# Selection of restorative materials in general dental practice in Sweden

Ivar A. Mjör
Department of Operative Dentistry, College of Dentistry, University of Florida, Gainesville, Florida, USA

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The aim of this study was to record any differences in the selection of materials in private dental practices in Sweden during 1993–95, after a ban on amalgam had been proposed by politicians, compared with those obtained in a similar survey in 1978–79. A total of 177 clinicians participated in the present survey, which recorded the total number of restorations they placed and the number of composite, amalgam, and glass ionomers inserted in the treatment of primary caries and for replacement of restorations. Furthermore, the number of intact amalgam restorations replaced by composite and the number and types of inlays and laminates cemented were accounted for. Marked changes in the selection of direct restorative materials were noted in the present study compared with the survey in 1978–79. Resin-based composite materials are taking over as the routine posterior restorative material, also in stress-bearing areas. Glass ionomer restorative materials are used preferentially in the treatment of primary caries. The use of amalgam restorations has decreased in relative and absolute numbers. Inlays are infrequently used but, when used, usually include three or more surfaces, and ceramic materials predominate. □ *Amalgam; clinical survey; composite; glass ionomer materials; operative dentistry*

*Ivar A. Mjör, Department of Operative Dentistry, University of Florida College of Dentistry, P.O. Box 100415, Gainesville, FL 32610–0415, USA*

Restorative dentistry in Sweden has faced a unique situation during the last few years in that politicians proposed the banning of dental amalgam, the most commonly used dental restorative material. Government legislation to this effect is pending, but some county health authorities have already instituted such a ban for the local Public Dental Health Service. The reason for the proposed political ban of dental amalgam has been to reduce or eliminate the use of mercury in all areas, including dentistry, to prevent pollution of the environment. However, the mass media have also focused on biologic side effects on patients who have amalgam restorations, despite assurance from authorities that all restorative materials in present use are safe and effective (1–3).

The present study was initiated to assess any effects of the pending legislation, of the mass media attention, or any other causes on the selection of direct restorative materials in private general dental practice. Data from the same organization of general practitioners (Praktikertjänst AB, Stockholm, Sweden) had been collected during 1978/79 (4–6). Therefore, attention was paid to the collection of data that would enable comparison with those obtained about 16 years previously. Furthermore, the present survey was designed to evaluate any differentiation in the selection of direct restorative material for the treatment of primary caries. In addition, the survey included specific questions related to the replacement of amalgam restorations by other materials even if the restoration had not failed.

## Materials and methods

All clinicians involved in the survey treated adult patients in general dental practices. They had signed up for a 3-year program in continuing dental education during 1993–95, including a course in restorative dentistry. In order not to overburden the participants, each practitioner was sent one of two sets of survey forms as part of the course material. Group I received forms requesting information on the following restoration factors: the total number of restorations placed, irrespective of type, except crowns and bridges; the number of composite restorations placed in the treatment of primary caries; the number of composite restorations replaced for various reasons; types of composite restorations placed; and types of inlays and laminates placed.

Dentists in group II received forms requesting information on the following factors: the total number of restorations placed, irrespective of type, except crowns and bridges; the number of amalgam restorations placed, irrespective of type, in the treatment of primary caries; the number of amalgam restorations replaced for various reasons; the number of intact amalgam restorations changed because of the change per se; the number of glass ionomer restorations placed in the treatment of primary caries; and the number of glass ionomer restorations replaced for various reasons.

The dentists were instructed to complete the registrations in a defined 2-week period about 2 months

Table 1. Total number and percentages of composite, amalgam, and glass ionomer restorations in groups I and II

| | *n* | % |
|---|---|---|
| Composite | 3450 | 60 |
| Amalgam | 1244 | 21 |
| Glass ionomer | 1085 | 19 |
| Total | 5779 | 100 |

before attending the continuing education course, so that the results could be summarized and presented to the group. A total of 249 clinicians in general dental practice participated in the 3-year program in continuing dental education, two groups each year from 1993 to 1995. An equal number of forms for group I and group II had been sent out randomly.

Some of the returned forms were incomplete; for example, a few clinicians had misunderstood the request for separate recording of all restorations placed and the composite or amalgam and glass ionomer restorations specified on the form. These forms were omitted in the calculation of the proportion of composite, amalgam, and glass ionomer restorations in groups I and II.

The results related to the selection of restorative materials for the treatment of primary caries were statistically analyzed by using a random-effect logistic regression model clustering on dentists, using an epidemiologic statistical software package (ERGET, CERC, Seattle, Wash., USA). Odds ratios (OR) were calculated—that is, the odds of using one particular material in the treatment of primary caries versus the use of another material. If the OR is near one, there is no association. A ratio higher than one proves an association is established. If the OR is less than one, an inverse or negative association has been established. *P* values < 0.001 will be referred to as statistically significant.

A comparison of results from those obtained in 1978–79 (4–6) will be made, although it was not possible to verify these comparisons statistically because the original raw data are no longer available.

## Results

A total of 177 clinicians participated in the survey, for a response rate of 71%; 99 in group I, for a response rate of 79%, reported on composite restorations, and 78 in group II, for a response rate of 62%, reported on amalgam and glass ionomer restorations. A total of 8061 restorations had been inserted, 4478 in group I and 3583 in group II. Only the composite restorations in group I ($n = 3450$) and the amalgam and glass ionomer restorations in group II, totaling 2329 restorations, included details related to selection of material for the treatment of primary caries and in the treatment of failed restorations.

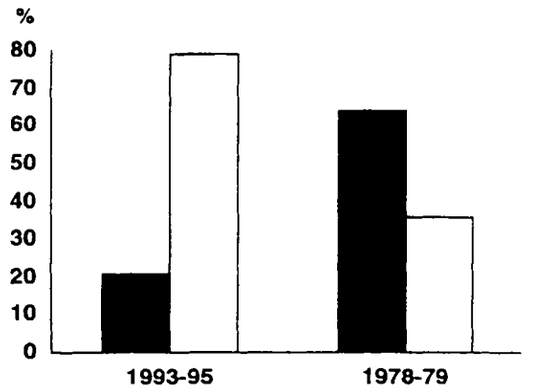


Fig. 1. The choice of direct restorative materials expressed as a percentage of tooth-colored (composite and glass ionomer) materials (white bars) and of amalgam (gray bars) in the 1993–95 survey and as a percentage of amalgam and tooth-colored (mainly composite, but including a few silicate cement) materials in the 1978–79 survey.

In group I, composite restorations comprised 77% of all restorations inserted. For group II, amalgam restorations made up 35% of all restorations placed, and glass ionomer restorations 30%. Thus, a skewed distribution of the restorative materials selected by the clinicians in groups I and II was noted. A few clinicians categorically stated that they did not use dental amalgam any more. When all the inserted composite, amalgam, and glass ionomer restorations in groups I and II are considered together, their distribution is as outlined in Table 1. A marked change in the use of direct restorative materials had occurred since 1978–79 (Fig. 1).

The proportion of amalgam, composite, and glass ionomer materials used for initial restorations in the treatment of primary caries and for replacement of restorations is shown in Fig. 2. The odds of a glass ionomer restoration being placed in the treatment of primary caries were significantly greater than those for

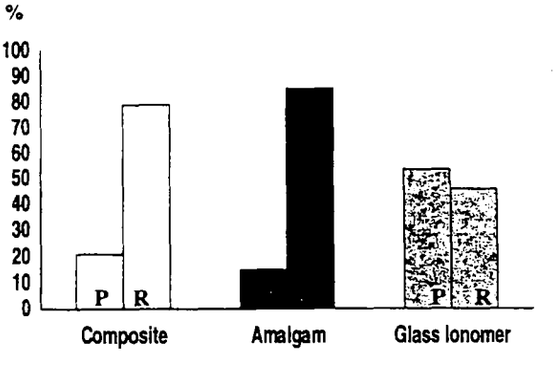


Fig. 2. The selection of direct restorative materials, expressed as percentages used to treat primary caries (P) and for replacement (R) of failed restorations, irrespective of the type of restoration inserted.

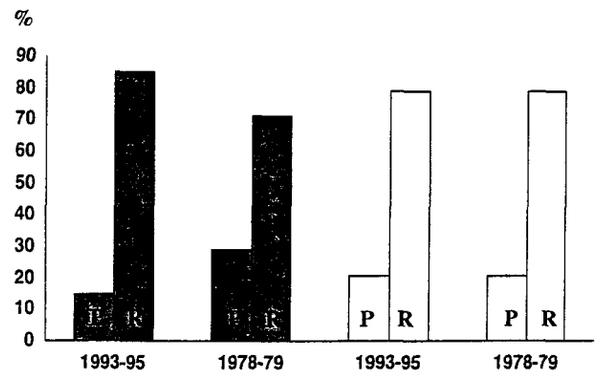


Fig. 3. A comparison of the selection of amalgam (gray bars) and composite (white bars) restorations expressed as percentages used in the treatment of primary caries (P) and for replacement (R) of failed restorations reported in the 1993–95 and the 1978–79 surveys.

an amalgam (OR = 6.9788) or a composite (OR = 4.082) restoration. The odds of a composite restoration being placed rather than an amalgam in the treatment of primary caries (OR = 1.972) are also significant. The great majority of amalgam and composite restorations were replacements of failed restorations, but 11% of the composite restorations inserted were associated with a change from amalgam, the change per se being the reason for replacement.

Glass ionomer restorations were not recorded in 1978–79, but a comparison between the proportion of composite and amalgam restorations in 1978–79 and 1993–95 indicated no change in the selection of composite materials in the treatment of primary caries. However, a smaller percentage of amalgam restorations was used in the treatment of primary caries in 1993–95 than in 1978–79 (Fig. 3). The class of restorations inserted was only recorded for composite restorations. Almost half of all composite restorations were placed in stress-bearing locations: 15% in class I, 32% in class II, and 9% in class IV. Class-III restorations comprised 19%, and class-V 24%.

Group I also reported on indirect restoration, and a total of 193 inlays, 4.3% of all restorations inserted, and 29 ceramic veneers were cemented. Ceramic inlays were by far the commonest (78%), whereas 21% were gold inlays. About two-thirds of all inlays covered three or more surfaces. Only 43 of the 99 clinicians had used indirect restorations, and 5 of these inserted about a third of all inlays. One clinician inserted almost a third of the gold inlays. Of all inlays, 43% were in teeth with previous amalgam restorations.

## Discussion

Since clinicians from the same organization of private practitioners who had signed up for continuing education courses participated in the 1978–79 ($n$ = 85) and 1993–95 ($n$ = 177) surveys, a comparison of the findings seems justified. The surveys show that marked changes have occurred in the use of direct restorative materials in Swedish general dental practices over the past 15–20 years. Similar changes have been noted by the Public Dental Health Service (Sundberg, 1996; unpublished observations). Many factors may have led to these changes, such as an altered situation in caries prevalence, availability of new and/or improved restorative materials, and the 'amalgam issue', caused by the proposed ban on the use of amalgam. Strong marketing of tooth-colored restorations may also have affected the move towards a 'white era' in operative dentistry. Judging by the low number of inlays inserted and the fact that almost half the composites placed are now class-I or class-II restorations, it appears clear that resin-based composite materials are taking over as the routine posterior restorative material. The 11% change from amalgam to composite in group I, in which the change per se and not the failure of the previous restoration was the reason for placing a composite, points in the same direction.

In the 1978–79 survey glass ionomer materials were not included because they were not in common use. In fact, silicate cement was still in use as an anterior restorative materials by a few clinicians at that time. At present, about four of five directly placed restorations are tooth-colored, whereas only one of three was tooth-colored in 1978–79. The use of amalgam has in this relatively short time changed from almost two of three restorations in 1978–79 to one of five in 1993–95.

A comparison of the reports by the clinicians in group I and those in group II shows a skewed distribution of the restorative materials used. Ideally, the percentage of composite restorations in group I should be the same as the difference between all restorations and those comprising amalgam and glass ionomer restorations in group II. Since an equal number of the two forms were randomly sent to those who had signed up for the continuing education courses, it may be speculated that a selective and elective participation by the clinicians in the two groups may have occurred; that is, relatively more clinicians favoring composite restorations participated in group I, and those favoring amalgam restorations participated in group II. As resin-based composite materials at present are the most commonly used material in Sweden, the greater response rate in group I than in group II may furnish support to this speculation. Conversely, clinicians in group II focusing on amalgam, the old-fashioned, soon-to-be-banned material, had a low response rate, which may reflect a hesitation by the clinicians to report on amalgam. Discussions with the participants during the continuing education courses lent support to these reasons for the skewed distribution of the responses. However, the representativeness of the results for all practitioners in Sweden cannot be ascertained, and the pooled results from all restorations inserted in groups I and II (Table

1) may, therefore, not be a fair presentation of the situation in Sweden.

The present common use of composite materials in stress-bearing restorations in Sweden contrasts with that in Denmark reported in 1987–88 (7), in Italy (8), in Korea, (9) and in the UK (Wilson, Burke and Mjör, 1996; unpublished observations). The short longevity of the resin-based materials, especially in posterior teeth (7, 10–13), undoubtedly will have an effect on the long-term cost of restorative therapy (14, 15).

The choice of restorative material for the treatment of primary caries indicates a significant preference for glass ionomer materials. The main reason for this selective choice of restorative materials is most likely the release of fluoride from glass ionomer materials, which has been demonstrated in vitro (16–18) and in vivo (19, 20). However, the benefit from this fluoride release has not been documented in general practice, and long-term results are lacking (21). Preliminary results from this study (22) have indicated that the clinical diagnosis of secondary caries is by far the commonest reason for replacement of glass ionomer restorations, a finding that is confirmed in the evaluation of the entire material (23). Clinical experience from an operative dentistry clinic in Belgium also indicates that glass ionomer restorative materials do not prevent the development of secondary caries (21). These observations are consistent with the findings of van Dijken et al. (24), who found that the fluoride levels in dental plaque on 1-year-old glass ionomer restorations were not high enough to inhibit accumulation of *Streptococcus mutans* and lactobacilli.

Indirect restorations were reported by group I in the present survey, and they comprised only 4.3% of the total number of restorations. More than half the clinicians had not placed any inlays. Most of the inlays were restorations covering three or more surfaces. Ceramic was by far the commonest inlay material used, and most of these were placed by a limited number of clinicians. The same trend was observed for gold inlays in that one clinician had a marked effect on the total number of gold inlays. Thus, it appears as if indirect restorations are becoming a subspecialty of operative dentistry practiced by only a few clinicians in Sweden. It is likely that the selection of ceramic materials for inlays is associated with esthetic concerns, despite the uncertainty about their longevity (25, 26) and the lack of practical teaching programs in the use of ceramic restorations in Scandinavia, including Sweden (27). Recent longevity studies by Roulet & Kanzler (29) suggest, however, that the use of new cementing materials is an important factor in the longevity of the inlays, a factor that has also been stressed by Toreskog & Rehnberg (28). The preliminary longevity data on adhesively luted ceramic inlays are encouraging (29), but more long-term studies are needed.

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## References

1. MFR Medicinska Forskningsrådet. Potential biological consequences of alternatives to dental amalgam. Proceedings of a State-of-the-Art Conference. Stockholm: Swedish Medical Research Council, 1992.
2. NIDR/NIH. Effects and side-effects of dental restorative materials. Proceedings of an NIH Technology Assessment Conference. Adv Dent Res 1992;6:1–144.
3. U.S. Department of Health and Human Services. Dental amalgam: a scientific review and recommended public health service strategy for research, education and regulation. Washington (DC): U.S. Department of Health and Human Services, 1993.
4. Mjör IA. Orsaker till revision av fyllningar. Tandlakartidn 1979; 71:552–6.
5. Mjör IA. Revision av fyllningar. Tandlakartidn 1980;72:375–80.
6. Mjör IA. Placement and replacement of restorations. Oper Dent 1981;6:49–54.
7. Qvist V, Qvist J, Mjör IA. Placement and longevity of tooth-colored restorations in Denmark. Acta Odontol Scand 1990;48: 305–11.
8. Mjör IA, Toffenetti F. Placement and replacement of resin based composite restorations in Italy. Oper Dent 1992;17:82–5.
9. Mjör IA, Um CM. Survey of amalgam and composite restorations in Korea. Int Dent J 1993;43:311–6.
10. Hendriks FHJ. Posterior composite restorations [thesis]. Nijmegen: University of Nijmegen, 1985.
11. Moffa JP. Comparative performance of amalgam and composite resin restorations and criteria for their use. In: Anusavice KJ, editor. Quality evaluation of dental restorations. Chicago: Quintessence Publ. Co., 1989:125–33.
12. Friedl K-H, Hiller K-A, Schmalz, G. Placement and replacement of compositer restorations in Germany. Oper Dent 1995;20: 34–8.
13. Mjör IA, Wilson NHF, Burke FJT. The relative cost of different restorations in the UK. Br Dent J 1996. In press.
14. Mjör IA. The long term cost of restorative therapy using different materials. Scand J Dent Res 1992;100:60–5.
15. Mjör IA. Problems and benefits associated with restorative materials. Side effects and cost-benefit analysis. Adv Dent Res 1992;6:7–16.
16. Forsten L. Fluoride release from a glass ionomer cement. Scand J Dent Res 1977;85:503–4.
17. Tveit AB, Gjerdet NR. Fluoride release from a fluoride-containing amalgam, a glass ionomer cement and a silicate cement in artificial saliva. J Oral Rehabil 1981;8:237–41.
18. Forss H. Effect of glass-ionomer cement *in vitro* and in the oral environment [thesis]. Kuopio: University of Kuopio, 1993.
19. Hattab FN, El-Mowafy OM, Salem NS, El-Badrawy WAG. An *in vivo* study on the release of fluoride from glass-ionomer cement. Quintessence Int 1991;22:221–4.
20. Koch G, Hatiboric-Kofman G. Glass ionomer cements as a fluoride release system *in vivo*. Swed Dent J 1990;14:267–73.
21. De Moor R. Evaluation of the long-term fluoride release of self-curing glass ionomer cements [thesis]. Ghent: University of Ghent, 1995.
22. Mjör IA. Glass ionomer restorations and secondary caries. A preliminary report. Quintessence Int 1996; 27:171–4.
23. Mjör IA. The reasons for replacement and the age of failed restorations in general dental practice. Acta Odontol Scand 1997;55:58–63.
24. van Dijken J, Persson S, Sjöström S. Presence of *Streptococcus*

*mutans* and lactobacilli in saliva and on enamel, glass ionomer cement, and composite resin surfaces. Scand J Dent Res 1991;99: 13–9.
25. Roulet J-F, Herder S. Ceramic inlays: an alternative for esthetic restorations in posterior teeth. J Fla Dent Assoc 1990;2:3c–6c.
26. Christensen R, Christensen G, Vogl S, Bagerter V. 2-year clinical comparison of 6 inlay systems. J Dent Res 1991;70(Spec issue):561 (abstract 2360).
27. Jokstad A, Mjör IA, Frazier KB. The teaching of all-ceramic restorations in Scandinavian dental schools: a survey. Acta Odontol Scand 1996;54:200–4.
28. Toreskog S, Rehnberg P. Vävnadsbevarande estetisk tandbehandling. En handbok i visioner. Solna: LIC Förlag, 1993. (English translation: Stockholm: Rehnberg Förlag, 1995).
29. Roulet J-F, Kanzler R. Longevity and margin quality of adhesively luted sintered ceramic inlays. J Dent Res 1996; 75(Spec issue):147 (abstract 1037).

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