Management of developmental enamel defects in the primary dentition

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Abstract: This study attempted to identify appropriate materials for restoration of enamel defects in the primary dentition, which were classified by severity and region with the modified developmental defects of enamel index. To identify the most appropriate materials, we used restorative materials to protect teeth and evaluated clinical outcomes of restoration. Three materials were used for restoration or repair after dislodgement of restorations. Our findings in this case suggest that, because of its durability and esthetic advantages, adhesive resin is beneficial for patients with enamel defects, particularly for restorations of less than two-thirds of the extent of the defect.

Keywords: adhesive resin; developmental defects of enamel index; primary dentition.

Introduction

Developmental defects of enamel (DDE) are abnormalities in enamel quality and quantity that affect tooth formation, hardness, and color. DDE can lead to worsened esthetics, tooth sensitivity, pulpitis, and hypoplasia with associated severe, early childhood caries (¹), erosion, and wear. DDE-associated occlusal abnormalities, tooth malalignment, and masticatory disturbances are often encountered in clinical practice. Management of DDE in children is challenging, because pediatric dentition is constantly developing. Materials and treatments must be carefully considered because occlusion continuously changes during tooth eruption and growth. Moreover, defects do not become apparent until the tooth has completely erupted.

Glass ionomer cement (GIC), composite resin (CR), and stainless steel crowns are commonly used for DDE treatment (²). However, GIC and CR often dislodge because of the greater difficulty in bonding these materials to compromised enamel than to healthy enamel. McDonald et al. reported ideal treatments for amelogenesis imperfecta (AI) in primary, mixed, and permanent dentitions (³). However, Venezie et al. reported that CR and GIC were unsuccessful for bonding brackets to enamel in patients with AI (⁴). Seow reported that patients with hypoplastic AI usually had sufficient enamel available for bonding and that CR veneers were sometimes successful (²). Furthermore, stainless steel crowns can be useful but have esthetic limitations. No study has investigated treatment of DDE in primary dentition, particularly during the entire period from the beginning to completion of eruption. We hypothesized that dentin bonding systems could be used to restore dentition in patients with DDE. If sufficient enamel were available for bonding, this would also address concerns regarding esthetics and tooth morphology.

The DDE index (⁵) was established for studies of dental fluorosis and epidemiologic research and considers the type, number, demarcation, and location of defects. The modified DDE (mDDE) index (⁶) uses a coding
system of 1 through 9, and the definitions for each of the conditions are the same as those in the original DDE index. The mDDE index divides defects into 3 types: demarcated opacities, diffuse opacities, and hypoplastic defects, which are coded as 1-9. The extent of the defect is recorded in thirds of tooth surface area, coded from 1-3.

No study has investigated the suitability of restoration materials and restoration methods in relation to the severity and extent of enamel defects, as classified by the mDDE index. The present case report describes dental management of multiple DDEs in a female pediatric patient. The mDDE index was used to categorize the defects, and clinical outcomes of the restoration were used to identify the most appropriate materials. We attempted to identify the optimal materials for restoration of defects in the primary dentition, the severity and extent of which were evaluated by the mDDE index.

**Case Report**

A girl aged 21 months was referred by the transplantation center at our hospital for treatment of poor dental esthetics. Biliary atresia had been diagnosed at age 1 month, and she had undergone the Kasai procedure and received steroid pulse therapy. At age 8 months, she underwent liver transplantation. Her birth weight was low (2,234 g). There was no family history of similar dental problems. The mother had been prescribed oral iron therapy during pregnancy.

Clinical examination revealed yellowish enamel defects without pulp exposure. According to the mDDE index (6), the patient had yellow enamel defects of demarcated opacities (code 2) and missing enamel due to hypoplasia (code 8). The extent of the defect was mixed (code 1-3). The impedance value of the enamel defects ranged from 3 to 12. Enamel hardness was normal, with left-right symmetry were observed. Buccal, occlusal, and lingual surfaces were rough, and linear ring-like defects were observed. None of the defects was associated with wear or caries. An open bite was observed between the primary cuspids. She continued finger sucking until age 3 years.

The patient’s parents provided written informed consent for tooth restoration. The treatment protocol was approved by the Ethics Committee of the National Center for Child Health and Development (No. 21).

**Treatment course and clinical outcomes**

We used GIC, CR, and adhesive resin (AR) for restorations, in accordance with the findings of a study of the feasibility of using these materials for primary teeth (7). Treatment was started at age 21 months. The defects in the primary maxillary and mandibular right and left first molars (8 surfaces) were coated with GIC (Fuji Type II, GC Corp., Tokyo, Japan); moisture prevention was used to protect the teeth. However, within 1-7 months, the GIC fillings began to dislodge from 6 of the 8 surfaces (75%), while the other 2 occlusal surfaces of the primary mandibular right and left first molars remained attached.

At age 2 years 6 months, self-curing adhesive resin (Super-Bond C&B [SB]; Sun Medical Co., Ltd., Moriyama, Japan) was applied according to the manufacturer’s instructions as a primary layer. CR (Clearfil AP-X, Kuraray Noritake Dental, Melville, NY, USA) was later applied as a second layer with a rubber dam and without anesthesia. SB and CR were applied to the defects on the primary mandibular right and left cuspsids, the first molar, and second molar (10 surfaces). Because the defects were widespread, we used preformed transparent deciduous posterior crown forms (TDPFs: TDV Dental Ltd., Pomerode, Brazil) for restoring the primary mandibular right and left first molars. The size of the tooth crown was measured, and a suitable TDPF was selected and adapted for the tooth (Fig. 1). However, CR fillings dislodged from all 10 surfaces (100%) within 2-10 months.

The affected sites at age 3 years 1 month are shown in Fig. 2. AR material (Bondfill SB; Sun Medical Co.,
(Sun Medical Co., Ltd., Moriyama, Japan) was applied in accordance with the manufacturer’s instructions, with moisture prevention and without local anesthesia, and 4-META self-etching primer (Sun Medical Co., Ltd., Moriyama, Japan) was applied around the defects (i.e., the normal enamel area) for 20 s and then air-dried. A wider area around the defects was coated with Bondfill by using the brush-dip technique to restore 18 teeth (27 surfaces; Fig. 3). After curing, the surface was polished with silicone rotary instruments (Fig. 4).

Within 3-12 months, the Bondfill AR dislodged from the distobuccal surfaces of the primary maxillary right first molar and primary mandibular right and left first molars (11%). Occlusal readjustment and repeated restorations were more frequently required than the primary restorations, although progress was good. The overall duration of treatment was 2 years 1 month. After treatment, preventive follow-up visits were scheduled for about 3 years. At a follow-up examination at age 5 years 10 months, there was no significant dislodgment or wear of Bondfill (Fig. 5). At the final follow-up examination, at age 6 years 11 months, the anterior primary teeth had been replaced by their successors (Fig. 6).

Table 1 Composition of Bondfill SB

<table>
<thead>
<tr>
<th>Components</th>
<th>Composition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teeth Primer</td>
<td>4-META, acetone, water, reducing agent</td>
</tr>
<tr>
<td>Monomer</td>
<td>MMA, 4-META, polyfunctional methacrylate</td>
</tr>
<tr>
<td>Powder</td>
<td>PMMA, TMPT, pigment</td>
</tr>
<tr>
<td>Catalyst V</td>
<td>TBB, TBB-O, hydrocarbon</td>
</tr>
</tbody>
</table>

MMA: methyl methacrylate; 4-META: 4-methacryloyloxyethyl trimellitate anhydride; TBB: tri-n-butylborane; TBB-O: partially oxidized tri-n-butylborane. All data were provided by the manufacturers.

Table 2 Proposed materials and types of restorations, by severity and region of enamel defects (hypoplasia) in the primary dentition

<table>
<thead>
<tr>
<th>Extent and severity of defect</th>
<th>Region (side)</th>
<th>Materials and type of restoration</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of defects with sensitivity</td>
<td></td>
<td>Buccal/labial and lingual surfaces</td>
</tr>
<tr>
<td>Code 1: &lt;1/3 of the extent of defect</td>
<td>Anterior</td>
<td>AR and/or CR</td>
</tr>
<tr>
<td>Code 2: At least 1/3 but &lt;2/3 of the extent of defect</td>
<td>Posterior</td>
<td>AR and/or CR</td>
</tr>
<tr>
<td>Code 3: At least 2/3 of the extent of defect</td>
<td>Anterior</td>
<td>CR veneers</td>
</tr>
<tr>
<td></td>
<td>Posterior</td>
<td>CR onlay and/or SSC</td>
</tr>
</tbody>
</table>


Discussion

The presence of a calcification pattern and a specific neonatal line, as described by Schour (8), suggested that our patient’s condition was caused by a systemic condition associated with prenatal or perinatal stress in the mother or fetus. Because of widespread DDE, we used TDPFs for the primary mandibular right and left first molars. This is a standard approach for patients with extensive crown loss but preserved cusps, as TDPFs can be adapted over CR, to reproduce typical occlusal and coronal forms. However, because TDPFs are only available in three sizes, increased occlusal adjustment is necessary in order to achieve the appropriate vertical dimensions.

Although our patient had widespread defects in some teeth, her teeth had hard cusps. Stainless steel crowns are the treatment of choice in patients with widespread defects and decreased vertical dimensions. The demand for esthetically pleasing restorations has steadily increased. CR is ideal for full crown restorations of primary molars with DDE, and it satisfies the esthetic demands of younger patients. However, its adhesion quality and durability in areas with extensive defects are unclear. Future in vitro studies should investigate adhesion and
durability of CR in areas with such defects, including those covering the entire crown and cusps. The high failure rate of CR restorations in our patients might have been caused by growth of the defects with tooth eruption, which was not proportionate to the bonding area of SB. Furthermore, stress was concentrated at the SB and CR margins, because of differences in the properties of these materials. SB is a 4-methacryloyethyl trimellitate anhydride/methyl methacrylate-tri-n-butylborane (4-META/MMA-TBB) resin that requires a water-rinsing step, which is a disadvantage. Conversely, Bondfill contains 4-META/MMA-TBB resin that includes trimethylolpropane trimethacrylate as filler (Table 1). It functions as a bonding agent and restorative material, is simply and easily applied, has a short curing time, and requires no water-rinsing step. Bondfill is commonly used for repairing fractured prostheses and damaged restorations, sealant, and areas with multiple pressure/stress points, as well as for treating tooth attrition and cervical caries where normal restorations would easily dislodge (9).

The bond strength of Bondfill was reported to be high (10). Therefore, we selected Bondfill AR for our patient. Bondfill did not dislodge from many of her teeth, probably because the area covered with Bondfill was much larger than that covered with SB before application of CR. Additionally, we increased the ratio of Bondfill to healthy enamel so that it was greater than the ratio of Bondfill to the defect areas. In children, the tooth crown continually changes until eruption has been completed. During eruption, the adhesion area constantly enlarges around the defect. We believe that the detachment of Bondfill caused the defect areas to enlarge, as the extent of the defect was coded as 3. Thus, the enamel was insufficient for bonding, because the Bondfill coating was too small to cover the extent of the defects. In addition, Bondfill dislodgment occurred because the defects were near the cusp. The cusp lacked healthy enamel, so it was difficult to coat around the defect. Therefore, the restoration should cover an area wider than the defect area. Moreover, Bondfill dislodgment resulted in increased stress at the incisal or occlusal edges coated with Bondfill during contact with the antagonist tooth. The occlusal surfaces of teeth undergo progressive physiological attrition in children; therefore, we believe it is necessary to restore occlusal surfaces with materials that have greater wear resistance. In this case, we may have to replace the materials if the she shows progressive physiological attrition in future. Table 2 shows the optimal materials for use, in relation to the severity and extent of enamel defects in primary dentition, as classified with the mDDE index.

Our findings suggest that use of Bondfill AR is effective for restoring DDE of primary teeth, as it is beneficial in terms of durability and esthetics and has sufficient adhesive properties and practicality in patients with DDE, particularly when restoration of less than two-thirds of the extent of the defect is required in children. Use of Bondfill AR requires careful attention when the extent of the defect is code 3 or greater (two-thirds of the extent of the defect or greater) and when the area onto which the material can be coated is limited.

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Conflict of interest

None declared.

References