**INTERNATIONAL JOURNAL OF HEALTH & MEDICAL RESEARCH**

ISSN(print): 2833-213X, ISSN(online): 2833-2148

Volume 05 Issue 11 November 2026

DOI : 10.58806/ijhmr.2026.v5i11n02

Page No. 1139-1143

# Silver Diamıne Fluoride in the Management of Dental Caries in Primary Teeth

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**ABSTRACT**

Early childhood caries is one of the most common chronic diseases of primary teeth and if left untreated it may have significant problems such as pain, infection, feeding problems and lower quality of life. Limited cooperation of young children can make conventional restorative treatment difficult and therefore non-invasive and minimally invasive treatment options have gained increasing importance. Silver diamine fluoride (SDF) is a topical medication that arrests the progression of active cavitated carious lesions. Specifically, many clinical studies and systematic reviews have reported that SDF solution 38% is an effective arresting agent for active dentinal caries in primary teeth . The antimicrobial effect of SDF is mainly due to silver ions, while the remineralization-promoting effect is due to its fluoride component. One of the main benefits is that it is quick and painless (without removal of tooth structure) to apply, particularly in young children with limited cooperation and high caries risk. But the chief disadvantage of the method is the permanent dark discoloration of the arrested carious tissue. The current literature is reviewed concerning mechanism of action, clinical effectiveness, principles of application, advantages and limitations, patient and parental acceptance of SDF in the management of caries in primary teeth and its relation to other minimally invasive treatment options.

**KEYWORDS:** Silver diamine fluoride, primary teeth, early childhood caries, caries arrest, minimally invasive dentistry.

## 1. INTRODUCTION

Childhood dental caries is one of the most important oral health problems. Early childhood caries in children less than six years of age, may involve multiple primary teeth in a short span of time and rapidly increase treatment needs . The difficulty in guiding behavior and in the use of local anesthesia, rotary instruments and relatively long treatment times during conventional restorative procedures in young children can complicate caries management [1,7].

Traditional management of cavitated carious lesions has largely focused on removal of carious tissue followed by restoration placement. However, the modern management of caries is increasingly geared toward the control of the biological activity of the disease, the preservation of sound tooth structure and where appropriate, the postponement or making of restorative procedures more conservative [7]. SDF has attracted a lot of attention in this context, as a non-invasive option to arrest active cavitated dentinal lesions.

SDF has been used in many countries for a number of years but has become more relevant again as evidence supporting its use in pediatric dentistry has increased. Systematic reviews and randomized clinical trials have shown that 38% SDF can decrease the activity of cavitated dentinal caries in primary teeth and stop the progression of lesions [1–5,11].

One of the main advantages of SDF is that it does not require removal of tooth structure by mechanical means. Thus, it can be an important temporary or long-term disease-control measure for children with difficulty in tolerating treatment, patients with high caries activity or where comprehensive restorative treatment cannot be provided immediately [8,11,12].

## 2. COMPOSITION AND MODE OF ACTION OF SILVER DIAMINE FLUORIDE

38% SDF is the most commonly used formulation in clinical practice. This solution contains ammonia and silver ions as well as a high concentration of fluoride. The caries-arresting effect of SDF is thought to be due to the combined actions of antimicrobial activity and remineralization rather than a single mechanism [6,8].

Silver ions exhibit antimicrobial activity against a wide spectrum of bacteria. They can influence the integrity of bacterial cell walls and membranes, inhibit enzyme systems and reduce bacterial metabolism. These factors contribute to the inhibition of microbial activity in active carious lesions [6].

Fluoride has been proven to reduce demineralization and increase mineral gain. The increased hardness of carious tissue may be due to deposition of fluoride and mineral-containing products on the dentin surface after SDF application. SDF has also been shown to reduce proteolytic degradation of dentinal collagen, and thus to help preserve the structural integrity of demineralized dentin

[1,6].

Clinically, arrested dentinal caries is characterized by a change from a soft, active lesion to a harder surface. Frequently, the lesion darkens after SDF treatment. Color change alone is not sufficient to determine caries arrest. Lesion hardness has to be assessed together with clinical activity and progression over time [4,7].

## 3. EFFECTIVENESS OF ARRESTING CARIES IN PRIMARY TEETH

The strongest evidence for SDF in pediatric dentistry is in relation to arrest of cavitated dentinal caries. Systematic reviews have reported substantial caries arrest in SDF-treated primary tooth lesions and indicate that SDF may be more effective than fluoride varnish alone in arresting active dentinal caries [2,3].

A systematic review and meta-analysis by Trieu et al compared SDF to sodium fluoride and found SDF to be more effective in arresting dentinal caries in children [3].

Another important clinical study by Fung et al. on treatment effectiveness evaluated different SDF concentrations and application frequencies. The study demonstrated that higher concentrations and repeated applications might increase caries arrest [4]. These findings suggest that SDF should not be considered a single application, but rather an intervention that requires regular clinical follow-up and reapplication as needed.

Previous randomized controlled trials have reported similar results. Chu et al. compared SDF with sodium fluoride varnish and found that SDF was effective in arresting dentinal caries in preschool children [19]. Zhi et al. compared the SDF and glass ionomer treatment and found that the SDF could achieve caries arrest in preschool children [18].

In 2026, a large randomized clinical trial demonstrated that SDF could provide clinical benefit in arresting dentinal caries in young children with severe early childhood caries [11]. Recent systematic evaluations regard SDF as one of the strong options for the non-invasive management of dentinal caries in primary teeth [13]. These findings are supported by

## 4. CONCENTRATION AND APPLICATION FREQUENCY

Caries arrest depends on SDF concentration as well as frequency of application. 38% SDF has been used in several pediatric studies and the evidence available suggests that this concentration may provide a more predictable arrest than lower concentrations [2,4].

Not all lesions may be sufficient for an SDF application. In children with high caries activity, regular monitoring of lesions is especially important and SDF may need to be reapplied to lesions that remain active. Fung et al. stated that more frequent applications could increase the rates of caries-arrest [4].

The same approach is supported by more recent clinical studies that evaluate the repeated applications. Studies comparing single vs. repeated applications have shown that reapplication can result in improved lesion control in some patient populations [14]. Therefore, a single application of SDF should not be considered as definitive treatment. The risk of caries in the child, hardness of the lesion, control of plaque, and the development of new caries should be assessed periodically [7].

## 5. PRINCIPLES OF CLINICAL APPLICATION

The SDF application is relatively simple compared to conventional restorative procedures. First, the lesion should be evaluated to see if it is an active cavitated dentinal carious lesion. However, note that SDF is not a substitute for teeth that have spontaneous pain, abscess, fistula or pathological pulpal findings suggestive of pulpal involvement or odontogenic infection [7,8].

A similar barrier or petroleum jello can be applied prior to application to protect the surrounding soft tissues. The carious surface is then cleared of gross debris and plaque, isolated, and dried as much as possible. SDF is applied only to the target lesion, using a microapplicator, in a very small quantity. The solution should be in contact with the lesion for the time recommended for the specific product and according to the manufacturer's instructions [7,8].

SDF can be used without complete removal of the carious tissue. This feature makes the technique especially useful for very young children, children with high dental anxiety, or those who cannot provide adequate cooperation for conventional restorative treatment [7,8].

At follow-up, the lesion should be examined for hardening and signs of progression. Reapplication of SDF might be considered for lesions that continue to be soft and active [4,7].

## 6. SDF & FLUORIDE VARNISH

Fluoride varnishes are used frequently in caries prevention in children. Their main role is to reduce the risk of development of caries and to assist remineralization of early lesions. SDF is especially helpful in arresting existing active cavitated dentinal caries [3,5]. Thus, fluoride varnish and SDF should not be treated as having similar clinical indications. SDF may be a better option for disease control in an active cavitated dentinal lesion, but fluoride varnish is still important for protecting sound surfaces and managing initial carious lesions [3,7].

The possible added benefit of SDF combined with fluoride varnish has also been investigated. Abdellatif et al, in a randomized field trial, compared SDF and sodium fluoride varnish with SDF alone . The results indicate that the combination can be used in specific situations, although SDF alone can also lead to considerable caries arrest [5].

## 7. SDF AND ART (ATRAUMATIC RESTORATIVE TREATMENT)

Atraumatic restorative treatment (ART) consists of selective removal of soft carious tissue using hand instruments and restoration of the cavity using high-viscosity glass ionomer cement. SDF, in contrast, aims at arresting the caries activity without the use of a restorative material [7,12,15].

The clinical objectives of the two approaches are therefore different. SDF controls disease but does not restore lost tooth anatomy. The aim of ART is to conservatively manage carious tissue and to restore functionally the cavity [12,15].

In recent years the Silver Modified Atraumatic Restorative Treatment (SMART) approach, which combines SDF and ART principles, has gained importance. In this technique, usually after SDF application, cavity is restored with glass ionomer cement. The objective is to combine the antimicrobial and caries-arresting effects of SDF with the restorative and fluoride-releasing effects of glass ionomer cement [12,15].

Randomized clinical trials and systematic evaluations published in 2026 indicate that the SMART approach could be promising for primary molars. However, long-term evidence is still emerging on which cases should be treated with SDF alone and which are more appropriate for ART or SMART [12, 15].

## 8. BLACK STAINING AND COSMETIC PROBLEMS

The major disadvantage of SDF is the dark brown or black staining that occurs in arrested carious tissue. The color change is mainly attributed to the deposition of silver compounds in the carious tissue and their oxidation with time. The color change may be less obvious on sound enamel but is usually apparent in active cavitated dentinal caries. Therefore, particular attention should be given to esthetic expectations when SDF is applied to primary anterior teeth [6,8].

Parents should be informed explicitly before application of SDF that the treatment may turn carious tissue black. Visual aids to assist parents in understanding expected appearance may ease the informed-consent process [8,10]. Parents have been reported to be more tolerant of discoloration of posterior primary teeth than staining in the anterior region [9,10]. Nevertheless, some parents might consider it an important advantage to avoid local anesthesia, sedation or general anesthesia despite the black staining [10].

## 9. USED IN COMBINATION WITH POTASSIUM IODIDE

Potassium iodide (KI) has been studied as a way to reduce black staining associated with SDF. KI is used right after SDF to promote silver iodide formation and to decrease the amount of free silver ions [6].

Some studies have shown a reduction in the initial discoloration, but the long term esthetic effectiveness seems variable. Moreover, heterogeneous results were also reported in the literature regarding the effect of KI on the caries arresting efficacy of SDF [6]. A systematic review by Haiat et al. examined the possible effects of combining SDF and KI on dental biofilm and discoloration, concluding that there is not sufficient robust evidence to claim that staining can be completely removed [6]. Thus, KI should not be considered a definitive method for prevention of SDF-related black staining.

## 10. ACCEPTANCE OF CHILD AND PARENT

SDF's success depends not only on its biological efficacy but also on its acceptance by children and parents. For children, the absence of injections, local anesthesia or rotary instruments is an important advantage. The short procedure time may also enhance treatment compliance especially in preschool aged children [8,10].

However, black discoloration is one of the main factors determining parental acceptance. Timms et al. [10] conducted a study of parental acceptability in the United Kingdom and the United States and demonstrated that parental treatment preferences were significantly affected by tooth location and esthetic effects.

Discoloration of posterior primary teeth is generally more acceptable than that of anterior primary teeth. Parental attitudes to SDF may, however, be more positive if the therapy can help the child to avoid extensive restorative procedures or general anesthesia [8,10].

## 11. SAFETY AND SIDE EFFECTS

SDF has generally been well tolerated in clinical studies when used at recommended amounts [1,8,11]. Due to the small amount used in application, systemic exposure is limited.

The most common side effect is black staining of the carious lesion. SDF may cause transient white discoloration or mild irritation upon accidental contact with the oral mucosa. Therefore, protection of the soft tissues and careful isolation while applying are important [8].

It should be emphasized that SDF is not a replacement for pulp therapy. The use of SDF alone and postponing definitive treatment is not indicated in a primary tooth with spontaneous pain, pulpal infection, abscess or fistula. In these cases alternatives like pulp therapy or extraction should be considered [7].

## 12. CLINICAL INDICATIONS OF SDF

SDF is particularly useful in children with high caries risk, multiple active cavitated lesions, and difficulty in tolerating conventional restorative treatment. It can be used to control disease and gain time when definitive restorative treatment cannot be provided immediately [1,7,11].

The SDF may be useful for the young child with limited cooperation, the patient with special health care needs and the population with limited access to conventional dental treatment [7,8].

Not all primary teeth with caries, however, can automatically be treated with SDF. All of these factors including the relationship of the carious lesion to the pulp, the symptoms of the child, the expected remaining time of the tooth in the mouth, restorative needs and esthetic expectations of the parents should be evaluated together [7,8,11].

## DISCUSSION

SDF provides an important alternative to the traditional restoration-based approach to active dentinal caries in primary teeth. Its main advantage is the possibility of decreasing activity of lesions without total mechanical removal of carious tissue. This is of particular importance in pediatric dentistry where traditional restorative procedures may be difficult to perform and may also be difficult for young children due to behavioral issues [1–4].

Current evidence suggests that 38% SDF in particular has a strong caries-arresting effect on cavitated dentinal lesions of primary teeth [1–4,13]. But the success of treatment does not only depend upon the material. Factors such as plaque control, dietary habits, caries risk, and frequency of application may also influence the outcome.

One of the main differences between SDF and fluoride varnish is that the primary objective of SDF is to arrest an existing cavitated lesion. Fluoride varnish is important in caries prevention and remineralization of early lesions and SDF is important in the management of active dentinal caries [3,5].

However SDF is not a restorative material. It does not replace lost tooth anatomy or function. If plaque retention, food impaction or functional problems persist in molars with large cavities, glass ionomer restoration or approaches such as SMART may have to be considered after SDF application [12, 15, 18].

The main clinical limitation is black staining. Therefore, parents and, when possible, the child should be informed about the esthetic outcome of treatment, especially when SDF is used in the anterior region [6,10]. Without sufficient discussion of esthetic issues, SDF may lead to dissatisfaction in spite of clinical success.

Current studies also indicate that SDF should not be used to indefinitely delay definitive treatment. SDF can be an advantageous stabilization method in severe early childhood caries, but the child's pulpal, functional and restorative requirements should be evaluated regularly [11,13].

## CONCLUSIONS

Silver diamine fluoride is an effective, rapid and minimally invasive means of arresting caries in primary teeth, particularly in the presence of active cavitated dentinal lesions. Current systematic reviews and clinical trials indicate that 38% SDF can provide significant clinical benefit in arresting caries in primary teeth.

The main advantages of treatment are the absence of local anesthesia, rotary instruments or removal of extensive caries, the quick application and the high acceptance by many young children. SDF is especially useful in children who are not very cooperative, have a high risk of caries and multiple lesions.

The main disadvantage of the method is permanent dark discoloration of arrested carious lesions. Therefore, parents should be informed in detail before the application and esthetic expectations should be carefully evaluated, especially in the anterior region. SDF cannot be viewed as a replacement for conventional restorative treatment in all circumstances. The primary goal of treatment is to control disease activity. For functional or restorative reasons, SDF can be combined with conservative restorative approaches, such as ART or SMART.

To conclude, SDF is an important tool in the current minimally invasive management of caries in primary teeth when used with appropriate case selection, proper application, regular follow-up and family education.

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