A laboratory comparison of the efficacy of two brush heads.

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Abstract

A new brush head (EB17) with soft co-extruded bristles has been developed for a new generation of power toothbrushes. The efficacy of this new brush head was compared with an established brush head (EB15) in combination with two driving systems: The Braun Oral-B Ultra Plaque Remover (D9) and the Braun Oral-B 3D Plaque Remover (3D). This laboratory study used a robot system, previously shown to be highly reproducible and predictive of clinical outcome. In each experiment, the toothbrush handle and two brush heads were tested 6 times in a cross-over design. Each typodont was brushed for 1 minute at an average brushing force of 1.95 N. Mean values for percentage removal of plaque substitute were calculated for buccal, lingual, occlusal, gingival margin and interproximal sites, plus all sites combined (buccal/lingual and occlusal). In the first experiment using the D9 driving system, the new EB17 removed consistently more plaque substitute than the EB15 at all investigated surfaces. Differences between the two brush heads were, however, not statistically significant. A similar result was obtained in the second experiment with the 3D driving system. In both experiments, the greatest difference between the two brush heads was observed at interproximal sites. With the D9, the EB17 was 4.6% more efficient, whilst with the 3D, the difference was 3.0%. It is concluded that when used with either the established D9 or the 3D handles, the new EB17 brush head is numerically more efficient than the EB15 brush head. The greatest advantage was seen at interproximal surfaces.

Introduction

Excluding user factors, the ability of an electric toothbrush to remove plaque is a combination of the brush head action and the brush head design, both of which can have a significant effect on efficiency. As a consequence, manufacturers are constantly trying to improve the overall efficacy of power brushes, by modifying the brush head action or developing improved brush head designs. Significantly increased plaque removal has been achieved with the Braun Oral-B range of power toothbrushes by increasing the oscillating/rotating frequency (D9 versus D7) and by adding a pulsating action (3D versus D9). In an attempt to further increase efficacy, a new novel brush head with co-extruded bifilaments has been developed (EB17), which offers advantages in terms of tooth surface contact and interproximal penetration.

As an initial way of assessing efficacy prior to clinical evaluation, a robot brushing system has been developed that simulates normal clinical toothbrush use[1]. A comparison of results obtained with this robot system with clinical studies suggests that the robot represents a reliable laboratory system for predicting clinical outcome[2]. Using this robot system, the new brush head EB17 was compared with the established EB15, when used in conjunction with the D9 and 3D driving systems.

Objective

To evaluate the efficacy with respect to removal of plaque substitute, of two brush heads, the established EB15 and the new EB17, when used with the Braun Oral-B D9 and 3D driving systems.

Materials and Methods

The efficacy of two toothbrush heads was evaluated using a third-generation robot brushing system[1]. Artificial teeth on upper and lower typodonts were sandblasted, and coated with a plaque substitute prepared from a mixture of commercially available water soluble paints. Using the robot system (Figure 1), each typodont was brushed in a controlled manner for 1 minute.

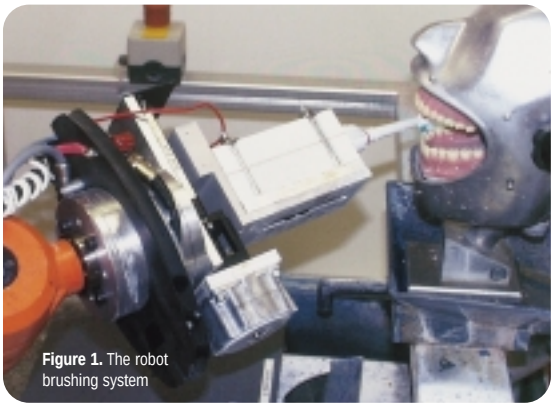


Figure 1. The robot brushing system

Each toothbrush and brush head combination was tested 6 times in a cross-over design with respect to the typodonts, at an average force of 1.95 N. Brushing force is controlled by means of a sensor (Kistler AG, Switzerland) which continually measures force and momentum-of-force every millisecond during brushing. The brush head position is adjusted every 3 milliseconds such that a consistent brushing force is maintained with a reproducibility of ± 0.2%. In this study, brush heads were used wet, with no dentifrice.

The toothbrush/brush head combinations compared in the study were the Braun Oral-B Ultra Plaque Remover (D9) and the Braun Oral-B 3D Plaque Remover tested with an EB15 and an EB17 brush head (Figures 2 & 3). The experiments with respect to brush head action (D9 and 3D) were performed, subsequently, at different times. Hence, this study does not allow an absolute comparison of efficacy of the different toothbrush driving systems.

The D9 has an oscillating/rotating action (frequency 63 Hz, free angle of oscillation 56°), whilst the 3D has an oscillating/rotating brush head action (frequency 63 Hz, free angle of oscillation 56°) combined with a pulsating action in the direction of the oscillation axis of the brush head at a frequency of 170 Hz (total amplitude with no load, 0.15mm).

Figure 2 and 3. The Braun Oral-B Plaque Remover (left) and 3D (right) and (insert) brush heads EB 15 (left) and EB 17 (right).

The EB15 is a small circular brush head with soft end-rounded bristles. The longer tufts are designed to enhance interproximal penetration[3]. The EB17 brush head is similar in size and configuration to the EB15, however, the EB17 brush head differs in that the blue crimped filaments in the inner field are replaced by co-extruded bifilaments. These novel bifilaments bend

slightly when wet, which reduces their axial stiffness, making the bristles softer. [4] As a result, tooth surface contact is enhanced, leading to greater interproximal penetration and overall polishing of the tooth surface.

Following brushing, plaque substitute remaining on the typodonts was measured by means of a computerised analysing system, the Vision system. This plaque analysing system automatically assesses levels of plaque substitute remaining after brushing on buccal, lingual, palatal and occlusal surfaces, plus interproximal and gingival margin tooth surfaces. Efficacy was expressed as the percentage of plaque substitute removed (mean ± the standard deviation).

Table 1. D9 driving system: Percentage removal of plaque substitute: mean (SD)

	Mean % removal of plaque substitute				Increased efficacy of D9/EB17 over D9/EB15 (%)
	D9/EB15		D9/EB17		
All surfaces†	81.8	(3.4)	82.3	(2.4)	0.5
Buccal	88.1	(3.2)	88.3	(2.8)	0.2
Lingual°	79.9	(2.7)	80.4	(1.5)	0.5
Buccal/lingual°	84.0	(2.8)	84.3	(2.1)	0.3
Occlusal	74.5	(5.5)	76.0	(4.9)	1.5
Gingival margin	55.3	(4.3)	58.5	(3.8)	3.2
Approximal	42.4	(4.8)	47.0	(4.6)	4.6

† Buccal/lingual° + occlusal
° Lingual and palatal, respectively

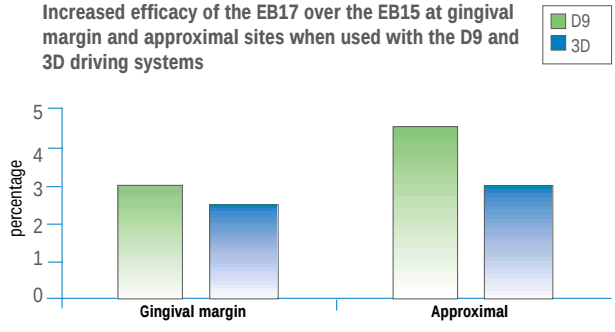
Table 2. 3D driving system: Percentage removal of plaque substitute: mean (SD)

	Mean % removal of plaque substitute				Increased efficacy of 3D/EB17 over 3D/EB15 (%)
	3D/EB15		3D/EB17		
All surfaces†	83.5	(2.7)	84.2	(1.2)	0.7
Buccal	87.6	(1.4)	88.7	(1.6)	1.1
Lingual°	80.3	(3.3)	82.4	(1.1)	2.1
Buccal/lingual°	84.0	(2.0)	85.6	(1.2)	1.6
Occlusal	81.8	(5.7)	79.9	(2.3)	-1.9
Gingival margin	50.7	(5.4)	53.2	(3.2)	2.5
Approximal	37.7	(5.2)	40.7	(2.6)	3.0

† Buccal/lingual° + occlusal
° Lingual and palatal, respectively

Figure 4.

Increased efficacy of the EB17 over the EB15 at gingival margin and approximal sites when used with the D9 and 3D driving systems



Results

A comparison of the new EB17 brush head with the established EB15 brush head revealed a consistent numerical advantage in favour of the EB17 at all sites investigated, except on occlusal sites with the 3D driving system.

As shown in Table 1, when tested with the D9 driving system, for all surfaces (weighted average buccal/lingual + occlusal) the EB15 removed 81.8 ± 3.4% plaque substitute compared with 82.3 ± 2.4% for the new EB17 brush head. Analysis of results for individual surfaces revealed that both brush heads were most effective at buccal/lingual and occlusal surfaces. The greatest difference between the two brush heads was found to be at gingival margin and approximal sites, which are known to be the most difficult areas of the dentition to clean effectively. At the gingival margin, the EB17 was 3.2% more effective than the EB15, whilst at approximal sites the EB17 was 4.6% more effective. Although there was a consistent numerical advantage in favour of the EB17, the differences were not statistically significant.

Similar results were found when the two brush heads were tested with the 3D driving system, as shown in Table 2. In this experiment, for all surfaces (weighted average buccal/lingual + occlusal) the EB15 removed 83.5 ± 2.7% plaque substitute compared with 84.2 ± 1.2% for the new EB17 brush head. As with the D9 driving system, the greatest differences between the established EB15 and the new EB17 brush head occurred at gingival margin and approximal surfaces where the EB17 was 2.5% and 3.0% more effective, respectively. Differences between the two brushes were, however, not statistically significant.

Figure 4 shows the differences in favour of the EB17 over the EB15 at gingival margin and approximal sites when used with the D9 and 3D driving systems.

Conclusions

- Using a laboratory robot brushing system, a new brush head (EB17) has been shown to be highly effective at removing plaque substitute, when used either with an oscillaing/rotating driving system (D9) or a combined oscillating/rotating-pulsating driving system (3D).
- Apart from occlusal surfaces the differences in favour of the EB17 were found when tested with both driving systems, but the differences did not achieve statistical significance.
- The greatest advantage in favour of the EB17 was observed at gingival margin and approximal surfaces, where efficient plaque removal is difficult to achieve.
- The EB17 may offer advantages in terms of plaque removal when used with either the D9 or the 3D driving systems, but this remains to be confirmed by clinical studies.

References

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2. Ernst C.–P. et al. Clinical plaque removing efficacy of a new power toothbrush. *Am J Dent* 1998; 11: S13-S16
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