# Management of Deep Carious Lesions Through Sealing in Primary Teeth

8

Nicola Innes

**Abstract**

The changes towards more conservative approaches to managing carious lesions in the permanent dentition have been mirrored for primary teeth. Prevention is key to treatment planning for the child with a carious primary dentition as the presence of the disease means that prevention has failed at some stage. Correct diagnosis of the presence/absence of carious lesions should be followed by investigation of whether each lesion is active/inactive and whether it is deep (advanced) or initial. Next a diagnosis of the status of the dental pulp must be made, to rule out irreversible pulpitis or infection of the dental pulp. The alternatives for managing carious lesions in an asymptomatic tooth (i.e., a tooth without signs or symptoms of irreversible damage to the dental pulp—pain/infection) are: Selective Removal to Soft Dentin and place a restoration; Sealing over the lesion with fissure sealant or resin infiltration; Sealing over the lesion with a crown using the Hall Technique; and No caries removal and no restoration using the Non-Restorative Cavity Control approach. These procedures are covered in detail in this chapter, their indications for different types of lesions and a flow chart to guide care planning is given.

## 8.1 Care of the Child with Deep Carious Lesions in Primary Teeth

Recently, there have been some notable changes in our approach to managing the child with carious lesions extending into dentin in their primary dentition. Historically, pediatric dentistry was considered as only a branch of traditional restorative dentistry and did not take into consideration the wider aspects of caring

N. Innes
School of Dentistry, University of Dundee, Dundee, UK
e-mail: n.p.innes@dundee.ac.uk



F. Schwendicke (ed.), *Management of Deep Carious Lesions*,
https://doi.org/10.1007/978-3-319-61370-3_8

for children with the disease. Alongside that, a greater understanding of the carious process has led to more conservative approaches to managing the lesion and teeth with the aim of preserving the dental pulp and tooth structure as much as possible through managing the biofilm [1] rather than trying to completely excise it [2]. This chapter deals with different approaches to, and methods for, managing the deep carious lesion in a primary tooth and discusses treatment planning and building a care plan. The differences between caring for primary teeth compared to permanent teeth and the core principles of treatment are discussed. We then look at carious lesion diagnosis specific to primary teeth and mention diagnosing for the dental pulp. The different treatment options are summarised, then explained in detail and this is followed by treatment planning for these options.

## 8.2 Differences Between Restoring Teeth for Adults and Children

The most obvious differences between managing caries in the primary dentition compared with the permanent dentition are anatomical ones: smaller teeth in small mouths; more bulbous teeth; larger pulp to crown ratio; less mineralized and thinner enamel; and splayed, ribbon-shaped roots that resorb. However, there are other fundamental differences that complicate providing care; child patients are different: they cannot look after their own oral health for a significant part of their childhood; they need to be brought for appointments; they like operative care even less than adults do; and they have less sense of "pain today for gain tomorrow" as they live in the present. As well as children being cognitively different from adults and holding a different place in society, primary teeth are morphologically different to permanent teeth and they exfoliate. However, children have the same rights to general and oral health as adults. Furthermore, adult dental disease begins in childhood, so prevention and education must be core to management.

Re-establishing successful prevention is a key part of managing established disease. Before considering managing dental caries, there must be acknowledgment that prevention has failed and a strategy has to be put in place to reconstruct successful preventive practices. For the child in the primary or mixed dentition stage, this must involve the parent/carer. Although they may develop the dexterity to carry out the physical activity of tooth brushing quite early, the age at which they have the cognitive ability to make decisions around caring for themselves comes much later. Until then, this is the responsibility of the adult caring for them.

## 8.3 Core Principles of Treatment Planning

The presence of disease does not mean that restorative management is necessary (see Chaps. 1 and 2). Instead, carious lesions can be sealed using different methods [3, 4]; options for sealing lesions have grown in number and include:

- Selective Removal to Soft Dentin where the lesion is sealed but the aim of avoiding damage to the dental pulp is balanced against the need for longevity of the restoration, as described in Chap. 5.

- Sealing of non-cavitated lesions using fissure sealants; the enamel surface must be relatively intact to allow an effective sealant, as described in Chap. 7.
- Sealing lesions under preformed crowns; the Hall Technique.

As well as sealing approaches for managing carious lesions, there is another option, employing a non-restorative approach:

- Regular and frequent removal of the biofilm through tooth brushing using a non-restorative cavity control approach. The carious lesion is made cleansable to allow repeated removal of the biofilm, preventing the lesion from progressing and promoting remineralization of the tissues.

Regardless of whether a sealing-in or biofilm removal care plan is derived or even if a restorative approach is resorted to, prevention needs to be reinstated as an active part of that care plan. This is just as important when non-cavitated (initial, white spot, etc.) lesions are present.

As the principles in Chap. 1 state: a restoration may not be necessary if it is possible to arrest the disease and overtreatment should be avoided. If carious tissue removal and a restoration are needed, the dental pulp vitality should be maintained.

The core principles, adapted and expanded from [5], can be summarised as: **Recognition** (of contributory factors); **Reorientation** (of lifestyle factors); **Remineralization** (of all lesions—visible and not visible, cavitated and non-cavitated); **Repair/restore** (where no other solution is possible) and **Review** (of the child, their oral health and their situation).

## 8.4 Carious Lesion Diagnosis in Primary Teeth

Diagnosis of the presence of dental carious lesions is not simply a binary decision on whether a carious lesion is present or not. It involves several decision steps.

### 8.4.1 Lesion Presence/Activity/Depth

Treatment possibilities for each lesion depend on its stage, activity and how advanced it is, therefore diagnosis needs to consider, for each surface of a tooth:

- Is there a carious lesion present—yes/no

  If yes, then for each lesion:

- Is the lesion—active/inactive?

  Deciding on activity

- Is the lesion—deep (advanced) yes/no?

### 8.4.2 Defining Lesion Activity

It can be difficult to tell whether a lesion has arrested or not at a single appointment as the true definition of an arrested lesion is one that does not progress over time. Nevertheless, it is often necessary to make a judgement on this at a single timepoint (although following up the tooth and child will confirm the diagnosis or will lead to a change in care if the lesion is seen to progress). Although this book is about deep dentinal lesions, for completion, enamel lesion characteristics are also mentioned.

For carious lesions that are confined to the enamel, the enamel surface will be rough when the lesion is active [6]. For dentinal lesions where the surface is exposed, the degree of hardness indicates how likely a lesion is to be arrested [6]. The harder the tissue, the less likely the lesion is to progress. Cleansability and presence of biofilm over vulnerable surfaces are two further factors that can influence a decision around whether a lesion is likely to be arrested. The less cleansable and more biofilm, the less likely the lesion is to be, become, or remain arrested. Of course, often the cleansability of the tooth can be influenced through non-restorative cavity control (see later in this chapter).

### 8.4.3 Defining Lesion Depth

There are no agreed definitions for lesion staging and here they are broken down depending on whether the lesion is considered initial or deep/advanced. The following definitions are used to allow identification of deep lesions and recommendations for their treatment to be specified:

#### 8.4.3.1 Occlusal Lesions (Molar)

- Initial—Clinical-visually, these lesions are usually non-cavitated, often with dentin shadowing or minimal enamel cavitation; radiographically, they extend into the outer 1/3 of dentin at most.
- Advanced/deep—Clinical-visually, the lesions show a dentin shadow or cavitation with visible dentin; radiographically, the middle or inner 1/3 dentin is affected, but a clear band of dentin is still visible between the advancing front of the lesion and the dental pulp.
- Extremely deep—These lesions share similar characteristic to the deep lesions, but without the radiographic band of dentin between the lesion and the pulp; they are often much harder to manage whilst maintaining the pulp (the pulp prognosis is much poorer, as often pulps are inflamed). More details can be found in Chap. 3.

#### 8.4.3.2 Proximal Lesions (Molar)

- Initial—Clinical-visually, these present as white spot lesions or can be detected as shadowing; radiographically, the lesions are confined to enamel or just into the dentin (extending into the enamel–dentin junction, but not much beyond).

- Advanced/deep—Clinical-visually, these show enamel cavitation or dentin shadow, or cavity formation with visible dentin; radiographically, they extend up to inner 1/3 dentin but a clear band of dentin is still visible between the advancing front of the lesion and the dental pulp.
- Extremely deep proximal lesions are similarly defined and characterized as those on occlusal surfaces.

#### 8.4.3.3 Anterior Tooth Lesions

- Initial—Clinical-visually, they are white spot lesions without dentinal affection.
- Advanced/deep show cavitation or dentinal shadow.

## 8.5 Diagnosis of the Dental Pulp Status

Having diagnosed the presence, activity and depth of the carious lesion, a further diagnosis relating to the dental pulp must be made. This is to ensure it is not irreversibly inflamed or infected. A careful clinical and radiographic assessment will establish whether there is irreversible pulpitis or peri-radicular periodontitis. Ensuring these are not present then allows options for the carious lesion to be determined. Management of the irreversibly inflamed and/or infected dental pulp with a pulp therapy of some kind is beyond the scope of this book.

### 8.5.1 Clinical Diagnosis and the Dental Pulp

The deep carious lesion can cause symptoms of pain. In the primary dentition, it can be difficult to determine whether the pain is due to reversible pulpitis, irreversible pulpitis or peri-radicular periodontitis.

Symptom reporting from the patient's history can be through the child or the parent and the clinical examination will allow clinical signs to be detected. Together these give information that will help to inform whether there are any signs or symptoms of irreversible pulpitis/peri-radicular periodontitis.

Irreversible pulpitis is characterized by spontaneous pain, pain from the tooth wakening the child or keeping them awake at night, and/or pain not resolved on removal of a stimulus—hot, cold, sweet. This can be a difficult judgement to make:

- children are not good reporters of symptoms especially when young and cognitively it can be difficult for them to understand what they are feeling and to express it;
- reversible pulpitis does not present with distinct and discernible symptoms that suddenly completely change to those of irreversible pulpitis. The transition is a gradual one towards irreversible pulpitis with episodes of progression, regression and intermittent resolution of symptoms; and
- there are multiple roots and multiple root canal systems. In a departmental audit of pulp vitality during pulp therapy, (in 2007), in around 1/3 of cases where there was a sinus or abscess, the dental pulp was still vital is one or more canals. This adds to the complexity of diagnosis.

Signs of pulpal infection include the tooth being tender to percussion when there is peri-radicular periodontitis as the peri-radicular tissues are inflamed. There may be an abscess or sinus associated with the peri-radicular (usually the furcal) area of the tooth. This tends to be seen at the mucogingival junction, or draining from the gingival sulcus of the tooth.

### 8.5.2 Radiographic Diagnosis and the Dental Pulp

A recent radiograph with the furcation area visible should show no signs of infection. Established infection will be visible as a radiolucent area in the furcal area (Fig. 8.1) although this can take a number of months to be significant enough to appear on a radiograph. This can often be seen clearly on a horizontal bitewing radiograph although sometimes it might be necessary to take a vertical bitewing to visualise the inter-furcal area clearly.

The bitewing radiograph serves another important diagnostic function that can help with determining whether the tooth is likely to have irreversible damage to the dental pulp; it allows an assessment of the extent of the carious lesion. Although it is not possible to gauge lesion depth with the same accuracy that would be achieved histologically, with skill and experience, the clinician can determine whether the lesion has already reached the dental pulp and therefore, whether it is too late to stop the progress of the lesion from reaching the pulp, in which case a pulp therapy should be performed (as has been discussed in Chaps. 1 and 3). When the carious lesion is viewed on a good quality bitewing radiograph, there is a band of dentin between the advancing lesion and the dental pulp (Fig. 8.1) (for further information on the well-defined deep lesion, see Chap. 3). This key sign is related to clinical success.

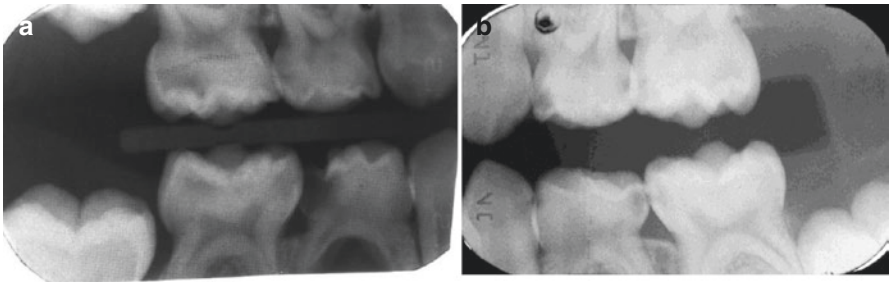


**Fig. 8.1** (**a**) Tooth 84 (lower right first primary molar) has a distal lesion extending into the dental pulp and there is no clear band of dentin between the lesion and the pulp. There is also a peri-radicular radiolucency visible. (**b**) Tooth 74 (lower left first primary molar) has a carious lesion on the distal surface extending into the middle 1/3 of dentin but a clear band of dentin is visible beween the advancing surface of the lesion and the dental pulp

## 8.6 What Alternatives Are There for Management?

Having established our parameters for deep lesions in the asymptomatic (i.e., no signs or symptoms of pain/infection) primary tooth, the groups of treatments are listed below. These options still follow the aims and principles established in Chap. 2: avoiding pulp exposure, preserving the dental pulp vitality, retaining tooth structure and avoiding unnecessarily invasive treatment. The details on these options presented in Sects. 8.7, 8.8, 8.9 and 8.10.

### 8.6.1 Selective Removal to Soft Dentin, Place a Restoration

This follows the same principles as those for permanent teeth (see Chaps. 2 and 5).

### 8.6.2 Sealing Over the Lesion with Fissure Sealant

This, as discussed in Chap. 7, involves using resin or glass ionomer cement materials to arrest the lesion through sealant placement. Sealants have been shown to be effective for fissure lesion prevention [7–11] but also management of proximal carious lesions [12].

### 8.6.3 Sealing Over the Lesion with a Crown Using the Hall Technique

As a method for sealing over carious primary molars this technique involves no tissue removal, tooth trimming or local anaesthesia. A correctly sized crown is simply pushed over the teeth and the lesion is sealed in, preventing ingress of nutrients and slowing or stopping progression of the lesion.

### 8.6.4 No Carious Tissue Removal and No Restoration; Non-Restorative Cavity Control (NRCC)

This is a method where an active decision is made to manage the lesion with no carious tissue removal. The cavity and lesion are made cleansable through removal of overlying enamel and dentin and ensuring that the lesion and tooth are cleaned frequently and regularly to remove the biofilm. Fluoride is often applied to help with the aim of this treatment option—to arrest the lesion and stop it from progressing as has been briefly discussed in Chap. 2.

### 8.6.5 Fluoride Adjuncts

Sodium fluoride varnish and silver diammine fluoride (SDF) have also recently become of interest (in the case of SDF this is re-interest) to assist the process of arresting lesions with NRCC and when sealing. It has been used alongside atraumatic restorative treatment (ART) and prior to placing a restoration. This has been called SMART (Silver Managed ART). Using medicaments to help arrest and remineralise tooth substance has also been tried under Hall Technique placed crowns (called SMART Hall by proponents). There is, as yet, no evidence to support SDF as an adjunct and it is not known whether such pretreatment improves outcomes or just adds an extra step to the treatments.

We will now describe all these options in more detail.

## 8.7 Selective Removal to Soft Dentin, Place a Restoration

The selective removal of carious tissue can, as described, be achieved using hand excavation with sharp instruments such as an excavator. This allows tactile feedback to indicate when to stop removing the lesion [2], and uses the same techniques as are used for cavity preparation via ART [13]. The aim is to preserve tooth tissue, avoid pulpal damage and exposure and retain as much residual dentin on the pulp floor as possible. Again, similarly to permanent teeth, this aim must be balanced against the cavity requirements to achieve maximum restoration longevity. In the pulpal area of a cavity, soft carious dentin is left defined if needed [14]. At the periphery of the cavity, to obtain an effective seal and maximize restoration survival the enamel and dentin are prepared to hard dentin. Figure 8.2 shows an upper primary molar managed with selective removal to soft dentin.

## 8.8 Fissure Sealants; Why Sealing Is an Option, but Sealants Might Not Do It

Fissure sealing has evidence to support its use for managing both proximal [12] and occlusal lesions [3, 15, 16]. However, evidence for sealants over carious lesions has mainly been obtained from studies of shallow lesions where there is no cavitation of the lesion. As discussed in Chap. 2 and the last chapter, fissure sealants are low-filled resins and when taken in a thin section are very brittle. The properties of the materials mean that they are not currently suitable for use in lesions where demineralisation of enamel and dentin have taken place to such an extent that the ability of the tooth to withstand biting forces has been compromised. Sealants will provide protection from the ingress of bacteria but will not add much to the strength of the tooth. In cases where the lesion is very deep, the sealant will usually not prevent the tooth beneath it from breaking down if the

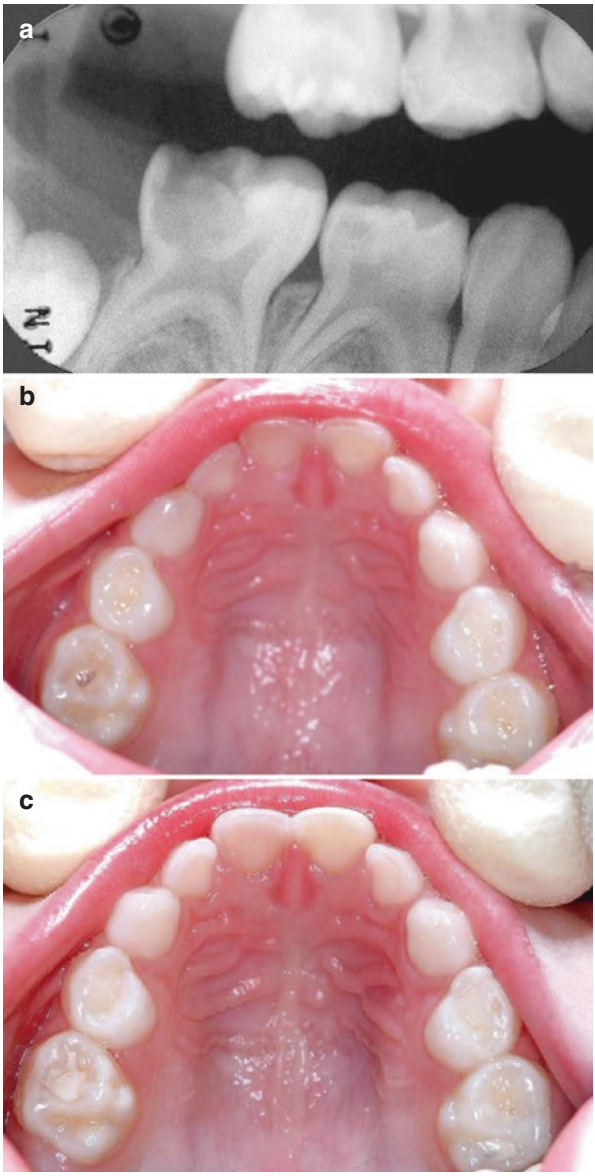


**Fig. 8.2** Management of an occlusal carious lesion in a primary molar. (**a**) Tooth 55 (upper right second primary molar) has a carious lesion on the occlusal surface extending into the middle 1/3 of dentin but where there is a clear band of dentin visible between the advancing edge of the carious lesion and the dental pulp. Tooth 85 (lower right second primary molar) has an occlusal lesion that has extended into the dental pulp and there is no clear band of dentin visible. (**b**) Clinical picture of tooth 55 (same child as A) before treatment and (**c**) shows the same tooth after treatment using selective removal to soft dentin by hand instruments and restoration with glass ionomer

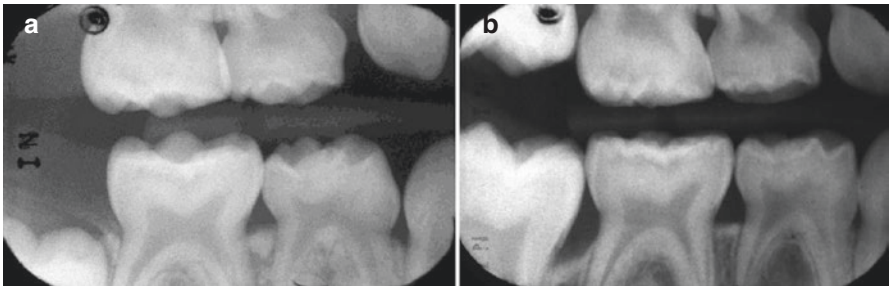


**Fig. 8.3** Sealing over occlusal carious lesions in primary molars. (**a**) Radiograph taken when the child was 5 years old showing initial carious lesions in all four first primary molars. These were sealed and radiograph (**b**) was taken 2 years later. There is no evidence of progression of any of the lesions

forces are too great. Figure 8.3 shows a case where radiographically the carious lesion is visible as extending into dentin although it should be noted that such a lesion would not be considered deep. A sealant was placed on the occlusal surface and 2 years later (Fig. 8.1b) there is no radiographic evidence of lesion progression. The "amount" of carious dentin that can be sealed under a sealant, or the exact extent of the lesion where this treatment option is likely to be successful, has not been measured in any detail.

## 8.9 The Hall Technique

There are several options for managing primary teeth with carious lesions that take advantage of being able to slow or stop the lesion progression by sealing the carious biofilm from the oral environment. One of the most predictable ways of creating a seal is to place a preformed metal (stainless steel) crown onto the tooth using the Hall Technique. No carious tissue is removed, no tooth preparation is carried out and no local anaesthesia needed. Crowns that have been manufactured for traditional use are simply pushed over the tooth. The Hall Technique offers a carious lesion management method for children that they, their parents and dentists find more acceptable [17, 18]. Crowns are known to be a durable and successful restoration but are greatly underused [19] and it is thought to be due to underteaching or anxiety by clinicians about their use [20], even though they often consider them a good restorative option [21]. The Hall Technique provides a way of fitting crowns using a simpler but highly successful method.

There is a strong body of evidence to support the Hall Technique generated in a variety of countries, different settings and with different operators and comparisons [18, 22–29]. The performance of the Hall Technique and child, parent and carer preferences have been evaluated in randomized control trials [18, 24]. Longitudinal evaluations of the technique in different settings and with a variety of operators [28, 30] have also been carried out. However, all studies have consistently shown the technique to either outperform or match standard restorations, including conventional placement of crowns using local anaesthetic. Table 8.1 gives indications and contraindications for use of the technique. Sometimes before a crown can be fitted, it is necessary to create space proximally. Space can be gained by placing

**Table 8.1** Indications and contraindications for choosing the Hall Technique as a treatment option for primary molars

| | |
|---|---|
| *Indications* for the Hall Technique include teeth with: | • Proximal lesions, cavitated or non-cavitated<br>• Occlusal lesions, non-cavitated<br>– If the child is unable to accept a fissure sealant<br>• Occlusal lesions, cavitated<br>– If the child is unable to accept selective removal and intra-coronal restoration |
| *Contraindications* for the Hall Technique include teeth with: | • Where no "clear band of dentin" can be seen on a radiograph (lesion no longer well-defined: high risk of irreversible pulpitis or pulp necrosis, see Chap. 3)<br>• Signs or symptoms of pulpal exposure, irreversible pulpitis, pulp necrosis, or peri-radicular periodontitis<br>• Crowns/teeth that are so broken down, they would be unrestorable with conventional techniques<br>• Children where the airway cannot be managed safely |

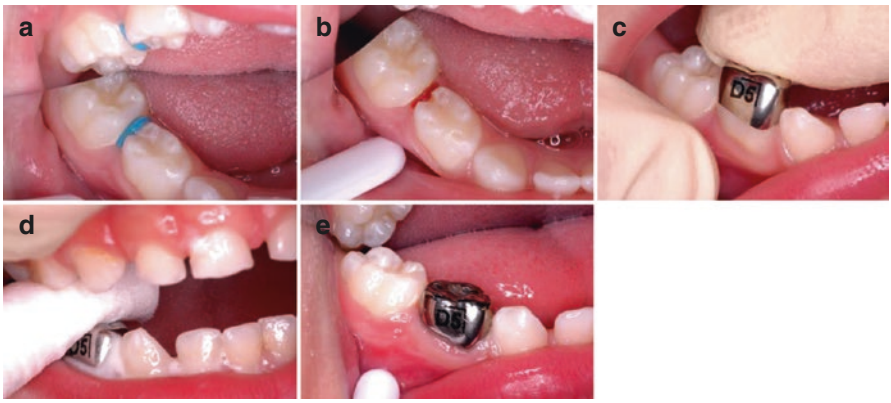


**Fig. 8.4** Placement of a Hall Crown. (**a**) An orthodontic separator placed between tooth 84 and tooth 85 and (**b**) shows the space created following its removal after 3 days. (**c**) A crown being tried on to tooth 85 to check for the correct size. Different crowns are tried over the tooth until the correct size is found (covering the cusps and giving a feeling of "spring back"). (**c**) The crown is filled with glass ionomer cement. (**d**) The crown is seated over the tooth (there is no local anaesthetic, tooth preparation or carious tissue removal) and, in this case, once the crown has been pushed over the tooth enough to engage the contact points, the child is using their bite force to seat the crown with cotton wool to help distribute the force. Excess cement is cleared away (mainly to remove the bitter taste of the glass ionomer which children do not like as well as to allow the area to be fully visualised) and position of the crown is checked before the cement sets. This is to ensure that it has not been pushed on in a more buccal or palatal direction or has failed to fully engage the mesial and distal undercuts. The crown should be well seated all around. At this stage, because the cement is still not set, the crown could be removed using a spoon excavator under the skirt of the crown if necessary and the procedure started again. (**e**) The crown has been fitted and the gingiva is blanching as the crown is sitting slightly subgingivally. The increase in the occluso-vertical dimension will resolve within a few weeks

orthodontic separators between the contacts for several days. The crown is fitted by choosing the correct size of crown, filling it with glass ionomer cement (luting consistency) and simply pushing it over the tooth (Fig. 8.4). More detailed and updated explanation and discussion of the technique and a step-by-step guide can be found at https://en.wikipedia.org/wiki/Hall_Technique.

Placing a Hall crown will disrupt the occlusion if there is an opposing tooth to the one being treated. This should be monitored before the crown is fitted, immediately afterwards (to ensure that the occluso-vertical dimension has not been disrupted by too much), and then at follow-up (to confirm the occlusion has returned to its pre-crown state). This can be done by measuring the distance from the lowest point on the gingivae on the lower canine to the tip of the upper canine (these are usually the most stable teeth in this age-group of children and should not be exfoliating or erupting).

## 8.10 Non-Restorative Cavity Control

As described in Chap. 2, Non-Restorative Cavity Control (NRCC) is a useful technique for where the tooth is so broken down that it cannot be restored and has been advocated by some for teeth with cavitations but where the lesions are cleansable (and being cleaned) although this is more contentious. In all cases, however, the tooth must be free from signs and symptoms of irreversible pulpitis or peri-radicular infection. Although there is some evidence for NRCC, this is still sparse and has tended to involve cohorts or other non-randomised control designs, making it difficult to gauge the comparative success rates for NRCC. Furthermore, different ways of carrying out NRCC have been described with some clinicians placing nothing over the cavity once it has been made cleansable and others applying a thin layer of a restorative material such as a cavity liner glass ionomer. Still others advocate placing and reapplying sodium fluoride varnish or silver diamine fluoride at different intervals. This adds to the difficulty in comparing NRCC with other techniques and makes giving parents/carers information on treatments' likely success relative to one another, difficult.

There is currently only one randomised control trial and this investigates cavitated proximal lesions treated with NRCC and compared it to the Hall Technique and conventional restorations. All lesions were occluso-proximal into dentin (International Caries Detection and Assessment System [ICDAS] codes 3–5) but restorable. The Hall Technique statistically and clinically significantly outperformed both the conventional therapy (non-selective carious tissue removal to hard dentin and a compomer restoration) and the NRCC (which performed similarly with no statistical difference to the conventional therapy). NRCC teeth experienced 5% restoration failure rates and 3% pain/infection after 1 year, the conventional restorations 11% and 5%, respectively, and for the Hall Technique teeth this was only 1% and 0%. Although the data is only from one study, it indicates that the Hall Technique is more likely to be clinically successful in restorable lesions and that NRCC might be best restricted to non-restorable lesions. Futhermore, a recent longitudinal study also cast doubts as to the effectiveness of NRCC as only 50% of the teeth in the study survived successfully without pain, pulpal or periapical pathology [31].

Traditionally NRCC has been considered for the occluso-proximal lesions where enamel has had to be removed to allow the active lesions to be opened to the environment. However, the principles of removing overlying tooth tissue (Fig. 8.5) that

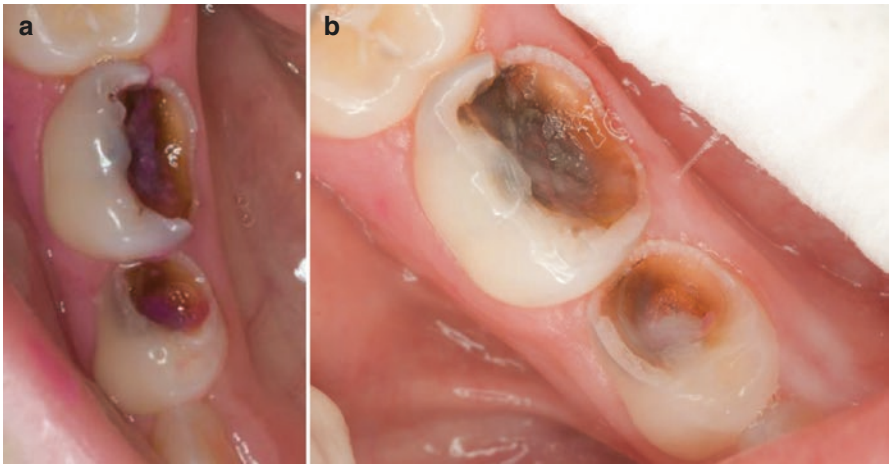


**Fig. 8.5** Non-restorative cavity control. (**a**) Teeth 84 and 85 (lower right first and second primary molars) with cavitated lesions which are still active. However, there is limited ability to clean them as demonstrated by the pink disclosing solution remaining in the cavities after toothbrushing by both the child and the parent under the clinician's supervision. (**b**) The teeth after some of the overhanging occluso-buccal enamel has been removed and the lesions are more open making them easier to be cleaned. Further enamel might be removed in stages in the future if this is necessary

is preventing the lesion from access to saliva, brushing and fluoride from toothpaste remain the same regardless of the shape of the lesion. The lesions shown in Fig. 8.6 are an example of lesions in primary molars that are not restorable and not easily cleansable but were opened up, making them cleansable and allowing them to be maintained.

Each tooth needs to be judged on its own merits as to whether this is a suitable treatment option. However, more importantly, there are a number of wider conditions that have to satisfy for NRCC to be successful. These involve willingness and ability of the patient or the patient/carer to accept responsibility and their role in ensuring the success of the procedure.

The steps involved in NRCC are:

1. The cavities must be made accessible to a toothbrush or adjunct (compare with cases in Chap. 2)
2. When carrying out tissue removal to make the lesion accessible to cleaning, the following points should be kept in mind:
   - If trying to expose occluso-proximal lesions in molars, try to keep the molars in contact towards the gingival margin area to prevent drifting.
   - If necessary, make a chamfer preparation.
   - Do not excavate.
   - Make the lesion accessible for adequate cleaning with a toothbrush.
   - The enamel–dentin junction does not need to be clean.

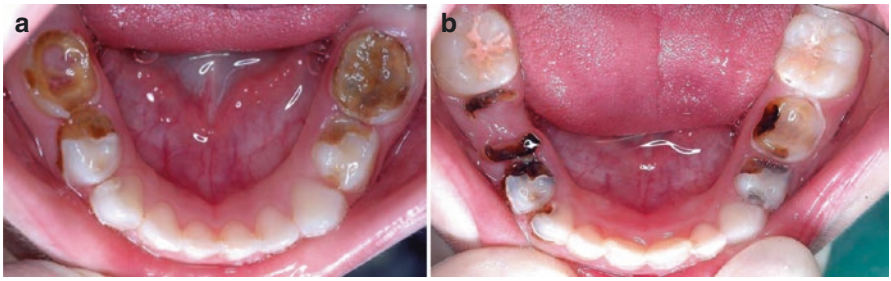


**Fig. 8.6** Lower arch of a 4-year-old boy with active, soft lesions in all primary molars. (**a**) Despite the extensive carious lesions, there is no pain and no signs of infection (no abscesses or sinuses or swellings). A highly intensive preventive programme was built with his mother and (**b**) shows the lesions arrested and hard 2 years later. The mesial lesion on the lower left first primary molar is trapping plaque and is not cleansable so it needs to be managed by being opened up

3. Sodium fluoride varnish or silver diamine fluoride varnish should be applied to the cavity to help the process of lesion arrest and remineralisation. Placing a layer of resin-modified glass ionomer cement-lining cement can be considered. This would be done after removing the biofilm with a prophy brush and toothpaste.
4. There should be some way of monitoring the lesions for progression, possibly through successive clinical photographs. These can be used to discuss the treatment success with the patient or parent/carer and whether a change in strategy is needed.
5. There is likely the need for intensive communication (using a theory-based approach such as motivational interviewing or coaching) and action planning is likely to be helpful.

Opening up lesions and using NRCC will only be successful if every one of these steps is taken into account. The technique is still commonly misunderstood as a "do nothing" treatment when it is very much the opposite. To be successful, there must be twice daily maintenance. However, this cannot be carried out by the clinician—their responsibility is to hand over care of the lesion to the patient or parent/carer and this can be very much more challenging than carrying out technically difficult dentistry [31]. Figure 8.6 shows what can be achieved when habits are changed and open lesions are brushed twice a day.

## 8.11 When Is Each Option Appropriate?

This section gives some guidance, for different types of lesions, which options might be the most appropriate to help with treatment planning. In all cases discussed here, these options relate to the deep carious lesion in the asymptomatic primary tooth with no infection.

### 8.11.1 Management Options for Arrested Lesions

For deep lesions in primary teeth that are not active (i.e., can be considered arrested), the carious lesion may be manageable with a non-restorative approach. In the past, a restoration would always have been recommended for any carious lesion in a restorable primary tooth on the basis that this is what has always been done for a permanent tooth. However, in the child, where the lesion is arrested and the tooth will exfoliate before the lesions progress to give pain or infection, placing a restoration may not provide any actual health benefit for the child. Non-restorative cavity control in this situation might provide the means for keeping the tooth present, avoiding pain and infection. It also avoids invasive treatment with its associated costs (both time and monetary), potential negative psychological impacts and possible iatrogenic damage to adjacent teeth or through damaging the pulp.

### 8.11.2 Management Options for Active Lesions in Teeth that Are Not Restorable

For teeth where there is so much tooth substance lost that it is no longer restorable, the management options are limited to non-restorative cavity control. If the tooth becomes symptomatic or signs of infection develop (as is often seen in cases where patient/carer compliance is not adequate), it will need to be extracted.

### 8.11.3 Management Options for Active Lesions in Potentially Restorable Teeth

A variety of treatment options are available for active lesions in such teeth. Often more than one option is clinically appropriate for a lesion/tooth depending on the lesion stage. However, other factors such as the child's ongoing caries risk status and how long the tooth is likely to be in the mouth before exfoliation need to be considered alongside these options.

#### 8.11.3.1 Primary Molar with Occlusal Lesion

Selective Removal to Soft Dentin is the first choice for these lesions because it is less invasive than placing a crown. Similar to the permanent tooth, the cavity depth is driven by the need to obtain sufficient depth for the restorative material. It is likely that simply placing a fissure sealant over a deep lesion will not be adequate as the lesion is likely to be cavitated or the tooth too weak to withstand forces. In such cases the Hall Technique might be a good alternative. The Hall Technique might also be chosen when the child is very young and adequate moisture control cannot be achieved to carry out a high quality, direct restoration.

#### 8.11.3.2 Primary Molar with Proximal Lesion

The Hall Technique is the first choice for these lesions, and it has been shown to have good longevity and very high success rates. A suitable alternative might be selective carious tissue removal and restoration. Whether this is followed by an intra-coronal restoration or a preformed crown will depend on the size of the lesion, preferences of the child and parent, and time to exfoliation.

#### 8.11.3.3 Primary Anterior Teeth

For advanced lesions, selective carious tissue removal to soft dentin would be the treatment of choice and then the tooth should be restored with an aesthetic adhesive filling material or a composite strip crown. However, it may be necessary to remove more of the lesion to reach firm dentin, if adequate depth and area to bond to cannot be achieved without further removal. In some cases, non-restorative cavity control might be suitable, for example, where the lesions can be opened for cleansing and fluoride adjunctive treatment should be considered.

## 8.12 Summary

- A greater understanding of caries and carious lesions has led to more conservative management approaches, supporting preservation of tooth substance, health of the pulp and providing child-centred treatment options.
- The core principles for treatment planning management of carious lesions for the child's primary dentition are the same as those described in Chap. 2.
- Diagnosis of the lesion is followed by diagnosis of the status of the dental pulp and only then can treatment options be determined.
- The carious lesion can be: selectively removed to soft dentin and then sealed; sealed into the tooth with a fissure sealant; sealed under a crown using the Hall Technique; not removed and managed with non-restorative cavity control.
- Treatment options are determined by the lesion, tooth child, their circumstances and the limitations of the techniques available.

## References

1. Marsh PD. Dental plaque as a biofilm and a microbial community—implications for health and disease. BMC Oral Health. 2006;6(Suppl 1):S14.
2. Schwendicke F, Frencken JE, Bjørndal L, Maltz M, Manton DJ, Ricketts D, et al. Managing carious lesions: consensus recommendations on carious tissue removal. Adv Dent Res. 2016;28(2):58–67.
3. Ricketts D, Lamont T, Innes NP, Kidd E, Clarkson JE. Operative caries management in adults and children. Cochrane Database Syst Rev. 2013;(3):CD003808.
4. Schwendicke F, Meyer-Lueckel H, Dörfer C, Paris S. Failure of incompletely excavated teeth: a systematic review. J Dent. 2013;41:569.
5. Walsh LJ, Brostek AM. Minimum intervention dentistry principles and objectives. Aust Dent J. 2013;58(Suppl 1):3–16.

6. Takahashi N, Nyvad B. Caries ecology revisited: microbial dynamics and the caries process. Caries Res. 2008;42(6):409–18.
7. Ahovuo-Saloranta A, Forss H, Hiiri A, Nordblad A, Makela M. Pit and fissure sealants versus fluoride varnishes for preventing dental decay in the permanent teeth of children and adolescents. Cochrane Database Syst Rev. 2016;(1):CD003067.
8. Ahovuo-Saloranta A, Hiiri A, Nordblad A, Makela M, Worthington HV. Pit and fissure sealants for preventing dental decay in the permanent teeth of children and adolescents. Cochrane Database Syst Rev. 2008;(4):CD001830.
9. Ahovuo-Saloranta A, Hiiri A, Nordblad A, Worthington H, Makela M. Pit and fissure sealants for preventing dental decay in the permanent teeth of children and adolescents. Cochrane Database Syst Rev. 2004;(3):CD001830.
10. Hiiri A, Ahovuo-Saloranta A, Nordblad A, Makela M. Pit and fissure sealants versus fluoride varnishes for preventing dental decay in children and adolescents. Cochrane Database Syst Rev. 2006;(4):CD003067.
11. Hiiri A, Ahovuo-Saloranta A, Nordblad A, Makela M. Pit and fissure sealants versus fluoride varnishes for preventing dental decay in children and adolescents. Cochrane Database Syst Rev. 2010;(3):CD003067.
12. Dorri M, Dunne SM, Walsh T, Schwendicke F. Micro-invasive interventions for managing proximal dental decay in primary and permanent teeth. Cochrane Database Syst Rev. 2015;(11):CD010431.
13. Frencken JE. The state-of-the-art of ART restorations. Dent Update. 2014;41(3):218–24.
14. Innes NP, Frencken JE, Bjorndal L, Maltz M, Manton DJ, Ricketts D, et al. Managing carious lesions: consensus recommendations on terminology. Adv Dent Res. 2016;28(2):49–57.
15. Wright JT, Tampi MP, Graham L, Estrich C, Crall JJ, Fontana M, et al. Sealants for preventing and arresting pit-and-fissure occlusal caries in primary and permanent molars: a systematic review of randomized controlled trials-a report of the American Dental Association and the American Academy of Pediatric Dentistry. J Am Dent Assoc. 2016;147(8):631–45. e18.
16. Fontana M, Platt JA, Eckert GJ, Gonzalez-Cabezas C, Yoder K, Zero DT, et al. Monitoring of sound and carious surfaces under sealants over 44 months. J Dent Res. 2014;93(11):1070–5.
17. Innes NP, Evans DJ, Stirrups DR. The Hall Technique; a randomized controlled clinical trial of a novel method of managing carious primary molars in general dental practice: acceptability of the technique and outcomes at 23 months. BMC Oral Health. 2007;7:18.
18. Santamaria RM, Innes NP, Machiulskiene V, Evans DJ, Alkilzy M, Splieth CH. Acceptability of different caries management methods for primary molars in a RCT. Int J Paediatr Dent. 2015;25(1):9–17.
19. Berg J. Second opinion: the stainless-steel crown for primary molars overuse? No, I say underuse. Dentaltown Magazine; 2013.
20. Threlfall AG, Pilkington L, Milsom KM, Blinkhorn AS, Tickle M. General dental practitioners' views on the use of stainless steel crowns to restore primary molars. Br Dent J. 2005;199:453.
21. Tran LA, Messer LB. Clinicians' choices of restorative materials for children. Aust Dent J. 2003;48(4):221–32.
22. Innes NP, Evans DJ, Stirrups DR. Sealing caries in primary molars: randomized control trial, 5-year results. J Dent Res. 2011;90(12):1405–10.
23. Narbutaite J, Maciulskiene V, Splieth CH, Innes NPT, Santamaria RM. Acceptability of three difference caries treatment methods for primary molars among Lithuanian children. 12th Congress of the European Academy of Paediatric Dentistry "A Passion for Paediatric Dentistry". Poland 2014.
24. Santamaria RM, Innes NPT, Machiulskiene V, Evans DJP, Splieth CH. Caries management strategies for primary molars: 1-yr randomized control trial results. J Dent Res. 2014;93(11):1062–9.
25. Schwendicke F, Stolpe M, Innes N. Conventional treatment, Hall technique or immediate pulpotomy for carious primary molars: a cost-effectiveness analysis. Int Endod J. 2016;49(9):817–26.

26. Zee V, Amerongen WE. Short communication: influence of preformed metal crowns (Hall technique) on the occlusal vertical dimension in the primary dentition. Eur Arch Paediatr Dent. 2010;11:225.
27. Page LA, Boyd DH, Davidson SE, McKay SK, Thomson WM, Innes NP. Acceptability of the Hall technique to parents and children. N Z Dent J. 2014;110(1):12–7.
28. Clark WD, Geneser MK, Owais AI, Kanellis MJ, Qian F. Success rates of Hall technique crowns in primary molars: a retrospective pilot study. J Dent Res. 2016;93:1430.
29. Al-Yaseen W, Evans DJ, Innes NP. How deep is too deep? A retrospective study of the relationship between radiographic caries lesion depth adn successful outcomes with the Hall technique. IAPD. Glasgow, UK; 2015.
30. Ludwig KH, Fontana M, Vinson LA, Platt JA, Dean JA. The success of stainless steel crowns placed with the Hall technique: a retrospective study. J Am Dent Assoc. 2014;145(12):1248–53.
31. Hansen NV, Nyvad B. Non-operative control of cavitated approximal caries lesions in primary molars: a prospective evaluation of cases. J Oral Rehabil. 2017;44:537.