

Effect of Fluoride Varnish application on Primary Dentition among Preschool Children in Dharan: A Randomized Controlled Trial

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ABSTRACT

Introduction: Topical application of fluoride varnish on the tooth surface prevents the dissolution rates of tooth materials and increases the re-precipitation of lost minerals.

Objective: To assess the effectiveness of fluoride varnish application in primary dentition among preschool children at high risk of dental caries.

Methods: A randomized controlled trial was conducted with two parallel-group, comprising 3–5-year-old children, 100 in each group (Fluoride varnish or Placebo varnish). Dental caries were recorded at baseline, three- and six-month using Caries Assessment and Treatment Instrument (CAST) scoring system. Statistical analysis was done using the Chi-square test for categorical data, Mann-Whitney U test, independent t-test, and Wilcoxon Signed Ranks test for quantitative data. The level of significance was set at $p < 0.05$.

Results: Overall, dental caries progression from baseline to three months and six months was more in placebo varnish group children than fluoride varnish (38.98% and 31.3% respectively). The proportion of children with new caries lesions was more in placebo group than that in the fluoride varnish group at every three months interval. The difference between the groups was statistically significant ($p < 0.05$). Fluoride varnish treatment once in six months had a better treatment effect with a preventive fraction of 62.1% in comparison to three months (59.0%).

Conclusions: Dental caries can be prevented effectively by the use of 5% sodium fluoride varnish. Fluoride varnish is efficacious when applied twice a year in children at high risk of dental caries.

Keywords: Dental caries; fluoride varnish; primary dentition; randomized controlled trial

INTRODUCTION

Dental caries in primary dentition has a detrimental effect on their oral health-related quality of life.¹⁻⁴ Therefore, innovative and effective intervention in the school setting have the potential to reduce caries and the resultant impact of the disease.⁵ But, for caries reduction, joint effort of

communities, professionals and individuals are required to reduce the nasty effect of sugar consumption and emphasize the beneficial impact of fluorides.⁶

Fluoride has several caries-protective mechanisms such as alteration of microbial breakdown and re-mineralization of enamel.⁷⁻¹⁰ A Cochrane review estimated the preventive fraction of fluoride varnish to be 33% for the milk teeth.¹ Thus, an increasing emphasis on the need for evidence-based health interventions requires the evaluation of the effect of fluoride varnish in primary dentition by a carefully designed randomized controlled trial that use placebo. It may generate sound data for lower- and middle-income countries like Nepal.

METHODS

The aim of the study was to assess the effect of fluoride varnish on caries progression and reduction in the

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incidence of dental caries in the primary dentition. Null Hypothesis: There is no significant difference in the progression of dental caries on the application of fluoride varnish and placebo. A randomized controlled clinical trial with parallel group study was implemented from October 2015 to September 2016, among the Government school children in Dharan, Nepal. Ethical approval for the study was obtained from the Institutional Review Committee, BPKIHS, Dharan (Ref. No. 448 /071/072). The study was registered retrospectively as a clinical trial (www.ctri.nic.in) by the National Institute of Medical Statistics (India Council of Medical Research); the Clinical Trial Registry India identifier no. CTRI/2016/02/006659 (Reg. date: 18/02/2016) (<http://ctri.nic.in/Clinicaltrials/login.php>).

Sample size: Sample size was calculated based on two previous studies.^{11,12} Taking 1:1 ratio of sample unit, $\alpha=0.05$, power of the study 80%, and confidence interval (CI) at 95%. Putting all these values into EPI-info 2007 software (CDC, Atlanta, USA, WHO), the sample size was determined to be 87. Adding 15% to compensate for the dropout rate, the required sample was 100 in each group (Group A and Group B).

Participants: Out of 38 Government schools of Dharan, initially eight schools (20% of total) were randomly chosen from the list using the lottery method. Being unable to achieve the required number of subjects from selected schools, additional six school children were examined. Permission for implementing the current study was obtained from all the school principals. Written informed consent was obtained from parents/guardians and proxy consent was obtained from school principals, where direct parents' consent was not acquired. Assent from all the children was taken prior to the examination and application of materials. Of 290 children of age 3-5 years examined at baseline, only 200 children who had ≥ 1 decayed/missing/filled tooth were enrolled in the study. However, children who had a history of allergic reactions that required hospitalization were un-cooperative and those who were not willing to take part in the study were excluded.

Randomization and Masking: Each child was assigned to a group (Group A; Fluoride Varnish (FV) or Group B; Placebo Varnish (PV)) with an allocation ratio of 1:1 by a biostatistician using computer-generated random numbers.

Allocation sequence numbers were then concealed in sequentially numbered opaque sealed envelopes. An assistant, not participating in the field study, prepared the intervention tubes according to the allocation lists, placing a tag for each treatment group. Patients' outcome assessors and biostatisticians were kept unaware of the type of treatment given during and after randomization and not unveiled until the analysis of data.

Oral examinations: The baseline and follow-up visits at three and six months involved a full mouth oral examination of all the teeth using the Caries Assessment and Treatment Instrument (CAST) scoring system.¹³ For analysis dmft score was calculated from CAST index.

All the examination throughout the study was done by a trained investigator. Intra-examiner reliability was assessed at baseline and in-between the study duration by re-examining 25 randomly selected participants. All the subjects were examined in the supine position under natural light. Oral examination was carried out by using sterilized instruments including a mouth mirror for indirect vision and a probe for removing excess plaque. A pro forma was used to collect the details on demographic characteristics (name, age and gender, school, class) and CAST coding boxes for 20 primary teeth.

Intervention and Measurements

Fluoride Varnish Application: Fluoritop SR Varnish (ICPA Health Product LTD, India) is an alcohol-based material. It contains sodium fluoride (50mg) equivalent to 22.6mg of fluoride. Varnish (0.5ml) was painted in a thin layer with the help of disposable applicators on all the primary teeth present in oral cavity except on root stump and tooth with pulpal involvement. An application took 4 minutes for each child. Before application, each tooth was wiped and dried with cotton wool rolls or gauze and varnish was painted onto all surfaces of the maxillary and mandibular anterior and posterior teeth. Parents/caregivers and children were asked to refrain from brushing their children's teeth with fluoride toothpaste on the day of application and were instructed to avoid eating hard and hot food and drinking for 2 hours. Varnish was applied at baseline and every three months for a period of six months. A total of three applications were received by each child. **Placebo:** Placebo varnish [PV; Manoj Pharmaceutical (P) Ltd. Dharan, Nepal] was identical to

FV except that it did not contain fluoride. The application procedure was similar to fluoride varnish.

Outcomes: The primary outcome was caries progression as measured by changing from the baseline enamel and dentinal caries into enamel, dentinal, pulp involvement, and missing due to caries. Baseline CAST codes were subtracted from the codes recorded at 3- and 6-month follow-up.

The secondary outcome was caries incidence as measured by the proportion of children developing any new enamel and dentinal caries during the study. Sound, pits and fissure sealant, and restored tooth at baseline were subtracted from the number of sounds, restored, and the decayed tooth at 3 and 6 months of follow-up. A child was considered to be an incident case of dental caries if the subtraction score was more than zero.

Statistical analysis: After completion of the survey, data obtained were entered in Microsoft Excel Sheet version 2007 and analyzed using the Statistical Package for Social Sciences (SPSS version 11.5, SPSS, Inc., Chicago, IL, USA). The level of significance was set at $p < 0.05$. Intra-examiner reproducibility for coding was

measured by Cohen’s kappa coefficient. Descriptive analysis was performed to summarize the clinical and socio-demographic characteristics of each group at baseline in order to assess how comparable the groups were at beginning of the study. Chi- square test was used to assess the difference in the proportion of children with caries progression and incidence in both the groups. Differences in mean dmft component between and within FV and PV groups were evaluated using Mann-Whitney U test, independent t-test and Wilcoxon Signed Ranks Test respectively.

RESULTS

Enrolment and Retention: The mean age of the participants was 4.15 ± 0.82 years. The first and second follow-up examinations were done at three months and six months intervals, consecutively. During the second follow-up, 177 children were examined which represented 88.5% retention rate. The CONSORT flow diagram tracks subject participation for the entire study (Figure 1). Overall, 44.5% were male and 55.5% were female participants in the study. Baseline mean dmft in all children who took part in the test and control group (Table 1 and 2) were found to be insignificant ($p > 0.05$).

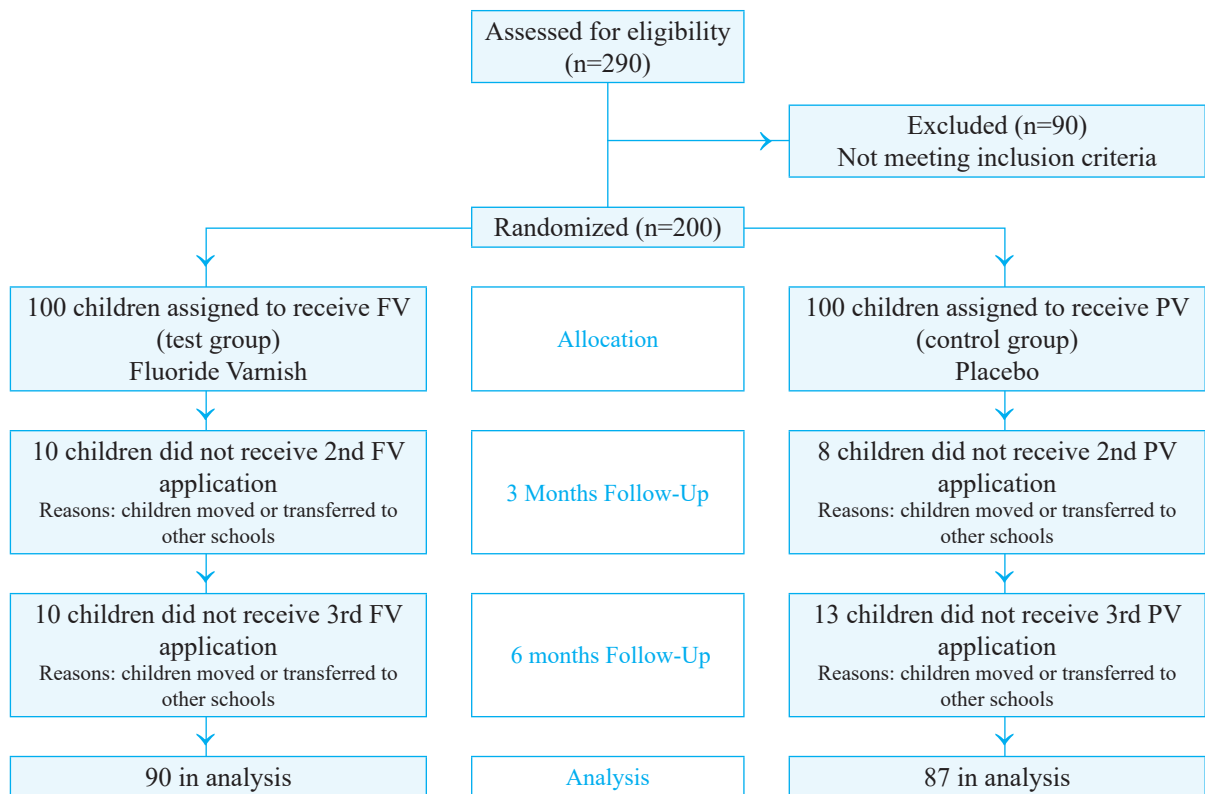


Figure 1: CONSORT flowchart of the children enrolled in intervention groups

Table 1. Baseline data on age and caries occurrence of participants in the intervention groups.

	Fluoride Varnish group Mean ± SD	Placebo Varnish group Mean ± SD	P value
Age	4.26 ± 0.80	4.07 ± 0.82	0.110a
dmft	3.75 ± 2.67	4.17 ± 3.17	0.540b

a Independent t-test, b= Mann- Whitney U test

Table 2. Baseline, Gender wise comparison of mean dmft between test and control groups.

Group	Mean dmft (Male)	Mean dmft (Female)	P value ^a
Fluoride Varnish (n=100)	4.79 ± 3.25	3.79 ± 2.52	0.165
Placebo Varnish (n=100)	5.17 ± 3.66	4.31 ± 3.15	0.261

a = Mann-Whitney U test

Table 3. Dental caries progression at different follow-up in FV+ and Control groups.

Follow-up period	Fluoride varnish group No. (%)	Placebo Varnish group No. (%)	P value ^a
3 months (n=182)	21 (23.33%)	36 (39.13%)	0.032
6 months (n=177)	24 (26.66%)	45 (51.72%)	0.001
3-6 month (n=171)	8 (9.10%)	17 (20.20%)	0.041

+ Fluoride Varnish a Chi-square test

Intra-examiner reliability: The overall kappa value for CAST index ranged from 0.86 to 0.93 at baseline and 0.81 to 0.91 at 3 months of follow-up. This suggested that the clinical intra-examiner reproducibility for detecting dental caries was very good.

Dental caries progression:

Dental caries progressed in children of both FV and control groups at 3- and 6-month follow-up. However, the control group children showed significant progression of dental caries at different intervals (Table 3).

Pair-wise comparison of FV and PV groups at different time periods revealed that there was a significant increase in severity of dental caries at 3rd and 6th months from baseline (p<0.05). However, the rate of difference in caries progression from 3rd to 6th month was almost static

(p=0.258) in FV group but it was different in PV group children (p<0.05) (Tables 4 and 5).

Preventive fraction (PF): The treatment effect of varnishes was expressed as a preventive fraction. It is the difference in caries incidence of the PV and FV group, divided by the incidence of the PV group, expressed as a percentage. FV at the six months had the best treatment effect with a preventive fraction of 62.1% in comparison to three months (59.0%).

Caries incidence:

Overall, the caries incidence was 28.24% at the end of the study. At three months, out of 92 children in the control group, 22 children developed new lesions which were more than the FV group where only eight participants had new cavities. Likewise, at six months, 37 children

Table 4. Mean dmft within FV+ group in different stages of the study.

		Number of pairs in FV ⁺	Mean rank	Median	P-value ^a
Pair 1	Baseline	90	4.50	3	0.001
	3 months			3.5	
Pair 2	Baseline	90	7.0	3	0.001
	6 months			4	
Pair 3	3 months	87	4.25	3.5	0.285
	6 months			4	

+ Fluoride Varnish, a Wilcoxon Signed Ranks Test

Table 5. Mean dmft within Control group in different stages of the study.

		Number of pairs in control group	Mean rank	Median	P-value ^a
Pair 1	Baseline	92	11.5	4	0.001
	3 months			5	
Pair 2	Baseline	87	19.0	4	0.001
	6 months			5	
Pair 3	3 months	84	10.5	5	0.004
	6 months			5	

^a Wilcoxon Signed Ranks Test

Table 6. Incidence of dental caries after application of Fluoride and Placebo Varnishes.

Follow-up period	FV ⁺ group No. (%) with New carious lesion	PV ⁺⁺ group No. (%) with New carious lesion	P value ^a
3 months (n=182)	8 (8.88%)	22 (23.91%)	0.011
6 months (n=177)	13(14.44%)	37 (42.52%)	0.001
3-6 month (n=171)	6 (6.80%)	18 (21.40%)	0.006

+Fluoride Varnish, ++ Placebo Varnish, ^a Chi-square test

showed caries incidence in control and 13 children in FV. The proportion of children with new caries lesions was significantly more in the control group than in the test group at every three-month interval ($p < 0.05$) (Table.6).

Adverse events: None of the children and children's caregivers reported any adverse effects associated with the interventions.

DISCUSSION

This study was carried out to determine the effectiveness of fluoride varnish in the prevention of dental caries in primary dentition compared to a placebo applied every three-month for six- months. Participants in this study experienced the positive effect of fluoride varnish on dental caries. The present study revealed that the dental caries progression in subsequent follow-up was less in both groups. The magnitude of caries progression in FV children was less than PV, (23.33% and 26.66% and 9.1%, 39.13%, 51.72% and 20.20%) at 3-month, 6-month, and 3-6-month intervals respectively. The study also found that the FV was effective at every three months of its application. The progression between the second and third applications was not significant ($p = 0.28$). Whereas, a statistically significant difference existed at every stage ($p < 0.05$) in the control group. These findings were consistent with a study done by Mohammadi, et al. (2015)⁹

and Ekstrand, et al. (2010).¹⁴ However, a Brazilian study¹⁵ result was inconsistent with the current study. American Dental Association (ADA) recently concluded that -Fluoride varnish applied every six months is effective in preventing caries in the primary and permanent dentition of children and adolescents. Two or more applications of fluoride varnish per year are effective in reducing the caries prevalence in primary or permanent teeth for moderate to high-risk children.¹⁶ In 2006, ADA suggested that the application of varnish at every three-month interval was efficient enough to provide caries prevention benefits among the people at the highest caries risk.¹⁶

The present study shows that there is an increment in caries with time. New caries development in children of the varnish group was lesser than the control group moreover, the incidence of dental caries was less evident within the children of the varnish group who were exposed twice to fluoride varnish. Overall, the caries incidence was 28.24% at the end of the study. A study revealed that in children with good oral health and who had received at least one fluoride varnish treatment, 37.73% were caries-free whereas, among the participants who had never received fluoride varnish treatment, only 26.80% were caries-free and the difference was statistically significant.¹⁷ This finding supports the preventive action of fluoride varnish shown by the present study. Fluoride

varnish application in a thin layer adheres to the tooth surface for longer periods (12 hours or more) and prevents the immediate loss of fluoride after application. It inhibits demineralization and stimulates the remineralization process. A study also proved that the incidence of caries was reduced by applying varnish twice a year with respect to a single application.¹⁸

Present research also found the preventive fraction (PF) of fluoride varnish at three and six months was 59.0% and 62.1%, respectively. This result is supported by a review done by Marinho, et al.¹⁹ and Rozier in 2001.²⁰ Adverse effect of the fluoride varnish was not reported in any of the children who were followed for a year in the current study. This could be because the amount of varnish painted on teeth was 0.5ml and this quantity of varnish delivers 3 to 11mg of fluoride ions per dose which is far below the probable toxic dose of 5 mg/kg body weight.²¹ This result is also supported by Gansky et al.²² and Ekstrand et al.,²³ as varnish is painted on teeth the plasma fluoride concentrations of 3.2 to 6.3 micromolar were found post-two-hour of application, followed by a rapid decrease over the next two hours and a slower decrease thereafter. These levels were comparable with those found after brushing with a fluoridated toothpaste ($3.63 \pm 0.45 \mu\text{mol/L}$) or after ingesting a 1-mg F⁻ tablet ($4.47 \pm 0.47 \mu\text{mol/L}$) and were considerably lower than those reported for APF gels (16 to 76 $\mu\text{mol/L}$). These data signify the minimal risk of varnishes.^{22,23} A study reported concerns of parents as discoloration of teeth after the first application of FV, and some children had burning sensation on the first day of placebo varnish application.¹

Thus, the study recommends that fluoride varnish application should be included compulsory in-school oral health programs, as it is very easy to apply and does not require a sophisticated armamentarium. It is suitable and practical for use in the community especially in young children and in other special need groups.

LIMITATION: Besides these findings, the study had few limitations. The confounder was not omitted as fluoridated toothpaste can reduce the dental caries progression and occurrence. Face-to-face parent interviews could be done to control these factors. Another limitation was the study findings may not be generalized to all the students as the study included high-risk populations with caries.

CONCLUSIONS

The study strongly suggests that dental caries can be prevented effectively by use of 5% sodium fluoride varnish. Topical application of fluoride varnish not only prevents the occurrence but can also stop the further progression of caries. It is more efficacious when applied twice a year in children at high risk of dental caries.

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Conflict of Interest: None

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