Original Article

Comparison of Efficacy of Manual and Powered Toothbrushes in Plaque Control and Gingival Inflammation: A Clinical Study among the Population of East Indian Region

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Abstract

Aim and Objective: To figure out, analyze and assess the effectiveness of powered toothbrush (Braun/Oral-B two-dimensional) and manual toothbrush (Oral-B40 Regular Advantage Plus) on supragingival plaque and gingival health.

Materials and Methods: The efficacy of powered toothbrush to that of manual one was compared by using a randomized clinical trial over a 4 weeks period in controlling plaque and gingivitis using gingival index, plaque index (PI), and oral hygiene index. A total of 45 patients with age group from 19 to 23 years were included in the study. Collected data were analyzed, and different subgroups were compared using Student's *t*-test, Levene's test, and Chi-square test.

Results: In both groups whether using powered or manual toothbrush, there was marked decrease in PI scores and gingival health improvement. However, there was better reduction in PI scores and improvement in gingival health in powered toothbrush group.

Conclusion: All individuals with both groups showed reduction in PI and hygiene index, but when it was assessed on the 4th week, individuals using powered toothbrush showed better results when compared to the individuals using manual toothbrush.

Keywords: *Dental plaque, gingivitis, oral hygiene, plaque control, powered toothbrush*

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Introduction

Bacterial plaque in the vicinity of gingival margin has been emphasized to play a potential role in the pathogenesis of periodontal disease. Its role in the etiology of periodontal disease has been extensively documented. Across the world, it is confronted that deterrence and reticence of accumulation of plaque on the surfaces of tooth result in a major breakthrough to achieve excellent periodontal health. Regular removal of supragingival plaque has been shown to reduce counts of pathogenic species both supra- and sub-gingivally.[1]

Various techniques have been introduced and investigated for successful usefulness of tooth brushing in plaque removal. Comparative studies are also available with regard to brushing techniques claiming significance of one over the other performed by both manual and powered toothbrush.

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The bristle toothbrushes were first invented about the year 1600, in China, and were first patented in America in 1857, and have since undergone little changes. A Swedish watchmaker Fredrick Wilhelm Tornberg is credited with designing the first mechanical toothbrush in 1885. According to Rosenthal, the first powered toothbrush was introduced at the American Dental Association Convention in St. Louis in 1938. It was in the 1960s that widespread use and testing of electric brushes in controlling plaque, gingivitis, and staining were initiated.[2]

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The electric toothbrush is both efficient and surprisingly appealing to patients. For these reasons, it has a definite use for some patients such as individuals lacking fine motor skills, especially the physically challenged and those who lack digital dexterity.

The motto in training oral hygiene procedures is it to reduce plaque accumulation. Although many advancements in the field of periodontology have been evaluated to control the oral hygiene, the ultimate prevention and control of gingivitis and periodontitis rest in the hands of the patients.[3]

Since the arrival and invention of the electric toothbrush, there has been continuing controversy whether or not it is more efficacious than a manual toothbrush. Some reports seem to indicate that powered toothbrushes are better than manual ones in maintaining good oral hygiene.[4] However, the results of previously conducted studies have concluded that both the brushing modalities have similar effect on plaque control.[5] Furthermore, like the manual brush, electric brushes are not very effective in removing plaque on the interproximal and lingual tooth surfaces.[6] Consequently, other mechanical devices in the form of toothpicks, floss, single-tufted toothbrush, interdental (bottle brush type) brushes, and water picks were devised and advocated to supplement a given brushing technique, for most effective and complete plaque removal.[1,7]

The goal of the present study was to appraise the safety and adequacy of the Braun/Oral-B two-dimensional (2D) powered toothbrush for the elimination of supragingival plaque and developing gingival health and to compare it to a routine manual toothbrush Oral-B40 Regular Advantage Plus toothbrush.

Aim and objective

To figure out, analyze and assess the efficacy and effectiveness of the powered toothbrush (Braun/Oral-B 2D) and manual toothbrush (Oral-B40 Regular Advantage Plus) on supragingival plaque and gingival health.

Materials and Methods

This study was conducted in the Department of Periodontics and Oral Implantology, Kalinga Institute of Dental Sciences, KIIT University, Bhubaneswar, from February to May 2016, after obtaining ethical approval from Institutional Ethics Committee (KIMS/KIIT/IEC/148/2016). Forty-five patients in the age group of 18–25 years participated in the study after giving informed consent.

The sample size was fifty calculated for α error fixed at 5% and β error fixed at 20%, expected mean difference 2.35 and standard deviation 2.26 based on the said calculation required in each group. The five individuals dropped out, and the total sample size was 45.

Patient selection criteria for the study

1. Moderate-to-good oral hygiene
2. No dental caries in the present teeth
3. Patients with no adverse habits of smoking and pan chewing
4. Patients who never used powered toothbrushes
5. Patients with minimum of twenty teeth present in their oral cavity
6. Patients with no systemic diseases and conditions
7. Patients not on nonsteroidal anti-inflammatory drugs, corticosteroids, or any other drugs, 1 month before the study.

Study design

Forty-five individuals were included in the current study and further divided into two groups:

- Group A: A total of 23 individuals were included in this group. Each of these individuals was allotted a manual toothbrush Oral-B40© Advantage and a tube of Colgate Total© toothpaste and they were asked to use modified Bass method of brushing
- Group B: A total of 22 individuals were included in this group. Each of these individuals were allotted a powered toothbrush Oral-B 2D© and a tube of Colgate Total© toothpaste. They were instructed to use the brush with the bristles at right angles to the gingival margin or sulcus.

Experimental design

The study duration was 28 days. The individuals were asked to report to the department on day 0, 7, 14, and 28, after completion of oral prophylaxis. All the individuals who participated in the study were advised to refrain from brushing their teeth for 24 h before their appointment on day "0".

On day "0"

Plaque was disclosed by using a disclosing solution in the form of a rinse for all individuals. The prebrushing plaque score was recorded in the prepared pro forma by using the Turesky Gilmore Glickman modification of the Quigley-Hein plaque index (PI).[2]

The gingival status for each individual was measured using the gingivitis component of Ramfjord's periodontal disease index, and gingival bleeding was measured with the gingival bleeding index.[2]

Following this, the individuals were instructed to brush with the allocated toothbrush and Colgate Total toothpaste and the brushing technique in which they were instructed (Group A and Group B – powered toothbrush) for 2 min in our department.

Re-examination was done after disclosing plaque, and the plaque score was recorded using the Turesky Gilmore Glickman modification of the Quigley-Hein PI.

Further, the individuals were instructed to use the allocated toothbrushes using the prescribed brushing technique at home daily for 2 min and were given appointments on the 7th, 14th, and 28th days.

On 7th day, 14th day, and 28th day

On day 7 and 28, the same investigational measures were carried out, and the PI, gingival index (GI), and russels periodontal index (RPI) were evaluated and measured like that as done on day "0", and statistical evaluation was done.

Different sets of written instructions for brushing techniques were given to each individual using the manual toothbrush and powered toothbrush, respectively.

Results

All 45 individuals successfully completed the study and maintained their recall appointments. Evaluation of clinical observations of PI, GI, and gingival bleeding index between Group A and B is presented in Tables 1-11 and Figures 1-7.

The participating individuals whether they used manual or powered toothbrush demonstrated a decrease in the PI score and gingival health improvement. The individuals using powered toothbrush showed a comparatively better decrease in PI scores and gingival health improvement on the 28th day.

Table 1: Characteristics of participants in the study

	Group A	Group B	Total
Sex			
Male	11	4	15
Female	12	18	30
Total	23	22	45

Table 2: Mean plaque index scores for Group A individuals

	0 day		7th day		14th day		28th day	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Prebrushing	1.56	0.4	1.53	0.54	0.88	0.39	00.71	0.31
Postbrushing	0.61	0.34	0.58	0.42	0.29	0.24	0.17	0.19

Steady decrease in the pre- and post-brushing mean plaque index scores from 0 to 7th, 14th, and 28th days, respectively. SD=Standard deviation

Table 3: Mean plaque index scores for Group B individuals

	0 day		7th day		14th day		28th day	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Prebrushing	1.77	0.34	1.43	0.56	0.98	0.45	0.70	0.44
Postbrushing	0.81	0.39	0.54	0.36	0.25	0.19	0.13	0.13

Steady decrease in the pre- and post-brushing mean plaque index scores from day 0 to 7th, 14th, and 28th days. SD=Standard deviation

Within the limitations of this study, following conclusions were made:

1. PI reduction was found in individuals of Group A and B from day 0 to day 28
2. A better significance was seen in individuals of Group B when comparison was done between Group A and B ($P = 0.052$)
3. Decrease in the gingival inflammation was seen in both groups which were evaluated using the GI scores
4. However, no significance difference was seen statistically in the GI scores when comparison was done between Group A and B
5. There was a statistically significant reduction in the percentage of gingival bleeding index when Group B was compared to that of Group A ($P < 0.001$).

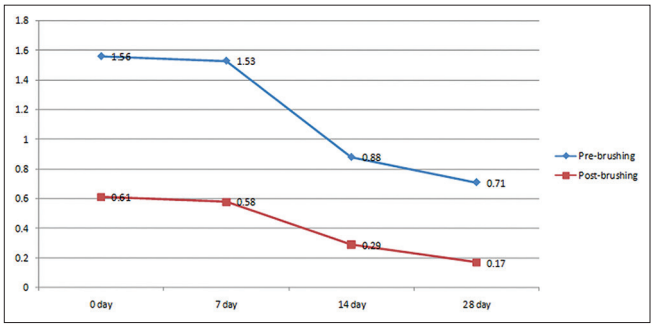

Figure 1: Mean plaque index score for Group A individuals

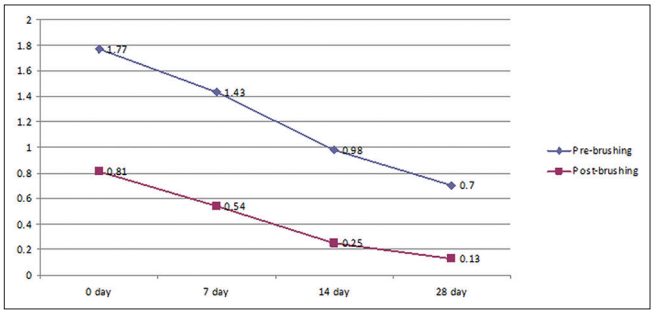

Figure 2: Mean plaque index score for Group B individuals

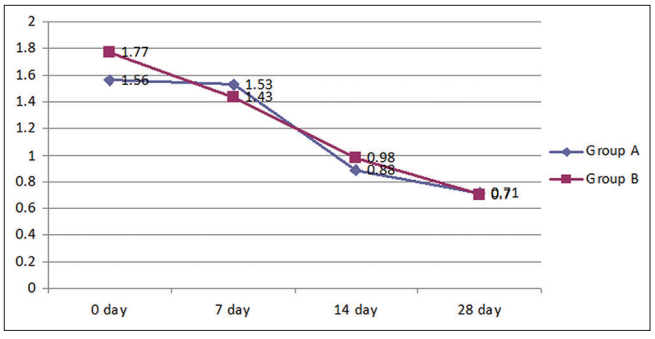

Figure 3: Comparison of prebrushing mean plaque index scores for Group A and Group B individuals

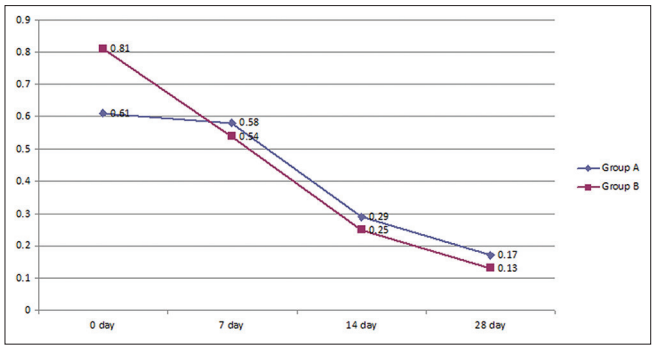

Figure 4: Comparison of postbrushing mean plaque index score for Group A and Group B individuals

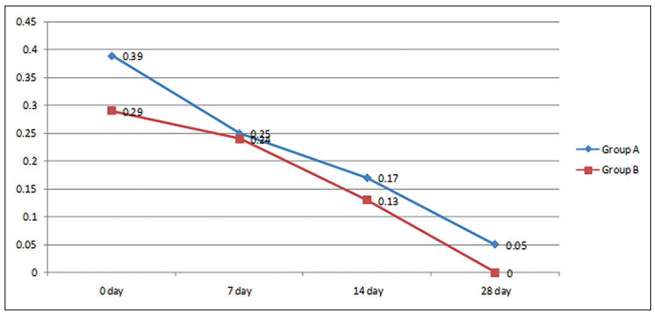

Figure 6: Mean gingival index scores for Group A and Group B individuals

Group A mean plaque index scores

Pre- and post-brushing PI scores (mean) were 1.56, 1.53, 0.88 and 0.71 and 0.61, 0.58, 0.29 and 0.71 on 0, 7th, 14th, and 28th days, respectively [Table 2].

Figure 1 shows steady decrease in pre- and post-brushing mean PI scores from day 0 to 7th, 14th, and 28th days.

Mean plaque index scores for Group B

Pre- and post-brushing mean PI score was 1.77, 1.43, 0.98, and 0.70 and 0.81, 0.54, 0.25, and 0.13 on 0, 7th, 14th, and 28th day, respectively [Table 3].

Figure 2 shows steady decrease in pre- and post-brushing mean PI scores from day 0 to 7th, 14th, and 28th days [Figure 2].

Prebrushing mean plaque index scores comparison for Group A and B

For Group A, it was 1.56, 1.53, 0.88, 0.71 and Group B was 1.77, 1.43, 0.98, and 0.70 on 0, 7th, 14th, and 28th days, respectively [Table 4].

Figure 3 shows decrease in prebrushing PI scores for Group A and B from day 0 to 28th day.

Postbrushing mean plaque index scores comparison for Group A and B

For Group A, it was 0.61, 0.58, 0.29, and 0.17 and in Group B, it was 0.81, 0.54, 0.25, and 0.13 on 0, 7th, 14th, and 28th days, respectively [Table 5].

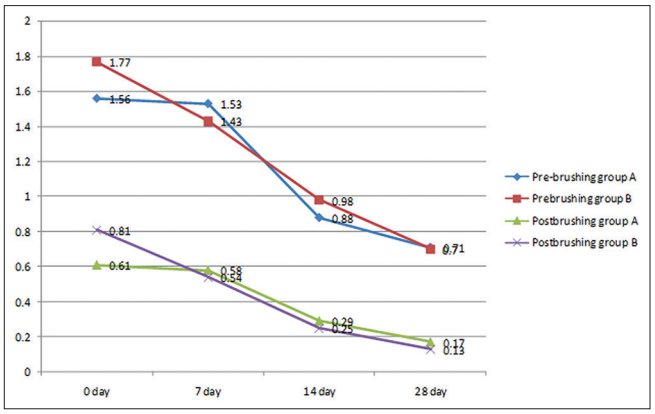

Figure 5: Comparison of pre- and post-brushing mean plaque index scores for Group A and Group B individuals

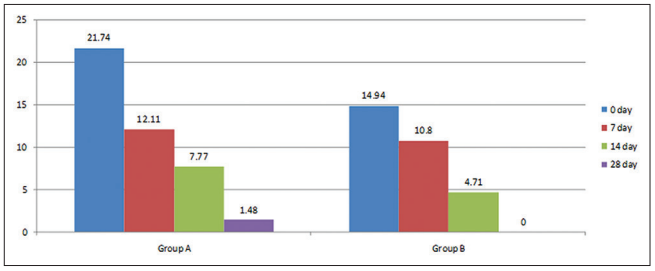

Figure 7: Percentage of gingival bleeding surfaces for Group A and Group B on 0, 7th, 14th, and 28th days

Table 4: Comparison of prebrushing mean plaque index scores for Group A and Group B individuals

	0 day		7th day		14th day		28th day	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Group A	1.56	0.44	1.53	0.54	0.88	0.37	0.71	0.31
Group B	1.77	0.34	1.43	0.56	0.98	0.45	0.70	0.44

Drift in decrease in the prebrushing plaque index scores for both Group A and Group B from day 0 to 28. SD=Standard deviation

Table 5: Comparison of postbrushing mean plaque index scores for Group A and Group B individuals

	0 day		7th day		14th day		28th day	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Group A	0.61	0.34	0.58	0.42	0.29	0.24	0.17	0.19
Group B	0.81	0.39	0.54	0.36	0.25	0.19	0.13	0.13

Trend in decline in the pre- and post-brushing plaque index scores for both Group A and Group B from day 0 to 28th day. SD=Standard deviation

Figure 4 shows trend in decline in postbrushing PI scores for both Group A and B from day 0 to 28th day.

Pre- and post-brushing mean plaque index scores comparison for individuals of Group A and B

The prebrushing mean PI score for Group A was 1.56, 0.71 and for B, it was 1.77, 0.70 on 0 and 28th days, respectively.

Table 6: Comparison of pre- and post-brushing mean plaque index scores for Group A and Group B individuals

	0 day				7th day				14th day				28th day			
	Group A		Group B		Group A		Group B		Group A		Group B		Group A		Group B	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Prebrushing	1.56	0.44	1.77	0.34	1.53	0.54	1.43	0.56	0.88	0.37	0.98	0.45	0.71	0.31	0.70	0.44
Postbrushing	0.61	0.34	0.81	0.39	0.58	0.42	0.54	0.36	0.29	0.24	0.25	0.19	0.17	0.19	0.013	0.13

Trend in decline in the pre- and post-brushing plaque index scores for both Group A and Group B from day 0 to 28, respectively.
SD=Standard deviation

Table 7: The difference in plaque index scores for Group A and B individuals (pre- and post-brushing)

	0 day	7th day	14th day	28th day
Group A				
Mean	0.9461	0.9570	0.5922	0.5370
t	12.07	11.61	9.48	10.08
P	<0.001	<0.001	<0.001	<0.001
95% CI	0.78-1.11	0.79-1.13	0.46-072	0.43-0.65
Group B				
Mean	0.9568	0.8845	0.7246	0.5664
t	10.97	10.84	9.73	6.73
P	<0.001	<0.001	<0.001	<0.001
95% CI	0.78-0.1.14	0.72-1.05	0.57-0.88	0.39-0.74

Highly significant difference between pre- and post-brushing mean values was seen in both Group A and Group B (*P*<0.001).
CI=Confidence interval

Table 8: Comparison of plaque index scores for Group A and Group B individuals (*t* and *P*)

	Mean	Mean difference	95% CI	*t*	*P*
Group A	1.39	0.25	−0.003-0.5	2.0	0.052
Group B	1.64				

CI=Confidence interval

Table 9: Mean gingival index scores for Group A and Group B individuals

	0 day		7th day		14th day		28th day	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Group A	0.39	0.16	0.25	0.09	0.17	0.17	0.05	0.12
Group B	0.29	0.12	0.24	0.17	0.13	0.14	0.00	0.00

Reduction in Gingival Index scores for Group A individuals and for Group B individuals from day 0 to 28th day. SD=Standard deviation

Table 10: Comparison of gingival index scores for Group A and Group B individuals (*t* and *P*)

	Mean	Mean difference	95% CI	*t*	*P*
Group A	0.34	−0.05	−0.14-0.05	−1.1	>0.2
Group B	0.29				

CI=Confidence interval

The postbrushing mean PI score for Group A was 0.61 and 0.17 and for Group B was 0.81 and 0.13 on 0 and 28th days, respectively [Table 6].

Figure 5 shows trend in decrease in the pre- and post-brushing PI scores for both Group A and B from day 0 to the 28th day.

Plaque index scores difference for Group A and Group B (pre- and post-brushing)

Pre- and post-brushing PI scores difference for 0, 7th, 14th, and 28th days for Group A and Group B were compared separately using paired *t*-test. Mean difference along with 95% confidence interval with a highly significantt-value and corresponding *P* value was seen. In all the intervals, a highly significant difference between pre- and post-brushing mean values was seen in both groups ($P < 0.001$) [Table 7].

Plaque index scores comparison for Group A and Group B (*t*- and *P* value)

An independent *t*-test was done for comparison of Group A and B for PI. For this analysis, the prebrushing value of the day 0 (at the time of recruitment into the trial) was taken as the initial value and the postbrushing value for the 28th day as the final value. The mean difference between Group A and B was 0.05. The 95% confidence interval for the differences in the reduction between the two methods of brushing was −0.003, 0.5. The *t*-value was 2.0 and $P = 0.052$, giving borderline significance.

Mean scores of gingival index for Group A and B

The mean GI score of Group A was 0.39, 0.25, 0.17, and 0.05 and B was 0.29,0.24, 0.13, and 0.00 on 0, 7th, 14th, and 28th, respectively [Table 9].

Figure 6 shows reduction in GI scores for Group A and B individuals from day 0 to the 28th day.

Gingival index scores comparison for Group A and B (*t*- and *P* value)

An independent *t*-test was employed to compare the GI score for Group A and B. The prebrushing values for 0 day were taken as the initial values and the postbrushing values for the 28th day were considered as parameters for comparison [Table 10].

The mean GI value for Group A was 0.34 and for Group B was 0.29. The mean difference between Group A and B was −0.05 with the confidence interval being −0.14, 0.05. The *t*-value was −1.1 and $P > 0.2$. However, the difference was not statistically significant.

Table 11: Percentage of gingival bleeding surfaces for Group A and Group B individuals

Day of examination	Group A	Group B	χ^2	*P*
0	21.74	14.94	18.96	<0.001
7th	12.11	10.80	0.95	>0.02
14th	7.77	4.71	39.12	<0.001
28th	1.48	0	16.39	<0.001

Gingival bleeding surfaces percentage for Group A and B

The percentage of gingival bleeding surfaces for Group A was 21.74% and for Group B was 14.94% on day 0. The Chi-square value was 18.96 which was statistically significant ($P < 0.001$).

On day 7, percentage of gingival bleeding surfaces for Group A and B was 12.11% and 10.80%. The Chi-square value was 0.95 which was statistically significant ($P < 0.02$).

On day 14, the percentage of gingival bleeding surfaces for Group A was 7.77% and 4.71% for Group B. The Chi-square value was 39.12 which was statistically significant ($P < 0.001$).

Finally, on day 28th, the percentage of gingival bleeding surfaces for Group A was 1.48% and 0% for Group B. The Chi-square value was 16.39 which was statistically significant ($P < 0.001$).

Figure 7 shows marked reduction in gingival bleeding index scores for Group B over Group A individuals from day 0 to 28th day, which was found to be statistically highly significant using Chi-square test ($P < 0.001$).

Discussion

In the current study, the individuals using the manual toothbrush Oral-B40 Regular Advantage Plus were also asked to exercise the modified Bass tooth brushing technique throughout the 28 days of the study period.

Individuals who used the powered toothbrush Braun/Oral-B 2D were advised to apply the bristles of the brush at right angles to the teeth concentrating on the gingival sulcus.

In the present study, plaque was scored by means of the Turesky Gilmore Glickman modification of Quigley-Hein PI; the same index was used in previously conducted studies.[8-16] Plaque was assessed on the facial and lingual surfaces of all the teeth after using a disclosing agent. The strength of this index is its application in clinical trials of preventive and therapeutic agents.

Pre- and post-brushing mean PI scores for Group A and Group B were evaluated and compared on days 0, 7, 14, and 28; it was found to be significant ($P < 0.001$) that proved the efficacy of plaque removal by both manual and powered toothbrush. This result was comparable to that of the studies conducted by Glavind and Zeuner[4] and Silverstone *et al*.[10] where a similar improvement in the status of hygiene was recorded in both groups.

When PI scores for Group A and B were compared, Group B showed a borderline significance ($P < 0.052$) to that of Group A, thus implying that the powered toothbrush cleaned supragingival plaque better than manual toothbrush over the 28 days period.

In this study, the gingival status was evaluated by the gingival status constituent of the Ramfjord's periodontal disease index. The same index was used by Baab and Johnson[17-19] in their study.

Mean GI scores fell from 0.29 on day 0 to 0.00 on day 28 for Group B; Group A showed a decline in mean GI scores from 0.39 on 0 day to 0.05 on the 28th day. On comparing the GI scores for Group A and B, both groups showed reduction in gingival inflammation but it was not statistically significant which is in contrast to the study conducted by Baab and Johnson[17] whose results proved that the group using the electrical brush showed a statistically significant reduction in GI scores to that of manual toothbrush.

There was a reduction in the bleeding surfaces for Group A, reduced from day 0 (21.74%) to that on day 28 (1.48%) and for Group B, it decreased from day 0 (14.94%) to that on day 28 (0). Further, gingival bleeding surfaces was compared between Group A and B; there was statistically significant reduction between Group B than that of Group A.

In this study, the percentage of gingival bleeding surfaces was assessed by using the gingival bleeding index of Ainamo and Bay and Heintze *et al*.[14] used the same gingival bleeding index to assess the bleeding surfaces and proved that the group that used electric toothbrush had significantly less bleeding surfaces when compared to the manual toothbrush individuals.[20-22]

In conclusion, Group A and B showed an explicit and continuing reduction of plaque accumulation and enhancement in the gingival health by the 4th week.

The results of the present study suggest that powered toothbrush has the potential to improve oral hygiene when compared with the manual toothbrush. The ability for optimal plaque removal and improving gingival health to an individual is provided by the use of powered toothbrush. Irrespective of manual dexterity or training, this confers good brushing technique on all who employ it.[23-27]

Conclusion

The present study showed overall improvement in plaque and gingival scores with powered toothbrush. This present study hence proved that Braun/Oral-B 2D Plaque remover can be used as an alternative to manual toothbrush and proves to be safe, superior, and effective in the improvement of gingival health overall. However, long-term studies should be carried out to evaluate the efficacy of these brushes on maintenance of oral hygiene.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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