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Long-term effect of the combined use of powered toothbrush and triclosan dentifrice in periodontal maintenance patients

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Abstract

Aim: To test the hypothesis of a superior clinical and microbiological effect of the combined use of powered toothbrush+triclosan-containing dentifrice compared with manual toothbrush+regular fluoride-containing dentifrice in periodontal maintenance patients.

Material and Methods: A total of 128 periodontitis subjects involved in recall programmes were randomized to use either powered toothbrush with triclosan-dentifrice (test) or manual toothbrush and standard dentifrice (control). Supportive periodontal treatment was provided at baseline and every 6 months. Plaque, bleeding on probing (BoP), probing pocket depth (PPD) and relative attachment level (RAL) were scored at baseline, 1, 2 and 3 years. Subgingival plaque samples were taken and analysed for their content of 40 bacterial species at each examination interval. All analyses were performed by ''intention-to-treat'' protocol.

Results: Both groups showed significant reduction in BoP, PPD and in mean total counts of the 40 bacterial species between baseline and 3 years, while plaque score and RAL remained almost unchanged. No significant differences between the two prevention programmes were found for any of the clinical outcome variables or in mean counts of the various bacterial species.

Conclusions: The study failed to demonstrate superior clinical and microbiological effects of powered toothbrush+triclosan dentifrice compared with manual toothbrush+standard fluoride-dentifrice in periodontitis-susceptible patients on regular maintenance therapy.

Key words: clinical trial; longitudinal; periodontal maintenance; prevention; randomized controlled trial; toothbrushing; triclosan

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Regular supragingival plaque removal is of decisive importance for the prevention of recurrence of periodontal disease in maintenance patients (Suomi et al. 1971, Glavind 1977, Axelsson & Lindhe 1981). In patients treated for moderate to advanced periodontal disease and maintained in a careful recall programme including supportive periodontal therapy (SPT), Lindhe et al. (1982) in an 18-month-study demonstrated that tooth sites that remained plaque-free showed no further loss of clinical attachment while plaque-contaminated sites demonstrated a mean attachment loss of 0.6 mm. However, for some individuals the ability to maintain a high standard of oral hygiene is difficult (Wood et al. 1989, van der Weijden & Hioe 2005). Thus, besides the search for methods to increase the patient's motivation to remove dental plaque, research has been directed to improve the efficacy of the self-performed oral hygiene measures. The development of powered toothbrushes represents one such approach. Powered toothbrushes with a rotation oscillation action (ROA) reduce plaque and gingivitis significantly better than manual toothbrushes (see systematic review by Robinson et al. 2005). Moreover, studies

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that included only periodontitis-susceptible subjects that received SPT revealed that powered brushing alone was equally effective (Boyd et al. 1989) as, or even more effective (Yukna & Shaklee 1993), than oral hygiene programmes including manual brushing and the use of inter-dental cleaning devices. However, with regard to the beneficial effect of the use of ROA-powered toothbrushes in this category of patients the data in the literature are inconclusive. Haffajee et al. (2001a) and McCracken et al. (2004) found no or only marginal overall differences when ROA toothbrushing was compared with manual toothbrushing. In a subsample including subjects with deep pockets (at baseline), however, Haffajee et al. (2001a) observed that ROA powered toothbrushing had more benefit on clinical parameters compared with manual brushing.

A further approach to improve the efficacy of self-performed infection control includes the use of dentifrices with antimicrobials. Two recent systematic reviews on the effect of triclosan-containing dentifrices (Davies et al. 2004, Hioe & van der Weijden 2005) showed that a dentifrice containing triclosan/copolymer is more effective in reducing plaque and gingival inflammation than a conventional fluoride dentifrice. Rosling et al. (1997a), in a 3-year prospective study, investigated the use of a triclosan-containing dentifrice in periodontitis-susceptible subjects enrolled in a maintenance programme. It was demonstrated that the daily use of a triclosan/copolymer-containing dentifrice, comparised with the use of a regular dentifrice, reduced the frequency of deep periodontal pockets and the number of sites showing additional clinical attachment and bone loss.

The potential of the combined use of powered toothbrush and a triclosan-containing dentifrice to improve the effect of self-performed supragingival plaque removal was evaluated in a recent 3-year study by Bogren et al. (2007). The study, which involved subjects without signs of destructive periodontal disease, failed to document beneficial effects on clinical and microbiological parameters beyond that obtained with manual toothbrushing and a regular fluoride-containing dentifrice. Considering that patients treated for periodontitis in most cases show anatomical conditions around their teeth that are different from those of periodontally healthy subjects [e.g. open inter-dental areas, sites with increased probing pocket depth (PPD)], as well as the positive observations referred to above on the use of powered toothbrushes or triclosan dentifrice in SPT patients, one may speculate that there could be a benefit of combining the two preventive measures in periodontitis-susceptible patients. Thus, the aim of the current 3-year randomized controlled study was to test the hypothesis that the use of an ROA-powered toothbrush combined with a triclosan-containing dentifrice will result in superior clinical periodontal conditions and in superior beneficial changes in the subgingival microbiota in periodontal maintenance patients, compared with the use of manual toothbrushing with a regular dentifrice.

Material and Methods

Subject sample

This study was designed as a prospective, randomized, controlled and single-masked clinical trial. A total of 128 adult subjects treated for moderately advanced chronic periodontitis, and involved in recall programmes for SPT for at least 1 year, were enrolled. The recruitments were performed between January 2000 and February 2002 among patients at three centres; two Specialist Clinics of Periodontology in the cities of Skövde and Göteborg (Sweden) and the Clinical Center for Periodontal Research, The Forsyth Institute, Boston, MA, USA.

The subjects had to (i) be $\geqslant$20 years of age, (ii) have at least 15 natural teeth and (iii) have a minimum of four teeth with a PPD of $\geqslant$5 mm. Individuals with (i) medical conditions or using drugs that could be expected to influence the course of periodontal disease or treatment and (ii) need of antibiotic prophylaxis for routine dental procedures were excluded. Furthermore, subjects who had received periodontal or antibiotic therapy in the previous 3 months were not eligible.

All subjects were informed about the design of the study, as well as potential risks and benefits of participation. Approval of the study protocol by the Ethics Committee at Göteborg University and the Institutional Review Board at The Forsyth Institute was obtained, and all participants signed informed consent before the start of the study.

Preventive programmes

Following a screening examination, the subjects were stratified according to self-reported smoking status (current smoker or non-smoker) and randomly assigned (successive blocks of serial numbers in randomly permuted blocks of four) with the use of computer-generated tables to test or control groups. A person otherwise not involved in the study performed the randomized procedure. The demographic characteristics of the subject sample are presented in Table 1.

The subjects in the test group were instructed to use an ROA-powered toothbrush (Oral-B®, Gillette, Boston, MA, USA), in accordance with information provided in the manual from the manufacturer, and a triclosan/copolymer/fluoride-containing dentifrice (Total®, Colgate; Piscataway, NJ, USA). Participants assigned to the control group were instructed to brush their teeth using the modified Bass technique and a conventionally designed, multi-tufted soft manual toothbrush and to use a standard fluoride-containing dentifrice (Protection Caries®, Colgate). The toothbrushing programmes were to be carried out twice a day. For both groups the self-performed plaque removal programmes also included daily inter-dental cleaning with dental floss, toothpicks and/or inter-dental brushes.

At baseline and every 6 months during the 3-year study period SPT was provided by a dental hygienist and included mechanical debridement of sites with PPD $\geqslant$5 mm, polishing of the teeth with a rubber cup and a low abrasive paste as well as reinforcement in oral hygiene. New supplies of toothbrushes, inter-dental cleaning devices and dentifrice were provided at each recall visit. Information regarding adverse events, medical or dental treatment between the visits, and compliance with regard to the use of the cleaning devices was collected using a structured interview.

Table 1. Baseline demographic characteristics of the subject sample

	Test	Control
Number of subjects	65	63
Mean age (range)	60 (36–82)	58 (34–79)
Current smokers (*n*)	19	19
Females (*n*)	37	38
Ethnicity/race (*n*)		
Caucasian	62	56
Others	3	7

Clinical assessments

Clinical examinations were performed before the treatment at baseline and after 1, 2 and 3 years and included registration of number of teeth, plaque, bleeding on probing (BoP), PPD and level of the gingival margin (GM). The assessments were made at four sites per tooth (mesiobuccal, distobuccal, mesiolingual and distolingual); third molars were excluded. Plaque was scored positive (present) if detected when a probe was run along the gingival aspect of the tooth surface. BoP was scored positive if a site bled immediately after pocket probing or if a site bled at completion of the probing of a jaw quadrant. PPD and GM were measured twice at each visit and to the nearest millimetre using a manual UNC 15 probe (HuFriedy®, Chicago, IL, USA). GM was assessed as the distance between the soft tissue margin and the cemento-enamel junction (CEJ)/border of a restoration. A negative value of GM was given when the GM was located apical to the reference point on the tooth. All clinical measurements were recorded on data sheets and scanned into a computer. Relative attachment level (RAL) was calculated as PPD minus GM. The PPD and RAL values were averaged for the pair of recordings taken at each examination time interval.

Throughout the study the examiners had no access to previously recorded data or the group assignment of the subjects. Before the start of the study, the examiners were trained to levels of accuracy and reproducibility for the various clinical parameters to be used. Calibration sessions were also scheduled during the study period. For both inter- and intra-examiner reproducibility, the standard deviation for PPD and GM measurements had to reach a level of <0.6 mm (PPD) and <0.8 mm (GM), with an agreement within ± 2 mm of at least 99% (PPD) and 96% (GM) of sites examined.

Microbiological assessments

Subgingival plaque samples were taken from each tooth (excluding third molars) for a maximum of 28 teeth in each subject at baseline, 1, 2 and 3 years. After removal of supragingival plaque, subgingival biofilm samples were taken using individual sterile Gracey curettes from the mesial surface of each tooth and placed into separate Eppendorf tubes containing 0.15 ml Tris EDTA buffer (10 mM Tris-HCl, 1 mM EDTA, pH 7.6). 0.10 ml of 0.5 M NaOH was added immediately to each sample. All samples were processed at The Forsyth Institute. Each sample was individually evaluated for its content of 40 bacterial species using checkerboard DNA–DNA hybridization as previously described (Socransky et al. 1994, 2004). In brief, the samples were lysed and the DNA placed in lanes on a nylon membrane using a Minislot device (Immunetics, Cambridge, MA, USA). After fixation of the DNA to the membrane, the membrane was placed in a Miniblotter 45 (Immunetics), with the lanes of DNA at 90° to the lanes of the device. Digoxigenin-labelled whole genomic DNA probes to 40 bacterial species were hybridized in individual lanes of the Miniblotter. After hybridization, the membranes were washed at high stringency and the DNA probes detected using antibody to digoxigenin, conjugated with alkaline phosphatase and chemifluorescence detection. Signals were detected using AttoPhos substrate (Amersham Life Sciences, Arlington Heights, IL, USA) and were read using a Storm FluorImager (Molecular Dynamics, Sunnyvale, CA, USA), a computer-linked instrument that reads the intensity of the fluorescence signals resulting from the probe-target hybridization. Two lanes in each run contained standards at the concentration of 10^5 and 10^6 cells of each species. The sensitivity of the assay was adjusted to permit the detection of 10^4 cells of a given species by adjusting the concentration of each DNA probe. Signals were evaluated using the Storm FluorImager and converted to absolute counts by comparison with standards on the same membrane. Failure to detect a signal was recorded as zero.

Data analysis

All data analyses were performed on an ''intention-to-treat'' basis and with the subject as the statistical unit. Hence, all subjects who entered the study ($n = 128$) were included in the analyses at all time intervals. For subjects lost during the study period (dropouts), the last available recordings were carried forward to represent all subsequent time points of evaluation.

With a sample size of 60 subjects per group, detection of a reduction of at least 35% in the mean percentage of sites colonized by one or more of the ''red complex'' species (*Porphyromonas gingivalis*, *Treponema denticola* and *Tannerella forsythia*) in test relative to control subjects with an α error of 0.05 had an 80% power. For identifying a mean difference in PPD of 0.3 mm with 60 subjects per group, assuming a standard deviation of 0.5 and an α error of 0.05, a power of 95% was achieved.

BoP, PPD and RAL were considered primary clinical outcome variables and plaque score a descriptor. The difference in mean counts of the 40 bacterial species was regarded as a secondary outcome variable. Plaque and BoP were expressed as percentages positive sites. Mean values for PPD and RAL were calculated for each subject. For data description, mean values and 95% confidence intervals were subsequently calculated for the test ($n = 65$) and control ($n = 63$) groups. The unpaired *t*-test was used for statistical analysis of differences between the groups. Significant differences over time were evaluated using repeated measures of ANOVA and the Scheffe test for post hoc analysis. The microbiological data consisted of the mean counts of 40 bacterial species from up to 28 sites in each of 128 subjects at baseline, 1, 2 and 3 years. The counts for individual species at each sampled site were averaged within a subject and then across subjects in the test and control groups at each time point separately. Significance of differences over time in each group was determined using the Friedman test and between groups at each time point using the Mann–Whitney test. The data were adjusted for 40 comparisons (Socransky et al. 1991).

Results

One hundred and twenty-four of the 128 subjects who entered the study were maintained until the final 3-year examination (Fig. 1). Among the dropouts, one subject belonged to the test and three to the control group. One of the individuals was exited for medical reasons that were unrelated to participation in the study, one because of personal problems and for two subjects no reason was given for their discontinuation. Two of the subjects were lost during the first and two during the second year of the study.

None of the patients that completed the 3-year study reported (i) adverse events related to participation in the

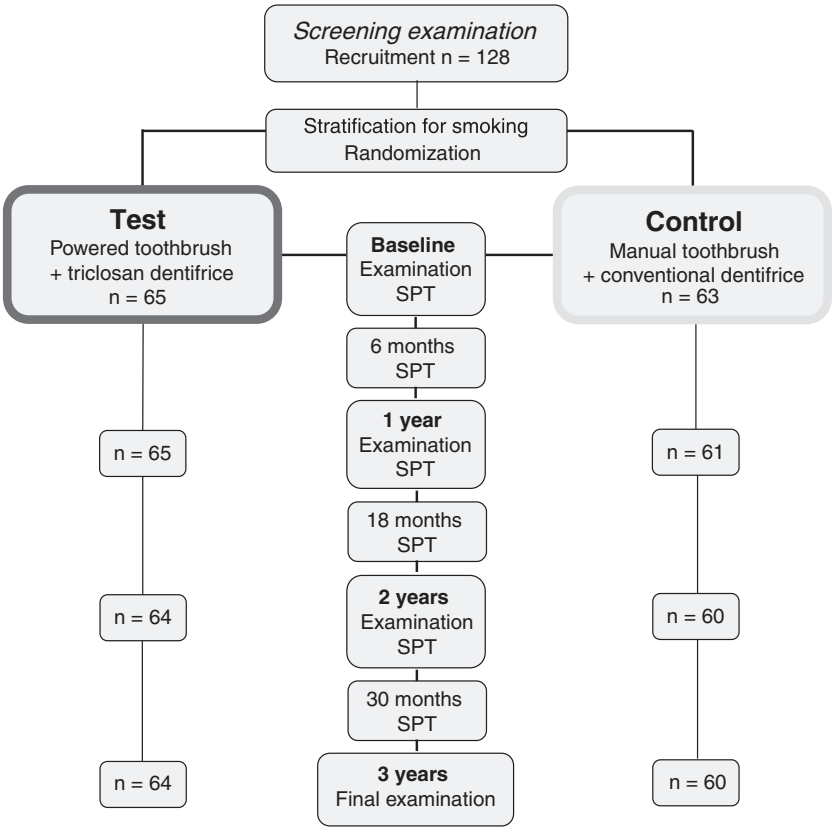

Fig. 1. Flow chart describing the outline of the study and the number of subjects examined at each time point over the 3 years in the test and control groups, respectively.

Table 2. Mean number of teeth for test and control groups at baseline, 1, 2 and 3 years

	Test ($n = 65$)	Control ($n = 63$)	Significance between groups
Baseline	24.7 (24.0–25.3)	23.6 (22.7–24.5)	NS
1 year	24.6 (23.9–25.2)	23.5 (22.5–24.4)	NS
2 years	24.3 (23.6–25.0)	23.3 (22.3–24.3)	NS
3 years	24.2 (23.5–24.9)	23.2 (22.2–24.2)	NS

Mean values (95% confidence interval).
NS, statistically non-significant ($p > 0.05$).

study, (ii) antibiotic drug therapy for a period exceeding 10 days between the annual examinations or (iii) antibiotic drug therapy within 3 months before the annual examinations. Furthermore, none of the subjects in the test or the control group reported a deviation in the compliance with the devices instructed for self-performed plaque removal.

Number of teeth

The mean number of teeth at the various examination intervals is reported in Table 2. The average number of teeth at baseline was 25 and 24 for the test and control group, respectively. During the 3-year study period the mean loss was 0.4 teeth for both groups. Seventy-four per cent of the subjects in both the test and the control group showed no tooth loss, while 22% had lost one to two teeth. The most severe loss observed among the subjects was five teeth in a subject of the test group.

Plaque scores

The plaque data at the various examination intervals for the two groups are given in Fig. 2. At the start of the trial the test and control groups demonstrated a mean plaque score of 42% and 50%, respectively. No statistically significant difference was found between the two groups at the various time points during the study, or over time within the groups.

BoP scores

The mean percent BoP values for the test and control groups are described in Table 3. At baseline both groups had a mean BoP value of 34%. A significant reduction in BoP score was observed for both the test and the control group at 3 years ($p < 0.01$); final BoP score 22% (test) and 24% (control). Seventy-eight per cent of the subjects in the test group and 71% in the control group exhibited a decrease in the BoP score between baseline and 3 years, whereas 20% and 27%, respectively, showed an increase. No statistically significant difference in the proportion of bleeding sites was observed between the two groups at any of the examination intervals.

PPD

The mean PPD values at the different examinations are presented in Table 4. The baseline mean PPD value was 3.3 mm for both the test and the control group. Compared with baseline, both groups showed a statistically significant reduction in mean PPD at the 3-year follow-up examination (0.3 mm; $p < 0.05$). Eighty-five per cent of the subjects in the test group and 89% in the control group exhibited a decrease in mean PPD, while 15% and 10%, respectively, demonstrated an increase ($p > 0.05$).

The mean percentage distribution of sites within various PPD categories (< 4, 4–5.5 and $\geqslant 6$ mm) at baseline and 3 years for the two groups is described in Table 5. The proportion of sites with PPD $\geqslant 4$ mm at baseline was 29% in the test and 27% in the control group with a non-significant reduction to 25% for both groups at 3 years.

A further analysis of the probing depth changes for sites with an initial PPD $\geqslant 4$ mm is presented in Table 6. At 3 years, 55% (test) to 57% (control) of these sites showed a PPD reduction of $\geqslant 1$ mm, while 7% (test) to 8% (control) showed a corresponding increase.

The total number of sites with baseline PPD $\geqslant 6$ mm was 288 in the test and 180 in the control group. At 3 years, 65% of these sites in the test group

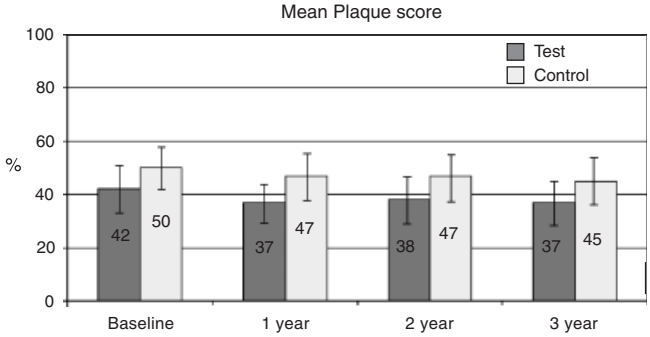

Fig. 2. The mean % of sites with visible plaque at baseline and after 1, 2 and 3 years for the two groups, respectively. The whiskers represent 95% confidence intervals. There were no significant differences between groups at any time point (unpaired *t*-test; $p > 0.05$).

Table 3. Mean BoP scores (%) for test and control groups at baseline, 1, 2 and 3 years

	Test ($n = 65$)	Control ($n = 63$)	Significance between groups
Baseline	34 (28.7–38.8)	34 (29.3–38.9)	NS
1 year	29 (25.2–33.6)	29 (25.4–33.1)	NS
2 years	23 (20.0–26.7)	27 (23.0–30.5)	NS
3 years	22 (18.5–24.9)	24 (20.8–26.4)	NS

Mean values (95% confidence interval).
NS, statistically non-significant ($p > 0.05$); BoP, bleeding on probing.

Table 4. Mean PPD (mm) for test and control groups at baseline, 1, 2 and 3 years

	Test ($n = 65$)	Control ($n = 63$)	Significance between groups
Baseline	3.3 (3.21–3.44)	3.3 (3.17–3.36)	NS
1 year	3.1 (3.02–3.26)	3.1 (2.98–3.19)	NS
2 years	3.1 (2.96–3.20)	3.0 (2.92–3.16)	NS
3 years	3.0 (2.91–3.14)	3.0 (2.89–3.10)	NS

Mean values (95% confidence interval).
NS, statistically non-significant ($p > 0.05$); PPD, probing pocket depth.

Table 5. Mean % of sites according to different PPD categories for test and control groups at baseline and 3 years

	Test ($n = 65$)	Control ($n = 63$)	Significance between groups
Baseline (mm)			
< 4	70 (66.6–74.0)	72 (68.8–75.4)	NS
4–5.5	25 (22.3–28.2)	24 (21.2–27.6)	NS
$\geqslant 6$	4 (3.1–5.8)	3 (2.3–3.8)	NS
3 years (mm)			
< 4	75 (70.8–79.0)	74 (70.3–78.3)	NS
4–5.5	22 (18.2–25.2)	23 (19.5–27.2)	NS
$\geqslant 6$	3 (2.1–4.6)	2 (1.6–3.0)	NS

Mean values (95% confidence interval).
NS, statistically non-significant ($p > 0.05$); PPD, probing pocket depth.

demonstrated a reduction of $\geqslant 1$ mm while 9% showed an increase of the same magnitude. In the control group the corresponding numbers were 67% and 10%, respectively.

There were no statistically significant differences with regard to PPD alterations between the test and control groups at the various examination intervals.

RAL

The mean RAL remained unchanged during the 3-year observation period in both the test and the control group (Table 7). The proportion of sites with baseline PPD $\geqslant 4$ mm that demonstrated a RAL change of $\geqslant 1$ mm at 3 years is described in Table 8. Forty-nine per cent and 53% of the sites in the test and control group, respectively, showed a reduction in RAL of $\geqslant 1$ mm while 13% (test) and 12% (control) showed a corresponding increase. No significant difference was observed between the two groups with regard to RAL change at any of the examination intervals.

A sub-analysis for each center with regard to the clinical data revealed no significant differences between the test and control groups for any of the outcome variables.

Microbiological assessments

A total of 12,233 subgingival samples were evaluated for the 128 subjects. Figure 3 presents the mean counts ($\times 10^5 \pm$ SEM) of the 40 test species in the test and control groups at baseline, 1, 2 and 3 years. While mean total DNA probe counts and mean counts of 20/40 and 27/40 species exhibited significant reductions over time in the control and test groups, respectively, there were no significant differences between groups at any time point.

Discussion

The results of the present 3-year study demonstrated, irrespective of the use of ROA-powered toothbrush+triclosan dentifrice or manual toothbrush+regular toothpaste (i) significant reductions in BoP and PPD values and (ii) significant, beneficial changes in amount and composition of the subgingival microbiota. However, no statistically significant differences were found between the two self-performed prevention programmes.

Systematic reviews have documented that (i) ROA-powered toothbrushes are more effective than manual toothbrushes (Sicilia et al. 2002, Deery et al. 2004, Robinson et al. 2005) and that (ii) triclosan/copolymer-containing dentifrices are superior to conventional fluoride dentifrices in removing plaque and reducing gingivitis (Davies et al. 2004, Hioe & van der Weijden 2005). In the interpretation of the findings in the present study of no difference between the two homecare programmes, several methodological issues have to be considered. The study focussed on patients

Table 6. Baseline PPD ⩾4 mm. Mean % of sites with an improved/worsened PPD of 1–1.5 and ⩾2 mm at 3 years

	Test ($n = 65$)	Control ($n = 63$)	Significance between groups
Improved PPD (mm)			
1–1.5	39 (35.2–41.9)	39 (35.4–41.8)	NS
⩾2	16 (12.8–18.9)	18 (15.0–21.5)	NS
Worsened PPD (mm)			
1–1.5	5 (3.5–6.7)	6 (3.4–8.1)	NS
⩾2	2 (0.8–2.2)	2 (0.6–2.8)	NS

Mean values (95% confidence interval).
NS, statistically non-significant ($p > 0.05$); PPD, probing pocket depth.

Table 7. Mean RAL change (mm) for test and control groups between baseline and 1, 2 and 3 years

	Test ($n = 65$)	Control ($n = 63$)	Significance between groups
Change			
Baseline – 1 years	0.0 (− 0.12–0.07)	0.0 (− 0.09–0.12)	NS
Baseline – 2 years	− 0.1 (− 0.20–0.06)	0.0 (− 0.17–0.10)	NS
Baseline – 3 years	0.0 (− 0.20–0.10)	0.0 (− 0.13–0.15)	NS

Mean values (95% confidence interval).
NS, statistically non-significant ($p > 0.05$); RAL, relative attachment level.

who had been involved in SPT programmes for at least 1 year following active treatment for moderate to advanced periodontal disease. Despite this, the baseline examination revealed a high proportion of deepened periodontal pockets at approximal tooth sites (on average 25% in the range 4–5.5 mm and about 5% ⩾6 mm), a mean plaque score of 42–50% and a BoP score of 34%. Hence, there was a clear potential for improvements of the periodontal conditions by the introduction of additional means for infection control. Also, in order to be able to properly test the hypothesis of an added benefit of the tested measures in a ''real-life'' situation, it was judged important to maintain the subjects on a secondary prevention protocol common for periodontitis-susceptible patients (Lang et al. 2003). For this reason, daily inter-dental cleaning with dental floss, toothpicks and/or inter-dental brushes were used in both groups. In addition, all subjects were given SPT every 6 months. The SPT included mechanical subgingival debridement of sites with PPD ⩾5 mm, polishing of the teeth as well as reinforcement in oral hygiene procedures. Moreover, the 3-year time frame of the study might more truly disclose the actual benefit of the home-care programme than more short-term frames. Because it was found that the control group only showed about 10% reduction in plaque score and 30% reduction in BoP score at 3 years, the current study design appears valid and able to detect potential, beneficial effects in the test group.

In a recent 3-year prospective randomized controlled study (Bogren et al. 2007) it was shown that the combined use of an ROA-powered toothbrush and a triclosan-copolymer dentifrice had no additional effect beyond that obtained with the use of a manual toothbrush and a regular dentifrice, on clinical or microbiological parameters, in adult subjects without signs of destructive periodontal disease. Haffajee et al. (2001a) and Cullinan et al. (2003a) suggested that the positive effects of powered toothbrushing or the use of triclosan dentifrice were most pronounced in patients with deepened periodontal pockets. Bogren et al. (2007) thus concluded ''it seems likely that the subjects . . . . had too few diseased sites to show additional benefit from the combined use of the ROA-powered toothbrush and the triclosan/copolymer-containing dentifrice.'' However, the current long-term study involving patients with a comparatively large proportion of diseased sites with PPD ⩾5 mm also failed to identify significant differences regarding the effects of the test and control home-care programmes.

The use of a triclosan-containing dentifrice in periodontal maintenance patients was investigated in a 3-year prospective study by Rosling et al. (1997a, b). The authors reported that the daily use of a triclosan/copolymer-containing dentifrice by periodontitis-susceptible subjects reduced, in comparison to the use of a regular toothpaste, the frequency of deep periodontal pockets and the number of sites exhibiting additional clinical attachment and bone loss. Furthermore, the improved periodontal conditions in the tricolsan group were associated with a statistically significant reduction in the total viable count in subgingival plaque samples and a reduced number of subjects positive for *P. gingivalis*. From a 5-year study of the unsupervised use of a triclosan/copolymer dentifrice in a large adult population sample, Cullinan et al. (2003a) reported a retardation of the progression of periodontal disease in subjects showing inter-proximal baseline probing depths of ⩾3.5 mm. In this study, however, no significant reduction of the prevalence of *P. gingivalis* was observed (Cullinan et al. (2003b). The positive findings reported in the above studies with regard to the use of a triclosan-containing dentifrice were not supported by the results of the current study. In contrast to the 3-year study on maintenance patients by Rosling et al. (1997a), our 3-year study revealed improved periodontal conditions for both the test and the control group with statistically significant reductions in BoP and PPD, but no change in the attachment levels. Furthermore, there were no differences between the groups with regard to the incidence of sites showing an increase in PPD or a further loss of clinical attachment. In fact, the proportion of approximal sites demonstrating an attachment loss of ⩾2 mm – 3% for both the test and the control group – was similar to that observed among the patients using the triclosan dentifrice in the study by Rosling et al. (1997a), 3.6%, while their control group showed a higher incidence (7%). Although it cannot be ruled out that the patients included in the study by Rosling et al. (1997a) may have shown higher susceptibility to disease progression than those included in the current sample, the most likely explanation for the differences in findings may be ascribed to the design of the trials. Thus, in the present study subgingival debridement of all sites with PPD ⩾5 mm was performed every 6 months as part of the SPT programme, while in the study by Rosling et al. (1997a, b) no subgingival treatment was provided during the maintenance period. The fact that the main difference in disease progression

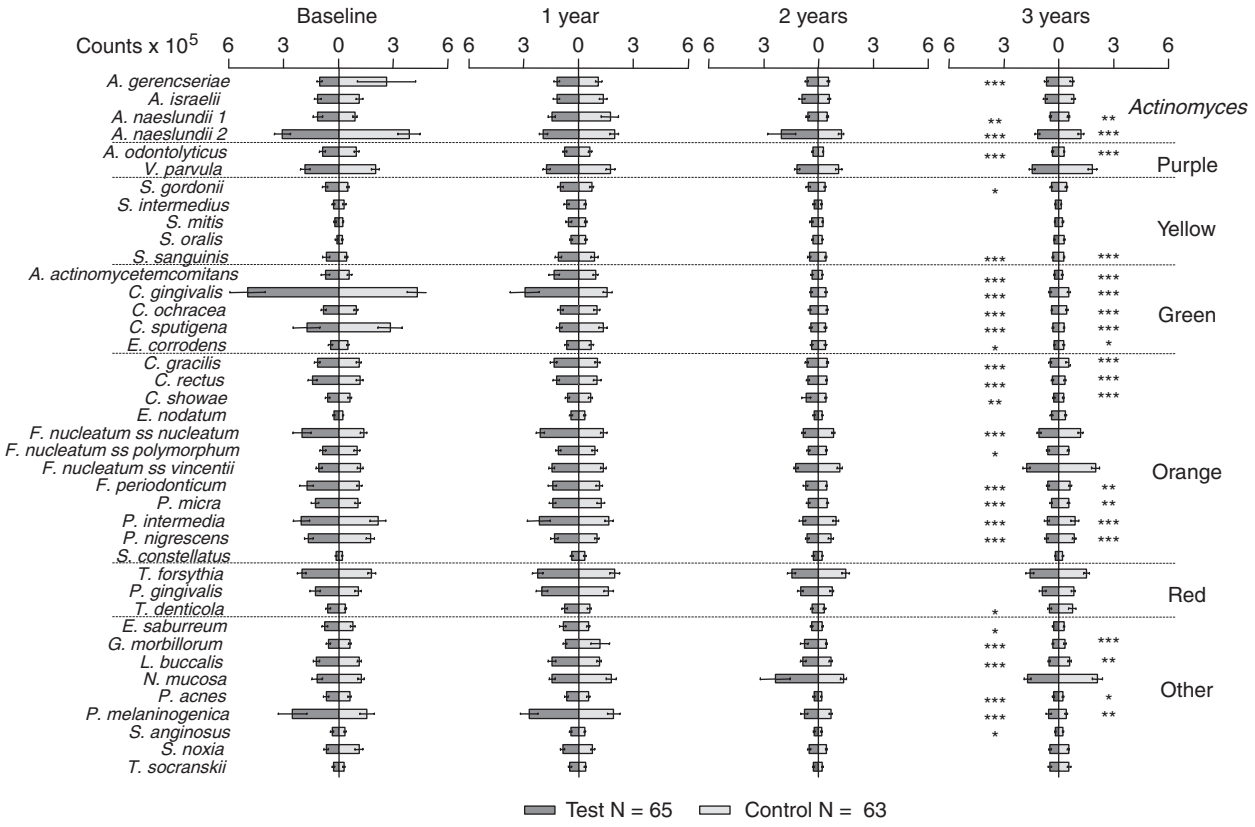

Fig. 3. Bilateral bar charts of the mean counts ($\times 10^5 \pm$ SEM) of the 40 test species in the test (red bars) and control (yellow bars) groups at baseline, 1, 2 and 3 years. Counts of each species were averaged within a subject and then across subjects in the test and control groups at each time point separately. Significance of differences between groups at each time point was determined using the Mann–Whitney test and adjusted for 40 comparisons (Socransky et al. 1991). There were no significant differences between groups at any time point. Significance over time was determined in each group using the Friedman test and adjusted for 40 comparisons. $^{*}p<0.05$; $^{**}p<0.01$; $^{***}p<0.001$. Asterisks adjacent to the control bars in the 3 years panel indicate species that changed significantly over time in the control group, while asterisks adjacent to the test bars in that panel represent species that changed significantly over time in the test group.

between the two studies is found in the control groups using a regular dentifrice, and not between the patient groups using the triclosan dentifrice, suggests that regularly performed subgingival debridement during maintenance is essential in limiting disease progression.

In the present study the microbiological assessments of the subgingival microbiota revealed significant reductions over time in (i) mean total DNA probe counts and (ii) mean counts of a majority of the 40 target species evaluated independent of the type of self-performed prevention programme, but no significant differences between the two prevention programmes. These findings are in large in accordance with data previously reported from controlled clinical trials in which the microbiological effects of the use of powered toothbrush or triclosan dentifrice in periodontal patients were examined (Murray et al. 1989, Rosling et al. 1997b, Haffajee et al. 2001b); however, in patients who did not receive subgingival debridement

Table 8. Mean % of sites with baseline PPD $\geqslant$4 mm showing an improved/worsened RAL of 1–1.5 and $\geqslant$2 mm at 3 years

	Test ($n = 65$)	Control ($n = 63$)	Significance between groups
Improved RAL (mm)			
1–1.5	30 (25.5–33.4)	35 (31.1–38.2)	NS
$\geqslant$2	19 (14.9–23.8)	18 (14.8–22.0)	NS
Worsened RAL (mm)			
1–1.5	10 (7.6–13.0)	9 (6.1–11.9)	NS
$\geqslant$2	3 (1.4–4.2)	3 (1.6–5.1)	NS

Mean values (95% confidence interval).
NS, statistically non-significant ($p>0.05$).

Rosling et al. (1997b) found a significantly greater reduction in the total viable counts in subgingival plaque samples with the use of a triclosan dentifrice.

Furthermore, in a 3-year study by Bogren et al. (2007) involving subjects without signs of destructive periodontal disease, the data failed to identify any beneficial, microbiological effects of powered toothbrushing and a triclosan-containing dentifrice beyond those seen with manual toothbrushing with a conventional fluoride dentifrice.

In conclusion, the findings from the present study failed to demonstrate superior clinical and microbiological effects of the use of a powered toothbrush plus a triclosan dentifrice compared with a manual toothbrush and a standard fluoride dentifrice in periodontitis-susceptible patients on regular maintenance therapy.

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Clinical Relevance

Scientific rationale for the study: Systematic reviews have shown that powered toothbrushes with a ROA are more effective in removing plaque and reducing gingivitis than manual toothbrushes and that triclosan/copolymer-containing dentifrices are superior to conventional fluoride dentifrices. No previous study has investigated the potential for beneficial effects of the combined use of the two plaque reduction modalities in periodontitis-susceptible individuals.

Principal findings: No significant clinical or microbiological differences were found between subjects that used powered toothbrush combined with triclosan dentifrice and those using manual toothbrush plus standard fluoride dentifrice in this 3-year study involving patients treated for periodontal disease and subjected to regular SPT.

Practical implications: Properly self-employed periodontal maintenance procedures, whether by the use of a powered brush and triclosan dentifrice or a manual toothbrush and regular toothpaste, provide clear clinical and microbiological benefits in periodontitis patients on SPT.