

Comparative Plaque Removal Efficacy of a New Children's Powered Toothbrush and a Manual Toothbrush

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Abstract

- **Objective:** The purpose of this study was to determine the plaque removal effectiveness of a new children's powered toothbrush and compare it to that of a manual brush.
- **Methods:** This examiner-blind, randomized study used a cross-over design. One-hundred and five qualifying male and female subjects (52 ages 8-12 and 53 ages 13-17) were randomly assigned either the powered brush (Spinbrush® GLOBRUSH) or a manual toothbrush (Oral-B® Indicator 30 Compact Soft Toothbrush) and instructed to brush at home with a standard fluoride toothpaste twice daily for two minutes during a one-week familiarization period. At the end of this period, the subjects returned to the study site after refraining from oral hygiene for twenty-four hours and from eating and drinking for four hours. Plaque was scored using the Rustogi Modification of the Navy Plaque Index, subjects brushed under supervision with their assigned toothbrush for two minutes, and plaque was rescored. They were then given the alternate toothbrush and the familiarization routine and evaluation process were repeated.
- **Results:** Within-group analysis showed that both toothbrushes produced statistically significant reductions from the pre-brushing baseline in whole mouth and regional plaque scores ($p < 0.0001$), with respective whole mouth reductions of 73.3% and 61.8% for the powered brush and the manual brush. Between-group analyses showed that the powered brush produced a statistically significantly greater plaque reduction than the manual brush, both whole mouth (12.8%, $p < 0.0001$) and at all subset sites, including difficult-to-reach areas such as the posterior lingual gingival region (74.9% greater plaque reduction, $p < 0.0001$).
- **Conclusion:** The Spinbrush GLOBRUSH was significantly more effective in reducing plaque than the manual toothbrush when evaluated using this single-use clinical model.

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Introduction

Since a high level of plaque control is essential for the maintenance of oral health, it is important that good tooth brushing habits be established at a young age. Younger children, in particular, may have difficulties with motivation and dexterity.¹ In order to obtain better compliance with a daily oral hygiene routine, powered and manual toothbrushes have been developed specifically to appeal to children, with appropriately sized brush heads and features to introduce a "fun" aspect to tooth brushing. Studies comparing powered to manual brush use by children have shown that, while both types of brushes produce significant plaque reductions, the powered brushes are generally significantly more effective in reducing whole mouth plaque as well as plaque at specific subsets of sites.¹⁻⁴ Studies have also indicated that powered brushes are often favored by children because these brushes engage their interest and are more fun to use.^{5,6}

Recently, a new children's powered toothbrush was introduced that is designed to maintain the child's interest and aid in proper brushing (Figure 1). Unlike most other children's powered brushes, this new brush uses a vibratory motion of the bristles to remove plaque. In addition, the toothbrush has a timer feature in which through light emitting diodes in the base, the handle changes color from red to green every thirty seconds to indicate that the child should move to a different quadrant; the brush is

turned off after two minutes. The purpose of this study was to determine the plaque removal effectiveness of this new children's powered toothbrush and compare it to that of a children's manual brush.

Materials and Methods

Study Design

This was a randomized, examiner-blind, cross-over clinical trial to investigate the plaque reduction efficacy of a children's powered toothbrush and compare it to that of a manual toothbrush with a single use. The study protocol was reviewed and approved by BioSci Research Institutional Review Board; the informed consent of parents or legal guardians and the assent of the subjects themselves were obtained before subjects were entered into the study.

Qualifying subjects were randomly assigned either the powered toothbrush (Spinbrush® GLOBRUSH, Arm & Hammer Co, Inc., Princeton, NJ, USA) or a manual toothbrush (Oral-B® Indicator 30 Compact Soft Toothbrush, Procter & Gamble Co., Cincinnati, OH, USA) based on a computer-generated random code. They were also provided with a standard fluoride toothpaste (Crest® Cavity Protection Regular Toothpaste, Procter & Gamble Co., Cincinnati, OH, USA), a timer, and a diary in which to record the time of each tooth brushing and any comments about their brushing experience.



Figure 1. Photograph of the children's toothbrush to illustrate its appearance and distinctive features.

Subjects were instructed on the proper use of their respective toothbrushes and performed their first brushing at the study site under supervision. They were then instructed to brush at home for two minutes twice daily for one week to allow them to become familiarized with using the assigned brush. They were also instructed to refrain from using any other oral hygiene products during this time. Following this period, the subjects returned to the study site having refrained from all oral hygiene procedures for the previous 24 hours and from eating and drinking for four hours. They received an oral soft and hard tissue examination and a baseline plaque scoring after rinsing with a disclosing solution (pre-brushing plaque index). The subjects were given a new toothbrush of the type they had been using during the previous week and brushed with a standard amount of the fluoride toothpaste for two minutes under supervision in a room without mirrors and out of view of the dental examiner. After brushing, the subjects rinsed once again with the disclosing solution and plaque was re-scored (post-brushing plaque index). The subjects were then given the alternate toothbrush and the entire one-week familiarization period and plaque assessments were repeated.

Study Population

One-hundred and five qualifying male and female children and adolescents between the ages of 8 and 17 (52 ages 8–12 and 53 ages 13–17) were recruited and enrolled into the study. Subjects were required to be in good general health, regularly use either a manual or a powered toothbrush, have at least eighteen natural teeth, and have a mean Modified Navy Plaque Index (MNPI) ≥ 0.60 . Subjects were excluded from the study if they had evidence of neglected dental health and need of prompt professional attention, an amount of extrinsic stain and/or calculus deposits that would interfere with a plaque assessment, evidence of major oral hard or soft tissue lesions at baseline, a history of a significant adverse event, allergy, or irritation that was due to oral hygiene products, fixed or removable orthodontic appliances, or a serious medical condition or transmittable disease.

Clinical Assessments

All the clinical assessments were made by a single, experienced dental examiner. The examiner was blinded to the randomized toothbrush assignments. Separate case report forms were used at each examination period for recording the clinical data.

Plaque Index. Pre- and post-brushing plaque was scored using the MNPI.⁷ Subjects swished with 5 ml of disclosing solution for 15 seconds, expectorated, and then rinsed with 10 ml of water for 10 seconds and expectorated. The MNPI is scored by dividing each of the facial and lingual tooth surfaces into nine predefined areas, and recording plaque as present or absent in each of these. In addition to scoring whole mouth plaque, the predefined areas allow for assessment of gingival, interproximal, mid-facial (or lingual), and incisal regions of each tooth surface. The mean plaque index for each subject was calculated by dividing the total number of areas with plaque by the total number of areas scored. Separate mean plaque indices were calculated for the whole tooth and separately for subsets of sites consisting of marginal and interproximal areas.

Oral Soft and Hard Tissues. The buccal, labial, and sublingual mucosae, lips, attached gingiva, mucogingival regions, tongue, hard and soft palates, oropharynx, and cervical regions of all teeth were examined at screening and at each of the two test sessions with particular emphasis on color, texture, soft tissue abrasion, or ulcerations. Any changes in the course of the study were recorded and an assessment made by the examiner as to whether or not they could be attributable to the toothbrush used.

Statistical Analyses

The study outcome variable was the difference between the subjects' pre- and post-brushing mean MNPI scores. The statistical plan included the calculation of whole mouth index scores as well as scores for predetermined subsets (proximal, facial, lingual, gingival sites). Within-group comparisons were performed by pre- and post-brushing mean indices using paired t-tests. Between-group comparisons were performed using an analysis of covariance (ANCOVA) model suitable for a crossover study design. The ANCOVA model included the fixed effects treatment and period, the random effect subject, and the pre-brushing score covariable. All comparisons were based on two-sided tests with a level of significance of $\alpha = 0.05$.

Results

One-hundred and five subjects were randomized into this study, of whom one-hundred and five satisfied all the protocol requirements and constituted the evaluable subject population. Three subjects not completing the study were exited for reasons unrelated to the products tested. Results of the oral mucosal examinations indicated that there were no clinically significant findings or product-related adverse events during the course of the study.

Table I
Comparison of Within-treatment Pre- and Post-brushing Mean Whole Mouth MNPI Scores

Group	Pre-brush Plaque Score (SD) ¹	Post-brush Plaque Score (SD) ¹	% Reduction	p-value ²
Power Brush	0.619 (0.055)	0.165 (0.094)	73.3%	< 0.0001
Manual Brush	0.642 (0.045)	0.245 (0.119)	61.8%	< 0.0001

¹Unadjusted mean MNPI (standard deviation) score

²p-value derived from paired t-test

Within-group whole mouth plaque reduction results are presented in Table I. Both toothbrushes produced statistically significant whole mouth plaque reductions from baseline ($p < 0.0001$), with 73.3% and 61.8% reductions for the powered brush and manual brush, respectively, and also produced statistically significant plaque reductions ($p < 0.0001$) at each of the twelve subsets of sites listed in Table II.

Between-group plaque reduction results are presented in Table II. Compared to the manual toothbrush, with a single brushing the powered brush produced a statistically significantly greater 12.8% whole mouth plaque reduction ($p < 0.0001$), as well as statistically

significantly greater plaque reductions at each of the twelve subsets of sites examined, with the highest percent difference (74.9%) in the posterior lingual gingival region.

Discussion

This study has shown that the children's powered toothbrush and manual toothbrush both produced statistically significant supragingival plaque reductions from baseline. However, when the efficacy of the powered brush is compared to that of the manual brush, whether for the mouth as a whole or for each of the pre-specified subsets of sites, the powered brush in all cases produced statistically significantly greater plaque reductions than did the manual brush. This was especially notable in sites that patients often have difficulty in brushing effectively, such as the posterior lingual gingival region where the powered brush produced a 74.9% greater plaque reduction than the manual brush. These results are consistent with those of previously reported studies.^{1,4}

Since both brushes were tested for a timed two-minute period, the greater effectiveness could be attributed to the novel mechanism and design of the powered brush, as well as the changing colors that provide an element of interest and excitement to brushing while serving the practical purpose of interacting with the user to properly apportion brushing duration throughout the mouth. These results indicate that the powered toothbrush tested in this study could be highly useful in helping to establish children's good oral hygiene habits at an early age and be a valuable addition to a preventive oral care regimen.

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Table II
Comparison of Between-treatment MNPI Reductions¹

Sites	Powered Brush Reduction	Manual Brush Reduction	Difference	95% CI	p-value ²	% Difference ³
Whole Mouth	0.451	0.400	0.051	(0.030, 0.072)	< 0.0001	12.8%
Interproximal	0.878	0.767	0.111	(0.074, 0.148)	< 0.0001	14.5%
Gingival	0.572	0.430	0.142	(0.107, 0.177)	< 0.0001	33.0%
Facial	0.493	0.460	0.033	(0.009, 0.056)	0.0072	7.1%
Lingual	0.413	0.335	0.078	(0.053, 0.103)	< 0.0001	23.2%
Lingual Interproximal	0.894	0.744	0.150	(0.100, 0.200)	< 0.0001	20.2%
Lingual Gingival	0.535	0.348	0.187	(0.145, 0.230)	< 0.0001	53.9%
Posterior Interproximal	0.897	0.775	0.122	(0.082, 0.161)	< 0.0001	15.7%
Posterior Facial Interproximal	0.870	0.776	0.094	(0.046, 0.141)	0.0002	12.1%
Posterior Lingual Interproximal	0.924	0.775	0.149	(0.098, 0.201)	< 0.0001	19.3%
Posterior Gingival	0.558	0.378	0.180	(0.143, 0.217)	< 0.0001	47.6%
Posterior Facial Gingival	0.603	0.461	0.142	(0.096, 0.188)	< 0.0001	30.8%
Posterior Lingual Gingival	0.513	0.294	0.220	(0.177, 0.263)	< 0.0001	74.9%

¹ Calculations based on baseline-adjusted ANCOVA

² p-value from post-ANCOVA t-test

³ Calculated as [(Powered brush reduction – manual brush reduction)/manual brush reduction]

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