Clinical evaluation of preventive and class-I composite resin restorations

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This study was initiated in 1986 in response to increased interest in restorative procedures favoring preservation of tooth substance and in the search for alternatives to dental amalgams. Eighty-seven preventive resin restorations in permanent molars and 35 occlusal composite resin restorations in primary molars (limited size) and 13 in premolars were followed up for 2 years. They were placed by a large number of operators, mainly dental students under supervision, and rated by five calibrated instructors in accordance with an internationally accepted system for the evaluation of the clinical performance of dental materials. One composite resin (Occlusin) was used. A survival model was used to calculate the cumulative theoretical number of successful treatments of children who had dropped out. For none of the 6 clinical variables was the success rate lower than 91%, and only 3 of 26 failures were of a nature requiring remake or correction. The failures occurred, with a few exceptions, during the 1st year of observation. The two types of restoration have thus proved to be efficient treatments fulfilling all reasonable requirements in modern operative dentistry. □ *Composite resin; occlusal prevention; sealant*

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Two major biologic concepts favoring increased use of composite resins in restorative dentistry have been launched over the past decade; the first stressed the importance of avoiding unnecessary loss of sound tooth substance, and the second, the search for alternatives to dental amalgams. No operative intervention seems to meet these requirements more adequately than the preventive resin restoration. Some of the first positive reports from long-term studies were published by Raadal (1) and Simonsen (2). The treatment is designed for early caries lesions in pits and fissures, with removal of carious tissue in enamel and dentin and insertion of a composite resin, followed by application of a sealant, which covers all remaining pits and fissures (3).

Composite resin has also been advocated as an alternative to dental amalgams for certain specified situations by an expert group at the National Swedish Board of Health and Welfare (4). One of these situations is class-I restorations of limited size, with moderate mechanical stress on the occlusal surface.

The aim of the present investigation was to evaluate the clinical performance of a composite resin material over a 2-year period on the above premises, using internationally accepted criteria.

Materials and methods

The study started in December 1986 as a community trial-like efficiency study comprising a large number of operators and observers and ended in May 1990. It was designed as a prospective observational investigation, in which the restorations were followed up for 2 years after insertion.

Subjects and types of treatment

The patient group comprised 111 children, aged 5 to 14 years, under treatment at the Department of Pedodontics, School of Dentistry, Malmö. Most of them were treated by dental students under the supervision of five instructors. Occasionally, the whole treat-

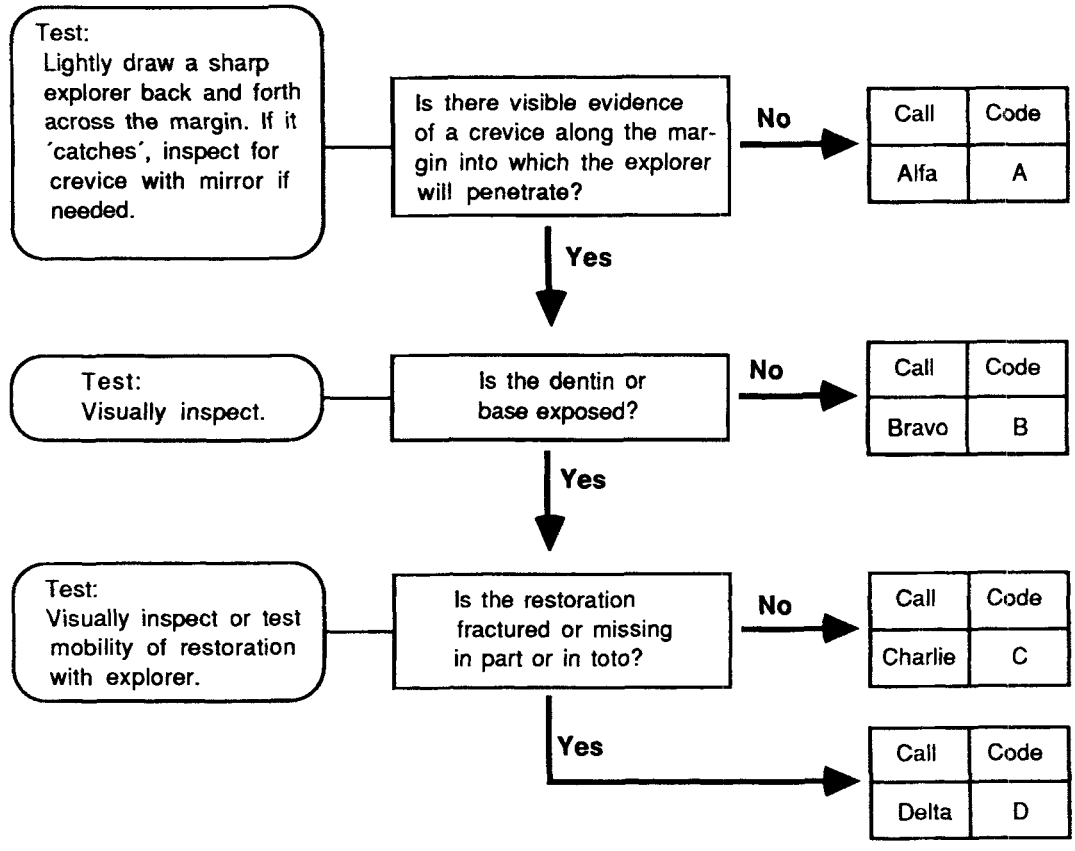

Fig. 1. Rating system and criteria for margin adaption in accordance with Ryge (5).

ment was performed by an instructor. The original number of restorations was 141. Three types of treatment were included in the study: I) preventive resin restorations in permanent molars; II) occlusal composite resin restorations of limited size in primary molars; and III) occlusal composite resin restorations in premolars.

Cavity preparation and composite resin technique

The operative intervention in connection with preventive resin restorations in permanent molars was strictly limited to the decayed area of the teeth. Conventional occlusal restorations in primary molars and premolars included the main fissure system of the tooth—that is, fissures prone to caries. The depth of the cavity preparation was determined by the size of the carious lesions. In non-carious parts of the fissures the preparation was restricted to the enamel—that is, the floor of the fissures. In all types of treatment undermined enamel was removed, exposed dentin lined, and undercuts avoided. Enamel margins were acid-etched but not beveled. A saliva ejector and cotton rolls were used to prevent the teeth from being contaminated with saliva.

The composite resin used was Occlusin (ICI, Imperial Chemical Industries PLC, Pharmaceutical Division, Macclesfield, Cheshire, England). Recommendations in the company's brochures for treatment of the material were followed. A Luxor light

polymerization unit (ICI) was used for curing. The sealant was the chemically cured Delton (Johnson & Johnson Consumer Products, Inc., New Brunswick, N.J., USA).

The composite resin and the sealant were carefully reduced in height to avoid occlusal interference, with attendant traumatic wear and fracture, particularly of the sealant. The sealant did not cover the composite.

Number of restorations, observation periods, and diagnostic methods

The final material consisted of 135 restorations, 87 in group I (67 first and 20 second

Table 1. Clinical performance of preventive resin restorations in permanent molars (I) and occlusal composite resin restorations in primary molars (II) rated in accordance with Ryge (5, 6)

	Observation time in months after treatment	No. of teeth followed up in the interval	No. of failures in the interval	No. of dropped-out teeth in the interval	Cumulative theoretical no. of successful treatments of dropped-out teeth	Proportion successful treatments
Margin adaptation						
I	6	87	2	0	0	0.98
	12	75	2	10	9.7	0.95
	24	66	1	7	16.4	0.94
II	6	35	1	0	0	0.97
	12	30	1	4	3.9	0.94
	24	18	0	11	14.9	0.94
Anatomic form						
I	6	86	1	0	0	0.99
	12	75	1	10	9.9	0.98
	24	67	0	7	16.9	0.98
II	6	35	0	0	0	1.00
	12	31	0	4	4	1.00
	24	18	0	13	17	1.00
Caries						
I	6	86	0	0	0	1.00
	12	76	1	10	9.9	0.99
	24	68	0	7	16.9	0.99
II	6	35	0	0	0	1.00
	12	31	0	4	4	1.00
	24	18	0	13	17	1.00
Color match						
I	6	86	4	0	0	0.95
	12	72	2	10	9.7	0.93
	24	64	0	6	15.7	0.93
II	6	35	1	0	0	0.97
	12	30	1	4	3.9	0.94
	24	18	0	11	14.9	0.94
Margin discoloration						
I	6	86	2	0	0	0.98
	12	74	3	10	9.6	0.94
	24	65	0	6	15.6	0.94
II	6	35	1	0	0	0.97
	12	30	2	4	3.7	0.91
	24	15	0	13	16.7	0.91
Surface structure						
I	6	86	0	0	0	1.00
	12	75	0	11	11	1.00
	24	68	0	7	18	1.00
II	6	35	0	0	0	1.00
	12	31	0	4	4	1.00
	24	18	0	13	17	1.00

molars), 35 in group II (5 first and 30 second molars), and 13 in group III. They were examined after 6, 12, and 24 months in accordance with the rating systems and criteria of Ryge (5) for evaluation of the clinical performance of restorative materials in clinical research. The variables are margin adaptation, anatomic form, caries, color match, and cavosurface margin discoloration. A sixth variable, surface structure, was added on the basis of the ratings system and criteria for the assessment of clinical quality and professional performance (6).

The examinations were performed by instructors calibrated to achieve at least an 80% inter-examiner agreement for independent ratings. The rating system and criteria are shown for one factor (margin adaption) in Fig. 1. All restorations met the Alfa criterion at base line, except for color match, for which Bravo could be accepted. All departures from the base-line ratings at the follow-ups were considered failures.

Data analysis

Five restorations in group I were discarded before the final analysis because single properties 'improved' during the course of the trial: one for margin adaptation, one for anatomic form, and three for color match. Obviously, there had been disagreement between the observers, which could not be corrected for at a later occasion. One restoration in group II was also excluded on account of therapeutic interference with regard to anatomic form.

Thirty-eight teeth dropped out during the trial. In most cases this was due to shedding of the teeth or to the child moving from the area. A few individuals did not show up in spite of repeated calls.

The dropouts were handled in accordance with a survival model (7); that is, a cumulative theoretical number of successful treatments of dropped-out teeth was calculated:

$$\frac{\text{Successful treatments during the observation period}}{\text{Teeth followed throughout the observation period}} \times \text{Theoretically successful treatments from foregoing interval + dropped-out teeth during the observation period}$$

The model assumes that the frequency of failure among the drop-outs should be the same as among the observed cases within the interval.

Example from Table 1, margin adaptation, group I, third interval: $(65/66) \times (9.7^* + 7) = 16.4$; $^*9.7 = (73/75) \times 10$. The proportion of successful treatments is thus $(65 + 16.4)/87 = 0.94$.

Results

The results for groups I and II are presented in Table 1. In no interval was the final success rate lower than 93% (color match) in group I. The corresponding figure for group II was 91%.

The types of failure are shown in Table 2. The single Delta for margin adaptation in group I occurred during the first interval, so the restoration could not be rated for any of the other variables. The two Charlies, for margin adaptation and anatomic form, in group I were both diagnosed during the second interval.

No failures were detected in group III. Thus the success rate was 100%, taking into account four dropouts, two during the second interval and two during the third.

Discussion

The results clearly show that the preventive resin restoration is a successful treatment of early occlusal caries lesions in permanent molars. This conclusion is supported by the fact that only three failures were registered below the level of Bravo (Table 2). Bravo implies that the defect should be kept under observation, whereas Charlie and Delta indicate that the treatments have to be remade or corrected, those rated Delta immediately.

Table 2. Distribution of failures among 87 preventive resin restorations in permanent molars (I) and 35 conventional occlusal composite resin restorations (II) observed for 2 years, rated in accordance with Ryge (5, 6)

	Code	Margin adaptation	Anatomic form	Caries	Color match	Margin discoloration	Surface structure
I	B	3	1	1	6	5	
	C	1	1	—*			
	D	1	—	—	—	—	—
II	B	2			2	3	
	C			—			
	D		—	—	—	—	—

* The rating level is not included in the criteria.

Several review articles have recommended preventive resin restorations for the situations specified in the introduction (8–10). The study that most resembles ours was published in 1990 by Walker et al. (11). Since 1981 about 330 preventive restorations had been placed and checked at recall examinations at a university clinic. The observation time ranged from 4 months to 5.5 years, with a weighted mean of 15.7 months. The composite resin and the sealant were evaluated separately. The sealant material was intact in nearly 82% of the cases. The composite resin was rated Alfa for margin adaptation, anatomic form, and color match in over 98%. When making comparisons, it should be emphasized that in our study the restoration was rated as a whole. This means that the success rate for the sealing was certainly very high, which probably should be ascribed mainly to the careful occlusal check and a meticulous utilization of the acid etch technique.

Welbury et al. (12) compared a minimal composite resin restoration with an amalgam restoration in 150 pairs of permanent molars in a 5-year follow-up study. The amalgam restoration occupied, on an average, 25% of the occlusal surface, compared with 5% for the minimal composite restoration. Eleven amalgams and eight composites failed. Some minor deteriorations occurred in both types of restoration. There were no significant differences between the median survival times of the restorations, but 49 of the composites needed repair of the sealant. The authors underscore that the minimal composite restoration involves less destruction of tooth tissue.

The composite resin restorations of limited size in primary molars displayed a pattern similar to the preventive resin restoration, with no failure below Bravo. All premolar restorations were rated Alfa. These two groups were, however, rather small.

A strength of the present study is that the restorations were placed by a large number of operators, mainly 4th-year dental students under supervision. A weakness, on the other hand, is that only one composite resin was used. There is little probability, however, that frequency figures would be notably different with other certified composite resins.

In summary, the present study has shown a high success rate over a 2-year period for both preventive resin restorations and composite resin restorations in occlusal cavities of limited size. To our knowledge, such results have not been obtained for dental amalgams under similar conditions. We therefore urge an increased use of sealants and composite resins on the above premises, being aware that their unrestricted use for stress-bearing posterior restorations is not recommended (13).

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