PEDIATRIC DENTISTRY/Copyright © 1990 by
The American Academy of Pediatric Dentistry
Volume 12, Number 1

# Assessment of marginal leakage around Class II composite restorations in retrieved primary molars

Anna B. Fuks, CD Aubrey Chosack, BDS (Rand), MSD
Eliezer Eidelman, Dr Odont, MSD

## Abstract

*The aim of the present investigation was to evaluate, by means of dye penetration, the microleakage around Class II composite restorations, in retrieved primary molars that functioned in the mouth for at least one year. The experimental material consisted of 13 exfoliated primary molars that had been restored with Herculite® (Kerr Corporation, Romulus, Michigan 48174 USA) at least one year previously, utilizing an incremental or a bulk filling technique.*

*The retrieved teeth were insulated with utility wax and nail polish, immersed in 2% basic fuchsin, embedded in acrylic resin, and ground off to various depths. The marginal leakage was assessed according the degree of dye penetration at the occlusal and cervical margins.*

*No difference was observed between the two filling techniques. In most teeth, no leakage at the occlusal margins was observed; minimal leakage, limited to the enamel, was observed at the occlusal margins of two teeth, one of each filling technique. Severe penetration was evident at the cervical margin of three restorations, two of them filled incrementally and the third using the bulk technique. Mild to moderate penetration was observed at the cervical margin in the majority of the other restorations.*

*It was concluded that an incremental filling technique could not eliminate microleakage at the cervical margins of Class II composite restorations.*

## Introduction

Several "posterior composites" have become available in recent years. However, their application for Class II restorations has not been fully accepted. Poor sealing of the margins is a major problem of these materials (Browne and Tobias 1986; Moore and Vann 1986a; Moore and Vann 1986b) occurring to a greater extent at the gingival margin (Lui et al. 1987). Gaps may appear at the tooth-resin interface as a result of polymerization shrinkage of the setting resin (Jensen and Chan 1985). These gaps are subsequently affected by other factors such as masticatory forces (Erickson and Jensen 1986), thermal changes, and water sorption.

Several methods have been suggested to decrease marginal leakage, such as beveling the cavosurface enamel (Moore and Vann 1986a; Moore and Vann 1986b), application of dentin adhesive agents, or filling the cavity incrementally (Donly and Jensen 1986; Leclaire et al. 1986).

The penetration of a dye, one of the oldest techniques available, has been utilized widely in several in vitro studies to assess microleakage (Fuks and Shey 1983; Fuks et al. 1984; Fuks et al. 1986; Holan et al. 1986). Other techniques, such as silver nitrate, air pressure, and radioactive isotopes, also have been employed (Fuks and Shey 1983). Recently, no differences were found when these techniques for measuring marginal leakage were evaluated (Strange and Hembree 1987).

Thermocycling is performed in in vitro studies in an attempt to simulate the in vivo conditions. However, in addition to temperature changes, restorative materials are subjected, among others, to masticatory forces (Erickson and Jensen 1986). In vitro simulation of in vivo conditions is difficult, if not impossible, and the conclusions are questionable.

The aim of the present investigation was to evaluate the microleakage around Class II composite restorations, utilizing two filling techniques, in retrieved primary molars.

The microleakage assessment, although done as an in vitro study, had the benefit of the preparation of the teeth for staining in vivo, with natural thermal changes and stresses of normal function in the mouth for at least one year. This eliminated the need for thermocycling, usually done in in vitro experiments.

## Materials and Methods

The experimental material consisted of 13 exfoliated primary molars restored with Herculite one year previously.

The retrieved teeth were part of a comprehensive study in which 60 primary molars had been restored with the mentioned composite resin using either a bulk or an incremental filling technique, and had been assessed clinically and radiographically after one year. Visual and tactile assessment of 16 proximal surfaces of the 13 retrieved teeth (three had MOD fillings) also had been done (Eidelman et al. 1989).

The furcation area of the 13 teeth and any eventual root remnants were insulated with IRM and triple-coated with a layer of varnish, melted utility wax, and a second layer of varnish, excluding the restoration and approximately 0.5–1 mm of the surrounding enamel margin (Holan et al. 1986). The coated teeth then were immersed in a 2% solution of basic fuchsin for 24 hr. After removal from the dye, the coatings were peeled off the teeth, washed thoroughly in water, and embedded in acrylic resin. Longitudinal mesiodistal sections were obtained by grinding off the embedded teeth. The sections were polished and blindly examined by the senior author, as described before (Holan et al. 1986). No replication was performed, since the reliability of this technique was assessed in previous works, and inter- and intraexaminer agreement was found to be more than 96% (Fisbein et al. 1988; Koenigsberg et al. 1988). Grinding and polishing was repeated to allow four to five observations of each restoration. The depth of dye penetration was considered as an indicator of marginal leakage. Six degrees of leakage were distinguished, utilizing a standardized system suggested by Going et al. (1960) and modified by Fuks and Shey (1983).

Degrees of leakage at the occlusal margin and at the cervical margin are represented by Arabic and Roman numerals, respectively.

Degree 0: No penetration of dye
Degree 1 or I: Penetration of dye along the occlusal or gingival wall limited to the enamel
Degree 2 or II: Penetration of dye along the entire length of the occlusal or gingival wall but not along the pulpal wall
Degree 3 or III: Penetration of dye along the pulpal wall
Degree 4 or IV: Diffusion of the dye into the dentin under the pulpal wall
Degree 5 or V: Penetration of dye through the dentin into the pulp chamber.

Every section was rated separately for the occlusal and cervical margins. The highest rating for each margin of the four or five observations was taken as the final score of the evaluated margin.

## Results

Leakage at the margins was assessed from the degree of dye penetration in the sections. No difference was observed between the two filling techniques, when the occlusal and cervical surfaces of the two groups were compared. Minimal leakage was observed at the occlusal margin (Degree 1) of two restorations, one from each filling technique group. All the other teeth showed no leakage (Table 1). The opposite was observed at the cervical margins.

Severe penetration of the dye (Degrees IV and V) was evident in three restorations, two of them filled incrementally and the third using the bulk technique (Fig 1). Only restoration of the incremental group showed no leakage, and mild to moderate penetration was observed in all the other restorations (Fig. 2 and Table 1). The differences in dye penetration at the cervical margin of the restorations in both groups had no statistical significance, when analyzed by a Chi-square test.

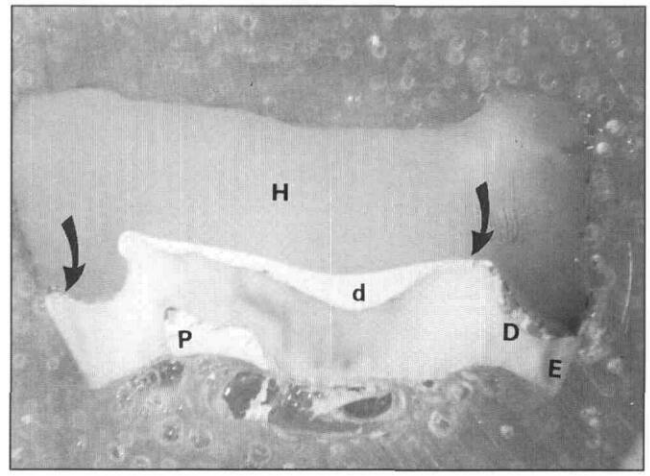


**Fig 1.** Longitudinal section of a retrieved primary molar restored with Herculite. Notice the penetration of the dye to the axial wall (Degree 3) at the distal margin, and through dentin (Degree 2) at the mesial margin. H = Herculite; d = dycal; E = Enamel; D = Dentin; P = Pulp.

## Discussion

The negligible amount of leakage at the occlusal margins observed in the present study reinforces the clinical success rate (Eidelman et al. 1989) and is in agreement with previous reports (Paquette et al. 1983; Oldenburg et al. 1985). Leakage limited to the enamel was observed in 15% of the occlusal margins (two out of 13 examined) when a bonding agent was utilized. These findings are similar to those described by Holan et al. (1986) in an in vitro study, when 16% of the occlusal margins revealed dye penetration when enamel bond was employed.

**Table 1:** Marginal Leakage at the Occlusal and Cervical Margins

| Depth of Dye Penetration | Number of Surfaces Examined | | | |
|---|---|---|---|---|
| | Incremental | | Bulk | |
| | Occlusal | Cervical | Occlusal | Cervical |
| 0 | 7 | 1 | 7 | – |
| 1 or I | 1 | – | 1 | 2 |
| 2 or II | – | 3 | – | 3 |
| 3 or III | – | 2 | – | 2 |
| 4 or IV | – | 1 | – | – |
| 5 or V | – | 1 | – | 1 |
| Total | 8 | 8 | 8 | 8 |
| 0* + 1** | 8 | 1 | 8 | 2 |
| 2+3+4+5*** | 0 | 7 | 0 | 6 |

* No dye penetration; ** penetration of dye limited to enamel; *** penetration of dye into dentin.

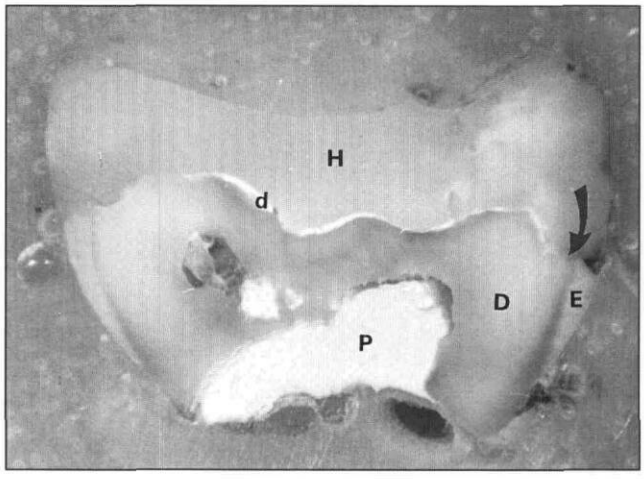


**Fig 2.** Longitudinal section of another retrieved primary molar filled incrementally with Herculite. No penetration of dye is evident at the mesial margin, and minimal leakage (Degree 1) can be observed at the distal margin. H = Herculite; d = dycal; E = Enamel; D = Dentin; P = Pulp.

In a study involving small restorations surrounded by enamel on facial tooth surfaces, smaller microgaps were found after incremental filling than after application of the resin in bulk (Herrin and Berry 1986). An incremental filling technique did not improve the quality of the cervical margin in the present study. This could be due to a combination of factors such as thin enamel, poor adherence of the material at the cervical margin, and the difficulty of condensation of the material to the gingival wall. In addition, polymerization contraction is related directly to marginal leakage, and increases with the size of the restorations. Shrinkage of small restorations in facial surfaces could be of lesser significance than in large Class II restorations.

Donly and Jensen (1986) assessed the stresses created by three different filling techniques during polymerization of posterior resin restorations. They found that a buccolingual filling technique resulted in significantly lower strain values than bulk polymerization, but no significant differences were observed using a gingivoocclusal incremental filling.

In the present study a gingivoocclusal incremental filling technique could not eliminate microleakage at the cervical margins of Class II composite restorations placed in primary molars. Dye penetration was observed in all but one of the cervical margins of all the teeth in both groups.

Dr. Fuks is an associate professor; Dr. Chosack is a professor; and Dr. Eidelman is a professor and chairman; all are from the Department of Pedodontics, Hadassah Faculty of Dental Medicine, Hebrew University, Jerusalem, Israel. Requests for reprints and all other correspondence should be addressed to: Dr. Anna B. Fuks, Department of Pedodontics, Hadassah Faculty of Dental Medicine, Hebrew University, Jerusalem, Israel, P.O.B. 12000.

Browne RM, Tobias RS: Microbial leakage and pulpal inflammation. A review. Endod Dent Traumatol 2:177-83, 1986.

Donly KJ, Jensen ME: Posterior composite polymerization shrinkage in primary teeth: an in vitro comparison of three techniques. Pediatr Dent 8:209-12, 1986.

Eidelman E, Fuks AB, Chosack A: A clinical, radiographic and SEM evaluation of Class II composite restorations in primary teeth. Operative Dent 14:58-63, 1989.

Erickson J, Jensen ME: Effect of pressure cycling on microleakage of composite restoration margins. J Dent Res 65:Abstract 895, 1986.

Fisbein B, Holan G, Grajower J, Fuks AB: The effect of VLC Scotchbond® and an incremental filling technique on leakage around Class II composite restorations. ASDC J Dent Child 55:29-33, 1988.

Fuks AB, Shey Z: In vitro assessment of marginal leakage of combined amalgam-sealant restorations on occlusal surfaces of permanent posterior teeth. ASDC J Dent Child 50:425-29, 1983.

Fuks AB, Grajower R, Shapira J: In vitro assessment of marginal leakage of sealants placed in permanent molars with different etching times. ASDC J Dent Child 51:425-27, 1984.

Fuks AB, Grajower R, Eidelman E: Assessment of marginal leakage of Class II combined amalgam-sealant restorations in primary molars. ASDC J Dent Child 53:343-45, 1986.

Going RE, Massler M, Dute HL: Marginal penetration of dental restorations by different radioactive isotopes. J. Dent Res 39:273-84, 1960.

Herrin HK, Berry EA: Variables affecting the microgap of the enamel-composite interface. J Dent Res 65:Abstract 777, 1986.

Holan G, Fuks AB, Grajower R, Chosack A: In vitro assessment of the effect of Scotchbond® on the marginal leakage of Class II composite restorations in primary molars. ASDC J Dent Child 53:18892, 1986.

Jensen ME, Chan DCN: Polymerization shrinkage and microleakage, in posterior composite resin dental restorative materials, Vannherle and Smith, DC editors, Minnesota Mining Mfg. Co., 1985. St. Paul, MN, pp 243-62.

Koenigsberg S, Fuks A, Grajower R: The effect of three filling techniques on marginal leakage around Class II composite restorations in vitro. Quintessence Int 20:117-121, 1988.

Leclaire CC, Blank LW, Hargrave LW, Pellen GB: A 2-stage composite resin fill technique and microleakage below the CEJ. J Dent Res 65:Abstract 799, 1986.

Lui JL, Shigeyuki M, Setcos JC, Lutz F, Schwartz ML, Phillips RW: Margin quality and microleakage of Class II composite resin restorations, J Am Dent Assoc 114:49-54, 1987.
Moore DH, Vann WF: A method to study marginal leakage of posterior composite restorations. J Dent Res 65:Abstract 778, 1986a.
Moore DH, Vann WF: Effect of the cavosurface bevel on posterior composite marginal leakage. J Dent Res 65:Abstract 898, 1986b.
Oldenburg TR, Vann WF, Dilley DC: Composite restorations for primary molars: two-year results. Pediatr Dent 7:96-103, 1985.
Paquette DE, Vann WF, Oldenburg TR, Leinfelder KF: Modified cavity preparations for composite resins in primary molars. Pediatr Dent 5:246-51, 1983.
Strange DC, Hembree JH: Comparison of three techniques for measuring marginal leakage of restorative materials. J Dent Res 66:Abstract 1494, 1987.

## What if OSHA pays a visit?

OSHA has authority over two areas in the dental office: hazard communication (right-to-know laws) and infection control.

The hazard communication rule sets standards designed to ensure that products containing hazardous chemicals are handled properly by employees. The rules requires chemical manufacturers and importers to convey hazard information to employers through labels on containers and material safety data sheets. All employers must pass this information on to their employees.

In the area of infection control, OSHA is utilizing its general authority to regulate workplace safety by imposing basic infection control requirements on dental workers, as well as on other healthcare workers.

In order to enforce its workplace regulations, OSHA is authorized by statute to conduct workplace inspections. Because of the large number of workplaces, inspections of dental offices will involve almost exclusively those offices in which an employee complains to OSHA.

If an OSHA inspector makes an unannounced visit to a dental office to make an inspection, the dentist has the right to demand that the inspector obtain a warrant prior to entry. The advantages of requesting this warrant are that the warrant should define the scope of the inspection; and the time it takes the inspector to get a warrant may allow the dentist more time to prepare for the inspector's arrival. The disadvantage is that the inspector may have, or may acquire, a broadly worded warrant allowing widespread inspection.

OSHA determines penalties based on the seriousness of the violation, the employers' good faith in attempting to comply with the regulations, size of the business and history of previous violations. A citation informs the dentist employer and employees of the alleged violations, proposed penalties, and how and when to correct the problems. The citation, which may include a fine, is mailed to the employer from the OSHA area office. An OSHA booklet that explains the employers' rights and responsibilities following an inspection should be included with the citation.

The dentist employer has 15 days from the time any citation and proposed penalty are received to contest either or both. Any notice of citation must be posted in a prominent location in the workplace for employees to see, or must be given personally to each employee, regardless of whether the employer intends to contest the matter.

OSHA poster 2203, "Job Safety & Health Protection," is available from any of OSHA's ten regional offices. If you're an employer of 11 or more employees (total of all employees in all offices), you should also obtain a copy of OSHA form 200, an accident.