Observation of Clinical Course with Light–cured Fluoride Releasing Composite Resin UniFil® F

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Abstract

A light–cured composite resin is widely used as a restorative material. Recently, it is expected that light–cured fluoride releasing composite resin facilitates the mineralization of caries. In this study, we selected a light–cured fluoride releasing composite resin “UniFil® F” combined with “UniFil® Bond” for the restoration of primary teeth, continuously observed for 3 years and 6 months after restoration.

In one of the patients with primary anterior tooth restoration, the restorative material fell out after 3.5 years and six revealed gaps and steps that increased with time. In contrast, only four of the patients with deciduous molar restoration presented steps palpable with a probe and expanding with time while one patient revealed marginal fracture. Marginal staining was discovered in four of the restored primary anterior teeth and three of the primary posterior teeth. The primary anterior teeth restorations showed no evidence of morphological change as compared with the time of restoration. In contrast, the restored primary posterior teeth revealed partial morphological changes recognizable with the naked eye after restoration in four patients. No abnormalities were observed in the color stability and discoloration, pulpal reaction and secondary caries. SEM observation revealed that while the superficial condition of the restorations of the primary anterior teeth was relatively smooth there was evidence of defective parts in the margins with the enamel. In some patients it was found that the restorations of primary posterior teeth developed a rough surface with time and micro-fractures in the margin.

The findings presented above indicate that while the clinical diagnoses and SEM observations generally showed favorable results over time there was evidence that with the passage of time the joint between the enamel and restorative material will develop certain defective locations that increase as time takes its course.

Key words: Fluoride releasing composite resin/Primary teeth/Clinical observation
Introduction

Composite resins have been modified and improved since they were first developed and are now most extensively being used in daily clinical dental practice, making a contribution not only by virtue of their aesthetic acceptability but also on account of their excellent adhesion to the dental structure. Their penetration is also due to the improved properties of the materials brought about by the significant advances in the macro molecular science, stimulated to a considerable extent by the increasing aesthetic demands of the patient.

While the development of improved composite resins has led to a significant increase in the adhesion of the materials to the dental structure, there are still many unresolved problems such as polymerization shrinkage inherently involved with the materials, enamel microcracking, temporal changes of adhesive surfaces, and marginal leakage caused by occlusal and masticatory stress. In addition, the adhesion system based, as it has been in recent years, on the sealed restoration method, fills bonding resin in the decalcified dentine, resulting in a residual fragile decalcified dentine in the cavity floor and thus presenting a problem in terms of bonding at this site. The use of fluoride has been suggested for calcification of the fragile dentine. Light-cured fluoride releasing composite resins that continue releasing fluoride from a restorative material after its hardening is expected for enhancement of acid resistance and prophylaxis of secondary caries by strengthening of the dental structure in the periphery of the dental cavity.

Lots of experimental studies have been reported on the re-calcification and durability of the light-cured fluoride releasing composite resins. However, in the mouth, occlusal and masticatory pressure, thermal change and food will affect the clinical results of restorations. Therefore, clinical results are a valuable means of evaluating restorative materials. Further, few studies have been reported based on the long-term clinical observation of their use.

In this study the authors carried out clinical observations for 3 years and 6 months on the restoration of the primary anterior teeth and primary posterior teeth using a light-cured fluoride releasing composite resin “UniFil® F” and a light-cured type bonding material “UniFil® Bond”.

Materials and methods

1. Materials

The scope of the present study was limited to the primary anterior teeth and primary posterior teeth that suffered from C2 caries as selected from the children who visited the Children’s Dental Clinic, Kyushu Dental College Hospital. The sites and the number of restorations examined were 30 restorations placed on the labial and the proximal surfaces.

<table>
<thead>
<tr>
<th>Restored teeth</th>
<th>Primary anterior teeth</th>
<th>Primary posterior teeth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A B C C</td>
<td>D E D E</td>
</tr>
<tr>
<td>Number</td>
<td>4 5 9 12</td>
<td>5 10 7 8</td>
</tr>
<tr>
<td>Total number</td>
<td>30</td>
<td>30</td>
</tr>
</tbody>
</table>

Table 1 Observation of the teeth
of primary anterior teeth and 30 restorations placed on the occlusal surface of primary posterior teeth. The types of the restored teeth are as shown in Table 1.

2. Method of restoration

Restoration was performed in the usual manner using the rubber dam dry field technique. The preparation for the primary anterior teeth was according to Black Class 3 or 5 cavities, and for the primary posterior teeth was according to Black Class 1 cavity. Cavity preparation limited to the removal caries. The conditions for restoration were as shown in Figure 1. For restoration, a light-cured type slow fluoride-releasing composite resin UniFil® F and a light-cured type bonding material UniFil® Bond (manufactured by GC) were used. At the time of recall, overall prognostic observation was conducted to evaluate every restoration after examining marginal adaptation, marginal discoloration, abrasion resistance, color shade of restorative material, pulp reaction and secondary caries. The time of recall for examination was at every half year up to 3 years and 6 months after restoration.

3. Preparation of replica

In order to observe the time-course changes in the surface properties and marginal conditions of the restorative materials, replica models were prepared at the time of recall. After washing out the dental surface, a laminated impression was taken using silicon impression material heavy type and injection type, and epoxy resin (EPON 815, Thomide 245, D.M.P.30) was injected to prepare a replica model. After gold evaporation had been applied to every replica model in the usual manner, observation using a scanning electron microscope (S-3300N, Hitachi) was carried out.

Results

1. Marginal adaptation (Table 2)

In the primary anterior teeth, a macroscopically observed gap and a step detectable by explorer palpation with the probe were first demonstrated at 6 months after restoration, subsequently after 1 year in 2 cases of restoration, after 2 years in 4 cases, and after 3 years in 6 cases, gradually increasing in number. Restoration avulsion was observed only in 1 case at 3 years postoperatively.

In the primary posterior teeth, a macroscopically observed gap and a step detectable by
explorer palpation with the probe was first observed at 1 year after restoration, and increased to 4 cases at 3 years and 6 months postoperatively. Furthermore, in 1 case with a step detected by the probe at 1 year postoperatively, exposure of the materials was observed at the site. Marginal fracture was first seen at 6 months after restoration, and it appeared in 1 case at 3 years and 6 months postoperatively.

2. Marginal discoloration (Table 3)

In the primary anterior teeth, partial discoloration in the margin of the restorative materials was first observed at 1 year after restoration in 3 cases, and increased to 4 cases at 3 years and 6 months.

In the primary posterior teeth, marginal discoloration began to be observed at 1 year after restoration in 1 case, and increased in number in the course of time to 3 cases at 3 years and 6 months postoperatively.

3. Abrasion resistance (Table 4)

In the primary anterior teeth, the postoperative course was favorable and showed no morphological changes at 3 years and 6 months postoperatively as compared with the time of restoration.

In the primary posterior teeth, restoration fracture was observed at 6 months postoperatively in 1 case, at 1 year in 3 cases, and at 3 years in 4 cases.

4. Discoloration and staining of restorations (Table 5)

Both the primary anterior teeth and the primary posterior teeth showed a favorable postoperative course in all cases, without showing any color mismatch or imbalance even at 3 years and 6 months after restoration.

5. Pulp reaction (Table 6)

From immediately after restorative operation until 3 years and 6 months postoperatively,
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Table 4  Abrasion resistance

<table>
<thead>
<tr>
<th>Restored teeth Evaluation</th>
<th>Primary anterior teeth</th>
<th>Primary posterior teeth</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>29(96.7)</td>
<td>26(86.7)</td>
</tr>
<tr>
<td>b</td>
<td>0( 0)</td>
<td>4(13.3)</td>
</tr>
<tr>
<td>c</td>
<td>0( 0)</td>
<td>0( 0)</td>
</tr>
<tr>
<td>d</td>
<td>1(3.3)</td>
<td>0( 0)</td>
</tr>
</tbody>
</table>

( ) : %

a : No morphological changes are observed
b : Morphological changes are observed in part of the restoration
c : Morphological changes and fracture occur in the entire restoration
d : Impossible to evaluation, because of dislodged restoration

Table 5  Discoloration and staining of restoration

<table>
<thead>
<tr>
<th>Restored teeth Evaluation</th>
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<th>Primary posterior teeth</th>
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<tbody>
<tr>
<td>a</td>
<td>29(96.7)</td>
<td>30(100)</td>
</tr>
<tr>
<td>b</td>
<td>0( 0)</td>
<td>0( 0)</td>
</tr>
<tr>
<td>c</td>
<td>0( 0)</td>
<td>0( 0)</td>
</tr>
<tr>
<td>d</td>
<td>1(3.3)</td>
<td>0( 0)</td>
</tr>
</tbody>
</table>

( ) : %

a : Color of the restoration matches that of the natural teeth
b : Color of the restoration slightly differs from that of the natural teeth
c : Color of the restoration differs from that of the natural teeth
d : Impossible to evaluation, because of dislodged restoration

Table 6  Pulpal reaction

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<thead>
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<tr>
<td>d</td>
<td>0( 0)</td>
<td>0( 0)</td>
</tr>
<tr>
<td>e</td>
<td>1(3.3)</td>
<td>0( 0)</td>
</tr>
</tbody>
</table>

( ) : %

a : No abnormalities are found
b : Acute temporary pulp reaction occurs after restoration
c : Sustained pulp reaction occurs after restoration, but pulp treatment is not required
d : Sustained pulp reaction occurs and pulp treatment is required
e : Impossible to evaluation, because of dislodged restoration

Table 7  Secondary Caries

<table>
<thead>
<tr>
<th>Restored teeth Evaluation</th>
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<td>0( 0)</td>
</tr>
<tr>
<td>d</td>
<td>1(3.3)</td>
<td>0( 0)</td>
</tr>
</tbody>
</table>

( ) : %

a : No caries are found in marginal areas of the restoration
b : Caries are found in a marginal area of the restoration
Cloudiness and discoloration are observed
Caries-associated softening and stickiness of the tooth structure are detected by explorer
c : Impossible to evaluation, because of dislodged restoration

no cases complained of discomfort with their primary anterior teeth or primary posterior teeth, showing a favorable postoperative course without requiring any treatment of the pulp.

6. Secondary caries (Table 7)
No occurrence of secondary caries was demonstrated in the primary anterior teeth or the primary posterior teeth.

7. Scanning electron–microscopic findings of replica models
(1) Primary anterior teeth
Case 1: Immediately after the restorative operation, the transition between the restorative material and the enamel was smooth and appeared lubricant on the surface, but the border of the composite resin restoration became obvious in the course of time, and showed morphological changes on the surface of the restoration (Fig. 2).

Case 2: Immediately after restoration, the bonding portion between the restorative material and the enamel was almost indiscernible, but the border between the enamel and the composite resin restoration became obvious, indicating the development of a large step at the bonding site at 3 years and 6 months postoperatively (Fig. 3).

Case 3: Already at 1 year after restoration, a step was observed between the restoration and enamel. The step increased in extent in the course of time, and its surface became
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Fig. 5 Primary posterior teeth Case 1.
- a: Immediately after restoration
- b: After 1 year
- c: After 2 years
- d: After 3 years and 6 months

CR: Composite resin
→: Margin of restoration

Fig. 6 Primary posterior teeth Case 2.
- a: Immediately after restoration
- b: After 1 year
- c: After 2 years
- d: After 3 years and 6 months

CR: Composite resin
→: Margin of restoration

Fig. 7 Primary posterior teeth Case 3.
- a: Immediately after restoration
- b: After 1 year
- c: After 2 years
- d: After 3 years and 6 months

CR: Composite resin
→: Margin of restoration

rough (Fig. 4).

(2) Primary posterior teeth

Case 1: Immediately after the restorative operation, the bonding portion between the restorative material and the enamel presented the appearance of a small bulge, but this was worn down in the course of time. At 3 years and 6 months postoperatively, the restoration was lower than the enamel, showing a slight step in the transition to the enamel (Fig. 5).

Case 2: Immediately after restoration, the transition between the composite resin restorative material and the enamel was smooth, but a step was observed between the composite resin restoration and the enamel, and the extent of this step was found to increase in the course of time (Fig. 6).
Fig. 8 Primary posterior teeth Case 4.
- a: Immediately after restoration
- b: After 1 year
- c: After 2 years
- d: After 3 years and 6 months

Case 3: Immediately after restoration, the transition between the composite resin restorative material and the enamel was smooth, but showed a step between them after 1 year, and as the margin of the composite resin restoration broke in the course of time, marginal deformation was in evidence (Fig. 7).

Case 4: Immediately after restoration, the surface of the restorative material was lubricant, but cracks developed on the surface of the restoration, and the size of these cracks was found to increase in the course of time (Fig. 8).

Discussion

Composite resins have seen successive improvements since they were first developed. Thanks to the progress in macro molecular over the years, their physical properties have been improved and dental adhesive systems have been developed. Because these composite resins offer superior dentine-bonding strength, are simple to apply, and also meet the patient's increasing demand for more esthetic qualities, they are now being used on an extensive scale in ordinary clinical practice for crown restoration. Nevertheless, there are still many unresolved problems. In recent years, the sealed restoration technique has given rise to criticism. The problem is that the brittle decalcified dentine is left at the cavity floor with the result that the bonding strength becomes weakened in this part. In order to re-calcify this brittle decalcified dentine, improve the acid resistance of teeth and prevent secondary caries, slow fluoride-releasing composite resins have been developed. They release fluoride after the resin has hardened. There are lots of experimental studies of light-cured fluoride releasing composite resin, however there are few studies of clinical evaluation with long-term clinical observation.

Various factors in the mouth affect the prognosis of restorations. Therefore, it is a valuable means of clinical observation. The purpose of this study was to investigate utility of light-cured fluoride releasing composite resin UniFil® F and light-hardened bonding material Unifil® Bond for primary anterior teeth and primary posterior teeth by clinical observation.

1. Marginal Adaptation
Marginal adaptation is characterized by the bond between the dentine and the composite resin. The quality of marginal adaptation is significantly determined by the marginal discoloration, pulp irritation and the incidence of secondary caries.

Marginal adaptation can deteriorate for a number of factors: Wear of the restorative material, marginal fracturing of the restorative material or fracture of the cavity margin in the enamel, polymerization shrinkage of the composite resin, occlusal and/or masticatory function, and fluid intrusion due to the presence of micro-leaks.

It should also be noted that polymerization shrinkage in the resin does not merely lead to formation of a gap in the portion with adverse bonding conditions but also results in development of fissures in the tooth enamel adjoining the cavity margin due to the separation of enamel rods with indirect destruction of the marginal shut and the destruction of the margin under the influence of stresses in the course of time.

The sealed restoration using a bonding resin filling in the decalcified dentine leaves a brittle decalcified dentine at the cavity floor and this area can be considered as a factor for the decrease in bonding strength. The literature concerning the long-term durability of the dentine-resin bond reports evidence that the resin-impregnated layer may also deteriorate as the bonding strength of the resin declines in the course of time.

In this study we have used UniFil® F for conditioning the dental surface. This is a self-etching system using an acidic monomer with a higher pH than the phosphoric acid that has conventionally been employed for dentine decalcification. Consequently, the enamel is etched to a lesser degree so that there is only minor resin tag formation. The inadequate polymerization degree due to the presence of residual self-etching primer does, however, lead to the problem that the physical properties of the bonding boundary area are reduced. Since the resin-impregnated layer has a small thickness and the bonding material thickness is large, there are only few defects associated with the destruction of the bond in the bonding boundary area with the resin so that the relatively thick bonding material layer can function as a buffer layer.

With the self-etching bonding system, the normal dentine is reported to have a bonding strength of 30 Mpa or more. From a clinical viewpoint, this is an almost satisfactory value. However, the bonding strength will significantly deteriorate when the dentine is infected with caries. Further, there are also reports claiming that fluoride conditioning of the decalcified dentine is effective. This suggests that the bonding strength can be improved with a slow fluoride releasing bond system using a composite resin.

This points to the possibility that a self-etching system can lead to marginal micro-fracturing and the emergence of brown stains on the margin.

Sasazaki et al. have published a report on their short-term clinical results achieved on restorations using a self-etching resin. The results show that a step was observed one week after filling and that the width of this step increased with time, eventually leading to the formation of a gap. In the early phase, the bonding layer wears and a step forms. With the passage of more time, the bonding layer is worn further, leading to the wearing-down of the
composite resin and the development of micro-fractures as the step widens. In order to achieve a better prognosis for marginal adaptation the report argues that the margin exposing thickness of the bonding material should be reduced.

In our study we have also encountered much distress about marginal adaptation and had patients who had lost their fillings and need renewed restoration in their primary anterior teeth. If we combine these observations with the SEM findings it is clear that the micro-fractures forming in the composite resin portion that stands slightly proud of the cavity in primary anterior teeth is the most frequent cause of failure. In the case of a self-etching primer, it is also possible to attribute this to the decline in its bonding strength with the uncut enamel. The primary posterior teeth are exposed to greater occlusal and masticatory stress than the primary anterior teeth. The load applied to the parts that have become thin due to the beveled joint may lead to fracture.

2. Marginal Discoloration

Marginal discoloration is profoundly related to marginal adaptation. The presence of a step or gap in the margin leaves a colored substance on the margin causing the adhesive bond with the enamel to deteriorate and results in the infiltration of the colored substance between the enamel and the restorative material, causing discoloration.

As stated above, it has been suggested that brown stains may occur as a result of poor bonding and the thinness of the resin-impregnated layer. In our study, there were four patients showing a discoloration in the margin of the restoration in the primary anterior teeth and three such patients in the deciduous posteriors. This discoloration was not serious and could be removed by polishing, and it was felt that these patients did not need a renewal of their restoration. This suggested that the step between the enamel and the restorative material may have been due to over-filling which had resulted in a taller restoration.

3. Abrasion

The composite resin is exposed to the action of moisture, temperature, the chemical substances in the food, and repeated occlusal and masticatory load application in the oral cavity. The infiltration of water into the composite resin has been observed to result in the deterioration of the matrix resin material, a decrease in bonding strength with the filler, the falling-out of the filler, and superficial destruction. The parts of the molars involved in mastication are subjected to compressive and tensile stresses, resulting in progressive wear.

The matrix resin constituting the composite resin, the properties of the filler material contained in the composite resin, the way in which it has been blended, and the bond between the resin matrix and the filler material have an effect on abrasion resistance. The UniFil® F material used in our study differs from the conventional resin in that it contains aluminosilicate glass as the filler material. It is therefore necessary to consider what effect this may have on the abrasion resistance.

It has also been reported that the compressive strength and bending strength of the slow fluoride releasing composite resin are equivalent to the corresponding values of the
conventional composite resins used for molars. They are therefore suitable for restoration of the mastication surface of molars\(^6\).

In our present study, there were no morphological changes in the primary anterior teeth. In the primary posterior teeth, however, there was evidence of fracturing and wear occurring with time as a result of masticatory stress. These changes, however, were of a minor nature and none of the patients were considered to require a renewal of their restorations. This supports the conclusion that UniFil\(^\circledR\) F offers adequate durability for both primary anterior teeth and primary posterior teeth.

4. Discoloration and Staining of the Restorative materials

The causal factors for the discoloration of the restorative material may be attributed to some deterioration of the composite resin material, its water absorption and staining. These are material problems. The type of matrix resin and filler used and the ratio in which they are blended can also have an effect.

Hirano\(^6\) has conducted immersion tests by placing the composite resin in a solution similar to the food and drinks normally consumed for 1000 days reports that micro-detachment at the matrix resin and the filler boundary were noted and that the refraction index had changed, with a change in color shade. It has also been reported that a UDMA type composite resin tends to show a gradual increase in its absorption rate with time when immersed in a 20 % alcohol solution. This suggests that there is a high probability of discoloration occurring in the composite resin with time. In our present study, however, we encountered no patients with discoloration or staining of their restorative materials or bother the primary anterior teeth and primary posterior teeth even after three and a half years.

5. Pulp Reaction

At present, it is believed that postoperative stimulation of the dental pulp is the most important cause of marginal micro-leakage. The bonding strength of the composite resin to the enamel and dentine is therefore a major factor. Similarly to the study of marginal adaptation, the UniFil\(^\circledR\) F used in this study poses a problem in terms of the bonding strength with the enamel when using a self-etching system. It has been reported\(^6\) that the resin–impregnated layer is thin also in relation to the dentine and that it has a poor bonding strength. On the other hand, the literature reports\(^2\) that the bonding strength with a normal, healthy dentine can be considered almost satisfactory from a clinical viewpoint. In our present study the problem is how the bonding strength with the enamel and dentine after reinforcing the teeth with slow fluoride-release may be affected. For both the primary anterior teeth and primary posterior teeth of our present study, there were no patients complaining of any discomfort and requiring a renewal of their restoration over the three and a half year study period. Nor was there any evidence of bond destruction on the bond boundary on a scale that might lead to bacterial invasion.

6. Secondary Caries

Secondary caries has a profound involvement in marginal adaptation and dentine bonding
strength. The main cause of secondary caries is due to bacterial infection occurring between the dentine and the composite resin restorative material as a result of marginal leakage. In view of the use of the sealed restoration method in recent years, we must also consider the possibility of secondary caries spreading from the cavity floor since this method leaves the decalcified dentine in the cavity floor.

The use of a restorative material with a slow-fluoride release function such as glass ionomer cement can improve the resistance of the dentine to caries by re-calcifying the decalcified dentine around the cavity\(^{17}\). The inclusion of fluoride in the enamel and dentine is known to enhance acid resistance\(^{25}\). There are many reports\(^{2,10}\) in the literature showing the success achieved with re-calcification of the decalcified dentine with a slow-fluoride releasing material. This makes it abundantly clear that the use of a fluoride releasing material is effective in controlling secondary caries and marginal caries.

Investigation of the fluoride amounts released by the slow-fluoride releasing composite resin has shown that fluoride is released in relatively large quantities in the initial phase\(^{19}\). Furthermore, brushing of the fluoride-release restoration and the use of a fluoride gel are a means of increasing the fluoride release and has a fluoride recharging potential\(^{5,20}\). Since the fluoride release will decrease after restoration surgery it is important for the patient to ensure proper oral management so as to increase the fluoride release as best is possible. The re-calcification of the dentine can also be affected by the bonding material immediately adjacent to the dentine. Even with the use of UniFil® Bond used in this study, which has no slow-fluoride releasing action, it is possible to incorporate fluoride\(^{21}\). Bonding materials with slow-fluoride releasing properties have also been developed and the fluoride eluted from the bonding material helps to re-calcify the enamel and dentine\(^{1-10}\) and is thus effective in preventing secondary caries.

The light-cured fluoride releasing composite resin used in this study contains fluoroaluminosilicate as the filler. It releases fluoride and thus helps to re-calcify the dentine.

In our present study, none of the patients developed secondary caries over the 3.5 year study period. At this department, we made restorations with the photopolymerized composite resins GRAFTLC\(^{22}\), and Estio LC\(^{23}\) and continued our follow-up investigations for three years. The results have shown that secondary caries did occur. Our zero-secondary caries result may thus be due to the effect of the fluoride-releasing action of UniFil® F. The fluoride released from the light-cured fluoride releasing composite resin promotes the re-calcification of the decalcified dentine in and around the cavity. This strengthens the dentine and enhances caries resistance.

7. Findings of Scanning Electron Microscopy (SEM)

The replica modeling method and investigation method used in our study is an extensively reported technique\(^{24-26}\). Horie\(^{26}\) has published a report about the error associated with the replica model. According to his data, the mean measurement results of the replica model and the original are in the range of 1 \(\mu\)m, and no significant difference can be found in the statistical difference study for the mean values. It has also been indicated that the
replaced values are 0.2μm smaller than the original after two years but this does not constitute a significant difference.

The morphology of the restoration and its margin shows evidence that the bonding strength between the restorative material and the enamel and the durability of the restorative material are subject to certain influences. In our present study, the bond area between the enamel and restorative material had been smooth but developed steps and gaps with the passage of time. These steps and gaps tended to widen with time. In a large number of patients, the steps and gaps are of two types: They either form because the restoration bulges out or because the restoration sinks in with regard to the enamel. Overfilling of composite resin may also lead to micro-fracturing in the portion that exceed the cavity margin. When a self-etching system is used, steps and gaps may reportedly also be caused as a result of a decrease in bonding strength with the uncut enamel. Those parts that show evidence of recession or fracturing of the restorative material are the portions corresponding to the bevel. The thinness of the composite resin may thus also lead to problem with the durability of the restorative material.

In the restoration of the primary anterior teeth, we found no evidence of morphological changes or fracturing of the restorations themselves. In contrast, it was found that fractures lines did emerge in the restorations of the primary posterior teeth. The parts subject to the masticatory stresses will thus give rise to problems of durability of the restorative material. This goes to emphasize the importance of occlusal adjustment and prolonged observation.

These findings presented above make it clear that the clinical diagnoses and SEM observations generally showed favorable results over time. There was evidence, however, that with the passage of time the joint between the enamel and restorative material will develop certain defective locations and that these defects will increase in width as time takes its course.

**Conclusion**

The authors have performed dental restorations with the light-cured fluoride releasing composite resin UniFil® F and the light-cured type bonding material UniFil® Bond on 60 patients and carried out a 3.5 year clinical follow-up study. Thirty restoration were made in the primary anterior teeth infected with C; at the labial and interproximal surfaces and thirty on the occlusal side of primary posterior teeth.

1. In one of the patients with primary anterior tooth restoration, the restorative material fell out after 3.5 years and six revealed gaps and steps that increased with time. In contrast, only four of the patients with deciduous molar restoration presented steps palpable with a probe and expanding with time while one patient revealed marginal fracture.

2. Marginal staining was discovered in four of the restored primary anterior teeth and three of the primary posterior teeth.

3. The primary anterior teeth restorations showed no evidence of morphological change as compared with the time of restoration. Their performance over time was thus favorable.
In contrast, the restored primary posterior teeth revealed partial morphological changes recognizable with the naked eye after restoration in four patients.

4. There were no patients with a visible color mismatch between the restorative material and the enamel after 3.5 years. The restorations can thus be said to have performed well over time.

5. For both the primary anterior teeth and primary posterior teeth, there were no patients complaining of any discomfort after restoration or patients requiring pulp treatment. In this sense, their performance over time was favorable.

6. There were no patients showing marginal caries and requiring renewed restoration.

7. SEM observation revealed that while the superficial condition of the restorations of the primary anterior teeth was relatively smooth there was evidence of defective parts in the margins with the enamel. In some patients it was found that the restorations of primary posterior teeth developed a rough surface with time and micro-fractures in the margin.

The findings presented above indicate that while the clinical diagnoses and SEM observations generally showed favorable results over time there was evidence that with the passage of time the joint between the enamel and restorative material will develop certain defective locations that increase as time takes its course.

Reference

光重合型フッ素徐放性コンポジットレジン「Unifil® F」の臨床的経過観察

西田郁子・小島幸美・西岡孝浩
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光重合型コンポジットレジンは、最も使用されている修復材料で、近年では、軟化象牙質の石灰化機能を有する光重合型フッ素徐放性コンポジットレジンが注目されている。本研究では、光重合型フッ素徐放性コンポジットレジン「Unifil® F」を光重合型ボンディング材「UniFil® Bond」を乳歯の修復に用い、3年6か月間臨床的観察を行った。

乳前歯では3年6か月経過後に修復物が脱落した症例が1例、ギャップおよびステップを認めた症例は経年的に増加し6例であった。乳臼歯では、辺縁破折のみられた症例は1例であったが、探針による触診でステップを認めた症例が経年的に増加し4例であった。辺縁部に着色のみられた症例は、乳前歯で4例、乳臼歯で3例であった。乳前歯修復では、修復時を比較して形態的変化はみられず、良好な経過を示したが、乳臼歯では、修復直後の形態を比較し肉眼的に一部変化を認める症例が4例みられた、修復物の変色および着色、歯齲反応、二次齲蝕の発症はみられなかった。

走査型電子顕微鏡による観察では、乳前歯修復物の表面性状は比較的滑らかであったが、辺縁部では歯質との不適合部分が認められた。乳臼歯修復では、経年的に表面が粗造になり、辺縁部ではわずかな破折している像が観察される症例も認められた。

以上の結果、臨床的観察及び走査型電子顕微鏡的観察において概ね良好な経過を示しているが、経年に歯質と修復材料の接合に不適当な部分の増加が認められた。