Comparative Evaluation of Powered and Manual Toothbrushes in Reducing Plaque and Gingivitis in Institutionalized Orphan Children

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Abstract

The purpose of this study was to compare the efficacy of powered toothbrush with that of manual toothbrush in the removal of plaque and reduction of gingivitis in institutionalized orphan children.

This was a randomized controlled examiner blind design study which included 80 institutionalized male orphan children aged 12-16 years. Baseline evaluation of plaque and gingival index scores was followed by an audio-visual health education on oral hygiene and tooth brushing methods to the study subjects and caretakers. Subjects were then randomly assigned to either manual or powered toothbrush groups, the plaque and gingival index scores were re-evaluated after toothbrushing intervention at 4 weeks and compared with baseline data.

No significant differences were noted between the two groups regarding plaque and gingival scores at baseline. However, statistically significant superior reduction in mean plaque and gingivitis versus baseline was seen in the powered toothbrush group compared to that in the manual toothbrush group (p=0.001) at 4 weeks interval.

Powered toothbrush (oscillating-rotating) was significantly more effective in the reduction of plaque and gingivitis levels compared to the manual toothbrush, in the present unsupervised toothbrushing intervention in institutionalized orphan children.

Clinical article (J Int Dent Med Res 2022; 15(2): 735-740)

Keywords: Powered toothbrush; Randomized Controlled Trial; Children; Institutionalized; Orphans.

Received date: 14 February 2022   **Accept date:** 21 March 2022

Introduction

Children from orphanages have been referred to as socially disadvantaged population who lack parental care and support[1]. These children can be considered one of the high-risk groups with reference to oral health care. Primary caretakers or teachers acting as their guardians usually supervise institutionalized orphan children. Poor oral hygiene has been one of the key predisposing factors for gingivitis and periodontal diseases. Literature suggests that children in orphanages have poor oral health and worse periodontal status due to lack of knowledge regarding correct oral hygiene practices, lack of motivation and ineffective brushing techniques. Further, limited access to oral care, especially preventive care, and dental neglect result in high unmet oral care needs[2-4]. Whilst mechanical and chemical plaque control measures have been reported to be efficacious in the prevention of occurrence of gingivitis through reduction of plaque[5], tooth brushing has been found to be most effective oral hygiene practice to maintain oral health[6]. Different types and designs of powered and manual toothbrushes have been developed specifically to appeal to children. Studies comparing the plaque-removal efficacy of powered and manual toothbrushes among different population groups have reported mixed results[7-11].

Similar data on socially disadvantaged children are scarce in the literature. The present study was undertaken to compare the efficacy of powered toothbrush with that of manual toothbrush in plaque removal and reduction of gingivitis, under unsupervised conditions, among

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12-16 years-old institutionalized male orphan children.

Materials and methods

The present study was a randomized, controlled examiner-blind trial with parallel design and involved 80 institutionalized male-orphan children aged 12-16 years recruited from an orphan care centre in sub-urban Southern city in India. Participation in the study was voluntary and the procedure was fully explained to the caretakers and/or guardians of the subjects involved in the study. Informed consent was obtained from the participants and concerned authorities of the orphanage prior to the study. The study was approved by the ethical and review board [ref: RC/007-2020]. All procedures performed in the study were in accordance with the ethical standards of the institutional research committee and the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Children present on the day of the examination were included. The exclusion criteria were potentially uncooperative children; children with systemic disorders that affect the periodontal disease; five or more caries lesions requiring restorative treatment; exposure to anti-inflammatory or antibiotic therapy; and dental prophylaxis in the past six months. Sample size calculation based on a 5% Type 1 error and 90% test power required 30 subjects in each group. 40 children were recruited into each group anticipating a 10-15% attrition rate.

Oral health examination including recording of baseline plaque and gingival indices were conducted in the orphanages using an intra-oral LED light, disposable mouth-mirror, a Community Periodontal Index probe in accordance with American Dental Association Type III specification[12]. Assessment of gingivitis was done by scoring gingival inflammation on six sites (mesio-buccal, buccal, disto-buccal, disto-lingual, lingual, mesio-lingual) on all scorable teeth using the Modified Gingival Index (MGI)[13]. Turesky-Gilmore-Glickman modification of the Quigley-Hein plaque index (1970)[14] (PI) was used to record the plaque score. A plaque disclosing agent was used before plaque index examinations and plaque was assessed on the facial and lingual surfaces of all the teeth. A plaque score per person was obtained by totalling all the plaque scores and dividing by the number of surfaces examined.

A dental health education including basic oral hygiene instructions was explained to the study subjects and caretakers by an audio-visual presentation. Subjects were then randomly allocated to two groups of 40 subjects each by throwing a coin; group 1 (manual toothbrush) and group 2 (powered toothbrush). Subjects in the manual toothbrush group were given a new manual toothbrush and those in the powered toothbrush group were given a new oscillation-rotation action powered toothbrush (Oral-B vitality electric toothbrush, Procter & Gamble, Cincinnati, OH, USA). Modified bass tooth brushing technique was demonstrated on study models using manual toothbrush and powered toothbrush for subjects in group 1 and group 2, respectively. Subjects in group 2 were given additional instructions regarding the use of powered toothbrush. Each child received ten minutes of individual instructions. Children were later asked to brush their teeth using the same technique in front of a mirror and were supervised. The same fluoridated toothpaste was provided to all the subjects to standardize the study and were instructed to follow the brushing technique demonstrated to them. Pea size amount of toothpaste was instructed to be dispensed on the assigned toothbrushes. Brushing time was instructed as two minutes each time twice daily. All the subjects were refrained from using any floss or mouth rinse for the duration of the study. No supervision of brushing activity in both the groups were done by the caretakers. The subjects were not informed about the follow-up examination. Care was taken to adhere to the standard infection control measures during the study.

Follow-up examination was done at 4 weeks after the intervention and the post-intervention plaque and gingival indices were recorded and compared with baseline scores. The percentages of mean reduction in plaque and gingivitis for the whole mouth was determined with the formula: percentage plaque reduction = pre-post / pre x 100 (pre=pre brushing value; post= post brushing value)[15]. No adverse events were reported by the participants during this study. The primary and secondary outcomes of this study were plaque removal and gingivitis reduction respectively, after toothbrushing.

Inter-examiner reliability:

Two examiners who were well trained and pre-calibrated performed the clinical examination and recorded plaque and gingival indices. The examiners were blinded with respect to the subject's group allocation. A blind re-examination of 10% of sample was performed and a Kappa score of 0.91 and 0.89 were achieved for intra-examiner and inter-examiner variability, respectively.

Statistical analysis:

Statistical analysis was done using the Statistical Package for the Social Sciences (IBM SPSS v.20 software for Windows [IBM Corp, Armonk, NY, USA]). Descriptive statistics including mean values and standard deviations were calculated. Mann-Whitney U-test was used to check for significant differences between the means of PI and MGI between the two groups, respectively. Wilcoxon-signed rank test was performed to determine whether there was difference between the baseline and post-intervention scores of PI and GI, within the two groups, respectively. Level of significance was set at 0.05.

Results

Out of the 80 subjects enrolled in the intervention, only 74 subjects completed the study. Five subjects from group1 and one subject from group 2 were excluded from the final sample and analysis, as they were not available for final examination [Fig 1]. The mean age (Mean±SD) in group 1 was 13.29±0.95 years and in group 2 it was 14.08±0.90 years.
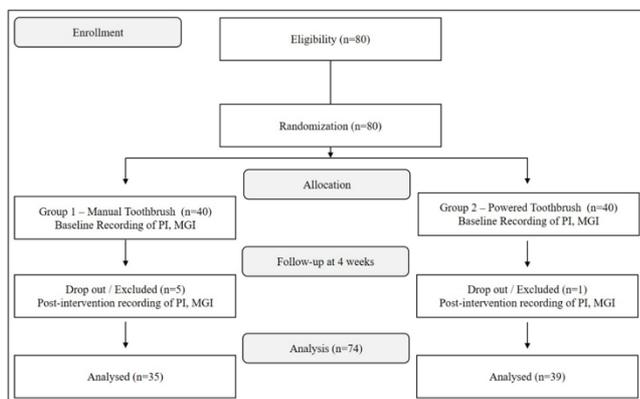

Figure 1. Flow diagram.

No statistically significant difference was noted between the two groups with regard to

mean PI and MGI scores at baseline. The mean baseline PI score of the powered brush group was 1.01, whereas the mean baseline PI score of the manual brush group was 0.98. At four weeks post-intervention, the PI score of the powered brush group (0.59) improved when compared to that of manual brush group (0.63). However, the difference was not statistically significant (p=0.64) [Table 1]. The mean baseline MGI score of the powered brush and manual brush groups were 1.06 and 1.08 respectively. The MGI score of powered brush group was significantly reduced (0.57) compared to that of the manual brush group (0.66) at four weeks post-intervention (p=0.049) [Table 2].

Intervention Groups	Plaque index				p-value^a
	Baseline (Mean±SD)	At 4 weeks Interval (Mean±SD)	Mean Difference (Mean±SD)	Plaque reduction percentage† (%)	
Manual toothbrush group (n=35)	0.98±0.38	0.63±0.37	0.35±0.83	34.7%	0.000*
Powered toothbrush group (n=39)	1.01±0.44	0.59±0.39	0.41±0.77	41.6%	0.000*
p-value^b	0.813	0.643	0.001*		

p-value^a: Wilcoxon signed rank test (within groups); p-value^b : Mann Whitney U test (between groups)
*Statistically significant (p<0.05)
†plaque reduction % = pre - post / pre x 100 (pre=pre brushing PI value; post= post brushing PI value)

Table 1. Comparison of mean plaque index values of both the groups at baseline and at 4 weeks interval.

Intervention Groups	Modified gingival index				p-value^a
	Baseline (Mean±SD)	At 4 weeks Interval (Mean±SD)	Mean Difference (Mean±SD)	Gingivitis reduction percentage† (%)	
Manual toothbrush group (n=35)	1.07±019	0.66±0.18	0.41±0.10	38.3%	0.000*
Powered toothbrush group (n=39)	1.06±0.21	0.57±0.18	0.48±0.64	46.2%	0.000*
P value^b	0.704	0.049*	0.001*		

p-value^a: Wilcoxon signed rank test (within groups) ; p-value^b : Mann Whitney U test (between groups)
*Statistically significant (p<0.05)
†gingivitis reduction % = pre - post/pre x 100 (pre=pre brushing MGI value; post= post brushing MGI value)

Table 2. Comparison of mean values of modified gingival index at baseline and at 4 weeks interval.

No statistically significant difference was noted between the two groups with regard to mean PI and MGI scores at baseline. The mean baseline PI score of the powered brush group was 1.01, whereas the mean baseline PI score of the manual brush group was 0.98. At four weeks post-intervention, the PI score of the powered brush group (0.59) improved when compared to that of manual brush group (0.63). However, the difference was not statistically significant

(p=0.64) [Table 1]. The mean baseline MGI score of the powered brush and manual brush groups were 1.06 and 1.08 respectively. The MGI score of powered brush group was significantly reduced (0.57) compared to that of the manual brush group (0.66) at four weeks post-intervention (p=0.049) [Table 2].
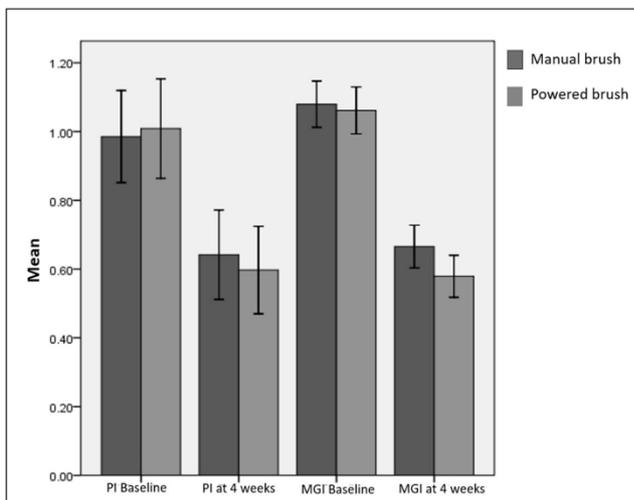

Figure 2. Mean reduction of plaque and gingivitis by toothbrush type in both the groups.

Within each group, the difference in mean values at baseline and at four weeks (post intervention) was statistically significant for both PI and MGI scores (p=0.000). The overall mean difference in the reduction rates of PI and MGI scores, between the two groups, was found to be statistically significant (p=0.001) [Fig 2].

Discussion

The present study was undertaken to compare the efficacy of powered and manual toothbrushes in reducing the plaque and gingivitis among 12-16 year-old institutionalized male orphan children. Literature has reported conflicting results regarding the plaque removal efficacy of powered and manual toothbrushes. In the present study, as both the manual and powered toothbrushes presented no significant differences in the baseline mean plaque and gingival scores between them at the initiation of intervention, they were considered homogenous at baseline. Further, both powered and manual brush groups were left unsupervised during the entire course of intervention after the single session of toothbrushing instructions given at baseline.

This study has shown that both powered and manual toothbrushes, under no supervision, produced significant reductions in mean plaque and gingival scores from baseline (p=0.000). However, when the efficacy of powered toothbrush was compared to that of the manual toothbrush, the unsupervised powered toothbrush group achieved statistically significant greater mean plaque and gingivitis reduction than did the unsupervised manual toothbrush group (p=0.001). The powered toothbrush group presented greater plaque reduction of 41.6% % at 4 weeks whereas in manual toothbrush group it was 34.7% during the same time duration from the baseline. Similarly, powered toothbrush group presented superior gingivitis reduction by 46.2% at 4 weeks, compared with that of the manual toothbrush group at 38.3%. These results are in agreement with those of previously reported studies which indicated that powered toothbrush was more effective in reducing plaque and result in a greater reduction in gingivitis than manual toothbrush[10,16-18]. On the contrary, few other studies have found no significant differences between powered and manual toothbrushes[7,9,19]. These contradictory differences could be attributed to differences in study design criteria and population.

The powered toothbrush used in the present study provides oscillation-rotation action which has been reported to be more effective in reducing plaque and gingivitis[17,20,21]. The greater efficacy of powered toothbrushes in removing the biofilm has been attributed to their hydrodynamic effects, higher rotation speed and superior interproximal cleaning abilities[22,23]. Heanue et al. (2003)[24] compared powered and manual toothbrushes and found that oscillation-rotation action powered brushes were more effective in removing plaque and reduce gingivitis than the manual brushes. Moreover, the criteria evaluated by Heanue et al. included only clinical trials with random allocation of participants, unsupervised manual and power tooth brushing intervention and those with the primary outcomes of change in plaque and gingivitis for atleast four weeks. In our study, similar criteria were followed. Davidovich et al. (2017)[18] in a randomised clinical study evaluated the plaque removal efficacy of a power toothbrush in children had concluded that the oscillating-rotating power toothbrush provided superior plaque removal relative to a manual brush with single use brushing in children.

Studies have shown that children are often inclined to the use of powered toothbrushes owing to their gadget appeal[25]. Although the brushing time in both the groups was two minutes, the greater effectiveness of electric brush could be attributed to the novel design and mechanism which could have provided an element of interest to the brushing activity resulting in better compliance and therefore superior reduction in powered toothbrush group. These findings corroborate with those of previous sudies[8,10]. However, 'Hawthorne bias' influencing the post-intervention result in the powered brush group due to the enthusiasm of using a novel brush design and also different motivation levels of subjects over the course of the intervention cannot be under-estimated, as suggested by Schlueter et al. (2010) [26].

In the present study, modified bass technique was the chosen brushing technique as several studies have reported this to be superior in reducing supragingival plaque[27]. Further, participants in both the groups were given the same fluoridated toothpaste and instructed to follow the same brushing time and frequency, to minimize confounding factors. The use of mouth rinses or dental floss were not considered in the present study and children were not informed that they would be re-examined 4 weeks after the baseline examination.

The main limitations of this study were the short-duration of 4 weeks due to the rules of the orphan care house that was selected to conduct this study. However, this does not affect the results found in this study because studies in the literature evaluating the efficacy of manual and powered toothbrushes over shorter and longer periods of time had obtained similar results. Moreover, the present study duration of 4 weeks, to evaluate the efficacy of powered and manual toothbrushes on plaque removal and gingivitis, was considered sufficient for plaque to accumulate based on Loe et al.[28] study, which indicated that clinical signs of gingivitis were observed in 10-21 days. Further, our study could not evaluate the participants' perception on the ease of using powered toothbrushes over manual toothbrushes.

Conclusions

Within the limitations of this study, we conclude that the oscillating-rotating powered toothbrush group showed significantly more reduction in the plaque and gingivitis levels compared to the manual toothbrush group. Further long-term trials with crossover design and larger sample may provide an insight into the merits and cost-effectiveness of powered toothbrush use in orphan children.

Declaration of Interest

The authors report no conflict of interest.

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