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## **Comparing the Effect of Fluoride Varnish vs. Resin Infiltration in Early Caries Management**

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### **Abstract**

Dental caries remains a prevalent global health concern, necessitating effective non-invasive management strategies. This study compares the efficacy of fluoride varnish and resin infiltration in arresting early enamel caries lesions. A randomized controlled trial was conducted on 120 participants aged 6–12 years with non-cavitated enamel lesions. Subjects were randomly assigned into two groups: fluoride varnish application (Group A) and resin infiltration (Group B). Caries progression was assessed at baseline, three months, and six months using ICDAS-II scoring and quantitative light-induced fluorescence (QLF) analysis. The results indicated a statistically significant reduction in lesion progression in both groups ( $p < 0.05$ ), with resin infiltration demonstrating superior lesion stability compared to fluoride varnish at the six-month follow-up ( $p = 0.01$ ). The findings suggest that while both interventions effectively manage early carious lesions, resin infiltration offers enhanced remineralization and lesion masking, making it a promising alternative to traditional fluoride therapy. Further longitudinal studies are recommended to evaluate long-term outcomes.

**Keywords:** Fluoride varnish, Resin infiltration, Early caries management

### **Introduction**

Dental caries is a major public health issue, affecting a significant proportion of children and adults worldwide. Early caries lesions, also known as white spot lesions, are non-cavitated areas of demineralization that can progress to irreversible structural damage if left untreated<sup>1</sup>. Non-invasive interventions such as fluoride-based remineralization therapies and resin infiltration techniques have gained increasing attention in recent years due to their ability to arrest lesion progression without requiring extensive restorative procedures<sup>2</sup>. Fluoride varnish is widely recognized for its ability to enhance enamel remineralization by promoting the precipitation of calcium and phosphate ions, forming fluorapatite that resists acid dissolution<sup>3</sup>. Its effectiveness in reducing caries progression has been demonstrated in multiple studies, particularly in high-risk

populations<sup>4</sup>. However, fluoride's efficacy is limited by patient compliance and the need for repeated applications<sup>5</sup>.

Resin infiltration, on the other hand, has emerged as a minimally invasive technique that seals porosities within demineralized enamel, preventing further acid diffusion and lesion progression<sup>6</sup>. This approach not only halts caries advancement but also improves esthetic outcomes by reducing lesion visibility<sup>7</sup>. Unlike fluoride therapy, resin infiltration provides immediate mechanical stability to the enamel structure, reducing the dependency on continuous topical applications<sup>8</sup>.

Despite growing evidence supporting both treatment modalities, a direct comparison between fluoride varnish and resin infiltration in early caries management remains underexplored. This study aims to assess and compare the effectiveness of these two interventions in arresting lesion progression and enhancing enamel integrity. By providing statistical analysis of lesion stability over time, the findings of this study will contribute to evidence-based decision-making in non-invasive caries management.

## Methodology

A randomized controlled trial was conducted at Islam Dental College Sialkot, enrolling 120 children aged 6–12 years with early enamel carious lesions (ICDAS codes 1 and 2). Participants were recruited following a thorough oral examination, and informed verbal consent was obtained from parents/guardians. Subjects were randomly assigned into two equal groups (n = 60):

- **Group A (Fluoride Varnish):** 5% sodium fluoride varnish was applied bi-monthly for six months.
- **Group B (Resin Infiltration):** Low-viscosity resin infiltration was performed using an established etching and infiltration protocol.

Caries lesion activity was assessed using ICDAS-II scoring and QLF at baseline, three months, and six months. Sample size estimation was performed using Epi Info software, assuming an 80% power and  $\alpha = 0.05$  to detect a 20% difference in lesion progression. Inclusion criteria included non-cavitated enamel lesions without active cavitation. Exclusion criteria encompassed patients

with systemic conditions affecting enamel integrity, previous fluoride treatments within six months, and cavitated lesions requiring restorative interventions.

Statistical analysis was conducted using SPSS version 26.0. Chi-square tests and repeated-measures ANOVA were used to compare categorical and continuous variables, respectively. A significance threshold of  $p < 0.05$  was applied.

## Results

**Table 1: Baseline Demographic and Clinical Characteristics**

Parameter	Fluoride Varnish (n=60)	Resin Infiltration (n=60)	p-value
Age (years)	8.2 ± 1.4	8.4 ± 1.3	0.62
Male (%)	52%	55%	0.78
Mean ICDAS Score	1.8 ± 0.3	1.7 ± 0.4	0.49

*No significant baseline differences between groups.*

**Table 2: Caries Progression Over Six Months**

Timepoint	Fluoride Varnish (ICDAS Score)	Resin Infiltration (ICDAS Score)	p-value
Baseline	1.8 ± 0.3	1.7 ± 0.4	0.49
3 Months	1.6 ± 0.3	1.4 ± 0.3	0.03*
6 Months	1.5 ± 0.2	1.2 ± 0.2	0.01*

*Significant improvement with resin infiltration at both follow-up intervals.*

**Table 3: QLF Lesion Fluorescence Loss Reduction (%)**

Timepoint	Fluoride Varnish (%)	Resin Infiltration (%)	p-value
3 Months	12.4 ± 2.1	19.8 ± 2.5	0.02*
6 Months	18.2 ± 2.6	27.5 ± 2.8	0.008*

*Resin infiltration showed a significantly greater reduction in lesion fluorescence loss.*

## Discussion

The results of this study demonstrate that both fluoride varnish and resin infiltration effectively arrest early caries progression, with resin infiltration exhibiting superior lesion stability and esthetic improvement. These findings align with previous research suggesting that resin infiltration enhances enamel integrity beyond fluoride-based remineralization therapies<sup>9</sup>.

A significant reduction in ICDAS scores and fluorescence loss in the resin infiltration group highlights its ability to halt caries progression more efficiently than fluoride varnish. The infiltration technique physically seals enamel porosities, preventing acid penetration and further demineralization<sup>10</sup>. In contrast, fluoride varnish relies on a biochemical remineralization process, which requires repeated applications to maintain efficacy<sup>11</sup>.

The biocompatibility and durability of resin infiltration contribute to its clinical advantages. Unlike fluoride varnish, which requires frequent reapplication, a single resin infiltration procedure provides long-term stabilization of early lesions<sup>12</sup>. Furthermore, the ability of resin infiltration to mask white spot lesions makes it an attractive option for esthetic considerations<sup>13</sup>.

Despite its benefits, resin infiltration has limitations, including a higher cost and technique sensitivity compared to fluoride varnish. However, its superior caries-arresting ability justifies its consideration as a first-line intervention for non-cavitated lesions<sup>14</sup>. Future studies should explore its long-term effectiveness and cost-benefit ratio in different patient populations.

The findings of this study contribute to the growing body of evidence supporting minimally invasive approaches to early caries management. The statistically significant differences observed between fluoride varnish and resin infiltration highlight the importance of treatment selection based on lesion characteristics and patient needs. The superior efficacy of resin infiltration in maintaining lesion stability aligns with previous studies that demonstrate its ability to penetrate enamel microporosities, creating a diffusion barrier against cariogenic challenges<sup>15</sup>. This suggests that resin infiltration may be particularly beneficial in high-risk populations where rapid lesion progression is a concern<sup>16</sup>.

The differences in lesion arrest rates between the two interventions may be attributed to their distinct mechanisms of action. Fluoride varnish primarily relies on chemical remineralization by facilitating the deposition of calcium and phosphate ions, whereas resin infiltration physically occludes enamel porosities, limiting the diffusion of acids and sugars<sup>17</sup>. While fluoride varnish has been extensively studied and remains a cornerstone in preventive dentistry, the results of this study reinforce the notion that resin infiltration offers a more immediate and sustained effect against lesion progression<sup>18</sup>.

One of the key advantages of resin infiltration observed in this study is its ability to mask white spot lesions. The esthetic improvement associated with resin infiltration is particularly relevant in pediatric and adolescent populations, where visible enamel demineralization can impact self-esteem and treatment adherence<sup>19</sup>. This cosmetic benefit, combined with its superior lesion stability, suggests that resin infiltration should be considered as a first-line treatment for patients with high esthetic concerns<sup>20</sup>.

However, it is essential to acknowledge the practical considerations of implementing resin infiltration in clinical settings. The technique is more time-intensive than fluoride varnish application and requires precise moisture control, which may pose challenges in younger or uncooperative patients. Additionally, the cost of resin infiltration remains higher than that of fluoride varnish, potentially limiting its widespread adoption in low-resource settings.

Despite these challenges, the superior caries-arresting ability of resin infiltration suggests that it could play a crucial role in modern preventive dentistry. Future research should focus on evaluating its long-term cost-effectiveness and exploring strategies to improve accessibility, particularly in community-based preventive programs.

In summary, the results of this study demonstrate that while fluoride varnish remains an effective non-invasive intervention for early caries management, resin infiltration offers superior lesion stability and esthetic benefits. The decision to use one treatment over the other should be guided by factors such as lesion severity, patient compliance, esthetic concerns, and resource availability. Long-term follow-ups and larger multicenter trials are needed to further validate these findings and refine clinical protocols for early caries management.

## Conclusion

This study confirms that while both fluoride varnish and resin infiltration are effective in managing early carious lesions, resin infiltration provides superior outcomes in terms of lesion stability and esthetic improvement. These findings support the integration of resin infiltration into preventive dental protocols, particularly in high-risk pediatric populations. Future research should focus on long-term comparisons and cost-effectiveness analyses to guide clinical decision-making.

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