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# The effectiveness of interdental flossing with and without a fluoride dentifrice

Gerald Z. Wright, D.D.S., M.S.D., F.R.C.D.(C)
W. H. Feasby, D.D.S., M.Sc., F.R.C.D.(C)
D. B. Banting, D.D.S., M.Sc.

## Abstract

*The present investigation was designed to: (a) confirm previous findings which demonstrated significant caries reductions by dental flossing, and (b) determine if self-applied unsupervised use of fluoride dentifrice enhances the effectiveness of interdental flossing. Grade 1 children were examined clinically and radiographically. Accepted for study were 188 children with at least one contra-lateral pair of intact, proximal surfaces from the distal of the primary cuspid to the mesial of the first permanent molars. Study surfaces were randomly assigned to test and control groups. Test surfaces were flossed on school days by trained assistants using unwaxed dental floss and control surfaces were unflossed. Subjects were also divided into fluoride and non-fluoride toothpaste groups who self applied the respective dentifrices under unsupervised conditions. Clinical and radiographic examinations were repeated after eight, 12 and 20 months. At 20 months, 147 children contributing 682 surfaces remained for study. There were 124 new proximal lesions observed. On the average, their test surfaces were flossed 258 times. Following statistical analyses, the major conclusions reached were: (a) interdental flossing by trained auxiliaries can significantly reduce interproximal caries, and (b) unsupervised use of a self administered fluoride dentifrice does not greatly enhance the effectiveness of interdental flossing for caries reduction.*

## Introduction

During the past decade, five clinical trials have focused on the effectiveness of dental flossing for proximal caries reduction.[1-5] These studies evaluated flossing alone or combined with other agents. Unfortunately, there is lack of unanimity regarding the benefits derived from the flossing procedure. Since dental flossing is incorporated in many children's preventive regimens, further investigation is indicated to establish conclusively the efficacy of this practice.

In a previous investigation, the authors of this paper found that a 52% to 55% reduction in the number of new proximal caries resulted from frequent interdental flossing.[1] That study, however, did not consider the type of dentifrice used by the subjects. Accordingly, the present study was designed to attempt to replicate previous findings and to determine whether a fluoride dentifrice enhances the effectiveness of interdental flossing.

## Methods and Materials

The study was conducted in Chatham, Ontario, Canada, a fluoride-deficient area using first grade school children as subjects. Permission was obtained from school officials to conduct the project, and letters explaining the nature of the research were forwarded to parents of all first grade students. Parents were also asked to indicate whether their child used a fluoride or nonfluoride dentifrice at home. These children will hereafter be referred to as members of the F or NF group respectively.

Children with permission were examined and subsequently accepted into the study if they displayed the following criteria: (1) there was at least one contra-lateral pair of intact (caries-free), unrestored, proximal surfaces present; (2) these surfaces were located between the distal of the first primary cuspid and the mesial of the first permanent molar; and (3) the proximal surfaces were in contact with the adjacent teeth. This design provided for both control and test surfaces in the same child's mouth.

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Two examiners (GZW and WHF) were used throughout the study. To determine interexaminer reliability, the examiners performed duplicate examinations on over 10% of the children. A proximal surface was considered to be carious if the lesion had progressed at least to the dentino-enamel junction radiographically. Throughout the study, incipient lesions not penetrating the dentin were considered to be intact. Surfaces with incipient proximal lesions at baseline were not accepted for study.

The investigative procedure consisted of four examinations over a 20 month period. The baseline examination occurred in September, 1975, and subsequent examinations occurred in June, 1976, September, 1976 and June, 1977. Data were obtained by visual examination using a mirror, an explorer and an artificial light source. The condition of the surfaces of all posterior teeth and primary cuspid teeth was determined and recorded. Bitewing radiographs were taken for each child at each examination. After the radiographs were developed and interpreted, any additional findings were recorded on the subjects' charts. When the results of the visual examination and the radiographs differed with respect to the status of a proximal surface, a concensus was reached by the examiners.

Proximal tooth surfaces were randomly designated as control or test by quadrants for each subject. If the upper and lower arches of one subject were included in the study, the test and control quadrants of the upper arch were determined randomly, then test and control quadrants for the lower arch were reversed from those in the upper arch. A master list outlining the quadrants to be flossed for each child was prepared and this list functioned as the daily work sheet. At no time were the examiners aware of which surfaces were test or control.

Research assistants, who were trained in a standardized flossing technique, performed the flossing.[6] Four research assistants were used throughout the study.

The research assistants were instructed to floss the test quadrants each school day with an unwaxed dental floss.* To minimize variations in the thoroughness of proficiency of the flossing technique, the research assistants were rotated monthly. No group of children was flossed by the same research assistant for longer than one month at a time.

Special instructions concerning oral hygiene procedures were not given to the pupils. However, they were told to continue to brush their teeth as usual, and sufficient quantities of dentifrice were allotted on a monthly basis to the subjects and their families.

Oneway analysis of variance was used to compare the children in the six schools with respect to baseline characteristics. Condescriptive and crosstabulation programs using the 't' and $x^2$ statistics respectively were used when making comparisons between children in the two toothpaste groups. The effectiveness of the floss was calculated by subtracting the attack rate of test surfaces from the attack rate of control surfaces and dividing the result by the attack rate of the control surfaces.[7]

* Johnson's Unwaxed Dental Floss.

## Results

A total of 228 first grade children were examined in six elementary schools in Chatham and 188 (82.5%) were accepted into the study. Of these, 99 (52.7%) identified that they used a fluoridated toothpaste and were assigned to the F group and 89 (47.3%) indicated their acceptance of a non-fluoride toothpaste and were assigned to the NF group. Table 1 shows the distribution of study subjects by school and toothpaste group.

**Table 1. Distribution of grade 1 children by school and toothpaste group at baseline**

| TOOTHPASTE GROUP | SCHOOL 1 | 2 | 3 | 4 | 5 | 6 | TOTAL |
|---|---|---|---|---|---|---|---|
| Fluoride | 24 | 16 | 14 | 27 | 6 | 12 | 99 |
| Non-Fluoride | 24 | 6 | 17 | 22 | 11 | 9 | 89 |

The baseline examination revealed that the mean number of decayed and filled (DF) surfaces for all children accepted into the study was 4.3. There were no statistically significant differences found among the six schools with respect to age, sex, proportion requiring dental care, number of children examined by each examiner, and average number of decayed and filled surfaces. Hence, data for the children from the six schools will be reported collectively. There were no statistical differences between demographic data or baseline oral health conditions of the F and NF groups (Table 2).

**Table 2. Mean number of decayed and filled surfaces by toothpaste group at baseline**

| *Group* | *Mean DF Surfaces* | *Standard Deviation* |
|---|---|---|
| *All Children Accepted* | | |
| Fluoride | 4.32 | 5.90 |
| Non-Fluoride | 4.19 | 4.96 |
| *Children Completing Study* | | |
| Fluoride | 4.59 | 6.01 |
| Non-Fluoride | 4.37 | 4.96 |

**Table 3. Incidence and attack rate* of proximal caries for flossed and control surfaces by toothpaste group**

| Toothpaste Group | Interval Months | Flossed Surface DF | Attack Rate Flossed Surfaces | Control Surface DF | Attack Rate Control Surfaces | Flossed Surface DF Control Surface DF |
|---|---|---|---|---|---|---|
| Fluoride | 0-8 | 6 | 1.4 | 9 | 2.1 | 1 |
| | 9-12 | 9 | 2.2 | 11 | 2.7 | 4 |
| | 13-20 | 13 | 3.4 | 20 | 5.3 | 13 |
| Non-Fluoride | 0-8 | 6 | 1.5 | 5 | 1.3 | 1 |
| | 9-12 | 3 | 1.0 | 8 | 2.6 | 2 |
| | 13-20 | 13 | 4.4 | 22 | 7.6 | 8 |

* per 100 surfaces at risk

Duplicate examinations performed on 29 children in the same class in one of the schools over the three examinations revealed that the consistency between examiners was r = 0.91 for decayed surfaces and r = 0.94 for decayed and filled surfaces.

The 188 children contributed 914 pairs of surfaces for study. Over the study period, 41 (21.8%) children moved away from the participating schools and were designated as drop-outs. Drop-outs were assumed to be lost from the study immediately following an examination period. Teeth lost through exfoliation or loss of contact were included with the drop-outs. Altogether, 232 pairs of surfaces were lost to follow-up through the study. There were no statistically significant differences found between the drop-outs and those who completed the entire 20-month study period with respect to sex, school, D, F, and DF surfaces at baseline, examiner, or need for dental treatment.

Test surfaces were flossed by trained auxiliaries an average of 258 times for those children remaining in the study for 20 months.

Table 3 shows the incidence of new proximal caries for the test and control surfaces over the study period by toothpaste group. For both toothpaste groups, the number of new proximal lesions initiating on control surfaces exceeded those on test surfaces except at the 8 month examination where, for the NF group, the incidence of new lesions was slightly greater for the test surfaces. The attack rates of new proximal lesions were greater for control surfaces compared to test surfaces at the 12 and 20 month examinations for both F and NF groups.

Figure 1 shows the cumulative number of new proximal lesions occurring on test and control surfaces at the three examination periods for both toothpaste groups. After 20 months, the percent effectiveness of interdental flossing was 30.0% for the fluoride group and 37.1% for the non-fluoride group. It can readily be seen that the treatment effect of flossing increases over time for both toothpaste groups.

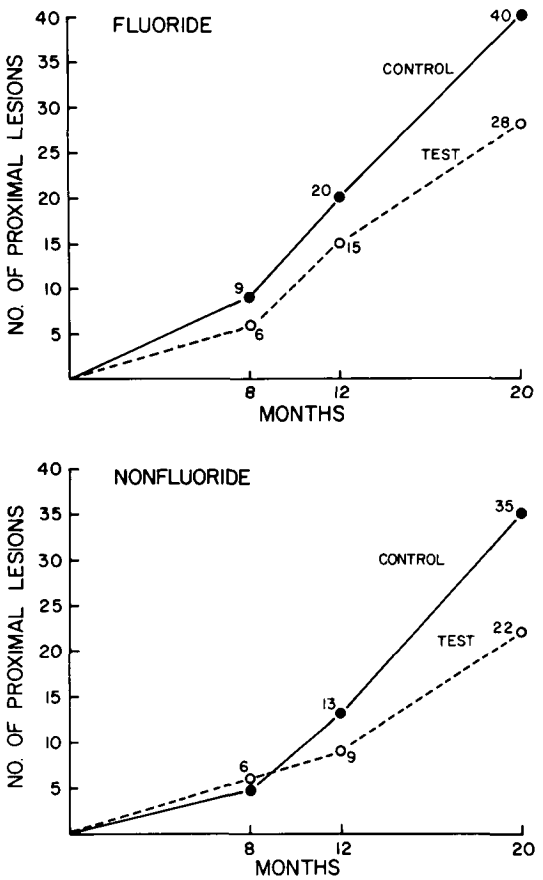


**Figure 1.** Cumulative number of new proximal lesions at each examination period.

A Sign test was performed to test for differences between the flossed and control surfaces in the 147 children remaining in the study for the entire 20 month period.[8] The difference was found to be statistically significant (Z = 2.94, P = .003).

## Discussion

The data from this study revealed a statistically significant beneficial effect from interproximal dental flossing by trained auxiliaries and supports the authors' previous findings which demonstrated significant caries reductions using dental floss.[1]

A second aim in this investigation was to determine whether self applied unsupervised use of a fluoride dentifrice enhances the effectiveness of interdental flossing. After 20 months, the effectiveness of interdental flossing was 30.0% for the F group and 37.1% for the NF group. Thus, little difference in the effectiveness of proximal flossing by trained auxiliaries was found when a fluoride or non-fluoride dentifrice was self administered under unsupervised conditions. The failure of the fluoride dentifrice to improve flossing effectiveness was unexpected.

Supervised toothbrushing was not feasible in this study. By using within subject comparisons, however, toothbrushing differences should be minimal. Every attempt was made to encourage the use of the allocated dentifrice and a sufficient quantity of toothpaste was supplied for the entire family, thereby facilitating compliance, but no data were collected on actual toothpaste use. Nonetheless, the investigators are of the opinion that fluoride dentifrices should still be used in conjunction with flossing since other tooth surface areas as well as poorly flossed proximal surface areas can derive benefits.

Although this study replicates previous findings in first grade children, it is important to note that not all clinical studies have shown caries reductions of this magnitude. Researchers in Sweden noted a 54% to 95% decrease in proximal dental caries increment using flossing, interdental tips, prophylaxis and topical fluorides,[2,3] whereas studies by Horowitz *et al.* and Silverstein *et al.* failed to show significant proximal caries reductions following supervised flossing each school day.[4,5] In addition to flossing, frequent rinsing and brushing with topical fluorides might explain the excellent proximal caries increment reductions in the Swedish studies. On the other hand, the fact that the children self-flossed could account for the lower reductions observed by the other investigators.

It is possible for selection biases to be present in the study groups which would make comparisons tenuous. For instance, regular use of a fluoride dentrifice might indicate a greater interest in preventive dentistry. However, there were no significant differences in the mean baseline DFS scores between the study groups and, when compared with the mean DFS scores for six-year-old children in Ontario, the amount of bias was found to be equal in direction and intensity for both groups.[9] The effect of bias on the comparison of toothpaste groups, therefore, was modest.

Statistical tests were not conducted with the individual surfaces as the observation unit because of the need to assume independence of surfaces within the same child. The Sign test used focused on mouths as the unit which deals with the clustering effect of multiple surfaces in the same child, and in addition, takes the pairing of test and control surfaces into account.

## Conclusion

Based on the conditions of this study, the following conclusions were determined:

- Frequent interdental flossing by trained auxiliaries has a statistically significant beneficial effect upon the dentition by reducing the incidence of proximal dental caries 30% in the presence of a fluoride dentifrice.
- A self applied unsupervised use of a fluoride dentifrice does not greatly enhance the effectiveness of interdental flossing in reducing proximal caries.
- These clinical results confirm previous findings that supervised interdental flossing can significantly reduce interproximal caries.


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GERALD Z. WRIGHT is Professor and Chairman of the Division of Pedodontics, The University of Western Ontario, Faculty of Dentistry, London, Ontario, Canada.

W. H. FEASBY is Professor and Chairman, Department of Pediatric and Community Dentistry, The University of Western Ontario, Faculty of Dentistry, London, Ontario, Canada.

D. B. BANTING is Associate Professor and Chairman, Division of Community Dentistry, The University of Western Ontario, Faculty of Dentistry, London, Ontario, Canada.

Requests for reprints may be sent to Dr. Gerald Z. Wright, Division of Pedodontics, Faculty of Dentistry, The University of Western Ontario, London, Ontario, Canada N6A 5B7.