



Selective removal of carious tissue in shallow, moderately deep and deep carious lesions in pediatric patients

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Abstract

The selective removal of carious tissue is a contemporary method of managing shallow, moderately deep, and deep carious lesions. The aim is to prevent pulp exposure while simultaneously restoring a tooth with no signs or symptoms of irreversible pulp pathology. The rationale behind selective removal is that the microorganisms, in the carious tissue that is left behind, are deprived of micronutrients when the carious lesion is hermetically sealed. The microorganisms thereby lose potency, slowing down the carious process. This helps the pulp–dentinal complex deposit reactionary dentin over the pulp. Depending on the depth of the carious lesion, the selective removal of carious tissue can be approached in two ways: Selective carious tissue removal to “firm” dentine and selective carious tissue removal to “soft” dentine. These conservative strategies decrease the likelihood of the need for more invasive and stress-inducing procedures in children.

Keywords Deep carious lesions · Selective removal · Minimally invasive · Partial caries removal · Carious lesion management · Contemporary caries management

Quick reference/description

Complete excavation of carious tissue in deep carious lesions can often lead to inadvertent and unnecessary exposure of the pulp. Selective removal of carious tissue is a minimally invasive treatment approach for the management of shallow to deep carious lesions in primary and young permanent teeth. This therapeutic procedure is beneficial to pediatric patients and provides an invaluable positive dental experience for the child.

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Overview

Treatment modality	Indications	Rationale
Selective removal of carious tissue to firm dentine	<ul style="list-style-type: none"> - Management of primary and young permanent teeth with shallow to moderately deep carious lesions without clinical signs and symptoms of irreversible pulpitis - Management of teeth with radiographic appearance of carious lesion extending to less than the pulpal third of dentine without bone loss or furcation involvement 	<ul style="list-style-type: none"> - The aim of removing carious tissue to firm dentine is to provide adequate depth for a restoration and concurrently, prevent pulpal irritation - Hermetic sealing of the carious lesion deprives the microorganisms present in the residual carious tissue of any substrate from the oral cavity resulting in inactivation of the carious lesion - Pulp protection is achieved by deposition of reactionary dentin - This minimally invasive treatment approach helps in reducing the possibility of aggressive, anxiety and pain-inducing operative procedures in children - It also facilitates root maturation in immature permanent teeth
Selective removal of carious tissue to soft dentine	<ul style="list-style-type: none"> - Management of primary and young permanent teeth with deep carious lesions without clinical symptoms of irreversible pulpitis - Management of teeth with radiographic appearance of carious lesion extending into the pulpal third of dentine without bone loss or furcation involvement 	<ul style="list-style-type: none"> - In deep carious lesions, excavation of carious tissue to a proper depth in soft dentine has to be carefully balanced with the goal of preventing pulp exposure as the zone of soft dentine forms a major part of deep carious lesions - Careful removal of soft dentine and achieving a hermetic seal that is provided by the peripheral sound enamel/hard dentine, inactivates the residual carious tissue due to lack of micronutrients - This treatment modality is more comfortable and less challenging for children as the need for pulp therapy is avoided

Materials/instruments

- Spoon excavator
- Rubber dam kit
- Resin-modified glass ionomer restorative cement (RMGIC)
- Mineral trioxide aggregate
- Preformed metal crown (PMC)

Procedure

Selective removal of carious tissue is a minimally invasive therapeutic modality for the management of shallow-to-deep carious lesions in primary and young permanent teeth. However, it is a philosophy that is applicable to all teeth. The term ‘selective’ removal of carious tissue was introduced by the International Caries Consensus Collaboration (ICCC) to describe the various degrees of carious tissue removal in the ‘peripheral’ and ‘pulpal’ regions of a carious lesion.

Selective removal of carious tissue is recommended in teeth with shallow to deep carious lesions to prevent unintentional pulp exposures that can occur when conventional techniques of complete caries excavation are employed.

While performing the procedure, achieving a balance between the two goals of carious tissue removal is necessary:

- Removal of adequate carious tissue to obtain sufficient depth for the placement of a stable restoration.
- Prevention of pulp exposure during carious tissue removal.

Division of the carious lesion into zones depending on the tactile sensation to hand instrumentation is recommended by the ICCC (Table 1). Removal of carious tissue to sufficient depth lands the operator in firm dentine in shallow to moderately deep carious lesions. On the other hand, in deep carious lesions, sufficient depth is achieved while the operator is still in soft dentine because the soft dentine occupies most of the depth of the carious lesion.

Selective carious tissue removal is followed by a hermetically sealed restoration. In the periphery of the lesion, carious tissue excavation should be done to hard dentine and sound enamel. The walls of the lesion devoid of firm or soft carious tissue will help in achieving a good adhesive seal of the restoration. A full coverage coronal restoration is recommended when the depth of the carious lesion is inadequate and does not allow placement of an intracoronal restoration of adequate volume.

Selective removal of carious tissue to firm dentine

Selective removal of carious tissue to firm dentine is advocated for the management of teeth with shallow to moderately deep carious lesions without any signs and symptoms of irreversible pulpitis. It is a minimally invasive treatment approach that decreases the possibility of aggressive, anxiety and pain-inducing

Table 1 Zones of carious tissue according to ICCC recommendations

Zones of carious tissue	Features
Soft dentine	Outermost zone of carious tissue
Firm dentine	Second zone of carious tissue after soft dentine
Hard dentine	Third zone of carious tissue closest to the pulp chamber

Fig. 1 Cross section of a moderately deep carious lesion

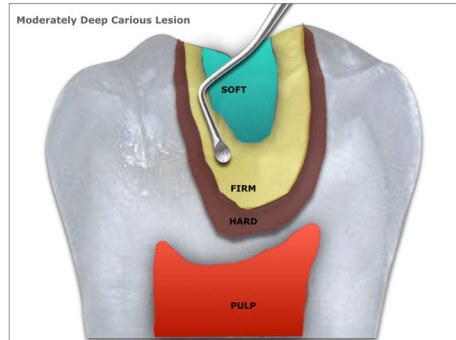
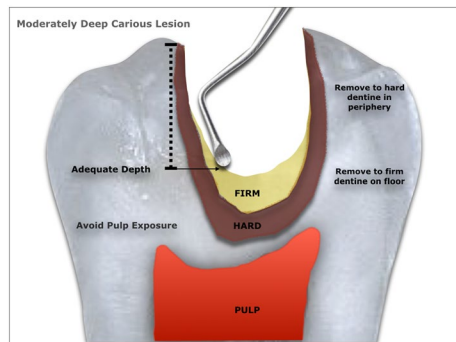


Fig. 2 Carious tissue removal in a moderately deep carious lesion



operative procedures in children. Carious tissue is removed to the depth that allows placement of a stable restoration of adequate bulk. In moderately deep carious lesions, the first zone of soft carious tissue, i.e. soft dentine, is narrower than the second zone of carious tissue, i.e. firm dentine (Fig. 1). Hence, this depth is achieved in firm dentine.

Rationale

One of the primary aims of removing carious tissue to firm dentine is to provide adequate depth for a stable intracoronal restoration. This aim should be well balanced with the other primary aim, i.e. prevention of pulpal irritation or pulpal exposure (Fig. 2). The carious tissue in the periphery of the lesion is removed to hard enamel and dentin to permit a good coronal seal.

Restoration of the tooth following selective tissue removal allows hermetic sealing of the lesion. This coronal seal deprives the microorganisms present in the residual carious tissue of any substrate from the oral cavity resulting in inactivation of the carious lesion. The restorations also induce deposition of reactionary dentin that further serves to protect the underlying pulp. It also facilitates root maturation in immature permanent teeth. The main factors that affect the success of restorations following selective removal of carious tissue to firm dentine are.

- Cleaning of the peripheral areas of the carious lesion to hard enamel and dentine to allow a good restorative seal.
- Long-term stability of the restoration.
- Hermetic seal of the lesion.

Clinical procedure for the selective removal of carious tissue to firm dentine

The preoperative clinical and radiographic examination of the involved teeth is performed (Fig. 3a, b). A detailed pain history is elicited from the parent and child to rule out symptoms of irreversible pulpitis. Radiographically, these carious lesions extend to less than the pulpal third of dentine. The decision to perform selective removal of carious tissue is taken after ruling out all signs and symptoms of irreversible pulpitis, bone loss or furcal pathology. The management of teeth with moderately deep carious lesions using the selective removal of carious tissue approach is performed as follows:

- The tooth/teeth to be treated are isolated with cotton rolls or rubber-dam for clear-cut visualization of the lesion (Fig. 3c).
- Carious tissue removal is performed (tooth 74) using a spoon excavator (Fig. 3d). In the periphery of the lesion, the carious tissue is removed until the walls of the lesion are clean and hard dentine is reached. Hard dentine maybe discolored with

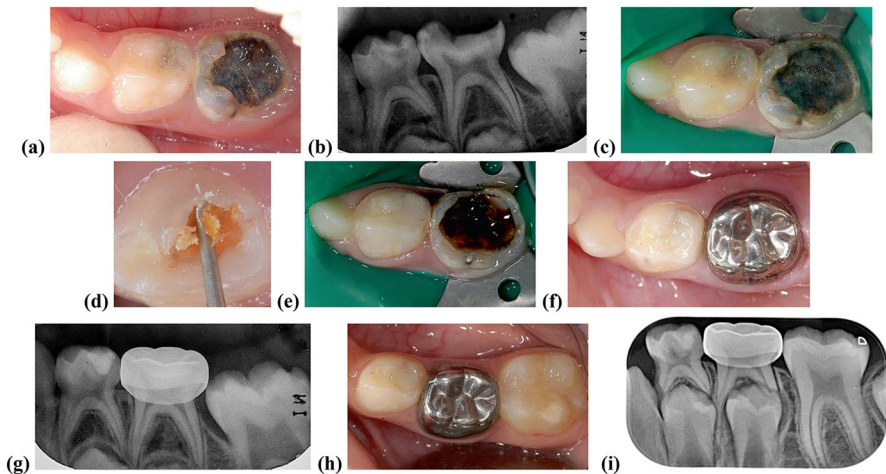


Fig. 3 Clinical procedure of selective removal of carious tissue to firm dentine in primary teeth. **a** Preoperative clinical view showing active occlusal lesion in tooth 74 and moderately deep carious lesion in tooth 75. **b** Radiograph showing carious lesions extending to the middle third of dentine in 74 and 75. **c** Isolation of teeth under rubber dam. **d** Selective removal of carious tissue to firm dentine in the floor of the lesion and to hard dentine in the periphery of the lesion. **e** Restoration of tooth 74 with RMGIC. **f** Placement of a PMC on tooth 75. **g** Postoperative radiograph. **h** Three-year follow-up shows stable restorations in teeth 74 and 75 and erupted first permanent molar. **i** Four-year follow-up radiograph demonstrates the success of the treatment and erupted permanent canine

a tactile sensation similar to sound dentine. Running a spoon excavator through hard dentine produces a scratching sound or “cry dentinaire”. In the depth of the lesion, carious tissue is removed to adequate depth landing the operator in firm dentine. Firm dentine will be resistant to hand excavation and will require considerable force to lift and remove firm carious tissue.

- The prepared tooth (Tooth 74) is restored with RMGIC (Fig. 3e).
- If the depth of the cavity following carious tissue removal is inadequate to support an intracoronal restoration (tooth 75 in Fig. 3e) and further tissue removal entails the risk of pulp exposure, a full coronal coverage restoration is recommended. In such cases, full coverage with a preformed metal crown provides a stable restoration and ensures a hermetic seal (Fig. 3f).
- A postoperative radiograph is obtained to allow for comparison with future radiographs. It is essential for checking the treatment outcome and lesion arrest (Fig. 3g). On follow-ups, success of treatment is evident with stable restorations, healthy gingival tissue (Fig. 3h), healthy periapical tissue and physiologic root resorption (Fig. 3i).
- In moderately deep lesions, the floor of the carious lesion may be covered with a thin layer of MTA. RMGIC can be placed immediately over the layer of MTA for a good hermetic coronal seal. MTA has a prolonged setting time and sets below the RMGIC (Fig. 4). Using a bioactive material for lining the lesion floor is not a prerequisite.
- In incompletely erupted permanent teeth, RMGIC is preferred as an intracoronal restoration. After complete eruption of the tooth, a composite resin restoration can be added, if the RMGIC restoration exhibits wear.

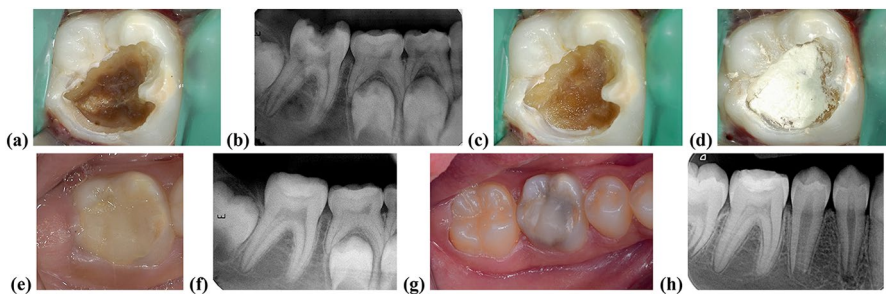


Fig. 4 Clinical procedure of selective removal of carious tissue to firm dentine in a young permanent tooth. **a** Preoperative occlusal view showing moderately deep occlusal carious lesion in tooth 46. **b** Radiograph showing moderately deep carious lesion with a definite layer of dentin over the pulp with no signs of periapical pathology. **c** Selective carious tissue removal to firm dentine in the floor of the lesion and to hard dentine in the periphery. **d** MTA liner placed on the floor of the lesion (optional step). **e** Final intracoronal restoration using RMGIC. **f** Postoperative radiograph. **g** Occlusal view of follow-up at 4 years shows stable restoration, healthy soft tissue, erupted premolars and second permanent molar. **h** Four-year follow-up radiograph showing arrest of the carious lesion and further root maturation

Selective removal of carious tissue to soft dentine

Selective removal of carious tissue to soft dentine is recommended for the management of teeth with deep carious lesions without any signs and symptoms of irreversible pulpitis. In primary and young permanent teeth with deep carious lesions, complete excavation of carious tissue can cause an exposure of the pulp. Inadvertent pulpal exposure necessitates invasive pulp therapy that can be demanding and challenging for both the child and the operator thus reducing associated distress, discomfort and anxiety.

Rationale

The main goal of selectively removing carious tissue to soft dentine is to prevent inadvertent pulp exposure. This primary aim should be balanced with gaining sufficient depth for the placement of a stable restoration of adequate bulk. The first zone in a carious lesion, i.e. soft dentine makes up a major portion of carious tissue in deep carious lesions (Fig. 5a). Therefore, sufficient depth for a stable restoration can be achieved in the zone of soft dentine itself.

The removal of soft dentine in deep carious lesions should be effectively balanced with avoiding a pulp exposure. Therefore, it is important for the clinician to consciously terminate the removal of carious tissue to an appropriate depth in soft dentine (Fig. 5b). The success of selective removal of carious tissue to soft dentine depends equally on restoring the tooth such that a hermetic seal is achieved between the peripheral hard enamel and dentin, and the restoration. This coronal seal inactivates the residual carious tissue due to lack of micronutrients. The tooth can also be restored with a full coronal coverage restoration when the extent of the carious lesion does not permit a stable intracoronal restoration and a good seal. Selective removal of carious tissue to soft dentine obviates the need for invasive pulp treatment and allows for comfortable delivery of care.

Avoiding invasive pulp therapy by performing selective caries removal in deep carious lesions is advantageous in immature permanent teeth as it permits

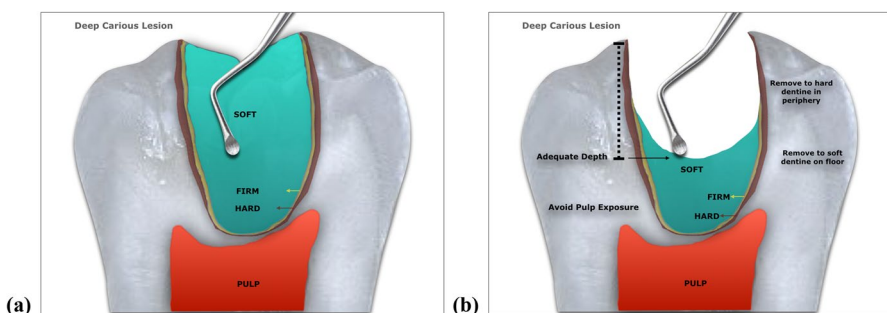


Fig. 5 a Cross section of a deep carious lesion. b Carious tissue removal to adequate depth in a deep carious lesion

continued maturation of the tooth and tooth root. It prevents the need for endodontic treatment and reduces the burden of future care for the family.

Clinical procedure for selective removal of carious tissue to soft dentine

The preoperative clinical and radiographic examination of the involved teeth is performed (Fig. 6a, b). A detailed pain history is elicited from the parent and child to rule out symptoms of irreversible pulpitis. Radiographically, these carious lesions extend into the pulpal third of dentine. The decision to perform selective removal of carious tissue is taken after ruling out all signs and symptoms of irreversible pulpitis, bone loss or furcal pathology. The management of teeth with

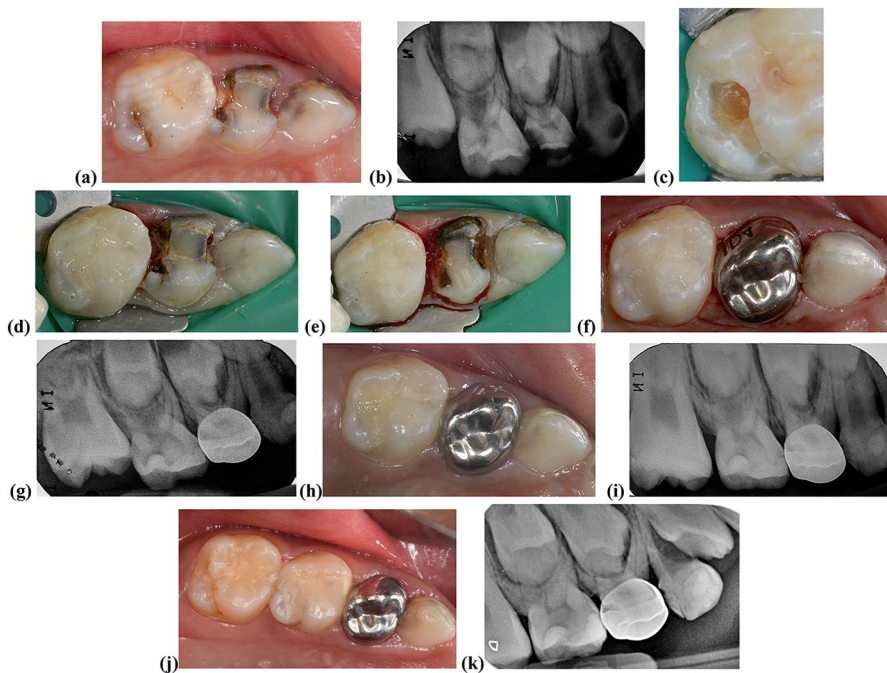


Fig. 6 Clinical procedure of selective removal of carious tissue to soft dentine in primary teeth. **a** Preoperative view showing multisurface carious lesions in teeth 53, 54, and 55. **b** Radiograph showing deep carious lesions in teeth 54 and 55 involving the inner third of dentine without signs of pulp pathology and moderately deep lesion in tooth 53. **c** Selective removal of carious tissue, in tooth 55, to soft dentine on the floor of the lesion and to hard dentine in the periphery. **d** Restoration of teeth 53 and 55 with RMGIC. **e** Selective carious tissue removal to soft dentine in tooth 54. Tooth prepared to receive a PMC **f** PMC placed on tooth 54. **g** Postoperative radiograph. **h** Follow-up clinical view showing stable restorations and soft tissue healing. **i** Two-year follow-up radiograph showing stable restorations and increase in zone of remineralization below restoration in tooth 55. **j** Three-year follow up—stable restorations, healthy gingival tissue and fully erupted first permanent molar seen **k** Three-year follow-up radiograph demonstrates success of the treatment technique. Note the increase in the remineralized zone separating the deep restoration from the pulp in tooth 55

deep carious lesions using the selective removal of carious tissue approach is performed as follows:

- The tooth/ teeth to be treated are isolated with cotton rolls or rubber-dam for clear-cut visualization of the lesion. Carious tissue is removed (tooth 55) using a spoon excavator (Fig. 6c). In the periphery of the lesion, the carious tissue is removed to hard dentine. Carious tissue is removed on the floor of the lesion to soft dentine. Careful effort is made to ensure that the pulp is not exposed while simultaneously obtaining sufficient depth for a stable intracoronal restoration.
- Soft dentine is easily removed when an excavator is pressed onto it. Carious tissue removal is discontinued when the risk of pulp exposure increases.
- If adequate cavity depth can be achieved to place a restoration of sufficient bulk, the tooth (tooth 55) is restored with RMGIC (Fig. 6d).
- If the depth or extent of the cavity does not permit a stable intracoronal restoration, the tooth is prepared to receive a PMC (Fig. 6e). Full coverage restorations provide stability and a hermetic coronal seal (Fig. 6f).
- A postoperative radiograph is obtained for comparison with future radiographs (Fig. 6g) to monitor treatment outcome and lesion arrest. Long-term follow-ups demonstrate treatment success evident from stable restorations, remineralization of carious tissue, healthy periradicular tissues and physiologic root resorption (Fig. 6i–k).
- In immature permanent teeth with incomplete eruption and/or extensive carious destruction of tooth structure, a PMC is recommended to achieve an impeccable coronal seal (Fig. 7).

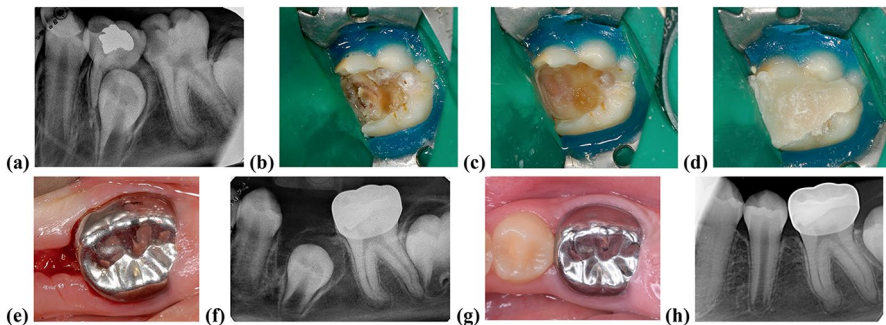


Fig. 7 Clinical procedure of selective removal of carious tissue to soft dentine in a young permanent tooth. **a** Radiograph showing tooth 36 with a deep carious lesion involving the pulpal third of dentine and no signs of periapical pathology. **b** Some undermined tooth structure removed for better visualization of the lesion **c** Carious tissue excavation from the walls to hard dentine and sound enamel and from the floor to soft dentine **d** Restoration of the tooth with RMGIC. **e** Placement of a PMC. **f** Postoperative radiograph. **g** Two-year follow up showing healthy gingival tissue, stable restoration on tooth 36 and erupted tooth 35. **h** Two-year follow-up radiograph showing stable restoration, healthy periradicular tissue and further root maturation in tooth 36

Advantages of RMGIC

The advantages of using RMGIC as a final restoration are:

- Less technique sensitive material
- Chemically bonds to tooth structure
- Acts as a fluoride reservoir and releases fluoride
- No marginal shrinkage
- Dual cure material

Pitfalls and complications

- A tooth with no signs or symptoms of pulp pathology may become symptomatic following treatment using the ‘selective removal of carious tissue’ technique. This is, however, not common.
- Iatrogenic pulp exposure can occur in deep carious lesions if carious tissue is removed incessantly.
- Failure of the coronal seal will result in failure of treatment.

Further Reading

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