

Clinical Article

Comparing Efficacy of Plaque Removal Using Professionally Applied Manual and Power Toothbrushes in 4- to 7-year-old Children

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Abstract: Purpose: The purpose of this study was to evaluate in 4- to 7-year-olds the efficacy of plaque removal of 2 toothbrushes: (1) the Philips Sonicare for Kids (SFK) power toothbrush with 2 amplitude settings (A and B); and (2) the Oral-B Stages 3 toothbrush (MTB). **Methods:** Sixty-eight children participated in a single-masked, randomized, split-mouth study. Only subjects with a Quigley Hein plaque index (modified by Turesky et al.; TQHI) of more than 1.8 were enrolled. Subjects were randomized to SFK A (low amplitude, 7°), SFK B (high amplitude, 9°), or MTB by quadrant and brushed by a dental hygienist. TQHI was scored at 1- and 2-minute intervals by quadrant by a masked examiner. Multivariate analysis of variances for a split-mouth design was applied, and P-values were adjusted using Dunnett-Hsu modification. **Results:** Mean baseline TQHI(+SD) scores were 2.89+0.06, 2.96+0.07, and 2.89+0.05 for SFK A, SFK B, and MTB, respectively. Adjusted mean postbrushing overall percent reductions for SFK A, SFK B, and MTB were 41%, 42%, and 29% at 1 minute and 67%, 65% and 49% at 2 minutes, respectively. Differences between both SFK and MTB were statistically significant. **Conclusions:** The Phillips SFK removed significantly more plaque than the Oral-B Stages 3 toothbrush at 1- and 2-minute intervals with professional brushing assistance in 4- to 7-year-old subjects. (*Pediatr Dent* 2012;34:61-5) Received April 22, 2010 | Last Revision August 17, 2010 | Accepted August 25, 2010

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It is the responsibility of parents to teach their children systematic and thorough oral hygiene procedures. Proper toothbrushing should be established in childhood because, once learned, it is likely that this habit will continue into adulthood.^{1,2} Provided it is thorough and performed twice daily, tooth-brushing is the primary contributor to good oral hygiene and remains the most reliable method of controlling supra- and subgingival bacterial plaque³ and reducing the risk of caries, periodontitis, and early tooth loss.⁴

The toothbrushes used in teaching proper brushing techniques should be adapted to the needs and skills of children for self-performed brushing.⁵ Various toothbrush designs have been recommended to remove dental plaque in children,⁶ with the most common instrument a manual, short-headed toothbrush that compensates for children's lack of dexterity.⁷

Although tooth-brushing appears to be a simple and effective means of removing plaque, studies have shown that brushing time and performance of children are inadequate and change as they grow.⁸⁻¹⁰ Most children brush their teeth regularly, but for only 30 to 45 seconds. Depending on their age and manual skills, teeth may be insufficiently cleaned.^{9,10}

Little information is available on the efficacy of power toothbrushes on young children, such as kindergarteners. Forrester et al. and Heanue et al. reported that a rotating/oscillating power toothbrush was superior to a manual toothbrush for adults and that available data for other power toothbrushes are inconsistent.^{11,12} Two other studies in adult populations showed that a sonic power toothbrush was superior to a manual toothbrush in plaque removal and gingivitis reduction.^{13,14}

The power toothbrush's timer helps ensure adequate brushing time, and the inherent bristle movement may compensate for a child's limited dexterity and skill, especially for cleaning hard-to-reach areas such as interproximal tooth surfaces.

The purpose of this study was to test the plaque removing ability of a recently introduced power sonic toothbrush for children—Sonicare for Kids (SFK, Philips Oral Healthcare, Snoqualmie, Wash) with 2 amplitude settings—vs a manual toothbrush, Oral-B Stages 3 (MTB, Procter and Gamble, Cincinnati, Ohio). All brushing was done by a dental hygienist to reduce user variability. The null hypotheses were: (1) All toothbrushes would show the same plaque removal capacity. (2) Brushing time would not influence the results. (3) SFK amplitude settings would not influence the plaque removal efficacy.

Methods

This was a randomized, single-blinded, split-mouth study design with 1- and 2-minute quadrant-timed equivalent, professionally applied brushings. The study design was reviewed and approved by the ethics committee of the medical faculty of the University of Erlangen-Nuremberg, Erlangen, Germany (approval no. 3853).

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Figure 1. Left side: power experimental SFK with base unit, dentrifice used and Oral-B Stages 3 manual toothbrush. Right side: detail of the toothbrush heads of the toothbrushes tested—A/B=Sonicare for Kids (SFK); C=Oral-B Stages 3 manual toothbrush (MTB).

Toothbrushes. All experiments used SFK toothbrushes at a low setting (7° amplitude, 260 Hz sonic sweeping action, SFK A) and a high setting (9°, 260 Hz, SFK B) along with a tapered mini-brush head on a “clean” setting (Figure 1). The easy-start feature and mode selection button were deactivated. The MTB was designed for 5- to 7-year-olds (Figure 1).

Study population. Parents of 4- to 7-year-olds residing in Erlangen were sent a recruitment letter providing all study details, which were also explained orally at screening. Parents of study participants provided informed consent.

A complete medical history was obtained at screening, and subjects were excluded if any of the following criteria were present: less than a total of 10 evaluable teeth or less than 3 per quadrant; systemic diseases affecting oral plaque or inflammation (eg, diabetes); regular use of drugs or antibiotics; systemic disorders such as Down syndrome; undergoing extensive dental treatment; presence of oral soft tissue lesions; or an initial average Quigley Hein plaque index,¹⁵ as modified by Turesky et al.¹⁶ (TQHI), score of less than 1.8 after refraining for 24 hours from any oral hygiene. Sixty-eight of the 69 children screened were enrolled (30 males, 38 females; mean age=5.3-year-old).

At the first appointment, a disclosing solution (Mira-2-ton, Hager Werken, Duisburg, Germany) was applied to the teeth to aid in identifying plaque. A TQHI plaque score was then recorded at 6 sites per tooth on a scale of 0 to 5, and an overall average was calculated.

Subjects were randomized in a ratio of 2:1 to SFK A to SFK B cohorts. Each toothbrush was assigned to 2 diagonally opposite located quadrants using SAS 9.1.3 software (SAS, Inc, Chicago, Ill). The other 2 quadrants were assigned to the MTB. The examiner performing the plaque assessments was masked to the toothbrush assignment. The overall study protocol is illustrated in Table 1. Oral B Stages 3 toothpaste was used throughout.

All quadrants were brushed for 15 seconds (equivalent to 1 minute full-mouth), followed by plaque assessment and soft tissue evaluation. After another 15 seconds per quadrant brushing session (equivalent to 2 minutes full-mouth), a final plaque scored was determined and the soft tissue was evaluated.

Prior to the study, the dental hygienist was trained in the correct use of each toothbrush by carrying out 5 complete patient sessions with the same protocol with comparison of the brushing results. These training sessions were also used to standardize and calibrate the plaque investigator, who evaluated the plaque up to 3 times without knowing whether or not a brushing session was performed. The training was continued until an intraexaminer reliability of Cohen’s kappa 0.9 was reached.

Brushing techniques. Prior to use, the bristles of the each toothbrush were moistened with tap water and a pea-sized amount of dentrifice was applied to the assigned toothbrush. With the bristles of the SFK toothbrush head placed along the vestibular gum line at a slight angle, the unit was turned on, and the bristles were gently moved under light pressure in a slight back-and-forth motion so the longer bristles could reach the interproximal spaces. The procedure was then repeated in the diagonally opposite quadrant.

The MTB was placed at a 45° angle against the vestibular gum line. The toothbrush was gently moved in small tooth-wide circular movements with light pressure for 15 seconds. The procedure was then repeated in the diagonally opposite quadrant. After brushing, all toothbrushes were rinsed with water and stored for further use.

Statistical analyses. The primary efficacy outcome variable for this study was the mean percent plaque score reduction from baseline. The primary study objective was to quantify, in terms of point estimates and confidence intervals, the mean percent plaque reduction values for the 3 treatment arms, SFK A, SFK B, and MTB, at both brushing time intervals. The study was implemented as a Neyman-Pearson error-based design. The sample size was calculated assuming a difference of 6.5% for percent plaque reduction with a standard deviation of 14, a split-mouth design, and a 0.05 2-sided significance level. Based on a pilot study and prior data, a sample size of 40 subjects was needed for approximately 0.8 power to detect a significant difference between 2 toothbrushes. To determine significant differences testing 3 toothbrushes, a sample size of 60 was calculated.

Table 1. ILLUSTRATION OF THE OVERALL STUDY THROUGHPUT: TOOTHBRUSH ASSIGNMENT TO DIAGONALLY OPPOSITE QUADRANTS AND COURSE OF THE STUDY TREATMENTS

<ul style="list-style-type: none"> • Informed consent • Intraoral exam • Safety—soft tissue check • Prebrushing plaque index • Brushing 15 seconds/quadrant 	
Upper right (UR): 15 secs	Upper left (UL): 15 secs
Lower right (LR): 15 secs	Lower left (LL): 15 secs
<ul style="list-style-type: none"> • Postbrushing plaque index 1 • Safety—soft tissue check • Brushing for 15 secs/quadrant 	
UR: 15 secs	UL: 15 secs
LR: 15 secs	LL: 15 secs
<ul style="list-style-type: none"> • Postbrushing plaque index 2 • Safety—soft tissue check • Professional cleaning/fluoridation • Dismiss subject 	

Table 2. DIFFERENCES IN TQHI* AND PERCENT CHANGE AT 1- AND 2-MINUTE BRUSHING TIME EQUIVALENTS FOR THE DIFFERENT REGIONS

Region	Data format	Brushing time equivalent (mins)	Adjusted means±(SD)			Treatment group difference	
			Sonicare for Kids (SFK) A	SFK B	Oral B Stages 3 (MTA)	SFK A vs MTB	SFK B vs MTB
Overall	TQHI	1	1.18±0.06	1.21±0.07	0.84±0.05	0.35 (<i>P</i> <.001)	0.37 (<i>P</i> <.001)
	%	1	41.70±1.91	41.30±2.46	28.83±1.67	12.87 (<i>P</i> <.001)	12.47 (<i>P</i> <.001)
	TQHI	2	1.88±0.06	1.98±0.08	1.43±0.05	0.45 (<i>P</i> <.001)	0.55 (<i>P</i> <.001)
	%	2	65.59±2.08	67.47±2.72	49.22±1.79	16.37 (<i>P</i> <.001)	18.25 (<i>P</i> <.001)
Anterior	TQHI	1	1.22±0.07	1.30±0.08	0.89±0.06	0.34 (<i>P</i> <.001)	0.41 (<i>P</i> <.001)
	%	1	42.16±2.15	43.43±2.72	30.17±1.91	11.99 (<i>P</i> <.001)	13.26 (<i>P</i> <.001)
	TQHI	2	1.94±0.07	2.04±0.09	1.46±0.06	0.48 (<i>P</i> <.001)	0.58 (<i>P</i> <.001)
	%	2	66.38±2.20	68.08±2.90	49.42±1.90	16.96 (<i>P</i> <.001)	18.66 (<i>P</i> <.001)
Posterior	TQHI	1	1.13±0.06	1.09±0.08	0.78±0.05	0.36 (<i>P</i> <.001)	0.32 (<i>P</i> =.005)
	%	1	40.77±2.11	38.20±2.85	26.99±1.77	13.78 (<i>P</i> <.001)	11.22 (<i>P</i> =.005)
	TQHI	2	1.81±0.07	1.91±0.09	1.40±0.06	0.40 (<i>P</i> <.001)	0.51 (<i>P</i> <.001)
	%	2	64.21±2.34	66.63±3.08	48.99±2.01	15.22 (<i>P</i> <.001)	17.64 (<i>P</i> <.001)
Interproximal	TQHI	1	1.14±0.05	1.17±0.07	0.81±0.05	0.33 (<i>P</i> <.001)	0.36 (<i>P</i> <.001)
	%	1	39.64±1.81	39.09±2.32	27.52±1.59	12.13 (<i>P</i> <.001)	11.58 (<i>P</i> <.001)
	TQHI	2	1.84±0.06	1.95±0.08	1.39±0.05	0.45 (<i>P</i> <.001)	0.56 (<i>P</i> <.001)
	%	2	62.98±2.07	65.22±2.72	46.92±1.79	16.06 (<i>P</i> <.001)	18.30 (<i>P</i> <.001)
Posterior interproximal	TQHI	1	1.08±0.06	1.02±0.08	0.74±0.05	0.35 (<i>P</i> <.001)	0.29 (<i>P</i> <.01)
	%	1	38.97±2.03	35.61±2.76	25.33±1.71	13.64 (<i>P</i> <.001)	10.28 (<i>P</i> <.001)
	TQHI	2	1.75±0.07	1.85±0.09	1.35±0.06	0.39 (<i>P</i> <.001)	0.50 (<i>P</i> <.001)
	%	2	61.82±2.40	64.17±3.18	46.78±2.05	15.04 (<i>P</i> <.001)	17.39 (<i>P</i> <.001)

* TQHI=Quigley Hein plaque index (modified by Turesky et al.).

† The analysis model includes fixed effects for treatment and section, a random effect for subjects, and prebrush plaque scores as a covariate. The calculated *P*-values are from Dunnett's adjustment.

The primary analysis was carried out on an intent-to-treat basis, including all randomly assigned quadrants of all subjects with a baseline and endpoint evaluation for all treatment groups. All variables were summarized by descriptive statistics. Mean plaque score was treated as a continuous variable.

The analysis of the statistical models, including parameter and confidence interval estimation, was accomplished using a linear mixed effects model with Bonferroni correction for multiple testing. Comparisons between treatments and time intervals were performed using the appropriate *F*-test at the 15-second (1 minute whole-mouth) and 30-second (2 minutes whole-mouth) quadrant brushing endpoints. These analyses were carried out for 7 regions: overall; anterior; posterior; vestibular/oral; interproximal; and posterior interproximal.

In addition, a secondary efficacy variable "no. of surfaces TQHI=0" was considered. For assessing cleaning efficacy, the per-subject and per-treatment group number of tooth surfaces that received a score of 0 was determined. Then, for each test product and time interval, the differences among toothbrushes were examined statistically using the Wilcoxon signed rank test for matched pairs to compare SFK A and SFK B with MTB and using the Wilcoxon signed rank test for comparisons between SFK A and SFK B. Statistical significance was set at *P*<.05. SPSS 17 software (SPSS Inc, Chicago) was used for statistical analyses.

Results

The mean tooth count was 21.18 (range=18-24) per patient and 5.1 (minimum=3, maximum=6) per quadrant. No statistically significant differences were found for the baseline TQHI mean values among the 3 treatment groups. After adjusting for section and within subject correlation, the mean±(SD) estimated overall plaque scores at baseline (BL) were: SFK A, 2.89±0.06; SFK B, 2.96±0.07; and MTB, 2.89±0.05. No adverse clinical signs or symptoms caused by the toothbrushes were noted by the children, the brushing hygienist, the investigator, or the parents during the study.

Table 2 shows the reduction in TQHI plaque scores at the 1- and 2-minute equivalent of quadrant brushing time vs BL TQHI. At both time intervals, the overall TQHI differences between SFK A and SFK B and the MTB were 0.36 and 0.5. No significant differences were found between the 2 power toothbrushes. The TQHI score reductions (average=0.1-0.2) were significantly smaller in the posterior interproximal region than the overall reductions for all 3 toothbrushes. Significantly higher plaque score reductions, however, were observed with the SFK toothbrushes in this region than with the MTB (*F*-test, *P*<.001, Table 2).

Both SFK toothbrushes reduced the overall plaque score more than 40% after a 1-minute brushing. This was significantly

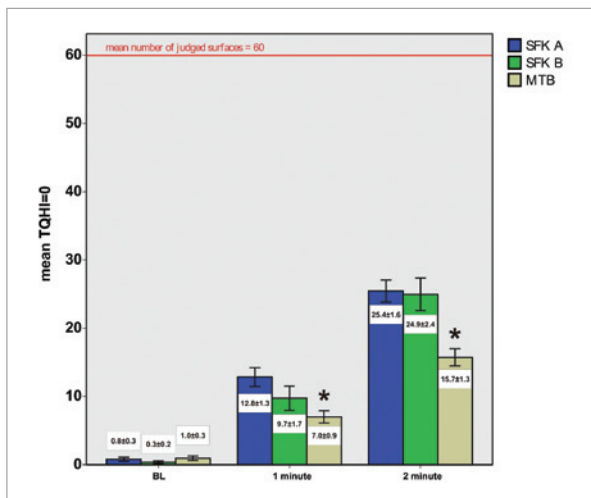


Figure 2. Mean number±(SD) of the time-dependent TQHI (Quigley Hein plaque index, modified by Turesky et al.) 0 scores for toothbrushes at baseline and after 1 and 2 minutes of brushing. The lower efficacy of the Oral-B Stages 3 toothbrush is clearly visible. The red line indicates the mean number of surfaces judged within 2 diagonally opposite quadrants (mean=60). Asterisks mark significant differences between the toothbrushes within the time intervals (Wilcoxon signed rank test, $P<.05$).



Figure 3. Vestibular view of the typical plaque distribution within primary teeth. Regions and ratings of TQHI (Quigley Hein plaque index, modified by Turesky et al.) scores are marked.

higher than the MTB, with a 28% reduction (F-test, $P<.001$). After a 2-minute whole-mouth brushing, the SFK A and SFK B overall plaque reductions were 66% and 67% respectively, while the MTB had the lowest plaque score reduction with 49%. The differences of 17% and 18% vs MTB were significant ($P<.001$).

The highest plaque score reductions after the 1-minute equivalent brushing for all 3 toothbrushes were in the anterior region: SFK A=42%; SFK B=43%; and MTB=30%. The lowest TQHI score reductions were in the posterior interproximal region: SFK A=39%; SFK B=36%; and MTB=25% (Table 2). The differences between the anterior and posterior interproximal regions ranged between 3% and 8%. For the 2-minute equivalent brushing interval, the percent reductions in the posterior interproximal region were: SFK A=62%; SFK B=64%; and MTB=47%.

Figure 2 illustrates the time-dependent TQHI=0 score (ie, clean) distribution. The mean number of plaque-free surfaces at BL was between 0 and 1 for all 3 toothbrushes. After an equivalent 1-minute whole-mouth brushing, the 2 SFK toothbrushes cleaned 12 (SFK A) or 9 (SFK B) out of 60 scored tooth surfaces and the MTB cleaned 7 surfaces. The differences between the SFK toothbrushes were not significant, but were significantly different to the MTB (Wilcoxon, $P<.001$). At the equivalent 2-minute whole-mouth brushing, the SFK A cleaned on average 25 tooth surfaces, the SFK B cleaned 24, and the

MTB cleaned 15. The results of the SFK power toothbrushes and the MTB were significantly different statistically (Wilcoxon, $P<.001$). In summary, within 2 minutes the SFK toothbrushes were able to completely clean nearly 42% of all judged tooth surfaces, whereas the MTB cleaned approximately 25%. Overall, both power toothbrushes were constantly more efficient than the MTB in all regions and for each time interval tested.

Discussion

The first part of the null hypothesis, that all toothbrushes would show the same plaque score reduction capacity, can be clearly rejected by the results. Highly significant differences between the SFK A and SFK B vs the MTB at both brushing times were found. After equivalent 1- and 2-minute brushing intervals, the power SFK toothbrushes reduced the plaque scores significantly more than the MTB.

The second part of the null hypothesis, that the time interval of brushing had no influence on the plaque removal, can also be rejected by the results for all 3 toothbrushes. The third part of the null hypothesis, that the 2 tested amplitudes of the recently developed SFK (7° and 9° bristle angles) would not result in differing plaque removal efficacy, was confirmed by the results. At the 1- and 2-minute brushing intervals, both amplitudes produced equal plaque score reductions.

The study design—24-hours of plaque accumulation followed by professional brushing—excluded patient-related factors, such as brushing technique, dexterity, motivation, or handedness, and ensured a consistent brushing technique.

The results showed an important influence of brushing time on the cleaning efficacy of the toothbrushes tested. Two minutes of brushing with the MTB did not generate adequate plaque removal in the posterior interproximal areas (47% TQHI score reduction) compared to the reductions obtained by the power toothbrushes (62% and 64% SFK A and SFK B, respectively) in these regions. This agrees with a previous report, which found that manual tooth-brushing alone cannot sufficiently clean the interproximal areas.¹⁴

Van der Weijden et al., recommended 2 minutes of brushing as a suitable time interval for children. The results of the present study showed that 2 minutes of brushing did not eliminate all remaining plaque in the posterior interproximal areas, especially when the MTB was used. The overall reductions obtained by the SFK toothbrushes in the present study (65% to 67%) were comparable to those found by Grossman et al. for the Oral-B Plaque Remover for Kids with a whole-mouth plaque score reduction after 2 minutes of brushing of 65%.¹⁵ The MTB overall value in the present study was 49% and approximately 42% in the Grossman et al. study. The reasons for these variations could be the different toothbrushes used and that children (age range=8-12 years) in the Grossman et al.¹⁷ study brushed their own teeth.

After 2 minutes of brushing, the MTB had a 49% reduction in plaque index, a slightly higher score compared to the SFK with a 41% reduction after just 1 minute. The differences in cleaning efficacy between sonic toothbrushes and MTB in the present study were rather high (10-15%). The distribution of plaque on the tooth surfaces, which was primarily located in the vestibular/gingival area at the neck of the teeth (Figure 3), may be one possible reason for this result.

One question remains after the present study: What level of plaque removal should be clinically reached within 1 session

of tooth-brushing for children? There are no recommendations with a solid scientific background, such as there are for prevention of caries and gingivitis, in the literature. Is 66% plaque removal enough or is it better to remove 100% of plaque, especially in the posterior proximal areas? Considering the results of the present study, which brushing time should be recommended?

Various studies have reported the average time spent on tooth-brushing to be between 50 and 70 seconds.^{16,17} The benefit of several short brushing sessions (<1 minute) is the frequent delivery of fluoride to the tooth surfaces. The results of the current study showed that, even after 2 minutes of professionally applied brushing, less than 50% of evaluated tooth surfaces were free of plaque using the SFK power toothbrushes and only one third of the surfaces brushed by MTB could be considered clean.

Santos et al. reported that the frequency of tooth-brushing had no influence on the amount of biofilm remaining on tooth surfaces in children.⁹ Considering those data and the current results, it can be concluded that the 2-minute recommendation for children cannot guarantee clean interproximal tooth surfaces.

The children in the present study abstained from oral hygiene for 24 hours prior to the professional brushing session. Typically, 24 hours (range=12-48 hours) of oral hygiene abstinence are used to test toothbrush efficacy.^{18,19}

Whether a dynamic sonic action, as described by Parini et al.,²⁰ could support the plaque (or biofilm) removal of the 2 SFK toothbrushes was not an objective of the present study; however, since the professionally applied brushing required an opened mouth during brushing, this dynamic water effect could be excluded as a reason for the good performance of the SFK toothbrushes.

We used the disclosing solution at BL and after each brushing interval. Due to the presence of old and thick plaque, we could prevent scoring errors caused by removal of only superficially disclosed plaque layers. The professional brushing dental hygienists were not masked to the disclosed plaque because the time management of the design required a high concentration on the brushing process. Therefore, an influence of the visible plaque during brushing on the results could not be excluded. It is possible that the disclosed plaque contributed to an overestimation of the plaque removal capacity of all toothbrushes tested.

Conclusions

The results of this study indicate that:

1. The Philips Sonicare for Kids power toothbrushes removed significantly more plaque (12-18% more) than the Oral-B Stages 3 toothbrushes.
2. This differences between the brushes should be considered clinically relevant.
3. SFK power toothbrushes result in cleaner teeth and/or shorter brushing times for children.

Acknowledgment

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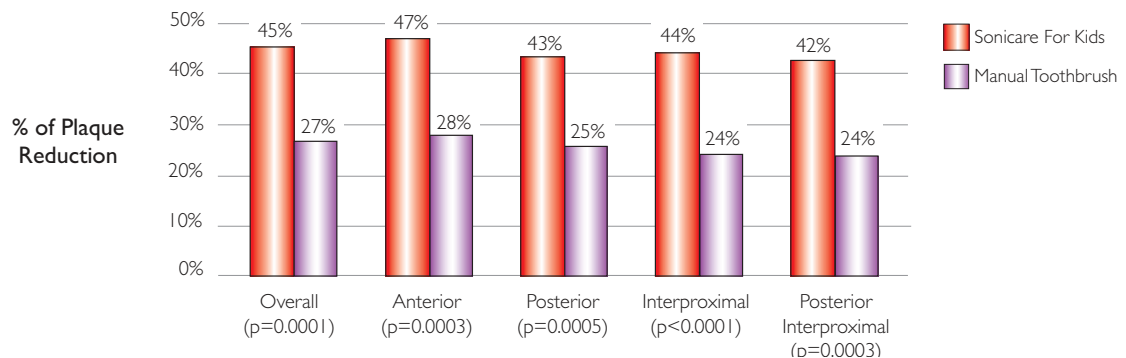
Plaque Removal

in vivo study

Comparison of plaque removal by Sonicare For Kids and a manual toothbrush in children aged 7–10 years

Milleman J, Putt M, Olson M, Master A, Jenkins W, Schmitt P, Strate J. *International J Pediatric Dent.* 2009; 19:s1

Objective	To compare the plaque removal efficacy and safety of Sonicare For Kids at “high” setting and Oral-B Stages 4® manual toothbrush (MTB) in children aged 7–10 years.
Methodology	Fifty-eight healthy children enrolled in and four withdrew from an IRB-approved single-blind, randomized, parallel-design study (totaling 32 females, 22 males; mean age 8.3 years). Informed consent/assent (with parent) was obtained. All subjects abstained from brushing for 26 ± 6 hours prior to examination visits. At Visit 1, subjects were screened for eligibility (Turesky-Modified Quigley-Hein Plaque Index (TPI) >1.8). Eligible subjects were enrolled and instructed on use of both devices (Sonicare For Kids and MTB) in alternating manner at home (twice daily for two minutes) for a one-week familiarization period. At Visit 2, baseline TPI was performed followed by a randomization and supervised two-minute brushing session with the assigned device. Post-brushing TPI scores were then obtained. Safety was assessed in oral soft tissue examinations at Visit 2. ANOVA was used for the primary statistical analysis.
Results	Sonicare For Kids removed significantly more plaque than a manual toothbrush from the dentition overall (p=0.0001) as well as in hard-to-reach areas, i.e., the posterior teeth (p=0.0005) and the interproximal spaces (p<0.0001) of children aged 7–10 years. Both toothbrushes were safe to use.
Conclusion	Sonicare For Kids was found to remove significantly more plaque than Oral-B Stages 4 manual toothbrush in children aged 7–10 years. It is also proven safe and gentle on oral tissues.



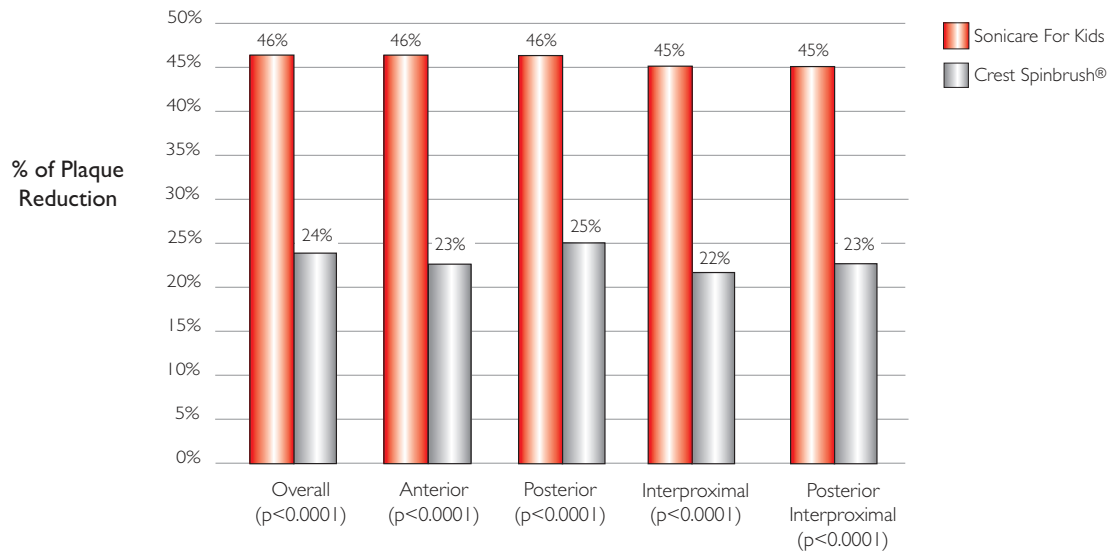
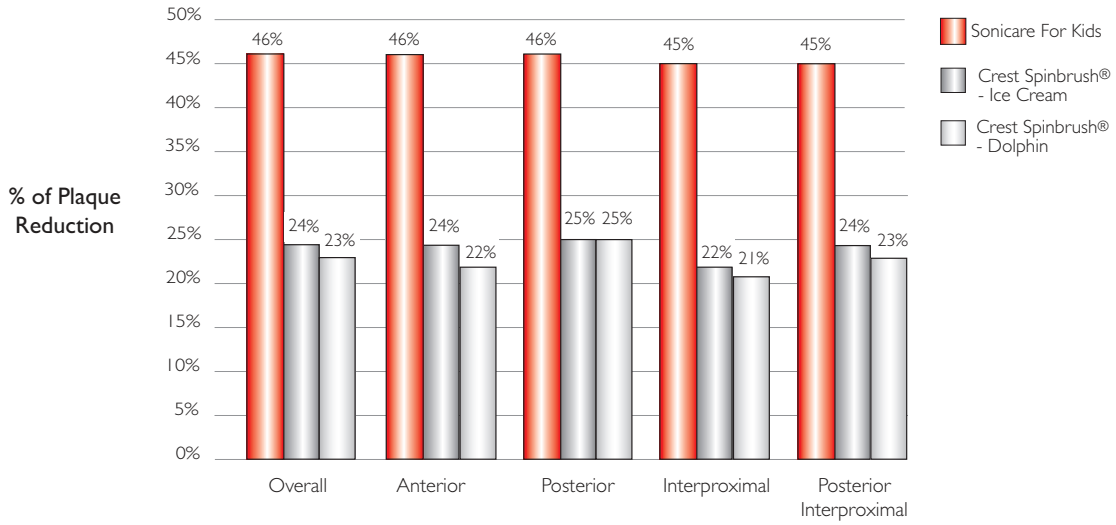
Plaque Removal

in vivo study

Comparison of plaque removal by Sonicare For Kids and a Crest battery-powered Spinbrush® for Kids in children aged 7–10 years

Milleman J, Putt M, Olson M, Master A, Jenkins W, Schmitt P, Strate J. *International J Pediatric Dent.* 2009; 19:s1

Objective	To compare the plaque removal efficacy of Sonicare For Kids at “high” setting and Crest battery-powered Spinbrush for Kids (“dolphin” and “ice cream cone” handle shapes) in children aged 7–10 years.
Methodology	Fifty-nine healthy children (mean age 8.5 years) participated in an IRB-approved single-blind, randomized, parallel-design study. Informed consent/assent (with parent) was obtained. Subjects abstained from brushing for 26 ± 6 hours prior to examination visits. At Visit 1, subjects were screened for eligibility (Turesky-Modified Quigley-Hein Plaque Index (TPI) > 1.8). They were instructed on use of both devices (Sonicare For Kids and Crest Spinbrush for Kids) in alternating manner at home (twice daily for two minutes) for a one-week familiarization period. At Visit 2, baseline TPI was scored followed by randomization and a supervised two-minute brushing session with the assigned device. Post-brushing TPI scores were then obtained. Safety was assessed in oral soft tissue examinations at Visit 2. ANOVA was used for the primary statistical analysis.
Results	Sonicare For Kids removed significantly more plaque than Crest Spinbrush for Kids (“dolphin” and “ice cream cone” handle shapes) from the dentition overall ($p < 0.0001$) as well as in hard-to-reach areas, i.e., the posterior teeth ($p = 0.0001$) and the interproximal spaces ($p < 0.0001$) of children aged 7–10 years. Both toothbrushes were safe to use.
Conclusion	Sonicare For Kids was found to remove significantly more plaque than Crest Spinbrush for Kids in children aged 7–10 years. It is also proven safe and gentle on oral tissues.



Plaque Removal

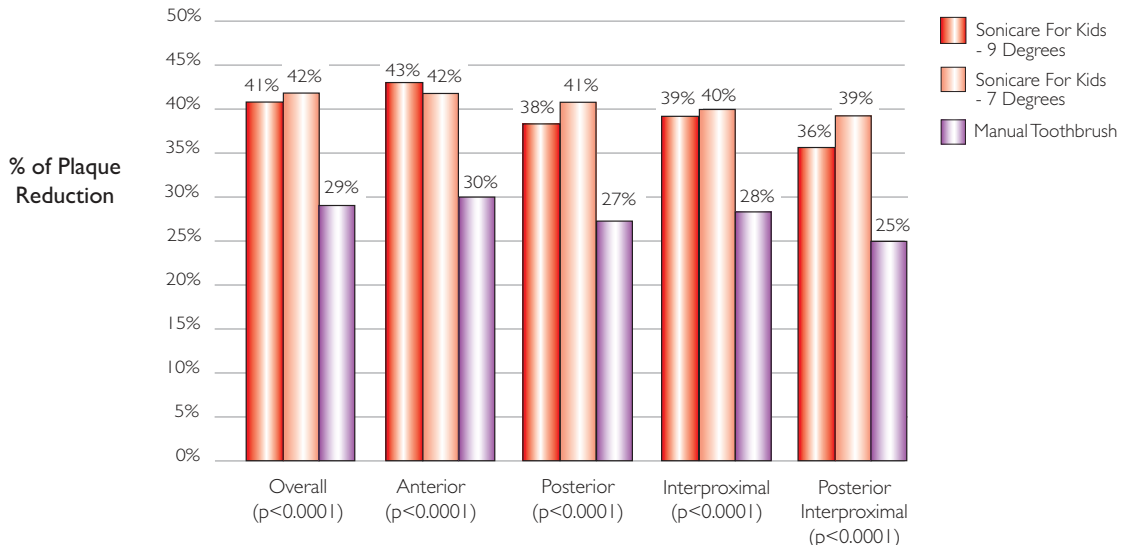
in vivo study

Comparison of plaque removal by Sonicare For Kids and a manual toothbrush in children aged 4–7 years in a professionally applied toothbrushing study

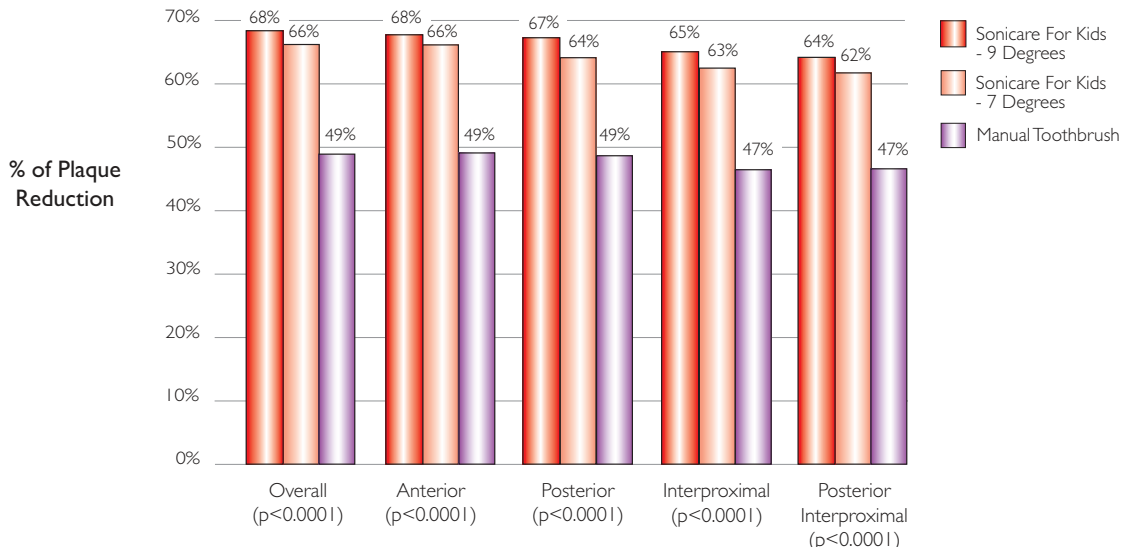
Pelka M, DeLaurenti M, Master A, Jenkins W, Strate J, Wei J, Schmitt P. *International J Pediatric Dent.* 2009; 19:s1

Objective	To compare the plaque removal efficacy of Philips Sonicare For Kids at “high” and “low” settings and Oral-B Stages 3® manual toothbrushes in a professionally applied brushing session simulating one and two minutes of brushing time in children aged 4–7 years.
Methodology	Sixty-eight healthy children (38 females, 30 males; mean age 5.3 years) participated in an IRB-approved single-blind, randomized, split-mouth-design study. Informed consent/assent (with parent) was obtained. Subjects were screened for eligibility (Turesky-Modified Quigley-Hein Plaque Index (TPI) >1.8). Eligible subjects were randomized to Sonicare For Kids “high,” Sonicare For Kids “low” and a manual toothbrush by quadrant and were brushed accordingly by clinical hygienists. TPI was scored at one- and two-minute interval equivalents by quadrant by a blinded examiner. Safety was assessed in oral soft tissue examinations. For statistical analysis, MANOVA for a split-mouth-design was applied and P-values were adjusted using the Dunnett-Hsu adjustment.
Results	Sonicare For Kids (in “high” and “low” settings) removed significantly more plaque than a manual toothbrush from the dentition overall ($p < 0.0001$) as well as in hard-to-reach areas, i.e., the posterior teeth ($p < 0.0001$) and the interproximal spaces ($p < 0.0001$) at one- and two-minute brushing intervals in children aged 4–7 years with professionally applied brushing sessions. Both toothbrushes were safe to use.
Conclusion	Sonicare For Kids was found to remove significantly more plaque than Oral-B Stages 3 manual toothbrush in children aged 4–7 years with professionally applied brushing. It is also proven safe and gentle on oral tissues.

Adjusted Mean Percent Plaque Reduction, Squirt Prototype
7 and 9 Degrees vs. Manual Toothbrush, 1-Minute Equivalent



Adjusted Mean Percent Plaque Reduction, Squirt Prototype
7 and 9 Degrees vs. Manual Toothbrush, 2-Minute Equivalent



Plaque Removal

in vivo study

Comparison of plaque removal by Sonicare For Kids and a Colgate® children's battery toothbrush in children aged 7–10 years

Payne D, Rimmer P, Olson M, Master A, Jenkins W, Schmitt P, Strate J. *International J Pediatric Dent.* 2009; 19:s1

Objective	To compare the plaque removal efficacy and safety of Philips Sonicare For Kids at "high" setting and Colgate children's battery toothbrushes ("Shrek" handle design) in children aged 7–10 years.
Methodology	Sixty-nine healthy children (mean age 8.4 years) participated in an EC-approved single-blind, randomized, parallel-design study. Informed consent/assent (with parent) was obtained. Subjects abstained from brushing for 26 ± 6 hours prior to examination visits. At Visit 2, subjects were screened for eligibility (Turesky-Modified Quigley-Hein Plaque Index (TPI) > 1.8). Eligible subjects were instructed on use of both devices (Sonicare For Kids and Colgate children's battery toothbrush) in alternating manner at home (twice daily for two minutes) for a one-week familiarization period. At Visit 3, baseline TPI was scored followed by randomization and a supervised two-minute brushing session with the assigned device. Post-brushing scores were obtained by scoring TPI. Safety was assessed in oral soft tissue examinations at Visit 3. ANOVA was used for the primary statistical analysis.
Results	Sonicare For Kids removed significantly more plaque than a Colgate children's battery toothbrush from the dentition overall ($p=0.0003$) as well as in hard-to-reach areas, i.e., the posterior teeth ($p=0.0037$) and the interproximal spaces ($p=0.0002$) of children aged 7–10 years. Both toothbrushes were safe to use.
Conclusion	Sonicare For Kids was found to remove significantly more plaque than Colgate children's battery toothbrush in children aged 7–10 years. It is also proven safe and gentle on oral tissues.

