Placement and longevity of tooth-colored restorations in Denmark

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A survey has been made of the use of materials and the reasons for placement of 2542 tooth-colored restorations in Denmark. In adults 38% of all the restorations were inserted because of primary caries, and 62% were replacements of failed restorations. In children primary caries was the reason for placing 68% of the restorations in deciduous teeth and 77% of those in permanent teeth. Resin-based materials were the most frequently used tooth-colored restorative, except in the treatment of deciduous teeth, for which glass ionomer cement was used preferentially. Silicate cement was used for less than 2% of the tooth-colored restorations, and the few old silicate cement restorations were most often replaced with resin materials. The reasons for replacement of resin restorations were dependent on dentition, age of the patient, and type of restoration. Secondary caries, fracture of restoration, and loss of fillings were the most frequently recorded failures. The age of the resin restorations replaced ranged from 0 to 19 years, and half of the failed restorations in adults were more than 6 years old. In permanent teeth in children half of the failed resin restorations were replaced within 2 years, whereas half of those in primary teeth were replaced within 1 year. □ *Composites; dental materials; glass ionomers; health care delivery; operative dentistry; silicate cements*

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Resin-based composite materials have replaced silicate cement as the tooth-colored material for use in anterior teeth. They also have a wider indication for use, including class-IV restorations, because of the retention potential of 'the acid-etch technique'. During the past decade resin-based materials have been developed specially for use in stress-bearing areas of posterior teeth. Acceptance programs for these 'posterior composites' have been developed by certifying agencies (1, 2).

Glass ionomer cements represent another type of tooth-colored material which entered the field of esthetic restorative materials, mainly for use in class-III and class-V type restorations but with potentials for use in small class-I and class-II restorations (3). Thus, the arsenal of tooth-colored restorative materials is in a state of flux. Treatment patterns are changing, even though little information is available on the outcome of the treatment. Therefore, the present survey will focus on a mapping out of treatment patterns, using tooth-colored materials in general clinical practice in Denmark, with emphasis on the reasons for failure of the restorations and their longevity. The data will be compared with a similar survey performed in 1980-82 (4).

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 in a given period of 3 weeks, 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. The dentists were also asked to record their major reason for the replacement; this might be primary caries or one of the nine

Table 1. Distribution of the 2542 tooth-colored 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	127 (68%)	60 (32%)
Permanent	≤16	295 (77%)	86 (23%)
Permanent	>16	752 (38%)	1222 (62%)

different reasons indicated in Table 4. The terms used were briefly described in enclosed instructions (5). When replacing a restoration the dentists were asked to record information about the type of the old and the new filling, the restorative materials used, and the approximate age in years of the old filling on the basis of information from records.

Results

Of the dentists receiving the questionnaire 265 (78%) responded with information about 15 to 31 restorations placed during the study period. Information was obtained on the placement of 7502 restorations, most of which were amalgam restorations reported on in another paper (5); 2353 of the restorations were made from resin-based composite materials, 146 from glass ionomer cement (mainly class-II restorations in deciduous teeth), and 43 were silicate restorations (mainly class-III restorations in adults). This report focuses on these tooth-colored restorations, especially the resin restorations because of their large number.

The distribution of the 2542 tooth-colored restorations in relation to dentition, age of the patient, and reason for restorative treatment is given in Table 1. The tooth-colored restorations represent 42% of the new restorations in adults and 23% of those in permanent teeth of children. In primary teeth only 5% of the new restorations inserted were in resin materials, whereas 7% were made in glass ionomer cement (5). More than two-thirds of the tooth-colored restorations in children and just over one-third of those in adults were made to arrest primary caries. The rest were replacements of failed restorations (Table 1).

Table 2 gives the percentage distribution of type of tooth-colored restorations in relation to dentition and age of the patients. The commonest type of restoration was class-III fillings, followed by class-V. However class-I and class-II fillings together accounted for more than half of the tooth-colored restorations in deciduous teeth, primarily glass ionomer restorations, and about one-third of those in permanent teeth of children, mainly resin-based restorations. Analysis of the 7502 new restorations disclosed that 93% of the class-III and almost

Table 2. Percentage distribution of the 2542 tooth-colored 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, $n = 187$	Permanent dentition ≤16 years, $n = 381$	Permanent dentition >16 years, $n = 1974$
Class I	14	28	4
Class II	40	3	6
Class III	23	31	47
Class IV	5	12	13
Class V	18	25	29

Table 3. Materials used for the 3819 replaced restorations in primary and permanent teeth

Replaced restoration	New restoration					
	Amalgam	Resin-based	Glass ionomer	Silicate cement	Cast	Total
Amalgam	2351	244	44	2	21	2662 (70%)
Resin-based	30	926	4	5	3	968 (25%)
Glass ionomer	7	9	10	—	—	26 (1%)
Silicate cement	3	114	3	26	—	146 (4%)
Cast	5	10	—	1	1	17 (0%)
Total	2396 (63%)	1303 (34%)	61 (2%)	34 (1%)	25 (1%)	3819 (100%)

all the class-IV fillings were tooth-colored restorations, whereas only 12% of the class-I, 7% of the class-II, and 53% of the class-V restorations were made of tooth-colored materials.

About a third of the tooth-colored restorations inserted were replacements. Many of these had previously been made using other materials. Table 3 shows the distribution of materials used in primary and permanent teeth for the 3819 replaced restorations and for those newly inserted. Most of the amalgam and resin-based fillings were replaced by the same materials. However, there was a tendency towards a change from amalgam to tooth-colored materials. Silicate cement restorations were usually replaced by resin-based materials. The few glass ionomer restorations were often replaced by another material. The distribution of the replaced fillings on the basis of the tooth-colored restorative materials used (Table 3) shows that only resin-based materials and silicate cements can be analyzed in some detail. Of the 146 replaced silicate cement restorations, 117 were failed class-III fillings. These restorations had a median age of 13.6 years. The main diagnoses for failure were marginal discrepancies (37%), followed by secondary caries (20%), corpus discoloration (15%), and loose filling (13%).

Tables 4 and 5 include information about the recorded major reasons for replacement of the 950 failed resin-based restorations. Secondary caries was the most frequently recorded reason for the replacement of class-III and class-V restorations. Loose or lost and fractured fillings were frequent reasons for failure of class-IV restorations, and even for class-III and class-V restorations insuf-

Table 4. Percentage distribution of replaced, failed resin 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 = 17	Permanent dentition ≤16 years, n = 68	Permanent dentition >16 years, n = 865
Secondary caries	24	12	32
Discoloration	—	13	13
Marginal discoloration	—	3	7
Marginal discrepancies	—	15	14
Anatomic form	—	—	1
Fracture of filling	—	18	8
Fracture of tooth	—	1	6
Loose/lost filling	71	31	18
Other reasons	6	7	1

Table 5. Percentage distribution of replaced, failed resin restorations in primary and permanent teeth as a function of the type of restoration and the major reason for replacement

Reason for replacement	Classes I, II restorations, n = 46	Class III restorations, n = 556	Class IV restorations, n = 181	Class V restorations, n = 158
Secondary caries	24	36	12	36
Discoloration	—	17	7	8
Marginal discoloration	—	7	3	11
Marginal discrepancies	20	14	9	15
Anatomic form	2	1	1	2
Fracture of filling	26	4	19	4
Fracture of tooth	11	6	6	1
Loose/lost filling	11	14	40	20
Other reasons	7	0	3	3

ficient retention was often noted as the major reason for replacement. Of the few class-I and class-II restorations, half were replaced because of secondary caries and bulk fracture of the filling.

Information on the age of the replaced fillings was given for 749 (79%) of the 950 resin-based restorations with failures. The accumulated percentage distributions of the age of resin restoration needing replacement in primary and permanent teeth in children and in permanent teeth in adults are shown in Fig. 1. The maximum survival time of failed resin restorations was 19 years. Of the failed restorations in adults 80% were replaced within 10 years, and 50% survived for more than 6 years, whereas the median longevity in children's teeth was less than 2 years in permanent teeth and less than 1 year in primary teeth.

The longevity of failed resin-based restorations as a function of the type of restoration and the reason for replacement is shown in Figs. 2 and 3. The durability of class-III resin restorations in adults exceeded that of other types of restorations, whereas class I and class II showed the shortest longevity (Fig. 2). Fracture of filling or tooth and loose or lost restorations were replaced earlier after treatment than fillings with secondary caries and esthetic shortcomings (Fig. 3).

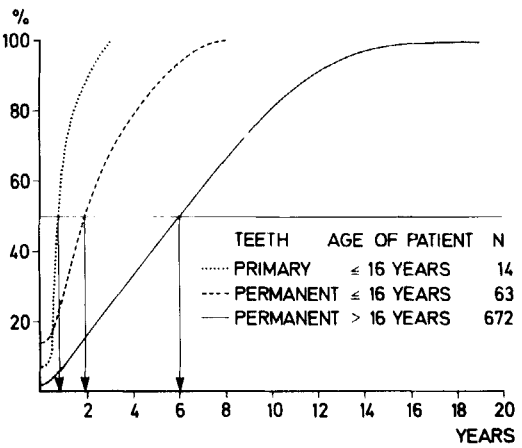

Fig. 1. Accumulated percentage distribution for the age of failed, resin-based restorations in relation to dentition and the age of the patient. The points at which the horizontal 50% line crosses the curves represent the time on the abscissa when 50% of the failed fillings had been replaced.

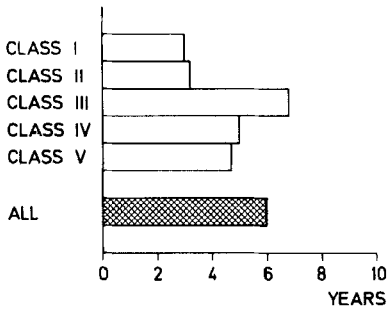

Fig. 2. Bar graph showing median recorded longevity of different types of failed, resin-based restorations in adults.

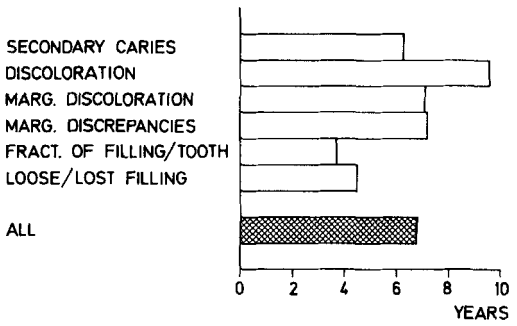

Fig. 3. Bar graph showing median recorded longevity of class-III resin-based restorations in adults which had been replaced for various reasons.

Discussion

The present survey is considered to be representative of the treatment patterns in operative dentistry in Denmark (5). The major trends in the reasons for replacing resin-based restorations are similar to those reported in 1980–82 (4) and in other cross-sectional studies (6–8). Secondary caries, discolorations, insufficient retention, and marginal degradation remain the major reasons for replacement. However, the frequency of secondary caries in permanent teeth was lower in the present survey than in that in 1980–82 (4). This finding indicates a positive trend in the effect of preventive interventions with the incidence and progression of the caries disease (9).

The longevity of the failed resin-based restorations remained the same in the survey from 1980–82 and in the present study. Thus, the increase in longevity of failed amalgam restorations in a similar comparison could not be noted for resin-based restorations (5). On the basis of longevity data, it was apparent that resin-based materials are most suitable for class-III-type restorations. As for class-I and class-II restorations, the longevity of the resin restorations that failed was about 3 years, compared with 8–9 years for amalgam restorations (Fig. 4). However, the use of resin-based materials for stress-bearing restorations in posterior teeth is a relatively new trend. The longevity data on such restorations are, therefore, encumbered with uncertainty and are probably too low (10).

The numbers of tooth-colored fillings, other than resin-based materials, are too small to enable a detailed discussion. The few silicate cements, 0.5% in all, were placed by a few dentists who still used this material as the routine material in anterior teeth, and most failed silicate restorations were replaced by resin-based materials. The present data on silicate cement restorations, therefore, represent a highly selected sample of 'survivors', and thus the results cannot be compared with data from previous surveys. Glass ionomer materials were only used in 2% of the newly inserted restorations. This limited use of these materials, which have been available for about 15 years, could be due to the fact that the first marketed brands were of poor esthetic quality and difficult to handle. Therefore a negative image may remain. Another reason may be that they are not considered to be esthetically as good as resin-based materials. However, glass ionomer cements have decided advantages in their fluoride release, which prevents secondary caries (3). They also show significantly less adhesion of *Streptococcus mutans* than resin-based materials (11). These properties have led to their recently increased use in deciduous teeth.

The selection of materials during the past decade has been influenced by several factors other than material quality per se. A call for tooth-colored materials to replace amalgam has been made by patients and manufacturers of resin-based materials and lately also by those marketing glass ionomer-based materials. Furthermore, the need to replace amalgam has been based on possible adverse effects from the mercury in amalgam, but largely without knowing the biologic side effects of the resin-based materials intended to replace the amalgam. The present data indicate that Danish dentists have a conservative view on the indiscriminate change from amalgam to resin-based materials. In fact, a few resin-based restorations were also replaced by amalgam.

A comparison of the longevity of various types of amalgam and resin-based restorations indicates clearly that amalgam restorations exceed resin-based materials in longevity in all situations. The largest dif-

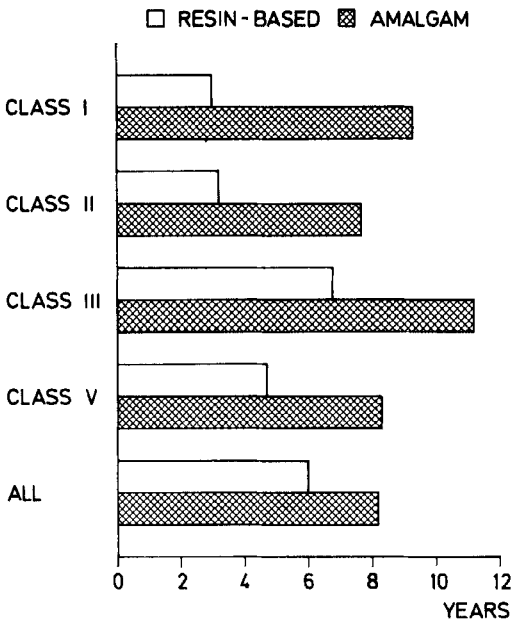

Fig. 4. Bar graph showing median recorded longevity of different types of failed resin-based and amalgam restorations in adults.

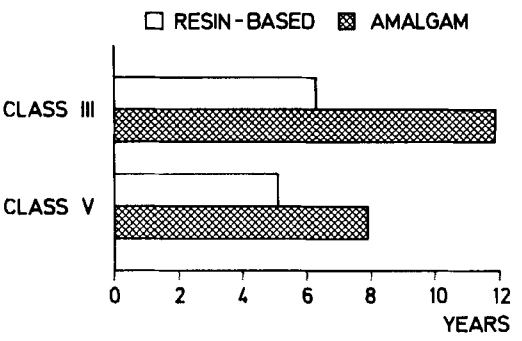

Fig. 5. Bar graph showing median recorded longevity of class-III and class-V resin-based and amalgam restorations in adults which had been replaced because of secondary caries.

ference is found for class-I and class-II restorations, which constitute the majority of the amalgam restorations. If all the restorations are considered, the longevity of amalgam restorations still exceeds that of resin-based materials by more than 2 years (Fig. 4). If secondary caries is considered, it is notable that the longevity of class-III and class-V amalgam restorations exceeds that of resin-based restorations by more than 5 years and almost 3 years, respectively (Fig. 5). Such factors are important when the lifelong cost and side effects of operative dentistry are considered. Obviously, esthetics are important in restorative dentistry, but in situations in which they are not, the longevity of restorations should be part of the decision about which material to select.

If operative intervention is deemed necessary to treat caries, the technical quality of the restorations is of utmost importance for their longevity. Other factors are also significant, such as the quality of the material and the oral hygiene of the patient. The assessment criteria are dependent on the material used, and it is important to determine which are of clinical significance (12). The esthetic demands on the tooth-colored materials are necessarily greater than on amalgam, but other factors, like plaque adhesion (13) and distribution of specific bacteria in the plaque (11), must also be considered. The relatively marked tendency for increased plaque adhesion on resin-based materials compared with amalgam calls for even more detailed patient instructions with regard to oral hygiene than usual when these materials are selected. Furthermore, these materials show degradation patterns and modes of retention different from those of amalgam. Problems with postoperative sensitivity has also been reported (14). Therefore, at a time of decreasing caries prevalence and less need for operative treatment, care should be exercised not to use 'esthetic or cosmetic dentistry' as the main criterion for operative treatment.

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