Placement and replacement of restorations in primary teeth

Ivar A. Mjör, Jon E. Dahl and Jacquelyn E. Moorhead

Department of Operative Dentistry and Division of Biostatistics, University of Florida, Gainesville, Florida, USA, and NIOM, Scandinavian Institute of Dental Materials, Haslum, Norway

Mjör IA, Dahl JE, Moorhead JE. Placement and replacement of restorations in primary teeth. Acta Odontol Scand 2002;60:25–28. Oslo. ISSN 0001-6357.

This practice-based study aimed to record the use of restorative materials, the type of restoration by class, and the reason for and the age of failed restorations in primary teeth by means of a survey of placement and replacement of restorations in 1996 and 2000/2001. Written alternative criteria for placement and replacement of restorations were provided for the participating clinicians. Details on 2281 restorations showed that primary caries was the main reason for inserting restorations in primary teeth. Replacements of failed restorations represented 14% of the fillings ($n = 2040$) in 1996 and 9% in 2000/2001 ($n = 241$). More than 80% of the fillings in primary teeth were of tooth-colored material, predominantly of the light-cured type. About 50% of failed amalgam and glass ionomer-type restorations were replaced due to secondary caries. The median age of amalgam restorations (3 years) was significantly higher than that of tooth-colored restorations (2 years). Any possible advantage of a cariostatic effect of glass ionomer-type materials is apparently annulled by their short longevity compared with amalgam. □ *Amalgam; compomers; glass ionomer; longevity; selection of materials*

Ivar A. Mjör, College of Dentistry, University of Florida P.O. Box 100415, Gainesville, FL 32610, USA. Tel: +1 352 392-4585, fax: +1 352 846-1643, e-mail: imjor@dental.ufl.edu

Ample data are available on the reasons for the initial placement and for the replacement of restorations in permanent teeth, both in longitudinal (1–4) and in cross-sectional studies (5–9). Less information is available related to restorations in primary teeth, especially from practice-based studies (7, 8, 10). Primary caries is the most common reason for placement of the first restoration in primary and permanent teeth, but the reasons for replacement and age of failed restorations vary depending on the dentition, at least for amalgam (7, 10, 11) and composite restorations (8, 12, 13). With regard to glass ionomer materials, the composition of these has changed during the past 20 years, including the introduction of reinforced glass ionomers and different types of resin-modified glass ionomers. More recently, a new type of material referred to as compomer has been introduced. Although the compomer is based on composite and glass ionomer technologies, it is more similar to resin composite than to glass ionomer and is, therefore, also termed polyacid-modified resin composite. These changes have made it difficult to study failures of specific types of glass ionomer, resin-modified glass ionomers, and resin composite restorations. Whenever amalgam and glass ionomer restorative materials in primary teeth have been compared, amalgams show the least failure and enhanced longevity (12, 14–16).

Effective caries preventive programs targeted at children have minimized the need for restorations. The selection of restorative materials in this new era of pediatric dentistry has not been well documented. The aim of the present cross-sectional study in Norwegian general practice was to survey the use of restorative materials and the type of restoration by class and to examine the reasons for their failure in primary teeth. Additionally, the longevity of restorations, expressed as the median age at the time of replacement of failed restorations, was investigated.

Materials and methods

A total of 243 Norwegian dentists in general practice accepted in 1996 the invitation to participate in the recording of several details related to 100 consecutively placed restorations in their routine daily work (17). The clinicians were asked to record the materials used in restoring initial lesions in teeth and those used in replacing failed restorations, including the tooth and surfaces treated, class of restoration, and the reason for placement and replacement of restorations. Since compomers had newly been introduced, they were not included as a separate entity in the study in 1996. Therefore, a supplemental survey of the use of restorative materials in primary teeth was carried out in December 2000–January 2001 including 10 randomly selected public dental clinics reporting data on all restoration work performed during 15 days. This study is referred to as the 2001 survey.

Provided the treatment record contained information on the date a failed restoration had been inserted, the age was recorded in years, but if this was less than 1 year, the number of months was reported. Several demographic data were also collected, including age and sex of the patients, sex and years since graduation of the clinicians, and type of practice (salaried clinician or private practice).

The reasons for placement and replacement of restorations were recorded on the basis of a list of alternative diagnoses. An explanation of each diagnosis was given in

Table 1. Materials in restorations in primary teeth, data from the 1996 and the 2001 surveys

Type of restoration	Amalgam	Composite	Conventional glass ionomer	Resin-modified glass ionomer	Compomer	Other
All new restorations (1996 survey) (n = 2040)	122 (6%)	143 (7%)	530 (26%)	1061 (52%)	–	184 (9%)
All new restorations (2001 survey) (n = 241)	11 (5%)	5 (2%)	42 (17%)	70 (29%)	92 (38%)	22 (9%)
Old, failed restorations (1996 survey) (n = 289)	49 (17%)	12 (4%)	110 (38%)	86 (30%)	–	32 (11%)

writing to the participating clinicians. The same alternatives were given for primary and permanent teeth. For replacements they included secondary (recurrent) caries, bulk and marginal fracture of restoration, fracture of tooth, and bulk and marginal discoloration, poor anatomic form, pain/sensitivity, change of material, and 'other' reasons. Replacement of a restoration due to primary caries on a different surface was not considered a replacement but rather placement of a restoration due to primary caries. Detailed descriptions of the reasons for replacement of restorations have been published (18, 19). A total of 24,429 restorations, equally distributed among female and male patients (17), were reported, and 8.4% of the restorations were in primary teeth. These restorations will be reported on in the present paper. All data management and statistical analyses (Kruskal–Wallis test) were performed, using the Statistical Analysis System (SAS).

Results

Details on 2040 restorations placed in primary teeth were recorded in the 1996 study. Most of the restorations were inserted in the treatment of primary caries (86%), whereas 14% were replacements of failed restorations. Most restorations were placed by salaried (98%) and by female (58%) clinicians. In the 2001 survey the 22 participating dentists reported data on 241 fillings, of which 91% were primary fillings and 9% replacements.

Almost 80% of all restorations placed in 1996 were of glass ionomer type, and the great majority of these were resin-modified glass ionomers (Table 1). The data collected in the second survey showed that 46% of the restorations were of glass ionomer-related restorative materials, and 38% were classified as compomer (Table 1). Failed restorations also showed a majority of glass ionomer restorations (Table 1). Few amalgam and composite restorations were placed, and 'other' materials (temporary fillings and steel crowns) comprised less than 10%. A larger proportion of amalgam restorations was found among the failed restorations (17%) than among the new restorations inserted in the present material (6%). Class-II restorations constituted the predominant type of restoration placed both in the 1996 survey and in the 2001 survey (Fig. 1).

No significant differences in the use of restorative materials were found to be dependent on the patients' sex, but there was a tendency to use more 'other' materials and amalgam in boys and more tooth-colored restorations in girls. Female and male dentists used the same types of restorative materials.

The reasons for replacement of restorations in primary teeth were recorded for 271 of the 314 failed restorations (86%). The clinical diagnosis secondary caries was the main reason for failure of all types of restorations in primary teeth, followed by fracture of restorations (Table 2). Bulk and marginal discoloration was not recorded for any of the tooth-colored materials in primary teeth. Change of material without failure of restorations occurred in 6% of the replaced amalgams, and they have been included under 'other' reasons.

The age of 78% of the 313 failed restorations was recorded. Three amalgam restorations in retained primary molars of adults were excluded from the analysis. The median age of the replaced restorations in children was 3 years for amalgam and 2 years for all tooth-colored

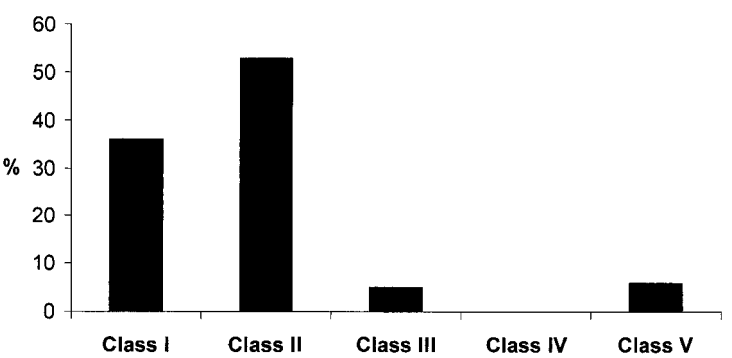

Fig. 1. Distribution of placed restorations (n = 1903) in primary teeth by class. The data from 1996 and 2001 were combined since there was no difference between the two surveys.

Table 2. Reasons for replacement of restorations in primary teeth ($n = 271$, combined data from 1996 and 2001 surveys)

Clinical diagnosis	Amalgam, $n = 48$	Conventional glass ionomer, $n = 117$	Resin-modified glass ionomer, $n = 93$
Secondary caries	53%	48%	50%
Fracture of restoration	24%	29%	13%
Bulk	24%	26%	12%
Margin	0%	3%	1%
Fracture of tooth	2%	2%	6%
Poor anatomic form	0%	1%	1%
Pain/sensitivity	2%	0%	0%
Material change	3%	0%	0%
Other*	13%	21%	30%

* Other, including lost restoration, poor contact, and material degradation.

restorations combined. The median age of the 12 tooth colored restorations replaced in the 2001 survey was 17 months. The Kruskal–Wallis test showed that the median age of all failed amalgam restorations was significantly ($P = 0.0001$) higher than that of glass ionomer restorations. These values were also representative for Class-II restorations ($P = 0.007$). Too few composite restorations were replaced to justify detailed analyses.

Discussion

The respondents in the present study were considered to be representative of the dental care providers in Norway (17). They comprised an experienced group of clinicians covering all geographic areas. Compared with the national averages, a slight underrepresentation of private practitioners and a higher rate of salaried dentists were found among the respondents.

All children and adolescents up to the age 19 years are entitled to free dental treatment in Norway, with the exception of some limitations related to orthodontics. Since the 1996 survey showed that salaried dentists in the public dental service almost exclusively carried out the treatment of primary teeth, the results are considered to reflect the situation in the treatment of primary teeth in Norway. It is noteworthy that private practitioners inserted only 2% of the restorations in primary teeth.

Two different approaches are available for studies of the long-term efficacy of dental restorations: longitudinal and cross-sectional clinical studies. With few exceptions (2, 3, 20), longitudinal studies rarely exceed 3- to 5-year observation periods. A major problem with longitudinal studies is patient dropout. However, it is an advantage that the clinicians involved are calibrated in the criteria used, but since few clinicians are included and often a selected group of patients are used, the representativity of the findings in these controlled clinical trials may be questioned.

Cross-sectional studies have the advantage that they include assessment of treatment performed recently and many years ago. However, the conditions at the time of placement of restorations are largely unknown. Another inherent problem is the lack of standardization and calibration of clinicians. Since many clinicians are involved, it is likely that an average type of treatment and criteria will be obtained. It has been claimed that studies based on a large group of unselected patients by a large group of unselected general dentists will provide a good basis for generalizing the findings (21). Thus, the present cross-sectional survey may give a true reflection of the treatment provided to the population studied. In support of this assumption, a recent longitudinal practice-based study of restorations in primary teeth in Denmark (12) showed identical or very similar results in many areas common to both studies—for example, the distribution of restorations by class and the fact that only 14% of all restorations represented replacement of failed restorations, with a even smaller percentage (9%) in the most recent data. Earlier studies have shown the percentage of failed restorations in primary teeth to be in the 20%–30% range (7, 8, 10). The proportion of failed restorations in permanent teeth of adults is much higher, often around 50%–60% (7, 8, 22, 23).

The testing of restorative materials and techniques for use in primary teeth requires the participation of children. The justification for using children in experimental studies may be questioned on ethical grounds. The present cross-sectional approach has the advantage that the registrations are made at regular visits, so no additional visit to the dentist is needed, and that these studies represent real-life, everyday dentistry.

No patient sex differences were found in the selection of restorative materials or in the reasons for replacement of restorations in primary teeth. These findings are in agreement with those in permanent teeth (17). A higher median age of amalgam restorations replaced by male clinicians was also found in permanent teeth (23). Female clinicians apparently use stricter criteria for acceptable restorations than male clinicians.

If it is accepted that the distribution of the materials in failed restorations reflects the past use of materials, it is evident that the use of amalgam has decreased and glass ionomers increased, especially the resin-modified glass ionomers and, most recently, the compomers. The move away from amalgam is a typical trend for all restorative therapy in Scandinavia (12, 17, 22) and also in Germany (13), even though the longevity and, therefore, the cost of restorative therapy will be negatively affected (7, 8, 12, 23).

In the selection of restorative materials much interest has focused on the potential cariostatic effect of glass ionomer cements, the resin-modified types, and the compomer, owing to the release of fluoride. However, no such effect has been shown in comparative studies of amalgam and glass ionomers (15, 16), and this finding was confirmed in the present study. On the other hand, Qvist et al. (12) claimed a cariostatic effect of glass ionomers on surfaces adjacent to glass ionomers. Bulk fractures were the second most common reason for the replacement of both types of restorations, as in the study by Qvist et al. (12).

'Other reason' for failure was higher than that reported for permanent teeth (5, 7, 8, 22). Since poor contact point, pulpal complications, and lost restorations (7, 8, 11, 12) were not singled out as reasons for failure of restorations in primary teeth in the present study, these criteria have been included as other reasons.

Resin composite restorations are rarely used in primary teeth, probably because of the high failure rate of these restorations, as shown by Qvist et al. (8). They are also more technique-sensitive and time-consuming than any of the other direct restorative materials and are, therefore, not indicated for routine use in pediatric practice. The resin-modified glass ionomer material and the compomer appeared to be the restorative materials that were selected for primary teeth, despite the relatively short life span of glass ionomer compared with amalgam restorations and the lack of long-term data for the compomer material. The most recent survey showed in fact that the compomer had become very popular.

The age of failed amalgam restorations in primary teeth is much shorter than that in permanent teeth (12, 22). This finding is to be expected because of the relatively short lifespan of the primary dentition. It may also reflect the greater difficulties encountered in operative dentistry on children compared with adults. However, the median longevity of glass ionomer-type materials in primary teeth is more in conformity with that found in permanent teeth (7, 8, 19, 22).

Conclusion

Caries is the predominant reason for placement and replacement of restorations in the primary dentition. More than 80% of the fillings were of tooth-colored material, predominantly of the light-cured type. The median age of amalgam restorations (3 years) was significantly higher than that of tooth-colored restorations (2 years).

Acknowledgements.—The assistance in selection of clinicians for this study by the Norwegian Dental Association and the participating clinicians is gratefully acknowledged. This study was supported in part by NIH/NIDR grant 2 P50 DEO9370-10 and by a Guest Research Fellowship from the Research Council of Norway in support of Dr. Ivar A. Mjör's Faculty Developmental Leave at NIOM, Scandinavian Institute of Dental Materials.

References

1. Elderton RJ. Longitudinal study of dental treatment in the general dental service in Scotland. Br Dent J 1983;155;91–6.
2. Jokstad A, Mjör IA. Replacement reasons and service time of class II amalgam restorations in relation to cavity design. Acta Odontol Scand 1991:49:109–26.
3. Osborne JW, Norman RD, Gale EN. A 14-year clinical assessment of 12 amalgam alloys. Oper Dent 1991;22: 857–64.
4. Letzel H, van't Hof MA, Marshall GW, Marshall SJ. The influence of the amalgam alloy on survival of amalgam restorations: a secondary analysis of multiple controlled clinical trials. J Dent Res 1997;76:1787–98.
5. Mjör IA. Placement and replacement of restorations. Oper Dent 1981;6:49–54.
6. Klausner LH, Green TG, Charbeneau GT. Placement and replacement of amalgam restorations. A challenge for the profession. Oper Dent 1987;12:105–12.
7. Qvist J, Qvist V, Mjör IA. Placement and longevity of amalgam restorations in Denmark. Acta Odontol Scand 1990;48:287–303.
8. Qvist V, Qvist J, Mjör IA. Placement and longevity of tooth-colored restorations in Denmark. Acta Odontol Scand 1990;48: 305–11.
9. Jokstad A, Mjör IA, Qvist V. The age of restorations in situ. Acta Odontol Scand 1994;52:234–42.
10. Mjör IA, Åsenden R. Årsaker til revisjon av amalgamfyllinger i Oslo offentlige tannhelsetjeneste. Nor Tannlaegeforen Tid 1986; 96:109–12.
11. Dunston KR, Milgrom P, Law D, Donifo PK. Practitioner-based evaluation criteria for dental education. J Dent Child 1978;45: 207–12.
12. Qvist V, Laureberg L, Poulsen A, Teglers PT. Longevity and cariostatic effects of everyday conventional glass-ionomer and amalgam restorations in primary teeth: three-year results. J Dent Res 1997;76:1387–96.
13. Hickel R, Manhart J. Glass-ionomers and compomers in pediatric dentistry. In: Davidson CL, Mjör IA, editors. Glass-ionomer cements. Chicago: Quintessence Publ. Co., Inc.; 1999. p. 201–26.
14. Hickel R, Voss A. A comparison of glass cermet cement and amalgam restorations in primary molars. J Dent Child 1990;57: 184–8.
15. Welburg RR, Walls AW, Murry JJ, McCabe JF. The 5-year results of a clinical trial comparing a glass polyalkenoate (ionomer) cement restoration with an amalgam restoration. Br Dent J 1991;170:177–81.
16. Östlund J, Möller K, Kock G. Amalgam, composite resin and glass ionomer cement in class II restorations in primary molars—a three-year clinical evaluation. Swed Dent J 1992;16:81–6.
17. Mjör IA, Moorhead JE, Dahl JE. Selection of restorative materials in permanent teeth in general dental practice. Acta Odontol Scand 1999;57:257–62.
18. Mjör IA, Moorhead JE. Selection of restorative materials, reasons for replacement and longevity of restorations in Florida. J Am Coll Dent 1998;65:27–33.
19. Burke FJT, Cheung SW, Mjör IA, Wilson NHF. Reasons for the placement and replacement of restorations by vocational dental practitioners and their trainers in the United Kingdom. Quintessence Int 1999;30:234–42.
20. Letzel H, van't Hof MA, Brijhoef MMA, Marshall GW, Marshall SJ. Failure, survival, and reasons for replacement of amalgam restorations. In: Anusavice KJ, editor. Quality evaluation of dental restorations. Chicago: Quintessence Publ. Co., Inc.; 1989. p. 83–92.
21. Martin JA, Bader JD. Five-year treatment outcomes for teeth with large amalgams and crowns. Oper Dent 1997;22:72–8.
22. Mjör IA. The reasons for replacement and the age of failed restorations in general dental practice. Acta Odontol Scand 1997;55:58–68.
23. Mjör IA, Dahl JE, Moorhead JE. The age of replaced restorations in permanent teeth in general practice. Acta Odontol Scand 2000;58:97–101.

Received for publication 26 March 2001
Accepted 10 July 2001