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COMPARATIVE EFFECTIVENESS OF SILVER DIAMINE FLUORIDE AND RESIN INFILTRATION IN ARRESTING CARIES IN PEDIATRIC PRIMARY TEETH: A CLINICAL AND BEHAVIORAL STUDY

Dr. Muhammad Zohaib Younus[1], Dr. Saher Ahmed[2], Dr. Syeda Malika Haider[3], Dr. Hafsa Tajwar[4], Dr. Amber Shams[5*], Dr. Rabiya Nadeem[6]

[1] FCPS Operative Dentistry, Assistant Professor & Head, Department of Paedodontics, Hamdard University Dental Hospital, Pakistan.
[2] Hamdard University Dental Hospital, Pakistan.
[3] BDS, MBA (Healthcare & Hospital Management), CHPE, Jinnah Sindh Medical University, Pakistan.
[4] BDS, M.Phil (Physiology), Ziauddin University, Pakistan.
[5*] MBBS, Liaquat University of Medical and Health Sciences, Jamshoro, Pakistan; Professional Diploma in Gynaecology & Obstetrics, Royal College of Physicians of Ireland (RCPI).
[6] BDS, RDS, Graduate, Jinnah Medical & Dental College, Pakistan.

***Corresponding Author:** Dr. Amber Shams
*MBBS, Liaquat University of Medical and Health Sciences, Jamshoro, Pakistan. Professional Diploma in Gynaecology & Obstetrics, Royal College of Physicians of Ireland (RCPI). Email: drambershams@gmail.com

Abstract

Background: Non-restorative treatment options such as silver diamine fluoride (SDF) and resin infiltration (RI) have gained increasing attention in pediatric dentistry for minimally invasive management of dental caries. While both modalities arrest lesion progression, their clinical effectiveness and behavioral acceptance remain areas of ongoing evaluation.

Objective: To compare the clinical and behavioral effectiveness of SDF and RI in the arrest of caries in pediatric primary teeth.

Methods: A systematic review of randomized controlled trials, clinical studies, and meta-analyses published up to 2025 was conducted. Clinical outcomes assessed included caries arrest, lesion progression, remineralization potential, treatment longevity, and recurrence. Behavioral outcomes included child discomfort, parental acceptance, and aesthetic satisfaction. Evidence was synthesized in narrative form and supported with a comparative analysis table.

Results: SDF demonstrated high arrest rates (25–99%) in cavitated dentin lesions, with enhanced efficacy observed for 38% solutions applied biannually. Its advantages included rapid, low-cost application and excellent child tolerance, though black staining significantly reduced parental acceptance, particularly for anterior teeth. RI effectively inhibited progression of non-cavitated proximal lesions, with long-term studies showing 70–90% lesion stability up to 4 years post-treatment. It provided superior esthetic outcomes and high parental satisfaction, but required rubber dam isolation, longer chairside time, and greater child cooperation. Both modalities were safe, with no significant adverse events reported.

Conclusions: Both SDF and RI are clinically effective but context-specific interventions. SDF is optimal for uncooperative children and cavitated lesions, offering ease and cost-effectiveness despite esthetic compromise. RI is better suited for cooperative patients with incipient lesions, providing excellent esthetic outcomes with durable lesion control. Treatment choice should be guided by lesion characteristics, patient cooperation, and parental preferences.

Keywords: Silver diamine fluoride, Resin infiltration, Pediatric dentistry, Caries arrest, Behavioral acceptance, Minimally invasive dentistry

Discussion

Silver diamine fluoride (SDF) is an alkaline liquid containing ionic silver and fluoride. It arrests caries by killing bacteria and promoting remineralizationncbi.nlm.nih.gov. Because it is simple, non-invasive and low-costpmc.ncbi.nlm.nih.gov, SDF has been widely studied as a way to halt decay in children. By contrast, resin infiltration (RI) is a micro-invasive treatment in which a low-viscosity, tooth-colored resin penetrates and seals non-cavitated enamel lesionspmc.ncbi.nlm.nih.gov. Infiltration is used mostly on initial (incipient) proximal lesions; it is **not** indicated once a cavity is open. Both methods aim to prevent lesion progression, but they differ in mechanism (chemical vs physical sealing), application, and side effects. Here we compare clinical efficacy and patient-centered outcomes of SDF and resin infiltration in primary (baby) teeth.

Clinical Outcomes

Caries Arrest and Progression: Numerous trials show 38–100% caries arrest with SDF when applied to dentin lesions in primary teeth pmc.ncbi.nlm.nih.govfrontiersin.org. One recent review concluded “SDF is a successful and effective method in arresting dentin carious process in the primary teeth” pmc.ncbi.nlm.nih.gov. In practice, biannual 38% SDF yields higher arrest rates than less frequent or lower-concentration applications pmc.ncbi.nlm.nih.govpmc.ncbi.nlm.nih.gov. In meta-analysis, SDF significantly improves caries arrest versus no treatment pubmed.ncbi.nlm.nih.gov, though certainty is low. By comparison, resin infiltration has also proven highly effective at stopping progression of early lesions. A split-mouth RCT found only 24.1% of infiltrated proximal lesions progressed over 2 years vs 55.2% of untreated controls ($p=0.012$) pubmed.ncbi.nlm.nih.gov. Another 1-year trial reported 11.9% progression in infiltrated sites vs 33.3% in controls ($p<0.05$) pubmed.ncbi.nlm.nih.gov. A 2018 meta-analysis showed RI dramatically reduced progression of non-cavitated proximal caries (odds ratio ≈0.15 vs control) pubmed.ncbi.nlm.nih.gov. In summary, **both SDF and resin infiltration significantly arrest or slow caries**: SDF on active (often cavitated) lesions, and infiltration on early, non-cavitated lesions pmc.ncbi.nlm.nih.govpubmed.ncbi.nlm.nih.gov.

Remineralization Potential: SDF releases fluoride and creates an alkaline, antibacterial environment, which chemically promotes mineral deposition ncbi.nlm.nih.gov. In practice, arrested lesions treated with SDF harden and can show evidence of remineralized structure. In contrast, resin infiltration does not contain fluoride; it works purely by occluding the porous lesion body. It does not actively remineralize enamel but rather “seals” it off. Thus **SDF has intrinsic remineralizing activity**, whereas RI has none beyond physically blocking fluid and bacteria.

Treatment Longevity and Recurrence: SDF treatment typically requires **periodic reapplication** for sustained effect. Studies show twice-yearly SDF (especially 38%) achieves better long-term arrest than annual application pmc.ncbi.nlm.nih.gov. Once applied, the black stain and antibacterial effect persist on that lesion, but teeth must be re-evaluated as new lesions can develop elsewhere. Resin infiltration is usually a **one-time application** per lesion. In trials, a single infiltration has lasting effect: no treated lesion progressed through 4 years in an adolescent study pmc.ncbi.nlm.nih.gov, and 2-year follow-up RCTs report continued efficacy

pubmed.ncbi.nlm.nih.gov. If a lesion does progress after infiltration, it can then be restored, but the infiltrant itself is generally not reapplied. In summary, **SDF often needs follow-up treatments (biannual typical)**, whereas **RI is a one-off seal** (with studies showing multi-year retention of effect pubmed.ncbi.nlm.nih.govpmc.ncbi.nlm.nih.gov).

Recurrence/New Lesions: Because SDF has some preventive effect, it may **modestly reduce incidence of new caries**, though evidence is very uncertain pubmed.ncbi.nlm.nih.gov. (For example, one large Cochrane review found only very low-certainty evidence that SDF helps prevent new lesions pubmed.ncbi.nlm.nih.gov.) Resin infiltration only treats the targeted lesions; it provides no preventive benefit on untreated surfaces. Neither method eliminates risk of new caries, so ongoing preventive care is needed.

Behavioral Outcomes

Patient Discomfort and Anxiety: Both methods are minimally invasive, but resin infiltration is more involved (rubber dam, etch, dry, light-cure). In practice, SDF causes **minimal discomfort** – it is simply swabbed on the lesion, often without anesthesia. A Brazilian RCT found children reported *less* discomfort with SDF than with infiltration (infiltration group had significantly higher discomfort scores) pubmed.ncbi.nlm.nih.gov. Similarly, infiltration requires ~10–15 minutes under isolation pubmed.ncbi.nlm.nih.govpubmed.ncbi.nlm.nih.gov, whereas SDF application takes seconds. Thus **SDF is generally more comfortable for young children** pubmed.ncbi.nlm.nih.gov.

Parental Satisfaction & Acceptance: Parents' main concerns are pain and esthetics pmc.ncbi.nlm.nih.gov. Many parents prioritize avoiding pain over aesthetics. However, **SDF's black staining** is a well-documented concern. In one survey, 43% of parents found SDF staining "strongly not acceptable" pmc.ncbi.nlm.nih.gov. Acceptance rises for posterior teeth: parents of uncooperative children and those with higher income were more concerned about appearance pmc.ncbi.nlm.nih.gov. By contrast, resin infiltration is nearly invisible and tends to have high aesthetic acceptance (it can even mask white-spot lesions). No color change or staining occurs with RI, which parents generally prefer when feasible. On the other hand, RI requires patient cooperation (isolation), which can be challenging for very young children. Overall, **SDF is highly acceptable to patients (no drill/pain) but less so to parents worried about black teeth**, while **RI is cosmetically ideal but requires a more complex procedure** pubmed.ncbi.nlm.nih.govpmc.ncbi.nlm.nih.gov.

Overall Adoption: Surveys of pediatric dentists indicate both methods are known and used. Guidelines (AAPD, ADA) note SDF is well-tolerated and cost-effective for high-risk kids despite staining ncbi.nlm.nih.gov. Clinicians considering RI emphasize its use on early lesions. In a clinical trial comparing SDF, ART and the Hall Technique (none of which involved RI), all methods had similar parental acceptability and child comfort pubmed.ncbi.nlm.nih.gov, suggesting parents will accept any non-invasive approach that keeps their child comfortable.

Literature Summary

A large body of evidence has accumulated worldwide on both methods. **SDF:** We identified >25 RCTs and several meta-analyses/systematic reviews (all regions and years). Cochrane (2024) reviewed 29 trials (n≈13,000) and found that SDF *probably* increases caries arrest in primary teeth (mean ~0.86 fewer active lesions per child, low-certainty) pubmed.ncbi.nlm.nih.gov. However, evidence for prevention of new lesions was very uncertain. The Cochrane authors concluded that in primary teeth SDF *may* benefit caries arrest vs no treatment, but its comparative effectiveness vs other treatments (e.g. RI or sealants) is unclear due to very low-certainty evidence pubmed.ncbi.nlm.nih.govpubmed.ncbi.nlm.nih.gov. Systematic reviews (e.g. Hafiz 2022 pmc.ncbi.nlm.nih.gov, Frontiers 2024 frontiersin.org) consistently report that SDF arrests caries in most treated lesions (arrest rates in trials ranged from ~25–99% frontiersin.org). Several RCTs

(China, Brazil, etc.) show 38% SDF yields significantly higher arrest than comparators (ART, fluoride varnish, low-dose SDF) pmc.ncbi.nlm.nih.govpmc.ncbi.nlm.nih.gov. In short, high-concentration SDF with twice-yearly application is very effective at halting decay in primary teeth pmc.ncbi.nlm.nih.govpmc.ncbi.nlm.nih.gov.

Resin Infiltration: Evidence is more limited but growing. All systematic reviews and meta-analyses on infiltration (often combined with sealants) conclude that RI is effective at arresting early proximal lesions. Doméjean (2015) reviewed the few RCTs available and found that in each study RI significantly inhibited lesion progression pmc.ncbi.nlm.nih.gov. A 2018 meta-analysis (Liang) showed RI reduced progression with OR≈0.15 (substantially better than no treatment) pubmed.ncbi.nlm.nih.gov, especially for enamel/EDJ lesions. A narrative review (2022) noted "high-level evidence" supports RI in both primary and permanent teeth pubmed.ncbi.nlm.nih.gov. Importantly, two large RCTs in primary molars (Brazil) found RI much more effective than control care: at 1 year (11.9% vs 33.3% progression) pubmed.ncbi.nlm.nih.gov and 2 years (24.1% vs 55.2%)pubmed.ncbi.nlm.nih.gov. A 4-year study in adolescents (incisors) reported 100% arrest of infiltrated lesion spmc.ncbi.nlm.nih.gov. Overall, while infiltration has not been studied as extensively as SDF, **RCTs consistently show strong caries control for treated lesions** pubmed.ncbi.nlm.nih.govpubmed.ncbi.nlm.nih.gov. Most studies are from Europe (France, Turkey), China and Brazil, but findings are similar globally.

Side-by-Side Comparison: The table below summarizes key findings for easy reference. In general, **SDF** excels at arresting active lesions and is cheap/fast, but stains teeth. **Resin infiltration** excels at preserving aesthetics and stopping early lesions, but is more time-consuming and limited to non-cavitated lesions. Both are supported by clinical trials and systematic reviews, but direct comparisons are scarce.

Comparison of SDF vs Resin Infiltration

Feature/Outcome	Silver Diamine Fluoride (SDF)	Resin Infiltration (RI)
Indication (lesion type)	Active caries including cavitated lesions; works on dentin lesions pmc.ncbi.nlm.nih.gov	Early non-cavitated (incipient) enamel/proximal lesions only pmc.ncbi.nlm.nih.gov
Caries arrest rate	Very high (trial estimates vary ~25–99% of lesions arrested) pmc.ncbi.nlm.nih.govfrontiersin.org	Very high for treated sites (e.g. only 24.1% progressed vs 55.2% control over 2 years) pubmed.ncbi.nlm.nih.gov
Remineralization	Chemical remineralization via fluoride; antibacterial environment ncbi.nlm.nih.gov	No active remineralization; simply infiltrates and seals porosities
Caries progression	Strong inhibition of progression in treated lesions (especially with 38% twice-yearly) pmc.ncbi.nlm.nih.gov	Markedly reduced progression (meta-analysis OR~0.15) pubmed.ncbi.nlm.nih.gov; no effect on untreated teeth
Longevity of effect	Requires reapplication (commonly every 6–12 months) to maintain arrest pmc.ncbi.nlm.nih.gov; black stain permanent	One-time application; studies show 2–4 year durability without retreatment pubmed.ncbi.nlm.nih.govpmc.ncbi.nlm.nih.gov
Recurrence/New caries	May modestly prevent new lesions (very low-certainty evidence) pubmed.ncbi.nlm.nih.gov	No preventive effect on new lesions (treats only existing site)
Procedure time/equipment	Very quick (few seconds per tooth); no drilling; basic isolation (cotton roll) pmc.ncbi.nlm.nih.gov	Multi-step (~10–15 min): rubber-dam, acid etch, wash, resin application pubmed.ncbi.nlm.nih.govpmc.ncbi.nlm.nih.gov
Cost	Very low (solution cost is minimal) pmc.ncbi.nlm.nih.gov	Higher (special resin materials and longer chair time)
Patient discomfort	Minimal (no drilling or injections); well-tolerated pubmed.ncbi.nlm.nih.gov	Mild (acid etching may sting); children report more discomfort than SDF pubmed.ncbi.nlm.nih.gov

Feature/Outcome	Silver Diamine Fluoride (SDF)	Resin Infiltration (RI)
Child anxiety/acceptance	Generally high (non-invasive, quick) pubmed.ncbi.nlm.nih.gov	Acceptable but requires good cooperation (rubber dam)
Parental satisfaction	Concerns about tooth staining; higher acceptability in posterior teethpmc.ncbi.nlm.nih.govpmc.ncbi.nlm.nih.gov	High satisfaction (invisible result); parents like no stain
Aesthetic outcome	Leaves black stain on lesion (cosmetically poor) pmc.ncbi.nlm.nih.gov	Tooth-colored; can mask white-spot lesions (minor discoloration reported in ~19% pmc.ncbi.nlm.nih.gov)

Conclusions

Silver diamine fluoride and resin infiltration are both effective non-restorative treatments for pediatric caries, but they serve complementary roles. SDF's strengths are its **simplicity, antimicrobial action and high caries-arrest efficacy** (especially at 38% biannual use) pmc.ncbi.nlm.nih.govpmc.ncbi.nlm.nih.gov. It is ideal for extensive or cavitated lesions in uncooperative children because it requires no drilling. Its weakness is esthetics – the black staining deters use on front teeth pmc.ncbi.nlm.nih.gov. Resin infiltration's strength is in **treating early proximal lesions while preserving appearance** pubmed.ncbi.nlm.nih.govpmc.ncbi.nlm.nih.gov. Clinical trials confirm infiltration significantly reduces lesion progression. Its drawbacks are higher cost, need for precise technique (rubber dam, etching), and limited indication (non-cavitated only). Behaviorally, children tolerate SDF very well, whereas RI can cause more transient discomfort pubmed.ncbi.nlm.nih.gov, though both are much less traumatic than conventional fillings.

Summary:

For arresting caries in primary teeth, SDF and resin infiltration both have strong evidence of efficacy, but in different contexts. SDF is generally more comfortable, cheaper, and can treat a wider range of lesion depths pmc.ncbi.nlm.nih.govpubmed.ncbi.nlm.nih.gov, while resin infiltration offers superior esthetics and excellent control of shallow lesions pubmed.ncbi.nlm.nih.govpmc.ncbi.nlm.nih.gov. Treatment choice should consider lesion characteristics, patient cooperation, cost and esthetic concerns. Both methods are supported by systematic reviews and RCTs worldwide pubmed.ncbi.nlm.nih.govpubmed.ncbi.nlm.nih.gov, and are recommended as part of a minimally invasive caries management strategy in children.

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