Journal of Dentistry and Oral Biology

Research Article
Published: 05 Apr, 2021

Is Sonic Brushing More Effective in Mixed Dentition? A Quantitative and Qualitative Analysis

*Noirrit-Esclassan**

Department of Dentistry, Toulouse University Hospital, France

Abstract

Background: Sonic brushing technology is progressing and its assessment mainly concerns adults.

Objectives: To compare the effectiveness and the acceptance of a sonic electric toothbrush and a manual toothbrush for plaque removal in children in mixed dentition.

Materials and Methods: 75 children with an average age of 8.5 years were randomly assigned to a 19 days period of manual toothbrush use (Elmex Junior®, Colgate Palmolive, and Basel Switzerland) or sonic electric toothbrush use (Sonicare For Kids®, Philips, and Amsterdam Netherlands). This was followed by a wash-out period, then crossover to the other brush for 19 days. The primary endpoint of this single-blind, crossover study was the determination of the change in plaque index, quantified as the average index assessed on six teeth on either side after 19 days of use. Exploratory measurements of plaque were also made after 12 days of use of each brush and after four months. The secondary aim was to know how the children perceived the brushes.

Results: There was a significantly higher plaque reduction after 19 days of use of the sonic electric brush as compared with the manual brush (-0.27 points; 95% confidence interval -0.35 to -0.19; $p<0.0001$). The higher the plaque index at D0, the greater the reduction in plaque index at D19 with the same period, toothbrush type and sequence. Longitudinal analysis showed a continuous decrease in the plaque index between D0, D12 and D19 with the electric toothbrush. During the four-month re-evaluation, the plaque index was, on average, lower than that measured at the start of the study. Children's perceptions of the two types of brushes were recorded.

Conclusion: For children, using a sonic toothbrush in mixed dentition provides better plaque removal than using a manual toothbrush. For the first time, school children expressed findings concerning an electric toothbrush.

Keywords: Sonic electric toothbrush; Manual toothbrush; Plaque index; Orthodontic treatment; Student's t-test

OPEN ACCESS

Correspondence:

Noirrit-Esclassan, Department of Dentistry, Toulouse University Hospital, Inserm U1048, I2MC, 31059 Toulouse, France, Tel: +33 6 61 96 84 35; E-mail: noirrit.e@odonto-tlse.eu

Received Date: *18 Feb 2021*

Accepted Date: *01 Apr 2021*

Published Date: *05 Apr 2021*

Citation:

Noirrit-Esclassan. Is Sonic Brushing More Effective in Mixed Dentition? A Quantitative and Qualitative Analysis. J Dent Oral Biol. 2021; 6(1): 1179.

ISSN: 2475-5680

Introduction

Numerous studies have compared manual and electric tooth brushing and have been scanned in systematic reviews. In 2010 the effectiveness of different designs of powered toothbrushes was compared [1]. Recently a Cochrane review [2], concluded there was moderate quality evidence that powered toothbrushes provided a statistically significant benefit with respect to manual toothbrushes in terms of plaque reduction, in the short term (one to three months of use) and the long term (after three months of use). These comparative studies have mainly focused on adult populations [1-3], people with disabilities [4-6] and young people undergoing orthodontic treatment [7-10]. However, little research has been done on children without risk factors [11-16] and none of these studies concerned sonic toothbrushes.

Tooth brushing skills improve with age and the duration of tooth brushing makes a significant difference to the oral hygiene status of a child [17]. Mixed dentition is a key period for establishing effective tooth brushing. Perceptions of oral health or brushing habits have been reported by parents [18-20], nurses [21] or adolescents [22] but, to the best of our knowledge, tooth brushing perception had never been reported by school children themselves before this study.

The main objective of this work was to determine the difference in plaque removal when a sonic electric toothbrush or a manual toothbrush was used by children with mixed dentition. The secondary objective was to collect children's perceptions of these different brushing methods.

Table 1: Inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
Healthy children	Reported disability that might affect tooth brushing
Presence of 6 assessable teeth: 21, 41, 16, 26, 36, 46	Presence of brackets or crowns on selected teeth
Informed consent signed	Use of additional dental hygiene aids (dental floss or brushes)
	Mobile teeth in the process of exfoliation or painful decayed teeth

Patients and Methods

Patients

This study took place in a primary school in the T… region. The sample initially included 76 children aged eight to nine years, from three classes of the same level.

The agreement of the Ethics Committee on non-interventional research of the Federal University of T* (CERNI) was obtained in advance. Similarly, the Academic Inspector, the headmaster of the school and the teachers of the three classes agreed to participate in this study. Written consent from parents and children was obtained after written information had been provided to them. The inclusion and exclusion criteria are described in Table 1.

Methods

In this crossover design, each child successively used a toothbrush of each type (electric and manual) for 19 days in a sequence that was randomized (either Manual then Electric [M+E] or Electric then Manual [E+M]) by the RSTAT software. The study therefore included two periods separated by a 23-day wash-out period (Figure 1). At the beginning of each period, plaque was assessed to obtain a baseline (D0) measurement. The modified Bass brushing method [23] was taught in each class with a PowerPoint support and demonstration on a macro-model before the start of the study. Then, during individual interviews with each included child, the children's ability to brush their teeth correctly using their own toothbrushes was verified and children were asked about any previous use of an electric brush.

On day zero of each period, a reminder of the brushing method was given in each class. After an initial assessment of the plaque index, we assigned the toothbrushes randomly and then used a two-minute supervised brushing session in order to verify the right brushing technique and correct the movements if necessary. This first evaluation was followed by a familiarization period lasting 12 days: The children were instructed to brush their teeth morning and evening for at least two minutes - with the assigned toothbrush and toothpaste only - according to the horizontal method [23].

Plaque assessments were performed single blind (assessors were blinded to the toothbrush used) - without notifying the families and children - on D0, D12 and D19 of each period. During the latency period (wash-out), which was used to eliminate any possible residual effect of period one on period two, the children returned the toothbrush they had used in the first period and went back to their usual toothbrush. In the second period, the same protocol was followed but the manual or electric toothbrushes used in the first period were replaced by electric or manual toothbrushes, respectively.

After period two was complete, both study toothbrushes were handed over to the children and they were free to use their favorite toothbrush. We performed a final plaque assessment approximately three months later, without warning the parents or children beforehand. The manual toothbrush supplied was the Elmex Junior 7 to 12 years (Figure 2). This brush has flexible, round, 0.17 mm to 0.2 mm, X-shaped strands to penetrate the interdental spaces. The head was small, and the ergonomic, non-slip handle had a stop for a stable and controlled grip.

The sonic electric toothbrush was the Sonicare for Kids (Philips, Amsterdam) (Figure 3), which is rechargeable and has a three-week battery life. It incorporated a Kid Timer and Quad Pacer two-minute timer: at the end of each 30-second interval during a two-minute brushing cycle, a beep sounded, indicating it was time to switch to another part of the mouth. The two brushing modes (three-seven years and seven-ten years) had the same frequency of 31,000 brush strokes per minute. The only variation was in the intensity of the vibration, which was greater in seven-ten year mode than in three–seven-year mode. Children were free to choose the brushing method that suited them best. The recommended brush head, which is similar in form to the head of the manual toothbrush, was suitable for the 7 to 12 year age range.

Elmex Junior toothpaste for 7 to 12 year-olds, with 1400 ppm fluoride content, was provided to both groups throughout the study. They were advised to use a pea-sized amount each time they brushed.

Plaque disclosing gel (GC Tri Plaque ID Gel™, GC Europe,

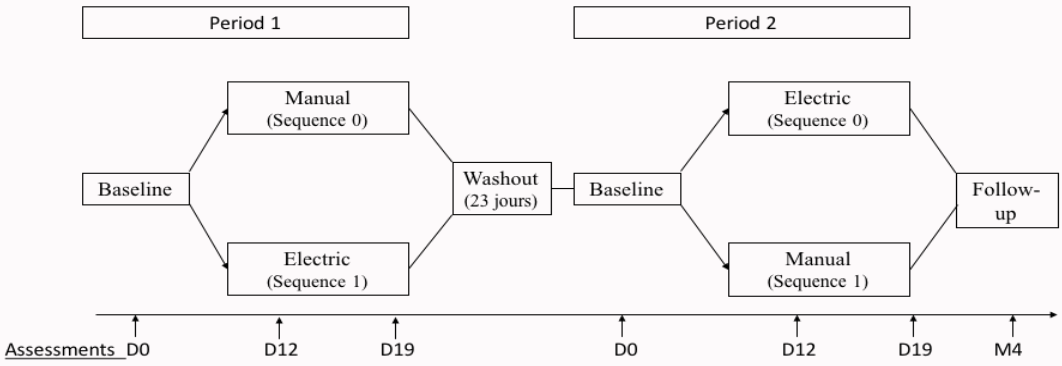

Figure 1: Timeline of the crossover study comparing electric and manual toothbrushes.

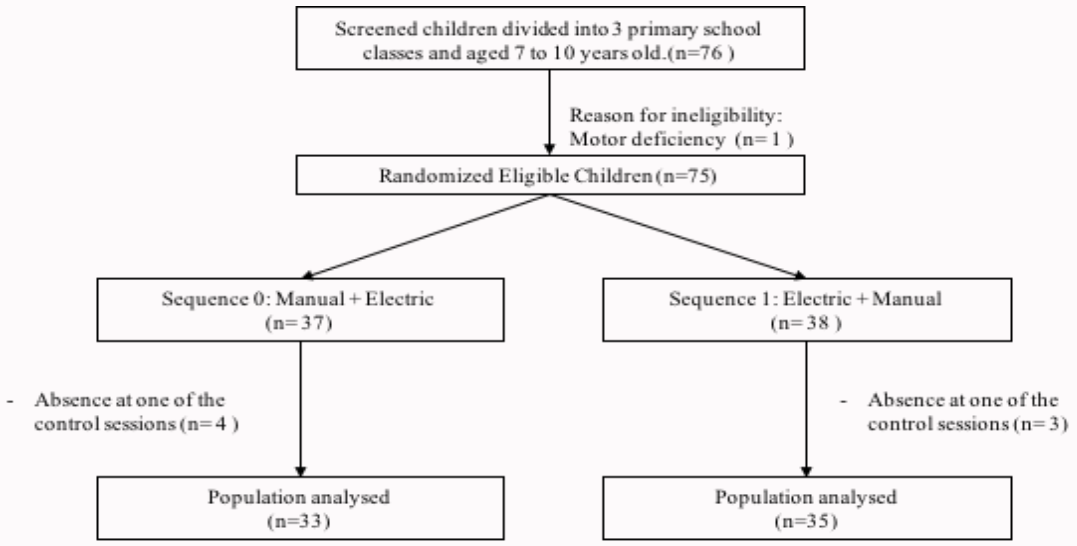

Figure 2: Flow-chart of study enrolment and follow-up.

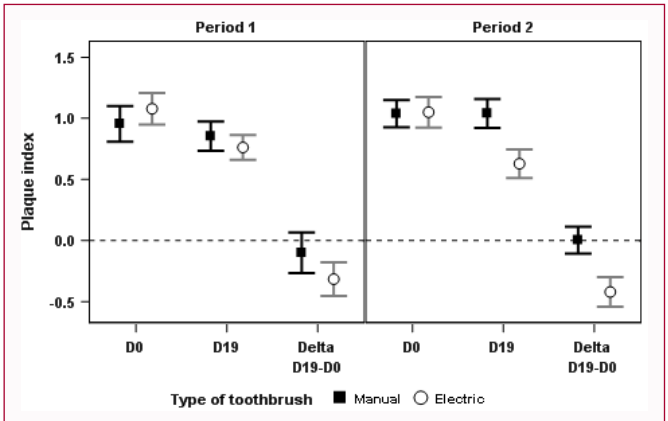

Figure 3: Plaque index (mean and 95% confidence interval) at D0 and D19 of each period and mean of intra-subject difference D19 minus D0 (Delta D19-D0) by type of toothbrush used during the period.

Leuven) was applied with a micro-brush to the vestibular and lingual faces of the maxillary and mandibular incisors 21 and 41, as well as the first four permanent maxillary and mandibular molars 16, 26, 36, 46. After rinsing, the plaque was evaluated using the simplified oral hygiene index (Table 2), by trained examiners (one senior dentist and one post-graduate student) equipped with a pupilloscope, mirror and probe. The children were always assessed by the same person.

The primary endpoint of the study was the plaque index variation between D0 and D19 for each period. At each visit, a score between zero and three was assigned for six teeth. The plaque index analyzed in this study corresponded to the average of the plaque indices measured on both sides of these six teeth (average of 12 scores). The simplified oral hygiene index takes the plaque and calculus indexes into account. Since no scaling was carried out during the study and the amount of calculus observed was mostly zero or negligible at baseline, we used only the plaque index. The examiners were calibrated through plaque assessment on pictures of 20 patients seen in a control consultation at hospital. Inter observer reliability was assessed using the Cohen Kappa test with a high level of agreement (κ=0.94).

For the secondary objective, a thematic analysis was carried out on the responses to open-ended questions. The sample size corresponded to all the participants' responses: 68 responses. Here, qualitative analysis did not follow the classic pattern in which data collection and analysis continue until data saturation and stability of conclusions is achieved. Data coding and grouping of data affiliated with the same code was carried out from the responses exported to a word processing file. Nvivo software (QDR international™, Cambridge, MA, USA) was used for coding. The grouping of the various codes into general themes and the organization of themes (changes, mergers and/or deletions) was then carried out and illustrated with data extracts.

Statistical analysis

The statistical analysis was performed on all children with data on plaque index at D0 and D19 of both periods. First, the analysis for the primary objective was carried out for each period separately. The mean plaque indexes measured at D0 and D19 of each period were calculated with their 95% Confidence Interval (CI) for each type of toothbrush as was the mean of the intra-subject variation of the plaque index between D0 and D19 (plaque index at D19 minus plaque index at D0 of each period, named delta D19-D0).

The carryover effect of each type of toothbrush (i.e. the residual effect of the toothbrush used in period one over period two) was tested

Table 2: Evaluation criteria for the Simplified Oral Hygiene Index.

Scores	Plaque Index Criteria	Calculus Index Criteria
0	No plaque	No calculus
1	Plate covering not more than 1/3 of the tooth surface, or presence of deposits.	Supragingival calculus covering not more than 1/3 of the tooth surface
2	Plaque covering between 1/3 and 2/3 of the tooth surface	Supragingival calculus covering between 1/3 and 2/3 of the exposed surface or presence of individual subgingival calculus blocks at the cervical part of the tooth or both.
3	Plaque covering more than 2/3 of the tooth surface	Supragingival calculus covering more than 2/3 of the exposed surface or a continuous band of subgingival calculus around the cervical portion of the tooth.

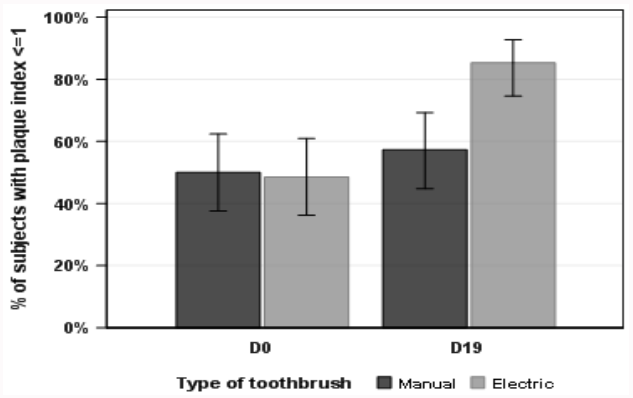

Figure 4: Percentage of subjects with a plaque index below or equal to 1 at D0 and D19 for each type of toothbrush used with 95% confidence intervals.

by comparing the D0 measurements of the two periods by a paired student's t-test, after checking the normality of the distributions. In absence of carryover effects, the results of the two study periods were pooled, allowing direct intra-subject comparison of the effect of the electric versus manual toothbrush. In this pooled analysis, the effect of the electric *vs.* manual brush on the delta D19-D0 plaque index was estimated using a linear mixed model with fixed effects for the D0 plaque index, sequence, period and type of toothbrush, and a random effect model to account for the correlation between each subject's two measurements. The effect of the period was explored to determine whether the response to both types of toothbrush was consistently higher or lower in one period than the other. The effect of the sequence was also studied to determine whether the response to the two types of toothbrushes differed depending on the order of use (M+E or E+M).

Then, the percentage of subjects with a plaque index ≤ 1, reflecting an acceptable amount of plaque, was calculated on D0 and D19 for each type of toothbrush used in any period with its exact 95% CI. Finally, a longitudinal descriptive analysis of the average change in the plaque index at each visit compared to the D0 of period one was carried out up to month four.

All statistical analyses were performed using SAS software version 9.4 (SAS Institute, Cary, NC, USA). A p-value <0.05 was considered statistically significant.

Results

Study population

Out of the 76 screened children belonging to the three classes, 75 were randomized in the study to receive either M+E or E+M. Seven of them were excluded from the analysis due to one or more absences from the primary assessment sessions to D19 (Figure 4). Thus we analyzed the results of 34 girls and 34 boys whose mean age was 8.5 years (Table 3). Overall, around one-third of the children used an electric brush before the study, either exclusively or alternating with a manual brush.

Variation of the plaque index by period

At the baseline (D0) of period one, randomized subjects in sequence 0 (M+E) had a slightly lower mean plaque index than randomized subjects in sequence one (E+M) (0.95 *vs.* 1.08 respectively, Table 3 and Figure 3). For each of the two periods, the plaque index decreased more sharply between D0 and D19 with the use of the electric toothbrush than with the manual brush (mean variation of -0.32 and -0.42 points with the electric brush *vs.* -0.10 and 0.00 with the manual brush for periods one and two, respectively) (Figure 5).

Test of carry-over effect

For each group, the plaque index at D0 of period 2 was not significantly different from that at D0 of period one on average (return

Table 3: Description of study participants at baseline.

	Sequence 0: Manual then electric (N=33)	Sequence 1: Electric then manual (N=35)	Total (N=68)
Sex: n (%)			
Girls	15 (45.5%)	19 (54.3%)	34 (50.0%)
Boys	18 (54.5%)	16 (45.7%)	34 (50.0%)
Age:			
Mean (SD)	8.8 (0.66)	8.3 (0.68)	8.5 (0.70)
Classroom (elementary level-CE2): n (%)			
1	13 (39.4%)	9 (25.7%)	22 (32.4%)
2	9 (27.3%)	12 (34.3%)	21 (30.9%)
3	11 (33.3%)	14 (40.0%)	25 (36.8%)
Usual toothbrush type: n (%)			
Manual	19 (57.6%)	25 (71.4%)	44 (64.7%)
Electric	5 (15.2%)	9 (25.7%)	14 (20.6%)
Manual and electric	9 (27.3%)	1 (2.9%)	10 (14.7%)
Examiner: n (%)			
1	8 (24.2%)	10 (28.6%)	18 (26.5%)
2	10 (30.3%)	7 (20.0%)	17 (25.0%)
3	6 (18.2%)	8 (22.9%)	14 (20.6%)
4	9 (27.3%)	10 (28.6%)	19 (27.9%)
Plaque index at D0 of Period 1:			
Mean (SD)	0.95 (0.410)	1.08 (0.375)	1.02 (0.395)

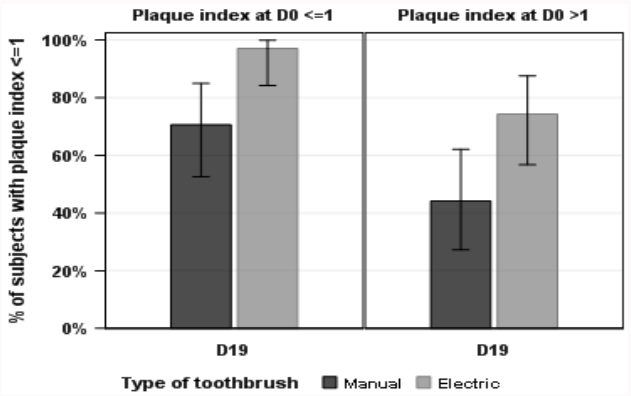

Figure 5: Percentage of subjects with a plaque index below or equal to 1 at D19 after each type of toothbrush by category at D0 with 95% confidence intervals.

to the original value), which means there was no significant residual effect of the brush used in period one on the second period (p=0.2229 for the group with manual brush in period one and p=0.5275 for the group with electric brush in period one).

Analysis of pooled periods

The decrease in plaque index averaged 0.08 points after 19 days of manual brush use and 0.34 points after 19 days of electric brush use according to the linear mixed model, which takes the sequence, period, D0 plaque index of each period and the correlation between each subject's measurements into account (Table 4). The plaque index after 19 days was, on average, reduced by 0.27 more points with the electric brush than with the manual brush (95% CI [-0.35; -0.19]). Therefore, the type of toothbrush used had a significant effect on the plaque index at D19 (p<0.0001) (Table 4).

A significant sequence effect (M+E or E+M) was also found on the change in plaque index at D19 (p=0.0206). The effect of the two types of toothbrushes on plaque reduction was stronger for the subjects in the M+E sequence than for subjects in the E+M sequence, at equal D0. The period was not significantly associated with the plaque index reduction at D19, which means that the effect was not significantly different for the two toothbrushes between the two periods (p=0.6395). When comparing the mean differences of plaque index between D19 and D0 for each period and each dental face, we did not find any significant difference.

The baseline plaque index (D0 of each period) was significantly associated with the D19 plaque index change (p<0.0001). The higher the plaque index at D0, the greater the decrease in plaque index at D19 for the same period, toothbrush type and sequence.

Analysis of the plaque index variation in two categories (≤ 1 and >1)

We observed a large increase in the percentage of subjects with a plaque index ≤ 1 (considered as an acceptable amount of plaque) after 19 days of electric toothbrush use: From 48.5% at D0 (33 subjects out of 68) to 85.3% at D19 (58 subjects out of 68). With manual toothbrushes, this percentage varied from 50% at D0 (34 subjects out of 68) to 57.4% at D19 (39 subjects out of 68) (Figure 6).

Most subjects (26/35, 74.3%) with an index >1 at D0 (large amount of plaque) saw their plaque index decrease to an acceptable level ≤ 1 after 19 days of electric toothbrush use, compared to 44.1% (15 of 34 subjects) with manual toothbrush use. All but one of the subjects with an index ≤ 1 at D0 maintained an index ≤ 1 after 19 days of electric brush use (32/33, 97.0%) while only 70.6% (24/34) of the subjects with an index ≤ 1 at D0 maintained an index ≤ 1 after 19 days of using the manual brush.

Longitudinal descriptive analysis

The plaque index decreased after 12 days of using the electric toothbrush, but the reduction was even greater after 19 days for the subjects in each sequence. For subjects in the M+E sequence (in period one), a decrease in plaque index was observed at D12 with the manual toothbrush, but this effect faded at D19. For subjects in the E+M sequence, when the manual toothbrush was used in period two, the plaque index remained stable between D0, D12 and D19.

The plaque index measured four months after the start of the study was higher on average than the indices measured after 19 days

Table 4: Least squares means estimate and 95% CI of plaque index variation at D19 for each type of toothbrush and comparison of electric versus manual toothbrush.

Criteria	Manual (n=68)	Electric (n=68)	Difference E-M	P-value
Least square means delta D19-D0 plaque index (95% CI)	-0.08 (-0.15; 0.00)	-0.34 (-0.42; -0.27)	-0.27 (-0.35; -0.19)	<0.0001

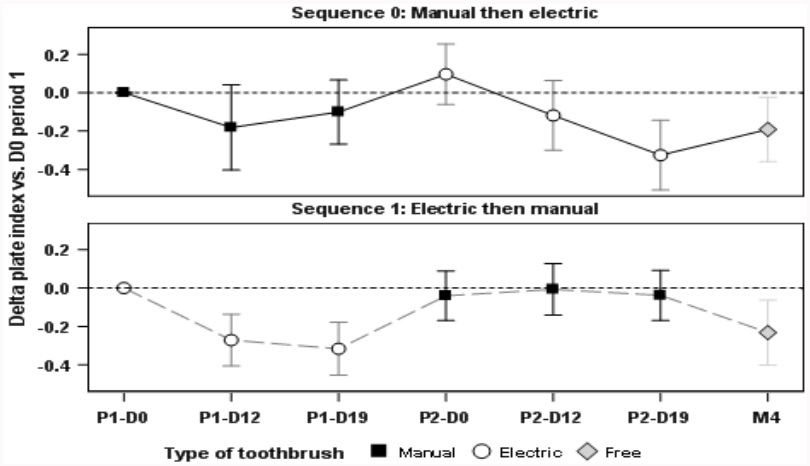

Figure 6: Delta plaque index mean and 95% confidence intervals at each visit compared to D0 period 1 by randomized sequence.

Table 5: Children's perception of the manual toothbrush.

Manual toothbrush topics	Quotes
Brushing harder, less help	"We have to make the motions on our own"
	"There's no stopwatch, we don't know how long we need to stay on the same area"
Practical material	"It's more convenient to carry and lighter"
	"The colours are pretty"
Pleasant brushing	"I preferred to brush my tongue with this brush"
Less effective brushing	"I feel like my teeth are less clean and smooth than with the electric toothbrush."

Table 6: Children's perception of the electric toothbrush.

Electric toothbrush topics	Quotes
Brushing more effective and less difficult	"I feel like my teeth are cleaner"
	"She rubs harder and better"
	"I have better access to teeth from the back of my mouth"
More playful material	"She's fun and motivating"
	"She's beautiful and you can put stickers on her"
Unpleasant brushing	"Toothpaste squirts everywhere"
	"The vibrations are strong and disturbing"
	"I didn't like brushing my tongue with it"
Complex application equipment	"It's heavier than the manual toothbrush"

of use of the electric brush but remained lower than the plaque index measured at D0 of both periods. During this month four visit, the children answered that they had used either the electric toothbrush or the manual toothbrush, and often both, without being specific enough to enable conclusions to be drawn. We also observed the expected effect of the wash-out period with a return of the mean plaque indexes at D0 of period two to approximately baseline values (Figure 6).

Qualitative analysis

Regarding the children's satisfaction and overall impression, a qualitative analysis of the responses to the anonymous questionnaire distributed to children found different themes. For example, with respect to manual brushing (Table 5), while children appreciated the ease of use and sensation ("it doesn't hurt"), some said they had difficulty brushing their teeth with this method ("you have to do the movements on your own") and mentioned its relative lack of effectiveness. The electric toothbrush (Table 6), was perceived by some children as more complex to use ("you have to load it") and vibrations could be unacceptable ("the vibrations are strong and annoying"), but it was also more fun and enjoyable ("it's fun and motivating") and more effective ("I feel that my teeth are cleaner") than the manual toothbrush.

Discussion

The main objective of this study was to assess the difference in plaque removal between manual and sonic electric toothbrushes in children with mixed dentition. A crossover design was chosen to measure the differences between the two types of toothbrushes on the same individuals (intra-subject) rather than between independent subjects, making the comparison more accurate. There was no carry-over effect in this study.

Our study showed, for the first time in mixed dentition, that a sonic electric toothbrush significantly reduces the plaque index compared to a manual toothbrush after 19 days of use. This significant effect of toothbrush type was estimated by a linear mixed model integrating the early period plaque index (D0), the sequence (E+M or M+E) and the type of brush as fixed effects, and the correlation between intra-subject measurements as random effects.

The analysis showed no period effect. On the other hand, in the manual and then electric sequence(M+E), the plaque reduction with the two types of brushes was more marked than with the electric then manual sequence (E+M), at the same D0. This was an inter-subject difference since the sequence effect could not be compared on the same individuals, each subject having only performed one sequence. We also found that, the higher the plaque index at D0, the greater the reduction in plaque index at D19 for the same period, toothbrush type and sequence. Imperfect initial brushing was therefore easier to improve than an early correct initial brushing technique.

The analysis of the plaque index in two categories (>1: High amount of plaque and ≤ 1 not ideal but acceptable amount of plaque), showed a large increase in the percentage of subjects with acceptable (≤ 1) plaque index after 19 days of electric toothbrush use (from 48.5% at D0 to 85.3% at D19 *vs.* from 50% at D0 to 57.4% at D19 with the manual brush). In particular, 74.3% of subjects with a high plaque index (>1) at D0 saw this index fall below or become equal to one after 19 days of electric toothbrush use. When brushing was good at D0 (index ≤ 1), all but one of the subjects maintained a ≤ 1 index after the 19 days of electric tooth brushing, which demonstrates superiority and consistency in biofilm removal effectiveness.

These observations can be explained not only by the effectiveness of the sonic electric toothbrush but also by the improved brushing time, due to the sound cues, and better brushing regularity, due to the perceived fun of its use. This is one limitation of our study, in which no timer was mandatory when the manual brush was used.

The improvement in the effectiveness of manual brushing was significantly less, especially when the basic index was above one. The electric toothbrush therefore brought most help to the children with poorer dental hygiene and helped to maintain the level of plaque removal in children who were already performing well.

Longitudinal analysis showed a continuous decrease in the plaque index between D0 and D12 and then between D12 and D19 with the electric toothbrush, regardless of the sequence. This improvement over time can be explained by the children learning to use this type of instrument and their good compliance. Only about one-third of the children in the sample had previous experience with an electric (but not sonic) brush either systematically or periodically. With the manual toothbrush, the plaque index did not improve from one session to the next, except at D12 for subjects who started the study with the manual brush (in the M+E sequence), which could be due to increased motivation related to their participation in the study and oral hygiene education sessions.

This study evaluated the effectiveness of two types of toothbrushes in an everyday use setting, without close monitoring of children or controlled brushing prior to assessment, unlike the studies by Garcia Godoy et al. [15] and Ghassemi et al. [16]. In fact, the brushing technique and frequency were initially taught to children and then reviewed after the washout period, but compliance was not verified before measuring the plaque index. The visits were made "by surprise", unannounced to the children (and even to the teachers sometimes) and the examiners were blinded to the type of toothbrush used. An improvement in the plaque index was therefore proof of the effectiveness of the toothbrush, but also of good compliance, since the children were autonomous. Despite a lack of consensus in international recommendations on tooth brushing (parental tooth brushing supervision, methods, etc.) [23,24], children can be expected to brush their teeth on their own at this age, even though it is linked to motor skills [22]. It is not only the brushing technique that is important but also the frequency [25] and duration [17]. Without supervision, the mean duration of tooth brushing in children aged 6 to 12 years was only 1.71 min [17].

We decided to evaluate the plaque index on permanent teeth exclusively because of the exfoliation process of first primary molars during the mixed dentition period. All of the children had already lost their primary lateral incisors at the beginning of the evaluations. The mean age of the children was 8.5 years (SD 0.7) and no children lost secondary molars during the study.

During the four-month re-evaluation, the plaque index was lower on average than that measured at the start of the study, which is encouraging in terms of the medium-term effectiveness of repeated oral hygiene. The children were given only two lessons in brushing technique, but each plaque disclosing session allowed them to assess their brushing and indirectly made them aware of the importance of dental hygiene [26]. Changes in dental hygiene habits are a complex process and are often based on repeated motivational sessions. A single instruction session might have a minimal effect [27].

The children's responses about the type of toothbrush used were not useable after four months because several children used both electric and manual toothbrushes, without being able to specify which one they used the most. Motivation plays a key role in improving children's oral hygiene practices, but requires a lot of follow-up and reminders [28]. The sonic toothbrush could also be a good motivational tool because of its playful aspect; visual supports have recently been added through connected digital applications.

The results of this study using a rechargeable sonic toothbrush corroborate those of previous longitudinal studies conducted in mixed dentition with oscillating rotating toothbrushes in groups of 29 to 105 children [15,16,29]. Da Costa et al. [29] did not find any difference with a 3D electric toothbrush in mixed teeth but found better lingual plate control of the anterior primary teeth. The results may vary according to the age of the population studied: In temporary dentition, Silverman et al. [11] showed no difference between three brushes, including two electric oscillating rotating brushes, in 58 children aged four to five years. In mixed dentition, the results are in favor of the rotary/oscillating [12,13] or vibratory [16,30] electric brushes. The frequency of brush strokes in sonic toothbrushes is rarely specified but might play a role in the reported effectiveness of tooth brushing, without increasing the incidence of bacteremia [31]. In young adults, Re et al. [3] also noticed a significantly greater removal of dental plaque, than with a manual toothbrush, with this technology producing fluid turbulent activity [32].

Various answers obtained after the qualitative analysis illustrate the variability of sensory feeling of school children. They were sensitive to the practical side of the brushes (weight, recharge time) and appreciated the timer integrated in the electric brush that guided them and encouraged them to increase their brushing time, which does not occur often with a manual toothbrush. As far as we know, this is the first qualitative analysis of tooth brushing perception by school children themselves, providing a comprehensive people-centered study. Previously, qualitative analysis was performed with adolescents but not with school children, or concerned parents' answers to questionnaires on their children's tooth brushing habits.

Our study shows an improvement of medium-term brushing in children with mixed dentition using sonic technology and the various perceptions of this method through qualitative analysis. After four months, the improvement in dental hygiene was sustained in the children included in the study.

Conclusion

Oral hygiene in children - and its maintenance - requires the acquisition of an age-appropriate brushing technique and sufficient learning time with regular follow-up and repetition of instructions. The introduction of the electric toothbrush at an age when children acquire some manual dexterity and independence from parental help motivates and sensitizes them to the importance of good oral health, thanks to its playful aspect and the incorporation of a stopwatch that controls brushing time. Along with this motivational aspect, the study of these children in mixed dentition showed that the use of an electric sonic toothbrush resulted in significantly better plaque removal than use of a manual toothbrush. Nevertheless, this improved brushing performance does not free families from the need to teach proper brushing technique and to have regular dental check-ups.

In conclusion, sonic electric toothbrushes significantly improve brushing performance compared to manual brushes in children with mixed dentition and can be recommended for families.

Acknowledgement

The authors would like to thank the children of M* Elementary School and their teachers, and Philips and Gaba for their technical support.

References

1. Deacon SA, Glenny AM, Deery C, Robinson PG, Heanue M, Walmsley AD, et al. Different powered toothbrushes for plaque control and gingival health. Cochrane Database Syst Rev. 2010;8(12):CD004971.

2. Yaacob M, Worthington HV, Deacon SA, Deery C, Walmsley AD, Robinson PG, et al. Powered versus manual toothbrushing for oral health. Cochrane Database Syst Rev. 2014:2014(6):CD002281.

3. Re D, Augusti G, Battaglia D, Giannì AB, Augusti D. Is a new sonic toothbrush more effective in plaque removal than a manual toothbrush? Eur J Paediatr Dent. 2015;16(1):13-8.

4. Doğan MC, Alaçam A, Aşici N, Odabaş M, Seydaoğlu G. Clinical evaluation of the plaque-removing ability of three different toothbrushes in a mentally disabled group. Acta Odontol Scand. 2004;62(6):350-4.

5. Ferraz NKL, Tataounoff J, Nogueira LC, Ramos-Jorge J, Ramos-Jorge ML, Pinheiro MLP. Mechanical control of biofilm in children with cerebral palsy: A randomized clinical trial. Int J Paediatr Dent. 2015;25(3):213-20.

6. Cui TQ, Lin HC, Lo ECM, Tao Y, Zhou Y, Zhi QH. Randomized clinical trial on the efficacy of electric and manual toothbrushes in plaque removal and gingivitis control in visually impaired school students. Quintessence Int. 2017;48(6):481-6.

7. Borutta A, Pala E, Fischer T. Effectiveness of a powered toothbrush compared with a manual toothbrush for orthodontic patients with fixed appliances. J Clin Dent. 2002;13(4):131-7.

8. Heasman P, Wilson Z, Macgregor I, Kelly P. Comparative study of electric and manual toothbrushes in patients with fixed orthodontic appliances. Am J Orthod Dentofacial Orthop. 1998;114(1):45-9.

9. Trimpeneers LM, Wijgaerts IA, Grognard NA, Dermaut LR, Adriaens PA. Effect of electric toothbrushes versus manual toothbrushes on removal of plaque and periodontal status during orthodontic treatment. Am J Orthod Dentofacial Orthop. 1997;111(5):492-7.

10. Erbe C, Klukowska M, Tsaknaki I, Timm H, Grender J, Wehrbein H. Efficacy of 3 toothbrush treatments on plaque removal in orthodontic patients assessed with digital plaque imaging: A randomized controlled trial. Am J Orthod Dentofacial Orthop. 2013;143(6):760-6.

11. Silverman J, Rosivack RG, Matheson PB, Houpt MI. Comparison of powered and manual toothbrushes for plaque removal by 4- to 5-year-old children. Pediatr Dent. 2004;26(3):225-30.

12. Grossman E, Proskin H. A comparison of the efficacy and safety of an electric and a manual children's toothbrush. J Am Dent Assoc. 1997;128(4):469-74.

13. Yankell SL, Emling RC. A thirty-day evaluation of the Rowenta Dentiphant powered toothbrush in children for safety and efficacy. J Clin Dent. 1996;7(4):96-100.

14. Vorwerk L, Ghassemi A, Hooper W, Patel V, Milleman J, Milleman K. Comparative plaque removal efficacy of a new powered toothbrush and a manual toothbrush. J Clin Dent. 2016;27(3):76-9.

15. García-Godoy F, Marcushamer M, Cugini M, Warren PR. The safety and efficacy of a children's power toothbrush and a manual toothbrush in 6-11 year-olds. Am J Dent. 2001;14(4):195-9.

16. Ghassemi A, Vorwerk L, Hooper W, Patel V, Sharma N, Qaqish J. Comparative plaque removal efficacy of a new children's powered toothbrush and a manual toothbrush. J Clin Dent. 2013;24(1):1-4.

17. Pujar P, Subbareddy VV. Evaluation of the tooth brushing skills in children aged 6-12 years. Eur Arch Paediatr Dent. 2013;14(4):213-9.

18. Shihadeh K, Maciel RR, Oliveira DD, Bavaresco CS, Reston EG, Moura FRR. Parents' perceptions and related factors of the oral health status of Brazilian children enrolled in public preschools. Eur Arch Paediatr Dent. 2020.

19. Suprabha BS, D'Souza V, Shenoy R, Karuna YM, Nayak AP, Rao A. Early childhood caries and parents' challenges in implementing oral hygiene practices: A qualitative study. Int J Paediatr Dent. 2021;31(1):106-14.

20. Mustafa M, Nasir EF, Åstrøm AN. Attitudes toward brushing children's teeth-A study among parents with immigrant status in Norway. Int J Paediatr Dent. 2021;31(1):80-8.

21. Natapov L, Kushnir D, Zusman SP. Sustainability of supervised toothbrushing in Israeli nurseries - teachers' perspective. Oral Health Prev Dent. 2019;17(5):433-7.

22. Kerr R, Claman D, Amini H, Alexy E, Kumar A, Casamassimo PS. Evaluation of the ability of five- to 11-year-olds to brush their teeth effectively with manual and electric toothbrushing. Pediatr Dent. 2019;41(1):20-4.

23. Muller-Bolla M, Courson F. Toothbrushing methods to use in children: A systematic review. Oral Health Prev Dent. 2013;11(4):341-7.

24. Dos Santos APP, Nadanovsky P, de Oliveira BH. Inconsistencies in recommendations on oral hygiene practices for children by professional dental and paediatric organisations in ten countries. Int J Paediatr Dent. 2011;21(3):223-31.

25. Schmalz G, Kiehl K, Schmickler J, Rinke S, Schmidt J, Krause F, et al. No difference between manual and different power toothbrushes with and without specific instructions in young, oral healthy adults-results of a randomized clinical trial. Clin Oral Investig. 2018;22(3):1147-55.

26. Cardoso CAB, Santos NM, Fracasso MLC, Provenzano MGA, Oliveira TM, Rios D. Dental plaque disclosure as an auxiliary method for infants' oral hygiene. Eur Arch Paediatr Dent. 2018;19(3):139-45.

27. Roscher T, Rösing CK, Gjermo P, Aass AM. Effect of instruction and motivation in the use of electric and manual toothbrushes in periodontal patients. A comparative study. Braz Oral Res. 2004;18(4):296-300.

28. Marini I, Bortolotti F, Parenti SI, Gatto MR, Bonetti GA. Combined effects of repeated oral hygiene motivation and type of toothbrush on orthodontic patients: A blind randomized clinical trial. Angle Orthod. 2014;84(5):896-901.

29. da Costa CC, da Costa Filho LC, Sória ML, Mainardi AP. Plaque removal by manual and electric toothbrushing among children. Pesqui Odontol Bras. 2001;15(4):296-301.

30. Jongenelis AP, Wiedemann W. A comparison of plaque removal effectiveness of an electric versus a manual toothbrush in children. ASDC J Dent Child. 1997;64(3):176-82.

31. Misra S, Percival RS, Devine DA, Duggal MS. A pilot study to assess bacteraemia associated with tooth brushing using conventional, electric or ultrasonic toothbrushes. Eur Arch Paediatr Dent. 2007;8(1):42-5.

32. Digel I, Kern I, Geenen EM, Akimbekov N. Dental plaque removal by ultrasonic toothbrushes. Dent J (Basel). 2020;8(1):28.