



THE EFFECTIVENESS OF SILVER DIAMINE FLUORIDE IN EARLY CHILDHOOD CARIES: A REVIEW

Dental Science

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ABSTRACT

Dental caries is the most common childhood chronic disease worldwide. Early childhood caries (ECC) is the presence of 1 or more decayed, missing, or filled tooth surfaces (dmfs) in any primary tooth in a preschool-aged child. Early treatment of ECC is important because it can lead to pain, sepsis, malnutrition due to the inability to eat, and poor general health. The traditional way to manage ECC involves surgical removal of all the infected and softened dental tissue followed by the filling of the cavity. Children with severe ECC or those who are not able to cooperate well for traditional restorative treatment. Now, Silver diamine fluoride (SDF) has been used as an alternative method for caries prevention and arrest. The aim of this review was to evaluate the scientific evidence regarding the effectiveness of silver diamine fluoride in preventing and arresting early childhood caries.

KEYWORDS

Silver diamine fluoride, early childhood caries, effectiveness

INTRODUCTION:

Early childhood caries is an infectious, and transmissible disease of teeth affecting young children caused by various factors and is related to susceptible, uninsured, and financially weak populations.¹ It is also the most prevalent condition included in the 2015 Global Burden of Disease Study, ranking 12th for deciduous teeth affecting 560 million children.² Early treatment of ECC is important because untreated caries can lead to pain, sepsis and spreading infection, malnutrition due to the inability to eat, and poor general health. Children with severe ECC or those who are not able to cooperate well for traditional restorative treatment often require general anaesthesia.³ The conventional way to manage ECC involves surgical removal of all the infected and demineralised dental tissue followed by the filling of the cavity to restore the function and aesthetics of the tooth.⁴ With a better understanding of caries pathology and evidence from clinical trials, it is generally accepted that arresting caries treatment can effectively prevent caries from progressing. Some researchers and dentists proposed a paradigm shift from surgical to non-surgical caries management in children.⁵ In recent times, SDF has been popularized for its capability to stop the caries progression and concurrently arrest the formation of new carious lesions.⁶ The aim of this review was to evaluate the scientific evidence regarding the effectiveness of silver diamine fluoride in preventing and arresting early childhood caries.

History: Japanese used silver as tooth cosmetics to prevent dental caries since 1000 years.⁷ In 1891, silver amalgam and nitric acid was used on carious teeth and had caries arresting properties.⁸ Silver nitrate was directly applied to carious cavities with analogous outcomes, and it was termed as Howe's solution.⁹ In Western Australia, 40% silver fluoride (AgF) was applied as the treatment for deep dental caries in primary teeth at school dental care services.¹⁰

The rationale of arresting caries in children: The purpose of arresting caries treatment is to halt or slow down caries progression in order to minimize children's discomfort and potential pulpal damage. Dental caries occurs when demineralisation outweighs remineralisation, resulting in a net loss of tooth minerals.¹¹

Mechanism: There could be following possible mechanisms of action of SDF against caries:

1. The first mechanism may be the occlusion of dentinal tubules with silver: According to Shimizu,¹² when SDF is applied on dentine, its dye permeability reduced and electric resistance enhanced. He also reported that silver and its compounds from SDF application blocked the diffusion of acid and invasion of microorganisms into the dentinal tubules. It also inhibited the further growth of microorganisms by oligodynamic action of silver.¹³ Additionally, obturation of the dentinal tubules decreased the surface area of dentin, which may be attacked by caries. It has also been seen that the use of 38% SDF repressed demineralization and preserved collagen from degradation

in demineralized dentin.¹⁴ The other mechanisms could be the cariostatic action of products produced by the reaction between SDF and minerals of the tooth. The fluoride present in amplified the resistance of the dentin to the action of acid resulting in reduced penetration of acid into inner dentin.¹⁵ When SDF is applied to dentin under in vivo conditions, its fluoride ions penetrated to a depth of 50–100 μ m.³¹ It has been proved that SDF ($\text{Ag}(\text{NH}_3)_2\text{F}$) reacts with hydroxyapatite (HA) of a tooth to release calcium fluoride (CaF_2) and silver phosphate (Ag_3PO_4), resulting in hardening of affected dentine.

A basic chemical reaction is shown below:

• $\text{Ag}(\text{NH}_3)_2 + \text{Ca}_{10}(\text{PO}_4)_6(\text{OH})_2 + 2\text{F}^- \rightarrow \text{Ca}^{++} + 2\text{F}^- + \text{Ca}_{10}(\text{PO}_4)_6\text{F}_2 + 2\text{OH}^-$
The Ag_3PO_4 that is formed on the tooth is insoluble to acid attacks. The CaF_2 formed as a reaction product becomes a pool of fluoride ions for the formation of fluorapatite ($\text{Ca}_{10}(\text{PO}_4)_6\text{F}_2$).¹⁶ It is also proved that fluoride ions enhance calcification of tooth, and restores lattice imperfection,¹⁷ and improves the crystallinity of HA.¹⁸

1. The anti-enzymatic actions of the reaction products between $\text{Ag}(\text{NH}_3)_2\text{F}$ and organic component of the tooth can be the next mechanism of action for caries arrest. Its antibacterial properties arise from inhibition of the enzyme activities and dextran induced agglutination of cariogenic strains of *Streptococcus mutans*.¹⁹ The resistance of dentin to trypsin increased when SDF is applied on the tooth surface.²⁰ Also, a study reported that resistance to collagenase and trypsin for dentin protein increased after treating the tooth with SDF.²¹

DISCUSSION:

A solution of 38% SDF has been reported as an effective treatment for caries arrest.²² SDF is usually recommended for children with a high risk of developing caries, often those living in poor conditions or developing countries.^{23,24}

Chu and his co-workers found that annual application of 38% SDF is more efficacious in arresting caries in primary anterior teeth when compared with the application of 5% sodium fluoride varnish every 3 months.²⁵

Yee and his co-workers found that adding tannic acid, a reducing agent, could not enhance the arresting effect on caries. While their findings support the effectiveness of 38% SDF in arresting caries, they found the one-off application of SDF at a reduced concentration (12%) could not arrest caries. Yee and her co-workers found that caries reversal can occur after a single application.²⁶

In addition, Zhi and her co-workers found that the caries arrest rate of 38% SDF was higher with biannual application than with annual application.²⁷

Gotjamanos performed SDF application followed by restoration with glass ionomer cement on 55 carious lesions on primary teeth in children. He then observed these restorations for 3 to 58 months before he extracted the restored teeth for orthodontic reasons. Histological assessments of the dental pulps of the extracted teeth were carried out. Results show that more than 90% had a satisfactory pulpal response. In general, the dental pulp had abundant reparative dentine. A wide odontoblast layer was present beneath the pre-dentine.¹⁰

In general, these studies demonstrate that SDF treatment is a simple and cost-effective method for caries control in children.^{25,28} As 38% SDF has high fluoride concentration (44,800 ppm F), some researchers are concerned about its high fluoride concentration causing dental fluorosis.²⁹

CONCLUSION:

SDF at concentrations of 30% and 38%, is more effective than other preventive management strategies for arresting dentinal caries in the primary dentition. Black staining of the carious lesions is a disadvantage of SDF treatment. Because SDF therapy is painless, simple, and low-cost, it could be widely recommended and promoted as an alternative preventive treatment to conventional invasive caries management, especially among child patients who are too young for conventional dental care or those with special needs.

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