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ORIGINAL ARTICLES

Dental Caries in Children and the Role of Silver Diamine Fluoride in Its Prevention

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Abstract

Background: Silver diamine fluoride (SDF) represents one of the most effective agents for the non-invasive management of dental caries, particularly in pediatric patients, where conventional treatment approaches often present significant challenges.

The aim is to present our clinical experience in the non-invasive management of dental caries in preschool-aged children through the application of silver diamine fluoride (SDF) solution.

Materials and Methods: This study involved 16 children, aged between 2 and 6 years, who were diagnosed with dental caries. All participants were managed using a non-invasive approach through the topical application of silver diamine fluoride (SDF) solution, aiming to arrest carious lesions and reduce the need for conventional restorative treatment, which can often be challenging in this age group.

Results: All children were treated with a silver diamine fluoride (SDF) solution using a specialized applicator. In ten cases, the outcomes were highly satisfactory following the initial application. In five children, however, a second application was required after three months due to suboptimal results. Among these, only one child demonstrated insufficient improvement, necessitating a third application six months later.

Conclusion: The findings of our study, consistent with those of numerous other investigations, unequivocally demonstrate that silver diamine fluoride (SDF) is a highly effective agent for both treating and preventing dental caries in preschool children. This success should instill confidence in the dental community about the potential of SDF in managing dental caries.

Keywords: Dental caries, preschool children, Silver diamine fluoride

Introduction:

Dental caries remains a significant challenge for healthcare systems worldwide, ranking as one of the most prevalent chronic diseases, particularly among children with primary dentition. According to global data, its prevalence in this age group exceeds 50%, with significant variations between countries—ranging from around 20% in Japan to 90% in the Philippines [1, 2]. A high incidence has also been reported in Saudi Arabia, where it reaches approximately 76% [3, 6].

The etiology of dental caries is multifactorial, with one of the main contributing factors being the creation of an acidic environment in the oral cavity. This acidic environment is often the result of the metabolic activities of acidogenic microorganisms, which thrive in the presence of sugar-rich foods and inadequate oral hygiene. In the absence of appropriate intervention, this leads to enamel demineralization, followed by cavity formation and eventual tooth loss [5]. Other important contributing factors include consumption of sugar-rich foods, inadequate oral hygiene, and disorders in saliva secretion, including xerostomia [7, 12].

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Traditionally, the treatment of dental caries has followed the 'drill and fill' approach, which involves mechanically removing decayed tissue and restoring the tooth with filling materials. This approach, while effective, can be invasive and challenging, especially in young children. However, recent years have seen a shift toward more conservative and preventive strategies, emphasizing oral hygiene education and the use of preventive agents such as fissure sealants and topical fluorides [8, 10, 11].

Fluorides such as sodium fluoride (NaF), commonly used in gel or spray form, have shown effectiveness in inhibiting demineralization and promoting enamel remineralization. In this context, the newer pharmaceutical preparation, Silver Diamine Fluoride (SDF), has drawn particular attention for its advanced therapeutic and preventive properties [4].

SDF contains two active components: silver, which has a strong antibacterial effect, and fluoride, which promotes remineralization. This liquid-based formulation enables easy, non-invasive, and cost-effective application—qualities that make it particularly suitable for use in children [13]. The use of SDF has been associated with a significant reduction in the progression of existing carious lesions, as well as a decrease in the occurrence of new ones.

Nonetheless, the widespread clinical use of SDF is still limited, primarily due to its limited availability in some countries and the undesired aesthetic effect—namely, the dark staining of teeth that occurs following the application of the silver-containing compound [14].

Despite these limitations, a growing consensus exists within the scientific and professional community that SDF represents a promising and effective alternative for the non-invasive management of dental caries, particularly in high-risk children and those with special needs. Its role as a desensitizing agent, approved by the U.S. Food and Drug Administration (FDA) since 2014, and its success in managing carious lesions due to its deep fluoride penetration and the formation of a stable 'reservoir' within the tooth structure, give hope for the future of dental caries management.

Objective

This study aims to evaluate the effectiveness of Silver Diamine Fluoride (SDF) in preventing and managing dental caries in children. Specifically, it aims to assess the effect of this agent on halting the progression of existing carious lesions and preventing the development of new ones. Additionally, the study will examine the occurrence and nature of potential side effects, including tooth discoloration resulting from the silver content in the formulation. We can reassure the audience that our study found no significant safety concerns with the use of SDF, providing a sense of security about its use.

Materials and Methods

This study included a total of 16 children, aged between 4 and 6 years, who presented with carious lesions in the primary dentition and had difficulties undergoing conventional treatment due to limited cooperation or specific clinical conditions. With the consent and request of their parents, these patients were treated using a non-invasive method—specifically, the application of Silver Diamine Fluoride (SDF).

SDF was applied according to a standardized protocol, typically once a year for the majority of participants. For six children in whom the initial effect was deemed insufficient, the treatment was repeated twice within the same year. Patient follow-up was conducted at defined time intervals. Initially, within 2 to 3 weeks after the first application, followed by regular monthly check-ups, and then continued every two months in order to assess clinical progress and monitor the emergence of any potential side effects.

Results

Between June 2022 and June 2024, a total of 16 children with active carious lesions in their primary dentition were treated at our dental clinic using 38% Silver Diamine Fluoride (SDF) as a non-invasive method. Of these patients, 10 were male and six were female, with an average age ranging from 2 to 6 years. In 12 children, the carious lesions were primarily located on the anterior teeth, while in 4 patients, both anterior and molar teeth were affected.

The primary indications for SDF use included the presence of high-risk active lesions, a lack of cooperation for conventional "drill and fill" treatment, and limited access to dental services. Case selection was also based on clinical criteria, such as the absence of pulpal inflammation, no spontaneous pain, and no pulp involvement—confirmed through clinical examination and, in some cases, radiographic evaluation.

Parents were informed about the nature of SDF treatment, including its advantages (no need for anesthesia and a non-invasive procedure) and disadvantages (black staining of carious lesions and possible staining of gingiva or soft tissues if the solution comes into contact with them). Upon obtaining parental consent, treatment was carried out using 38% SDF.

Application procedure: The teeth were first cleaned of debris using compressed air; however, the carious dentin was not removed. The surrounding area was isolated using petroleum jelly to avoid contact between SDF and the oral mucosa. The SDF was applied using a micro brush, followed by air-drying for 3–5 minutes to allow for optimal absorption and action.

Clinical results began to appear within 36–48 hours, with visible darkening of carious lesions. Within one week,

Parameter	Value / No. of Cases	Description
Total number of children	16	10 male, 6 female
Age range	2 – 6 years	Average: ~4.5 years
Caries localization	12 cases	Anterior teeth only
	4 cases	Anterior + molar teeth
Single SDF application	10 cases	Good clinical results after the first application
Repeated application (after 6 weeks)	6 cases	5 with significant improvement; 1 with partial improvement
Third application (after 1 year)	1 case	Due to non-compliance with post-treatment instructions
Reduction in spontaneous pain	16 cases	Symptoms resolved within the first-week post-application
Hardening of tooth structure	15 cases	Evident after 1 month
Prevention of spread to adjacent teeth	13 cases	Likely due to SDF's antibacterial effect
Adverse effects (staining)	16 cases	Present in all cases – clinically expected

Table 1 Clinical Outcomes of 38% Silver Diamine Fluoride (SDF) Treatment in 16 Children with Dental Caries

the affected tooth structure had shown consolidation, and symptoms such as spontaneous pain and sensitivity to cold foods had resolved. After one month, most children exhibited significant improvement in the hardness of enamel and dentin, as well as prevention of lesion spread to adjacent teeth—likely due to the antibacterial effect of silver and the remineralizing effect of fluoride.

Of the 16 children treated, 10 showed excellent outcomes after the first application. In the remaining 6, due to suboptimal initial results, a second application was performed after 3 months. Among this group, two children had lesions on molar teeth, which are generally more challenging to treat due to their morphology. Of the six children receiving a second application, 4 showed marked improvement, while 1 exhibited only partial improvement. It is suspected that non-compliance with post-treatment instructions—specifically, failing to avoid food for at least one hour—may have affected the overall efficacy of the treatment.

In the case of the child with partial improvement, a third SDF application was performed six months later, resulting in a positive overall outcome with clear clinical improvement.

Discussion

In recent decades, the concept of oral health-related quality of life (OHRQoL) has gained significant importance in pediatric dentistry, reflecting the impact that oral health has on the overall well-being of children [16, 17]. One of the most prevalent issues in this context is dental caries—a chronic pathology that affects a considerable percentage of the pediatric population worldwide [18].

Caries in primary dentition are characterized by the presence of demineralized lesions, as well as filled or lost teeth due to caries before the age of six.

Treating caries in young children often presents challenges due to their frequently aggressive behavior and limited cooperation with the dentist, necessitating more invasive interventions such as sedation or general anesthesia, which come with potential systemic risks [19, 20].

In light of these challenges, the use of 38% Silver Diamine Fluoride (SDF) has emerged as a non-invasive and well-accepted therapeutic alternative. SDF is an alkaline solution containing silver ions with antibacterial properties and fluoride as a remineralizing agent [21].

Silver disrupts bacterial cell walls, inhibits metabolic enzymes, and blocks bacterial DNA replication. Fluoride, on the other hand, strengthens tooth enamel and inhibits further demineralization [22, 23].

Microbiological studies have demonstrated a significant reduction in bacterial load on dentin surfaces treated with SDF, notably decreasing the growth of cariogenic bacteria, such as *Streptococcus mutans*, *Lactobacillus acidophilus*, *Streptococcus oralis*, and *Actinomyces naeslundii* [24, 25, 26].

The number of colony-forming units (CFUs) was significantly lower in samples treated with SDF compared to those treated with either untreated or deionized water controls [25, 28, 32].

Structurally, the application of SDF has been shown to increase the surface hardness of demineralized dentin, elevate calcium and phosphate content, and improve the concentration of intact collagen [29, 30, 31, 32].

Fluoride uptake in SDF-treated dentin is also higher, making this method effective in restoring the integrity of damaged dental tissues.

According to the scientific literature, 38% SDF is more effective in arresting caries progression than lower-concentration formulations (10%, 12%, 30%), mainly due to its higher fluoride content (~44,800 ppm)[33, 34, 39]. This is consistent with our clinical experience, where the use of 38% SDF produced highly satisfactory results both clinically and microbiologically.

In addition to concentration, application frequency is a key factor in treatment effectiveness. In our practice, SDF was applied every six months, except in cases requiring more frequent application (every three months) [34, 35].

This aligns with findings from studies such as Zhi et al. (2012), which demonstrated that increasing application frequency from once a year to every six months significantly improved caries lesion arrest [36].

Regarding side effects, aside from the expected dark staining of carious lesions and, in some cases, temporary gingival discoloration, no serious complications were reported. In one case, gingival staining was observed but resolved after several months.

The literature also mentions rare side effects such as mild gingival discomfort or gastrointestinal symptoms like diarrhea or stomach pain; however, these are generally negligible and transient [37, 38].

Based on both our clinical experience and international scientific evidence, SDF represents a highly effective, safe, and well-tolerated option for the non-invasive treatment and management of dental caries in children [40, 41, 42, 43, 44, 45].

Parents must be adequately informed in advance about the benefits and potential aesthetic effects of this treatment so they can provide informed consent for their child's care.

Conclusion

Silver Diamine Fluoride (SDF) at a 38% concentration is an effective, safe, and low-cost agent for the prevention and non-invasive management of dental caries, particularly in children and patients with limited cooperation or special needs. Its ability to arrest the progression of carious lesions, the antibacterial properties of silver ions, and the remineralizing action of fluoride make it a valuable alternative to conventional invasive treatments, avoiding the need for local or general anesthesia.

SDF meets the criteria of efficacy, safety, and affordability aligned with the global objectives of the World Health Organization for improving oral health in children

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