

Comparison of Two Power Interdental Cleaning Devices on Plaque Removal

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Abstract

- **Objective:** The objective of this randomized, single-use, single-blind, two-group, parallel clinical trial was to evaluate the supra-gingival plaque removal efficacy of two power interdental devices combined with a manual toothbrush.
- **Methods:** Eighty-two (82) subjects completed the study. Subjects were randomly assigned to one of two groups: Waterpik® Water Flosser (WF) plus manual tooth brushing or Sonicare® Air Floss (AF) plus manual tooth brushing. Pre-brushing and interdental cleaning scores were obtained using the Rustogi Modified Navy Plaque Index (RMNPI). Subjects were instructed on the use of the manual toothbrush and assigned an interdental product. Post-brushing and interdental cleaning scores were obtained after a supervised two-minute brushing and use of the interdental device. Scores were recorded for whole mouth, marginal, approximal, facial, and lingual regions for each subject.
- **Results:** There were no differences in the pre-cleaning plaque scores for whole mouth, marginal, approximal, facial, or lingual regions. Both groups showed significant reductions in plaque from baseline for all regions. The WF group demonstrated significantly higher reductions as measured by the RMNPI compared to the AF for whole mouth (74.9% vs. 57.5%), marginal (58.6% vs. 36.7%), approximal (92.1% vs. 77.4%), facial (83.6% vs. 69.1%), and lingual (65.7% vs. 45.4%).
- **Conclusion:** The use of the Waterpik Water Flosser removes significantly more plaque from tooth surfaces (whole mouth, marginal, approximal, facial, and lingual) than the Sonicare Air Floss when used with a manual toothbrush.

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Introduction

Supragingival plaque has long been established as an etiological factor in the development of gingivitis.¹ The accumulation of plaque (or biofilm) at the gingival and approximal margins can lead to gingivitis and, subsequently, the bacterial species present in the plaque can move subgingivally and initiate a periodontal infection.² Mechanical removal of supragingival plaque remains the primary method to prevent and treat gingivitis. Regular removal of plaque can reduce the incidence or severity of gingivitis and also alter the composition of the subgingival microflora.³ This in turn helps prevent the proliferation of subgingival bacteria and advanced periodontal infections or recurrence of disease.⁴

The primary mechanical method to remove supragingival plaque is the toothbrush. A systematic review measured the plaque removal ability of manual toothbrushes after a single use and found an average of 43% plaque removal, with a range of 28–53%.⁵ Individuals tend to use the same pattern of brushing each time, missing the same areas of their teeth no matter how many times they repeat the procedure. The greatest accumulation of plaque on the teeth is on the distolingual and mesiolingual surfaces of the mandibular molars and premolars, followed by the distobuccal and mesiobuccal surfaces of the maxillary and mandibular molars.⁶

It is generally accepted that individuals do not practice an effective tooth brushing technique, resulting in inadequate plaque removal. Additionally, toothbrushes have their limitations and cannot access the proximal surfaces of the teeth. Interdental devices are designed to clean the interdental space and proximal surfaces of the teeth to supplement tooth brushing. Typically, flossing is the method of choice for these areas. However, the public's use of dental floss is minimal, thereby leaving plaque on the surfaces of the teeth. If given a choice, individuals will choose other interdental devices over dental floss.^{7,8} This study was designed to evaluate the effect of two power interdental devices paired with a manual toothbrush on supragingival plaque removal.

Materials and Methods

Subjects

Eighty-two healthy, non-smoking male and female adults between the ages of 25 and 65 (Table I) were recruited for this study. Enrolled subjects met the inclusion criteria of a minimum of ≥ 0.60 for pre-cleaning plaque based on the Rustogi Modified Navy Plaque Index (RMNPI) score.⁷ All subjects had at least 20 scoreable teeth not including third molars, and no hard or soft tissue lesions. Exclusion criteria included advanced periodontal disease, probing depth greater than five mm, systemic disease

Table I
Demographic Data

	Group I: WF (n = 41)	Group II: AF (n = 41)	p-value
Age (years)			0.649
Mean	45.7	44.8	
SD	9.79	9.05	
SEM	1.53	1.41	
Range	26–63	27–63	
Gender			0.602
Male	8 (19.5%)	11 (26.8%)	
Female	33 (80.5%)	30 (73.2%)	
Smoking	0 (100%)	0 (100%)	

SD = Standard Deviation, SEM = Standard Error of the Mean.

p-value for age from a t-test; p-value for gender from a Fisher's Exact test.

such as diabetes or autoimmune disease, medication use that can influence gingival health, pregnant at the time of the study, or use of antibiotics within six months of the study. Subjects with orthodontic appliances, implants, crowns, bridges, or other appliances were not included. The study protocol and forms were approved by the institutional review board (Institutional BRCL). Subjects completed a medical history and read and signed a consent form.

Study Devices

The Waterpik® Water Flosser (WF; Water Pik, Inc., Fort Collins, CO, USA) is a power-driven device that has a reservoir, pressure control, and delivers a pulsating stream of water that is directed at the gingival margin and approximal areas (Figure 1A). The reservoir holds enough water to clean the whole mouth from the facial and lingual surfaces. Subjects followed manufacturer's instructions, using a Classic Jet Tip directed at the gingival margin and following a pattern throughout the mouth, at a medium-high pressure setting, and the reservoir filled with 500 ml of lukewarm water.

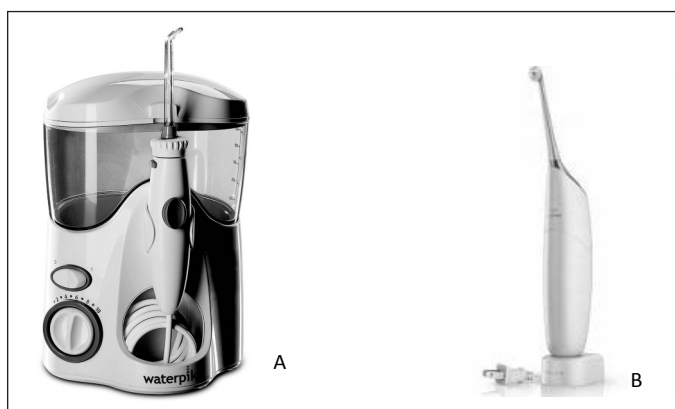


Figure 1. Products used in study. A. Water Flosser (Water Pik, Inc.). B. Air Floss (Philips Healthcare).

The Sonicare® Air Floss (AF; Philips Healthcare, Bothell, WA, USA) is a hand-held rechargeable device that utilizes air under pressure to deliver microdroplets of water and air to the interdental area (Figure 1B). The small reservoir holds two teaspoons of water. Subjects filled the reservoir to capacity with lukewarm water and followed manufacturer instructions, placing the guiding tip between the teeth from the facial aspect and activating

the device by pushing the activation button at the interdental space.

Study Design

This randomized, single-blind, single-use, two-group, parallel clinical trial evaluated the plaque removal efficacy of a manual toothbrush with either the WF or AF. Subjects were randomly assigned to one of two groups prior to pre-cleaning plaque scores. Group I received an American Dental Association standard manual toothbrush (Oral-B® Indicator 35, Procter & Gamble, Cincinnati, OH, USA) and a Waterpik Water Flosser model WP-100. Group II received the same manual toothbrush and a Sonicare Air Floss. Both groups used Crest® Cavity Protection Toothpaste, regular mint flavor (Procter & Gamble, Cincinnati, OH, USA). The study end point was the single-use change scores of the RMNPI for whole mouth, marginal, approximal, facial, and lingual areas.

Subjects abstained from brushing for 12–14 hours prior to their appointment. Oral soft and hard tissue assessments were done pre- and post-cleaning. Subjects rinsed with erythrosine (FD&C #3) disclosing solution (Germiphene Corporation, Brantford, ON, Canada) for one minute and then expectorated. One examiner, who was blinded to the products assigned and calibrated for intra-examiner reproducibility of the RMNPI, scored all subjects at both time points. The RMNPI divides the tooth into nine sections and emphasizes the marginal and approximal regions. Whole mouth scores include all nine sections (A–I), marginal scores follow the free gingival margin and include three areas (A–C), and approximal scores are based on the mesial and distal line angles up to the contact point (D, F; Figure 2). Subjects received their toothbrush and were instructed to use the brush with the Bass technique for two minutes and were timed. Subjects then used their assigned interdental device prior to brushing, as demonstrated using manufacturer's instructions.

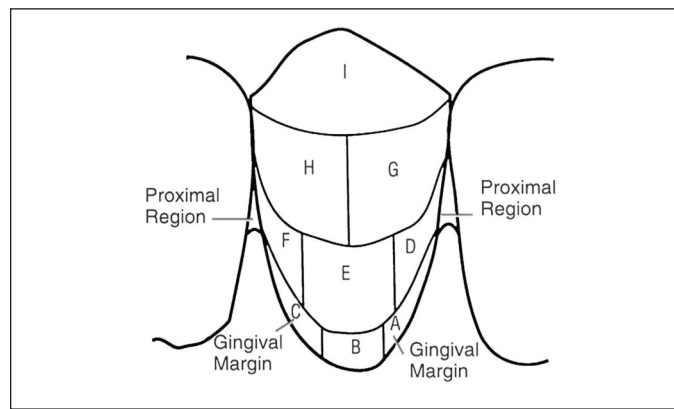


Figure 2. Rustogi Modification of Navy Plaque Index. Plaque is assessed for each tooth area (A through I) and is scored using the following scale: 0 = absent, and 1 = present. Facial and lingual surfaces of all gradient teeth are scored and a mean plaque index (MPI) is calculated for each subject at each examination. Subjects' scores were calculated for the whole mouth (areas A through I), along the gingival margin (areas A through C), and proximal (approximal) (areas D and F).

Data Analysis

Data were collected on a Plaque Examination Form for each subject. Case report forms were completed in their entirety,

reviewed for completeness and accuracy, and signed by the appropriate individual. Data from the Plaque Examination Form underwent key batch entry and verification. Data were tabulated according to clinical scoring appropriate for the RMNPI whole mouth, marginal, approximal, facial, and lingual regions. Data were summarized using descriptive statistics (mean, minimum, maximum, standard error, and standard deviation) by treatment group. The baseline pre- and post-plaque scores were evaluated separately for each treatment utilizing a paired t-test. Between-treatment comparisons were evaluated using a two-independent groups t-test. All statistical tests were conducted using a significance level of $\alpha = 0.05$.

Results

Whole Mouth

Pre-cleaning comparability of whole mouth plaque indicated no statistical differences between the groups. Both groups showed statistically significant changes from pre-cleaning to post-cleaning scores for whole mouth RMNPI; 74.9% for the WF group and 57.5% for the AF group ($p < 0.001$). The WF group was significantly better than the AF group for whole mouth plaque removal (Table II).

Marginal Region

Pre-cleaning comparability of marginal regions indicated no statistical differences between the groups. Both groups' post-cleaning scores were significantly better than their pre-cleaning scores for the marginal region. The WF group was significantly superior to the AF group; 58.6% vs. 36.7%, respectively ($p < 0.001$; Table II).

Approximal Region

Pre-cleaning comparability of approximal regions indicated no statistical differences between the groups. The WF and AF groups demonstrated significant improvements from pre-cleaning scores. The WF group was significantly superior to the AF

group for the approximal region, 92.1% for the WF and 77.4% for the AF ($p < 0.001$; Table II).

Facial and Lingual

Pre-cleaning comparability of facial and lingual plaque scores indicated no statistical differences between the groups. Both groups demonstrated a significant reduction for facial and lingual plaque scores ($p < 0.001$) from pre-cleaning to post-cleaning. The WF group was significantly superior to the AF group for the facial area (83.6% vs. 69.1%, $p < 0.001$) and lingual area (65.7% vs. 45.4%, $p < 0.001$; Table II).

Discussion

Daily tooth brushing remains the most common and practical way of maintaining low levels of supragingival plaque and good gingival health. In industrialized countries, 80–90% of the population use a toothbrush once or twice a day.^{10,11} The removal of supragingival plaque is important in preventing the initiation and proliferation of subgingival pathogenic bacteria and gingivitis.^{2,3} A minimum of twice-daily brushing is recommended to remove plaque, deliver fluoride, and provide a clean fresh feeling.^{4,12} Individuals tend to form patterns when brushing, and miss areas such as the approximal and marginal areas. The adjunctive use of an interdental cleaner is necessary to clean the interdental area and proximal surfaces of the teeth where tooth brushing cannot reach, and is the site where infection and gingivitis is likely to first occur.¹³ Dental floss is the most recommended interdental cleaning device, but new products and clinical studies have introduced other devices that are effective and thus increasingly recommended.

The purpose of this study was to evaluate the supragingival plaque removal efficacy of a manual toothbrush plus a power interdental cleaning device; a Water Flosser or an Air Flosser. The WF, also known as an oral irrigator or dental water jet, works through the direct application of a pulsating stream of water or other solution. The WF has been tested in more than 50 studies,

Table II
Pre-brushing RMNPI and Post-Brushing Plaque Reductions

		Pre-Brushing Mean (SD)	Post-Brushing Plaque Reduction Mean (SD)	Change Score Mean (SD)	% Change ¹ from Baseline	% Greater Plaque Removal Score
Whole mouth	WF	0.62 (0.019)	0.16 (0.069)	0.46 (0.065)	74.9%	30%*
	AF	0.62 (0.021)	0.26 (0.086)	0.36 (0.077)	57.5%	
Facial	WF	0.63 (0.039)	0.10 (0.070)	0.53 (0.074)	83.6%	21%*
	AF	0.63 (0.041)	0.20 (0.123)	0.44 (0.104)	69.1%	
Lingual	WF	0.60 (0.028)	0.21 (0.098)	0.40 (0.097)	65.7%	45%*
	AF	0.61 (0.027)	0.33 (0.099)	0.28 (0.090)	45.4%	
Marginal	WF	1.00 (0.000)	0.41 (0.159)	0.59 (0.159)	58.6%	60%*
	AF	1.00 (0.000)	0.63 (0.176)	0.37 (0.176)	36.7%	
Approximal	WF	1.00 (0.000)	0.08 (0.090)	0.92 (0.090)	92.1%	19%*
	AF	1.00 (0.000)	0.23 (0.141)	0.77 (0.141)	77.4%	

SD = Standard Deviation.

¹Change from pre-treatment $p < 0.001$.

*WF was significant more effective than AF ($p < 0.001$).

and has repeatedly demonstrated it is safe and provides significant reductions in gingival bleeding, gingivitis, plaque, subgingival pathogenic bacteria, pro-inflammatory mediators, and pocket depth.¹⁴⁻²⁹ It has been tested on individuals with orthodontic appliances, crowns, bridges, and implants showing superior benefits compared to traditional oral hygiene.^{17,21,26-28} Individuals in periodontal maintenance programs or living with diabetes have benefited from the addition of a WF with significant reductions in gingival bleeding and gingivitis.^{15,18,19,22,25} Most recently, a WF has shown superior results for the reduction of gingivitis, gingival bleeding, and plaque biofilm compared to tooth brushing and string flossing in three separate trials.^{16,28,29}

The AF is new to the market, and designed to deliver micro droplets of water directly to the interdental area via a hand-held rechargeable device. To date, there are no full studies published in peer-reviewed journals on the efficacy of the AF in reducing clinical parameters or how it performs in comparison to dental floss. Only “data on file” and one published abstract³⁰ are cited.

The present study compares the single use of a WF to the AF in removing supragingival plaque when combined with manual tooth brushing. Correct use of the WF, AF, and manual toothbrush was explained and demonstrated to the subjects. Subjects used either the WF or the AF prior to brushing for a timed two minutes. All products were found to be safe, and there were no adverse effects from the single cleaning with them. Subjects did not have difficulty using either product.

In all cases, the WF was superior to the AF for removing supragingival plaque biofilm, even in areas often missed by tooth brushing, *i.e.*, approximal, marginal, and lingual areas (Figure 3). These results for the WF support previous studies that show a better reduction in biofilm compared to regular oral hygiene, including string floss.

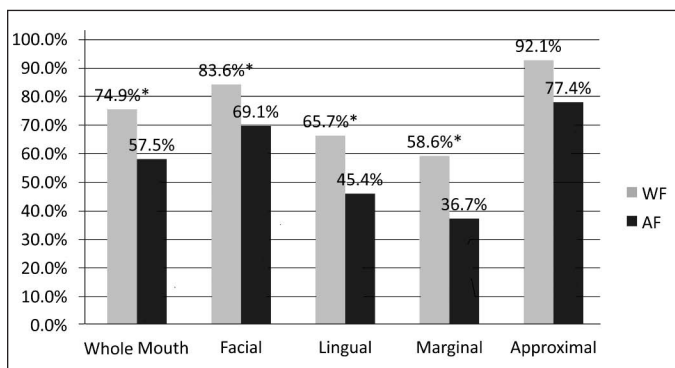


Figure 3. Mean % reduction in PI (RMNPI) at 4 weeks. *Significant difference in favor of the WF ($p < 0.001$).

In conclusion, the results from this study demonstrate that the Waterpik Water Flosser is more effective than the Sonicare Air Floss in the removal of supragingival plaque when combined with manual tooth brushing. Additional studies are recommended to evaluate the differences between the products on the reduction of gingivitis.

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