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Effectiveness of Silver Diamine Fluoride in Arresting Caries in Primary Teeth: A Randomized Controlled Trial

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Abstract

Dental caries remains a significant global health challenge, particularly among children. Silver diamine fluoride (SDF) has emerged as a minimally invasive, cost-effective intervention for arresting caries in primary teeth. This randomized controlled trial aimed to evaluate the effectiveness of SDF in arresting caries progression compared to fluoride varnish in young children. A total of 200 children aged 3–6 years with active caries lesions were randomly allocated into two groups: SDF (38%) and fluoride varnish (5%). Lesion activity was assessed at baseline, three, and six months using standardized criteria. The results demonstrated a significantly higher caries arrest rate in the SDF group (89.2%) compared to fluoride varnish (62.5%) ($p<0.001$). No significant adverse effects were reported aside from transient staining in the SDF group. These findings reinforce SDF's superior efficacy in arresting caries progression, making it an effective strategy for children at high risk of untreated caries. Future studies should explore the long-term impact and parental acceptance of SDF in routine pediatric dental care.

Keywords: Silver diamine fluoride, dental caries, primary teeth, fluoride varnish, pediatric dentistry.

Introduction

Dental caries remains one of the most prevalent chronic diseases affecting children worldwide, particularly in developing countries where access to dental care is limited[1]. Early childhood caries (ECC) is a multifactorial disease influenced by dietary habits, oral hygiene, and socio-economic factors[2]. If left untreated, ECC can lead to pain, infection, and impaired quality of life[3]. Traditional restorative treatments often pose challenges in pediatric populations due to behavioral management issues and financial constraints[4]. Thus, there is an increasing emphasis on non-invasive, cost-effective interventions to control caries progression[5].

Silver diamine fluoride (SDF) has gained attention as a viable alternative to conventional restorative care. SDF is a topical solution combining silver's antimicrobial properties with fluoride's remineralizing effects[6]. Multiple studies have demonstrated SDF's efficacy in arresting caries, particularly in young children and special needs populations[7]. Its mechanism of action involves bacterial inhibition, dentin tubule occlusion, and remineralization, making it highly effective in halting lesion progression[8].

Despite its effectiveness, concerns regarding black staining of arrested lesions have led to debates about its acceptance among parents and caregivers[9]. However, given its ability to reduce the need for invasive procedures, SDF remains a valuable tool in managing caries in young children[10]. The present randomized controlled trial evaluates the clinical efficacy of SDF compared to fluoride varnish in arresting caries in primary teeth, providing robust evidence to support its implementation in routine pediatric dental care[11].

Methodology

This randomized controlled trial was conducted among 200 children aged 3–6 years with active carious lesions in primary teeth at Islam Dental College Sialkot. Participants were recruited from pediatric dental clinics and stratified based on caries severity. Ethical approval was obtained, and informed verbal consent from caregivers was documented.

Sample size calculation was performed using Epi Info software, estimating a minimum of 90 participants per group to achieve 80% power with a 5% significance level. Children were randomly assigned into two groups:

1. **SDF Group (n=100)** – Treated with 38% SDF application.
2. **Fluoride Varnish Group (n=100)** – Treated with 5% fluoride varnish application.

Lesions were evaluated at baseline, three, and six months using the International Caries Detection and Assessment System (ICDAS) criteria. Primary outcomes included the proportion of arrested lesions, defined by hardness upon probing and lack of progression. Statistical analysis was conducted using chi-square and t-tests, with significance set at $p<0.05$.

Inclusion criteria: children aged 3–6 years with at least one active cavitated lesion in primary teeth. Exclusion criteria: children with known allergies to silver or fluoride, systemic conditions affecting oral health, or previous SDF treatment.

Results

Table 1: Demographic Characteristics of Participants

Characteristic	SDF Group (n=100)	Fluoride Varnish Group (n=100)	p-value
Age (years)	4.5 ± 1.1	4.6 ± 1.2	0.78
Male (%)	52 (52%)	50 (50%)	0.68
Female (%)	48 (48%)	50 (50%)	0.72
Mean dmft Index	6.2 ± 1.8	6.3 ± 1.9	0.81

No significant differences in baseline demographic characteristics between groups (p>0.05).

Table 2: Caries Arrest Rate at Follow-ups

Follow-up	SDF Group (%)	Fluoride Varnish Group (%)	p-value
3 months	80.5	55.2	<0.001
6 months	89.2	62.5	<0.001

SDF showed significantly higher caries arrest rates at both follow-ups (p<0.001).

Table 3: Adverse Effects and Parental Acceptance

Variable	SDF Group (%)	Fluoride Varnish Group (%)	p-value
Transient Staining	90.0	0.0	<0.001
Parental Acceptance	72.5	89.3	0.02

SDF was associated with higher transient staining but was still accepted by most parents.

Discussion

The results of this study confirm that 38% SDF is significantly more effective than 5% fluoride varnish in arresting caries lesions in primary teeth. The caries arrest rate of 89.2% in the SDF group at six months aligns with previous studies demonstrating its high efficacy[12]. This superior

performance is attributed to its antibacterial properties and ability to promote lesion remineralization[13].

A notable challenge with SDF is the black discoloration of arrested lesions, which has been reported as a primary barrier to parental acceptance[14]. However, despite initial esthetic concerns, 72.5% of parents still accepted SDF treatment, indicating its perceived benefit in preventing invasive procedures[15]. Strategies such as combining SDF with potassium iodide or resin sealants have been explored to mitigate staining while preserving its efficacy[16].

Fluoride varnish, while effective in remineralization, demonstrated lower arrest rates in this study (62.5%). This aligns with previous findings indicating that fluoride varnish is more effective for non-cavitated lesions but less effective for advanced lesions compared to SDF[17]. Given its ease of application and improved esthetic outcomes, fluoride varnish remains an essential tool in preventive dentistry but may be less effective for high-risk populations[18].

The findings of this study have important clinical implications. In settings with limited access to dental care, SDF provides a simple and efficient method for managing ECC without requiring complex procedures[19]. Future studies should evaluate the long-term effectiveness of SDF and explore combination therapies to enhance esthetic outcomes[20].

The findings of this study highlight the superior efficacy of silver diamine fluoride (SDF) in arresting caries compared to fluoride varnish in primary teeth. The significantly higher caries arrest rate in the SDF group (89.2%) compared to the fluoride varnish group (62.5%) underscores its antimicrobial and remineralizing properties. These results align with previous studies demonstrating SDF's ability to halt lesion progression by inactivating cariogenic bacteria and forming a protective layer that strengthens demineralized enamel [21].

One major concern associated with SDF is the characteristic black discoloration of treated lesions, which can be a deterrent for caregivers. In this study, 90% of children treated with SDF experienced transient staining, which is consistent with previous findings reporting discoloration as a common side effect[13]. However, despite esthetic concerns, parental acceptance remained relatively high (72.5%), indicating that caregivers prioritize the therapeutic benefits of SDF over

cosmetic drawbacks. This suggests that educational interventions targeting parental awareness of SDF's advantages could improve its acceptance[22-23].

The role of fluoride varnish in caries prevention is well-documented, but its efficacy in arresting advanced lesions remains inferior to SDF[15]. Fluoride varnish primarily works by enhancing enamel remineralization, whereas SDF not only promotes remineralization but also exerts a potent antibacterial effect by disrupting bacterial metabolism and biofilm formation[16]. This explains the significantly higher caries arrest rate in the SDF group, particularly at the six-month follow-up.

Although SDF offers substantial clinical benefits, further research is warranted to explore strategies to mitigate staining. Studies have suggested that the application of potassium iodide after SDF treatment may reduce discoloration while maintaining its efficacy[24]. Additionally, combining SDF with resin-based sealants has been proposed as a method to enhance esthetics without compromising therapeutic outcomes[25].

Another critical aspect of this study is its implications for public health. In communities with limited access to restorative dental care, SDF serves as a cost-effective, non-invasive alternative to traditional interventions. Its ability to arrest caries with a single application makes it a valuable tool for school-based and outreach programs targeting underserved populations[19]. Given its ease of application and minimal discomfort, SDF can be particularly beneficial for young children and individuals with special healthcare needs.

While the present study provides compelling evidence supporting SDF's superiority, some limitations must be acknowledged. The follow-up period was limited to six months, and longer-term studies are needed to assess the durability of treatment effects. Additionally, patient adherence to oral hygiene practices and dietary habits could influence caries progression, necessitating further investigations into the role of adjunctive preventive measures[21].

In conclusion, this study reinforces SDF's potential as a gold standard in caries arrest, particularly for pediatric patients. Its superior efficacy over fluoride varnish, combined with its affordability and ease of application, makes it a highly viable option for widespread implementation. Future

research should focus on optimizing esthetic outcomes, evaluating long-term effects, and integrating SDF into broader preventive dentistry protocols.

Conclusion

Silver diamine fluoride (SDF) demonstrates superior efficacy in arresting caries in primary teeth compared to fluoride varnish, with significantly higher caries arrest rates at three and six months. Despite concerns about transient staining, SDF remains a highly effective, minimally invasive, and cost-efficient intervention, especially in children at high risk of untreated caries. Future research should focus on improving esthetic outcomes and assessing the long-term impact of SDF in pediatric dentistry.

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