Clinical Dentistry Reviewed (2019) 3:19
https://doi.org/10.1007/s41894-019-0059-3

TREATMENT

Lesion management in pediatric dentistry: non-restorative cavity control

Meenakshi S. Kher[1] · **Ashwin Rao**[2]

Received: 5 October 2019 / Accepted: 9 October 2019 / Published online: 3 November 2019

Abstract

Non-restorative cavity control (NRCC) involves managing a carious lesion without removing carious tissue and in most cases without placing a restorative material. The rationale for this minimally invasive lesion management technique is based on the current understanding that the disease dental caries develops at the level of 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. NRCC aims at controlling the biofilm activity on the tooth and lesion surface, while simultaneously preventing further demineralization and facilitating remineralization. This conservative modality reduces treatment-related anxiety in young children and children with special needs while reducing the need for treatment under sedation and general anesthesia.

Keywords Non restorative cavity control · Nonrestorative treatments · Fluoride varnish · Silver diamine fluoride · Caries arrest · Caries management

Quick reference/description

Non-restorative cavity control (NRCC) involves managing a carious lesion without removing carious tissue and in most cases without placing a restorative material. The rationale for this minimally invasive lesion management technique is based on the current understanding that the disease dental caries develops at the level of 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. NRCC aims at controlling the biofilm activity on the tooth and lesion surface, while simultaneously preventing

✉ Meenakshi S. Kher
meenakshiskher@gmail.com

[1] Happy Tooth Clinic for Kids, Mumbai, India

[2] Department of Paedodontics and Preventive Dentistry, Manipal College of Dental Sciences Mangalore, Manipal Academy of Higher Education, Mangalore, India

further demineralization and facilitating remineralization. This conservative modality reduces treatment-related anxiety in young children and children with special needs, while reducing the need for treatment under sedation and general anesthesia.

Overview

Treatment modalities		Indications	Contraindications
Non-restorative cavity control (NRCC)	Using 5% sodium fluoride varnish	Tooth surfaces showing active enamel demineralization, white spot lesions or non-cavitated cleansable lesions In potentially cleansable lesions, if consent is not granted by the caregiver for the use of silver diamine fluoride Cleansable and potentially cleansable lesions in children where cooperation is compromised due to age or disabilities making conventional operative dentistry a challenge	Positive treatment outcome is caregiver driven rather than operator driven. A noncompliant caregiver can be considered a relative contraindication
	Using silver diamine fluoride (SDF)	Primary tooth surfaces displaying potentially cleansable lesions or active cavitated dentinal lesions (soft carious lesions in dentin) particularly in children with compromised cooperation that can make conventional operative dentistry a challenge Deep active carious lesions with no signs or symptoms of pulp involvement, where the lesion can be arrested by scrubbing with SDF before restoring it with intracoronal or extra-coronal restorations To arrest inaccessible small proximal lesions where extensive tooth preparation would be required to gain access and place a restoration Multi-surface dentinal lesions or difficult to treat cavitated carious lesions. e.g. primary lower anterior teeth SDF is the preferred choice of treatment in children with limited access to dental care	If the caregivers do not consent to the use of SDF because of the resulting black discoloration of the carious lesion

Materials/instruments

- Tooth brush and fluoride containing dentifrice used by caregiver
- 5% sodium fluoride varnish and applicator brush
- Rotating rubber cup or tuft
- 38% silver diamine fluoride solution
- Petroleum jelly
- Micro-brush
- High-viscosity glass ionomer cement
- Spongy dental floss

Procedure

NRCC, also called non-operative caries treatment, is a paradigm shift in the management of dental caries in children. This novel method of treating carious lesions without removing carious tissue rationalizes that the carious lesion is a localized symptom of the disease dental caries. Since dental caries occurs at the level of the plaque biofilm, the objective of the procedure is to manage the activity of the biofilm on the surface of the lesion and to arrest the carious lesion. Teeth selected for NRCC show no signs or symptoms of pulp pathology. The selection of the treatment technique depends on the type of carious lesion, which is classified based on how accessible the biofilm is on the lesion surface (Table 1).

This minimally invasive method of managing carious lesions is particularly effective in the treatment of primary teeth with cleansable and potentially cleansable lesions.

Table 1 Classification of carious lesions

Types of carious lesions	Interpretation	Treatment approach
Cleansable	Non-cavitated lesions that are easily accessible to plaque disruption	Cleansable lesions are treated conservatively without removing carious tissue by inactivating and remineralizing them using the non-restorative cavity control method
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/caregiver	Potentially cleansable lesions are treated conservatively without removing carious tissue by inactivating and remineralizing them using the non-restorative cavity control method. In very large lesions in posterior teeth a glass ionomer restoration may be placed in the treated lesion
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 treated in the same way as cleansable lesions. In very large lesions in posterior teeth a glass ionomer restoration may be placed in the treated lesion

NRCC using 5% sodium fluoride varnish

NRCC using 5% sodium fluoride varnish is based on the rationale that impeding the initiation and progression of a carious lesion is mainly dependent on mechanical plaque disruption and limited consumption of free sugars. Simultaneously, fluoride delivery to the tooth and lesion surface by the caregiver and clinician contributes to arrest of the carious lesions. Therefore, NRCC using a fluoride varnish is an optimal combination of professional and home disruption of plaque using fluoridated dentifrices and professionally applied fluoride varnishes for carious lesion inactivation.

Certain narrow cavitated lesions have reduced access to plaque removal. These potentially cleansable lesions are converted to cleansable lesions by widening the cavity and making it accessible for mechanical plaque disruption.

Since limiting the consumption of sugar and diligent tooth brushing at least twice daily is essential for plaque disruption and preventing further demineralization, caregivers play an important role in the success of NRCC. Fluoridated dentifrices are used for tooth brushing to deliver fluoride onto the tooth and lesion surface. Parallel to home care, this mode of NRCC involves professional oral prophylaxis and fluoride varnish application regimens using 5% sodium fluoride varnish.

Technique of 5% sodium fluoride varnish application

Step 1: Tooth brushing using a fluoridated dentifrice (Fig. 1a)

The caregiver is instructed to follow the correct brushing technique for complete plaque disruption or removal. A fluoride concentration of 1000 ppm with an age appropriate amount of dentifrice is usually recommended. For lesion arrest in NRCC, a higher concentration of 1200–1450 ppm is recommended, as the remineralizing effects of fluoride are dose related. The amount of toothpaste advised in children is a "smear" of fluoridated toothpaste (approximately 0.1 mg F) under age 3, a "pea size" (approximately 0.25 mg F) for children age 3–6 years and 1–2 cm in children over 6 years. Minimal rinsing should be performed after tooth brushing. Caregivers are instructed to fix faulty feeding habits if any and limit the intake of free sugar in food and drinks.

Step 2: Oral prophylaxis (Fig. 1b)

The NRCC technique recommends regular professional oral prophylaxis using a rotating rubber cup or tuft and a light abrasive paste. This removes the mature, stubborn plaque thereby suppressing bacterial activity.

Fig. 1 NRCC using 5% sodium fluoride varnish. **a** Meticulous tooth brushing twice daily with fluoridated toothpaste. **b** In-office oral prophylaxis with a rotating rubber cup and a light abrasive paste. **c** Application of 5% sodium fluoride varnish using an applicator brush

Step 3: Sodium fluoride varnish application (Fig. 1c)

After air-drying the lesion surfaces, 5% sodium fluoride varnish is applied once every week for 3 weeks. This weekly application is followed by fluoride varnish application once every 3 months for 1 year. Topical application of high concentrations of fluoride results in the formation of a calcium fluoride reservoir in the active lesion. The release of calcium fluoride slows down the progress of lesion activity.

Step 4: Long-term follow-up

A long-term follow-up is recommended to monitor lesion activity and progression of the lesion (Fig. 2)

Transforming non-cleansable lesions to cleansable lesions

In primary teeth such as incisors, multisurface carious lesions are a frequent presentation. These sheltered lesions make plaque disruption and fluoride delivery difficult, especially in hard-to-approach proximal areas. Removal of the overhanging tooth structure allows for greater access making these lesions cleansable. Oral prophylaxis is then performed followed by 5% sodium fluoride varnish application thereby promoting lesion arrest and preventing further progression of the lesion (Fig. 3). NRCC with SDF is an alternative treatment for these lesions if parents/caregivers consent to the resulting black discoloration.

NRCC using 38% silver diamine fluoride solution

NRCC can also be performed using 38% silver diamine fluoride (SDF), a colorless fluoride delivery solution that can effectively arrests active carious dentinal lesions. NRCC with SDF is a noninvasive, easy to use, safe and economical method of carious lesion management. It is of special value in the treatment of carious lesions

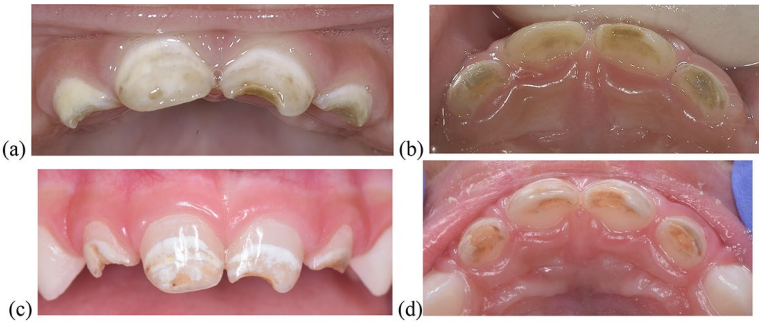

Fig. 2 Long-term follow-up of NRCC using 5% sodium fluoride varnish. **a** Preoperative labial view—cleansable and potentially cleansable lesions in primary incisors. **b** Preoperative palatal view—cleansable and potentially cleansable lesions in primary incisors. **c** Labial view on 20-month follow-up showing no progression of lesions, arrest of the cavitated lesions and healthy erupted enamel cervical to the arrested lesions. **d** Palatal view on 20-month follow-up showing no progression of lesions, arrest of cavitated lesions and healthy enamel cervical to the arrested lesions

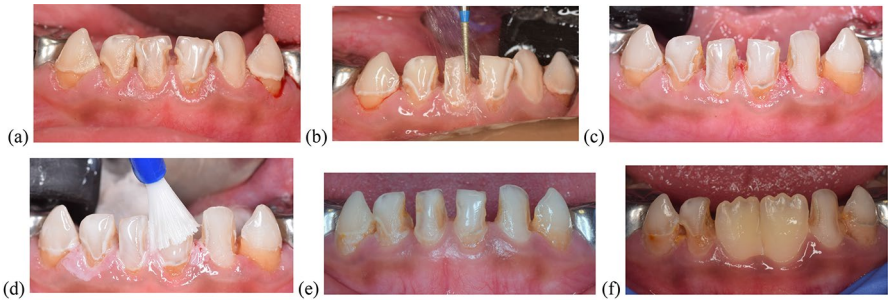

Fig. 3 Transforming non-cleansable lesions to cleansable lesions and NRCC with fluoride varnish in a 4-year-old child with special management considerations **a** Multisurface carious lesions on primary lower anterior teeth with inaccessible proximal lesions. **b** Removal of overhanging tooth structure that shelters the carious lesions. **c** Accessible and cleansable carious lesions. **d** In-office application of 5% sodium fluoride varnish following oral prophylaxis. **e** 6-month follow-up showing no carious lesion progression. Lesions appear darker and less active. **f** Two-year follow-up, permanent central incisors erupted following exfoliation of primary incisors

when conventional operative care is limited by special management considerations in children. Use of SDF often obviates the need for sedation and general anesthesia that would be required in these children for operative management. SDF is particularly beneficial in communities where restorative treatment is inaccessible or not affordable.

When carious lesions are treated with SDF, the remnant ionic silver restricts additional biofilm formation. The treated dentin becomes more resistant to cariogenic bacteria resulting in prevention of further cavitation. Therefore, the silver in the SDF solution acts as an antimicrobial and the high concentration fluoride (44,800 ppm) stimulates remineralization of the lesion. Ammonia provides stability to the solution.

Multiple mechanisms result in a predictable arrest of a carious lesion following NRCC with SDF. These are:

- Enhanced resistance to acid dissolution and enzymatic digestions through formation of silver protein conjugates
- Increased mineral density and hardness through hydroxyapatite and fluorapatite formation
- Antiprotease activity preventing the breakdown of the dentinal organic matrix
- Direct bactericidal action against cariogenic bacteria
- Increased resistant to biofilm formation

Technique of SDF application in posterior carious lesions

- Petroleum jelly is applied to the perioral areas to prevent accidental staining due to SDF (Fig. 4c).
- Sufficient isolation with cotton rolls is essential during SDF application. The lesion is thoroughly air-dried. To allow better contact of SDF with carious den-

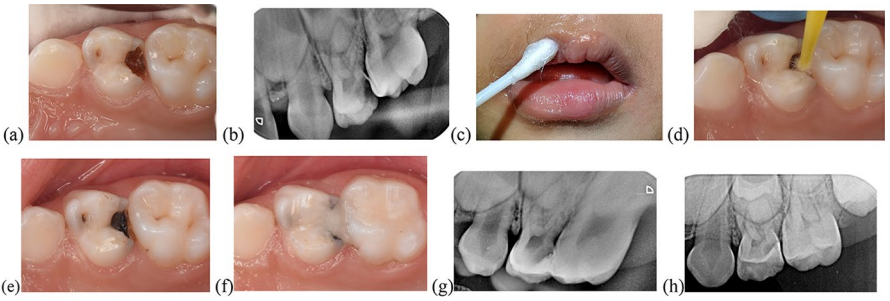

Fig. 4 SDF application in posterior carious lesions with no signs or symptoms of pulp pathology. **a** Preoperative deep dentinal carious lesion on the disto-occlusal surface of tooth 64. **b** Preoperative radiograph showing carious lesion involving inner third of dentin on tooth 64. **c** Perioral application of petroleum jelly. **d** Scrubbing of SDF into the lesion with a micro-brush after air-drying the lesion. **e** Well-arrested shiny dark lesion. (f) Tooth 64 was restored with high-viscosity glass ionomer cement—silver diamine fluoride modified atraumatic restorative technique (SMART). **g** Post-operative radiograph of tooth 64. **h** Note the lesion arrest and increase in remineralized zone between the lesion and pulp at 18-month follow-up

tin, superficial loose debris can be removed. However, removal of carious tissue is not necessary.

- Using a micro-brush, SDF is scrubbed into the lesion for a minute followed by gentle drying (Fig. 4d). One drop of SDF is adequate to treat approximately 6 teeth.
- Post-application, the treated site should be isolated for up to 3 min when possible.
- Fluoride varnish can be applied on the lesion following SDF application to allow the SDF to maintain contact with the lesion surface and to mask the metallic taste of SDF.
- Patients are instructed not to eat or drink for 30 min post-application.
- Tactile assessment of the hardness of the lesion surface following treatment is a better indication of lesion arrest as compared to the black discoloration (Fig. 4e).
- In posterior teeth with large carious lesions if the clinician is unsure of complete arrest of carious activity after one SDF application, a second application can be performed after 1 week.
- Biannual applications are indicated in children with persistent poor oral hygiene
- In large lesions in posterior teeth that are not easily cleansable, a glass ionomer restoration can be placed after SDF application or on follow-up. This is referred to by the acronym SMART (Fig. 4f)
- A postoperative radiograph can be obtained in posterior teeth to compare with future radiographs and monitor carious lesion arrest and remineralization (Fig. 4g)
- Long-term follow-up is recommended to monitor carious lesion activity and remineralization (Fig. 4h).

Technique of SDF application for the arrest of interproximal lesion

- Petroleum jelly is applied to the perioral areas to prevent accidental staining due to SDF.
- A spongy dental floss is used for application of SDF interproximally. The interproximal region is gently air-dried followed by interdental insertion of the floss (Fig. 5b).
- An applicator tip is used to saturate the floss with SDF solution (Fig. 5c).
- The floss is pulled across the interdental space and stabilized in place for 1 min to facilitate absorption of the solution onto the lesion surface (Fig. 5c).
- The process of SDF application is repeated to ensure thorough interproximal application of SDF.

SDF application on anterior teeth

Anterior teeth have a higher rate of success with NRCC using SDF than posterior teeth due to ease of cleansability and enhanced exposure to natural light leading to higher precipitation of silver (Fig. 6).

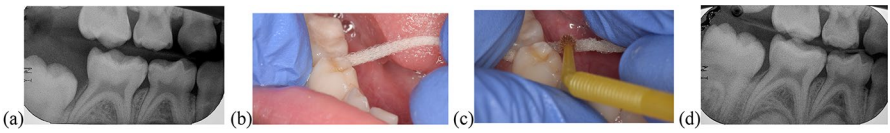

Fig. 5 Arrest of proximal lesions using SDF. **a** Bitewing radiograph showing small interproximal lesions on teeth 84 and 85. **b** Interdental insertion of spongy floss. **c** Saturation of floss with SDF solution using an applicator tip. The floss is pulled across and kept in place for a minute to allow absorption of solution onto lesion surface. **d** Arrest of interproximal lesions on teeth 84 and 85 demonstrated by no increase in lesion size after 1 year

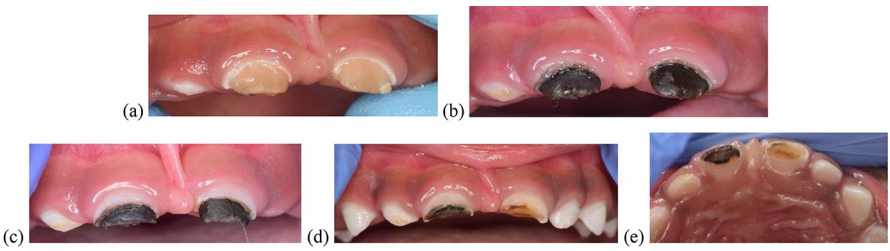

Fig. 6 Arrest of carious lesions in primary anteriors using SDF in an 8-month-old infant. **a** Partially erupted central incisors with soft dentinal lesions affecting all surfaces. **b** Hard and dark arrested lesions at 2-week follow-up. **c** Three-month follow-up showing further eruption and healthy plaque-free tooth structure. **d** Labial view at 1 year after treatment, no new lesions, some arrested dentinal tissue has sheared away from the incisal edges. **e** Palatal view at 1 year after treatment, no new lesions, the discolored dentinal surfaces are arrested and hard proving the successful outcome of NRCC in this toddler

After SDF application, the lesion activity is monitored at 2–4 weeks. The lesions are expected to have a dark and shiny appearance and feel hard to tactile pressure. Follow-up visits are recommended depending on the child's caries activity at 3–6 months. Since reduced rates of lesion arrest are observed in children with a high plaque index, the caregiver's motivation to minimize associated risk factors for dental caries is crucial. A popular NRCC protocol using SDF includes monitoring the lesions every 3 months and applying SDF biannually for 2 years.

Pitfalls and complications

- As the remineralizing ability of fluoride varnish is limited, the outcome of NRCC using sodium fluoride varnish is governed by compliance of the caregiver to:
  - Regulate inappropriate feeding habits
  - Restrict exposure of free sugars in food and drinks
  - Perform appropriate and diligent oral hygiene methods to avoid plaque accumulation in affected areas
- Use of SDF leads to black discoloration of the carious lesion that can be an esthetic concern for caregivers.
- Transient gingival irritation and a metallic taste are minor side effects.
- Accidental contact of SDF with skin or mucosa leads to a temporary stain or silver tattoo. SDF should be handled with care to prevent permanent staining of clothes, equipment and operating surfaces.

Further reading

1. Kher MS, Rao A (2019) Lesion management: no removal of carious tissue. Contemporary treatment techniques in pediatric dentistry. Springer, Cham
2. Tinanoff N, Baez RJ, Diaz Guillory C et al (2019) Early childhood caries epidemiology, aetiology, risk assessment, societal burden, management, education, and policy: global perspective. Int J Paediatr Dent 29:238–248
3. Pitts N, Baez R, Diaz-Guallory C et al (2019) Early childhood caries: IAPD Bangkok declaration. Int J Paediatr Dent 29:384–386
4. Urquhart O, Tampi MP, Pilcher L, Slayton RL, Araujo MWB, Fontana M, Guzmán-Armstrong S, Nascimento MM, Nový BB, Tinanoff N, Weyant RJ, Wolff MS, Young DA, Zero DT, Brignardello-Petersen R, Banfield L, Parikh A, Joshi G, Carrasco-Labra A (2019) Nonrestorative treatments for caries: systematic review and network meta-analysis. J Dent Res 98(1):14–26
5. Schwendicke F (2017) Contemporary concepts in carious tissue removal: a review. J Esthet Restor Dent 29(6):403–408. https://doi.org/10.1111/jerd.12338
6. Schwendicke F, Frencken JE, Bjørndal L, Maltz M, Manton DJ, Ricketts D, Van Landuyt K, Banerjee A, Campus G, Doméjean S, Fontana M, Leal S, Lo E, Machiulskiene V, Schulte A, Splieth C, Zandona AF, Innes NP (2016) Managing carious lesions: consensus recommendations on carious tissue removal. Adv Dent Res 28(2):58–67

7. Slayton RL, Urquhart O, Araujo MWB, Fontana M, Guzmán-Armstrong S, Nascimento MM, Nový BB, Tinanoff N, Weyant RJ, Wolff MS, Young DA, Zero DT, Tampi MP, Pilcher L, Banfield L, Carrasco-Labra A (2018) Evidence-based clinical practice guideline on nonrestorative treatments for carious lesions: a report from the American Dental Association. J Am Dent Assoc 149(10):837–849.e19
8. Crystal YO, Niederman R (2019) Evidence-based dentistry update on silver diamine fluoride. Dent Clin N Am 63(1):45–68
9. Crystal YO, Niederman R (2016) Silver diamine fluoride treatment considerations in children's caries management. Pediatr Dent 38(7):466–471
10. (2017) Chairside guide: silver diamine fluoride in the management of dental caries lesions. Pediatr Dent 39(6):478–479