

Evaluation of Effect of Silver Diamine Fluoride in Arresting Dental Caries Using International Caries Classification and Management System (ICCMS): An *In Vivo* Study

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ABSTRACT

Background: In terms of maintaining esthetics and function, reducing pain, and encouraging wellness, primary dentition care is just as important as permanent tooth care. The purpose of this research was to see how efficient silver diamine fluoride is at preventing tooth decay.

Materials and method: The 3-month clinical experiment included a sample size of 30 children (both males and females) aged 4–8 years by applying silver diamine fluoride on the carious tooth to evaluate the efficacy of silver diamine fluoride in arresting the caries. The children were kept on follow-up and IOPA's were taken to check the arrest of caries at baseline, 1 month and after 3 months. To assess the progression of caries radiographic interpretation of IOPA X-rays was done using ICCMS scores at baseline, 1 month and 3 months.

Results and conclusion: The current study found that topical 38% silver diamine fluoride arrest tooth decay and was effective for treating dental caries in school-aged children in the short term.

Keywords: Caries arrest, Dental caries, Primary teeth, Silver diamine fluoride.

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INTRODUCTION

Dental caries is most common dental problem which is encountered on daily basis.¹ It is a complex, multifactorial disease which remains a significant problem across all age groups.²

Nowadays, many products are available such as silver diamine fluoride, nano silver fluoride, silver nitrate which are cost effective and require minimal invasive techniques.^{3,4} When compared to fluoride varnish and acidulated phosphate fluoride gel, SDF has proved to be effective in stopping lesions and has a higher fluoride absorption.⁵

SDF is a colorless solution that is applied to caries lesions with a microbrush and contains silver and fluoride amines at a concentration of 25% silver, 8% amine, 5% fluoride, and 62% water. Because silver is unstable, it is dissolved in ammonia-laced water to generate a more stable complex. It's the highest concentrated fluoride product on the market for caries prevention.⁴ SDF has been used for decades in Japan, China, Brazil, and Argentina at concentration varying from 10 to 30% for prevention and arrest of dental caries. SDF was approved in February 2017 in Canada at a concentration of 38% for prevention and arrest of carious lesion in both primary and permanent teeth. Silver diamine fluoride is believed to have antimicrobial properties while promoting remineralization.⁶

It is considered as silver bullet with minimal adverse event. Silver is an antibacterial substance. Silver ions are released by SDF solution and have three oxidation states: silver ions, divalent silver ions, and trivalent silver ions, however only the silver I state is stable enough to be used as an antibiotic. Although the fluoride content of^{7,8} SDF at a concentration of 38% is high (44,800 ppm), researchers determined that the concentration associated with toxicity is significantly lower since just a tiny amount of silver diamine fluoride solution is given to the carious lesion.^{9,10}

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SDF is simple and inexpensive to apply to the dental surface, and it adheres to the philosophy of minimal intervention dentistry. There are studies on the silver diamine fluoride and its effect on carious lesion but very little data is available on its clinical use and efficacy on carious encountered in the region of Uttarakhand. Therefore, this study is being conducted to see its effect on various patients in Rishikesh, Uttarakhand.

METHOD

A 3 months clinical study was planned including sample of 30 children incorporating both males and females aged 4–8 years will be selected amongst the patients reporting to the Outpatient Department.

Method of Collection of Data

A complete medical and dental history was taken prior to application of the silver diamine fluoride. Oral examination of the

child was done. After the clinical examination, children who fulfilled inclusion criteria having primary or permanent teeth with class I caries was selected for application of 38% silver diamine fluoride and written consent form from parents was taken.

Inclusion Criteria

Patient Selection

- Children without allergic to silver compound,
- Children who are co-operative and willing to participate in the study,
- Teeth selected as per ICCMS score 1 to 4.

Tooth Selection

- Primary molar with class I caries,
- No intraoral or extraoral swelling present,
- Primary molar selected as per ICCMS score 1 to 4.

Exclusion Criteria

- Children below the age of four years and above the age of 8 years,
- Primary molar with large carious lesion,
- Presence of any abscess,
- Children with allergy to silver compound,
- Teeth falling under ICCMS score 5 and 6.

Steps of Study

- Informed consent was obtained from the parent/guardian.
- Radiograph of the involved tooth was taken.
- A protective coating of the petroleum jelly was applied on the lip and mucosa of the selected patient to prevent a temporary appearing tattoo by SDF by its contact with the lip or mucosa. Care was taken not to inadvertently coat the carious surface (Fig. 1).
- Isolation of the affected area with the help of cotton rolls was done.
- The application of 38% silver diamine application was done over the carious surface with the help of the microbrush. To minimize the systemic absorption excess of SDF was removed with cotton pellets (Fig. 2).
- Applied area was kept isolated for 2 minutes, and then gently rinsed with water (Fig. 3).
- Patient was recalled after 1 month and after 3 months. Radiographic evaluation done, based on ICCMS (Fig. 4, Table 1).

Observation and Results

Following the application of 38% silver diamine fluoride, 30 teeth were analyzed and categorized into distinct ICCMS scores (score 1, score 2, score 3, and score 4) based on the amount of radiolucency as determined by IOPA X-ray.

The clinical effectiveness of 38% SDF in preventing caries is shown in Table 2 in relation to ICCMS scores. At baseline 30 teeth were evaluated which were having different score number depending upon the extent of radiolucency. At baseline in score 1, 6 (20%), score 2, 11 (36.7%), in score 3, 9 (30%), and in score 4, 4 (13.3%) teeth were included. After 1 month, under score 2 arrest of caries seen in 10 teeth and there was progression of caries in single tooth. Under score 3, 10 teeth showed the sign of arrest of caries and only progression of caries took place in single tooth. Under score 4 arrest of caries were seen in all the four teeth.

After 3 months of the application of silver diamine fluoride teeth were again evaluated and it was seen that under score 1 that

arrest of caries took place in five teeth and there was progression of caries only in one tooth. Under score 2 arrest of caries were seen in 11 teeth, and under score 3 arrest of caries was seen in nine teeth and under score 4 the arrest of caries was seen in all the four teeth but there was progression of lesion in one tooth as the total number of teeth got increased to five under score 4. On overall comparison of clinical effectiveness of SDF in arresting caries in relation to ICCMS scores at different intervals using Chi-square test, there was found to be no statistical significant difference ($p > 0.05$) at different time intervals. These findings have been depicted in Table 2, Graph 1.



Fig. 1: Dental caries wrt 75



Fig. 2: Application of silver diamine fluoride



Fig. 3: Black discoloration after application of silver diamine fluoride

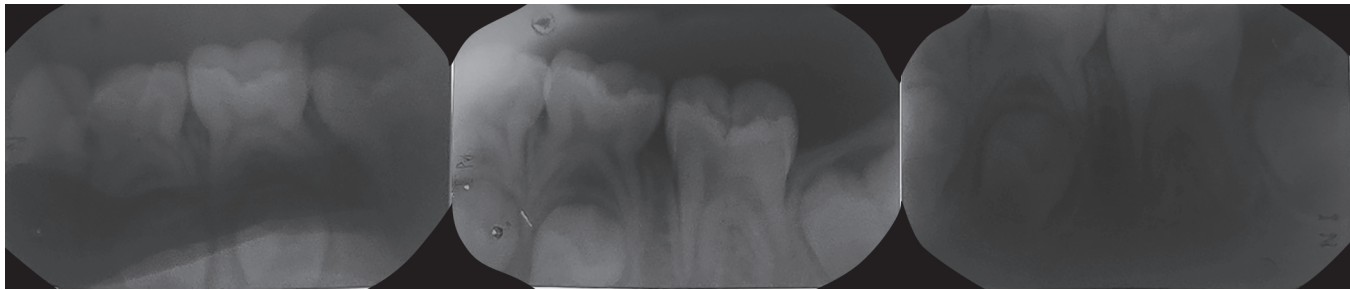


Fig. 4: Radiographic interpretation of IOPA X-ray using ICCMS scores at baseline, 1 month and 3 months

Table 1: The International Caries Classification and Management System (ICCMS)

| | ICCMS score | |
|---------------------|-------------|---|
| RA initial stages | 1 | Radiolucency in the outer ½ of the enamel |
| | 2 | Radiolucency in the outer ½ of enamel +/-ED |
| RB moderate stages | 3 | Radiolucency limited to the outer 1/3 of dentin |
| | 4 | Radiolucency reaching the middle 1/3 of dentin |
| RC extensive stages | 5 | Radiolucency reaching the inner 1/3 of dentin, clinically cavitated |
| | 6 | Radiolucency into the pulp, clinically cavitated |

DISCUSSION

Silver diamine is one of the new approach to arrest the caries and is widely used now a days.¹¹ There are studies on the silver diamine fluoride and its effect on carious lesion but very little data is available on its clinical use and efficacy on carious encountered in the region of Uttarakhand. Therefore, this study is being conducted to see its effect on various patients in Rishikesh, Uttarakhand.

The total number of children included in the study were 30. In most of the studies done on silver diamine fluoride, they had taken large number of sample size. A study was done by Fung MHT et al.¹³ in the year 2018 in which at the baseline, SDF was applied to 888 children with 4,220 decaying tooth surfaces, and 799 children with 3,790 surfaces were assessed at the 30-month evaluation. A total of 375 children aged 3 to 5 years were involved in a study conducted by Chu C H et al.¹⁴ in 2002. Because this study was conducted in the department on patients who came into the OPD, the sample size for this study was smaller, with only 30 children included.

An amount of 38% of silver diamine fluoride was used. The percentage of silver diamine fluoride in accordance with Fung MHT et al.¹³ who conducted a randomized clinical trial of 12% and 38% silver diamine fluoride treatment in 3 to 4 years children who had atleast one activated cavitated caries lesion. They concluded that silver diamine fluoride at a concentration of 38% is more effective than that of 12% in arresting active caries in primary teeth. This study was also in accordance study done by Milgrom P et al.¹⁵ on topical silver diamine fluoride for dental caries arrest in preschool children: a randomized controlled trial and microbiological analyses of caries associated microbes and resistance gene expression. In their study they concluded that the topical 38% silver diamine fluoride is effective and safe in arresting cavities in preschool children.

To evaluate the arrest of the caries after the application of the silver diamine fluoride, IOPA was taken at the base line, after 1 month and after 3 months. Radiographic assessment was done by the trained radiologist who was blinded to the procedure done. Assessment was done by him at the baseline, after one month and after three month. Depending upon the radiolucency on the IOPA, each tooth was assigned a particular score which was according to The International Caries Classification and Management System (ICCMS). This was in line with a research conducted by Cortes A et al.,¹⁶ which enrolled 600 students from kindergartens and schools. Radiographs were taken. Children were examined clinically using the Clinical (C) and Radiographic (R) ICCM Caries Scoring System. A study which was done by Milgrom P et al.¹⁵ was in accordance to our criteria, to check the arrest of the caries. In this study, Nyvad criteria was followed to check the arrest of the caries 14 to 21 days post intervention.

From February 2000 to March 2003, Llorda JC et al.¹⁷ conducted a 36-month controlled clinical study. Six monthly applications of 38% silver diamine fluoride are effective in controlling caries in deciduous teeth, according to the results of a 36-month study. Three month follow-up was taken because this study was conducted as part fulfillment of the postgraduate curriculum and had to be completed in a limited time span.

The main disadvantage of silver diamine therapy is that it leaves a black stain, which has limited its application. Potassium iodide can be used to remove the stains. Crystal Y O et al.¹⁸ conducted a study in 2017 on parental attitudes and acceptance of silver diamine fluoride staining, which included 98 mothers and 22 fathers from various backgrounds. Only 53.6% of parents said they were likely to use silver diamine fluoride to treat their child's posterior teeth, compared to only 26.9% who said they were likely to use it to treat their child's anterior teeth. Another study which was done by the Nguyen V et al.,¹⁹ in which 10 group of teeth were treated to evaluate the effect of potassium iodide and silver diamine fluoride treatment. Visual examination and color measurement were used to evaluate colour changes among the group. In their study, they concluded that all teeth with potassium iodine treatment showed minimal to nonstaining after 4 weeks. Groups that went silver diamine fluoride treatment alone were noticeably darker compared with groups that had potassium iodide treatment.

Extracted carious primary molars were collected and sorted into pairs matched by tooth type, size, and location of the carious lesion in a study by Patel J et al.²⁰ Teeth were divided into two groups: those who received 38% silver diamine fluoride and potassium iodide right away, and those who received 12% silver diamine fluoride right away. Within 2 minutes of applying silver diamine fluoride, black staining appeared, and the intensity of the staining increased for up to 6 hours. They came to the conclusion that silver diamine fluoride has the ability to stain dental hard tissues visibly, and that its staining potential can be altered by using potassium iodide.

Table 2: Comparison of clinical effectiveness of group (38% SDF) in arresting caries in relation to ICCMS scores

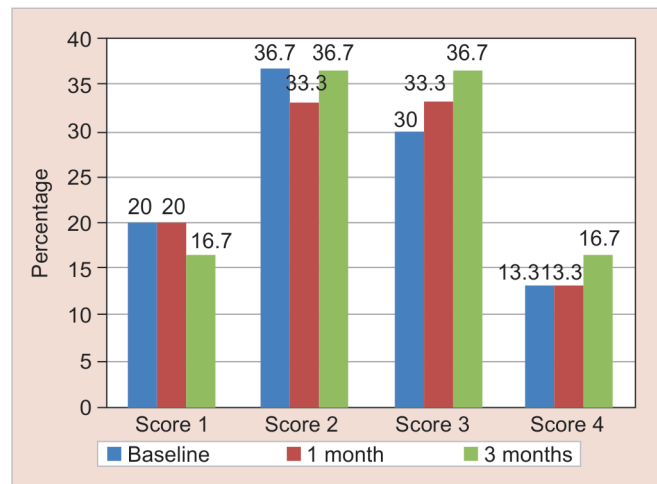
| Group | Score 1 n(%) | Score 2 n(%) | Score 3 n(%) | Score 4 n(%) | Total n(%) |
|----------|-----------------|-----------------|-----------------|-----------------|---------------|
| 38% SDF | | | | | |
| Baseline | 6(20%) | 11(36.7%) | 9(30%) | 4(13.3%) | 30(100%) |
| 1 month | 6(20%) | 10(33.3%) | 10(33.3%) | 4(13.3%) | 30(100%) |
| 3 months | 5(16.7) | 11(36.7%) | 9(36.7%) | 5(16.7%) | 30(100%) |

Score 1: radiolucency in the outer ½ of the enamel

Score 2: radiolucency in the inner ½ of the enamel + enamel dentin junction

Score 3: radiolucency limited to the outer 1/3 of dentin

Score 4: radiolucency reaching the middle 1/3 of dentin

**Graph 1:** Comparison of clinical effectiveness of group (38% SDF) in arresting caries in relation to ICCMS scores

CONCLUSION

According to the findings of the study, silver diamine fluoride at a concentration of 38% is beneficial in preventing caries in primary teeth (within the study's limitations). Silver diamine can be a breakthrough dental agent as it is cost effective, easy to use, and is efficient. It is recommended that 38% silver diamine fluoride should be incorporated in preventive pediatric dentistry regularly as a mean to early childhood caries or as an adjunct to arrest caries in young uncooperative children.

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