# ORIGINAL ARTICLE

PA Versteeg MF Timmerman S Paraskevas GA van der Weijden Evaluation of several brushing motion combinations in relation to plaque-removing efficacy with Oral-B® CrossAction Power: a professional brushing study

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© 2006 The Authors. Journal compilation © 2006 Blackwell Munksgaard Abstract: Aim: The aim of this study was to evaluate the additional effect of a newly developed battery-operated brush Oral-B® CrossAction Power with a hybrid brush head design (CAPB). The brush combines an oscillating/rotating part, a PowerHead®, with a non-moving part with CrissCross® bristles. It was compared with a manual control toothbrush Butler® GUM 311 (CTB). Material and methods: Thirty subjects were requested not to brush their teeth 48 h prior to the examination, when plaque removal efficacy was assessed by scoring plaque before and after brushing. Plaque was assessed according to the Silness & Loë Index at six sites per tooth. Subjects were brushed by a dentist using one of the four randomly chosen procedures of brushing in each quadrant. The CAPB was used with three different modes of brushing each in different randomly chosen quadrants, with the manual toothbrush being used in the remaining quadrant as a control. Results: The baseline plaque levels ranged from 1.69 to 1.74 and the end levels ranged from 0.39 to 0.45. In terms of percentage, the results with the four procedures run from 75% to 79%. These differences between the battery brush and manual brush irrespective of the brushing mode used were not statistically significant. Conclusion: The results of this Professional Brushing Study show that the CrossAction Power® toothbrush was as effective as a regular manual toothbrush.

Key words: plaque; toothbrush

## Introduction

Plaque control is essential for the prevention of inflammatory periodontal diseases. Oral hygiene is the most common method of achieving it. Improvement in the efficacy of toothbrushing can lead to a reduction in the prevalence and severity of gingival inflammation.

The first electric toothbrushes mimicked the back-andforth motion commonly used with a manual toothbrush. When such devices were first introduced, there were many reports of their effectiveness. However, an early authoritative report reviewed such research and stated that manual and electric toothbrushes were equally effective in removing plaque (1). In reviewing many of the published reports over the past decades, one comes to the conclusion that newer types of rechargeable electric toothbrushes have become more effective in the removing supra-gingival plaque and controlling gingivitis. Controlled clinical trials over the past 10 years have also shown that rechargeable electric toothbrushes are superior to manual brushes. Modern design features are responsible for this (2). Powered toothbrushes were introduced to consumers in the 1960s and have continued to evolve in both design and performance. More recently, powered toothbrushes with round oscillating bristle heads have become a prominent aid for delivering oral hygiene in both the United States and Europe (3).

Originally, powered toothbrushes were charged by internal batteries, recharged by electric base units. However, as powered toothbrushes have recently been made simpler and less expensive, and use replaceable conventional batteries, an even larger number of powered toothbrushes with visual similarities are now available to the general public.

The present study was designed to evaluate the additional effect of a battery-operated brush with a hybrid brushhead design (Oral-B® CrossAction Power). The brush combines an oscillating/rotating part, a PowerHead®, with a non-moving part with CrissCross® bristles. The brush head, with its combination of fixed and moving bristles, was designed to have a more traditional sized brush head permitting patients to brush their teeth in an optimal manner as recommended by a dentist, while the motorized circular portion of the brush promotes more effective cleaning. It was compared with a manual control toothbrush (Butler® GUM 311). In addition, this study evaluated which type of brushing motion provides the best results with the CrossAction Power brush when compared with a manual toothbrush.

## Materials and methods

### Subjects

Thirty healthy panellists of both sexes were recruited from a student population at the Academic Center for Dentistry Amsterdam (ACTA). The volunteers were informed about the background of the study, its objectives and their involvement. Medical history forms were completed for each subject and reviewed by the investigator. Subjects were considered eligible for the study if they had at least five teeth in each quadrant. The exclusion criteria were: (i) presence of a removable prosthesis, (ii) oral lesions or periodontal problems, (iii) history of periodontal disease and (iv) presence of acute intra-oral lesions.

Subjects attended the clinic after having refrained from any oral hygiene practices for 48 h. A complete oral soft-tissue examination was performed. Plaque removal efficacy was assessed by scoring plaque before and after brushing. Plaque was evaluated at six sites per tooth on all teeth. One and the same examiner performed all clinical measurements (PAV). The plaque was assessed by the Silness & Loë Plaque Index (4), except on the third molars and central incisors.

#### Toothbrushes

In the study, two brushes (Oral-B Laboratories, Boston, MA, USA) were used (Fig. 1): (i) Oral-B® CrossAction Power (CAPB) (Oral-B Laboratories, Boston, MA, USA), a batteryoperated brush which combines a clinically proven oscillating/ rotating part, a PowerHead® (Oral-B Laboratories), with a nonmoving part with CrissCross® bristles (Oral-B Laboratories) similar to a manual toothbrush with cross-placed hairs – this makes the brush a hybrid of a power and a manual toothbrush (which effectively surrounds teeth to loosen and whisk away plaque from surfaces and hard-to-reach back teeth) and (ii) a manual control toothbrush Butler® GUM 311 (CTB) (Sunstar Butler, Chicago, IL, USA). This is a soft, multi-tufted toothbrush with a brushhead measuring 23 mm in length and 7 mm in width. The bristle tufts are all of the same length and positioned perpendicular to the handle, in three rows.

### Toothbrushing

The CAPB was used with three different modes of brushing each in different randomly chosen quadrants, with the manual



Fig. 1. Butler GUM 311 (left) and Oral-B® CrossAction Power (right).

toothbrush being used in the remaining quadrant as a control. Professional brushing was performed by the same dentist for all subjects. The CAPB was used with a short brushing stroke at moderate speed (120 strokes min<sup>-1</sup>) and high speed (416 strokes min<sup>-1</sup>) with the oscillating/rotating part of the brush turned on. As a control, the brush was also used with a short brushing stroke at high speed (416 strokes min<sup>-1</sup>) with the oscillating/rotating part turned off. As a second control, one quadrant was brushed with the CTB with short brushing strokes at high speed (416 strokes min<sup>-1</sup>).

The length of each stroke at moderate speed was approximately  $1-1\frac{1}{2}$  tooth, and the length of the stroke at high speed was approximately 1 tooth.

The CAPB was held horizontally, lightly angled (10–20°) towards the gingival margin, except on the lingual side of the cuspid, lateral and central incisor, where it was held vertically. The CTB was held with a 45° angulation towards the gingival margin and also held vertically on the lingual side of the cuspid, lateral and central incisor (modified Bass method).

The total brushing time was 2 min (30 s per quadrant, 15 s for the buccal side and 15 s for the lingual side). A timer was used to keep track of brushing time and a metronome for the rhythm of the brushing strokes.

Brushing took place in an area away from the examiner to guarantee the blindness of the study.

## Analysis

In all individuals, the mean plaque index was calculated for each quadrant. The remaining plaque after brushing was regarded as the main outcome variable. Post-brushing plaque scores were analysed using a repeated-measure analysis with baseline plaque scores as a covariant.

The proportion of plaque removal was calculated by expressing differences between pre-brushing and post-brushing scores in terms of percentage of the pre-brushing plaque scores. Two-sided values of P < 0.05 were accepted as statistically significant.

## Results

Of the 32 subjects initially selected for the study, 30 proved to have accumulated a sufficient amount of plaque to be suitable for the study. Two subjects presented with almost no plaque after 48 h of non-brushing and were therefore not considered for the study.

The mean results are presented in Table 1. The mean baseline levels ranged from 1.69 to 1.74 for the quadrant that was assigned to each brush; the end levels ranged from 0.39 to 0.45.

The percentage reduction with the four procedures ranged from 75% to 79%. Irrespective of the brushing mode used, the differences between the battery brush and manual brush proved not to be statistically significant.

## Discussion and conclusion

The process of maintaining good oral hygiene is helped greatly by the use of an efficient modern toothbrush, be it manual or powered. To some extent, powered brushes have overcome the limitations of the manual dexterity and skill of the user. From a review of the literature it is clear that, while there are different powered toothbrushes available now, particularly the low-cost battery-operated brushes are not supported by published clinical data. With the exception of the Colgate Actibrush® (Colgate Palmolive, New York, NY, USA) and Crest Spinbrush Pro® (Proctor & Gamble, Cincinnati, OH, USA),

<i>n</i> = 30	CrossAction Power – moderate speed brushing stroke (120 min <sup>-1</sup> )	CrossAction Power – high speed brushing stroke (416 min <sup>-1</sup> )	CrossAction Power shut off – high speed brushing stroke (416 min <sup>-1</sup> )	Manual brush (Butler®GUM) – high speed brushing stroke (416 min <sup>-1</sup> )	<i>P</i> -value (Friedman test)
All sites					
Pre-brushing	1.69 (0.36)	1.74 (0.32)	1.72 (0.39)	1.70 (0.40)	0.3533
Post-brushing	0.45 (0.34)	0.39 (0.32)	0.44 (0.36)	0.40 (0.31)	
Difference	1.24 (0.31)	1.35 (0.29)	1.27 (0.33)	1.30 (0.31)	0.2223
% reduction	75% (17)	79% (16)	76% (17)	78% (15)	

#### Table 1. Mean results of plaque scores pre-brushing and post-brushing

Plaque reduction in terms of percentage. Standard deviation values in parenthesis.

there are little or no clinical data to suggest that they are better than a manual toothbrush (5, 6).

The present study was designed to evaluate the plaqueremoving effect of a battery powered test brush with a hybrid brush head design (CAPB). This test brush was compared with a flat-trimmed manual toothbrush (CTB). The results of this study show that the CAPB was as effective as the CTB. The present study also tried to investigate whether, a specific technique with the hybrid combination of power brush head and manual brush head is required to maximize efficiency. The high and low brushing motion speeds did not appear to attribute to differences in efficacy.

These results are in line with those of a study by Dörfer *et al.* (5). They compared Dr. Johns Spin Brush Classic® (Dr. Johns Products Ltd., Bedford Heights, OH, USA) with a manual toothbrush. The Spin Brush also has a hybrid brush head with an oscillating/rotating part and a conventional part consisting of unpowered, flat-trimmed bristles. From their results it appeared that the manual toothbrush was significantly more effective than the Spin Brush. This reduced efficacy may be related to the oscillating/rotating action of which it is known that the frequency and the angle of oscillation both influence plaque removal (7, 8). It is however clear from the combined results that the hybrid brush head action is not optimal with regard to maximizing plaque removal and thus the advantages of an oscillating/rotating brush head action have not been realized (9).

In the present study, the manual toothbrush was used according to the Bass method. Clinical reports have demonstrated the effectiveness of the Bass method (10) and several studies have compared the Bass method with other toothbrushing techniques. Gibbs and Wade (11) compared the effectiveness in plaque removal of the Bass method and the Roll technique, showing that the Bass method was superior in cleaning the tooth tissue adjacent to the gingival tissue of the lingual and facial aspects, the gingival margins and the sulcus. This may explain in part why the manual toothbrush was as effective as it was, removing 78% of the plaque within 2 min.

The present study design was based on the so-called shortterm plaque model, the rationale of which has been discussed in a previous paper (12). This model was designed in an attempt to control as many variables as possible, including duration of toothbrushing, manual dexterity, motivation, the frequency of brushing and the 'novelty effect' (12). Subjects are requested not to brush for 48 h. The level of plaque is then assessed before and after brushing. In a split-mouth design, brushing can either be done by a professional or by the panellists themselves. Other research groups have now successfully used the same model to test different brushes (13, 14). In the present study, professional brushing was performed by the same dentist who was responsible for the professional brushing in a short-term study performed in 1993 (12). The mean plaque removal in the present and former study was 78%. Both studies used the same manual toothbrush, the Butler® GUM 311. This outcome shows that with this model it is possible to provide reproducible results.

This Professional Study shows that after a single use no statistically significant differences in plaque scores between four brushing procedures was present. Both the battery-powered brush and the manual toothbrush yielded significant reductions in plaque.

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