth and permanent teeth of children. □ *Dental materials; health care delivery; operative dentistry*

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Several studies have documented that dentists vary widely in their treatment planning (1–3), including the point of time for operative treatment of approximal caries (4–7). Often operative treatment was undertaken at early stages of caries development, when non-operative treatment procedures might have arrested further lesion progression (5, 7). Several factors are believed to be responsible for the preference of restorative treatment, one being the profession's faith in the quality and durability of restorative dental work. This belief, however, contrasts with recent reports documenting a general poor quality of restorations, which for the regular dental patient leads to frequent replacement of fillings (1, 8–10).

Restorative treatment of dental caries accounts for the major part of the economic resources spent on dental health care. It is important, therefore, to explore possibilities for expanding the durability of restorative work. The first step in this direction is to investigate the frequency of replacements and the reasons for failure of restorations.

This communication focuses on information on treatment patterns and longevity of amalgam fillings collected from Danish dentists.

## Materials and methods

The material was collected during the period 1980–82. A questionnaire was sent to 338 dentists who were about to participate in postgraduate courses in cariology. For each of the first 30 fillings they placed during a given 2-week period, the dentists were asked to record information on whether a filling was made because of primary caries or as a replacement of an old filling. In the latter case the dentists were asked to record information about the type of old and new filling, filling materials used, and the approximate age of the old filling in years on the basis of information from records. Finally, the dentists were asked to record their major reason for the replacement; this might be primary caries or one of the nine different reasons indicated in Table 3. The terms used were

briefly described in 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 gaps between tooth and restoration, whereas fracture of filling was restricted to true bulk fractures. In addition, information on patient age was recorded. This information was used in the analysis to distinguish between patients ( $\leq 16$  years) receiving free dental treatment by salaried dentists in the Danish Public Child Dental Service, and patients of 17 years or more. The latter are treated by general practitioners who are remunerated on the basis of a fee per item of service.

Of the participating dentists 261 (77%) responded with information about 18 to 30 restorations placed during the study period. The total material included 1772 fillings in primary teeth and 5227 fillings in permanent teeth; 6052 were amalgam restorations, 883 resin restorations, 13 silicate restorations, and 51 cast restorations. This communication focuses on the amalgam restorations; a detailed analysis of the resin restorations will be given in a subsequent paper (11).

## Results

The distribution of the 6052 amalgam restorations in relation to dentition, age of the patients, and reason for restorative treatment is given in Table 1. Most fillings were made to arrest primary caries (71%), but

variations were noted in relation to dentition and age. Thus, replacements of failed restorations were commonest in adult patients.

Table 2 gives the percentage distribution of type of restoration in relation to dentition and age of patients. The most frequently performed 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.

About one-third of the 1738 failed restorations were replaced because of secondary caries (Table 3). Replacement owing to marginal discrepancies accounted for another third in permanent teeth in children less than 17 years of age, whereas this reason was less common in the two other subgroups. Fractures of fillings and teeth accounted for 21% of the replacements in children's permanent teeth, in contrast to 37–40% in primary teeth and in the adult group. Lost fillings were a particularly frequent reason for new restorative work in primary teeth.

The associations between reasons for replacement of failed restorations and type of restoration are outlined in Table 4. The most frequently recorded reason for replacement of class I and V restorations was secondary caries. Marginal discrepancies apparently were a more frequent reason for replacement of class I restorations than for larger fillings. Fractures of fillings and teeth were the commonest reason for failures in class II fillings—that is, MO/DO and MOD fillings.

Information on the age of the replaced filling was available for 1410 (81%) of the

Table 1. Distribution of 6052 amalgam restorations in primary and permanent teeth in accordance with the age of the patients and the reason for treatment

Dentition	Age of patient, years	Reason for treatment with amalgams			Total
		Primary caries	Replacement owing to primary caries	Replacement of failed fillings	
Primary	$\leq 16$	910 (53%)	179 (11%)	626 (37%)	1715
Permanent	$\leq 16$	2446 (74%)	288 (9%)	571 (17%)	3305
Permanent	$> 16$	382 (37%)	109 (11%)	541 (52%)	1032
Total		3738 (62%)	576 (10%)	1738 (29%)	6052

Table 2. Distribution (%) of the 6052 amalgam restorations in primary and permanent teeth in accordance with the age of patients and the type of restorations

Type of restoration	Distribution of restorations, %		
	Primary dentition, ≤16 years	Permanent dentition, ≤16 years	Permanent dentition, >16 years
Class I	23	69	22
Class II	70	22	58
Class III	4	2	4
Class V	3	7	16
No. of restorations	1715	3305	1032

Table 3. Distribution (%) of replaced, failed amalgam restorations in primary and permanent teeth in accordance with the age of patients and the major reason for replacement

Reason for replacement	Distribution, %		
	Primary dentition, ≤16 years	Permanent dentition, ≤16 years	Permanent dentition, >16 years
Secondary caries	23	32	33
Discoloration	—	—	1
Marginal discoloration	—	2	—
Marginal discrepancies	9	29	15
Anatomic form	—	2	1
Fracture of filling	36	18	30
Fracture of tooth	1	3	10
Lost filling	28	8	7
Other reasons	2	7	4
No. of restorations	626	571	541

Table 4. Distribution (%) of replaced, failed amalgam restorations in primary and permanent teeth in accordance with the type of restorations and the major reason for replacement

Reason for replacement	Distribution, %			
	Class I	Class II	Class III	Class V
Secondary caries	40	22	32	45
Discoloration	—	0	1	1
Marginal discoloration	1	0	6	—
Marginal discrepancies	27	14	4	13
Anatomic form	1	1	1	—
Fracture of filling	15	38	7	5
Fracture of tooth	3	6	4	2
Lost filling	9	15	38	31
Other reasons	5	4	4	3
No. of restorations	519	1064	68	87

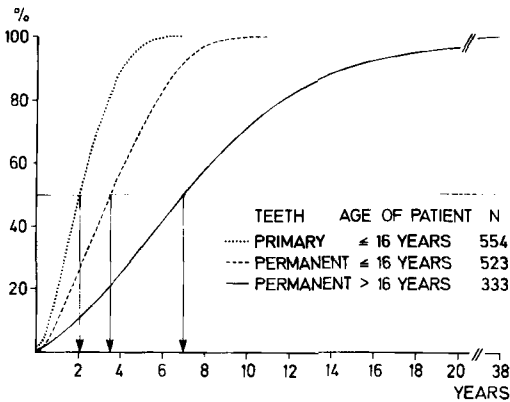


Fig. 1. Accumulated percentage distribution of the age of replaced, failed amalgam restorations in relation to dentition and the age of the patient. The points at which the horizontal 50% line crosses the curves represent the time on the abscissa when 50% of the failed fillings had been replaced.

1738 fillings with failures. Curves were prepared illustrating the accumulated percentage distribution for time of replacement of amalgam fillings—that is, the age of the failed restorations (Fig. 1). In adult patients the amalgam fillings had lasted for periods of up to 38 years, but only half of the fillings survived for more than 7 years. The age curves for primary teeth and permanent teeth in children were much steeper, indicating a relatively short longevity of such restorations (Fig. 1).

Detailed analysis showed that small class I, III, and V restorations had an increased longevity compared with class II restorations. The difference in median longevity amounted to approximately 4 years with regard to class I and II, MOD restorations in adults. In addition, there was an association between longevity and reason for replacement. Typically, lost and fractured fillings were replaced shortly after restoration, whereas the most extended durability was noted for fillings replaced because of secondary caries and marginal discrepancies. For example, there was a difference of 2½ years in the median longevity of MO/DO restorations replaced in adults because of fracture of filling and secondary caries.

## Discussion

Considering that restorative dentistry is the commonest treatment of caries, the number of studies that have attempted to assess the appropriateness of this treatment technology is relatively limited. However, there has been a growing interest in the reasons for failures and the longevity of fillings (12–23).

Detailed information with particular emphasis on marginal fractures has been obtained from controlled clinical trials (24, 25). Such studies require large resources, and they are therefore often conducted as short-term studies. Thus, the clinical relevance of the trials is inconclusive with regard to the longevity of the restorations. The longitudinal studies available on amalgam restorations have mainly been restricted to information about the longevity of selected fillings performed by the authors and on selected groups of patients (15, 19, 20, 22, 26–31).

Because dentists vary considerable in their clinical decision making (1–7), only cross-sectional studies involving a large number of dentists can provide relevant information on the actual longevity of dental restorations. In addition, it is possible from such studies to obtain information on the relative use of different materials, the rate of replacement, depending on variables such as type of restoration and material, and the prevailing reasons for replacement of restorations. Generalization of the information obtained is, however, clearly related to the representativity of the participating dentists and the validity of the recordings. With regard to our data it should be noted that no objections or comments were made by the dentists about the recording procedure and that internal analysis of data from different groups of dentists only showed minor variations. Also, it is noteworthy that almost 80% of the participating dentists responded and that the age of 81% of the replaced fillings was reported.

With regard to the relatively short longevity of amalgam restorations in children, it must be kept in mind that our data are truncated owing to the exfoliation of primary teeth and end of the public dental service

around the age of 17. However, it is remarkable that a large proportion of restorations in children apparently is replaced shortly after restorative treatment.

There are no such limitations to the recordings concerning replacement of failed amalgam restorations in adults. The median longevity, computed on the basis of the present data, thus represents a relatively fair estimate of the actual durability of amalgam restorations in Denmark. It is interesting that the longevity of these restorations corresponds well with other cross-sectional data from general practitioners in other industrialized countries, even though the rate of replacements in our data is relatively low (13, 17, 19, 20). On the basis of this consistency it is tempting to believe that there are inherent limitations to the amalgam restorative technique, determining the durability of restorations. It is therefore understandable that research and teaching programs have focused particularly on these elements, to improve the durability of amalgam restorations.

However, the large variation in the age of replaced restorations in our study, ranging from 0 to 38 years, makes it more likely that a major part of the replacements may be attributed to factors other than the clinical properties of the material. This assumption is supported by the observation that time for replacement not only depended on the type of restoration but also varied in relation to the dentition, the age of the patient, and the reason for replacement. Similar observations have been recorded previously (17, 20, 23, 31). Thus, to increase the durability of amalgam restorations, it seems relevant to initiate a discussion of the extent to which reasons for replacement represent true failures of significance for the function of the restored teeth (32).

The commonest reasons for replacements in our study were secondary caries and marginal discrepancies; the latter restorations were possibly replaced in an attempt to prevent secondary caries. However, the frequencies of these two reasons also varied in relation to dentition, age of the patient, and type of the restoration, in keeping with previous reports (14, 18). For example, mar-

ginal discrepancies were a prominent reason for replacement of fillings in permanent teeth in children (Table 3), explaining the short longevity of failed restorations in this subgroup. Thus, the present data indicate that dentists working within the Public Child Dental Service spent a relatively large amount of time on replacing fillings to approach the quality of 'ideal' restorations (33).

Secondary caries was recorded as the reason for replacement of 40% of the class I restorations, and 27% were replaced owing to marginal discrepancies (Table 4). However, the median longevity of the two types of failed restorations was similar. This observation indicates the need for a more elaborated distinction between true secondary caries requiring treatment and marginal discrepancies without importance for the prognosis and function of the restored tooth. There is no doubt that experience from the past, when the caries incidence was still much higher, has led to unnecessary replacement of restorations with marginal discrepancies and caries-like discolorations (21, 23, 33).

The frequency of replacements owing to secondary caries in our study was much less than that commonly observed, whereas marginal discrepancies caused replacements at almost the same level as that of other reports (12, 14, 16-18, 21, 23). This observation suggests that the regular dental patient in Denmark is characterized by a relatively controlled caries progression. In this perspective it is interesting that the proportions of replacements owing to bulk fracture of restorations and lost fillings in the present material were higher than previously recorded by other investigators (12, 14, 17, 18, 21, 23). A fraction of these may be explained by the fact that primary and permanent teeth in children were included in our sample. Such restorations are known to be replaced more frequently owing to fractured restorations and less frequently due to secondary caries than in adults (14, 23). In addition, it is essential to consider the possibility that operative treatment of very early stages of caries may lead to violation of fundamental principles of cavity preparation. This assumption is consistent with previous

data from the same postgraduate courses, demonstrating that 'white spot' lesions accounted for 56% of restoratively treated approximal caries in permanent teeth (7), presumably leading to preparation of small and shallow cavities with a resulting inadequate thickness of the amalgam.

It is obvious that this basic problem cannot be solved by simply recommending improved cavity preparation. It requires, however, an updated and detailed definition of the indications for placement and replacement of restorations in the light of present knowledge about current possibilities of active, non-operative treatment of initial, small carious lesions (34–36) and emphasis on prevention of caries in general.

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