

Research Article

Effect of Toothbrush Replacement Frequency on Plaque and Gingival Inflammation: A Clinical Study Comparing 1-Month Vs 3-Month Replacement Intervals

Usman Manzoor Warraich^{1*}, Syeda Kinza Asghar², Vishal³, Ashique Hussain Sahito⁴, Saima Salman⁵, Umar Farooq Khan⁶

^{1*}BDS, FCPS, Assistant Professor Periodontology, Bakhtawar Amin Medical and Dental College, Pakistan.

²Assistant Professor Periodontology, HBS Medical and Dental Hospital/ College, Islamabad, Pakistan.

³FCPS Resident in Periodontology and Oral Implantology, Altamash Institute of Dental Medicine, Karachi, Pakistan.

⁴Assistant Professor, Department of Periodontology, Liaquat University of Medical and Health Sciences, Jamshoro Pakistan.

⁵Associate Professor, Department of Periodontology, Bhitai Dental and Medical College, Mirpurkhas, Sindh, Pakistan.

⁶Assistant Professor Periodontology, HBS Dental College, Islamabad, Pakistan.

Corresponding Author: Usman Manzoor Warraich

BDS, FCPS, Assistant Professor Periodontology, Bakhtawar Amin Medical and Dental College, Multan, Pakistan.

Email: drusman.mw@gmail.com

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ABSTRACT

Background: Continuous use of a toothbrush wears it down. This impacts plaque removal and may worsen gingival inflammation. Although some guidelines suggest a 3-month replacement, there is evidence for improved plaque removal with replacement after 1 month.

Aim of Study: This study examines the effect of 1 month and 3 month replacement intervals on plaque accumulation and gingival inflammation.

Methodology: 120 adult participants of either sex (aged 18-50 years) and with habitual tooth brushing were enrolled (balanced to n=60 per group). Group A replaced toothbrushes once a month and Group B, once in 3 months. Scores for the Plaque and Gingival indices (PI and GI respectively) were recorded before and after 3 months. SPSS version 26 was used for statistical analysis. Independent t-tests and paired t-tests were used to compare the results for statistical significance with $p < 0.05$.

Results: Initial scores for plaque and gingival indices were similar across both groups ($p > 0.05$). Group A was observed to have a lower Plaque Index (PI) score in the 3 month assessment (3 month replacement A; $PI = 0.89 \pm 0.34$) compared to Group B (3 month replacement B; $PI = 1.28 \pm 0.41$; $p = 0.001$). Group A also had a lower Gingival Index (GI) score ($GI = 0.74 \pm 0.29$) compared to Group B ($GI = 1.12 \pm 0.37$; $p = 0.002$). Both groups showed some improvement from initial assessment. Group A showed a greater reduction in plaque accumulation and gingival inflammation scores as compared to group B.

Conclusion: Compared to the three-month replacement standard, replacing a toothbrush every month led to better plaque control and less gingival inflammation. Improved oral hygiene and better periodontal health may be possible by replacing a toothbrush more often.

Keywords: Toothbrush Replacement, Plaque Index, Gingival Inflammation, Oral Hygiene, Periodontal Health, Clinical Study.

INTRODUCTION

General health and wellness rely heavily on the state of one's oral health. The accumulation of dental plaque is the primary cause of gingivitis as well as other periodontal diseases. The most effective and

recommended dental preventive measure is daily plaque removal through toothbrushing. Persistent plaque leads to gingival inflammation and ultimately, periodontal attachment and tooth loss (Petker et al., 2019).

Brushing technique and frequency, toothbrush design, and the condition of bristles all affect the quality of toothbrushing. As a toothbrush ages, the ability to clean plaque from a tooth's surface as well as the gingival margin is significantly reduced due to worn and splayed bristles (Van der Weijden et al., 2020).

Over time, daily mechanical brushing stresses the bristles of a toothbrush and alters their alignment. Worn bristles, along with those incapable of remaining stiff, greatly diminish the toothbrush's ability to clean interproximal areas and eliminate plaque. Several studies have shown a strong correlation between worn brushes and elevated plaque scores. The inverse has also been shown for new or minimally worn brushes. Consequently, for the purpose of maintaining optimal cleaning, brush replacement has been incorporated into oral hygiene recommendations (Rawls et al., 2020).

The American Dental Association states that toothbrushes should be replaced every 3-4 months or sooner if the bristles are frayed. Plaque buildup may increase and lead to gingival health issues (American Dental Association, 2022) because of the reduced efficiency when cleaning with an old toothbrush.

Gingivitis is one of the most common oral diseases and is attributed to the lack of control of plaque. Studies have shown that controlling plaque better improves gingival health by lowering inflammation and bleeding (Van der Sluijs et al., 2023).

Many studies have tested the relationship between the design of a toothbrush and oral health. Having easily replaced toothbrushes with intact bristles leads to less plaque and is better for health of the gums and teeth (Marchesan et al., 2021).

While most recommend a replacement every 3 months, it may be better for some people to replace toothbrushes more often. For some people, rapid deterioration of the bristles may lead to a toothbrush that is less effective before the end of the replacement period (Van der Weijden et al., 2020). Recent studies suggest that more often replacing toothbrushes may lead to better gum health and control of plaque (Lee & Ha, 2021).

While the toothbrush recommendation literature encourages more frequent replacements, there is a lack of comparative clinical evidence on the effects of monthly versus three-monthly replacements. The purpose of this study was to investigate the

impact of different toothbrush replacement frequencies on plaque formation and gum inflammation using participants who replaced their toothbrushes once a month and those who replaced their toothbrushes once every three months. The results of this study will help develop scientifically substantiated oral hygiene practices and suggest the most suitable toothbrush replacement frequency for improving gum health.

METHODOLOGY

Study Design: This study was a randomized controlled clinical trial that investigated the impact of different toothbrush replacement frequencies on plaque and gingival inflammation. This study evaluated the oral health effects of participants who replaced their toothbrushes on a monthly basis in comparison to those who replaced their toothbrushes on a quarterly basis. The trial was three months long, and a clinical evaluation was conducted at the start and at the end of the study.

Study Setting: This study was conducted in the department of Periodontology and Preventive Dentistry. The clinical evaluations were conducted in the outpatient dental clinic. The duration of the study was six months and included participant recruitment, the intervention, follow-up, and analysis of the data.

Study Population: The target population included adults who visit the dental outpatient department to receive the routine dental examination and preventive oral health services and who practiced regular toothbrushing and agreed to follow the study protocol during the entire follow-up period.

Sample Size: For this study, 120 participants were recruited. The total sample size was calculated using OpenEpi software with a confidence level of 95%, statistical power of 80%, and a presumed moderate effect size of previous studies on oral hygiene interventions. Each study arm had 60 participants.

Sampling Technique: For participant selection, a simple random sampling technique was employed. Those who fulfilled the eligibility criteria were recruited in the order they arrived. The sample size was completed once it reached 120 participants. To reduce selection bias, participants were allocated to the two intervention groups by a computer-generated random number.

Inclusion Criteria: Those who were aged, between 18 to 50, had at least 20 fully

erupted and 30 natural teeth, and were independently brushing their teeth, were included in the study. Those who had at least mild, but not more than moderate, plaque and gingival inflammation, were also included in the study. Those who provided a signed informed consent and agreed to follow-up were included in the study.

Exclusion Criteria: People undergoing orthodontic procedures were not included. Neither were people with advanced periodontitis, people with uncontrolled diabetes, people with immunosuppressive conditions, and people with prophylactic antibiotics. People who had their teeth professionally cleaned in the last 3 months, smokers, pregnant women, and people who take drugs that change the status of their gingiva were not included.

Study Groups and Intervention: Participants were randomly assigned to 2 groups after their baseline assessment. Group A participants were instructed to replace their toothbrush on a monthly basis for the duration of the study (3 months). Group B participants were instructed to replace their toothbrush in 3 months, per the standard recommendation. To eliminate the impact of external factors, all participants were given the same soft-bristled toothbrush, and the same, standard, fluoridated toothpaste. Participants were given the same oral hygiene instruction during the baseline assessment and were instructed to perform their brushing using the modified Bass brushing technique, twice a day.

Data Collection Procedure: Participants' baseline age and gender were captured through a structured questionnaire. Clinical assessments were carried out by an examiner who underwent calibration, and were done in a controlled, standardized manner. For assessment of plaque and gingival inflammation, the Plaque Index (Silness and Loe) and of the Gingival Index (Loe and Silness) were utilized, respectively. Routine clinical assessments were done at baseline and at the end of the 3 month study period. Participants were contacted, as needed, to confirm that they were following the instructed

oral hygiene practices and were adhering to the specified schedule for replacement of the toothbrush.

Study Variables: Two levels of the independent variable, toothbrush replacement frequency, were designated as either monthly replacement or replacement every three months. The dependent variables were the Plaque Index scores and the Gingival Index scores, which were assessed both pre and post the intervention period. Age and gender were recorded for post hoc analysis.

Data Analysis: Data were processed in the Statistical Package for the Social Sciences (SPSS; version 26). Descriptive statistics were computed as frequency distributions, percentages, means, and standard deviations. Comparison of means of plaque and gingival scores between the two independent groups was executed using independent sample t-tests while the assessment of means of scores of plaque and gingival indices of a single group was assessed using the paired sample t-tests. Additionally, a Chi-square test was used to analyze a categorical outcome, and a p-value of ≤ 0.05 was deemed statistically significant.

Ethical Considerations: For this study, informed consent was obtained for all participants. Study participants were briefed on the study risk and benefits. Throughout the study, researchers ensured the confidentiality of study participants was protected. Data were utilized solely for the study. Study participants had the right to withdraw from the study without any consequences.

RESULTS

The results showed that both replacement schedules for the toothbrush proven to be beneficial for the oral hygiene status. Replacing toothbrushes every month showed significantly less plaque accumulation and lesser gingival inflammation. Monthly replacement showed improved overall clinical outcomes and better periodontal health as compared to the traditional three-month replacement schedule.

Table 1. Demographic Characteristics of Participants (N = 120)

Variable	Group A (1-Month)	Group B (3-Month)	Total (%)
Age 18–30 Years	24	22	46 (38.3%)
Age 31–40 Years	21	23	44 (36.7%)
Age 41–50 Years	15	15	30 (25.0%)
Male	28	30	58 (48.3%)
Female	32	30	62 (51.7%)

Each group consisted of 60 individuals, with female representation at 51.7%. Most individuals were aged between 18 and 40.

Table 2. Baseline Comparison of Plaque and Gingival Index Scores

Variable	Group A Mean $\pm$ SD	Group B Mean $\pm$ SD	T-Value	P-Value
Plaque Index	1.89 $\pm$ 0.42	1.85 $\pm$ 0.39	0.54	0.592
Gingival Index	1.71 $\pm$ 0.36	1.68 $\pm$ 0.34	0.47	0.641

No statistically significant differences were recorded between groups at baseline, indicating similar oral health status at baseline

Table 3. Comparison of Plaque Index Scores after 3 Months

Group	Baseline Mean $\pm$ SD	3-Month Mean $\pm$ SD	Mean Reduction	P-Value
Group A	1.89 $\pm$ 0.42	0.89 $\pm$ 0.34	1.00	<0.001
Group B	1.85 $\pm$ 0.39	1.28 $\pm$ 0.41	0.57	<0.001

Over the study period, both groups had significant reductions in plaque scores;

however, the monthly replacement group had a greater reduction.

Table 4. Comparison of Gingival Index Scores after 3 Months

Group	Baseline Mean $\pm$ Sd	3-Month Mean $\pm$ Sd	Mean Reduction	P-VALUE
Group A	1.71 $\pm$ 0.36	0.74 $\pm$ 0.29	0.97	<0.001
Group B	1.68 $\pm$ 0.34	1.12 $\pm$ 0.37	0.56	<0.001

Inflammation of the gums improved in all participants in both groups but improved

significantly more in participants whose toothbrushes were changed monthly.

Table 5. Between-Group Comparison at 3-Month Follow-Up

Outcome Variable	Group A Mean $\pm$ Sd	Group B Mean $\pm$ Sd	T-Value	P-Value
Plaque Index	0.89 $\pm$ 0.34	1.28 $\pm$ 0.41	-5.66	0.001
Gingival Index	0.74 $\pm$ 0.29	1.12 $\pm$ 0.37	-6.23	0.002

Participants whose toothbrushes were changed once a month had higher gingival health scores and lower plaque scores than

participants whose were changed once every three months.

Table 6. Overall Clinical Improvement According To Replacement Frequency

Clinical Outcome	Group A	Group B	X ² Value	P-Value
Marked Improvement	42 (70.0%)	24 (40.0%)	10.95	0.001
Moderate Improvement	15 (25.0%)	26 (43.3%)		
Minimal Improvement	3 (5.0%)	10 (16.7%)		

Marked clinical improvement was achieved by a significantly higher percentage of participants in the monthly replacement group than in the group that replaced their toothbrushes every three months (70.0% vs. 40.0%, $p=0.001$).

DISCUSSION

This study compared replacing a toothbrush every month with the typical 3-month interval

to see how replacement frequency influences plaque and gingival inflammation accumulation. Results showed those participants who replaced their toothbrushes monthly had significantly lower results for both the plaque and gingival indices in the 3-month follow-up. This data implies that replacement of a toothbrush occurs more often, it positively impacts a person's oral hygiene and the health of their gums.

Plaque score improvement was reported by both groups during this study, but the group that replaced their toothbrush every month showed a greater improvement. This indicates that worn out toothbrushes negatively impact plaque score the most. As a toothbrush is used, the bristles become frayed and worn and lose the ability to effectively remove biofilm the crevices of a person's mouth. Results from Sforza et al. 2021 showed that a worn out toothbrush removes significantly less plaque from a person's mouth compared with a toothbrush that has intact bristles. In addition, a worn out toothbrush can no longer brush the more difficult and out-of-reach areas of the mouth.

The current study also indicated clearly diminished gingival inflammation in those replacing their toothbrush every month. Since plaque accumulation is the primary instigator of gingivitis, the reduction of gingival index scores in the monthly replacement group was likely due to improved control of plaque. Findings of the present study resemble those of Tawakoli et al. (2022), where interventions that enhanced control of plaque significantly reduced gingival bleeding and inflammation. This study demonstrated the strong correlation of control of plaque to gingival health.

Of note in the current study is that 70% of the monthly replacement group showed significant improvement and only 40% of the three-month replacement group showed the same. This finding suggests that the frequency of replacing a toothbrush may be a simple and easy to change behavioral practice that can positively impact the overall health of a person. Such findings were also reported by Pitchika et al. (2021), where a focus on improvement of the effectiveness of tooth brushing and other oral hygiene interventions caused significant reduction of gingival inflammation and of plaque accumulation in a brief time period of follow-up.

There are explanations for the greater effectiveness of monthly toothbrush substitutions pinpointed in this study. Particularly, the integrity of the bristles appears to be preserved throughout the month of use. The stiffness of the bristles of a new toothbrush and the alignment of the bristles make that toothbrush more effective in the cleaning of the surfaces of the teeth and the margins of the gums. Previous studies suggest that toothbrushes that are worn out lose their effectiveness in cleaning teeth. Individuals that are careless with their

toothbrushes tend to have negative effects on their oral hygiene. These previous studies draw to the same conclusion that in order to control plaque and replace toothbrushes regularly, toothbrushes should be effectively maintained.

These studies suggest that the control of plaque and the regular replacement of toothbrushes may be proactive in controlling the progression of periodontal diseases. This conclusion is consistent with a recent systematic review. Serrano et al. (2022) found that daily control of plaque reduced the inflammation of the gums and focused on the health of the gums. Such control greatly limited the wear and rending of the oral hygiene instruments.

The current study is the first of its kind, concentrating on the frequency with which toothbrushes are replaced. Future studies may build on these results to assess the impact of regular toothbrush replacement on the oral hygiene routines of the participants. On the other hand, frequent replacement of toothbrushes may have a positive, direct impact on the oral hygiene of the participants. This was the conclusion of Ramseier et al. (2021), who stated that regular oral hygiene resulted in a significant control of plaque levels even in the absence of other preventive measures. This study also demonstrated a clear negative impact on the control of plaque levels.

These findings affect preventative dentistry. Current advice on oral hygiene suggests that a toothbrush should be replaced every three months. The results of this study suggest that, for those whose toothbrushes show significant wear and tear, the toothbrush should be replaced more frequently. Thus, dental practitioners may design personalized toothbrush replacement schedules that are based on the individual's toothbrush wear level and their periodontal health.

Limitation of Study:

Positive findings in this study do come with some limitations. The study was short and did not consider the long-term effects of monthly toothbrush replacement. Participant adherence to the prescribed method of brushing was evaluated based on their account of the event. This may have introduced bias.

Future Suggestions:

Future studies are encouraged to include larger, more comprehensive, and diverse populations. These studies should evaluate the long-term effects on periodontal health and

provide an extended timeframe for evaluating the effects of enhanced toothbrush replacement.

CONCLUSION

The findings of this study indicate an improvement in both plaque control and gingival inflammation by substituting the toothbrush on a monthly basis compared with the standard replacement every three months. The results illustrate the value of replacing the toothbrush frequently to improve the health of the user by maintaining good oral hygiene.

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