

## ORIGINAL RESEARCH

# Evaluation of the Efficacy of a Conventional Bristle Brush and Cross-action Brush in Routine Oral Hygiene Practice: A Comparative Study

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## ABSTRACT

**Background:** Toothbrush filament configuration can vary to a large extent with a considerable emphasis on the design and texture of bristle of a toothbrush in order to enhance effective removal of plaque.

**Aims:** The aim of the study was to compare the plaque removing efficiency of two branded toothbrushes with different brush head design and bristle arrangement in routine oral hygiene practice.

**Materials and methods:** The study was randomized single blind, involving 100 healthy individuals, 50 samples in each group. At the time of initial examination the subjects randomly picked toothbrushes (Oral B fresh-clean and Oral B cross-action) and common toothpaste by lottery method along with the printed instructions to use the assigned brush for next 28 days. Plaque and gingival indices were recorded at appointed time every 0, 7th, 14th, 21st and 28th day. Finally, the results were subjected to student's unpaired 't test'.

**Results:** Plaque and gingival scores showed a significant decrease in all parameters at all time intervals. Plaque and gingival scores were found to be significantly reduced in 3rd and 4th week time interval with respect to both the brushes though the cross-action brush showed better result with mean reduction of gingival index score from 1.812 at baseline to 1.5733 at 4th week as compared to fresh-clean brush which showed mean reduction of gingival index score from 1.4161 at baseline to 1.4016 at 4th week.

**Conclusion:** Among the two toothbrushes it was Oral-B cross-action toothbrush which showed the maximum reduction in plaque and gingival index scores followed by Oral-B fresh-clean toothbrush. It can be concluded that the arrangement of bristles plays a convincing role in reduction of plaque besides the manual dexterity of an individual.

**Keywords:** Clinical trials, Plaque control, Toothbrush, Toothbrush design, Bristle.

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## INTRODUCTION

The benefits of optimal home-use plaque-control measures include the opportunity to maintain a functional dentition throughout life, broadly speaking, the self-care or home-use activities that contribute to the oral health status of an

individual include toothbrushing by manual or electric means combined with interdental cleaning.<sup>1</sup> It is generally agreed that there is a positive correlation between the degree of plaque accumulation and gingival disease. The role of plaque as an etiological factor in the development of chronic inflammatory disease is well documented.<sup>2</sup> Bacterial plaque initiates an inflammatory process in the supporting structures of the tooth, and if allowed to continue loss of tooth.<sup>3</sup> Consequently, the removal of all microbial deposits from the tooth remains essential in the prevention of periodontal infections. The removal of microbial plaque leads to resolution of gingival inflammation, and cessation of plaque control leads to reoccurrence of inflammation. Thus, plaque control is an effective way of preventing and treating gingivitis and therefore is a critical part of all the procedures involved in the prevention and treatment of periodontal diseases.<sup>4</sup>

Till date, the most dependable mode of plaque control is mechanical cleaning with a toothbrush making it the most efficient device for oral hygiene maintenance.<sup>5</sup> Plaque removal by manual tooth brushing remains the most common method of oral hygiene and is quite effective when correctly performed for an appropriate duration. Numerous variables influence the fabrication and design of toothbrushes. These variables include bristle material, length, shape, diameter, number of bristles, design of brush head, size and arrangement of tufts and angulations of brush head to the handle and handle design.<sup>6</sup> Considerable emphasis has been placed on the design of toothbrush which provides maximum accessibility to all areas of mouth and it should not traumatize the gingival tissues and at the same time it should remove plaque from all surfaces of the teeth effectively. With a view to improve the oral hygiene status of the country, various company including multinationals are introducing newer oral care products in the toothbrush and dentifrice range.

The market today is flooded with bewildering array of tooth cleansing products and each day more and more products are being added. The consumer therefore is perplexed and confused regarding which product to be used. The task of advising the patient the use of particular oral hygiene product then falls on the oral health care personnel and they have to do so keeping the needs of the particular

patient in mind. Moreover manufacturers of each toothbrushes claim superiority in plaque removal over other brushes. This study was conducted to evaluate and compare the plaque removing efficacy of two different types of commercially available manual toothbrushes.

## MATERIALS AND METHODS

A total of 100 nonclinical (1st and 2nd years) dental students aged between 18 and 25 years were selected based on inclusion and exclusion criteria. All the selected subjects met with the following criteria: (1) No more than two dental caries or adverse restorations; (2) subjects with gingival index score less than or equal to 1.9; (3) plaque index score less than or equal to 1.9; (4) no supplemental plaque control aids used over the previous 6 months; (5) no mucosal disorders like ulcers and high frenum attachment; (6) teeth should be in good alignment; (7) minimum of 24 teeth with no interposed edentulous spaces or loss of interdental contacts; (8) no prosthetic rehabilitation and orthodontic appliance.

### Exclusion Criteria

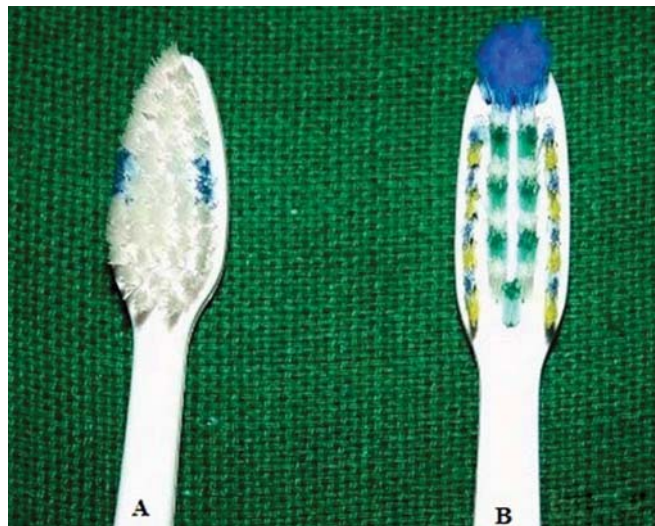
(1) Reported use of antibiotics or anti-inflammatory medications for three consecutive days or more within the previous 1 month or had any medical condition with requirement of prophylactic antibiotics before study; (2) subjects having any systemic diseases; (3) smoking or tobacco-related habits.

### Brushes

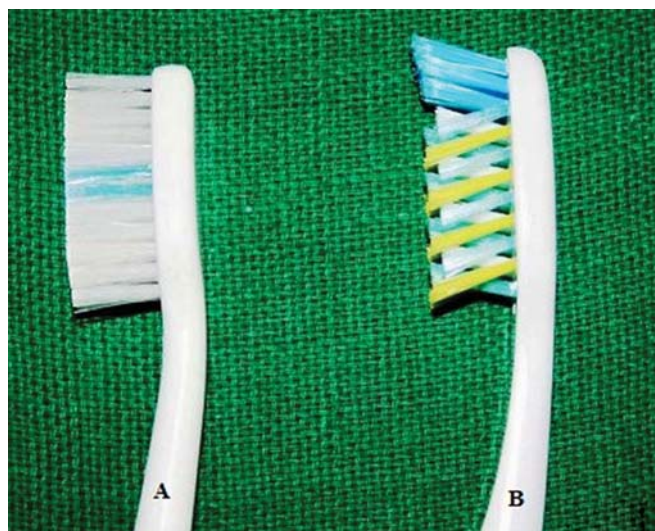
The two brushes used in this study were of different designs with differences in arrangement of bristles with similar texture (medium) and configuration. All the brushes were the product of the same manufacturer (Oral-B Division, Gillette Diversified Operations Ltd, New Delhi, India).

**Brush 1 (Figs 1A and 2A):** The brush head is diamond shaped with a convex toe. The bristles are conventional flat, rounded end. It has 4 light blue indicator tufts 2 on each side. Its spoon shaped handle gives a better control while brushing. Length—3 cm (head), 3.5 cm (shank), 11 cm (handle). Width—1 cm (brush head). Number of rows—2 to 4. Number of tufts—40 (10-12) per row. Number of filaments per tuft—35. Length of the filaments—1 cm.

**Brush 2 (Figs 1B and 2B):** The brush head is oval shaped with flat toe. The bristles are of four colors, blue, white, green and yellow along with light blue colored indicator bristles. All the four colored bristles are of different lengths which are arranged in criss-cross pattern in opposite



**Figs 1A and B:** Front view: (A) Conventional toothbrush, (B) cross-action toothbrush



**Figs 2A and B:** Side view: (A) Conventional toothbrush, (B) cross-action toothbrush

direction to each other to lift out and sweep away the plaque. Extra long bristles at the tip of the head helps to clean the most posterior surface of the distal most teeth in an arch there by resulting in more complete cleaning. Blue indicator bristles fade halfway indicating to replace the brush. It has a soft rubberized grip which ensures greater comfort and control. Length—3.2 cm (head), 3.5 cm (shank), 12 cm (handle). Width—1 cm (brush head). Number of rows—04. Number of tufts—38 (10-12) per row. Number of filaments per tuft—blue power tip—7 tufts with 40 bristles each. Yellow—2 rows with 8 tufts 4 on each side with 28 bristles each. White 2 rows at the center 8 tufts 4 on each side with 60 bristles. Green—2 rows at the center 7 tufts 3 on each side with 60 bristles. Light blue indicator—8 tufts 4 on each side with 28 bristles. Length of the filament blue power tip (1.3, 1.2, 1.2 cm), yellow (1.2 cm), white (1 cm), green (1.1 cm), light blue indicator (1 cm).

## Brushing Instructions

1. Should use allotted toothbrush and toothpaste only.
2. Should brush twice daily, each brushing should be 3 to 5 minutes by bass method.
3. Should not use any other oral hygiene measures (flossing, toothpicks, mouthwashes, etc.), during the study.
4. Should not take routine dental treatment or antibiotics and anti-inflammatory medications during the study unless emergency.
5. Should attend the appointments regularly.

## Criteria for Grouping

The subjects were divided into two groups of 50 depending on the type or the toothbrush assigned: B1 (Fig. 1A) conventional bristle brush (Oral-B fresh-clean) and B2 (Fig. 1B) cross-action brush (Oral-B cross-action).

## Study Design

Sample size for number of subjects was decided with each having 50 subjects, since it was a parametric study. After the subjects were selected on the basis of inclusion and exclusion criteria, subjects were interviewed for their general health, dental history and a detailed intraoral examination was done. The records were maintained in a written format designed for the study. Ethical clearance from the institutional ethical committee was obtained prior to the study, after taking a written consent of the subjects the study was undertaken. At the time of initial examination the subjects randomly picked toothbrushes (by lottery method) that were numbered and individually packed in along with the printed instructions and common toothpaste by a third person, the coded numbers marked on the covers were recorded. Plaque index by Turesky modification of Quigley and Hein 1970,<sup>7</sup> and gingival index by Loe and Silness 1963<sup>8</sup> were recorded for all 100 subjects at baseline followed by every 7th, 14th, 21st and 28th days.

## RESULTS

The result of the collected data was subjected to statistical analysis of variance to assess the significance. Standard deviation was calculated and the values were subjected for quantification with small parametric student's t-test. The results are depicted in the form of tables and graphs. The probability value (p-value) gives the tests of significance.

The plaque index and gingival index for two different brushes were tabulated at baseline, 1st, 2nd, 3rd and 4th visits recall respectively.

Tables 1 and 2 show the mean and standard deviation for the two groups of brushes at different time intervals.

**Table 1:** Comparison of gingival index between two groups

Component	Mean	SD
B1	1.4016	0.3082
B2	1.5733	0.2246

**Table 2:** Comparison of plaque index between two groups

Component	Mean	SD
B1	1.2035	0.2872
B2	1.5391	0.2823

Table 3 shows the student's unpaired t-test applied to compare between the two groups with respect to plaque index. The results were statistically significant with p-value of  $p < 0.0001$ .

In an attempt to compare between the groups with respect to gingival index unpaired student's t-test was applied, the result between B1 and B2 was statistically significant (Table 4).

Table 5 reveals percentage reduction of plaque and gingival index for two types of brushes. Interestingly, all the data related to plaque index and gingival index for both the brushes showed highly significant reduction at p-value less than 0.05 and at 95% level of confidence.

## DISCUSSION

The manual toothbrush used in our daily life for brushing was introduced way back in the 1920s, it is since then the toothbrush became an affordable oral hygiene device for the masses. Tooth brushing with toothpaste is the most common oral hygiene habit and in last decade, there have been inventions of numerous new designs so as to increase the efficacy of a toothbrush. Most variations/innovations observed are with the design of the brush head and configuration of the filaments. Manufacturers, in their designs, are clearly attempting to improve the efficacy and safety of their products; however some electric toothbrushes appear more effective than manual ones. At present, there is no clearly established method to evaluate efficacy of the toothbrush although many methods have been proposed. Thus, unless highly trained, most subjects will consistently miss areas of the dentition, the scores from which may then mask increased efficiency of cleaning by a particular brush at other sites.<sup>9</sup>

The present study was conducted with 100 subjects, but 44 subjects in group B1 and 46 subjects in B2 could complete the study. Subjects who participated in the study demonstrated great variations in their ability to clean their teeth and were presumably dependent on manual dexterity, and ability to follow instructions. Maintenance of low level

**Table 3:** Comparison of plaque index between two groups using unpaired t-test

Component	Mean**	SD****	N***	t-value	df*	p-value	Significance*****
B1	1.2035	0.2872	220	12.3616	448	<0.0001	S
B2	1.5733	0.2823	230				

\*Degree of freedom; \*\*Mean score of plaque index for all five visits time intervals; \*\*\*Number of observations; \*\*\*\*Mean standard deviation score of plaque index for all five visits time intervals; \*\*\*\*\*Significant

**Table 4:** Comparison of gingival index between two groups using unpaired t-test

Component	Mean**	SD****	N***	t-value	df*	p-value (5% level)	Significance*****
B1	1.4016	0.3082	220	6.7751	448	<0.0001	S
B2	1.5733	0.2246	230				

\*Degree of freedom; \*\*Mean score of plaque index for all five visits time intervals; \*\*\*Number of observations; \*\*\*\*Mean standard deviation score of plaque index for all five visits time intervals; \*\*\*\*\*Significant

**Table 5:** Consolidated percentage reduction of plaque index and gingival index for two groups in 4 weeks from baseline (percentage of reduction)

Groups	Mean	SD
B1	25.93	12.13
B2	59.85	53.65

of plaque, consistent with gingival health, is an important element of any dental health program. A high level of oral hygiene can be maintained over extended periods by individuals who are provided with regular tooth-cleaning instruction and scaling. Stephen et al<sup>10</sup> explained that normally, individuals who participate in an experimental dental health programs fail to comply with the instructions that they have been given. As a result, there is some return to pre-study plaque levels, although some benefits from the programs remain.<sup>10</sup> Keeping this in mind, this study was focused toward nonclinical dental students (1st and 2nd years) who to a great extent could follow the instructions given and understand the importance of their participation in the study. Thus, in our present study it has been confirmed that when suitable oral hygiene technique is advocated with scientific guidance, the gingival health can be improved markedly. After the 28-day pre-experimental period, approximately 60% of participants had <10% gingival bleeding on probing, whereas none of the participants had this degree of gingival health prior to the study.

There are several designs and angulations of commercially available toothbrushes and the user often gets confused as to which brush he or she should use. Thus, there is a need for the study on the use of variety of toothbrushes; both for the patient and the dentist. Hence, this study is designed which could be informative in the perspective of variety of brushes and their efficacy. A total of 90 subjects participated in this study and the study was undertaken in four stages. First stage comprised of oral

prophylaxis for each subject followed by oral hygiene recommendation by bass method. The participant was then given a particular new toothbrush and was asked to report every week so as to assess the plaque and gingival index scores. At the end of 28 days the data was collected and subjected to the statistical analysis.

Although in the present study the two toothbrushes B1 (Oral-B fresh-clean) and B2 (Oral-B cross-action) were of different design, they were chosen from the same manufacturer meeting the specification proposed by American Dental Association. These two brushes differed in brushing surface, number of tufts, number of bristles, arrangement of bristles and length of bristle. The comparison of parameters, i.e. plaque index and gingival index mean values showed significant difference from among all four study brushes. The comparison of two toothbrushes with respect to baseline, first, second, third and fourth weeks plaque scores and gingival scores showed significant difference in all parameters at all time intervals specially at third week as shown in Table 1. According to Cohen (1973)<sup>11</sup> trial periods of three weeks are advisable if a toothbrush is to be tested accurately. The findings of this study are in accordance with Cohen (1973)<sup>11</sup> showing the trend toward progressively reduced plaque scores with all the kinds of study brushes during the third and fourth weeks of the trial. This contrast with the results of a previous trial conducted by Scopp (1976),<sup>12</sup> where an experimental toothbrush was found to produce lowest plaque scores in the first week. One explanation may be that patients tend to revert to the technique they are most comfortable with.

It was observed that the B2 toothbrush users had, on an average, 59.85% greater plaque removal scores than that of B1 toothbrush users who had, on average 25.93% plaque removal scores. This might be due to criss-cross bristle pattern of B2 group which helped to reach between the inter-

proximal areas of the teeth and helped to sweep away the plaque along the gum. Also its thin handle with soft rubberized grip might have helped the subjects to brush their teeth effectively and comfortably.

Thus, B2 (Oral B cross-action toothbrush) demonstrated a statistically significant greater reduction in plaque compared to the other manual toothbrush ( $p < 0.0001$ ) as shown in Table 4. This is in correlation to a study by Bustillo (2000)<sup>13</sup> who studied the effectiveness of a criss-cross bristles arrangement in a battery-powered brush on plaque removal capacity compared with four manual toothbrushes. He demonstrated that a particular battery-powered toothbrush with criss-cross bristles arrangement removed more plaque as compared to other five manual toothbrushes in postbrushing studies, suggesting it was more related with the arrangement of the bristles. Thus, a strategic inference can be drawn that the bristle arrangement is of primary importance irrespective of the brush being manual or powered provided the user has a good manual dexterity.

The effectiveness of these brushes on gingival status when evaluated by gingival index showed significant decrease in all the parameters at all time interval levels of usage of any particular toothbrush.

The B2 group also showed a significant reduction in gingival health. The B2 toothbrush had, on average, 53.65% reduction in gingival scores than that of other groups who had, on average 12.13% reduction in gingival scores as shown in Table 5.

Irrespective of the type of brush used when comparing the baseline data and final data parameters including the plaque index and gingival index, there is a significant difference in reduction of the respective scores as shown in Table 1. This might be because of direct or indirect motivation of the subjects toward plaque removal during this 6 months of study period.

## CONCLUSION

The comparison of two toothbrushes with respect to baseline, 1st, 2nd, 3rd and 4th weeks plaque and gingival scores showed a significant decrease in all parameters at all time intervals. It was seen that specially at 3rd and 4th weeks time interval a significant reduction in plaque and gingival scores, irrespective of type of brush used. This may be probably due either direct or indirect motivation of the subjects toward plaque control during these 8 weeks study. Among the two toothbrushes it was Oral-B cross-action toothbrush which showed the maximum reduction in plaque and gingival index scores followed by Oral-B fresh-clean toothbrush. Though the Oral-B cross-action and Oral-B fresh-clean toothbrush showed maximum reduction in

plaque and gingival index, it could be due to its pattern of arrangement of bristles.

There are few limitations with this study. The investigation was carried out on a small and highly selected sample group. Another limitation is the duration of the study period considered for the each toothbrush. The variability of the results in the study suggests that 4-week study period may not be long enough to measure exact difference in the efficacy of the two toothbrushes.

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