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Silver Diamine Fluoride -A Futuristic Remedy for Caries Termination

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Abstract:- Various studies in literature worldwide report high prevalence of Early Childhood caries (ECC). Conventional restorative methods for ECC are not always affordable or possible, as it requires patient cooperation for desirable outcome. Silver diamine fluoride (SDF) was first promoted in Japan in late 1960's. It is painless and simple to use for young children or patients with special needs. When SDF is applied on carious lesions, the fluoride enhances remineralization and the silver ions act as an antibacterial agent and inhibit the growth of cariogenic biofilm. SDF also preserves the dentin collagen from further degradation. SDF at 38% has been used mostly in various countries.

Keywords:- *Silver diamine fluoride; Dental caries; Caries arrest; Fluoride based material; Patient cooperation.*

I. INTRODUCTION

The global burden of oral illness, as well as the severe social and economic consequences that come with it, is becoming a significant problem.[1] Early childhood caries, for example, is an infectious and transmissible multifactorial and microbiological illness of the teeth that affects young children and is linked to vulnerable, uninsured, and financially disadvantaged populations.[2] One out of every four children aged 2 to 5 years suffers from dental caries.[3] It's a disease in which the infection starts in the bacterial biofilm that coats the tooth's surface. Fermentable carbohydrates, salivary variables, and acidogenic bacteria are all important contributors in dental caries. The majority of tooth decay goes untreated because oral care treatments are unsuitable, expensive, or unavailable.

Untreated carious decay in children over a longer period of time results in further complicationslike high caries risk for the remaining primary and permanent teeth present in oral cavity, resulting in no show to school, pain and infections; expensive emergency procedures; restricted growth and development and it leads to concomitant need for general anesthesia.[4]In developing and underdeveloped countries, untreated caries and a limited use of dental care are two of the most significant public health issues affecting children. Antibacterial agents, fluoride-based products like as professional applied varnishes, pit and fissure sealants, preventative resin restorations, and diet change can all help to prevent and treat carious lesions. It is mandatory to seek out productive, cost-effective methods to reduce the burden of untreated caries in preschool children with high caries risk and having limited access to oral health care.[5]Traditionally, a decaying tooth is treated by removing infected and demineralized tooth structure and then replacing it with a filling material[6].Furthermore, dental caries treatment can be challenging and may need a high level of artistry on the part of the dentist, as well as expensive equipment and restoration costs. In addition, the patient's cooperation is required. Due to their low adaptive potential, this is especially challenging for extremely young children. As a result, treating a carious tooth in such youngsters might be a challenge for the dentist. In order to address untreated dental cavities in such occasion, therapy for arresting caries has been proposed[7]. SDF has recently gained popularity due to its potential to halt caries development. Children those who are young to have their caries treated with traditional treatments SDF can be usedas an alternative. Furthermore, for many children from low-income families or those who live in locations with limited access to dental services, SDF application can be a cost-effective method to manage tooth decay.

In 2014,FDA in the US approved silver diamine fluoride (SDF) with claims of its efficacy driving rising interest in its use. Silver and fluoride in an alkaline solution work together in arresting carious lesions via number of processes. The AAPD guideline recommends using 38% SDF; this formula is available in the United States[9].

This article herby presents an in detail discussion and meta-analysis of the same, hence analyzing the validity of SDF as a treatment option for caries arrest and prevention.

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A. *SILVER DIAMINE FLUORIDE (SDF*)

It is a colorless liquid that unites the remineralizing effects of fluoride with the antibacterial effects of silver. It is a promising therapeutic agent for the management of enamel and dentin caries in young and special health care need children. Several studies have demonstrated its efficacy in decreasing certain cariogenic bacteria[9]. It has ability to remineralise hard tissues of the teeth[10,11]. The mechanism(s) of action in vivo conditions of SDF are still being studied. The fluoride element hardens the tooth structure and resists dissolution of minerals during assault by acid byproducts of bacterial metabolism[12]. SDF may interfere with the bio film formation and may kill the bacteria that produce acid, thereby causing imbalance in the oral cavity. Therefore, be can used to arrest caries by promoting remineralization and make alterations to bacterial metabolism on the dental tissue.

Effectiveness of SDF for caries arrest in deciduous teeth and the prevention of new caries lesions have been proven in several systematic studies. It satisfies the six quality goals set forth by the US Institute of Medicine:

- Safe—over 3800 people have participated in clinical studies, and no major side effects have been reported[14].
- Effective—approximately 80% of treated lesions are arrested.[15]
- Effective—can be used by health professionals in a variety of health and community settings in less than one minute with minimum preparation;
- It is utilized as an intervention agent as soon as the carious lesions are diagnosed; it is also effective.
- Patient-centered—minimally invasive and painless, satisfies a child's or adult's urgent demand in the initial treatment session; and
- Patient-centered—minimally invasive and painless, satisfies a child's or adult's urgent demand in the initial treatment; and
- Equitable—its application of medication is effective and inexpensive.

The only disadvantage of SDF usage is tooth discoloration due to the precipitation of silver byproducts, which limits its usage in visible regions.

B. *PATIENT SELECTION*

Inclusion Criteria

- High caries risk children having active cavitated carious lesions.
- Special health care need children and with cavitated carious lesions.
- Children with multiple cavitated carious lesions who wants treatment in single visit.

Exclusion criteria for tooth selection:

- Teeth with history of spontaneous pain.
- Cavitated carious lesions that involve the pulp.
- Teeth with cavitated lesions on multiple surfaces which cannot be approached with a brush for applying SDF.

II. METHOD OF APPLICATION

- Gross debris is removed from the cavity.
- Caries excavation is not necessary for SDF application.
- A protective coating should be applied to soft tissue.
- Isolation with cotton rolls or other isolation methods should be done.
- Dry lesion with gentle flow of compressed air.
- Dispense 1-2 drops of solution into a disposable dappen dish.
- Dip brush into the medicament and to remove excess dab the brush on the side of the dappen dish before application.
- Apply SDF to the cavitated tooth.
- Application time should be at least one minute.
- Gentle flow of compressed air is used until SDF is dry.
- Apply 5% NaF varnish to the remaining teeth after SDF treatment to help prevent caries.

A. *Patient follow- up*

47 to 90 percent effectiveness in preventing dental cavities with a single application of SDF is recorded, depending on the size of the lesion and the location of the tooth[16].

For the evaluation of caries arrest, follow- up is advocated.[17]

- Follow-up at 2-4 weeks after SDF application to evaluate the lesion arrest.
- Reapply SDF if the treated lesions do not appear arrested and restore after treatment with SDF.
- It has been reported that biannual re-application increases caries arrest rate when compared to single application when the lesions are not restored.

III. MECHANISM OF ACTION

The possible mechanisms of SDF for caries arrest are as follows:

- By forming a squamous layer partially plugging the dentinal tubules.
- Arrest of the caries process occurs as the acid produced and cariogenic microorganisms can’t invade through the blocked dentinal tubules.
- By blocking of dentinal tubules, the sensitivity decreases in treated teeth (desensitizing)
- Inhibiting respiratory process, DNA unwinding, cell wall synthesis and cell division of microorganism.
- Inhibits biofilm formation.
- Inhibitory effect on Matrix Metalloproteinase, reducing degradation of organic collagen matrix.
- Silver phosphate and calcium fluorideformed after SDF applicationmakes the tooth resistant to dissolution.
- Yamage et al. (1990) hypothesised that a combination of fluoride and silver ions could prevent the loss of calcium and phosphate ions. [18]
- Deposit of silver phosphate is the main mechanism of SDF responsible for the increased hardness and black staining of the arrested lesion.
- Chu CH et al.(2002) conducted a study that concluded that SDF has antibacterial action against cariogenic microorganisms like S. mutans or A. naeslundii.[19]

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IV. CONTRAINDICATION

- Children with stomatitis
- Ulcerative gingival diseases
- Allergic to silver compounds

A. Adverse effects

There have been no known side effects from using it to treat dental caries so far[3].

The only side effect reported till date is a small white lesion, moderately painful in the mucosa, which eventually disappears after 2 days without any need for further treatment. It was recorded for three subjects who were followed for up to three years.[22,21]"

B. Other side effects include-

- SDF stains the tooth.
- Metallic or bitter taste which is transient.
- If SDF comes in contact with the skin causes"temporary tattoo".
- SDF stains clinic surfaces and clothes.

V. REVIEW RESULTS:

A. Bonding effects of dental materials

- There is no influence of SDF on composite bonding employing self-etch or light cure etch methods to non-carious dentin [23].
- After applying SDF, rinsing with water avoided a 50% reduction in GIC bond strength[24].
- SDF reduced the dentin bonding strength of resin-based crown cement by 1/3[25].

B. Current evidence on the effectiveness of sdf for caries prevention and arrest

According to several randomized clinical studies and systematic reviews, SDF halt caries in the primary dentition and root caries in adults, and it may prevent the creation of new carious lesions.

C. Caries Arrest on Primary Teeth in Children

In comparison to no therapy and several alternative treatment methods, all clinical trials confirm SDF's efficacy in arresting caries in the primary dentition. According to a 2016 meta study done by Gao et al.[15], the proportion of primary dentition caries arrest treated with 1 application, yearly, and biannual followed up for 6 to 30 months was 81% (95% confidence interval, 68%–89% p<.001). According to Chibinski[26]et al. (2017), it was seen that caries arrest by using SDF was 66 % greater than other active materials after 12 months, while it was 154%higher than no therapy.In comparison of SDFs with active therapies, Chibinski and his colleagues also observed risk ratio 1.66 (95% confidence interval, 1.41-1.96), and a risk ratio of 2.54 (95% confidence interval, 1.66-3.85) when comparing SDFs without therapy.

The arrest rates of caries in children applying twice a year were modest in all teeth compared to once a year. Children who had a visible plaque, after yearly application of SDF had reduced chance of arresting caries[27]. Fung and his colleagues believed that the risk of cavity arrest can increase from yearly to semi-annual for children with poor dental hygiene[28].

D. Caries Arrest on Permanent Teeth in Children

Llodra and colleagues[29](2006)In both primary and first permanent molars, about 77 percent of treated caries that was active at baseline turned inactive over the course of a year. Another research of 22 children concluded that effectiveness of SDF was more when compared to dental brushing or glass ionomer restoration at 3 and 6 months in preventing caries in permanent molars, but that they were all equally beneficial at 30 months in preventing non-cavitated lesions[30].

E. Caries Prevention in Children

Llodra and colleagues[29] (2006) showed that over the course of 36 months, development of new carious lesions in permanent teeth in the SDF group were 0.4 and in the water control group were 1.1. The SDF groups had average of 0.3 new lesions in primary teeth compared to 1.4 in the water control group. Chu and colleagues[18] (2002) conducted a study for maxillary anterior teeth in preschool children and concluded that development of new carious lesions in the SDF group was less when compared to FV with 4 yearly applications (0.47 versus 0.7 new),where as in the water control group was 1.58 over a period of 30 months. According to a systematic review, the preventative fraction for SDF was found to be greater for primary teeth when compared to permanent teeth (>60% on permanent teeth and >70% on primary teeth).

Monse et al. [31] (2012) found that PRR as sealants were more effective versus a single application of SDF.

Oliveira and colleagues[32] conducted a systematic review and meta-analysis on caries prevention in primary teeth and found that, as compared to placebo over a period of 24 months, a reduction of 77.5% in the development of new caries in treated and untreated deciduous teeth. At follow up of 18 and 30 months, clinical performance of SDF was betterthan fluoride varnish, while at 12 months, when compared to glass ionomer cements (GIC) it was found that GIC was better than SDF (not statistically significant).

Llodra et al.[29]conducted a study which included posterior teeth and newly erupted first permanent molars and concluded that non cavitated lesions have been difficult to classify and thus overlooked. Direct comparisons with the preventative efficacy of other fluoride administration methods are challenging since such studies (on FV toothpaste, for example) often report new cavities.

F. Caries prevention in the Adults

Hendre et al.[33] (2017) did not find any research on coronal caries, but incorporated 3clinical trials on prevention and arrest for root caries. 24 % preventative fraction was reclaimed for SDF in a follow up of 24-month and a 71 % preventative fraction in a follow up of 36-month. In a clinical trial of 24 months, the preventative fraction for caries development was 725% higher, and in a 30-month study, it was 100% higher than placebo. Based on their findings, the researchers advocate using SDF for seniors

who have a higher risk of developing root caries, either alone or in combination with other therapies such as dental hygiene education.

VI. CONCLUSION

According to the WHO's 2016 guidelines on Early Childhood Caries, SDF has been proven to be potentially beneficial for Public Health Intervention. SDF can arrest dentin caries in primary teeth and prevent recurrence of the dental disease. It emphasized its use as a tertiary preventive technique to lessen the negative effects of existing caries and thus enhance the quality of life of children.

- **Clinical significance**

The current article discusses the benefits of utilizing SDF as a preventative agent, the time of administration, and the necessity for follow-up restorative treatment. When comparing anterior and posterior dentition, as well as primary and permanent dentition, there is a significant variation in each of the continuing methods. There is a need to review the impact on oral microflora following SDF application as a preventive strategy, and well-designed randomized clinical trials indicating the intensity and frequency of application, as well as management of arrested lesion for longer periods in young children, particularly those with permanent dentition, are also required.

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