Clinical Dentistry Reviewed (2019) 3:22
https://doi.org/10.1007/s41894-019-0060-x

TREATMENT

Lesion management in pediatric dentistry: resin infiltration, sealing carious lesions and Hall technique

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Received: 5 October 2019 / Accepted: 9 October 2019 / Published online: 15 November 2019

Abstract

Management of a carious lesion without removal of the carious tissue is based on the concept that the disease dental caries develops in the plaque biofilm. The microbial environment of the biofilm, driven by the presence of free sugar, causes an imbalance in the demineralization and remineralization of dental hard tissues resulting in a carious lesion. The main objective of these conservative methods of managing carious lesions is to control the biofilm activity on the tooth and lesion surface. These techniques simultaneously remineralize the tooth surface and restore the tooth while cutting off access to further plaque activity. Sealing carious tissue and Hall technique are of value especially in children who are very young or with special needs, reducing the necessity for treatment under sedation and general anesthesia. The dental experience consequently becomes more pleasant, less demanding and stressful for children and families.

Keywords Hall crown · Sealing carious lesions · Resin infiltration · Minimally invasive dentistry · Caries arrest · Caries management

Quick reference/description

Management of a carious lesion without removal of the carious tissue is based on the concept that the disease dental caries develops in the plaque biofilm. The microbial environment of the biofilm, driven by the presence of free sugar, causes an imbalance in the demineralization and remineralization of dental hard tissues resulting in a carious lesion. The main objective of these conservative methods of managing carious lesions is to control the biofilm activity on the tooth and lesion surface. These techniques simultaneously remineralize the tooth surface and restore the tooth while cutting off access to further plaque activity. Sealing carious tissue and Hall technique are of value especially in

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children who are very young or with special needs, reducing the necessity for treatment under sedation and general anesthesia. The dental experience consequently becomes more pleasant, less demanding and stressful for children and families.

Overview

Treatment modalities	Indications	Contraindications
Resin infiltration in interproximal lesions	Interproximal carious lesions extending radiographically from inner half of enamel to outer third of dentin with no visible signs of clinical cavitation	Open cavitated lesions Cavitated lesions extending into the mid- or inner third of dentin In children with limited cooperation
Sealing of carious tissue	Non-cavitated occlusal carious lesions in dentin and enamel in children with limited cooperation for operative procedures Minimally cavitated potentially cleansable lesions in non-occlusal regions like buccal pits	Signs or symptoms of pulp pathology Children not available for a follow-up
Hall technique	Small to moderate carious lesions, particularly approximal lesions Hypoplastic primary molars In children with limited cooperation for conventional operative procedures	Signs and symptoms of pulp pathology

Materials/instruments

- Rubber dam kit
- Resin infiltration kit (Icon, DMG Hamburg, Germany) [kit components enlisted later]
- Light cure unit
- Resin-modified glass ionomer cement (Fuji II LC, GC Corporation, Tokyo, Japan)
- Cotton rolls
- Contouring hand instrument
- Preformed metal crown (3M ESPE, St. Paul, MN, USA)
- Medical grade tape
- Glass ionomer luting cement

Procedure

In the primary dentition, several treatment approaches are available for treating carious lesions. A novel concept of managing carious lesions involves treating the lesion without removing carious tissue. Some of the procedures in this minimally invasive treatment category rationalize that since dental caries occurs at the level of the plaque biofilm, managing the activity of the biofilm by sealing the biofilm from access to nutrients in the oral environment will arrest lesion activity. These minimally invasive techniques simultaneously restore the tooth. Selection of the appropriate treatment technique depends on the accessibility of the biofilm on the carious lesion surface. Carious lesions can be classified based on how accessible the biofilm is to plaque disruption as follows (Table 1).

The minimally invasive techniques of sealing carious lesions, Hall technique and resin infiltration are effective in the treatment of many primary teeth with non-cleansable lesions.

Resin infiltration in interproximal lesions

Bitewing radiographs can commonly detect non-cavitated proximal lesions. Conservative treatment modalities like resin infiltration can be used to arrest carious interproximal lesions extending into enamel or the outer third of dentin, as these are usually non-cavitated lesions.

Based on the severity of the lesion as seen on a radiograph, interproximal lesions can be classified as follows (Table 2).

Resin infiltration technique is based on the rationale that non-cavitated proximal lesions have an intact surface layer with an underlying porous lesion body. This

Table 1 Classification of carious lesions

Types of carious lesions	Interpretation	Treatment approach
Cleansable	Non-cavitated lesions that are easily accessible to plaque disruption	The lesions are inactivated and treated conservatively without removing carious tissue and using the method of non-restorative cavity control (NRCC)
Potentially cleansable	Cavitated dentinal lesions that allow visual and tactile examination of the lesion and lesion activity and are assessed by the clinician to be cleansable by the child/caretaker	
Non-cleansable	Cavitated or non-cavitated lesions where the plaque biofilm is isolated below the undercuts of the carious lesion and is inaccessible to common or adjunctive cleaning devices	Non-cleansable lesions are conservatively managed by converting them to cleansable lesions. They are then treated in the same way as cleansable lesions using NRCC These lesions can also be treated by sealing the carious lesion and with the Hall technique. Early non-cavitated proximal lesions can be managed by resin infiltration

Table 2 Classification of carious lesions on the basis of lesion severity as seen on radiographs

Type of lesion	Depth of lesion
E0	No lesion
E1	Lesion restricted to outer half of enamel
E2	Lesion extending into inner half of enamel
D1	Lesion restricted to outer third of dentin
D2	Lesion extending into middle third of dentin
D3	Lesion extending into inner third of dentin

lesion body allows diffusion of acids into the dentin via a pathway. Resin infiltration involves penetration of these porosities by a low-viscosity light-cured resin known as 'infiltrant' via capillary action, thereby blocking the diffusion pathway of the proximal lesion and arresting carious lesion progression. The enamel crystals in the body of the lesion are also coated with the resin to prevent additional dissolution. The resin infiltration kit (Icon, DMG Hamburg, Germany) comprises:

- Plastic flattened wedges
- Special foil applicators
- 15% hydrochloric acid gel in a syringe (Icon-etch®)
- Ethanol (icon-dry)
- Infiltrant resin in a syringe (icon-infiltrant)

Interproximal carious lesions usually have minimal or no visual access. In primary molars interproximal lesions are prevalent and should be suspected in children who are at high risk of dental caries. Bitewing radiographs should be an adjunct to visual inspection of these primary molars (Fig. 1a).

Technique of resin infiltration

– As complete isolation is crucial for the resin infiltration procedure, the tooth with the carious lesion should be isolated using a rubber dam (Fig. 1b). A wedge is inserted interdentally to achieve tooth separation and facilitate access to the interproximal lesion.
– A special foil applicator is utilized for application of the 15% hydrochloric acid gel (Fig. 1c). The foil applicator is composed of two thin foil films that are welded to form a pocket, which is filled by hydrochloric acid gel injected into it via an attached syringe. The lesion is air-dried and the foil applicator is placed interproximally. Following its interdental insertion, one foil protects the adjacent tooth from the etching acid. The 15% hydrochloric gel acid (Icon-etch®) is dispensed into the foil pocket and then applied onto the carious lesion through a small kidney-shaped zone of perforation on the other foil. The gel is maintained in contact with the lesion for 120 s.
– An air water spray is used to rinse the gel, and the lesion is air-dried for 15 s (Fig. 1d).

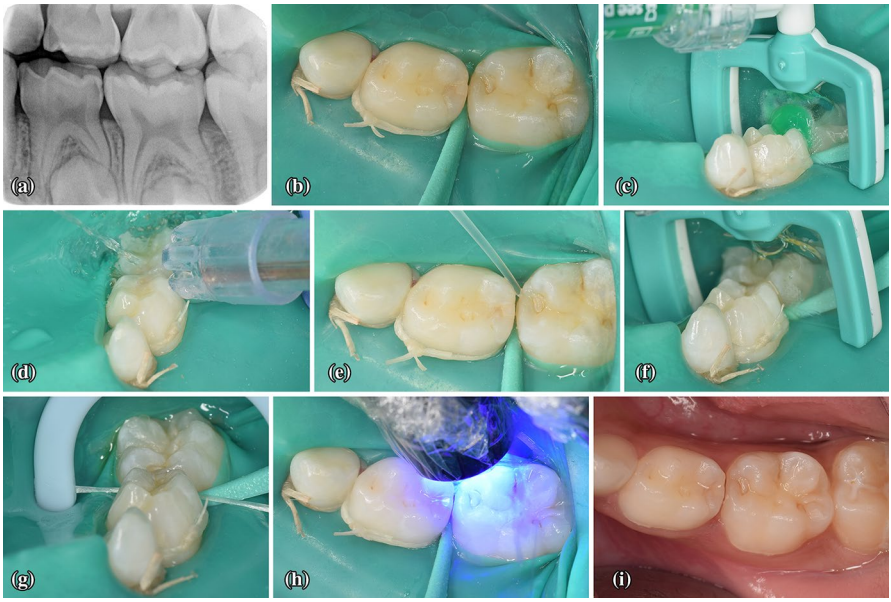

Fig. 1 Resin infiltration in interproximal lesions. **a** Bitewing radiograph showing interproximal lesion on tooth 74 extending into D1 zone. **b** Isolation and tooth separation using a rubber dam and wedge. **c** Application of hydrochloric acid gel using special foil applicator. **d** Rinsing of the gel with air water spray. **e** Ethanol application for desiccation of the lesion. **f** Infiltrant application using a fresh foil applicator. **g** Cleaning of contact areas using dental floss. **h** Light curing the resin infiltrant. **i** Postoperative clinical view of the treated tooth

- Ethanol (icon-dry) is applied interdentally using a syringe and fine delivery tip for 15 s to ensure complete desiccation of the proximal surface (Fig. 1e). The lesion is air-dried for 15 s following ethanol application. Presence of moisture within the lesion body impairs the capillary action, by which the infiltrant will saturate the porous body of the carious lesion.
- A new foil applicator is attached to the resin infiltrate syringe and inserted interproximally. The resin infiltrant (icon-infiltrant) is dispensed onto the applicator and stabilized in place for 3 min (Fig. 1f). The infiltrant is a light-cured, unfilled resin with very low viscosity that contains 99% triethylene glycol dimethacrylate and camphorquinone and is easily absorbed into the lesion body. A 3-min application of the infiltrant is required as the capillary penetration process into porous enamel is gradual and time dependent.
- The excess infiltrant is air blown with simultaneous removal of the foil applicator after 3 min. The contact areas are cleaned with dental floss (Fig. 1g).
- The infiltrant is light cured for a total duration of 40 s from the occlusal, buccal, and lingual aspects (Fig. 1h). To enhance resin penetration into the lesion, a repeat 1 min resin infiltrant application after curing the first application can be performed.

– The infiltrant is not observed on radiographs, as it is radiolucent. Regular radiographic monitoring of infiltrated carious lesions should be performed to monitor lesion progression.

Sealing carious tissue

Carious lesion management by sealing the carious tissue involves "sealing in" of the carious lesion without any carious tissue removal. It is a highly advocated treatment modality to arrest or reverse non-cavitated occlusal carious lesions in primary and permanent teeth. The lesion arrest and remineralization may be adequate and the restoration stable in the long term. Alternately, in case of wear or breakdown of the restoration, the tooth may require conventional operative restorative treatment when the child is older and more able to cooperate. This procedure offers a simple, effective minimally invasive treatment solution that is invaluable in children whose ability to cooperate for operative procedures is compromised by age or special needs.

Sealing a carious lesion predictably arrests the lesion. The commonly used sealant materials are glass ionomer sealants, resin-based sealants, polyacid-modified resin sealants, and resin-modified glass ionomer sealants. The ideal material of choice for sealing carious tissue is glass ionomer restorative cement (GIC) because of its properties such as:

- Fluoride release
- Chemical bond
- Hydrophilic nature
- Ease of application
- Cariostatic effect

Resin-modified glass ionomer cement (RMGIC) is the preferred GIC for sealing carious tissue as it has the same properties of GIC along with additional properties of:

- Resistance to microleakage
- Command cure
- Adequate wear resistance

Sealing carious tissue is based on the rationale that dental caries depends on the plaque biofilm environment on the surface of the tooth. Alteration of this environment in the carious lesion can affect the pathogenicity of the cariogenic bacteria present in the plaque biofilm. The bacteria are deprived of nutrition from the intraoral sugar substrates by hermetically sealing the biofilm under a restoration. The sealing of the biofilm decreases its pathogenicity and diversity leading to delayed carious lesion progression. The fluoride release from the restorative material aids in remineralizing the lesion. Simultaneously, the pulp–dentinal complex is also stimulated to facilitate the formation of reactionary dentin and tubular sclerosis that aids in further isolation of the cariogenic bacteria and arrest of the carious lesion.

Technique of sealing of carious tissue

- The tooth with the carious lesion is isolated using cotton rolls and air dried. Resin-modified glass ionomer cement (RMGIC) is dispensed onto the occlusal surface from a capsule (Fig. 2b). A capsule is commonly used to dispense the material as it ensures a mix with an ideal restorative consistency, and is quick and easy to use and prevents incorporation of air bubbles in the restoration.
- RMGIC is dispensed in excess on the occlusal surface of the tooth and is condensed into the grooves with a gloved finger (Fig. 2c) ensuring that the material flows well into the deep pits and fissures on the surface of the tooth.
- A suitable hand instrument is used to remove the excess cement (Fig. 2d). Removal of excess cement and finishing is dependent on patient cooperation. If patient ability makes a clean-up difficult, the excess GIC may be left behind to eventually wear off.
- The RMGIC is light cured (Fig. 2e). As an alternative to RMGIC, conventional self-cure GIC can also be used. RMGIC with its property of command cure is useful in children, where limited cooperation and time impair accurate material insertion and necessitate bulk packing of the material.
- After sealing carious tissue, monitoring the integrity of the sealant through follow-up visits is crucial.

The Hall technique

The Hall technique includes cementation of a preformed metal crown (PMC) over a carious primary molar using GIC without removal of carious tissue, crown preparation, and use of local anesthesia. Therefore, it is considered as an extension of sealing carious tissue. As this technique is minimally invasive, it reduces treatment-related anxiety in children.

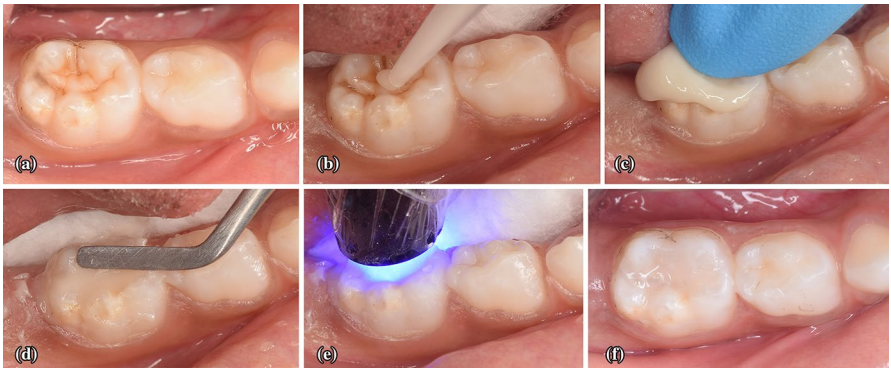

Fig. 2 Sealing carious tissue using RMGIC. **a** Hypomineralized occlusal surface and stained occlusal pits and fissures on tooth 85 indicating carious pits with possible plaque stagnation activity. **b** RMGIC dispensed onto occlusal surface from a capsule. **c** RMGIC is condensed into the pits and fissures using a gloved finger. **d** Excess cement removed using an appropriate hand instrument. **e** Light curing the RMGIC. **f** Postoperative occlusal view

When pulp pathology is excluded following clinical and radiographic evaluation in a carious primary molar, a PMC of a suitable size is selected and cemented over the tooth resulting in sealing of the carious lesion and the coronal tooth structure. The rationale for the use of the Hall technique is the same as that of sealing carious tissue.

Technique for the placement of a Hall crown

- After tooth selection, a PMC is secured with a medical grade tape on the occlusal surface of the crown prior to trial in the mouth for size selection (Fig. 3a, b). The steel crown is small and can be slippery when handled with a gloved finger. Using a tape to secure the crown can avoid slippage from the clinician's fingers and accidental aspiration or swallowing of the crown. Additionally, a gauze pack can also be placed in the mouth, distal to the teeth to be treated, to protect the airway.
- Crown selection is done by trial and error, and the smallest crown that fits two-thirds of the coronal tooth structure is selected (Fig. 3c). The crown should demonstrate a spring back action at the contact areas. While trying the selected PMC, the crown should not be pushed over the tooth completely as crown removal can be difficult if it snaps into place.

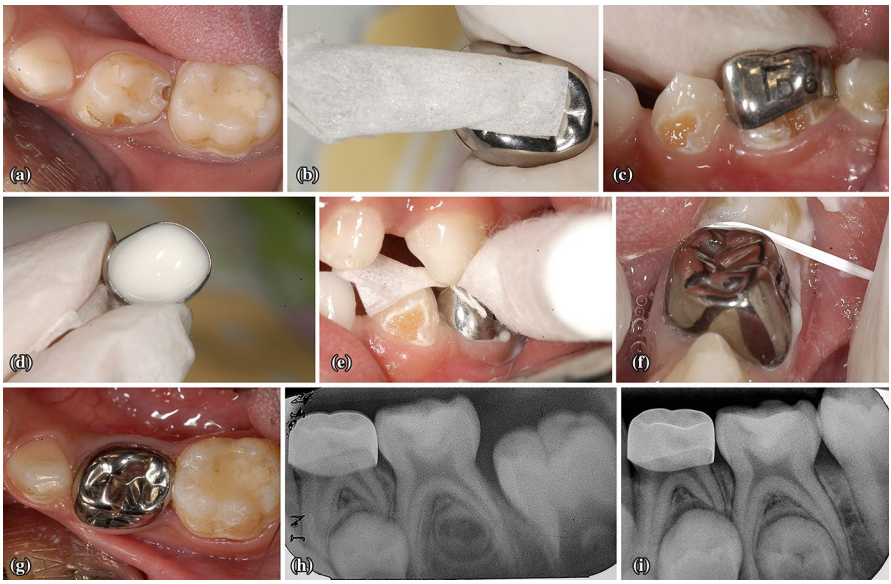

Fig. 3 The Hall technique on a primary lower molar. **a** Tooth 74 with old stable occlusal restorations and new carious lesions on the buccal and distal surfaces. **b** Securing the crown before trial with a medical tape. **c** Selection of the preformed metal crown. **d** Loading the crown with GIC. **e** Cementation of the crown. **f** Interproximal cleaning with a dental floss. **g** Postoperative occlusal view. **h** Postoperative radiograph. **i** Two-year follow-up showing stable Hall crown and healthy periradicular tissue in tooth 74 and a fully erupted tooth 36

- The selected crown is completely loaded with GIC without air bubble incorporation (Fig. 3d). When a Hall crown is placed on the second primary molar prior to the eruption of the first permanent molar, the smallest crown size fitting the primary molar should be selected to decrease the chances of impaction of the erupting first permanent molar below the margins of a larger crown. Tooth preparation can also be considered to minimize the crown size in such cases.
- The loaded PMC is seated into place over the tooth (Fig. 3e). To facilitate the seating of the crown, the child is instructed to bite down on a cotton roll. In case of an inadequate fit, an appropriate hooked hand instrument, like a sickle scaler, is used to remove the PMC immediately before setting of GIC.
- Dental floss is used to clean the luting cement from the interdental areas (Fig. 3f). The excess GIC is removed and the adequacy of the fit is reevaluated. The child is then advised to continue biting down on the PMC till the cement sets.

When the Hall crown is first cemented, visible gingival blanching occurs in the deciduous dentition that resolves quickly. A postoperative radiograph is obtained to monitor the treated teeth and for comparison with future radiographs (Fig. 3i). In molars with tight proximal contacts, placing orthodontic separators for 2–3 days to create interproximal separation allows for placement of a Hall crown. After cementation of the Hall crown, minor occlusal discrepancy is observed, as operative tooth preparation is not performed. The discrepancy settles in a short duration in the growing primary dentition.

Pitfalls and complications

- Resin infiltration for interproximal lesions requires reasonable patient cooperation and involves higher costs of treatment.
- Regular monitoring of sealed carious lesions is necessary to ensure timely repair.
- If an oversized Hall crown is placed on the second deciduous molar prior to eruption of the first permanent molar, the erupting permanent molar can be impacted below the margins of the metal crown, predominantly in the maxillary arch.

Further reading

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