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A clinical comparison of an oscillating/rotating powered toothbrush and a manual toothbrush in patients with chronic periodontitis

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Abstract

Objectives:

Primary objective: To compare the relative efficacy of an oscillating/rotating powered toothbrush to that of a conventional manual toothbrush in a group of periodontal patients over a 16-month period with respect to plaque control.

Secondary objective: To compare differences in pocket depth (PD) and bleeding index (BI) between the two groups over a 16-month period.

Material and Methods: Forty patients were recruited to a 16-month, single-blind, two-group, randomised, parallel group clinical trial to compare the effects of manual and oscillating/rotating powered toothbrushes in a cohort of patients with chronic periodontitis. None of the patients had previous experience of using an oscillating/rotating brush and had a mean plaque index (PI) of >2.0 (modified Quigley and Hein index) at baseline. Patients were stratified by gender, age and smoking status then randomised to using a manual or an oscillating/rotating brush for the duration of the study. Conventional non-surgical periodontal therapy was undertaken within the first month after baseline. PI was the primary outcome measure with PDs and BI also recorded at baseline and months 3, 6, 10 and 16.

Results: Mean full-mouth (FM) scores at baseline for oscillating/rotating brushing and manual brushing groups were as foolows: PI, 3.4 and 3.5; BI, 1.7 and 1.5; and PD, 3.4 and 3.3. The mean reduction in FM scores from baseline to 16 months were: PI, 0.72 and 0.75; PD, 0.43 and 0.57; and BI, 0.74 and 0.83, respectively. Repeated measures ANOVA were used to compare differences between groups (adjusted for baseline levels) at months 3, 6, 10 and 16 and showed no statistically significant difference between groups for PI and PD ($p>0.05$). A difference of 0.2 BI units was detected in favour of the manual brushing group ($p=0.04$).

Conclusion: Over a 16-month period, there were no differences in PI reduction or PD reduction between patients who underwent non-surgical management of chronic periodontal disease and used either an oscillating/rotating powered toothbrush or a conventional manual toothbrush. A difference in gingival bleeding reduction was detected in favour of the patients allocated the manual brush.

Key words: oral hygiene; periodontal disease; powered toothbrushes

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Microbiological plaque is the main aetiological factor in the development of periodontal diseases. Regular and effective removal of plaque from all surfaces of the teeth, both above and below the gingival margin, is essential for the prevention of these diseases (Suomi et al. 1971, Nyman et al. 1975, Axelsson & Lindhe 1981). For this

purpose a range of manual and powered toothbrushes have been developed and marketed, although comparative studies between manual and powered brushes have led to somewhat equivocal results (Waerhaug 1981, Walsh & Glenwright 1984, Niemi 1987, Baab & Johnson 1989, Killoy et al. 1989, Walsh et al. 1989, Haffajee et al. 2001). Studies comparing contemporary designs of toothbrush have not found manual brushing to be superior to power-assisted brushing. One study, comparing the Braun Plak Control powered brush with a triple-headed manual brush, did show superiority for plaque removal by the manual brush (Zimmer et al. 1999). In 2003 a systematic review, including 29 clinical trials, was published that used data involving more than 2500 subjects for a meta-analysis comparing the effectiveness of powered with manual brushes upon oral health (Heanue et al. 2003). This review concluded that a small advantage in plaque removal and reduction in gingivitis was seen for the oscillating/rotating design of powered brush, although, the clinical significance of this was not known. The reviewers also proposed that trials of longer duration were required to provide evidence for any effect or benefit, from regularly using a powered brush, might have upon periodontitis and dental caries.

The successful outcome of periodontal therapy is dependent upon a number of factors and the greatest influence is the ability of the individual to maintain a high level of plaque removal. The role of powered brushes in support of periodontal therapy has been previously investigated. A number of studies have recorded clinical measures over 6 months or less comparing powered brushes alone or powered against manual brushes (Toto & Farchione 1961, Berman et al. 1962, Ash et al. 1964, Rainey & Ash 1964, Chasens & Marcus 1968, Howorko et al. 1993, Yukna & Shaklee 1993, O'Beirne et al. 1996, Bader & Williams 1997, Haffajee et al. 2001). The results are largely equivocal with respect to the relative efficacies of powered to manual and rival powered brushes.

Boyd et al. (1989) undertook a long-term study monitoring the effect of a rotational powered brush used for 12 months during periodontal maintenance. They concluded that the Rotadent® (RoDentec, Inc., Batesville, AK, USA) was as effective as conventional toothbrushing, flossing and toothpicks. Bader et al. (2000) reported tooth loss in two groups of patients who used either the Rotadent® or a manual brush. They suggested that the statistical difference in tooth loss over 10 years was as much as one tooth in favour of the Rotadent®, was clinically significant and impacted upon the long-term management of patients with periodontal disease. The Rotadent®, however, was introduced over 15 years ago and contemporary brushes have progressed substantially giving the potential for greater differences between powered and manual brushes.

No study has compared the relative effects of a powered brush to a manual brush in patients with chronic periodontitis. Most studies have recruited subjects who were in maintenance therapy after the treatment phase of periodontal disease has been completed. The aim of this study was to compare the effects of using either a manual or an oscillating/rotating design of brush on oral hygiene and clinical outcome measures in patients undergoing treatment for chronic periodontitis.

The primary outcome variable used to assess the efficacy of the brushes was plaque index (PI). Two secondary outcome variables, pocket depth (PD) and bleeding index (BI) are also recorded.

Materials and Methods

A two-group, parallel, single-blind, 16-month longitudinal study was designed. Patients who attended periodontal clinics were recruited to the study over a 5-month period. The study compared a typical oscillating/rotating powered toothbrush with a conventional manual brush.

Ethical approval was obtained from the Joint Ethics Committee of Newcastle and North Tyneside Health Authority prior to the initiation of the study.

Subjects

Forty patients who had attended periodontal diagnostic clinics at the Newcastle Dental Hospital were recruited into the study. The subjects were stratified and randomised to one of the two brushing groups. The following inclusion and exclusion criteria were applied:

Inclusion criteria

- Written informed voluntary consent;
- aged between 25–70 years;
- a minimum of 20 permanent teeth;
- periodontal disease identified clinically by a minimum of 10 sites with PDs of at least 5 mm confirmed radiographically by a cemento-enamel junction to alveolar bone distance of at least 2 mm;
- a mean full-mouth (FM) plaque score of at least 2.0.

Exclusion criteria

- Previous routine use of a powered toothbrush;
- mental handicap;
- physical handicap that restricted the free movement of the hands or fingers;
- receiving oral hygiene instructions from a dental professional within the previous 6 months;
- acute intraoral lesions.

Clinical trial

A numerically balanced stratified (for gender, age, smoking status) and randomised allocation of patients produced two groups ($n = 20$). Both groups of patients were supplied with the same readily available standardised fluoride-containing toothpaste (Colgate Total, Colgate Palmolive (UK) Ltd, Surrey, UK) and toothbrushes for the duration of the study. Toothbrush heads and manual toothbrushes were replaced every 2 months. Additional interdental aids (floss and interdental brushes) were supplied where appropriate and according to individual needs.

Sample size

Plaque

Estimating a reduction in PI over the study of 1.2 U (Van der Weijden et al. 1994), a 25% difference between groups (with SD = 0.3) would give a standardised difference of 1. Using Sample Size software (version 2), 19 subjects per group would give 85% power to detect the difference with $p = 0.05$.

PDs

Conventional scaling and root planing in patients with 5 mm periodontal pockets is likely to result in a 1 mm mean reduction in PD (Becker et al. 1988). Assuming a post-treatment difference of 0.5 mm between groups to be clinically significant, an intersubject standard deviation of 0.5 would give a standardised difference of 1. Again, 19 subjects per group would give 85% power to detect the difference at $p = 0.05$.

Therefore 20 patients were recruited to each group.

Stratification and randomisation

The stratification variables for the study were as follows: gender; age (<40, 40–50, >50 years); and smoking status (current smokers or non- and ex-smokers). Data for stratification were collected at the screening appointment to allow allocation to each group at baseline. A 75% weighted randomisation was used to balance the distribution of the stratification characteristics between the groups.

Clinical measures

All clinical measures (plaque, PD and bleeding) were undertaken at six sites per tooth: mesio-buccal; mid-buccal; disto-buccal; disto-lingual; mid-lingual; and mesio-lingual. The measures were recorded on electronic scanable data record sheets, which identified the subject, visit, brushing group and clinical measure. Mean, FM, interproximal (IP) and smooth surface (SS) scores for each subject were calculated at each time point.

Examination of the oral soft tissues

The gingival and palatal soft tissues were examined at each visit. Visible signs of soft tissue laceration, abrasion, ulceration or swelling of the gingival margin and surrounding soft tissues were noted. Lesions were categorised by location to four gingival sites (mesial, buccal, distal and lingual/palatal) per tooth and by size in millimeters.

PI

The modified Quigley and Hein index (PI) (McCracken et al. 2001) was used to record disclosed plaque at six points per tooth.

PD

PDs were recorded in millimeters for each tooth using a University of North Carolina (UNC) periodontal probe.

Bleeding

Bleeding from the periodontal pocket was recorded 20–30 s after probing the mesial and distal sulci with a periodontal probe using the papilla BI as described by Saxer & Muhlemann (1975).

Toothbrushes

Group 1: Oscillating/rotating powered brush
Group 2: Manual brush

Design

A total of 11 visits were planned for data recording. Two additional appointments were arranged to allow for the non-surgical treatment of periodontal disease. All clinical measures were undertaken by two calibrated research hygienists (F. S., L. H.) who remained blinded to the treatment groups.

Screening (3–4 weeks prior to baseline)

A single examiner (G. M.) screened all the patients to assess eligibility prior to recruitment into the study. A verbal explanation of the trial with written information was given and a consent form completed. Demographic data necessary for stratification and randomisation were collected. Radiographs were taken and used to confirm the inclusion criterion. Finally, after examination of the oral soft tissues, a PI was recorded. A supragingival scale was performed to allow unhindered access for clinical measurements at the next visit. An appointment for within 1 month of screening was made for baseline records.

Baseline (time = 0)

The oral soft tissues were examined. Clinical measures of PD, BI and PI were recorded. Each subject was allocated to a treatment group after stratification and randomisation. A separate clinical investigator (G. M.) to those recording clinical data allocated the toothbrush and provided oral hygiene instruction using the allocated toothbrush and any supplemental interdental aids.

Instrumentation visits (<1 month after baseline)

Conventional, non-surgical treatment of periodontal disease (using hand and ultra-sonic instruments) was completed under local anaesthesia: supragingival scaling; subgingival debridement (root planing); and application of fluoride varnish post-operatively. Treatment was undertaken by one of the two research hygienists (F. S., L. H.).

Months 1, 2, 4, 5 and 8 (follow-up)

- Examination of the oral soft tissues.
- Recording of PI.
- Reinforcement of oral hygiene instructions.

Months 3, 6, 10 and 16 (follow-up)

- Examination of the oral soft tissues.
- Recording of PD, BI and PI.
- Reinforcement of oral hygiene instructions.
- Removal of reformed calculus and re-instrumentation of pockets according to individual needs.

On completion of the month 16 visit the subjects were considered to have completed the clinical trial. They were re-assessed to evaluate their long-term periodontal maintenance needs. Where necessary further appointments were made for supragingival scaling, subgingival debridement and oral hygiene reinforcement.

Oral hygiene instructions

Standardised oral hygiene instructions were given to all subjects by the same clinical investigator at baseline and all subsequent visits. The advice was to brush for 2 min in the morning and 2 min in the evening. Supplemental interdental cleaning was recommended, with patients shown how to use floss and/or interdental brushes with advice to use them at least once a day. A 2 min brushing regimen was chosen as this fitted with the generally accepted advice by the profession and with timer supplied in the powered toothbrush.

The specific verbal instructions for each type of toothbrush was followed by a demonstration on a clinical model.

Calibration of examiners

Plaque

Calibration exercises recorded weighted κ statistics in excess of 0.6 for both intra- and interexaminer agreement for the PI.

PD

Both research hygienists undertook repeated measurements (at least 10 min apart) of PD in patients not involved with the study. The mean differences in millimeters were calculated for the repeated measurements: hygienist 1, mean difference 0.3 mm ($n = 24$ sites)

and hygienist 2, mean difference 0.4 mm ($n = 36$ sites).

Statistical analysis

Data were recorded on scanable record forms, checked for accuracy and completeness, read using Teleform® software and downloaded into a Minitab® work sheet (version 11). Initial sorting and calculation of subject means for plaque, PD and bleeding was completed. The mean values were identified by a subject number (1–40), visit number (1–10) and brushing group (1 or 2) and were then transferred to an SPSS® worksheet (version 11) for analysis.

Analysis was undertaken on an intention to treat basis. Differences between the groups at FM, IP and SS sites were compared using analysis of covariance with mixed effects models. Observations recorded at each visit were regarded as repeated measures nested within subjects and the variations between subjects were modelled as random effects. Differences between the two groups were fitted as fixed effects.

Longitudinal changes in the clinical parameters were analysed within a two-way analysis of variance framework (subjects by occasions). Differences between time points were investigated (once a significant variation between occasions had been identified) by examining parameter estimates and by fitting contrasts to test various hypotheses.

Results

A total of 32 subjects successfully completed the 16-month visit; therefore, eight subjects did not complete the trial. Three subjects withdrew after baseline due to time constraints. Two subjects did not return after baseline and gave no reason for their lack of attendance. One subject attended for visits up to month 6 and then failed to return giving no reason. Two subjects failed to return at month 16 despite requests to attend. Clinical outcomes were recorded for: 20 subjects per group at baseline; 16 (group 1) and 18 (group 2) at month 3; 17 (group 1) and 18 (group 2) at month 6; 17 per group at month 10; and 16 in each group at month 16.

Twenty-one soft tissue lesions (ulcers and abrasions) were recorded for 13 subjects over the course of the trial, five subjects in group 1 and eight in group 2. All lesions were less than 3 mm in diameter and patients were asked to return to the clinic if their lesion(s) had not resolved within a week. None of the subjects returned for re-examination of any of the soft tissue lesions that had been recorded.

The demographic and baseline clinical data for those subjects who completed the trial are summarised in Table 1. The groups show similarities with respect to age, gender distribution, number of smokers and the baseline clinical parameters. No statistical differences (two-sample *t*-tests) were detected between the groups for baseline measures of PI, PD or BI ($p > 0.05$).

PI

The mean PI scores for all visits are summarised in Fig. 1. The mean (SD)

Table 1. Demographics and baseline clinical measurements of subjects who attended visits up to month 16

	Brushing group	
	oscillating/rotating brush	manual brush
n	16	16
mean age (range)	49 (32–67)	49 (32–68)
male:female	9:7	9:7
smokers	4	6
Baseline data (full mouth)		
mean plaque index (SD)	3.4 (0.4)	3.6 (0.5)
mean probing depth (SD)	3.5 (0.9)	3.4 (0.7)
mean bleeding index (SD)	1.7 (0.5)	1.6 (0.7)

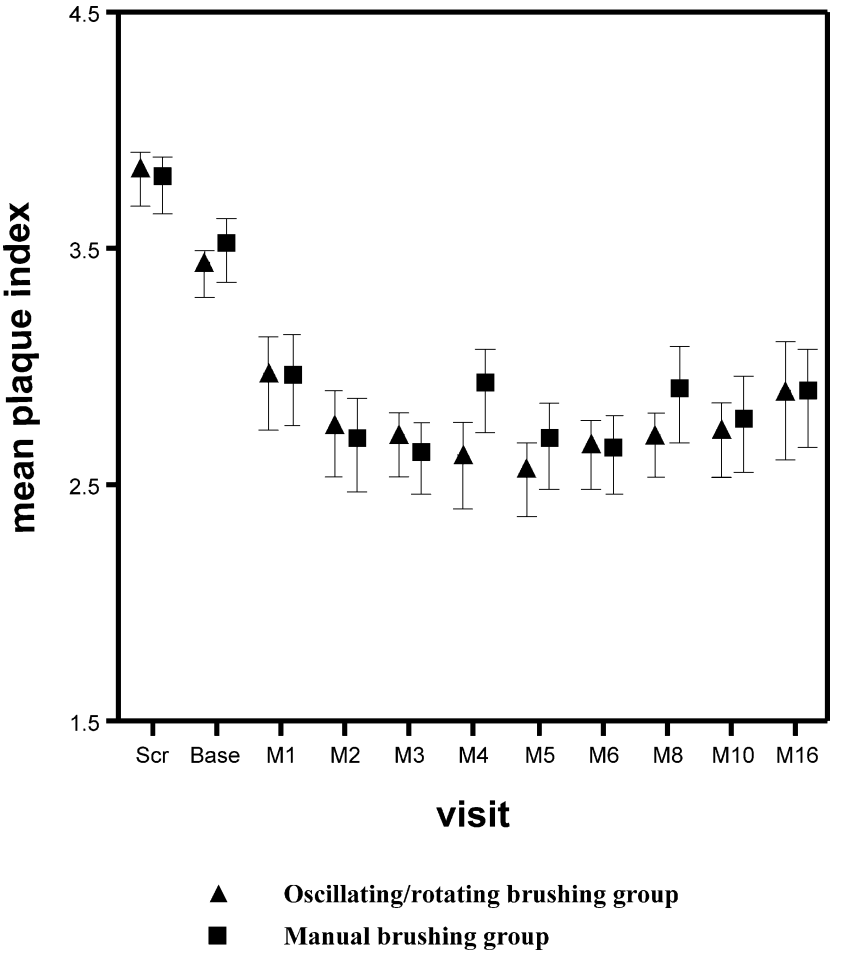

Fig. 1. Brushing group mean (SE) plaque index recorded at screening (Scr), baseline (Base) and months 1–16 (M1–16) for all surfaces (FM, full-mouth). ▲, oscillating/rotating brushing group; ■, manual brushing group.

FM plaque scores recorded at screening were as follows: oscillating/rotating brush, 3.8 (0.5) and manual brush, 3.8 (0.5). At baseline a reduction in plaque for both groups of approximately $\frac{1}{4}$ of a PI unit was seen. The level of plaque reduced further over the following 3 months by approximately $\frac{3}{4}$ of a PI unit, remaining relatively constant to month 6 (with the exception of group 2 at month 4). A small increase in mean PI was seen for both groups at month 16. A similar pattern of changes in PI was recorded for IP and SS sites.

PD

Mean PDs recorded at baseline, 3, 6, 10 and 16 months are shown in Fig. 2. The mean (SD) PDs for all surfaces (FM) were 3.4 (0.2) and 3.3 (0.2) for the oscillating/rotating brushing and manual brushing groups, respectively. The mean (SE) reduction in the FM mean PD after 3 months was: oscillating/rotating brush, 0.4 (0.1) and manual brush, 0.6 (0.1). This reduction in PD remained stable at 6 months followed by a small increase to month 16 in both groups. The pattern of reduction in pockets from baseline to 3 and 6 months was the same for IP and SSs.

BI

Fig. 3 shows the mean BI at baseline, 3, 6, 10 and 16 months. The mean FM BIs at baseline were as follows: oscillating/rotating brush, 1.7 (0.5) and manual brush, 1.5 (0.7). The FM mean (SE) bleeding scores were reduced at month 3 by PTB, 0.7 (0.1) and MTB, 0.8 (0.1). This reduction of BI remained to month 10 with a small increase seen for both groups after 16 months. Similar magnitudes of change were seen for IP and SSs.

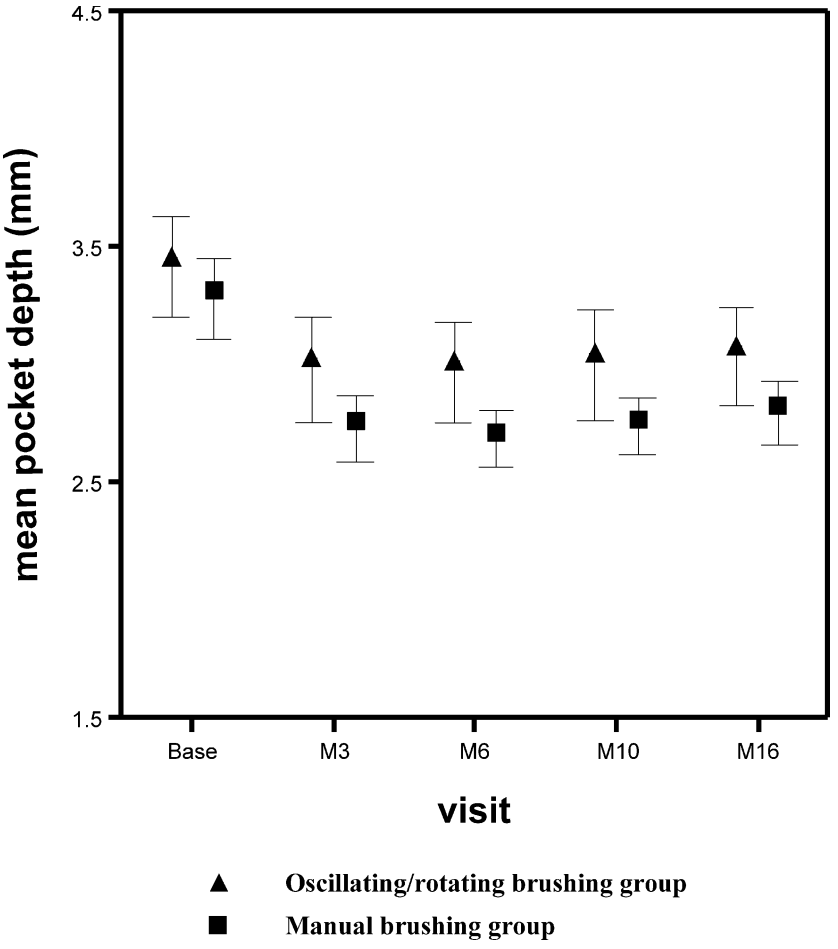

Fig. 2. Brushing group mean (SE) pocket depth recorded at baseline (Base) and months 3–16 (M3–16) for all surfaces (FM, full-mouth). ▲, oscillating/rotating brushing group; ■, manual brushing group.

Differences between the groups, for all clinical outcomes are summarised in Table 2. No statistically significant differences, at $p = 0.05$, were detected between the groups for PI or PDs over the entirety of the trial. ANCOVA detected a difference in BI between brushing groups in favour of the manual brush: FM surfaces 0.2 ($p = 0.04$) and IP surfaces 0.27 ($p = 0.03$).

The longitudinal changes in PI and PD were assessed using the pooled data from the two groups. The data for BI were assessed separately. The two-way ANOVA detected highly significant differences ($p < 0.001$) in all three clinical measures between visits and this warranted further investigation. The mean PIs recorded at screening and baseline were compared with those recorded at the remaining visits. The analysis showed that there was a highly significant reduction in plaque from these three visits when compared with the levels recorded at months 1–16 ($p < 0.001$). The reduction from screening and baseline in the mean PI and 95% CI over FM sites was: screening 1.0 (0.9–1.2) and baseline 0.7 (0.6–0.9). The mean PD and mean BI were significantly lower at months 3, 6, 10 and 16 compared with baseline ($p < 0.001$). The reduction from baseline in mean PD (95% CI) over FM sites was 0.5 (0.4–0.6). The reduction from baseline in mean BI (95% CI) for each group was: oscillating/rotating brush, 0.7 (0.46–0.88) and manual brush, 0.8 (0.62–0.97). The results for each clinical outcome and for each site are summarised in Table 3.

Discussion

This study primarily sought to evaluate the potential advantage of using an oscillating/rotating brush over a manual brush with respect to plaque removal in a cohort of patients receiving treatment for chronic periodontitis over a 16-month period. A course of non-surgical periodontal management was completed in the first month after baseline records were taken. The changes in two secondary variables, PDs and BI were also recorded.

No statistical difference was detected between the oscillating/rotating brushing and manual brushing groups in the primary clinical outcome measure of PI or the secondary outcome measure of PD at any time point during the study.

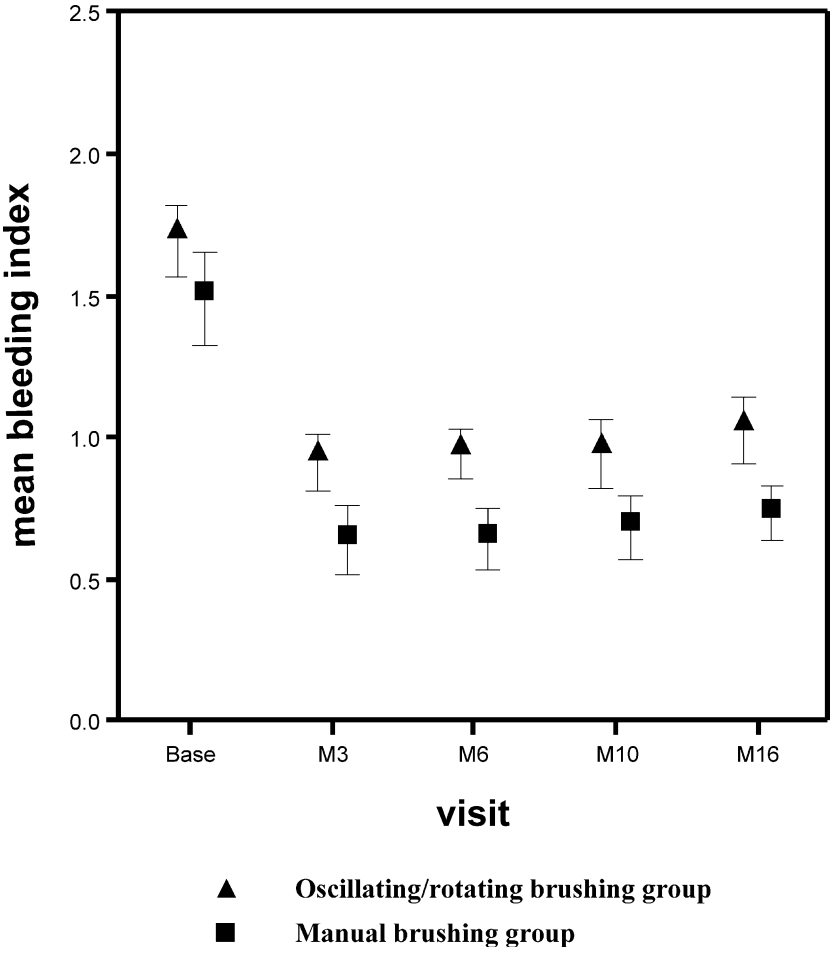

Fig. 3. Brushing group mean (SE) bleeding index recorded at baseline (Base) and months 3–16 (M3–16) for all surfaces (FM, full-mouth). ▲, oscillating/rotating brushing group; ■, manual brushing group.

Table 2. Differences in the group means (ANOVA) between the oscillating/rotating brush and the manual brush with 95% CIs at: full mouth (FM); interproximal (IP); and smooth surfaces (SS).

Surface	Difference between the means	*p*-Value	95% CI for the difference between the means
Plaque index			
FM	0.08	>0.05	−0.20 to 0.36
IP	0.03	>0.05	−0.28 to 0.34
SS	0.10	>0.05	−0.16 to 0.37
Pocket depths			
FM	−0.17	>0.05	−0.42 to 0.07
IP	−0.19	>0.05	−0.47 to 0.09
SS	−0.16	>0.05	−0.36 to 0.04
Bleeding index			
FM	−0.20	0.04	−0.39 to −0.01
IP	−0.27	0.03	−0.48 to −0.06
SS	−0.07	>0.05	−0.25 to 0.10

There were comparable reductions in both of these clinical markers for the two groups over the 16 months of the trial. A difference in favour of the manual brushing group ($p = 0.04$) of 0.2 BI units (FM sites) was detected for reduction in gingival bleeding; this increased to 0.3 BI units over IP sites ($p = 0.03$). Although not statistically significant, the oscillating/rotating brushing group showed a greater reduction in PI than the manual brushing group, with a difference between groups at FM sites of approximately 0.1 PI units. The manual brushing group showed a greater reduction ($p > 0.05$) in PD (difference in the mean at FM sites of 0.2 mm).

The longitudinal analysis (Table 3) confirmed statistically that the levels of plaque, pocketing and bleeding all reduced significantly over the initial stages of the trial (baseline to month 3) and remained at the reduced levels for the remaining months of the study (Figs 1–3). Plaque levels also reduced from screening to baseline indicating the possible presence of a Hawthorne effect arising as the patients receiving a supragingival scaling at screening. A greater reduction in PI was seen between baseline and month 1 followed by a smaller decrease in plaque levels from month 1 compared with all successive time points. PDs and BI were shown to reduce significantly from baseline to month 3 and then remained relatively constant for the duration of the study.

The mean data for plaque and pockets suggest that the two groups behaved the same for the duration of the trial. PI reduced from screening to baseline, baseline to month 1 and then remained stable to month 16. PPD reduced from baseline to month 3, and then remained relatively unchanged during the following 13 months. This conflicts with the BI data that suggest an advantage in using the manual brush. Data were compared to include BI measures up to month 10 and indicated no differences between groups, it would therefore seem that the advantage became statistically significant only during the final 6 months of the trial.

The results of this trial suggest that there was little clinical advantage present in favour of either the oscillating/rotating brush or a manual brush. There was an improvement in the oral health of all patients in both groups with respect to the levels of plaque, pocketing and bleeding. Haffajee et al. (2001) compared an oscillating/rotating brush (Braun Oral-B D15, Braun GmbH, Kronberg, Germany) to a standard manual brush (Crest Complete, Proctor and Gamble, Cincinatti, OH, USA) used by two groups of periodontal maintenance patients over a 6-month period (Haffajee et al. 2001). The results of this study showed that both brushes significantly reduced PD, PI and bleeding on probing. The powered brush also significantly reduced gingival indices and probing attachment levels, although no statistical differences between the

Table 3. Longitudinal change (Δ) in the pooled within-subject mean data for plaque index (PI) and pocket depths (PDs). Longitudinal change (Δ) in brushing group data shown for bleeding index (BI)

	Site	Reduction in the mean	*p*-Value	95% CI
Plaque index				
Δscreening	FM	1.0	<0.001	0.89–1.19
	IP	1.0	<0.001	0.88–1.24
	SS	1.0	<0.001	0.87–1.13
Δbaseline	FM	0.7	<0.001	0.55–0.86
	IP	0.8	<0.001	0.61–0.96
	SS	0.6	<0.001	0.42–0.69
Pocket depths				
Δbaseline	FM	0.5	<0.001	0.40–0.60
	IP	0.6	<0.001	0.49–0.72
	SS	0.3	<0.001	0.22–0.38
Bleeding index				
Δbaseline				
oscillating/rotating	FM	0.7	<0.001	0.58–0.90
	IP	0.8	<0.001	0.59–0.93
	SS	0.7	<0.001	0.56–0.85
manual	FM	0.8	<0.001	0.70–0.97
	IP	0.9	<0.001	0.79–1.08
	SS	0.6	<0.001	0.49–0.76

powered and the manual brushes were detected for any of the clinical measures, at any of the time points, during the study. The results from the current study support the findings of Haffajee's group in that there are only small differences in the reduction of clinical outcomes of periodontal disease between those patients using oscillating/rotating brushes and those using conventional manual brushes, when used over an extended period in patients with chronic periodontal disease.

The approximate $\frac{1}{2}$ mm reduction in PD recorded in this study fell within the lower end of the range reported in the periodontal literature. For example, Badersten et al. (1981) recorded mean pocket reductions of approximately 1.7 mm for moderately advanced periodontitis and 2 mm for severely advanced periodontitis (Badersten et al. 1984). A reduction of approximately 0.3 mm was recorded by Haffajee et al. (1997) and Cugini et al. (2000) at 9 and 12 months following scaling and root planing. This study aimed to undertake non-surgical management under conditions that would be similar to those undertaken in dental practice: scaling and root planing over two visits, with half the dentition treated at each visit. This was followed by further subgingival debridement and disruption of the subgingival biofilm at 3, 6, 10 and 16 months after baseline. By providing further episodes of non-surgical management throughout the study, it is possible that the secondary outcome measure of PD was influenced possibly masking any true difference between the groups as a result of the different toothbrushes being used.

Eight subjects dropped out of the study to leave a total of 32 subjects (16 per group) who completed the trial. This was three patients less per group than with the power calculations estimated to provide an 85% power to detect a clinically significant difference in plaque or pocketing between the two groups with $p = 0.05$. The effect of this smaller number of subjects in each group was to reduce the power of the study to 80%. It is possible, therefore, that the results might have arisen by chance alone (one in five). This level of statistical power still provides a good level of type II error protection. If these data were taken in isolation, a level of caution in any interpretation would be prudent.

Neither the results from this study nor those from Haffajee's group were included within the meta-analysis for the systematic review by Heanue et al. (2003). Both of these studies provide evidence for the equivalent effects of an oscillating/rotating brush or a manual brush upon subjects with periodontal disease. It is unfortunate that detailed information was not available within the published literature to allow strengthening of the evidence base used to validate these oral hygiene products. We also agree with the reviewers that there is a deficit in the quality and volume of data available on the long-term effects of using powered toothbrushes, and, there is a need for greater standardisation in clinical trial design, clinical measurement and reporting of data (Heanue et al. 2003).

Conclusions

- No significant clinical or statistical differences in PI or PDs was detected *between* the two groups using either an oscillating/rotating brush or a manual brush.
- A significant difference in gingival bleeding was detected in favour of the manual brush after 16 months.
- Significant statistical and clinical longitudinal reductions in PI, PD and BI from baseline records were detected for *both* groups.

Acknowledgments

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