Accepted: 16 July 2017

DOI: 10.1111/idh.12307

ORIGINAL ARTICLE

WILEY International Journal of Dental Hygiene

Randomized controlled trial on mouth rinse and flossing efficacy on interproximal gingivitis and dental plaque

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Abstract

Objective: The objective of this study was to compare the efficacy of an essential oils mouth rinse and dental floss on dental plaque accumulation and gingivitis in interproximal areas.

Methods: With informed consent, a parallel randomized controlled clinical trial was developed with 60 third-year dental hygiene students, randomly divided into two non-blind groups of 30 individuals each. For a period of 2 weeks, one group used an essential oils mouth rinse, according to manufacturer's instructions, and the other group flossed twice a day. Both groups received a toothbrush and fluoridated toothpaste for home dental hygiene care. A baseline dental hygiene appointment consisted of tooth scaling, prophylaxis and collection of the study data, using the Lobene modified gingival index; Saxton & Ouderaa gingival bleeding index and the Quigley & Hein modified by Turesky dental plaque index.

Results: At baseline, there was no significant difference between the groups for interproximal gingival inflammation ($P = .214$), gingival bleeding ($P = .829$) and dental plaque accumulation ($P = .860$). After 2 weeks of treatment, no significant differences were found between the essential oils mouth rinse and dental flossing for reduction of interproximal gingival inflammation ($P = .938$) and bleeding ($P = .307$). Essential oils mouth rinse showed to be significantly better than dental flossing in reducing interproximal dental plaque accumulation ($P = .006$).

Conclusion: The use of an essential oils mouth rinse may be advised, as a complement, for patients unable to floss effectively, as it is more effective in reducing interproximal dental plaque accumulation than dental floss.

KEYWORDS

dental floss, dental plaque, essential oils, gingivitis, interproximal areas, mouth rinse

1 | INTRODUCTION

To prevent oral diseases, it is necessary to disrupt dental plaque. Intervention procedures can be grouped into two types: those who physically, by mechanical action, remove the microorganisms and those who, by chemical action, aim to eliminate the microorganisms, reduce their metabolism or alter the environment in which they grow.[1]

The pathogenic nature of dental plaque can be reduced by maintaining an effective oral hygiene, using mechanical and chemical approaches including daily toothbrushing, flossing or other interproximal oral hygiene techniques and an antiseptic mouthwash.[2,3] A 2-minute daily toothbrushing routine alone is not sufficient to completely remove dental plaque.[4]

Several studies have demonstrated the usefulness of regular use of dental floss in interproximal dental hygiene and the advantages of

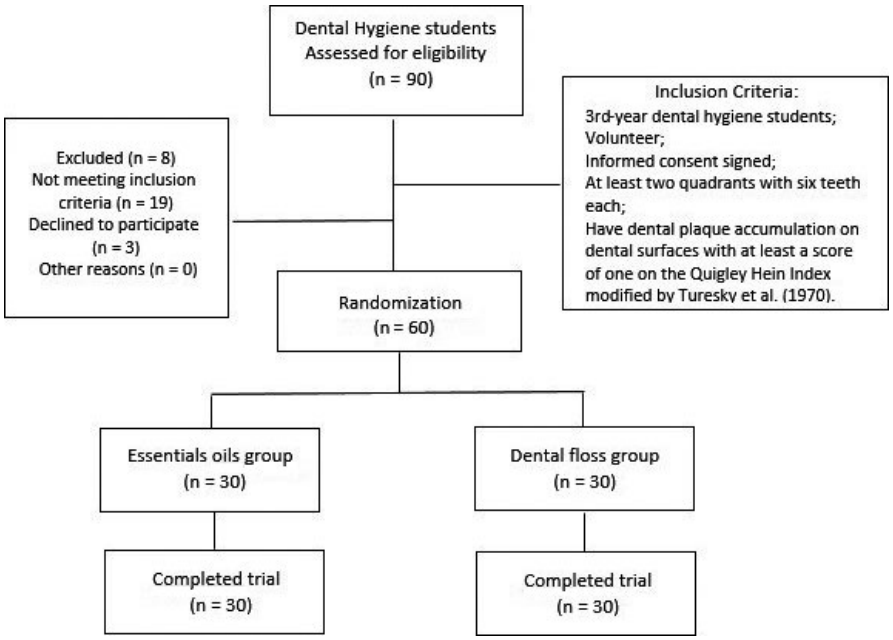

FIGURE 1 Flow chart of the study design

its use to complement toothbrushing[5,6] regardless the type of dental floss used.[7] However, it is also described in the literature that the use of dental floss at home, without supervision, is not effective in preventing interproximal caries[6,8] and most studies fail to demonstrate that flossing is effective in plaque removal.[9]

The effectiveness of dental floss as an interproximal oral hygiene technique is very limited by the ability of performing it, with a described removal of only 15%-19,4% of the interproximal dental plaque.[5,10] Dental floss should only be recommended for areas where interdental brushes cannot be used, as these are more effective in reducing dental plaque accumulation.[11] The use of dental floss as an adjunctive to toothbrushing is less effective in removing interproximal dental plaque than the use of an antibacterial mouth rinse to complement toothbrushing.[12] The instruction on flossing should be considered in individual cases, when the oral health professional believes that the patient is able to achieve a high-quality flossing technique.[13]

The use of adjunctive antiplaque chemical agent, for chemical plaque control, in managing gingivitis has proven to be of significance to improve oral health in terms of gingival inflammation, bleeding on probing and plaque indices,[14] but only with short-term effects.[3] Essential oils are volatile substances extracted from aromatic plants that have the ability to delay or inhibit bacterial development. The components of essential oils with higher antibacterial effect are phenolic compounds and aliphatic alcohols.[15] Essential oils are able to penetrate dental plaque and to reduce its accumulation in interproximal areas.[16]

The existing literature indicates the effectiveness of a mouth rinse with essential oils in reduction of gingivitis and interproximal dental plaque.[17-19] Essential oils mouth rinses seem to have an effect on plaque accumulation and gingivitis that is beyond its alcohol vehicle solution.[20] A systematic review of experimental articles made in 2007 by Stoeken indicates significant differences between the essential oils mouth rinse and dental floss, favourable to the mouth rinse, in reducing gingivitis and interproximal dental plaque accumulation.[16,19,21-25]

The aim of this clinical trial was to evaluate and compare the efficacy of a mouth rinse with essential oils and dental floss in reducing dental plaque accumulation and gingivitis in interproximal areas.

2 | METHODOLOGY

This trial was designed as a randomized, controlled, observer blinded, two parallel groups clinical trial. The endpoint is dental plaque accumulation and gingival health of interproximal areas after 2 weeks of use of an essential oils mouth rinse (Listerine Cool Mint) or dental floss. The randomization of the participants was performed by LL with a 1:1 allocation.

2.1 | Sample selection

Sixty 3rd-year (final year of the programme) dental hygiene students at the University of Lisbon volunteered to participate in this study (convenience sample) and were randomly assigned (LL) into two groups of 30 participants each. For this sample size, the probability is 90 per cent that the study will detect a treatment difference with a two-sided .05 significance level, if the true difference between treatments is .854 times the standard deviation. The fact of being 3rd-year dental hygiene students assures the ability to perform a correct dental flossing technique.

Inclusion criteria consisted in being a 3rd-year student of the dental hygiene degree, to volunteer to participate with signed the informed consent; have at least two quadrants with six teeth each and have dental plaque accumulation on dental surfaces with at least a score of one on the Quigley Hein Index modified by Turesky et al (1970). The exclusion criteria were the current use of a mouth rinse or mouthwash as an adjunct to oral hygiene; having had an oral hygiene

TABLE 1 Percentages and *P*-value for the reduction of the general and interproximal indexes obtained at baseline and 2 wk after the beginning of the clinical trial, for each study group

	Experimental group							
	Mouth rinse (n = 30)				Dental floss (n = 30)			
Variable	*Baseline*	Two weeks	*P*-value[◊]	% reduction	*Baseline*	Two weeks	*P*-value[◊]	% reduction
Interproximal gingival index mean (SD)	0.97 (0.79)	0.27 (0.47)	.050[¥]	72.1	1.2 (0.82)	0.39 (0.58)	<.001[¥]	67.5
Interproximal bleeding index mean (SD)	0.18 (0.29)	0.03 (0.07)	.016[¥]	83.3	0.17 (0.23)	0.02 (0.04)	.001[¥]	88.2
Interproximal plaque index mean (SD)	2.0 (0.55)	1.27[*♯] (0.66)	.050[¥]	36.5	2.0 (0.59)	1.65[*♯] (0.46)	<.001[¥]	17.5
Gingival index mean (SD)	0.96 (0.79)	0.27 (0.47)	<.001[¥]	71.9	1.1 (0.81)	0.39 (0.58)	<.001[¥]	64.5
Bleeding index mean (SD)	0.18 (0.29)	0.04 (0.07)	.016[¥]	77.8	0.10 (0.13)	0.02 (0.05)	.003[¥]	90
Plaque index mean (SD)	2.0 (0.58)	1.41 (0.56)	<.001[¥]	29.5	2.0 (0.60)	1.64 (0.39)	.001[¥]	18

[¥]Difference statistically significant between baseline and 2 wk period.
[*]Difference statistically significant in the 2 wk study period (*P* = .006).
[◊]Paired *t* test.
[♯]Chi-square Test.

appointment in the last 6 months; having had antibiotic therapy in the 3 months prior to the study; having cavitated caries with fracture of teeth structure (Figure 1).

2.2 | Study implementation

All clinical examinations were performed by the same observer (HL), dental hygienist for 25 years and trained in the collection of this type of data, blind to the study groups in order to reduce data collection bias, at the dental hygiene clinic in the University of Lisbon Dental Medicine School. The study protocol was approved by the Ethics Committee at the Lisbon Dental Medicine School. Clinical trial registry was performed and has the registration NCT01236950. All subjects signed an informed consent form before the start of the clinical trial. Study start date: April 2007; Study completion date: September 2008.

After baseline data collection an initial appointment for scaling and polishing took place, performed by HL, and participants were allocated using a computer-generated randomized allocation procedure, to one of the two experimental groups; one group performed a mouth rinse with essential oils in as the active ingredients (30-second rinse with 20 ml of mouthwash twice daily, according to the manufacturer's instructions) and the other group used dental floss twice a day (Colgate® Total waxed floss Colgate-Palmolive, S.A. Switzerland) for interproximal dental hygiene. Every participant received, at this initial dental hygiene appointment, a manual toothbrush and a fluoride toothpaste along with verbal instructions, by MB, to perform their oral hygiene routine twice a day for 2 weeks, using only the material assigned to them.

Data collection occurred with an interval of 2 weeks, both performed by the same blinded observer (HL). The first appointment was called the baseline data and gave the researcher demographic information and initial clinical data. The second appointment allowed for the collection of the clinical data necessary to evaluate treatments in comparison with baseline values.

2.3 | Clinical measurements

The evaluation of mouth rinse and dental floss efficacy on interproximal gingivitis and dental plaque was performed clinically, by HL using the Plaque Index by Quigley & Hein (1962), modified by Turesky et al (1970),[26] the Lobene modified Gingival Index by Lobene et al (1986)[27] and the Gingival Bleeding Index by Saxton & van der Ouderaa (1989).[28] These indices are widely accepted for use in clinical trials. The clinical parameters were measured at day 1 (baseline) and then again at day 15 (end of the study). Data were registered in clinical record sheets created for this clinical trial. These clinical indices allow the evaluation of interproximal areas as they record the information on those areas.

2.4 | Statistical analysis

Data were analysed with descriptive statistical techniques using SPSS v18. Treatment groups were compared within group with *t* test for baseline and the values after 2 weeks and intergroups at baseline with chi-square test, with a 0.05 significance level.

Comparison among treatments after the 2-week period was performed using one-way analysis of covariance (ANCOVA) with treatment as factor and the baseline values of clinical parameters as covariant, with a 0.05 significance level. The ANCOVA is accepted as the adequate statistical test to analyse the efficacy of dental plaque removal in clinical trials.

3 | RESULTS

The participants in this clinical trial had a minimum age of 19 years and maximum of 34 years old, with a mean age of 21.2 years old (SD of 2.8 years). The majority of the individuals (80%) were female. There were no significant differences between experimental groups for age

($P = .719$) or gender ($P = .052$). The 30 assigned participants to each group were followed for the entire study period, with no dropouts and information were collected for all participants.

3.1 | Within group comparison

Reductions for the indexes values were observed between baseline and the 2 weeks (end of study period). The higher reduction was observed on the bleeding index for the mouth rinse with essential oils (77.8%, $P < .001$) and flossing (80%, $P < .001$). For the gingival index, the mouth rinse with essential oils showed a reduction of 71.9% ($P = .016$), and the dental floss showed a reduction of 64.5% ($P = .003$). The plaque index was reduced by 29.5% ($P < .001$) in the mouth rinse group and 18% ($P < .001$) in the dental floss group.

As interproximal areas are evaluated by these indices, data were analysed only for those specific sites. Data on the interproximal indices percentage reductions between baseline and the 2-week period can be observed in Table 1, for each study group.

The highest reduction was observed for interproximal bleeding index with a value of 83.3% for the mouth rinse with essential oils and a value of 88.2% for the dental floss. The interproximal gingival index decreased by 72.1% in the group using mouth rinse with essential oils and by 67.5% in the group using dental floss. The interproximal plaque index showed a greater reduction (36.5%) in the group who used the mouth rinse with essential oils than the group that used dental floss (17.5%). Significant differences were found in the reduction of all indexes both for the mouth rinse with essential oils and for flossing.

3.2 | Between-groups comparison

For baseline data, no significant differences were found between the essentials oils mouth rinse and the floss groups for gingival index ($P = .314$), bleeding index ($P = .183$) and dental plaque index ($P = .892$). The same was observed when considered only the interproximal data, no statistically difference for the interproximal gingival index ($P = .214$), interproximal bleeding index ($P = .829$) and interproximal dental plaque index ($P = .860$).

The differences in study indices between the mean values of the two groups after 2 weeks were not statistically significant.

The P value obtained for the gingival index values was .848 indicating no significant difference between the experimental group using mouth rinse with essential oils and for the experimental group using dental floss. Regarding the Bleeding Index, the P value of .627 indicates no difference between the two groups. The ρ value of .065 indicates no significant difference between the experimental group using the mouth rinse with essential oils and the experimental group using dental floss, regarding the Plaque Index.

For the interproximal components of the indices, the mean value of the index after the 2-week period shows that there is only a significant difference between the groups for the interproximal plaque index, with the essential oils mouth rinse showing a lower mean value ($P = .006$).

4 | DISCUSSION

The imbalance in gender distribution in the sample is justified by the fact that the student population of the Dental Hygiene degree is predominantly female. This phenomenon of higher percentage of women in education is common in most western countries.[29]

The results of the present clinical trial are similar to those found in 2007 by Stoeken having, however, only statistically significant differences favourable to the mouth rinse with essential oils in the reduction of interproximal plaque accumulation, while differences were described for gingivitis and dental plaque in the original article by Stoeken.[21] They are also partly in accordance with those obtained in a clinical trial conducted by Bauroth in 2003[22] where participants were divided into three groups, the brushing and mouth rinse with essential oils group, the brushing and flossing group and the brushing and placebo mouthwash group. It was found that the highest reduction of interproximal plaque was obtained in the brushing and essential oils mouth rinse group, being significantly different to the brushing and dental flossing group ($P < .001$). For the gingival index, the mouth rinse with essential oils group reduced index values in a significant way ($P < .001$) when compared to the floss group, which does not occur in the present study. The experimental groups with dental floss and the essential oils mouth rinse showed significantly better results than the mouthwash group.[22]

Sharma et al (2004) conducted a clinical trial for 6 months with 3 experimental groups, a group using tooth brush and a control mouthwash, a group using tooth brush, dental floss and a control mouthwash and a third group using toothbrush, dental floss and a mouth rinse with essential oils. The group using toothbrush, dental floss and a mouth rinse with essential oils showed the best results in the reduction of the Gingival Index (Löe & Silness) and in the reduction of Plaque Index (Quigley e Hein, modified by Turesky) with reductions of 21% and 51.9%, respectively, with the differences being statistically significant from the other groups.[25]

The results obtained in the present study are partially in line with the results of the clinical trial conducted by Sharma et al in 2004, however, in that study the group that performed the mouth rinse with essential oils also used dental floss, which prevents direct comparison with the present study.[25]

In another study by the same author using as clinical assessment methodology the same indexes of the present clinical trial, there researchers compared three groups who used a mouth rinse with essential oils or dental floss or a control mouthwash, in addition to daily toothbrushing. The conclusions obtained were very similar indicating that there was no significant difference between the group using a mouth rinse and the group using dental floss, for the Gingival Index but significant difference in the reduction of interproximal dental plaque, favourable to the mouth rinse.[24]

A significant reduction of interproximal dental plaque without a significant reduction of the gingival inflammation was observed in a clinical trial conducted by Finkelstein et al in 1990. In this study, reductions of 21% were obtained for dental floss and reductions of 27% for essential oils when compared with a group which used only

a toothbrush.[30] The authors concluded that the mouth rinse is not effective in reducing the gingival inflammation and interproximal dental plaque accumulation.

This study presents as its main limitation and a potential bias the fact that participants are 3rd-year students of dental hygiene, therefore, not representatives of the general population. This bias is positive in nature as it assures the good use of dental floss, which does not happen in the general population. For this reason, the external validity of the study may be compromised. The bias may reduce the difference between the essential oils mouth rinse and the floss group which in fact may be higher for the general population due to the difficulty in performing a proper interproximal dental hygiene using dental floss.

5 | CONCLUSION

From the results obtained in the present clinical trial it is possible to state that the use of a mouth rinse with essential oils and flossing resulted in significant reductions in the values of the Plaque Index, Gingival Index and Bleeding Index, total and interproximal, after using it for a 2-week period.

Regarding gingival inflammation, bleeding and dental plaque accumulation around the teeth in general, no significant differences were found between the use of dental floss and the mouth rinse with essential oils. Same happened for the interproximal spaces on gingival inflammation and bleeding. The mouth rinse with essential oils showed significant better results in reducing interproximal dental plaque accumulation.

The results obtained in this clinical trial show, as described in the scientific literature, that a mouth rinse with essential oils is more effective than dental floss in reducing interproximal dental plaque accumulation, which may be of interest for the prevention of major oral diseases.

6 | CLINICAL RELEVANCE

6.1 | Scientific rationale for study

Claims have been made that a mouth rinse with essential oils can be as effective as flossing for a patient's daily dental hygiene. A parallel randomized controlled clinical trial was developed with 3rd-year dental hygiene students as volunteers.

6.2 | Principal findings

This study suggests that a mouth rinse can be used as a complement to flossing because it helps controlling interproximal dental plaque accumulation.

6.3 | Practical implications

A patient presenting difficulties in performing an effective dental hygiene in interproximal areas will benefit from the use of a mouth rinse with essential oils as a complement for daily flossing.

CONFLICT OF INTEREST

The authors present no conflict of interests. This study was funded by the authors.

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How to cite this article: Luís HS, Luís LS, Bernardo M, dos Santos NR. Randomized controlled trial on mouth rinse and flossing efficacy on interproximal gingivitis and dental plaque. *Int J Dent Hygiene*. 2018;16:e73–e78. https://doi.org/10.1111/idh.12307