Original Article

EFFICACY OF TOOTH BRUSHES OF DIFFERENT BRISTLES DESIGN IN PLAQUE REMOVAL

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ABSTRACT:

OBJECTIVE:

To evaluate the efficacy of four different deigns of manual tooth brushes available in the market, with respect to plaque removal efficacy.

MATERIALS AND METHODS:

It was an interventional kind of study that was examiner blind. 30 volunteers from the same age group (19 to 25 years) participated. Four brushes were selected to be checked and compared for efficacy and were given codes that were revealed only at the end of the study. For the quantitative (Percentage reduction) assessment of plaque, Gilmore-Glickman Modification of Hein Plaque Index was chosen.

RESULTS:

Flat-bristle designed toothbrush showed a total reduction of 57%. For Concave-bristle designed toothbrush, the value changed from 112.67 to 47.63 with a reduction of 57.67%. Zigzag bristle designed toothbrush showed a Post-brushing mean plaque score of 54.07 compared to 117.57 (mean pre-brushing score) giving rise to a reduction of 54.01%. Whereas crisscross bristle designed tooth brush showed a post-brushing plaque score of 75.00, compared to 109.46 (pre-brushing mean plaque score) with a total reduction of the value 31.48%. This suggests that all the four toothbrushes have shown plaque reduction, somehow to a greater or lesser extent. The reduction was also found to be statistically significant as the p-values were less than 0.05.

CONCLUSION:

Based on the results obtained from the study it comes forward that though newer and newer varieties of toothbrush bristle designs are coming in the market, no one is exceptional in efficacy for removing plaque.

KEYWORDS: Plaque; Manual tooth brush, plaque disclosing agent, Erythrosine-PA

INTRODUCTION:

Plaque is a community of microorganisms that appear as a thin, soft, translucent and tenaciously adherent layer on the unshedding surfaces of oral cavity. This community harbors usually bacteria that are mostly involved in the disease process of dental or periodontal tissues or even both in the oral cavity[1]. Plaque control includes its removal and prevention of its accumulation. Plaque is hence required to be removed to prevent the disease process and to maintain the oral hygiene. [2]

Various methods have been used for plaque removal since long. Mechanical way of

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removing plaque is the most ancient method and is still proving to be the most effective[2, 3, 4]. To prevent plaque accumulation, disruption of this complex structural and functional entity is required and this job can easily and effectively performed by toothbrushes.

Daily use of manual toothbrush is the most dependable way of achieving oral health in most of the population.[2, 4] Toothbrushes have undergone little changes in their basic structure since they were first appreciated by Chinese in the late 16th century. Many modifications have been made to the size, shape, bristle arrangement, texture and stiffness, head design, angulations between head, shaft and handle and other features. A wide variety of toothbrushes is available now-a-days in the market leading to creation of a dilemma in the consumer's mind with respect to efficacy of each toothbrush. Moreover, parameters such as cost, availability, advertising claims, family tradition or personal habits define which toothbrush is going to be used by a particular person. [2]

Several studies have been performed to check and compare the efficacy of different manual toothbrushes especially with reference to the arrangement of bristles but still contradictory results have come to observation. Some authors have reached the conclusion that no toothbrush is superior to the other and user is by far the most significant variable in determining efficacy[5, 6, 7, 8] whereas studies and clinical trials performed by others, document superiority of some specific toothbrushes. [3, 9, 10, 11]

Considering the importance of plaque removal and a state of confusion for the selection of toothbrush, present study was undertaken. The objective of present study was to evaluate the efficacy of four different designs of manual toothbrushes available in the market, with respect to plaque removal efficacy.

MATERIALS AND METHODS:

The study was an *in-vivo* crossover type. Clinical trials were carried out at outpatient clinic of Operative Dentistry, Nishtar Institute of Dentistry, Multan. It was an interventional kind of study that was examiner blind. 30 volunteers with equal number of males and females (Under graduate dental students) from the same age group (19 to 25years) participated. A written informed consent was taken from all the volunteers according to the rules of medical bioethics issued from the Institutional Ethical Review Committee. Volunteers were selected fulfilling the inclusion and exclusion criteria.

Inclusion criteria:

Volunteers had a full dentition.
Teeth were in normal healthy condition.
There was no crowding, no fixed or removable prosthesis in their mouth.
They had normal periodontium.

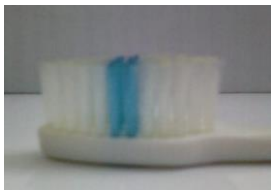
Exclusion criteria:

Those having partially erupted wisdom teeth.
Those with pathological periodontal pockets.
Those with cervical, lingual or buccal restorations.
Those with open bite and incompetent lips.

All volunteers were briefed about the study well in advance. Four brushes were selected to be checked and compared for efficacy and were given codes that were revealed only at the end of the study. The brushes used were as follows:

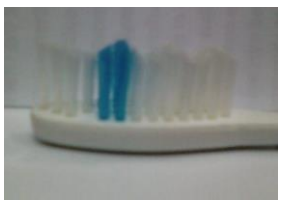
A: Flat bristle designed toothbrush
B: Concave bristle designed toothbrush
C: Crisscross bristle designed toothbrush
D: Zigzag bristle designed toothbrush

Brush-A



Brush-B

Brush-C



Brush-D

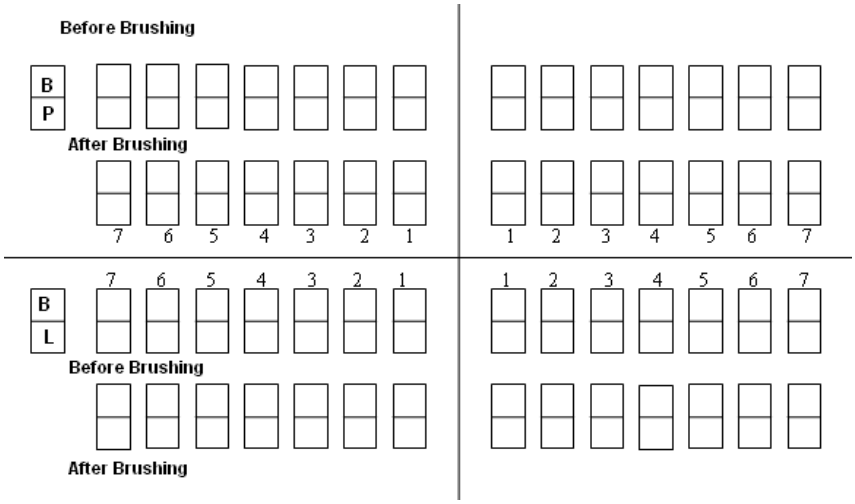
All brushes were of medium softness. Volunteers were asked to refrain from all kinds of oral hygiene practices for 24 hours before trial. There was no restriction to eating habits. The study comprised of four stages for each volunteer. One stage consisted of three cycles. In each cycle pre and post brushing plaque scores of the volunteer were noted. Plaque was disclosed by using erythrosine-PA England.

Volunteer was asked to chew the tablet and swish it for at least 30 seconds. Extra stain was rinsed off by plain water rinses. The Gilmore-Glickman modification of the Quigley-Hein plaque index was used to assess the plaque score with unaided eye and help of dental mirrors and was recorded on the designed proforma. The mentioned plaque index was used because of its simplicity and reliability in the results.[12] Volunteer was then provided with the specific toothbrush for that stage by the examiner who was blind to the study protocol. The volunteer used his/her own technique of brushing for his/her own length of time but the two parameters were observed and noted. No dentifrice was added to the toothbrush. Three cycles were performed for each clinical trial with a washout period of at least 24 hours. Same protocol was followed for all the 30 participants.

PLAQUE SCORING CRITERIA:

0: No plaque
1: Isolated flecks of plaque at the gingival margin
2: A continuous band of plaque up to 1mm at the gingival margin
3: Plaque greater than 1mm in width and covering up to one third of the tooth surface
4: Plaque covering from one thirds to two thirds of the tooth surface
5: Plaque covering more than two thirds of the tooth surface

Name: _____ Age: _____Gender: _____
Type of toothbrush employed: _____ Brush Code: _____
Visit No: _____ Date: _____
Gilmore-Glickman modification of the Hein Plaque index



PLAQUE INDEX:

Plaque index of individual= $\frac{\text{sum of score of each tooth}}{\text{Total number of teeth examined}}$

KEY:

B
P
B= Buccal
P= Palatal

B
L
B= Buccal
L= Lingual

All the data was entered and analyzed using computer program SPSS-20.0. Descriptive statistics were applied to calculate mean and standard deviation. Student *t*-test (To observe statistical significance) was applied to compare pre and post brushing in upper as well as lower teeth. P-value equal to or less than 0.05 was considered significant.

RESULTS:

Results obtained from a sample size of 30 containing equal number of male and female participants were self explanatory. A reduction in post-brushing plaque scores was observed for all the four toothbrushes. P-values have manifested that plaque reduction was statistically significant i.e. p-values were less than 0.05. Results can be tabulated as follows

	N	**Pre Brushing**	**Post Brushing**	**Reduction**	**Percentage reduction**
Mean	30	113.27	48.70	64.57	57.00%
Range	30	31-169	7-101	N.A	Significant at p<0.05

Table-1: Plaque Removal by Flat Bristle Toothbrush

	N	**Pre Brushing**	**Post Brushing**	**Reduction**	**Percentage reduction**
Mean	30	112.07	47.63	64.63	57.67%
Range	30	44-172	9-93	N.A	Significant at p<0.05

Difference between pre and post brushing plaque is statistically significant p<0.05

	N	**Pre Brushing**	**Post Brushing**	**Reduction**	**Percentage reduction**
Mean	30	109.46	75.00	34.46	31.48%
Range	30	71-156	4-102	N.A	Significant at p<0.05

Table-2: Plaque Removal by Concave Bristle Toothbrush
Difference between pre and post brushing plaque is statistically significant p<0.05

	N	**Pre Brushing**	**Post Brushing**	**Reduction**	**Percentage reduction**
Mean	30	117.57	54.07	63.50	54.01%
Range	30	67-148	21-99	N.A	Significant at p<0.05

Table-3: Plaque Removal by Crisscross Bristle Toothbrush
Difference between pre and post brushing plaque is statistically significant p<0.05

Table-4: Plaque Removal by Zigzag Bristle Toothbrush

Bristle design	**Plaque before brushing**	**Plaque after brushing**	**Percentage reduction**
Flat	113.27	48.70	57.00%
Concave	112.07	47.63	57.67%
Crisscross	109.46	55.00	31.48%
Zigzag	117.57	54.07	54.01%

Difference between pre and post brushing plaque is statistically significant p<0.05

Table No: 5 Comparison of Plaque Removal by Different Toothbrush

Flat-bristle designed toothbrush the mean plaque score has come to 48.70 (post-brushing) from a pre-brushing mean score of 113.27. It showed a total reduction of 64.57. For Concave-bristle designed toothbrush, the value changed from 112.67 to 47.63 with a reduction of 65.04. Zigzag bristle designed toothbrush showed a Post-brushing mean plaque score of 54.07 compared to 117.57 (mean pre-brushing score) giving rise to a reduction of 63.50. Whereas crisscross bristle designed tooth brush showed a post-brushing plaque score of 75.00, compared to 109.46 (pre-brushing mean plaque score) with a total reduction of the value 34.46. This suggests that all the four toothbrushes have shown plaque reduction, somehow to a greater or lesser extent. The reduction was also found to be statistically significant as the p-values were less than 0.05.

DISCUSSION:

Since years, toothbrushing has served mankind to prevent dental and periodontal diseases. Toothbrushes do this job by disrupting the plaque mechanically. Some parameters related to toothbrush efficacy are well defined e.g. bristles' softness and at least once in 48 hours use of toothbrush[2]. Bristle arrangement and designs are however changing day by day and each claims better effectiveness for plaque removal. This study was undertaken to check, if really, any of the four selected toothbrushes, exceeds in its efficacy for plaque removal.

For this purpose, four toothbrushes with different bristle designs were selected. Pre-brushing and post-brushing plaque scores were noted for whole dentition except for 3rd molars. This was because of the reason that there could be partially erupted 3rd molars in the selected age group which could disturb our plaque scores. Other dental conditions e.g. crowding, presence of removable or fixed prosthesis, open bite and incompetent lips were also excluded because all these give rise to poor oral hygiene and hence greater plaque accumulation which again could make an unnecessary false positive increase in plaque scores.

Volunteers with increased periodontal pocket depths were also not included because poor periodontium status could pose problems, both to the examiner and the volunteer himself, while scoring plaque due to bleeding tendencies. Moreover, gingival enlargement can mask cervical areas buccally and this could have led to false negative plaque scores.

Cervical, buccal or lingual restoration bearing volunteers were also excluded because these were also excluded because these were the surfaces noted for plaque scores and restorations, no matter how smooth they look, do differ at microroughness from normal dental tissue and hence lead to greater possibilities for plaque accumulation[2].

For the quantitative assessment of plaque, Gilmore-Glickman Modification of Hein Plaque Index was chosen. The above mentioned plaque index scored both on the facial and lingual surfaces of whole dentition, which was in consistence with our requirements. Moreover, full mouth scores revealed better values to be compared and related with the results.

To give emphasis on the selected variable i.e. toothbrush bristle design, all other parameters were kept constant e.g. toothbrush bristle texture (medium softness) and brand. In addition, volunteers used their own methods for brushing, as for the four toothbrushes used, the technique as per same volunteer remained the same.

While comparing the pre-brushing and post-brushing mean plaque scores from tables 1-4, it can be noted that, for Flat-bristle designed toothbrush the mean plaque score has come to 48.70 (post-brushing) from a prebrushing mean score of 113.27. It showed a total reduction of 64.57. For Concave-bristle designed toothbrush, the value changed from 112.67 to 47.63 with a reduction of 65.04. Zigzag bristle designed toothbrush showed a Postbrushing mean plaque score of 54.07 compared to 117.57 (mean pre-brushing score) giving rise to a reduction of 63.50. Whereas criss-cross bristle designed toothbrush showed a post-brushing plaque score of 75.00, compared to 109.46 (pre-brushing mean plaque score) with a total reduction of the value 34.46. This suggests that all the four toothbrushes have shown plaque reduction, somehow to a greater or

lesser extent. The reduction was also found to be statistically significant as the p-values were less than 0.05. This goes in consistence with most of the studies performed previously[5, 6, 7, 8, 13]. However it is seems evident that the difference between pre and post-brushing plaque scores for criss-cross bristle designed toothbrush was less as compared to the rest of three brushes.

Comparing percentage reduction for the four toothbrushes from table-5 reveals that Flat bristle designed and Concave bristle designed toothbrushes showed maximum plaque reduction. Minimum plaque reduction was observed for Criss-cross bristle designed toothbrush was though less than Flat and Concave bristle type, yet it was greater than the Criss-cross one.

Less percentage reduction for Criss-cross type and a greater percentage reduction for Flat and Concave bristle type toothbrushes could be due to a variety of reasons. For example, most of the population is habitual for using flat bristle designed toothbrushes and even for this very type, manual dexterity is the main feature, determining the plaque removing efficacy[5]. So, unless a complexly designed toothbrush is used in a proper way with a particular protocol, it can not prove itself effective. More the complex structure, more the strict protocol to be followed and hence more it will be difficult for a lay man to use it. On the other hand, simple design of toothbrush bristle was frankly used by the volunteers with their very own method of toothbrushing. Some of the volunteers had even reported discomfort while using Criss-cross type.

Another reason that can be correlated is the angulated bristles of the Criss-cross type of brush. For the rest of three toothbrushes, though as seen from above, surface of the toothbrush head varied, the angulation of single bristle tuft with the base of head was at right angle. Such bristles provided a stroke that was put perpendicularly to the tooth surface and hence delivered maximum force. But for Criss-cross type, optimum force couldn't be applied due to an angle that was less than 90^{o} to the tooth surface. Moreover, a toothbrush with bristles, arranged at a right angle to the base are easy to be adapted to one's own technique of brushing rather than those that are already angulated. In addition, it can be noted, that criss-cross design might be more helpful in removing plaque from approximal surfaces but not the buccal and lingual ones. Because the plaque index selected scored the plaque on later ones, an overall less percentage reduction for Criss-cross bristle designed toothbrush was observed.

The results obtained were statistically significant and reliable because of the involvement of cross over type of single use study design[14].

CONCLUSION:

Based on the results obtained from the study it comes forward that though newer and newer varieties of toothbrush bristle designs are coming in the market, no one is exceptional in efficacy for removing plaque. Though complexity in the newer products do increases but the plaque removing efficacy does not increases proportionately.

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FAILURES ARE OFTEN THE RESULTS OF TIMIDITY AND FEARS; DISAPPOINTMENTS ARE THE RESULTS OF BASHFULNESS; HOURS OF LEISURE PASS AWAY LIKE SUMMER-CLOUDS, THEREFORE, DO NOT WASTE OPPORTUNITY OF DOING GOOD.

Hazrat Ali (Karmulha Wajhay)