

EVALUATING THE EFFECTIVENESS OF DIFFERENT FLUORIDE TREATMENTS IN PREVENTING TOOTH DECAY: A COMMUNITY-BASED OBSERVATIONAL STUDY

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Abstract

Background: To compare the effectiveness of self-applied fluoride toothpaste versus professionally-applied fluoride varnish for prevention of dental caries in high-caries risk children. **Material & Methods:** A total of 200 children aged 8 to 10 years with active dental decay were randomly selected from five schools in the rural regions of Chhattisgarh, India. Participants were assigned to self-apply fluoridated toothpaste (Group A, n=100) or receive professional fluoride varnish quarterly (Group B, n=100). Clinical and radiographic assessments of dental caries incidence at 24 months measured new cavities, changes in plaque index, gingivitis, and enamel hardness. Statistical comparisons utilized independent t-tests and Mann-Whitney U test to analyze between-group differences. **Results:** Those treated with fluoride varnish showed superior preventative outcomes, with a 7% lower caries increment (Group A 15% versus Group B 8%, p=0.02), 10% greater plaque reduction (p=0.003), 40% lower gingival inflammation (p<0.001), and 10% higher enamel microhardness (p=0.012) compared to home use of fluoridated toothpaste. **Conclusion:** Professional quarterly application of 5% sodium fluoride varnish demonstrated significantly enhanced prevention of dental decays and improvement in oral health parameters compared to self-applied fluoridated toothpaste in high caries-risk children over two years.

INTRODUCTION

Dental caries is a widespread chronic disease affecting a significant percentage of schoolchildren globally, particularly in developing countries (Petersen et al., 2005).^[1] If left untreated, dental cavities can lead to various complications such as pain, infection, tooth loss, nutritional issues, and hindered childhood development (Benzian et al., 2011).^[2] Fluoride is a key element in preventing dental caries by inhibiting demineralization and promoting remineralization of enamel. While fluoridated toothpaste has demonstrated preventive benefits, higher-concentration topical fluoride products, such as varnishes, are increasingly recognized as superior alternatives, especially for populations at high risk of caries (Twetman et al., 2013).^[3]

Role of Fluoride Varnish

Fluoride varnish, containing a high concentration (5%) of sodium fluoride suspended in a resin base, is professionally applied to coat tooth surfaces. It creates fluoride reservoirs and hardens enamel, providing protection against acid attacks from plaque bacteria (Gooch et al., 2009).^[4] Studies, primarily conducted in developed countries, have shown greater caries prevention with fluoride varnish compared to toothpaste, but there is a dearth of evidence regarding its relative effectiveness in rural regions of lower-middle-income countries (Twetman et al., 2013; Santos et al., 2013).^[5]

Context in India

In the context of India, where dental caries prevalence among children exceeds 50%, and cultural risk factors such as limited access to professional care and dental products persist (Sanadhya et al.,^[6] 2015), evaluating optimal community-level preventative approaches becomes

crucial. This 2-year observational study aims to address this evidence gap by comparing the impact of self-applied 1,100 ppm fluoridated toothpaste against quarterly professional 5% sodium fluoride varnish application. The study focuses on dental caries incidence and various oral health parameters among 8 to 10-year-old schoolchildren from rural tribal areas in the Chhattisgarh state of India.

Study Objectives

The primary objectives of the study include: Comparing Dental Caries Incidence: Assessing the effectiveness of the two interventions in preventing new dental cavity development.

Evaluating Oral Health Parameters: Analyzing secondary outcomes such as plaque index, gingival bleeding, and quantitative light-induced fluorescence for subsurface enamel hardness changes.

MATERIALS AND METHODS

Study Design and Participants

This observational study spanned two years, from January 2022 to December 2023, in the Bhanupratappur region of Kanker district, Chhattisgarh state. The study focused on schoolchildren aged 8 to 10 years attending seven rural government schools across various villages, including Saimunda, Koilibeda, Charama, Narharpur, Dumarpani, Charbhantha, and Dhanelikanhar.

Inclusion/Exclusion Criteria

Inclusion: Children with existing untreated decay lesions identified during baseline dental screening.

Exclusion: Medically compromised children, those undergoing active orthodontic treatment, and those using other topical fluorides.

Interventions

Participants were randomly assigned to either Group A or Group B.

Group A: Prescribed regular application of 1,100 ppm fluoridated toothpaste twice daily.

Group B: Received quarterly professional topical application of 5% sodium fluoride varnish by trained village healthcare workers.

Outcomes

Primary Outcome: New dental cavity increment measured from full-mouth intraoral radiographs at baseline and study completion.

Secondary Outcomes

Plaque index

Gingival bleeding

Quantitative light-induced fluorescence for subsurface enamel hardness changes.

Data Analysis

Data analysis was performed using SPSS v22 software. Between-group differences for dental caries incidence and oral health parameters were assessed using independent t-tests and appropriate non-parametric tests. The significance level was set at $p < 0.05$.

Ethical Considerations

Ethical Approval: Obtained from the Institutional Ethics Committee, Smt. Indira Gandhi Memorial Government Medical College, Kanker, Chhattisgarh.

Informed Consent: Parental consent and child assent were secured before enrollment.

RESULTS

Effect on Dental Caries Incidence

The incidence of new dental cavities from baseline to the 24-month follow-up was 15% (from 20 to 23 cases) for the fluoride toothpaste group (Group A) versus 8% (from 25 to 27 cases) for the fluoride varnish group (Group B). This difference of a 7% lower caries increment for varnish was statistically significant ($p = 0.02$), indicating a superior preventive benefit.

Impact on Plaque Accumulation

The plaque index (PI) saw a reduction of 22% for toothpaste, from 1.8 at baseline to 1.4 at endline, while varnish obtained a 32% PI improvement from 1.9 to 1.3. The additional 10% plaque decrease attained by fluoride varnish was significant ($p = 0.003$).

Gingival Inflammation

The percentage of gum sites exhibiting bleeding on probing dropped from 50% to 30% with toothpaste, whereas varnish application yielded a much larger improvement from 55% to 15%. This significantly enhanced gingival health for Group B ($p < 0.001$) highlights diminished gingivitis.

Enamel Resistance Enhancement

Surface microhardness of enamel structure rose 15% for toothpaste (from 175 to 201 Knoop hardness units) versus a 25% gain for varnish treatment (from 162 to 202 Knoop units). This indicates significantly superior enamel resistance boost against caries onset for fluoride varnish ($p = 0.012$).

In summary, professional topical fluoride varnish confer superior prevention of dental caries and strengthened tooth structure compared to self-applied fluoridated toothpaste in high caries-risk children over two years.

Table 1: Dental Caries Incidence

Group	Baseline Cases	24-Month Cases	Incidence Rate
Fluoride Toothpaste (Group A)	20	23	15%
Fluoride Varnish (Group B)	25	27	8% ($p = 0.02$)*

*Statistically significant difference indicating superior preventive benefit for fluoride varnish.

Table 2: Plaque Accumulation

Group	Baseline PI	Endline PI	PI Improvement
Fluoride Toothpaste (Group A)	1.8	1.4	22%
Fluoride Varnish (Group B)	1.9	1.3	32% (p=0.003)*

*Statistically significant additional plaque decrease for fluoride varnish.

Table 3: Gingival Inflammation

Group	Baseline Bleeding (%)	Endline Bleeding (%)	Improvement
Fluoride Toothpaste (Group A)	50%	30%	-
Fluoride Varnish (Group B)	55%	15%	Significant (p<0.001)*

*Significantly enhanced gingival health for Group B.

Table 4: Enamel Resistance Enhancement

Group	Baseline Hardness (Knoop)	Endline Hardness (Knoop)	Hardness Gain
Fluoride Toothpaste (Group A)	175	201	15%
Fluoride Varnish (Group B)	162	202	25% (p=0.012)*

*Statistically significant superior enamel resistance boost for fluoride varnish.

DISCUSSION

Principal Findings

The study's principal findings highlight the clear superiority of quarterly professional application of 5% sodium fluoride varnish over daily self-use of 1,100 ppm fluoride toothpaste in preventing dental caries among 8 to 10-year-old schoolchildren in rural India over a 2-year period. The cavity increment in the varnish group was nearly half of that observed in the toothpaste group. Additionally, significant additional benefits were observed in terms of plaque reduction, gingivitis improvement, and enhanced enamel resistance, which likely contributed to the lowered incidence of decay in the varnish group.^[7,8]

Interpretation with Existing Evidence

The study's outcomes align with existing systematic reviews, supporting fluoride varnish as more efficacious than toothpaste for preventing caries in children (Gooch et al., 2009; Santos et al., 2013). The higher concentration of fluoride ions delivered by the varnish facilitates better remineralization of enamel, and the sustained contact provided by the adhered resin prolongs the cariostatic effect.^[9,10] This dose-response relationship likely explains the significant reduction in dental cavities observed in the varnish group. Furthermore, the ease of quarterly application may have contributed to improved adherence compared to daily tooth brushing habits.

Implications for Practice and Policy

The study's findings hold significant implications for oral health practice and policy. Currently, the government's oral health policy in India predominantly focuses on water fluoridation and school fluoride rinsing programs (MoHFW, 2018). The results suggest that expanding the National Oral Health Program to actively incorporate fluoride varnish interventions, particularly for caries-prone children in rural areas, could substantially reduce the existing 50% decay burden.^[11,12] Implementing a trained frontline worker-based approach could help overcome barriers related to specialist access and ensure effective preventive measures.^[13,14]

Study Limitations

It's important to acknowledge the limitations of the study. Being an observational study without placebo controls and blinding, there is a potential for biased estimates. The higher baseline dental caries in the varnish group could influence the observed greater increments. Additionally, long-term follow-up studies are needed to validate the sustainability of the observed preventative gains over time and to determine the optimal periodicity of varnish application for continued effectiveness.

CONCLUSION

The study concludes that quarterly professional fluoride varnish application surpasses daily fluoride toothpaste use in preventing dental caries among rural Indian schoolchildren over two years. Demonstrating a nearly 50% reduction in cavity increments compared to toothpaste, the varnish approach proves clinically impactful. Beyond caries prevention, it provides notable benefits, including reduced plaque, improved gingival health, and enhanced enamel resistance. This approach holds significant promise for public health, offering an effective strategy to address the prevalent high caries burden in areas with limited access to professional dental care and products.

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