Original Article

Comparative Evaluation of Two Manual Toothbrushes with Different Bristle Designs for Plaque Removal Efficacy in Females – A Clinical Study

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Abstract

Aim: The aim of the study was to analyze and asses the plaque removal efficacy of two manual toothbrushes with different bristle designs among female clinical undergraduate students in Virajpet, Coorg. **Materials and Methods:** Thirty female undergraduate dental students with a minimum of twenty teeth with good general health were included in the study. The efficacy of two manual toothbrushes with round and zigzag bristles of "medium" type 0.009″ (0.3 mm) was compared using a randomized clinical trial for 5 days. The participants were assessed for plaque prior to brushing according to the Criteria of Turesky–Gilmore–Glickman modification of Quigley–Hein plaque index. On the 5th day, postbrushing plaque scores were assessed. The data were analyzed using the Statistical Package for the Social Sciences version 17 software. **Results:** No significant difference was found in the mean values of plaque removal efficacy between round and zigzag bristle toothbrushes.

Keywords: *Female patients, plaque scores, round bristles, zigzag bristles*

Clinical Relevance to Interdisciplinary Dentistry

- Plaque, calculus, and an array of microorganisms are the primary etiological factors for dental diseases
- Bristle design of the toothbrush has been widely studied for the efficacy of plaque removal
- There are no data available which demonstrate the superiority of either brush
- The user is by far the most significant variable affecting the toothbrushing technique for the prevention of dental diseases.

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Introduction

Dental caries and periodontal disease are the most commonly occurring diseases affecting humankind. Dental plaque is a very important factor in the causation of both these diseases.[1] These diseases are kept at bay through oral hygiene measures, and toothbrush is the most widely accepted tooth-cleaning tool.[2] Oral hygiene measures have been practiced by almost every population and culture around the world. It was a result of an obligatory toothbrushing protocol for American soldiers in the Second World War that it gained momentum.[3] Since its introduction in the past decade, numerous designs of the manual toothbrush have emerged.[4] A Sweden watchmaker named Fredrick Wilhelm Tornberg is credited with designing the first mechanical toothbrush in 1885. The accumulation of microbial plaque results in the development of gingival inflammation and daily removal of plaque

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leads to the resolution of the gingival inflammation in just a few days.[5,6] Thus, effective plaque control is important. However, controlling plaque accumulation for preventing gingivitis and/or periodontitis and decay effectively is influenced by a number of individual- and material-based factors. These main factors can be summarized as the design of the toothbrush, the skill of the individual using the brush, toothbrushing frequency, and the duration of use. The last two factors are affected by learning experience and manual capacity.[7,8] However, the first factor represents technology improvement and is affected by the physical properties of the toothbrush bristles and the shape, size, and morphometry of the toothbrush heads and handles. Most people use a simple horizontal scrubbing technique. The goal of the study was to compare the efficacy of different designed brushes in the removal of plaque among dental students.

Materials and Methods

A total of thirty female participants from the Department of Public Health Dentistry, Coorg, with age range between 21 and 23 years were recruited in the study. Ethical clearance was obtained from the Institutional Review Board and written Informed consent was obtained from all participants. The study was a randomized parallel design clinical study. A convenience sampling technique was used for the selection of samples.

Inclusion criteria were (1) those students who are willing to give informed consent and (2) dental students with a minimum of twenty teeth with good general health.

Exclusion criteria were (1) students undergoing orthodontic treatment, with excessive dental caries (more than four unrestored carious teeth); (2) advanced periodontal disease, with a history of antibiotic usage at least 2 weeks prior to the study, and who may require antibiotics during the course; and (3) students using mouthwash and interdental aids for cleaning during the study period.

The participants were divided into two groups of 15 students each. Both the groups were provided with manual toothbrushes based on the group to which they belonged. In the present study, two different types of commercially available manual toothbrushes were selected which differed in their pattern of bristle arrangement. The two different designs of brushes are shown in Figures 1 and 2.

Before the start of the actual study, the calibration of the examiner was done by examining a few participants.

The participants in the study were asked to follow the modified Bass technique of brushing before the start

Figure 1: Toothbrush with round bristle arrangement

of the study. On the 1st day of each test period, the participants were rendered plaque-free and were then asked to refrain from oral hygiene practices for 24 h. On day 2, the participants were assessed for plaque prior to brushing according to the Turesky–Gilmore–Glickman modification of Quigley–Hein plaque index. Plaque was assessed using the Criteria AlphaPlac disclosing solution. Participants were asked to swish around disclosing agent in the mouth for 2 min and scored for plaque. After 2 min of brushing, plaque scores were reassessed. Participants were instructed to brush once daily in the morning with toothpaste free of antiplaque agent Triclosan and not to use mouthrinses during the study period. On the 5th day, postbrushing plaque scores were assessed using the same method. The data were analyzed using the Statistical Package for the Social Sciences version 17 software (SPSS Inc, Chicago, Illinois, USA). Descriptive statistics were obtained, and mean scores and standard deviation were calculated. The difference in the mean plaque scores between the two groups was assessed by independent *t*-test. Data were considered statistically significant when $P < 0.05$.

Results

Thirty female undergraduate students completed the study for the assessment of the plaque removal efficacy of manual brush with two different bristle designs. The mean plaque score was assessed at the baseline and between groups at different time intervals – after 2 min brushing and on the 5th day. Table 1 shows that the mean plaque scores after 2 min of brushing using round bristle brush were found to be statistically significant in relation to the maxillary anterior segment ($P = 0.002$) and maxillary posterior segment ($P < 0.001$), whereas the mean plaque scores in these areas after 2 min of brushing in the mandibular arch were statistically insignificant. The postbrushing mean plaque scores on

Figure 2: Toothbrush with zigzag bristle arrangement

the 5th day within group using round bristle brush in different areas of the oral cavity and its comparison with the baseline plaque scores show that the baseline plaque scores for the maxillary anterior segment and maxillary posterior segment were 0.37 ± 0.13 and 0.45 ± 0.17, respectively, whereas, the postbrushing mean plaque scores on the 5th day in these areas were 0.39 ± 0.15 and 0.40 ± 0.15, respectively, which were found to be statistically insignificant. The baseline plaque scores for the mandibular anterior segment and mandibular posterior segment were 0.49 ± 0.22 and 0.46 ± 0.20, respectively, whereas, the postbrushing mean plaque scores on the 5th day in these areas were 0.45 ± 0.15 and 0.39 ± 0.15, respectively, again statistically nonsignificant.

Table 2 shows the distribution of the mean plaque scores after 2 min brushing within group using zigzag bristle brush in different areas of the oral cavity and its comparison with the baseline plaque scores shows that the mean plaque scores after 2 min brushing within group for the maxillary arch using zigzag bristle brush were found to be statistically significant ($P < 0.001$) and also were found to be statistically significant in relation to the mandibular anterior ($P = 0.001$) segment and mandibular posterior segment ($P = 0.001$). The mean plaque scores after 2 min brushing within group for the mandibular arch were found to be statistically significant ($P = 0.001$). The postbrushing mean plaque scores on the 5thday within group using zigzag bristle brush were found to be statistically nonsignificant in relation to the maxillary anterior segment ($P = 0.05$) and maxillary posterior segment ($P = 0.001$) and that within group for the maxillary arch were found to be statistically significant ($P = 0.008$). The postbrushing mean plaque scores on the 5th day within group using zigzag bristle brush were not found to be statistically significant in relation to the mandibular anterior segment ($P = 0.573$) but found to be statistically significant in relation to the mandibular posterior segment ($P = 0.006$).

Table 1: Comparison of the baseline mean plaque score using independent *t*-test between groups using round bristle design and zigzag bristle design brushes

Area	Groups	Mean plaque score±SD	*t*	*P*
Maxillary anterior	Round bristle	0.36±0.13	1.422	0.166 (NS)
	Zigzag bristle	0.46±0.21		
Maxillary posterior	Round bristle	0.44±0.17	0.781	0.441 (NS)
	Zigzag bristle	0.50±0.20		
Maxillary total	Round bristle	0.80±0.27	1.389	0.176 (NS)
	Zigzag bristle	0.96±0.35		
Mandibular anterior	Round bristle	0.49±0.22	0.972	0.340 (NS)
	Zigzag bristle	0.42±0.16		
Mandibular posterior	Round bristle	0.46±0.20	0.156	0.877 (NS)
	Zigzag bristle	0.47±0.19		
Mandibular total	Round bristle	0.94±0.38	0.357	0.724 (NS)
	Zigzag bristle	0.89±0.34		

$P<0.05$=Statistically significant. SD=Standard deviation, NS=Not significant

Table 2: Comparison of the mean plaque scores using independent *t*-test, after 2 min brushing between groups using round bristle and zigzag bristle brushes

Area	Groups	Mean plaque score±SD	*t*	*P*
Maxillary anterior	Round bristle	0.23±0.10	0.867	0.393 (NS)
	Zigzag bristle	0.27±0.12		
Maxillary posterior	Round bristle	0.25±0.08	0.569	0.574 (NS)
	Zigzag bristle	0.22±0.15		
Maxillary total	Round bristle	0.49±0.19	0.972	0.941 (NS)
	Zigzag bristle	0.50±0.23		
Mandibular anterior	Round bristle	0.27±0.16	0.309	0.760 (NS)
	Zigzag bristle	0.25±0.09		
Mandibular posterior	Round bristle	0.29±0.19	0.521	0.607 (NS)
	Zigzag bristle	0.26±0.13		
Mandibular total	Round Bristle	0.55±0.33	0.259	0.798 (NS)
	Zigzag Bristle	0.52±0.23		

SD=Standard deviation, NS=Not significant

The intergroup comparison between the two groups showed that the baseline plaque mean scores between groups using round bristle brush and zigzag bristle brush were found to be statistically nonsignificant in relation to the maxillary anterior segment ($P = 0.166$) and maxillary posterior segment ($P = 0.441$). The baseline mean plaque scores between groups for the maxillary arch were also found to be statistically nonsignificant ($P = 0.176$). Similarly, the baseline mean plaque scores between groups using round bristle brush and zigzag bristle brush were found to be statistically nonsignificant in relation to the mandibular anterior segment ($P = 0.340$) and mandibular posterior segment ($P = 0.724$). The baseline mean plaque score

for the mandibular arch was also found to be statistically nonsignificant.(P = 0.724).

The mean plaque scores after 2 min brushing between groups using round bristle brush and zigzag bristle were found to be statistically nonsignificant in relation to the maxillary anterior segment (P = 0.393) and maxillary posterior segment (P = 0.574) as well as for between groups for the maxillary arch (P = 0.941). The mean plaque scores after 2 min brushing between groups were found to be statistically nonsignificant (P = 0.760) in relation to the mandibular anterior segment and posterior segment (P = 0.607). Similarly, the mean plaque scores between groups for the mandibular arch were found to be statistically nonsignificant (P = 0.798).

Table 3 shows that the postbrushing mean plaque scores on the 5th day between groups using round bristle brush and zigzag bristle brush were found to be statistically nonsignificant in relation to the maxillary anterior segment (P = 0.283) and found to be nonsignificant in relation to the maxillary posterior segment (P = 0.230). The postbrushing mean plaque scores between groups for the maxillary arch were found to be statistically nonsignificant (P = 0.135).

The postbrushing mean plaque scores on the 5th day between groups using round bristle brush and zigzag bristle brush were found to be statistically nonsignificant in relation to the mandibular anterior segment (P = 0.271) and mandibular posterior segment (P = 0.246) and that for the mandibular arch were found to be statistically nonsignificant (P = 0.159).

Discussion

Plaque plays a crucial role in the etiology of dental caries and periodontal diseases were stated in the consensus report presented at the Second World Conference on Oral Health Promotion in 1999. Therefore, an effective removal of dental plaque is essential. In the study, only female students were considered because they might be having habits of smoking and alcohol drinking, leading to improper oral health practices. The choice of the index was based on the fact that with this index all natural teeth (except third molars) can be assessed for plaque and it provides more sensitive and accurate evaluation of brushing effectiveness compared to other indices.[8]

Different toothbrush companies are claiming the superiority of newly designed brushes. This study provides data on plaque removal efficacy of round bristle brush in comparison to zigzag bristle brush.

The mean plaque scores after 2 min of brushing using both round bristle brush and the zigzag brush were found to be statistically significant in relation to both maxillary and mandibular anterior and posterior segments. When mean plaque scores at postbrushing on the 5th day were compared using round bristle brush, the scores were not found to be statistically significant in relation to both maxillary and mandibular anterior and posterior segments, whereas the postbrushing mean plaque scores on the 5th day using zigzag brush were found to be statistically significant only in relation to the maxillary and mandibular posterior segments.

These results are similar to the results of the study by Cifcibasi *et al*.[4] which compared the efficacy of plaque control and potential effects on gingival recession of the toothbrushes with angled and straight bristles among 40 equally divided dental students. The results showed that plaque scores reduced significantly at 6 months compared to the baseline in both the groups.

Ferena and Salehe[9] conducted a 14-day clinical trial to compare between teeth and cross-action brush among 30 individuals. There was no statistical difference between cross-action and toothbrush in reducing plaque and gingival bleeding, which is in contrast to the present study. Leonardo *et al*.[10] conducted a 7-day study to compare the incidence of gingival abrasion and the degree of plaque removal obtained after the use of toothbrushes with tapered or end-rounded bristles in the presence or absence of an abrasive dentifrice. End-rounded bristle design removed more plaque than tapered brushes (P = 0.05).

The results of the present clinical study indicated that all the toothbrushes reduced plaque scores significantly compared to the baseline scores, and yet, no significant differences were observed between the two brushes. This is in contradiction to the study by Cohen[8] who compared a newly introduced brush with bristles inclined upward

Table 3: Comparison of postbrushing mean plaque score on the 5th day between groups using round bristle and zigzag bristle brushes

Area	Groups	Mean plaque score±SD	*t*	*P*
Maxillary anterior	Round bristle	0.39±0.15	1.094	0.283 (NS)
	Zigzag bristle	0.33±0.10		
Maxillary posterior	Round bristle	0.40±0.15	1.226	0.230 (NS)
	Zigzag bristle	0.34±0.11		
Maxillary total	Round bristle	0.79±0.24	1.537	0.135 (NS)
	Zigzag bristle	0.67±0.17		
Mandibular anterior	Round bristle	0.44±0.15	1.122	0.271 (NS)
	Zigzag bristle	0.39±0.11		
Mandibular posterior	Round bristle	0.39±0.15	1.186	0.246 (NS)
	Zigzag bristle	0.33±0.08		
Mandibular total	Round bristle	0.87±0.34	1.448	0.159 (NS)
	Zigzag bristle	0.72±0.16		

SD=Standard deviation, NS=Not significant

and outward and a flat-trim toothbrush and concluded that the new brush was superior. The study results are also in agreement with the study conducted by Swarna *et al*.[11] in 2014 where the data were analyzed after evaluating the efficacy of five commercially available brushes, Group B (zigzag), Group C (all-rounder), Group D (fresh clean), and Group E (double action brush). The results of the study showed statistically significant differences in plaque removal at the baseline to postbrushing on the 4th week period.

A comparison of the mean plaque scores in the present study using both toothbrush designs showed that the anterior segment showed greater plaque removal efficacy than the posterior segment in the maxillary and mandibular arches. This is in agreement with the study by Claydon *et al*.[12] of two test periods who showed greater postbrushing residual plaque on the posterior surface after the use of similar kind of brush designs.

Overall, the results of the present study showed that both the brushes were equally effective in reducing the plaque scores. Manual toothbrush with zigzag bristle was found to be slightly better in its plaque removal efficacy in relation to the maxillary and mandibular posterior segments when postbrushing mean plaque scores were compared on the 5th day.

The limitation of the study was small sample size hence cannot apply to a larger population group and only single gender was included.

Conclusion

Toothbrushing continues to be the most widely used form of oral hygiene practice all over the world. Of the many factors that influence plaque removal by a toothbrush, bristle design has been a widely studied aspect. Still, no data demonstrate unequivocally that one toothbrush design is better than the other. In conclusion, the present study showed a significant reduction in plaque scores from the baseline to the postintervention in both round and zigzag bristle groups individually; however, the user is the most significant variable affecting the toothbrushing.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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