Restorative Management of Dental Enamel Defects in the Primary Dentition

10

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Abstract

Many genetic and environmental conditions can interfere with the normal development of primary teeth and can manifest as defects in the enamel. Such defects can be associated with pain and discomfort and can have esthetic implications which may affect the young child's self-esteem. It is not only important for clinicians to be able to diagnose the defects but also to understand the implications these might have on restorative techniques and materials they choose. Restorative management can be challenging because of the limited cooperation in some children, the extent of the defects, and the sensitivity that may be present. The main aims of treatment should be to alleviate pain and sensitivity, improve esthetics, and manage any other concerns that the child or the parents might have. This should be followed by consideration of long-term treatment planning involving progression of the primary through to the mixed dentition. In many cases, especially where there is a genetic component with generalized involvement of both the primary and subsequent permanent teeth, an interdisciplinary approach to management is appropriate. Finally it is important to be able to provide treatment in a manner the child finds acceptable. This chapter helps the reader identify and effectively manage primary teeth with commonly encountered enamel defects.

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Introduction

In this chapter the management of developmental defects of enamel (DDE) in children is discussed, and the choice of techniques and materials, which are appropriate in the growing child, is elaborated upon. An important consideration is that many affected children will not have had any invasive dental treatment before. Suggested strategies for managing young children are included.

Etiology of DDE in the Primary Dentition

The etiology of DDE in the primary dentition can be divided into systemic and local causes. Local factors affecting primary teeth are limited to traumatic injuries. This is occasionally seen following neonatal intubation or the use of an oral airway for an extended period of time [1]. However, this has to occur at a very young age, i.e., before birth or during infancy, for it to affect enamel formation of the anterior primary teeth, making this an unusual phenomenon. Systemic factors, on the other hand, are more common and comprise a variety of conditions [2, 3] which are summarized in Table 10.1 below and discussed in more detail in Chaps. 1, 2, 3, and 4.

Unlike genetically determined defects, the effect of developmental factors on enamel formation depends upon the timing, duration, and severity of these factors and is usually referred to as chronological hypoplasia/hypomineralization (Fig. 10.1). For these factors to affect the formation of enamel in primary teeth, they will occur during hard tissue formation of the primary teeth. This starts with central incisor formation at 13–16 weeks after fertilization and ends with the second primary molars at 8–11 months of age [4]. The type of resulting defect will reflect whether the insult occurred during enamel matrix formation (leading to hypoplasia), mineralization (causing hypocalcification defects), or during maturation phase (causing hypomaturation defects). A clinician is likely to encounter two main types of enamel defects: hypoplastic and hypomineralized enamel. Hypoplastic enamel [4, 5] (Fig. 10.2) is caused by incomplete or defective formation of the organic

Table 10.1 Systemic factors that may be associated with DDE in primary teeth

Factors	Examples
Genetically determined	Amelogenesis imperfecta [3]
Chromosomal anomalies	Down syndrome
Congenital defects	Cardiac defects, unilateral facial hypoplasia or hypertrophy [2]
Inborn errors of metabolism	Galactosemia, phenylketonuria, alkaptonuria, erythropoietic porphyria, primary hyperoxaluria
Neonatal disturbances	Prematurity, hypokalemia
Infectious diseases	Measles, chickenpox
Neurological disturbances	
Chronic medical diseases	Hepatic disease, endocrinopathies, renal disease, enteropathies
Maternal health during pregnancy	Hypertension, nutritional deficiency, substance abuse
Nutritional deficiencies	Vit. D deficiency

Fig. 10.1 Chronological hypoplasia affecting the lower second primary molars and chronological hypomineralization affecting lower first permanent molars

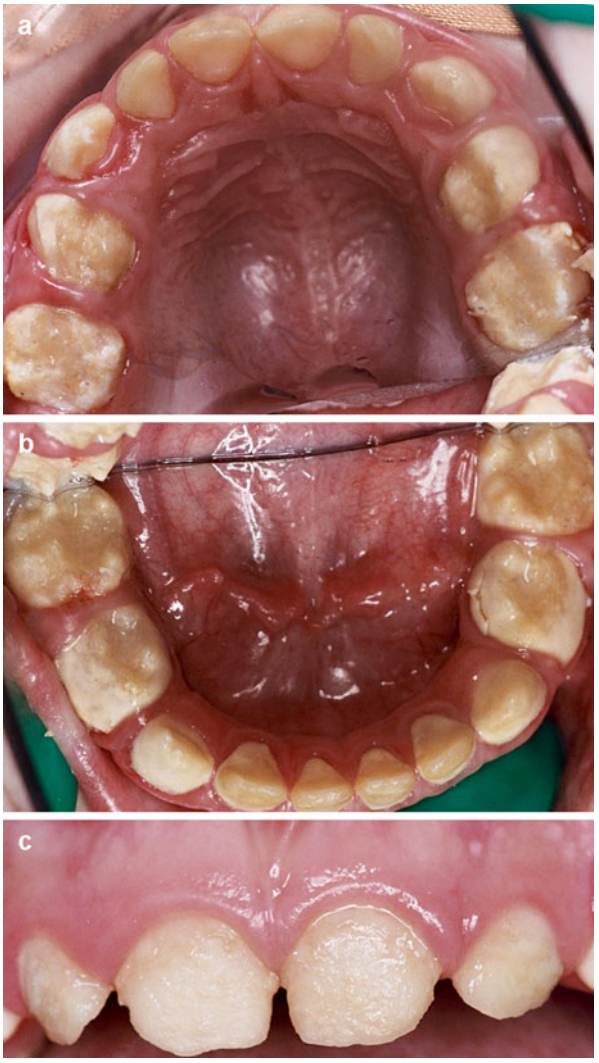

Fig. 10.2 (**a**–**c**) Preoperative images of a 3-year-old child with a hypoplastic form of AI. Note the buildup of calculus associated with the lower primary molars (Courtesy of Nicky Kilpatrick)

enamel matrix by ameloblasts during tooth formation (secretory stage) resulting in thinner but normally mineralized enamel. Hypomineralization occurs due to a failure in enamel matrix mineralization [4, 5]. This is further divided into hypocalcification (defective mineralization) or hypomaturation (defective removal of proteins from enamel matrix preventing maturation). Clinically, hypocalcified enamel is usually yellow-brown in color with more potential for enamel breakdown, while hypomature enamel may appear normal, mottled, or slightly opaque [4, 5].

Management of DDE in Primary Teeth

The management of enamel defects in generalized conditions or where they are likely to affect the permanent dentition is challenging and usually requires immediate-, short- and long-term planning [6]. Patients with amelogenesis imperfecta (AI), for instance, may have other associated anomalies such as disturbances in eruption, anterior open bite, pulpal calcifications, pathological root or crown resorption, and/or taurodontism. These anomalies affect the long-term management and usually require an interdisciplinary approach starting in the later primary/early mixed dentition. Patients with primary teeth defects often present at a young age and the parents want immediate treatment to improve the child's appearance. However, it is important to make a treatment plan which will encompass a stepwise approach that includes a short-, medium-, and a long-term treatment plan. Children with DDE often require several interventions throughout their primary, mixed, and permanent dentition stages [7], and should general anesthesia (GA) be required, it is crucial to plan and provide the necessary management in a timely manner so that the least number of GAs are required throughout the child's life.

The aims of management, especially at the primary dentition stage, include:

1. Prevention and maintenance of good oral hygiene
2. Desensitization and pain management of affected teeth
3. Restorative management (esthetic management and stabilization of affected teeth)
4. Behavior management to help children manage the dental care they need

Prevention

The gingival condition and oral hygiene of patients with both generalized defects, such as in AI or isolated defects, are often poor. Figures 10.1 and 10.3 show the presence of calculus in children with hypoplastic and hypomineralized AI. This occurs because many of the teeth are sensitive to thermal and toothbrush stimuli, which prohibits effective toothbrushing. Having enamel defects can also be an additional caries risk factor as the teeth are rough and porous with softer and/or thinner enamel. Therefore, treatment planning should firstly focus on prevention including effective oral hygiene instruction using warm water and very soft brushes,

Fig. 10.3 Anterior view of the mixed dentition in a child with AI showing poor oral hygiene, calculus deposits, and gingivitis

optimizing fluoride exposure both at home and with regular professional application, diet advice and sealants, or temporary restorations where appropriate. A guide is given in the UK Department of Health and British Association for the Study of Community Dentistry toolkit [8]. Comprehensive dietary analysis and advice is essential from both a caries and tooth surface-loss perspective. This will involve identifying fermentable carbohydrates and acidic foods and beverages in the diet and advising on their reduction and timing of use to minimize damage.

It is unrealistic to expect children with DDE to dramatically improve their oral hygiene without some intervention to reduce the sensitivity of the teeth. This might include the use of preventive agents such as topical fluorides or calcium phosphate-containing products or by placing interim restorations (glass ionomer cements or compomers) that will seal the dentine, thereby allowing the child to brush the affected teeth with less discomfort. In younger children, below 6 years-of-age, parents should help with brushing twice daily and should carry out regular flossing if the contact areas are closed.

Reducing Sensitivity

Several strategies are available for the treatment of the sensitivity associated with DDE, although none have been found to be reliable for every case (see Chap. 9). It is important to consider desensitization in order to reduce the discomfort felt by many children with DDE. This sensitivity also makes restorative interventions, especially with adhesive materials, even more challenging. Some of the suggested methods for desensitization include the use of topical fluoride preparations, in particular fluoride varnishes, such as Duraphat® 22,600 ppm F (Colgate Oral Care) or 3M Espe Fluoride Varnish with tricalcium phosphate. Care should be taken to use the recommended amounts on erupting teeth with DDE in preschool-aged children. More recently a combination of casein phosphopeptide and amorphous calcium phosphate (CPP-ACP – GC Tooth Mousse/MI Paste) with and without fluoride has also been advocated to help decrease sensitivity. CPP-ACP helps create, stabilize, and deposit a supersaturated solution of calcium and phosphate at the enamel surface. Therefore, it has been suggested that home application of a CPP-ACP-containing cream especially

when combined with fluoride use will help remineralize and desensitize by acting as a source of bioavailable calcium and phosphate. Other topical fluorides may also be useful; among these are stannous fluoride gels, such as Gel-Kam® 1,000 ppm F (Colgate Oral Care) or OMNI Gel 0.4 %/1,000 ppm F (3M). There has also been a suggestion that desensitizing toothpastes may help with some hypomineralized teeth. Currently there is no strong evidence to support the efficacy of these strategies in the management of DDE, though all these products may help reduce sensitivity and enhance mineralization of the hypomineralized areas. However, none of the available products are always effective, and clinicians should consider using products in combination or trying different products in an attempt to alleviate the symptoms in patients.

Pain and Anxiety Management

Pain management in children is an integral part of good pediatric dentistry. Both the technique and choice of local analgesia are important for the provision of high quality, effective restorations in children, particularly if they are to last for the lifetime of the primary teeth (up to 8 years). In particular, teeth that have DDE are more likely to be sensitive and consequently providing effective analgesia is often more difficult than for unaffected teeth.

Behavior Management

Clinicians should evaluate the understanding and coping skills of the child with DDE when the teeth require intervention. One of the commonly encountered problems is that children with DDE present with higher levels of anxiety. This is especially true in cases where the defect is associated with sensitivity or where previous treatment has been attempted without appropriate pain control or behavior management. If such defects are suspected, especially when associated with sensitivity, it is important not to air-dry these teeth during examination but to dry them gently with a cotton pellet. Managing young children requires empathy and some knowledge of behavior management techniques for children. Many pediatric dentistry textbooks cover useful techniques for helping children cope with restorative care. In the center of all the techniques is "tell, show, and do" which will allow most children to be able to cooperate for restorative care when it is presented in age-appropriate language and demonstration. This of course takes a little extra time but is time well spent in preparing a child for more complex care as they grow older.

Local Analgesia

For children who have been sensitized to previous invasive dental treatment, in particular local analgesia, the use of computer-controlled anesthesia (such as the Wand and the Wand STA – controlled dental anesthesia, Dental Practice Systems, Welwyn, Herts,

UK) can be an excellent way to administer local analgesia. The Wand provides several advantages over conventional syringes including the fact that it does not look like a conventional syringe; the fine bevel of the needle and the slow speed with which the local analgesic solution can be administered make it a simple way to deliver painless local analgesia. The use of 4 % articaine should be considered in managing older children especially where there is a history of failed local analgesia. For children over 4 years-of-age who are extremely wary of local analgesia, infiltration with 4 % articaine in the lower arch as opposed to an inferior dental block may provide adequate analgesia for restorations to be placed [9]. It is also important to make use of topical anesthesia. The preemptive use of systemic analgesics (in accordance with local guidelines) can also be an effective way of helping children cope with care successfully [10].

Sedation

In extremely apprehensive children who are otherwise cooperative, the use of inhalation sedation should be considered. This form of sedation has the particular benefit of having an analgesic effect which lessens the child's response to painful stimuli. Hence for children whose apprehension is due to sensitive teeth that have been previously treated without effective local analgesia, inhalation sedation with nitrous oxide and oxygen provides a safe, effective, and noninvasive method for managing the child's anxiety [11]. Other forms of sedation can be utilized according to local guidelines and clinicians' usual practice.

General Anesthesia

Clinicians treating children with severe enamel defects should consider the early use of general anesthesia to allow effective successful stabilization of the primary teeth. Previous studies of treatment under general anesthesia have shown good outcomes with decrease in the numbers of repeat restorations [12]. Children with severe enamel defects often present before they are old enough to cope with restorative dentistry; therefore, the use of general anesthesia is effective and valid for this group.

Restorative Management of DDE in the Primary Dentition

The decision to provide restorative management of enamel defects in primary teeth depends on several factors:

1. Type of enamel defect. AI is a generalized condition affecting the entire crown in addition to often being more severe than other developmental defects. The type of AI will also affect the type of restoration provided. Where there is missing enamel or enamel loss after eruption, full-coverage restorations should be considered early in the planning.

2. Extent and severity of the defects. In some cases of chronological hypoplasia, children may have few if any symptoms or significant tooth surface loss, which will suggest that less radical restorative options can be considered.
3. Associated symptoms. In cases of severe sensitivity, full coverage should be considered.
4. Esthetics with possible psychological effects on the child. The psychological impact of these conditions in children should never be underestimated (see Chap. 7). Esthetic management should be offered as soon as the child and the parents wish to have this carried out.
5. Patient cooperation and the method of treatment. In children who cannot cope with treatment under local analgesia, alternative strategies such as sedation or general anesthesia should be considered [7].

Interim Restorations

In some cases it may be appropriate to place interim therapeutic restorations to immediately alleviate pain and sensitivity while awaiting more definitive restorative treatment. The provision of these interim restorations also allows the clinician to establish rapport with the child and assist in behavior management. Materials such as resin-modified glass ionomer can be useful as these materials incorporate appropriate bonding for both enamel and any exposed dentin (Fig. 10.4) [13]. Some of the materials also incorporate a color that allows good visualization of the extent of the restoration on the tooth surface, e.g., Fuji VII/Triage (GC Corporation). The release of fluoride from these materials, although not proven to be a major factor, may also help to reduce sensitivity by encouraging further mineralization of the surrounding enamel. Compomer materials (polyacid-modified composite) might also be considered and can be placed using self-etching primers. These materials have the advantage of being more wear resistant than glass ionomer cement-based materials and have dual-bonding technology, which may seal both enamel and dentin effectively especially when further sealed with adhesive resin or fissure sealant following placement [13].

Longer-Term Restorations of Molar Teeth

Composite Resin Restorations

Composite resin should be considered in cases where:

- The defect is demarcated to a defined area, no more than two surfaces
- Cusp tips are not involved
- There is no significant sensitivity
- Margins of the defect are supragingival

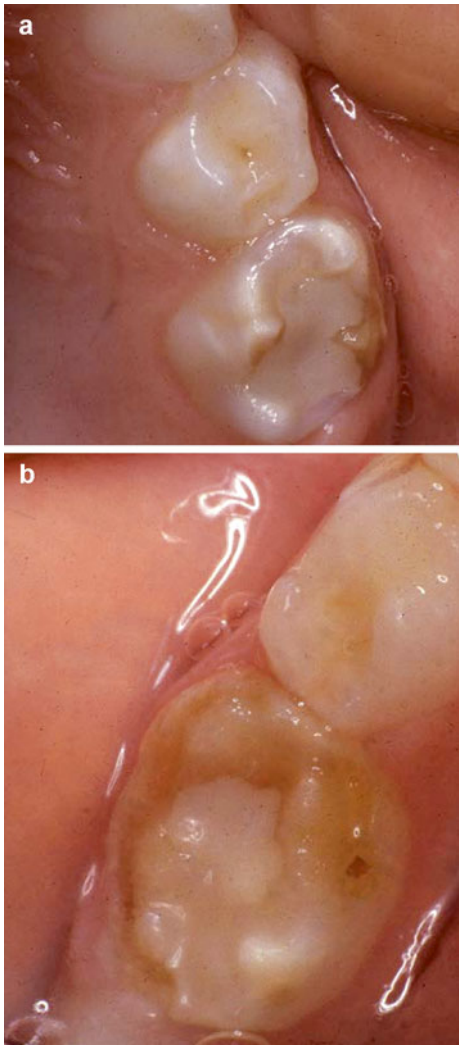

Fig. 10.4 (**a**, **b**) Example of the use of a glass ionomer cement used for interim protection on hypoplastic second primary molars in a 3-year-old (Courtesy of Nicky Kilpatrick)

There is evidence to suggest that hypomineralized enamel does not always show a typical etch pattern compared with normal enamel. This can potentially reduce the strength and integrity bond of enamel to composite resin [14, 15]. This is less of an issue with mild cases where normal enamel is present around isolated lesions. Pretreatment with 5 % sodium hypochlorite has been advocated to improve bond strength to hypocalcified enamel [16, 17]. The removal of affected enamel and bonding to dentin, which may be sclerotic, has also been suggested. However research outcomes are still not clear on the most reliable approach to bonding to sclerotic dentine in primary teeth. Recent research would suggest that reduced etching times may result in more reliable bonding particularly when using a total-etch

system [18]. Clinicians may need to try different approaches to achieve good results and reviewing research on the particular bonding system being used when planning treatment can be very helpful.

Preformed Crowns

Full coverage with either stainless steel or other esthetic preformed crowns should be considered in cases where:

- The defect involves multiple surfaces.
- There is significant sensitivity.
- Margins of defects are subgingival.
- There is involvement of the cusp tips in posterior teeth.
- Enamel is prone to "chipping," especially in some cases of AI.
- Treatment has to be carried out under general anesthesia and the child is unlikely to manage restorative care in the immediate future.

While preformed metal crowns (stainless steel crowns) are a well-recognized option for the treatment of carious primary molars, they also have an important role in the management of DDE-affected primary molars [19] (Figs. 10.3, 10.5, 10.6, and 10.7). Figures 10.3 and 10.5 illustrate good occlusal support provided by stainless steel crowns. The placement of stainless steel crowns requires minimal tooth preparation. They are less bulky than the white preformed crowns that may suffer wear and chipping of the veneer (Fig. 10.8). More recently for very young children, a technique, known as the "Hall Technique," has been described in which stainless steel crowns are placed with no preparation (Fig. 10.7) [20]. While this technique is promoted for children presenting with dental caries, anecdotal reports suggest that using this technique to place stainless steel crowns over hypomineralized or hypoplastic primary second molars soon after they erupt is a successful way of managing these teeth. Furthermore adopting this technique means that young children can be treated, without resorting to general anesthesia, early in the dental chair without local analgesia. Long-term studies of the use of stainless steel crowns for carious teeth would suggest that crowns placed over teeth with DDE have advantages over other restorative materials [21]:

1. Perform better where more than two surfaces are affected.
2. Less tooth removal is required.
3. Failure rate is much less than other restorative materials.
4. Moisture control is less critical than when restoring with other materials.
5. Placement is less time consuming than resin restorations.
6. Are more cost effective as shown by the outcomes over time.

Fig. 10.5 (**a–c**) Intraoral images of same child in Fig. 10.1 with hypoplastic AI, 2 years post-comprehensive restorative care under general anesthetic. Note the significant improvement in gingival health brought about by reduction in sensitivity (Courtesy of Nicky Kilpatrick)

Longer-Term Restorations of Anterior Teeth

Composite restorations are appropriate when restoring anterior teeth with demarcated defects affecting a maximum of two surfaces. Where lesions are diffuse, are large, involve multiple surfaces, or are associated with sensitivity, the use of strip crowns or preformed crowns is advocated [22, 23]. The technique for placing strip crowns involves the removal of approximately 1–2 mm of enamel from all the surfaces of the crown. The enamel is etched and prepared for bonding according to the manufacturer's instructions and the crown is filled with composite, placed on the tooth, with excess removed from the margins and the composite cured. Once the strip crown has

Fig. 10.6 (**a**) Preoperative photograph of child with hypomaturation-hypoplasia AI. (**b**) Postoperative photograph showing restoration of the hypoplastic second primary molars using stainless steel crowns. The anterior teeth were mildly affected, asymptomatic, and esthetically acceptable, therefore were managed with preventive care

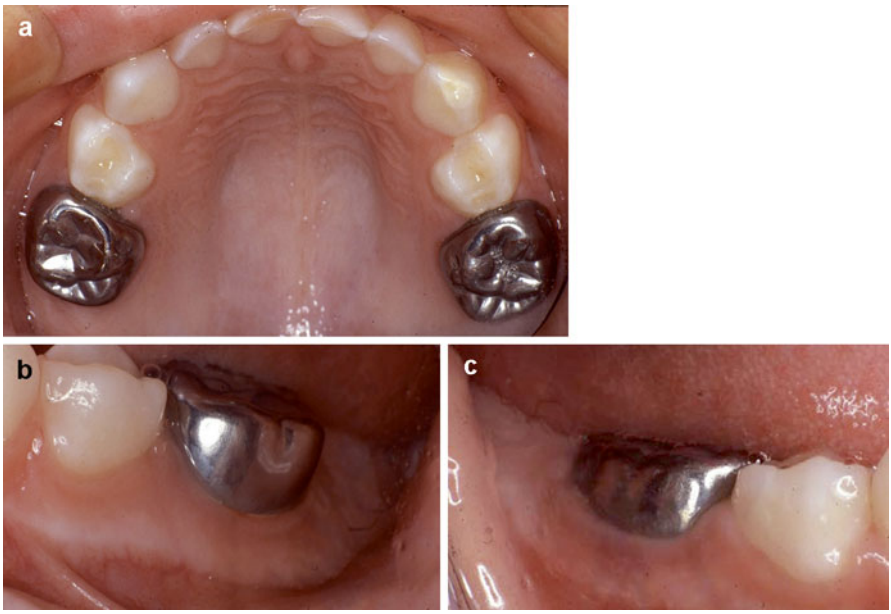

Fig. 10.7 (**a–c**) Same child as in Fig. 10.4 post-placement of stainless steel crowns on second primary molars using the Hall technique (Courtesy of Nicky Kilpatrick)

Fig. 10.8 Occlusal view showing restoration of the lower right second primary molar with NuSmile Signature white crown in which the veneer has chipped but the crown remains intact

Fig. 10.9 Occlusal view of anterior strip crowns and stainless steel crowns placed in a child with AI (Courtesy of Nicky Kilpatrick)

been removed, the restoration is finished in the usual manner (Figs. 10.5c and 10.9). More recently, the use of preformed white veneered crowns such as NuSmile Signature and pre-veneered Kinder Krowns® or zirconia crowns such as NuSmile zirconia and Zirconia Anterior Kinder Krowns® is advocated by some clinicians. These crowns provide very good esthetic results (Fig. 10.10). However they do require more extensive crown preparation and care must be taken to protect the pulp. The preformed crowns do have a higher cost and chipping can occur in the veneered stainless steel crowns (Fig. 10.8). Further studies are needed to assess the longevity of these restorations with particular attention being paid to their cost-effectiveness.

Extraction of Primary Teeth with DDE

In some cases extractions of severely affected teeth may be required. This should be done with evaluation of the space requirements in the developing dentition. In children where multiple teeth are affected and extractions are required, an

Fig. 10.10 Anterior primary incisors with zirconia crowns in a 2-year-old child (Courtesy of Bernadette Drummond)

interdisciplinary approach involving an orthodontist should be considered to optimize the development of the permanent dentition occlusion. Wherever possible, preventive and restorative approaches should be the preferred option as this always gives the child and their family a positive dental health message, where preservation of teeth is considered important. For further discussion regarding the interdisciplinary treatment planning needed for these children, see Chap. 8.

Summary

Children who suffer from DDE in their primary dentition deserve the highest quality restorative and preventive treatment. These children can be young, extremely apprehensive, and often caries-free, which means that management of affected teeth may be their first experience of invasive dentistry. Treatment should be provided with the use of appropriate behavior management techniques and analgesia to help children develop skills to cope with the restorative care both immediately and into their future.

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