

A Comparative Study on the Effectiveness of Different Orthodontic Toothbrush Designs in Removing Dental Plaque

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Abstract

Dental plaque among patients with orthodontic appliances is common. However, plaque removal using an ordinary toothbrush is challenging. This study therefore, aimed at evaluating the effectiveness of three different types of orthodontic toothbrushes in removing dental plaque in orthodontic patients. Thirty patients, 27 females and 3 males, were randomly assigned to three groups: Group A, B and C with corresponding toothbrushes assigned to each group. Group A was assigned Toothbrush A (V-shaped bristles), Group B, Toothbrush B (Vtrim bristles), and Group C, Toothbrush C (W-shaped bristles). These were used three times for 2 weeks. Bass method was used for brushing. Silness and Loe plaque index was used to score the plaque index for the three trials. The results were analyzed using One-way ANOVA and Tukey's Post Hoc test. All three orthodontic brushes tested were independently effective in removing plaque as manifested by decrease in mean plaque index scores. Comparing the three toothbrushes with specific designs, results showed that there were no statistical differences between the three toothbrushes when it comes to its ability to remove plaque. Although post hoc analysis favors Toothbrush A as superior over Toothbrushes B and C, it was not statistically significant.

Introduction

Studies show that there is a high prevalence of caries in patients with fixed orthodontic appliances. Brackets persistently trap food debris that makes it much harder to keep the teeth clean as food collects in between the brackets, or in and around places that the bristles cannot easily reach causing severe plaque accumulations. The major consensus for prevention of cavities and periodontal inflammation in orthodontic treatment is plaque control. However, the presence of orthodontic appliances makes treatment challenging. Singh et al (2011) mentioned that complete plaque removal with a conventional toothbrush does not seem to be realistic for major part of the population. For this reason, different types of specially designed toothbrushes have been developed in recent years in order to improve the plaque removal. Currently, most of the studies conducted deal with the comparison of the orthodontic manual toothbrushes against orthodontic electrical toothbrushes. Manual orthodontic toothbrushes have undergone advancements in bristle design and material

but studies comparing different types of toothbrushes available in the market seems rare or none at all. As Orthodontists all over the world recommend the use of manual orthodontic, Gomes et. al. (2012) stressed that unbiased and wellconducted trials are necessary to assess the effectiveness and even the risks of common brands of orthodontic toothbrushes during orthodontic treatment. This study was conducted at the Adventist University of the Philippines, Puting Kahoy, Silang, Cavite from August 2014 to January 2015 and aimed at investigating and evaluating the efficacy of three orthodontic toothbrushes in eliminating microbial dental plaque on teeth and brackets of patients with fixed appliances by comparing the pre- and post-brushing plaque index score using three types of orthodontic brushes.

Methods

This study was conducted at Adventist University of the Philippines, Puting Kahoy, Silang, Cavite from August 2014 to January 2015. A total of thirty patients were consecutively recruited. Patients were considered eligible for study inclusion if they have been wearing upper and lower orthodontic fixed appliances, had minimum of

26 scorable teeth or 52 surfaces (excluding third molars), absence of dental anomaly or pathology and should be under the care of Dentist / Orthodontist at the time of recruitment.

Three different types of locally available orthodontic tooth brushes with varied toothbrush bristle designs were used (Table 1). Bass technique was used in brushing for a definite time, same dentifrices and with the same amount of toothpaste. To control each participant's dexterity and force, the 30 patients were divided into three groups (Groups A, B and C) with 10 participants in each group. Each group used different kinds of

orthodontic toothbrush. Group A were given Toothbrush A (V-shaped bristles), Group B, Toothbrush B (V-trim bristles), and Group C, Toothbrush C (W-shaped bristles) (Figure 1). The same orthodontic tooth brushes were used three times by each of the participants after one week interval. A red disclosing solution was used to identify the dental plaque on the tooth surfaces.

Plaque removal was assessed using Modified Silness and Loe index. Plaque is then scored in each area based on the four codes used in the original Silness and Loe index using the following formula:

Total score (Sum of mesial, distal, gingival, incisal)

$$\text{Plaque index} = \frac{\text{Total score}}{\text{number of surfaces examined}}$$

The index for the patient is obtained by summing the indices for all six teeth (16, 12, 24, 36, 32, 44) and then dividing by number of tooth examined.

$$\text{Index for Patient} = \frac{\text{Sum of indices for tooth \# 16, 12, 24, 36, 32, 44}}{\text{number of tooth examined}}$$

Interpretation:

A score of 0 to 1 is considered low

A score of 2 to 3 is considered high

Informed consent was obtained for each study patient. Results were analyzed utilizing one way ANOVA and multiple comparison Tukey's HSD test.

Results and Discussion

Tables 1, 2 and 3 shows the plaque index score difference before and after the brushing sessions. There were three trials that had been conducted for each type of orthodontic brushes and the plaque index scores result of before and after the brushing sessions were recorded. The tables show that majority of the participants had a plaque index score of 0 to 1 before and after brushing which means that even before brushing their teeth they already considered having low plaque index score.

Table 4 shows that the Mean plaque index scores of three toothbrushes for the all trials. Toothbrush A had 0.8112 (SD = 0.30987) Mean plaque index scores before brushing and 0.3452 (SD = 0.21144) Mean plaque index

score after. For toothbrush B the Mean plaque index score before brushing is 0.7232 (SD = 0.27015) and after brushing it became 0.3516 (SD = 0.18302). For toothbrush C the Mean plaque index score before brushing is 0.7248 (SD = 0.31265) and after brushing is 0.3351 (SD = 0.15442). The Mean Plaque Index of Pre-brushing and Post-brushing using the three orthodontic toothbrushes are considered Low.

A paired-samples t-test was conducted to compare the Mean plaque index removal in pre-brushing and post-brushing. There was a significant difference in the scores of pre-brushing in Toothbrush A (M= 0.8112, SD= 0.30987) and Post-brushing (M= 0.3425, SD= 0.21144) conditions; t(23)= 10.350, p = 0.000. There was a significant difference in the scores for the Toothbrush B pre-brushing (M= 0.7232, SD= 0.27015) and postbrushing (M= 0.3516, SD= 0.18302) conditions; t(24) = 8.014, p = 0.000. There was a significant

difference in the scores for the Toothbrush C pre-brushing ($M= 0.7248$, $SD= 0.31265$) and post-brushing ($M= 0.3351$, $SD= 0.15442$) conditions; $t(24) = 7.722$, $p = 0.000$. These results show that there is statistically significant difference of pre-brushing and post-brushing of plaque removal using toothbrush A, Toothbrush B and toothbrush C.

Table 6 shows that a one-way between subjects ANOVA was conducted to compare the Toothbrush A, Toothbrush B and Toothbrush C in plaque removal. It shows that there is no statistically significant difference in plaque removal at the $p<0.05$ level for the three toothbrushes [$F(2, 71) = 1.168$, $p = 0.317$].

Post hoc comparisons using Tukey HSD test on table 7 also shows that there is no statistically significant difference in plaque removal pairwise. But in table 8, Post hoc analyses using the Scheffe post hoc criterion for significance indicated that the average number of plaque removed is higher in the Toothbrush A ($M = 0.4688$, $SD = 0.22188$) than in the other two toothbrushes which are Toothbrush B ($M = 0.3716$, $SD = 0.23185$) and Toothbrush C ($M = 0.3897$, $SD = 0.25233$).

Although the plaque index scores of all the participants measured low even before brushing, there was still decrease in the plaque index scores after brushing using the Toothbrush A, Toothbrush B, and Toothbrush C. The result also showed that there is a statistically significant difference in plaque removal between pre-brushing and post-brushing which meant that the three toothbrushes used were all effective in plaque

removal.

When comparing which one of the toothbrush can remove more plaque, Toothbrush A got the highest score in plaque removal. The reason of these results can be attributed to the unique design of v-shaped bristles, such as lowered bristles in the middle of the brushfield, have improved cleaning efficacy (Schatzle et al, 2008). The bristles at the end of the head are longer which make it easier to clean underneath the wire and around the brackets (Fink, 2013). While the designs of the toothbrush C with planar type of bristles, cannot reach the plaque in hard to reach area.

The study also revealed that most of the participants have a good oral hygiene habit since all of the participants have low plaque index scores even before the start of brushing session.

Conclusion

All of the three types of orthodontic brushes have good capability in removing plaque from patients with fixed orthodontic appliance because of decreased in plaque index scores after brushing.

Thereby we conclude that there is significant difference with the three toothbrushes but there is no superior toothbrush in removing dental plaque among the three toothbrushes although toothbrush A showed the highest Mean plaque removed.

The result would suggest that all of the toothbrush are equally effective but the use of V shaped bristle toothbrush may be of benefit in promoting oral health among patients with fixed orthodontic appliances.

Tables and Figures (A)

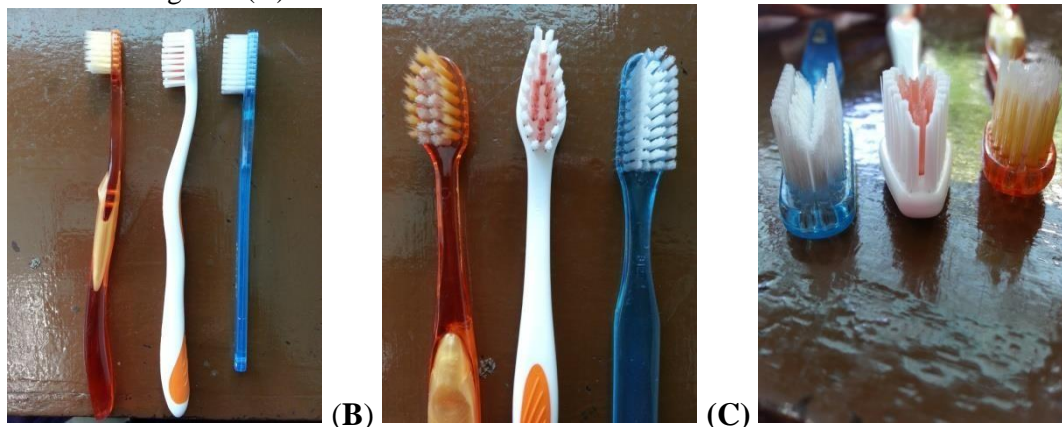


Figure 1. Proximal view, Front view and Close-up view of the three orthodontic toothbrushes. (A) Proximal view of the orthodontic toothbrushes (from left to right: Toothbrush C, Toothbrush B and Toothbrush A); (B) Front view of the orthodontic toothbrushes (from left to right: Toothbrush C, Toothbrush B and Toothbrush A); (C) Close up view to the bristle designs of the orthodontic toothbrushes (from left to right:

Toothbrush A, Toothbrush B and Toothbrush C).

Figure 2. Diagram showing modification of the Silness and Loe index as described by Williams. The tooth is divided into mesial (M), distal (D), gingival (G), and incisal (I) regions for plaque measurement.

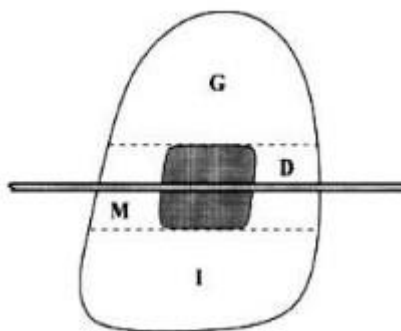


Table 1. Types of Orthodontic Toothbrushes

	Ortho toothbrush A	Ortho toothbrush B	Ortho toothbrush C
Head size	Standard and Conventional	Standard, Compact and Diamond shape	Standard and Diamond shape
Bristle	V-shaped rounded tip bristle	V-trim bristles shaped; Soft and longer outer bristle; firm, medium and shorter inner bristle	W-shaped cut bristles; Soft and slim with two different heights of bristles outside;
Handle	Plastic grip with straight handle	Rubber grip with contra-angle handle	Rubber grip with contra-angle handle
Price	P 85	P 120	P 75

Table 2. The Plaque Index System Modified Silness and Loe Scores

Scores	Criteria
0	No Plaque
1	A film of plaque adhering to the free gingival margin and adjacent area of the tooth. The plaque may be seen in situ only after application of disclosing solution or by using the probe on tooth surface.
2	Moderate accumulation of soft deposits within the gingival pocket, or the tooth and gingiva margin which can be seen with the naked eye.
3	Abundance of soft matter within the gingival pocket and/or on The tooth and gingival margin.

Table 3. Dental plaque index score of participants before and after using Toothbrush A for brushing

Toothbrush A						
Respondent	1st Trial		2nd Trial		3rd Trial	
	Before	After	Before	After	Before	After
R1	1.17	0.25	0.5	0	0.42	0.17
R2	0.54	0.33	0.96	0.58	0.7	0.38
R3	1.17	0.29	0.54	0.21	1	0.29
R4	0.05	0.08	0.5	0	0.25	0
R5	1.17	0.25	0.83	0.25	0.42	0.17
R6	1.13	0.58	0.38	0.25	0.75	0.33
R7	1.13	0.54	0.75	0.38	1	0.67
R8	1.33	0.67	1	0.63		
R9	1.04	0.67				
R10	0.79	0.33				

Table 4. Dental plaque index score of participants before and after using Toothbrush B for brushing.

Toothbrush B						
Respondent	1st Trial		2nd Trial		3rd Trial	
	Before	After	Before	After	Before	After
R1	1.04	0.67	0.46	0.25	0.54	0.33
R2	0.58	0.5	0.79	0.42	0.79	0.04
R3	0.83	0.5	0.5	0.25	0.33	0.17
R4	1.17	0.58	0.75	0.04	0.83	0.33
R5	0.63	0.38	1.04	0.46	0.83	0.33
R6	0.54	0.38	1.13	0.33	0.42	0.17
R7	1	0.83	0.83	0.33	0.67	0.38
R8	0.5	0.38	0.17	0.08	0.38	0.17
R9	0.54	0.33				

R10 1.17 0.33

Table 5. Dental plaque index score of participants before and after using Toothbrush C for brushing

Toothbrush C						
	1st Trial		2nd Trial		3rd Trial	
Respondent	Before	After	Before	After	Before	After
R1	0.58	0.46	0.75	0.25	0.79	0.38
R2	1.08	0.41	0.71	0.33	0.5	0.37
R3	0.25	0.12	0.63	0.33	0.5	0.04
R4	0.47	0.29	0.75	0.33	0.29	0.13
R5	0.63	0.5	1.58	0.75	0.5	0.29
R6	0.83	0.33	1.08	0.58	0.79	0.3
R7	1.17	0.25	0.83	0.46	1	0.13
R8	1.08	0.41	0.54	0.38		
R9	0.46	0.38				
R10	0.33	0.17				

Table 4. Mean Plaque Index for all the trials

Subject		Mean	Std. Deviation
Toothbrush A	Pre-brushing	0.8112	0.30987
	Post-brushing	0.3452	0.21144
Toothbrush B	Pre-brushing	0.7232	0.27015
	Post-brushing	0.3516	0.18302
Toothbrush C	Pre-brushing	0.7248	0.31265
	Post-brushing	0.3351	0.15442

Table 6. Mean Plaque Index for all the trials using T-test

Subject		Mean	Mean Diff.	t	df	sig. (2tailed)	Verbal Interpretation
Toothbrush A	Pre-brushing	0.8113					Statistically significant
	Post-brushing	0.3425	0.4688	10.35	23	0.00	

Toothbrush B	Pre-brushing	0.7232	0.3716	8.014	24	0.00	Statistically significant
	Post-brushing	0.3516					
Toothbrush C	Pre-brushing	0.7248	0.3897	7.722	24	0.00	Statistically significant
	Post-brushing	0.3351					

Table 7. One-way analysis of variance of toothbrushes in plaque index scores

		Source			F	P
df	SS	MS				
		Between Groups	2	0.13	0.065	1.168
				0.317		
		Within Groups	71	3.95	0.56	
		Total	73	4.08		

Table 8. Multiple Comparison of Toothbrush A, Toothbrush B and Toothbrush C using Post hoc Tukey test

(I) TB	(J) TB	Mean Diifference (I-J)	Std. Error	Sig
TB A	TB B	0.972	0.06741	0.326
	TB C	0.791	0.06741	0.473
TB B	TB A	-0.0972	0.06741	0.326
	TB C	-0.0181	0.06672	0.96
TB C	TB A	-0.0791	0.06741	0.473
	TB B	0.0181	0.6672	0.96

Table 9. Descriptive Statistic

Subject	N	Mean	Std. Deviation	Minimum	Maximum
Toothbrush A	24	0.4688	0.22188	0.13	0.92
Toothbrush B	25	0.3716	0.23185	0.08	0.84
Toothbrush C	25	0.3897	0.25233	0.08	0.92
Total	74	0.4092	0.23643	0.08	0.92

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