Evaluation of Dental Flossing on a Group of Second Grade Students Undertaking Supervised Tooth Brushing

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Purpose: This study aimed to evaluate the effect of flossing on the presence of plaque and gingivitis in school students undertaking supervised oral hygiene.

Materials and Methods: Thirty-three non-users of dental floss were selected from a larger panel. The study had a preliminary phase of 21 days, followed by two experimental phases of 21 days, separated by an interval of 21 days. The study was crossover and blind with two experimental groups. The addition of flossing to brushing was assigned to one group in each phase. Instructions in brushing and flossing were provided at the beginning, with re-instruction twice a week. The Visible Plaque Index (VPI) and the Gingival Bleeding Index (GBI) were determined at start and end of each phase. The medians were analyzed using the Wilcoxon and Mann-Whitney tests.

Results: In the first phase, the median interproximal GBI reduced from 62.1% to 17.9% with flossing, and from 59.3% to 22.2% without flossing. In the second phase, the median percentage of bleeding also reduced from 31.9% to 17.3% without flossing, and from 26.0% to 8.9% with flossing. The change in percentage was significant in both phases but similar for both groups. Similar results were observed in sites with VPI and sites where VPI and GBI were present. Free sites responded similarly to the interproximal sites.

Conclusions: A regimen of brushing produced significant reductions in the presence of VPI and GBI both at free and interproximal sites; the inclusion of flossing into the regime did not represent significant improvements with respect to VPI and GBI.

Key words: dental floss, oral hygiene, brushing, gingivitis

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The use of dental floss to control interproximal plaque is known to be difficult for the majority of the population, despite being widely recommended by dentists. Using dental floss appears to be limited to 30% of the population and has been shown to be independent of geographical distribution (Rise et al, 1991; Lang et al, 1995; Kuusela et al, 1997; Trentin and Oppermann, 2001) and of the age group studied (Meei-Schia and Rubinson, 1982; Murtooma et al, 1984; Sogaard et al, 1991). Oral hygiene habits, including the use of dental floss, may depend on factors such as: motivation of the individual (Macgregor et al, 1998); frequency of visits to the dentist (Macgregor et al, 1998); educational level (Hamilton and Coulby, 1991; Ronis et al, 1993); and socio-economic level (Gift, 1986; Kuusela et al, 1997; Macgregor et al, 1997; Colussi, 1998). These observations may explain why the accumulation of plaque (Hansen and Gjermo, 1971; Axelsson and Lindhe, 1978; Ramberg et al, 1995) and the occurrence of gingivitis (Lövdal et al, 1958, 1961; Löe and Silness, 1963) are more common at interproximal sites.

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On one hand, a number of short-term clinical studies have demonstrated a significant improvement in the interproximal gingival condition with the correct use of dental floss (Finkelstein and Grossman, 1979; Graves et al, 1989; Lobene et al, 1982). On the other hand, long-term studies indicate that indefinite re-instruction and individual monitoring may be necessary for the dental flossing habit to become a component of oral hygiene (Albandar et al, 1994; Axelsson and Lindhe, 1978).

What is not clear however is the impact of dental flossing on individuals who are strongly motivated and brush their teeth efficiently. Some studies undertaken in children and adolescents have observed that the incorporation of flossing in oral hygiene routines does not significantly contribute to the improvement of the interproximal gingival condition (Vogel et al, 1975; Robinson, 1976; Reitman et al, 1980; Rich et al, 1989). The correct use of dental floss requires manual dexterity, a skill with which children have difficulties and which requires long-term learning.

In populations of adolescents and young adults the incorporation of these oral hygiene habits is obviously facilitated since most have acquired these manual skills. Preventive programs aimed at this age group emphasize exactly this question (Buischi et al, 1994; Albandar et al, 1995). The frequency of dental flossing in this age group is relatively low (Murtooma et al, 1984; Rise et al, 1991). In fact, control of plaque through brushing has also been shown to be inadequate (Buischi et al, 1994).

Bearing in mind the necessity to improve gingival health by altering oral hygiene habits, it would be interesting to establish whether the level of gingival health among adolescents who do not brush their teeth adequately, and also do not use dental floss, would benefit from instruction and training directed towards improving brushing only, compared to brushing associated with dental flossing.

The object of the present study was to evaluate the effect of the use of floss on the presence of dental plaque and gingivitis in a group of second grade students who were brushing their teeth under supervision.

MATERIAL AND METHODS

Sample

One hundred and fifty-four second grade students enrolled in the local high school were initially examined and answered a questionnaire to identify their flossing habits. Of the 98 non-users of dental floss, 33 students (14 female and 19 male with an age varying from 14 to 18 years) with the highest score for percentage of proximal gingival bleeding were selected to participate in this study. The basic requirements for participation in the study were: to be free of systemic disease; not using any medicine routinely; not to have undergone periodontal treatment or used antibiotics in the previous six months; to have at least 20 interproximal spaces; and to have parental free and informed consent.

Factors under investigation – Use of Dental Floss

Target factors – presence of plaque and gingival bleeding

To estimate the accumulation of plaque the Visible Plaque Index (VPI) was used based on the Silness and Löe Index considering non-visible plaque (scores 0 and 1) and visible plaque (scores 2 and 3). Gingival inflammation was estimated using the Gingival Bleeding Index (GBI) (Ainamo and Bay, 1975). VPI was performed by an experienced dentist while, GBI was performed by a second practitioner. The two examiners were trained to measure the indices with the participation of a senior investigator. Training was completed when perfect agreement was reached. Both examiners were blind to the distribution of the participants in the experimental groups, and the clinical study crossover and blind was developed in three distinct phases.

Initial removal of retentive factors of plaque (RRFP) was undertaken 21 days before the first examination of the study. At this stage no oral hygiene instructions were given.

At the initial examination of the first experimental phase the VPI and GBI were assessed. Using the data of interproximal GBI the participants were classified into three categories: high GBI, intermediate GBI and low GBI. From this classification pairs from the same category were allocated to Group 1 or Group 2:
Group 1. Flossing (F) → No flossing (NF).
Group 2. No flossing (NF) → flossing (F).

The experimental phase of the study began with the following procedures for each group:
Group 1. Instruction and training in brushing and the use of dental floss.
Group 2. Instruction and training in brushing only.

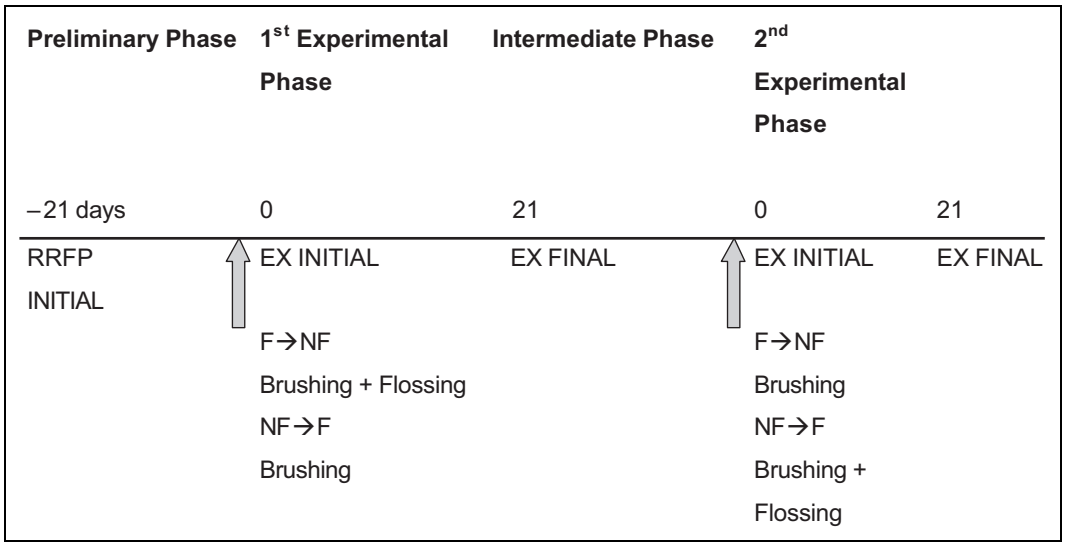

Fig 1 Flow Chart of Experimental Phases.

Both groups received instruction, motivation and training in brushing using the mini-scrub technique. The instructors considered the orientation session complete when all the participants could adequately demonstrate the technique. Afterwards the students in Group 1 were given additional instruction, motivation and training in the use of dental floss.

All participants were asked to undertake these oral hygiene procedures at least once a day. Besides the basic instruction of procedures for the mechanical removal of plaque, the participants received reinforcement of motivation and training in the appropriate procedures for each subject at a frequency of twice per week. Each participant received two Johnson and Johnson® toothbrushes (# 30) and 25 m of Johnson & Johnson® waxed dental floss. One brush was for home use and the other remained in the clinic for re-instruction sessions.

Measurement of VPI and GBI was carried out after 21 days followed by a prophylaxis. During the following 21 days the participants of Group 1 were instructed to stop using dental floss; however, both groups continued brushing.

At the beginning of the second experimental phase, re-examination was undertaken to determine VPI and GBI. Group 1 should now brush and continue without flossing while Group 2 was given instruction, motivation and training in the use of dental floss and also in brushing:

Group 1. Instruction and training only in brushing.

Group 2. Instruction and training in brushing and dental floss.

The final measurements of VPI and GBI were undertaken after 21 days in the two experimental groups, followed by prophylaxis and guidance in the daily use of floss (Fig 1).

Analysis of Results

The results were measured using VPI and the GBI, undertaken at each experimental examination. From individual percentages the median percentage of these parameters for the experimental groups in the two phases of the experiment were calculated. The percentages, as well as the medians, were calculated separately for interproximal and free sites.

The analysis of data evaluated the behavior of sites that bled or that had visible plaque, or that presented concomitant bleeding and visible plaque at the beginning and end of each experimental phase. In addition, the percentage change was determined Δ for each group from the individual values of percentage change Δ, which were calculated for the evaluated parameters using the following formula:

$$\Delta = \frac{\text{final value} - \text{initial value} \cdot 100}{\text{initial value}}$$

The statistical analysis was undertaken using Wilcoxon and Mann-Whitney tests in accordance with the type of comparison undertaken for a value

Table 1 General characteristics of the experimental groups

Group	n	Gender		Median age	Median of teeth examined	Median of surfaces examined		Median of bleeding sites		Median percentage of bleeding	
		M	F			prox	free	prox	free	prox	free
F → NF	16	9	7	15.4	26.7	51.4	55.4	33.0	16.8	67.0	31.9
NF → F	17	10	7	15.8	27.0	51.9	55.9	35.4	14.4	69.2	26.8

Table 2 Median of percentage of proximal sites with visible plaque at the beginning and at the end of each experimental phase, with the respective median of percentage of reduction Δ according to the experimental group (F = with flossing, NF = no flossing)

Groups	n	1st Phase				2nd Phase			
		Initial	Final	p	Δ	Initial	Final	p	Δ
F → NF	16	29.8	6.1	< 0.001	– 81.6	22.0	1.9	< 0.001	– 91.2
NF → F	17	35.7	14.8	< 0.001	– 70.0	20.4	5.4	= 0.001	– 75.7
p	–	0.279	0.206	–	0.181	0.626	0.499	–	0.159

p: statistical significance

$\alpha = 0.05$. Statistical calculations were carried out using the SPSS V6.0 program.

RESULTS

We can see that all groups showed a similar distribution at the beginning of the study, not only in relation to gender and age, but also the number of teeth/surfaces examined. Initially, the median of the percentage of interproximal bleeding was similar for the two groups: being 67.0% for group F → NF and 69.2% for group NF → F. These distributions were similar for the free surfaces, with however less bleeding than at interproximal sites (Table 1).

When the initial and final values are considered, significant reductions can be observed both for the presence of visible plaque as well as interproximal gingival bleeding, independent of the group or the phase of the experiment under consideration. However, the initial and final values for the two groups were similar both in the first and the second phase. For example, in group F → NF an initial median percentage of 29.8% of visible plaque reduced to 6.1% in the first phase; correspondingly for group NF → F these values changed from 35.7% to 14.8%. In the second phase, when group F → NF was not using floss, there was a median reduction from 22.0% to 1.9%. While for group NF → F that used dental floss in this phase, the values reduced from 20.4% to 5.4% (Table 2).

In Table 3 we can see that for group F → NF the initial median percentage of 62.1% for interproximal bleeding reduced to 17.9% in the first phase; while for group NF → F these values reduced from 59.0% to 22.2%. In the second phase when group F → NF were not using dental floss the median reduced from 31.9% to 17.3%. While for group NF → F who used dental floss in this phase, the median percentage reduced from 26.0% to 9.0%. The medians of the percentage of reduction Δ calculated from the comparison of initial and final percentages of interproximal bleeding and interproximal visible plaque were found to be similar, independent of the group and experimental phase considered. In the first phase, when dental floss was used a median percentage of reduction in bleeding was 67.7% and 61.1% when dental floss was not used. Similarly, in the second phase, after the use

Table 3 Median of percentage of interproximal bleeding sites at the beginning and at the end of each experimental phase, with the respective median of percentage of reduction Δ according to the experimental group (F = with flossing, NF = no flossing)

Groups	n	1st Phase				2nd Phase			
		Initial	Final	p	Δ	Initial	Final	p	Δ
F → NF	16	62.1	17.9	< 0.001	– 67.7	31.9	17.3	< 0.001	– 52.1
NF → F	17	59.3	22.2	< 0.001	– 61.1	26.0	9.0	< 0.001	– 69.7
p	–	0.842	0.417	–	0.121	0.857	0.158	–	0.193

p: statistical significance

Table 4 Median of percentage of proximal faces with concomitant visible plaque and bleeding at the beginning and at the end of each experimental phase, with the respective median of percentage of reduction Δ according to the experimental group (F = with flossing, NF = no flossing)

Groups	n	1st Phase				2nd Phase			
		Initial	Final	p	Δ	Initial	Final	p	Δ
F → NF	16	18.8	1.9	< 0.001	– 92.7	4.7	0	= 0.001	– 100.0
NF → F	17	18.5	2.0	< 0.001	– 88.9	3.7	0	< 0.001	– 100.0
p	–	0.339	0.346	–	0.346	0.814	0.706	–	0.680

p: statistical significance

of dental floss, the Δ was 69.7% and 52.1% when floss was not used. There was a similar tendency, after the use of dental floss in phase 1, where the median percentage reduction of plaque was 81.6% and 70.0% when floss was not used. Similarly, in the second phase, after the use of dental floss the Δ was 75.7% and 91.2% when floss was not used.

Comparing the reduction of interproximal sites with the concomitant presence of visible plaque and bleeding in locations that initially showed visible plaque and bleeding (Table 4), we can see that the medians of percentage reduction Δ were similar, independent of the group and of the experimental phase considered. For example, in the first phase the percentage was 92.7% when floss was used and 88.9% when dental floss was not used. Similarly, in the second phase, after the use of dental floss the Δ was 100.0% and without the use of dental floss 100.0%. When considering the initial and final values we can see significant reductions, independent of the group or the experimental phase considered. However, the initial and final values for the two groups were similar in the first and second phases.

Tables 5, 6 and 7 show the behavior of the free sites in relation to the presence of visible plaque, bleeding and the association of visible plaque with bleeding, respectively. The results were similar to those found at interproximal sites. We could observe for example that the medians of percentage of reduction were similar between each other, independent of the group and the experimental phase. The initial and final medians showed a significant reduction in the two experimental groups both in the first and second experimental phase. Furthermore, it could be observed that the initial and final medians for the two groups were similar in both the first and second phases.

DISCUSSION

In the present study, the introduction of a regimen of brushing was efficient in reducing the presence of visible plaque, and the presence of gingival bleeding – both when considered separately or in association. Furthermore, we observed that the inclusion of dental flossing to this regimen of super-

Table 5 Median of percentage of free faces bleeding at the beginning and at the end of each experimental phase, with the respective median of percentage of reduction Δ according to the experimental group (F = with flossing, NF = no flossing)

Groups	n	1st Phase				2nd Phase			
		Initial	Final	p	Δ	Initial	Final	p	Δ
F → NF	16	30.2	6.5	< 0.001	– 77.5	13.8	3.7	< 0.001	– 91.2
NF → F	17	24.1	5.6	< 0.001	– 75.0	7.1	3.6	< 0.001	– 75.7
p	–	0.339	0.717	–	0.493	0.638	0.898	–	0.159

p: statistical significance

Table 6 Median of percentage of free faces with visible plaque and at the end of each experimental phase, with the respective median of percentage of reduction Δ according to the experimental group (F = with flossing, NF = no flossing)

Groups	n	1st Phase				2nd Phase			
		Initial	Final	p	Δ	Initial	Final	p	Δ
F → NF	16	19.5	2.7	< 0.001	– 78.7	13.2	3.6	< 0.001	– 75.0
NF → F	17	23.2	5.4	< 0.001	– 68.2	16.1	3.3	< 0.001	– 75.0
p	–	0.207	0.292	–	0.337	0.942	0.412	–	0.603

p: statistical significance

Table 7 Median of percentage of free faces with concomitant visible plaque and bleeding at the beginning and at the end of each experimental phase, with the respective median of percentage of reduction Δ according to the experimental group (F = with flossing, NF = no flossing)

Groups	n	1st Phase				2nd Phase			
		Initial	Final	p	Δ	Initial	Final	p	Δ
F → NF	16	10.2	0.0	= 0.001	– 91.7	3.6	0.0	= 0.005	– 88.9
NF → F	17	10.7	1.7	< 0.001	– 80.0	3.6	0.0	= 0.001	– 75.0
p	–	0.458	0.303	–	0.526	0.757	0.572	–	0.573

p: statistical significance

vised tooth brushing represented no significant increase in the ability to remove plaque and reduce marginal bleeding.

In a study of this nature, experimental design is fundamental and must avoid confounding factors such as the Hawthorne effect, the effect of co-intervention of acquired behavior, as well as errors in the time periods of evaluation (Kleisner and Imfeld, 1993). The use of dichotomous systems for the evaluation of results, the analysis of individual results for free and interproximal sites, standardization of the method of brushing and the process of oral hygiene instruction for the experimental groups are important aspects that were partially or totally ignored both in investigations with different results (Lobene et al, 1982; Finkelstein and Grossman, 1979; Graves et al, 1982), as well as studies with similar results (Hill et al, 1973; Robinson, 1976; Mauriello et al, 1987; Rich et al, 1989). Adopting an experimental design similar to the present

study, when comparing the use of floss associated with brushing, a rubber stimulator associated with brushing, and the use of brushing only, Mauriello et al (1987) observed that both the VPI index as well as the GBI and the median number of sites with bleeding maintained their reductions after an interval of three weeks. In their analysis of results the authors used the median of differences comparing a single result for the two active experimental phases. Thus, they did not take into consideration the maintenance of observed reductions after the intermediate period.

In this study the two experimental phases were analyzed independently as the initial conditions in both were considerably different. However, the fact that medians of percentage of reductions Δ were similar in the first and second phase show that, if there was really a co-intervention effect, it was of such a magnitude that it would not significantly influence the ability to modify the behavior of the two experimental phases.

The results of the present study show that the introduction of a regime of plaque control produced a reduction of visible plaque and gingival bleeding, both at interproximal sites as well as at free sites. Kleisner and Imfeld (1993) observed that the habit of brushing by participants can lead to an underestimation of their effect on interproximal control, especially in studies of short duration. Both with high levels of plaque (beginning of first phase), as well as with low levels of plaque (beginning of second phase), we observed that medians of percentage of reduction Δ of bleeding and of plaque were similar when comparing the use/non-use of dental floss associated with brushing.

The use of dental floss appears to be restricted when oral-hygiene-related habits are investigated despite efforts by the dental profession to introduce dental floss as a universally habitual measure. Because the present study suggests that the needs of individual patients should be taken into account, the results may contribute to reducing the gap between what the profession recommends and what the population does. In the present study we were able to demonstrate significant reductions in the presence of visible plaque and gingival bleeding at free and interproximal sites with a regime of supervised tooth brushing. Based on the data in our study, and since the toothbrush is almost universally accepted for oral hygiene, it seems reasonable to suggest that oral health programs should be initially directed towards the improvement of brushing, followed by careful evaluation of the need to use dental floss. In those cases where the presence of proximal bleeding persists there is a justification for the introduction of dental floss use. It must be noted that this suggestion carries two additional conditions. Firstly, the justification previously mentioned must be incorporated into a protocol targeted specifically towards the fulfillment of these objectives and, secondly, the importance of using floss to prevent caries must not be forgotten.

CONCLUSIONS

The brushing regime adopted in this study resulted in significant reductions in the presence of visible plaque, of gingival bleeding, and the associated presence of visible plaque and gingival bleeding, both at interproximal and free sites. The additional inclusion of dental flossing into this brushing regime showed no significant improvement in relation to the parameters evaluated in young school children.

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