

## Quantitative wear assessments for composite restorations in primary molars

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### Abstract

*Studies to date have assessed wear of composite restorations in primary molars using the United States Public Health Service (USPHS) evaluation criteria. Direct clinical evaluations of 148 Ful-Fil® restorations using the USPHS wear criteria were made at baseline, 6, 12, and 24 months. Quantitative assessments were made by comparing calibrated standard casts with the die stone casts obtained at the same recall intervals. Results for the USPHS evaluation revealed almost no wear after 24 months. Quantitative results, reported in average micrometers of wear, were: baseline — 0; 6 months — 40; 12 months — 72; 24 months — 93. Although wear was minimal, it was apparent that the USPHS criteria did not identify early wear as critically as the quantitative method. After 24 months, wear was within the guidelines for the ADA's acceptance program in primary molars.*

**R**esearch on composite restorations in primary molars has proliferated in the past few years and several clinical trials have been reported.<sup>1-4</sup> Better understanding about the properties that influence the clinical performance of composites has led to significant improvements in those used for posterior restorations. These advances are underscored by the fact that recently the ADA granted provisional acceptance to a composite material (Ful-Fil<sup>a</sup>) for use in primary molars.<sup>5</sup>

A major factor limiting the suitability of composite restorative materials in posterior teeth has been inadequate wear resistance.<sup>6,7</sup> To date, no in vitro wear tests have been found that will predict composite wear performance accurately. Thus, clinical trials remain

the only definite evaluation technique for posterior composite formulations.<sup>8</sup>

Most primary tooth studies of posterior composites have addressed wear in clinical trials using the United States Public Health service (USPHS) criteria developed by Cvar and Ryge<sup>9</sup> (Table 1). Recently, several investigators have concluded that wear measurements based on these criteria may not be precise enough for predicting in vivo performance.<sup>6-8,10</sup> To complement these criteria, a number of methods have been described to make physical measurements of material loss using impressions and study casts. Santucci and Racz<sup>11</sup> have described a method of measuring the ledge which forms between the enamel occlusal surface and the composite restoration at several points. Dennison et al.<sup>12</sup> have described a volumetric measurement technique using a wafer of silicone impression material between a template of baseline and recall casts. Lutz et al.<sup>6</sup> have described a method using computer mapping of a restoration cast. While these methods are appealing, all are time consuming and some involve expensive equipment and supplies.

In 1981 Goldberg et al.<sup>13</sup> presented a technique that

TABLE 1. USPHS Criteria for Rating Restorations for Anatomical Form (Wear)

Alfa	Restoration is continuous with existing anatomic form.
Bravo	Restoration is discontinuous with existing anatomic form, but missing material is not sufficient to expose dentin or base.
Charlie	Sufficient material is lost to expose dentin or base.

<sup>a</sup> LD Caulk Co, Division of Dentsply International: Milford, DE.

<sup>b</sup> Ransom and Randolph Co: Toledo, OH.

relied on the use of impressions and study casts for making quantitative wear assessments. This technique was modified and investigated further by Leinfelder et al.<sup>10</sup> and Goldberg et al.<sup>8</sup> In this method, evaluations are made by visual inspection and comparison to a set of calibrated standard casts of posterior permanent teeth with composite resin restorations. The standard casts exhibit varying amounts of wear at relatively equal intervals that range from no observable wear to severe wear (Table 2). Wear is defined as the extent to which the lateral walls of the original cavity preparation are exposed. In other words, using this method of wear assessment, wear represents the distance from the cavo-surface margins to the occlusal surface of the composite restoration.

Recently, Taylor et al.<sup>14</sup> established the validity of this method and showed it to have high levels of self- and interexaminer correlation. Using this method, Taylor also found no evidence of improved precision with repetition, with prior clinical training, or with experience as a clinical evaluator.

Although primary tooth restorations may have a shorter life expectancy than their permanent tooth counterparts, occlusal wear could be detrimental to the developing dentition because it may lead to supereruption of the opposing teeth. Because occlusal wear of primary molar composite restorations is an important consideration and because few studies have attempted to measure such wear, this study was undertaken to quantify occlusal wear of composite restorations in primary molars after 2 years of clinical service.

## Methods and Materials

The data for this study were generated from a clinical trial investigating Ful-Fil posterior composite restorations for primary teeth.<sup>4</sup> Fifty-one patients aged 4-8 participated in this study. The recall rates (rr) with the number of restorations rated were: baseline — 184

(rr = 100%); 6 months — 175 (rr = 95%); 12 months — 165 (rr = 94%); and 24 months — 148 (rr = 91%). All restorations had opposing occlusal contacts.

As part of the study, evaluations of wear were conducted at baseline, 6-, 12- and 24-month intervals using the USPHS criteria for direct clinical assessment of anatomical form (Table 1). At each interval, 2 evaluators independently evaluated each restoration using these criteria. Disagreements were resolved immediately by consensus.

Quantitative wear measurements were determined from die stone casts (Castone<sup>b</sup>) derived from polyether impressions (Polyjel<sup>a</sup>). These casts were developed at recall intervals coinciding with those previously listed. Independently, 2 teams of 2 examiners evaluated the die stone casts of these restorations. Evaluations involved visual inspection and comparison to a set of 6 calibrated standard casts of posterior permanent teeth with composite restorations. An occlusal wear category score was assigned to each restoration, based on the method described by Goldberg et al.<sup>8</sup> and Leinfelder et al.<sup>10</sup>

The 2 examining teams evaluated the casts independently. Individually, the members of each team rated the casts and assigned a category score based on the standard casts. If wear was judged to fall between 2 adjacent standards, an intermediate value was awarded. Where members of the team did not agree on the cast rating, a forced consensus was reached. The wear values were assigned to each restoration without the examiner's knowing the date of recall.

An average wear value was calculated for each team's rating for each recall period and converted to micrometers of wear based on measurements of the standard casts (Table 2). Then, the mean wear value of the 2 teams was determined for the recall period.

## Results

Results of the USPHS evaluation for anatomical form were: baseline — 100% Alfa; 6 months — 100% Alfa; 12 months — 100% Alfa; 24 months — 99% Alfa, 1% Bravo (Table 3). No Charlie ratings were recorded at any recall interval. Mean micrometers of wear, as determined by wear measurements by the 2 evaluator

TABLE 2. Categories and Measurements for Calibrated Standards

Category	Standard Casts Measured Wear (Micrometers)	Interpolated Wear (Micrometers)
1.0	0	
1.5		46
2.0	92	
2.5		156
3.0	221	
3.5		271
4.0	322	
4.5		352
5.0	382	
5.5		437
6.0	493	

TABLE 3. Wear Findings Through 24 Months

Evaluation Method	Time Periods			
	Baseline	6 Months	12 Months	24 Months
USPHS Criteria (% Alfa)	100%	100%	100%	99% (1% Bravo)
Quantitative assessment (micrometers)	0	40 ± 12*	72 ± 24	93 ± 11

\*Mean ± SE.

teams, were: baseline — 0; 6 months — 40; 12 months — 72; 24 months — 93 (Table 3).

The validity and reliability of the quantitative assessment method were reported previously by Taylor.<sup>14</sup> Interexaminer reliability for the USPHS evaluations over the 4 recall periods was 99%.

## Discussion

Prior to the introduction of the USPHS criteria in 1971, no specific system was available to evaluate the clinical performance of restorative materials. Cvar and Ryge's system<sup>9</sup> (USPHS criteria) gave the profession a method of evaluating restorations systematically over time. This evaluation system made a significant contribution to clinical dental research and these criteria have been used in many studies to evaluate the clinical performance of materials. However, recent studies have suggested that clinical wear assessments based on the USPHS criteria may not be precise enough for predicting in vivo performance of posterior composites. Based on this information, the ADA Council on Dental Materials, Instruments, and Equipment recently revised the guidelines for acceptance of composite resin materials for posterior restorations.<sup>15</sup> Now the guidelines require quantitative assessments of wear rather than those assessments made with the USPHS criteria. While there are other methods for making such assessments, the method described here is efficient, practical, and economical.

The clinical method of wear assessment using the USPHS criteria showed essentially no wear (99% Alfa; 1% Bravo) at 24 months. The quantitative method showed an average of 93  $\mu\text{m}$  of occlusal wear after 24 months. The quantitative wear rate over 24 months is illustrated in Figure 1. Different results are obtained with each system because the use of the explorer to determine wear clinically is less sensitive than the ability to detect a shadow or ledge on a model. This difference punctuates the need for a quantitative method of wear assessment.

The differential wear rates were as follows: baseline - 6 months — 40  $\mu\text{m}$ ; 6 - 12 months — 32  $\mu\text{m}$ ; 12 - 24 months — 21  $\mu\text{m}$ . The differential wear rate and the percentage of change over time are illustrated in Figure 2. Of the total wear after 24 months, 43% occurred after 6 months, 34% between 6 and 12 months, and 23% between 24 and 36 months. The USPHS system shows a slow start of wear with almost none after 24 months, whereas the quantitative method shows early wear which decreases over time. This amplifies further the difference between the 2 methods of wear assessment.

The ADA guideline for posterior composite wear in primary molars requires that average wear be less than 50  $\mu\text{m}$  per year. In this study total wear at 2

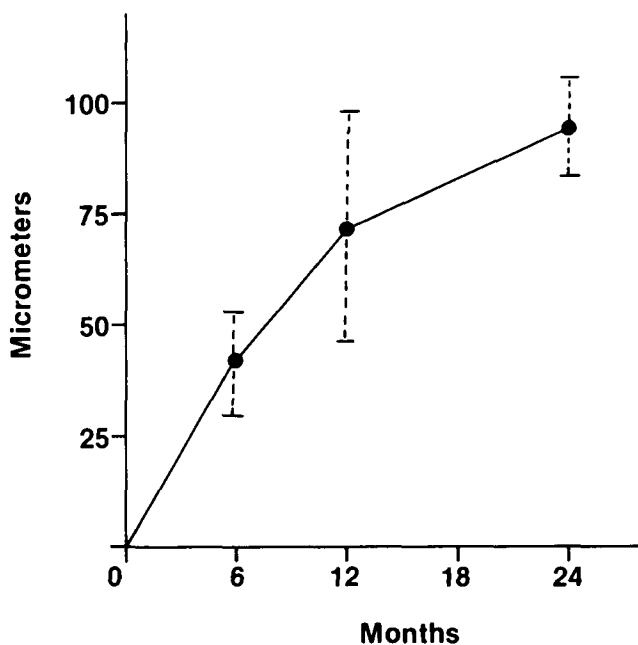


FIG 1. Wear rate over 24 months (bold dots represent mean  $\pm$  SE).

(t)	$\mu\text{m}$	$\Delta \mu\text{m}$	% $\Delta$
0.0	0	0	
0.5	40	40	43%
1.0	72	32	34%
2.0	93	21	23%

FIG 2. Differential wear rate illustrating percentage change over time.

years (93  $\mu\text{m}$ ) is within the ADA's guidelines. These wear data contrast sharply with wear rates for earlier generation composites like Adaptic<sup>®</sup> and Concise<sup>®</sup>, which are reported to be in the range of 150  $\mu\text{m}$  per year.<sup>16</sup>

Some investigators have observed that the enamel of primary teeth may abrade more readily than that of permanent teeth; they speculated that this abrasion may be advantageous because it may help keep pace with the occlusal wear of posterior composite materials.<sup>2</sup> While some abrasion over time was noted on the stone casts in this study, the evaluators agreed that the primary teeth appeared to wear very little during the 24-month clinical trial. Furthermore, most abrasion appeared to be restricted to cuspal areas or other areas not directly tangential to the resin resto-

ration. It must be noted that these observations were subjective, and the rate of enamel abrasion in primary molars needs additional study. However, until abrasion of primary tooth enamel has been quantified systematically, the use of posterior permanent tooth standards seem appropriate for assessing composite wear in primary molars.

## Conclusions

1. This study suggests that the USPHS criteria for assessing loss of anatomical form (wear) are too insensitive to detect minimal loss of composite restorations in primary molars.
2. In this study of Ful-Fil composite in primary molars, the total mean occlusal wear was 93  $\mu\text{m}$  after 24 months. The occlusal wear rate increased from baseline to 24 months; however, the differential wear rate decreased as a function of time from baseline to 24 months.
3. At 24 months, occlusal wear of Ful-Fil in primary molars is within the guidelines for the ADA acceptance program.

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