ORIGINAL RESEARCH

Safety and Efficacy of Plaque Removal Using Manual and Powered Toothbrush in Cerebral Palsy Children by Parents/Caregivers: A Randomized Control Crossover Trial

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Abstract

Aim: The aim of our study was to check the safety and efficacy of plaque removal using manual and powered toothbrush in cerebral palsy children by parents/caregivers.

Materials and methods: This was a single blinded, crossover randomized control trial conducted on 60 cerebral palsy children between the age of 6 to 14 years. They were randomly divided using a flip coin method into two groups: group A—manual toothbrush and group B—powered toothbrush. The plaque index (PI), gingival index (GI), and gingival abrasion (GA) score were measured at baseline, then at an interval of 3, 6, 9, and 12 weeks. This was followed by a crossover between two groups with a washout period of 1 week.

Results: Both manual and powered toothbrush showed a significant reduction in plaque and gingival score before and after crossover when compared to baseline ($p < 0.05$). The GA score was reduced to 100% in both groups. However, there was no statistically significant difference between both the groups before and after the crossover. Also, through the questionnaire it was observed that both child (86.6%) and parent (70%) showed positive feedback towards powered toothbrush.

Conclusion: It can be concluded from the present study that the efficacy of a powered toothbrush is comparable to that of a manual toothbrush. Parents and caregivers, on the contrary, displayed a favorable attitude towards the use of powered toothbrushes due to their ease of use.

Clinical relevance: Cerebral palsy is one of the most common neurological disorders among children. It is associated with poor motor skills and manual dexterity that hampers their ability to brush and thus leads to poor oral hygiene. A powered toothbrush seems more appealing and is specially designed for patients with poor neuromotor coordination.

Keywords: Cerebral palsy, Dental plaque, Gingivitis, Oral hygiene, Powered toothbrush, Randomized clinical trial, Toothbrushing methods.

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Introduction

Cerebral palsy is a nonprogressive neurological disorder caused by lesions or permanent damage to the brain in prenatal and perinatal periods when the central nervous system is in the developing phase. It affects approximately 2.5/1,000 live births all over the world.[1] A definite cause associated with this disability is not yet known, but factors leading to hypoxia or decreased oxygenation to a developing brain can contribute to brain damage, leading to cerebral palsy.[2,3]

Cerebral palsy is broadly divided into congenital and acquired types. It is also classified into four—spastic, athetosis, ataxic, and mixed according to the extent of cerebral and neuromuscular involvement. Among all these types, the spastic type of cerebral palsy is more commonly observed, with a prevalence of approximately 70% of cases.[4]

Cerebral palsy is associated with muscular weakness, stiffness or paralysis, irregular gait, and uncoordinated or involuntary movements. It has also been recognized that cerebral palsy can have direct or indirect effects on the oral health of an individual. Oral health diseases, such as dental caries, gingivitis, periodontal diseases, sialorrhea, malocclusions, bruxism, and trauma are more prevalent among these individuals. Patients with cerebral palsy tend to have greater plaque accumulation and gingivitis owing to their poor neuromuscular coordination and muscular dexterity.[5] So, the prime goal in these patients is to provide optimal oral health care by effective plaque control measures.

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Dental plaque is a bacterial biofilm that adheres to the tooth surfaces and is believed to be the primary cause of gingival inflammation and periodontitis. Therefore, it is important to prevent plaque accumulation in order to maintain gingival and periodontal health.[6]

There are various mechanical and chemical plaque control measures being implemented for effective plaque removal. Among these, toothbrushing is the most effective and widely used

as oral hygiene aid.[7] The first manual, plastic handle toothbrush with nylon bristles was introduced in 1930.[6] Since then, there have been various modifications and advances in the design of toothbrushes for effective and complete plaque removal. With subsequent development, the concept of a powered toothbrush was introduced in 1855 by a watchmaker Frederick Wilhelm. Powered toothbrushes were initially designed with back-and-forth motion and were commercially available in the 1960s. Currently, powered toothbrushes are available with vibratory and rotatory motions.[7]

According to the literature, published reports comparing powered and conventional toothbrushes reveal conflicting results depending on the subjects studied, the type of toothbrush used, the length of study, and methods of statistical analysis.[8–11] Powered or electric toothbrush seems to be more appealing and can be more advantageous in physically impaired individuals with poor manual dexterity and lack of fine motor skills, such as cerebral palsy patients. Hence, the aim of this study was to check the safety and efficacy of plaque removal and gingival health using manual and powered toothbrush in cerebral palsy children by parents/caregivers.

Materials and Methods

A single blinded randomized control crossover trial was planned to compare the safety and efficacy of plaque removal using manual and powered toothbrushes. The study design was according to the Consolidated Standards of Reporting Trials (CONSORT) (Flowchart 1—CONSORT flow diagram) checklist and was ethically approved by Sumandeep Vidyapeeth Institutional Ethic Committee (SVIEC/ON/DENT/BNPG14/D15022 dated—9th March 2015).

The present study was conducted among cerebral palsy children between the age-group of 6–14 years in "Spandan School for Special Children" in Vadodara District, Gujarat, India. Prior permission was taken, and a schedule for examining the study subjects was given to "Spandan School for Special Children." Prior to the study, participants and their parents were briefed about the study's objectives and design, and written informed consent was obtained. A total of 60 children diagnosed with cerebral palsy between the age-group of 6–14 years were selected on the basis of the inclusion and exclusion criteria of the study. After the selection of the participants, they were randomly divided into two groups, each comprising 30 participants by flip coin method. This was followed by a crossover after 3 months with a manual and powered toothbrush. The groups were as follows:

- Group A—a total of 30 subjects were given a manual toothbrush.
- Group B—a total of 30 subjects were given a powered toothbrush.
- Group A—manual toothbrush.
- Group B—powered toothbrush.

Clinical examination of each participant was carried out by the principal investigator (Fig. 1). The baseline score of plaque and gingivitis was recorded using the PI (Sillness and Loe, 1964) and GI (Loe and Sillness,1963) respectively.[12] Also, each participant was evaluated for GA (according to the method adapted by Danser et al.).[13] Two-tone plaque disclosing solution and Schiller's Iodide solution (for GA) were used during every visit. Complete oral prophylaxis was done 1 week before the commencement of the study. Caregivers of each participant were trained for proper brushing techniques through videos, followed by a hands-on session in order to get a standardized outcome. The follow-up was done at an interval of 3, 6, 9, and 12 weeks. After 3 months, giving a gap of 1 week, a crossover of the manual and powered toothbrush was done and follow-up was done at the same intervals as mentioned earlier. Also, a closed-ended questionnaire was formulated regarding the use of manual and powered toothbrushes and was given to the parents/caregivers of the participants at the end of the study to check the safety and efficacy of both toothbrushes.

The collected data was entered in a Microsoft Excel (2016) spreadsheet and was statistically analyzed using Statistical Package for the Social Sciences version 21 for inferential data. Descriptive statistical analysis was carried out using *t*-test, where $p \leq 0.05$ was considered significant.

Fig. 1: Clinical intraoral examination and index recording procedure of a child in a school

Results

The present study was a randomized control crossover trial conducted to compare the safety and efficacy of plaque removal using manual and powered toothbrushes among cerebral palsy children between the age-group of 6–14 years. Participants were divided into two groups—groups "A" and "B," each consisting of 30 participants. Results were obtained by the comparison of the groups that have emerged after the crossover trial. These groups were—AM : Group 'A' - Manual (M) toothbrush BP : Group 'B' - Powered (P) Toothbrush AFTER CROSSOVER - AP - Group 'A' - Powered (P) Toothbrush BM - Group 'B' - Manual (M) toothbrush.

Among 60 participants included in the study, 17 (28.3%) were girls and 43 (71.7%) were boys, with a mean age of 9.37 ± 2.39 years. Prior to the study, 55 children were using a manual toothbrush and five were using a powered toothbrush.

The mean values of plaque score before and after crossover intervention are shown in (Table 1). The results of the present study indicated a gradual reduction in plaque score from baseline in both groups at each follow-up visit ($p < 0.05$). Before crossover, the mean reduction in PI score after 12 weeks for a manual toothbrush and powered toothbrush was 0.62 ± 0.29 and 0.68 ± 0.29, respectively. Whereas, after crossover, the mean reduction in the PI score for a manual toothbrush and powered toothbrush was 0.63 ± 0.29 and 0.68 ± 0.29, respectively (Table 2). However, there was no significant difference observed between both the groups before and after the crossover intervention.

The mean values of gingival score before and after crossover intervention are shown in (Table 3). The results of the present study show that there was a gradual reduction in GI from baseline in both

Flowchart 1: CONSORT flow diagram

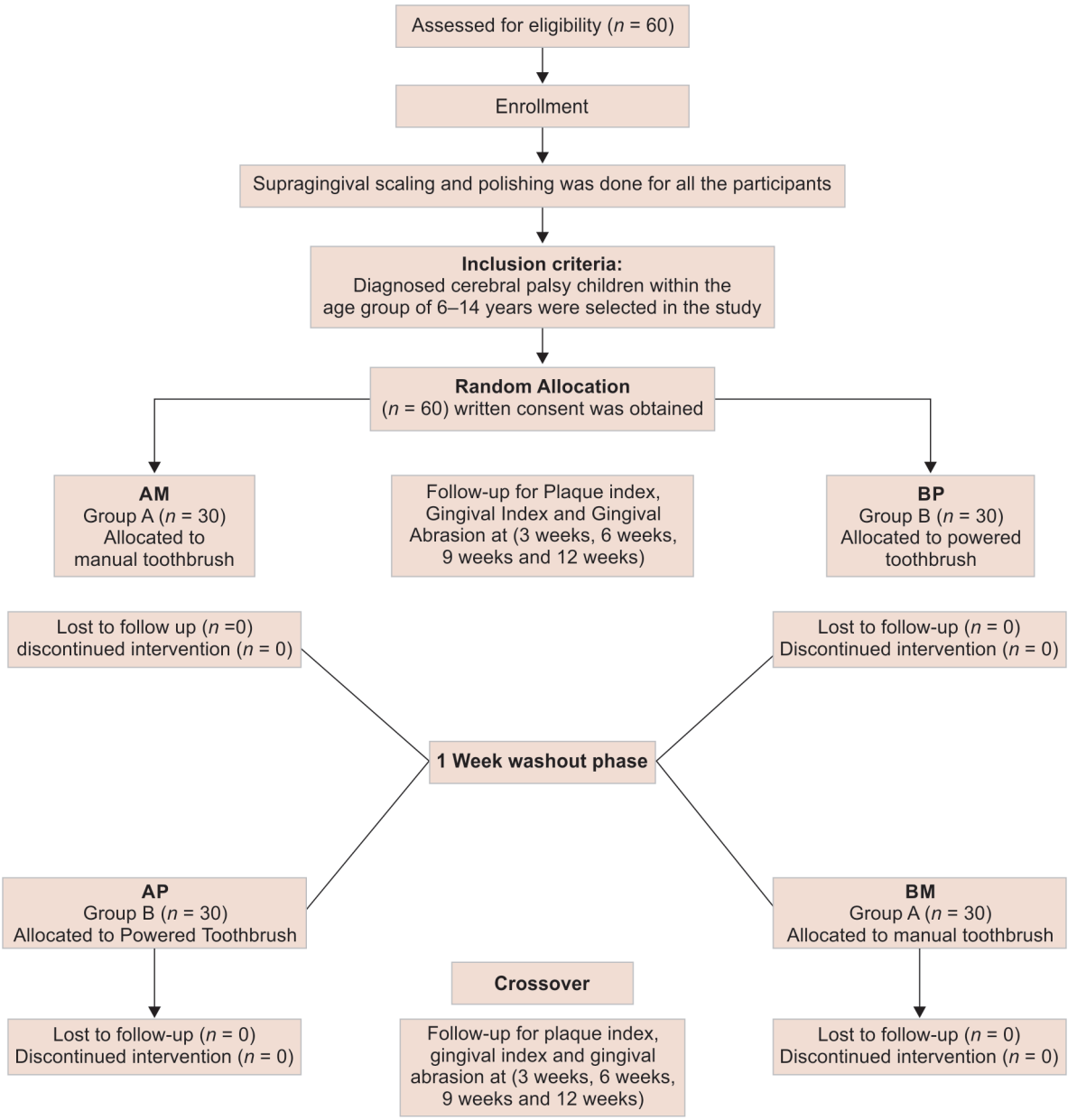

Table 1: Before and after crossover comparison of PI score within the groups from baseline to 12 weeks follow-up in cerebral palsy children

	Before crossover		*After crossover*	
PI at follow-up interval	*Group: A Intervention: M (AM)*	*Group: B Intervention: P (BP)*	*Group: A Intervention: P (AP)*	*Group: B Intervention: M (BM)*
Baseline	1.61 ± 0.29	1.41 ± 0.48	1.64 ± 0.14	1.55 ± 0.42
3 weeks	1.48 ± 0.27	1.27 ± 0.44	1.50 ± 0.15	1.40 ± 0.41
6 weeks	1.37 ± 0.25	1.13 ± 0.39	1.34 ± 0.14	1.26 ± 0.41
9 weeks	1.25 ± 0.26	0.98 ± 0.38	1.19 ± 0.18	1.15 ± 0.41
12 weeks	1.00 ± 0.31	0.76 ± 0.32	0.91 ± 0.24	0.96 ± 0.39

groups at each follow-up visit ($p < 0.05$). Before crossover, the mean reduction in GI score after 12 weeks for manual toothbrush and powered toothbrush was 0.65 ± 0.33 and 0.75 ± 0.40, respectively. Whereas, after crossover, the mean reduction in PI score for manual toothbrush and powered toothbrush was 0.68 ± 0.32 and 0.65 ± 0.27, respectively (Table 4). However, there was no significant difference observed between both the groups before and after the crossover intervention.

Table 2: Before and after crossover comparison of mean difference in PI Score within the groups from baseline to 12 weeks follow-up in cerebral palsy children

	Before crossover			*After crossover*		
PI at follow-up interval	*Group: A Intervention: M (AM)*	*Group: B Intervention: P (BP)*	*p-value* (AM vs BP)*	*Group: A Intervention: P (AP)*	*Group: B Intervention: M (BM)*	*p-value* (AP vs BM)*
Baseline—3 weeks	0.14 ± 0.10 (p < 0.05)**	0.16 ± 0.10 (*p* < 0.05)**	0.42	0.13 ± 0.06 (*p* < 0.05)**	0.13 ± 0.06 (*p* < 0.05)**	0.87
Baseline—6 weeks	0.27 ± 0.24 (*p* < 0.05)**	0.31 ± 0.20 (*p* < 0.05)**	0.44	0.28 ± 0.18 (*p* < 0.05)**	0.25 ± 0.13 (*p* < 0.05)**	0.38
Baseline—9 weeks	0.41 ± 0.24 (*p* < 0.05)**	0.45 ± 0.24 (*p* < 0.05)**	0.52	0.40 ± 0.22 (*p* < 0.05)**	0.37 ± 0.20 (*p* < 0.05)**	0.56
Baseline—12 weeks	0.62 ± 0.29 (*p* < 0.05)**	0.68 ± 0.29 (*p* < 0.05)**	0.46	0.64 ± 0.28 (*p* < 0.05)**	0.63 ± 0.28 (*p* < 0.05)**	0.91

*$p \leq 0.05$, unpaired *t*-test; **$p \leq 0.05$, paired *t*-test (when comparing between intervals)

Table 3: Before and after crossover comparison of GI score within the groups from baseline to 12 weeks follow-up in cerebral palsy

	Before crossover		*After crossover*	
GI at follow-up interval	*Group: A Intervention: M (AM)*	*Group: B Intervention: P (BP)*	*Group: A Intervention: P (AP)*	*Group: B Intervention: M (BM)*
Baseline	1.61 ± 0.30	1.42 ± 0.47	1.64 ± 0.14	1.55 ± 0.46
3 weeks	1.44 ± 0.26	1.25 ± 0.44	1.46 ± 0.09	1.38 ± 0.32
6 weeks	1.34 ± 0.27	1.10 ± 0.41	1.30 ± 0.16	1.22 ± 0.41
9 weeks	1.22 ± 0.26	0.98 ± 0.38	1.16 ± 0.19	1.11 ± 0.41
12 weeks	0.97 ± 0.33	0.72 ± 0.35	0.86 ± 0.28	0.92 ± 0.43

Table 4: Before and after crossover comparison of mean difference in GI score within the groups from baseline to 12 weeks follow-up in cerebral palsy children

	Before crossover			*After crossover*		
GI at follow-up interval	*Group: A Intervention: M (AM)*	*Group: B Intervention: P (BP)*	*p-value**	*Group: A Intervention: P (AP)*	*Group: B Intervention: M (BM)*	*p-value**
Baseline—3 weeks	0.19 ± 0.13 (*p* < 0.05)**	0.15 ± 0.25 (*p* < 0.05)**	0.51	0.19 ± 0.12 (*p* < 0.05)**	0.15 ± 0.07 (*p* < 0.05)**	0.14
Baseline—6 weeks	0.32 ± 0.21 (*p* < 0.05)**	0.33 ± 0.22 (*p* < 0.05)** (*p* < 0.05)**	0.98	0.35 ± 0.24 (*p* < 0.05)**	0.26 ± 0.15 (*p* < 0.05)**	0.09
Baseline—9 weeks	0.45 ± 0.25 (*p* < 0.05)**	0.46 ± 0.28 (*p* < 0.05)**	0.81	0.44 ± 0.24 (*p* < 0.05)**	0.37 ± 0.19 (*p* < 0.05)**	0.29
Baseline—12 weeks	0.65 ± 0.33 (*p* < 0.05)**	0.75 ± 0.40 (*p* < 0.05)**	0.34	0.65 ± 0.27 (*p* < 0.05)**	0.68 ± 0.32 (*p* < 0.05)**	0.74

*$p \leq 0.05$, unpaired *t*-test; ** $p \leq 0.05$, paired *t*-test (when comparing between intervals)

The mean score of GA of both the groups before and after crossover is shown in (Table 5). Before crossover, the GA score was reduced to 100% within 6 weeks of the interval and remained 100% for both groups till 12 weeks of follow-up. Before crossover, the mean reduction in GA score at the end of 12 weeks for manual and powered toothbrush was 1.00 and 1.13, respectively. In the AP group, GA score was reduced to 100% at 3 weeks of the follow-up interval while in the BM group it was reduced to 100% at 6 weeks of follow-up. The mean reduction in the GA score was found to be highly significant during each follow-up for both groups. The mean reduction in GA score for a manual toothbrush and a powered toothbrush was 1.03 and 0.77, respectively (Table 6).

According to the results of the questionnaire, it was concluded that 70% of parents observed that powered toothbrushes made their child clean their teeth regularly than the manual ones. They received positive feedback from the child (86.6%) while using an electric or powered toothbrush. Nearly >60% of parents thought that electric toothbrush made the oral care for their child easier than manual. Nearly 73% of them observed that the sound and vibration of the electric toothbrush made their children anxious initially. About 53.4% of them thought that the small brush head of the electric toothbrush was able to clean the teeth of the child. Whereas only 38% of them could see whether the toothpaste properly squirts everywhere in the mouth when you brush their teeth with the electric toothbrush.

Discussion

Among various plaque control measures, mechanical plaque removal using a manual toothbrush is the most common oral hygiene aid. However, differently abled population pose difficulty in using manual toothbrush owing to their weak motor skills and

Table 5: Before and after crossover comparison of GA score within the groups from baseline to 12 weeks follow-up in cerebral palsy children

	Before crossover		*After crossover*	
GA at follow-up interval	*Group: A Intervention: M (AM)*	*Group: B Intervention: P (BP)*	*Group: A Intervention: P (AP)*	*Group: B Intervention: M (BM)*
Baseline	1.10 ± 1.15	0.93 ± 1.08	1.07 ± 1.20	0.83 ± 0.98
3 weeks	0.03 ± 0.18	0.03 ± 0.18	0.00 ± 0.00	0.03 ± 0.00
6 weeks	0.00 ± 0.16	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
9 weeks	0.00 ± 0.16	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00
12 weeks	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00	0.00 ± 0.00

Table 6: Before and after crossover comparison of mean difference in GA score within the groups from baseline to 12 weeks follow-up in cerebral palsy children

	Before crossover			*After crossover*		
GA at follow-up interval	*Group: A Intervention: M (AM)*	*Group: B Intervention: P (BP)*	*p-value**	*Group: A Intervention: P (AP)*	*Group: B Intervention: M (BM)*	*p-value**
Baseline—3 weeks	0.97 ± 1.13 ($p < 0.05$)**	1.13 ± 1.14 ($p < 0.05$)**	0.58	0.77 ± 1.04 ($p < 0.05$)**	1.00 ± 1.14 ($p < 0.05$)**	0.41
Baseline—6 weeks	1.00 ± 1.08 ($p < 0.05$)**	1.13 ± 1.14 ($p < 0.05$)**	0.64	0.77 ± 1.04 ($p < 0.05$)**	1.03 ± 1.16 ($p < 0.05$)**	0.35
Baseline—9 weeks	1.00 ± 1.08 ($p < 0.05$)**	1.13 ± 1.14 ($p < 0.05$)**	0.64	0.77 ± 1.04 ($p < 0.05$)**	1.03 ± 1.16 ($p < 0.05$)**	0.35
Baseline—12 weeks	1.00 ± 1.08 ($p < 0.05$)**	1.13 ± 1.14 ($p < 0.05$)**	0.64	0.77 ± 1.04 ($p < 0.05$)**	1.03 ± 1.16 ($p < 0.05$)**	0.35

*$p \leq 0.05$, unpaired *t*-test; **$p \leq 0.05$, paired *t*-test (when comparing between intervals)

poor manual dexterity. To overcome this and to improvise brushing, powered toothbrushes were introduced. This study was designed to compare the effectiveness and safety of powered and manual toothbrush in plaque removal in cerebral palsy patients.

The results of the present study indicated that participants in both the groups before and after crossover showed a gradual reduction in the PI score over subsequent intervals. At each interval, there was a statistically significant difference observed within both groups when compared with the baseline score. However, there were no statistically significant intergroup differences noted in mean PI scores at any follow-up intervals. Similar findings were reported by Ferraz et al., Neelima et al., and Goyal et al., wherein both manual toothbrushes and powered toothbrushes were equally effective and efficient in reducing plaque accumulation.[14–16] However, Bozkurt et al. reported that a powered toothbrush is more efficient compared to a manual toothbrush in cerebral palsy patients.[17] This can be attributed to the difference in study design, method of recording plaque score, and duration of the study.

Similar to plaque score, GI score also showed a gradual reduction in both groups over subsequent intervals. At each interval, there was a statistically significant difference observed within both groups when compared with the baseline score. However, there were no statistically significant intergroup differences noted in mean GI scores at any follow-up intervals. This was contradictory to the results of the study by Bozkurt et al., wherein the gingival inflammation was significantly reduced with a powered toothbrush compared to a manual toothbrush in cerebral palsy patients.[17] Similar to the present study, Vandana et al. and Jamkhande et al., showed a significant reduction in plaque and gingival bleeding scores in mentally challenged children.[18,19]

Present study also compared the effect of powered and manual toothbrushes on GA, concluding that GA score was reduced to 100% in both groups, with no statistically significant difference. However, the score reduced to 100% within 3 weeks for a powered toothbrush compared to 6 weeks for a manual toothbrush. This shows that healing of the gingival tissue occurs faster with the powered toothbrush than with the manual toothbrush. This can be attributed to a small size brush head and less brushing force in a powered toothbrush that prevents excessive scrubbing of the gingival tissues. To our knowledge, this was the first study evaluating the effect of a powered toothbrush on GA in cerebral palsy patients.

In a study conducted by Danser et al. and Walsh et al., both powered and manual toothbrushes showed an equal incidence of GA.[13,20] On the contrary, Niemi et al. and Rosema et al. observed less GA on using an electric toothbrush compared to a manual toothbrush, but the difference was not statistically significant.[21,22]

As it was a crossover trial, washout period of 1 week was followed after the first intervention so as to prevent the carryover effect. In this session, parents were instructed to brush their child's teeth with the same toothbrush they were using prior to the initiation of the study. During this period, as parents and caregivers were not under supervision, there was an increase in PI, GI, and GA scores that was observed.

The results of our study indicated that plaque removal efficacy and acceptance of a power toothbrush was clinically superior compared to a manual toothbrush. This can be due to ease of use and as a result of the "novelty effect" while using a power toothbrush. However, there was no statistically significant difference observed between both interventions. It can be stated that when used as part of a daily oral hygiene regimen, the powered toothbrush was preferred over the manual toothbrush in reducing plaque and gingivitis over a period of 6 months in a crossover trial and can be a safe and effective adjunct to professional instrumentation to maintain the health of periodontium in the special children but at the same time, it is crucial to emphasize that

a recommendation should be based on a critical evaluation of the individual children's oral hygiene status.

Conclusion

It can be concluded from the present study that there was a significant reduction in plaque, gingival, and GA scores in both groups at every subsequent interval. Parents/caregivers had also received positive feedback from the child on the use of the powered toothbrush. However, the intergroup comparison showed no statistically significant difference between the efficacy of manual and a powered toothbrush before as well as after the crossover.

Clinical Significance

Cerebral palsy is associated with poor motor skills and manual dexterity that hampers a child's ability to brush and thus leads to poor oral hygiene. A powered toothbrush seems more appealing and is specially designed for patients with poor neuromotor coordination, aiding in effective plaque removal and better oral hygiene.

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