Plaque Removal Efficacy of Different Toothbrush Bristle Designs and Brushing Technique - A Comparative Clinical Study

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Abstract

Of all the mechanical plaque control methods, toothbrushes used along with the appropriate brushing technique stands to be the primary beneficial homecare method. However, there is still confusion about the ideal toothbrush and brushing technique to be followed. The

study aimed at evaluating the efficacy of three different toothbrush bristle designs and brushing technique in plaque removal. 33 subjects were randomly divided into, Group A (flat-trim bristle design), Group B (criss cross bristle design) and Group C (360º bristle design). The study was carried out in two test periods(test period1- unsupervised, testperiod 2-supervised) with a washout period of 2 days. At the start and end of each five day test period, all the subjects were assessed for plaque according to Quigley-Hein plaque index. Kruskal-wallis test was applied to compare of plaque scores at baseline and at 5 days among the groups. Mann-whitney test was applied to compare the plaque scores between the groups and comparison of the plaque scores at baseline and at 15 days between supervised and unsupervised groups. Wilcoxon sign test was applied to compare within the group between time intervals (baseline and 5 days). No statistical significance was found among the groups with respect to plaque scores in unsupervised and supervised groups. On intragroup comparison, all the groups showed significant difference between the time intervals in both unsupervised and supervised brushing. On comparing the plaque scores between unsupervised and supervised brushing at baseline and at 5 days in each group, Group B showed statistically significant difference at baseline and at 5 days. Present clinical study indicated that all the toothbrushes bristle designs reduced plaque scores significantly compared to the baseline scores. Among the three bristle designs, crisscross bristle design with modified bass brushing technique showed statistically significant difference at baseline and at 5 days.

Keywords

Introduction

In the process of establishment of gingivitis many factors play a role leading to periodontitis out of which dental plaque is considered a prime etiological factor. In the periodontal tissues microbial plaque begins an inflammatory response which if allowed to continue it may ultimately lead to tooth loss. [1-3]

Thus, complete elimination of microbial plaque remains as a primary treatment objective in regaining the health of periodontium. Among the patient home care methods of oral hygiene practices, use of mechanical tooth brushes remains as the best tool for removal of plaque.[4]

Mechanical toothbrushes have experienced a great degree of complexity over a period of time. In the past many changes have been included in head and bristle design of the brush which lead to many revolutionary tooth brush designs. Tooth brush head designs changes like triple-headed and two-headed have been experimented. V-shaped, Multitufted, Two-level, Curved, Trimmed, Circular & Diamond shapes in bristle patterns have made their appearance in the history of toothbrush evolution.[5]

Toothbrushes are over the counter products and so no special instruction is given for use when it is purchased.6 This causes confusions for the common man in selecting a toothbrush and brushing method for which usually they may seek professional advice.[5]

Normal tooth brushing practices adequately performed by anyone could be sufficient to control bacterial plaque. Several toothbrushing techniques have been proposed, the modified Bass and the Horizontal Scrub technique being two of the most commonly recommended techniques in dental practice.[7] However, compared to all the prevalent tooth brushing techniques, modified

Bass technique is the most effective in reducing plaque and gingivitis.[8]

Various studies have been conducted in testing the plaque removal efficacy of manual toothbrushes and brushing techniques.[5] However, as of yet no conclusive data are available about the ideal design of toothbrush or brushing technique.[9]

Therefore, the present study aims to evaluate the efficacy of three commercially available tooth brushes and a particular brushing technique in plaque removal.

Materials and Methods

The present clinical study was conducted on Under graduates, Interns and Postgraduates of Sri Siddhartha Dental College and Hospital, Sri Siddhartha Academy of Higher Education, Agalakote, Tumkur. Necessary permission was obtained from the concerned authorities before starting the study and the study protocols followed were in accordance with Helsinki Declaration of 1975, as revised in 2013. The study was conducted for a period of 3 months.

Subjects between the age group of 18 to 27 years, who were systemically healthy, with a minimum of 25 intact teeth were included in the study. Those undergoing orthodontic treatment, excessive dental caries (more than four unrestored carious teeth), advanced periodontal disease, under antibiotics and /or anti-inflammatory medications in the past 2 weeks or who may require antibiotics during the course of the study, were excluded from the study.

33 subjects satisfying the inclusion and exclusion criteria were selected. A written informed consent was obtained from the subjects for the study. The subjects were randomly divided into three groups of 11 members each by lottery method and allocated the respective toothbrush. Group A subjects were allocated a flat-trim bristle design, Group B subjects were allocated a criss cross bristle design and Group C subjects were allocated a 360º bristle design.

All the subjects were then rendered plaque free with professional scaling during the preparatory period, 1-2 weeks prior to the start of the study.

The study was carried out in two test periods each test period lasting for five days with a washout period of 2 days.

In the first test period of the study, the tooth brushing was performed by the subjects themselves (unsupervised brushing) with the allocated toothbrush. The subjects were instructed to brush their teeth using their own technique and length of brushing with the allocated toothbrush and not to use any other interdental aids or mouthwash during the test period.

A washout period of 2 days was allowed between the study periods, during which the subjects were asked to return to their old hygiene practices.

During the second test period, the subjects in the three test groups were again allocated new toothbrushes, taught and demonstrated the Modified Bass technique and were supervised during brushing using the given toothbrush.

At the start and end of each five-day test period, the subjects were assessed for plaque according to the criteria of Turesky and Gilmore modification of Quigley-Hein plaque index.

Plaque was assessed on the buccal and lingual surfaces of all teeth except the third molars using the erythrosine disclosing solution.

Statistical Analysis

The data obtained from the randomized controlled study was then subjected to statistical analysis.

A power analysis was established by G*power, version 3.0.1(Franz Fauluniversitat, Kiel, Germany). A

sample size of 11 per group would yield 90% power to detect significant differences, with effect size of 0.95 and significance level at 0.05. Since there are three groups, the overall sample size was 33.

The comparison of plaque scores at baseline and at 5 days, supervised and unsupervised, among the groups was done using Kruskal-wallis. The comparison of the plaque scores between the groups and comparison of the plaque scores at baseline and at 15 days between supervised and unsupervised groups was done using Mann-whitney test. The comparison within the group between time intervals (baseline and 5 days) was done using Wilcoxon sign test.

Results

Of the 33 subjects included in the study there were no dropouts.

Kruskal-wallis test was applied to compare the plaque scores (unsupervised and supervised) at baseline and at 5 days among the groups. Kruskal-wallis test showed no statistical significance among the groups with respect to plaque scores- unsupervised (p=0.55; 0.75) (table 1) and supervised (p=0.85; 0.21) (table 2). Post-hoc Mann-whitney test was applied to compare the plaque scores between the groups (A,B,C). There was no significant difference seen between the groups with both unsupervised and supervised brushing (table 3). Wilcoxon sign test was performed to compare the difference between different time intervals (baseline and 5 days). All the groups showed significant difference between the time intervals in both unsupervised and supervised brushing (table 4). Mann-whitney test was applied to compare the plaque scores between unsupervised and supervised brushing at baseline and at 5 days in each group. Group B showed statistical significant difference at baseline (p=0.032) and at 5 days(p=0.027) whereas Group C(p=0.021) showed

statistical significant difference at 5 days(p=0.027) (table 5).

Discussion

There is universal agreement that a positive correlation exists between bacterial plaque on the tooth surfaces and gingival inflammation.[4] This is supported by several epidemiological surveys.[10] Mechanical plaque control which includes manual toothbrushes used with proper brushing technique is the most important strategy to prevent periodontal disease.[4]

The normal tooth brushing practices adequately performed by anyone could be sufficient to control bacterial plaque. Several tooth brushing techniques have been proposed, the modified Bass and the Horizontal Scrub technique being two of the most commonly recommended techniques in dental practice.[7] However, compared to all the prevalent tooth brushing techniques, modified Bass technique is the most effective in reducing plaque and gingivitis.[8]

So far, several workshops and reviews have consistently concluded that there is no superior design of manual toothbrush,[11-13] nevertheless different companies are still coming out with different designs, each claiming superiority, backed by the results of their own clinical research teams. [4]

Therefore, the present clinical study was undertaken to evaluate if any significant differences exist between three different bristle designs of toothbrushes and a particular brushing technique in plaque removal.

Different studies have been conducted for different time periods and no fixed duration has been agreed upon. Studies ranging from single use to 1 month to 6 months have been conducted.[4] However in this study, a randomized clinical trial with two test periods of 5 days and a washout period of two days was designed.

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 used in other studies [14, 15] where only certain designated teeth were assessed. Moreover, the index is simple, reliable and reproducible and facilitates comparison with other studies.[4]

Of the 33 subjects included in the study there were no dropouts. For intergroup comparison Kruskal-wallis test was applied to compare the plaque scores (unsupervised and supervised) at baseline and at 5 days among the groups. Kruskal-wallis test showed no statistical significance among the groups with respect to plaque scores- unsupervised (p=0.55; 0.75) (table 1) and supervised (p=0.85; 0.21) (table 2).

Post-hoc Mann-whitney test was applied to compare the plaque scores between two particular group at a time. There was no significant difference seen between the groups with both unsupervised and supervised brushing (table 3).

This is in agreement to the study results obtained by Sripriya N and Shaik Hyder Ali KH (2007), where it was noted that no significant difference was seen in the reduction of plaque scores among the four tooth brushes.[4]

Wilcoxon sign test was performed to compare the difference in plaque scores between different time intervals (baseline and 5 days). All the groups showed significant difference in plaque scores between the time intervals in both unsupervised and supervised brushing (table 4).

This is in agreement to the study results obtained by Sripriya N and Shaik Hyder Ali KH (2007), where it was noted that all the brushes showed a significant reduction in the post-brushing plaque scores.[4]

These observations are also in accordance with results obtained by Chakrapani S et al (2014), where all five commercially available brushes showed significant reduction in plaque score over 8 weeks.[5]

For intragroup comparison Mann-whitney test was applied to compare the plaque scores between unsupervised and supervised brushing at baseline and at 5 days in each group. Group B showed statistically significant difference at baseline (p=0.032) and at 5 days (p=0.027) whereas Group C (p=0.021) showed statistically significant difference at 5 days (p=0.027) (table 5)

This is similar to results obtained by Sharma et al, who compared five toothbrushes having flat trimmed bristles, multi-level straight bristles with three advanced crisscross bristles and concluded that advanced crisscross bristles were superior among them. Even though statistically insignificant, Group B [Colgate Zigzag] has shown increase in percentage reduction of plaque index.[16] Similar results were obtained in studies by Turner et al.[17] and Kakar et al. [18]

Table 1: Comparison of the plaque scores at baseline and at 5 days (unsupervised) among the groups using Kruskal-wallis

		N	Minimum	Maximum	Median	IQR	Kruskal-wallis	P value
Baseline	Group A	11	2.10	4.10	2.50	0.90	1.18	0.55
	Group B	11	2.10	4.20	2.90	1.50		
	Group C	11	2.00	4.40	2.50	1.30		
At 5 days	Group A	11	1.20	3.10	1.90	0.70	0.56	0.75
	Group B	11	1.10	3.10	1.90	0.70		
	Group C	11	1.20	2.60	1.80	0.70		

Table 2: Comparison of the plaque scores at baseline and at 5 days (supervised) among the groups using Kruskal-wallis

		N	Minimum	Maximum	Median	IQR	Kruskal-wallis	P value
Baseline	Group A	11	1.80	3.40	2.20	0.40		
	Group B	11	1.60	3.40	2.40	0.70	0.32	0.85
	Group C	11	1.60	2.90	2.50	1.10		
At 5 days	Group A	11	0.90	2.20	1.50	0.60		
	Group B	11	0.80	2.20	1.30	0.40	3.03	0.21
	Group C	11	0.80	2.20	1.30	0.40		

Table 3: Comparison of the plaque scores between the groups using Mann-whitney test

Groups			Group A v/s Group B	Group A v/s Group C	Group B v/s Group C
Unsupervised	Baseline	U value	47.50	57.50	45.50
		P value	0.39	0.84	0.32
	At 5 days	U value	56.50	48.0	55.5
		P value	0.79	0.41	0.74
Supervised	Baseline	U value	56.0	53.0	54.5
		P value	0.76	0.62	0.69
	At 5 days	U value	41.0	35.50	56.0
		P value	0.19	0.09	0.76

Table 4: Comparison within the group between time intervals (baseline and 5 days) using Wilcoxon sign test

		Baseline v/s 5 days (Unsupervised)	Baseline v/s 5 days (Supervised)
Group A	Z value	-2.93	-2.93
	p value	.003*	.003*
Group B	Z value	-2.93	-2.95
	p value	.003*	.003*
Group C	Z value	-2.96	-2.94
	p value	.003*	.003*

Table 5: Comparison of the plaque scores at baseline and at 15 days between supervised and unsupervised groups using Mann-Whitney test

	Group A		Group B		Group C	
	Baseline	At 5 days	Baseline	At 5 days	Baseline	At 5 days
U value	31.5	32.5	28.0	27.0	45.0	25.5
P value	.056	.065	0.032*	0.027*	.307	0.021*

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Figures

Initial examination and test participant screening

Medical history and diagnosis

Patient education and declaration of consent

Professional teeth cleaning, removal of local irritation factors, oral hygiene instructions

Randomized allocation of test participants to their respective groups

Group A (n=11)   Group B (n=11)   Group C (n=11)

First Test Period

Baseline
- Determination of plaque index (QHI)
- Distribution of toothbrushes and toothpaste
- Unsupervised brushing

Checkup
Determination of plaque index (QHI), 5 days after baseline

Washout period of 2 days
- Subjects were asked to return to their old hygiene practices

Second Test Period

Baseline
- Determination of plaque index (QHI)
- Distribution of toothbrushes and toothpaste
- Supervised brushing

Checkup
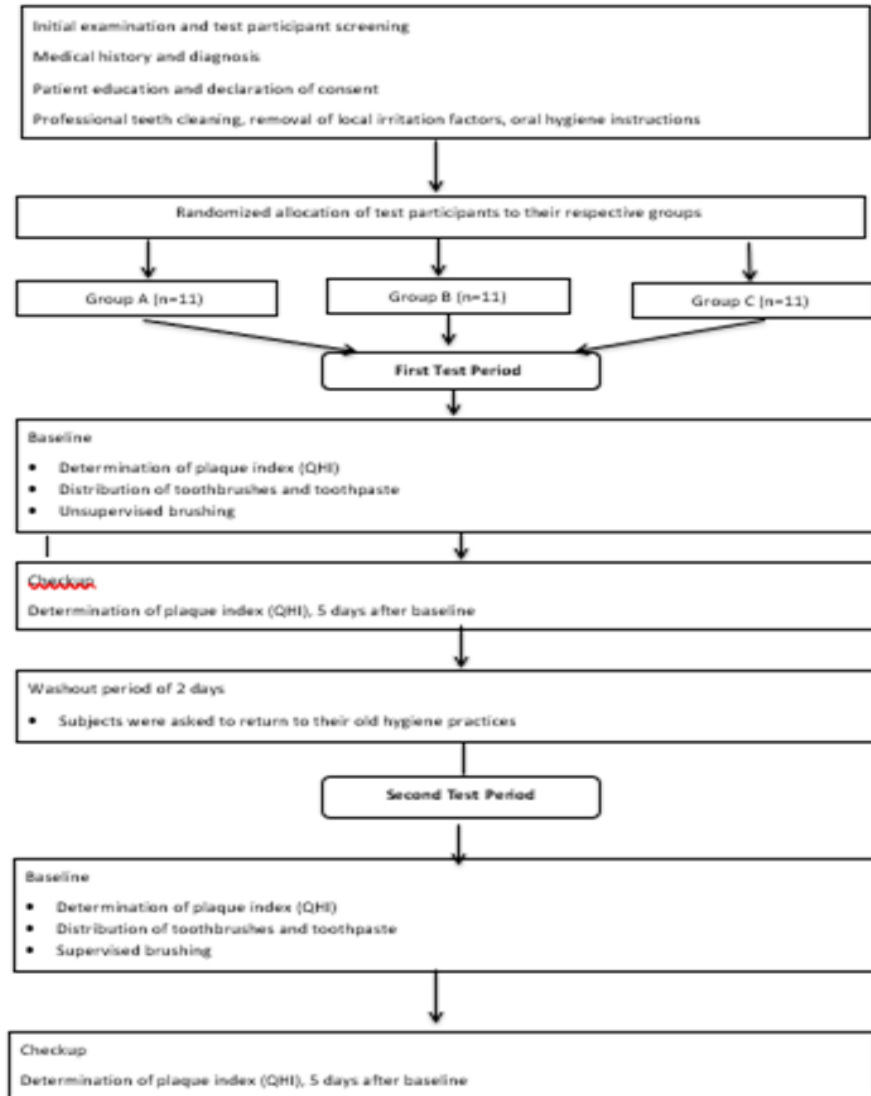Determination of plaque index (QHI), 5 days after baseline

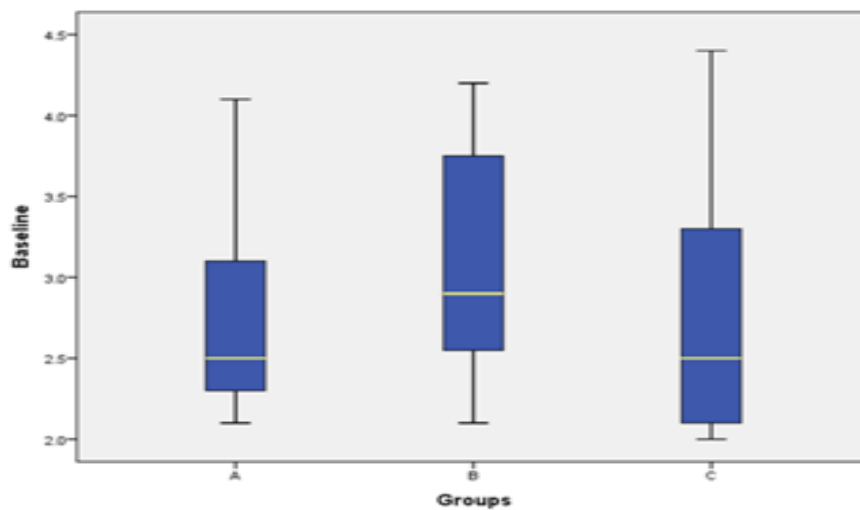**Figure1:** Flow chart presenting schematic diagram of the methodology

Figure 2: Comparison of the plaque scores at baseline (Unsupervised)
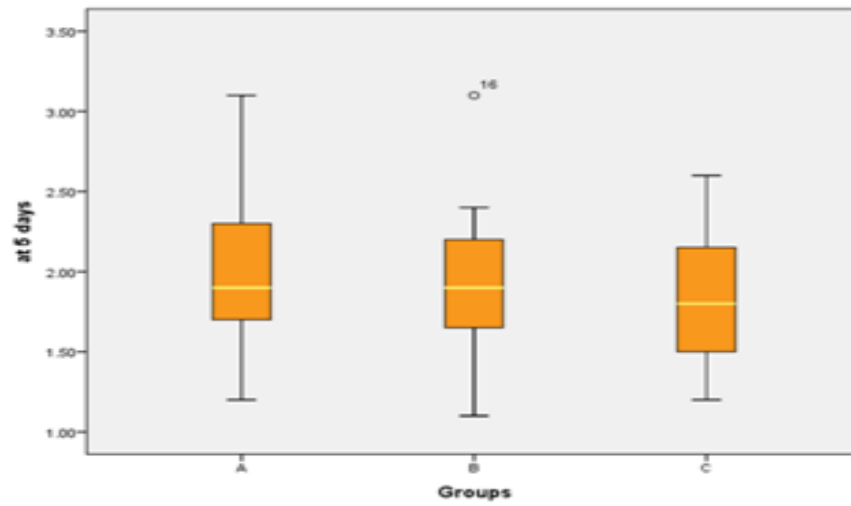
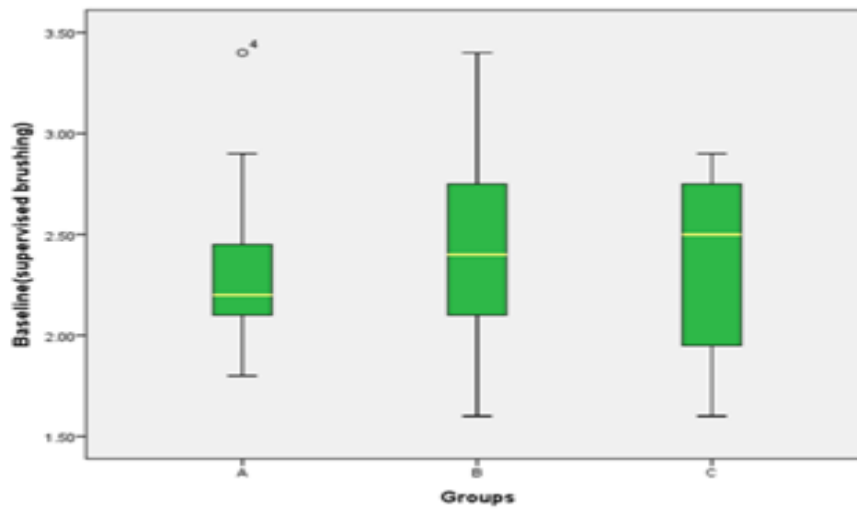**Figure 3:** Comparison of the plaque scores at 5 days (Unsupervised)

Figure 4: Comparison of the plaque scores at baseline (Supervised)
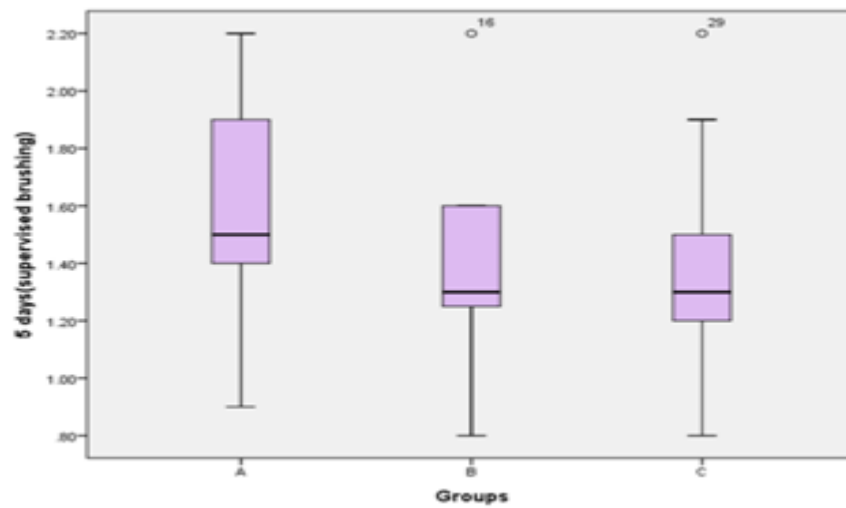

Figure 5: Comparison of the plaque scores at 5 Days (Supervised)

Conclusion

The result 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 three brushes. Overall, the results of the present study showed that all three brushes were equally effective in reducing the plaque scores and there was no superior design of manual toothbrush

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