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Comparison of the Efficacy of Two Bristle Designs of Toothbrushes in Plaque Removal in 13-15 Year Old Children.

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Abstract
Aims and objective*: To compare plaque removal efficacy of two bristle designs of toothbrushes; zig-zag and flat trim.*
Materials and method: *The study was an investigator blind, randomized, crossover design carried out on 13-15 year old school children to test the efficacy of two bristle designs of toothbrushes in single use plaque removal. The study was carried out in two test periods with a wash out period of 4 days between each test period. On day one of each test period plaque removal was carried out for all participants through oral prophylaxis following which they were asked to suspend oral hygiene practices for 24 hours. On the second day, the subjects were asked to brush with the allocated tooth brush for 2 minutes and were assessed for plaque using Turesky Gilmore modification of Quigley Hein plaque index both pre and post brushing.*
Result*: A comparison of percentage reduction of the mean plaque scores between the two brushes showed no significant differences between them. Although the difference between the pre brushing and post brushing plaque scores was greater with brush A (zig-zag) (0.669±0.24) as compared to brush B (flat- trim brush) (0.573±0.41), the values were statistically insignificant.*
Conclusion*: The present study shows that both the brushes are equally efficacious in plaque removal which indicates that bristle design is only one of the influencing factors for plaque control.*
Keywords: *toothbrush, bristle design, plaque control*

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I Introduction

Dental caries and periodontal problems are the most commonly occurring dental diseases. Dental plaque is the major causative factor for both of these diseases.[1,2,3] It has been a well known fact that the accumulation of microbial plaque on the tooth surface results in the development of gingival inflammation and daily removal of plaque using both mechanical and chemical aids leads to maintenance of gingival health in just a few days.[4] Although, there are many adjuncts for maintaining oral hygiene but by far the most widely accepted and adopted tooth cleaning tool is still the toothbrush[5]. Numerous brands of toothbrushes are emerging these days with every company claiming superiority of their product over others. People being the consumer sector, also choose brushes based on cost, availability, advertising claims, family tradition or habit, shape, colour due to lack of professional advice when it comes to selection of a toothbrush. While selecting an effective toothbrush, the bristles are perhaps the most important consideration. As there are so many varieties of brushes currently available and also due to constant development of new brushes, the dental professionals must have a high level of knowledge of these products and advice the patients accordingly.[6] Amongst the many bristle designs available in the market a few include flat trim, multilevel, wavy design, zigzag[7,8,9]. Although, there are studies conducted in India on the efficacy of manual toothbrushes in plaque removal but their results have been contradictory and most of them have targeted the adult population. So, this study has been conducted on 13-15 year old children with the objective of comparing the plaque-removing efficacy of two readily available designs of toothbrushes and thereby suggesting the better manual brush of the two based on the results and previous research.

II Materials And Method

This clinical study was conducted on 13 to 15 year old school children in a higher secondary school in Bangalore. Before the study could be initiated, ethical clearance from the Institutional ethical committee was sought and all necessary permissions from the school authorities were obtained.

Two different bristle designs of commercially available manual toothbrushes (zigzag and flat bristles) were selected for the study (fig 2, 3). Both the groups of toothbrushes were of "soft" bristle type. 9 Male and 9 female children aged 13-15 years with overall good general health, dentate (having a minimum of 25 teeth) were included in the study (fig 1), whereas the subjects with severe dental caries (i.e. more than four un-restored carious teeth), advanced periodontitis, undergoing orthodontic treatment, who may require antibiotics during the time duration of the study or with a history of antibiotic usage at least 2 weeks prior to the study were excluded. The study was a randomized, examiner blind crossover clinical study to evaluate the efficacy of two designs of toothbrushes in single use plaque removal. A random list was prepared on the basis of which subjects were distributed into the two brush groups. The randomization procedure was carried out by a non participating dentist. Both the toothbrushes were given a code and the decoding was done only at the end of the study. Before the start of the study, the subjects were taught the modified bass method of brushing. The study was carried out in two test periods. 4 days were allowed as a wash out period between the two study periods for the subjects to return to normal oral hygiene practices. Oral prophylaxis was carried out for all the subjects on the first day of each test period to render them plaque-free. They were then asked to refrain from oral hygiene practices for 24 hours. On the next day, assessment for plaque prior to brushing was carried out using Turesky and Gilmore modification of Quigley-Hein plaque index. Using the erythrosine disclosing solution, plaque was assessed on the buccal and lingual surfaces of all teeth except the third molars. The subjects were then randomly allocated the toothbrushes after which they were asked to brush for 2 minutes. They were then again scored for plaque using the same index. The same procedure was followed during the next test period. Mean plaque index for each subject was determined by adding all the individual plaque scores (two per tooth) and dividing the whole by the total number of surfaces examined. Any accessory plaque control aids were eliminated from the study.

III Statistical Analysis

Descriptive and inferential statistical analysis has been carried out in the present study. Student t test (two tailed, dependent) has been used to find the significance of study parameters and for the paired comparisons. The Statistical software namely SAS 9.2, SPSS 15.0 were used for the analysis of the data.

IV Results

Of the 18 subjects included in the study, there were no dropouts. The codes given to the two brushes were as follows:
BRUSH A = zigzag bristle design (fig 2)
BRUSH B = flat bristle design (fig 3)

The results of the study were as follows:

Equal number of male and female subjects participated in the clinical study. There were 9 males (50%) and 9 females (50%). Distribution of pre-brushing plaque scores among the two brushes showed that the plaque accumulation during both the test periods were to a similar degree (1.02±0.36, 1.01±0.39 respectively). Although "Brush A" group showed greater accumulation of plaque, the numbers were not statistically significant.

Comparison of the pre-brushing plaque scores amongst the two test periods on the **upper (**1.07±0.33, 1.13±0.39 respectively)**, lower (**1.00±0.39, 1.07±0.40 respectively)**, lingual** (1.00±0.43, 1.14±0.43 respectively) and **anterior** (0.68±0.33, 0.75±0.49 respectively) surfaces showed that the plaque accumulation was similar during the two test periods. Although, the plaque accumulation in the "Brush B" group was slightly more on all of these surfaces, it was not a statistically significant result. (Table 1 and Table 2)

Likewise, on comparison of the pre-brushing plaque scores among the two test periods on the **buccal** surfaces showed that the plaque accumulation were similar during the two test periods(1.04±0.38, 1.03±0.42 respectively) Though the "Brush A" group showed greater accumulation of plaque on the buccal surfaces, it was not statistically significant.(Table 1, Table 2)

Overall, the anterior surfaces showed lesser plaque accumulation when compared to the other surfaces

Distribution of **post-brushing** plaque scores among the two brushes showed that the amount of residual plaque was similar for both brushes (0.35±0.19, 0.45±0.23 respectively). Though "Brush B" group showed greater post-brushing out residual plaque when compared to the other group, it was not statistically significant.

Comparison of the **post-brushing** plaque scores among the two brushes on the **upper** (0.37±0.22, 0.50±0.23)**, lower** (0.44±0.29, 0.49±0.24)**, lingual** (0.44±0.22, 0.62±0.30 respectively) surfaces showed that the

residual plaque accumulation was similar for both brushes Though the "Brush B" group showed greater residual accumulation of plaque on all these surfaces, the results were not supported by a statistical significance.

Comparison of the post-brushing plaque scores among the two brushes on the **buccal** (0.38±0.33, 0.35±0.19) as well as **anterior** (0.13±0.17, 0.13±0.16 respectively) surfaces showed that the residual plaque accumulation was similar for both brushes. Though the "Brush A" group showed greater residual accumulation of plaque on both surfaces, it was not statistically significant

A comparison of percentage reduction on the mean plaque scores between the two brushes showed no significant differences between both. Both the brushes reduced plaque to a similar degree on all surfaces.

V Discussion

It is well established that bacterial plaque is the causative factor of gingival inflammation. Out of the various plaque control agents, manual toothbrushes are the most widely used aid in controlling gingival and periodontal diseases.[6] The factors that influence clinical evaluation of efficacy of toothbrushing like hand pressure, bristle design, brushing time, dexterity, brushing technique are correlated to the amount of plaque deposited on tooth surfaces[10]. These constraints were however taken care of in the present study as the brushing technique (modified bass) was demonstrated and hence taught to all the participants. On one hand, companies with their research teams are frequently launching different designs of toothbrushes claiming superiority of their products over the ones already available in market. On the other hand, several workshops and reviews have over and over concluded that there are no superior designs of manual toothbrushes.[11] Therefore, the present study was undertaken to find out which out of the two designs of bristles is better in plaque removal in 13-15 year old children. Here, a cross-over design to assess the efficacy of the two brushes in single-use plaque removal was employed. Single use plaque removal is considered as efficacious as conventional plaque removal studies to assess the efficacy of brushes.[10, 12, 13.]

The index was chosen as it facilitates the assessment of all natural teeth (except third molars) for plaque and provides more sensitive and accurate evaluation of brushing effectiveness based on its scoring criteria.[14] Also, it is simple, reproducible, reliable and facilitates comparison with other studies.[15,16] The results of the study showed greater plaque accumulation on the posterior surfaces in comparison to the other surfaces. This is in agreement with many other previous studies.[17, 18]The plaque scores were comparable during both the test periods. The results of the study showed no statistically significant differences between both brushes in their plaque removing efficacy. This is similar to the study conducted by Bergenholtz *et al.* who compared the toothbrush having v-shaped bristles with a flat-trim toothbrush in his study and found out that no significant differences exist between the two toothbrushes[19]. It is also similar to the studies conducted by Staudt, who compared the efficacy of three toothbrushes - namely, convex bristle, multilevel bristle and flat-trim bristle and came onto similar result.[20]

In the present study, there was a significant reduction in the post brushing plaque scores compared to the baseline plaque scores. This is in line with the study by Claydon and Addy who conducted a single-use plaque removal study to compare the efficacy of four different bristle designs of toothbrushes and concluded that the brushes removed approximately 60% of the accumulated plaque and whatever minute differences were seen were of little clinical significance[18]. The results of the present study are also similar to the study by Claydon and Leech, who conducted a single-use study to compare the efficacy of a double-textured prototype manual toothbrush with three branded products and found that all four brushes removed about 50% of the accumulated plaque and no toothbrush design was significantly superior to the other[21].

In this study, the V-trim toothbrush (zigzag) is equally effective as the flat-trim toothbrush and no significant differences were observed between the two brushes, but a similar comparison study by Turner *et al.* and Kakar *et al.* showed that the zigzag toothbrush removed more plaque compared to the flat-trim toothbrush[22,23]. The present clinical study showed that both the toothbrushes reduced plaque scores significantly compared to the baseline scores but still no significant differences were observed between the two brushes. This is in contradiction to the study by Cohen, who compared a newly introduced brush with bristles inclined upward and outward and a flat trim toothbrush and concluded that the new brush showed superior plaque removal[17].

In this study, a comparison of the percentage plaque reduction on all surfaces showed that the anterior surface showed greater reduction and the posterior surface least reduction than the other surfaces. This is in agreement with the study by Claydon, who showed greater post-brushing residual plaque on the posterior surface[18].

VI Figures And Tables

Figure 1: 9 males and 9 females who participated in the study

Figure 2: Brush A

Figure 3: Brush B

Table 1: Evaluation of outcome variables in Brush Group A

Outcome variables	Pre	Post	difference	95% CI	t value	P value
brushing score	1.02±0.36	0.35±0.19	0.669	0.55-0.79	11.664	<0.001**
Ant brushing score	0.68±0.33	0.13±0.17	0.548	0.39-0.70	7.593	<0.001**
Upper jaw brushing	1.07±0.33	0.37±0.22	0.692	0.56-0.83	10.976	<0.001**
Lower jaw brushing	1.00±0.39	0.44±0.29	0.557	0.41-0.71	7.893	<0.001**
Facial surface brushing	1.04±0.38	0.38±0.33	0.662	0.52-0.80	10.072	<0.001**
Lingual brushing	1.00±0.43	0.44±0.22	0.563	0.41-0.71	7.958	<0.001**

Table 2: Evaluation of outcome variables in Brush Group B

Outcome variables	Pre	Post	difference	95% CI	t value	P value
brushing score	1.02±0.39	0.45±0.23	0.573	0.37-0.78	5.989	<0.001**
Ant brushing score	0.75±0.49	0.13±0.16	0.620	0.35-0.89	4.842	<0.001**
Upper jaw brushing	1.13±0.39	0.50±0.23	0.629	0.41-0.85	5.949	<0.001**
Lower jaw brushing	1.07±0.40	0.49±0.24	0.568	0.34-0.79	5.222	<0.001**
Facial surface brushing	1.02±0.42	0.35±0.19	0.677	0.44-0.91	6.055	<0.001**
Lingual brushing	1.14±0.43	0.62±0.30	0.516	0.31-0.72	5.394	<0.001**

VII Conclusion

Although there are various aids available for mechanical plaque control, manual toothbrush is still the most accepted and widely used one for maintenance of good oral hygiene. Of the many factors that influence plaque removal by a toothbrush, bristle design has been widely and thoroughly studied. The present study shows that both the brushes are equally efficacious in plaque removal. Although the difference between the pre brushing and post brushing plaque scores was greater with zigzag bristle brush (0.669±0.24) as compared to flat- trim brush (0.573±0.41), the values were not statistically significant. However, long term studies with a larger sample size can provide better information on the efficacy of bristle designs on plaque control.

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