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Plaque Removal Efficacy with Flared Bristles of the Toothbrush: A Prospective, Double-Blinded, Clinical Trial

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Aim: The aim of this study is to investigate the efficacy of regularly changing toothbrushes compared to using new and flared bristle toothbrushes on plaque removal during brushing. The study results can aid in educating patients and increasing awareness for appropriate recommendations regarding when to change toothbrushes.

Materials and Methods: Forty participants were randomly selected and informed consent was obtained after providing a clear explanation about the study. All the participants underwent full mouth ultrasonic scaling at baseline, followed by recording baseline plaque scores and receiving oral hygiene instructions using the Modified Bass technique. All were provided identical toothbrushes and toothpaste. They were randomly divided into two groups: Group 1 changed toothbrushes every month for 3 months, and Group 2 used the same toothbrush for 3 months. One examiner allocated participants to groups based on randomization and scheduled review visits, recording bristle flaring. The other two examiners, blinded to group allocation, recorded plaque scores using the O'Leary Plaque Index (a measure of plaque accumulation) and adverse events. Toothbrush bristle flaring was verified and recorded using the Conforti Index at each visit.

Results: In Group 1, toothbrush flaring and plaque scores did not change after each month. Group 2 exhibited increased toothbrush flaring at months two and three, with a corresponding increase in plaque scores after two months that progressively worsened after three months.

Conclusion: In short, the proposed study conducted by clinical trial may determine whether participants (Group1) who change toothbrushes every month or participants (Group 2) who change toothbrushes at a period of two and three months brings any beneficial effect on plaque removal efficacy. For optimum plaque removal efficacy, it is crucial to change the toothbrush every two to three months before the flaring of toothbrushes starts.

Keywords: Plaque removal, Flared bristles, Toothbrush flaring, Plaque deposition,

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Introduction

Tooth brushing is the most effective way to maintain a healthy mouth. It is an essential part of daily oral hygiene practices, as it helps remove dental plaque, which is the primary causative agent of periodontal diseases such as gingivitis and periodontitis. However, flaring of toothbrush is unavoidable as toothbrush may wear off due to frictional contact with natural teeth over repeated use. Previous study reported that a toothbrush loses its effectiveness and cleanliness in brushing once the bristles are frayed, leading to plaque deposition in the oral cavity.[1]

Dental plaque is the most common aetiology leading to periodontal disease, especially gingivitis. Plaque develops within hours of bacterial colonisation of the pellicle on the tooth. In other words, toothbrushes play an important role in the elimination of plaque and further prevent the occurrence of periodontal disease.[2] Therefore, the effectiveness of the Toothbrushes is dominant in maintaining good oral hygiene.

However, the effectiveness of toothbrushing in plaque removal can be influenced by various factors, including the technique, duration, and the condition of the toothbrush itself.

Toothbrush bristles are prone to flaring and wear over repeated use, which can potentially reduce their plaque removal efficacy. Previous studies have reported conflicting findings regarding the recommendation for toothbrush replacement due to bristle flaring.

Different slogans such as “Throw it away, replace your toothbrush when it begins to flare” and “Replace your toothbrush every 3-4 months” are used in the advertisement of toothbrushes. Nevertheless, not all people change their toothbrushes based on the recommendation period due to socioeconomic factors and lack of appropriate oral health awareness. Is there a scientific basis for replacing the toothbrush every 3-4 months for better oral health or is it only a marketing strategy to increase sales is still inconclusive based on the current evidence.[3]

There is a study that showed plaque removal ability of worn toothbrushes is worse statistically significant compared to the new toothbrush, and the effectiveness of the Toothbrushes depending upon their state of wear.[4] However, another study showed that the naturally worn and laboratory worn toothbrushes have no significant effect on plaque removal in comparison to the new toothbrushes in children and adults.[5]This conflicting.

evidence has led to uncertainty about the appropriate recommendation for toothbrush replacement. While various dental associations and toothbrush manufacturers often recommend replacing toothbrushes every 3-4 months or when the bristles become visibly frayed or worn, there is a lack of consensus on the scientific basis for this recommendation.

Considering the conflicting reports on the recommendation time of toothbrush replacement, the aim of this study was to investigate the efficacy of between changing of toothbrush and

new and flared bristle toothbrushes upon brushing in on the plaque removal. The study results can aid in educating and increasing the awareness among patients in suggesting appropriate recommendations for changing toothbrushes.

Materials and Methods

The study design is a prospective, double-blinded, randomized controlled clinical trial. The research proposal was submitted and after obtaining the ethical approval from Research Management Center (RMC) MAHSA University, informed signed consent was obtained from the participants recruited with a clear explanation about the

study. A total of 56 young adults within an age range of 18 to 35 years from MAHSA university Selangor were recruited after screening for following inclusion and exclusion criteria.

As for the inclusion criteria, participants with fully erupted complete dentition and with healthy gingiva or mild gingivitis were included for the study. Participants were screened for exclusion criteria such as presence of systemic disease, smoking and alcohol abuse habit, pregnancy, periodontal disease, malocclusion, crowding, antibiotics taken within the past 3 months, prosthesis (denture, crown and bridge) and orthodontics appliance were excluded.[6]

Once the participants are recruited, baseline parameters such as demographic data and plaque score (O'Leary Plaque index) were recorded and a full mouth scaling was performed at baseline and oral hygiene instructions using Modified Bass technique were given for a duration of 3 minutes. All the participants were given a soft bristled Oral-B toothbrush and a standard fluoridated toothpaste without any active ingredient. Participants were sent regular WhatsApp reminders to ensure their compliance towards twice brushing with recommended technique. All participants will be recalled after 1 month from baseline. Prior to the plaque assessment, the participants were randomly distributed using computer generated random numbers into 2 groups of 28 participants each. Group 1 consisted of 28 participants who changed their toothbrushes every month for three months. Group 2 comprised 28

participants who did not change their toothbrushes for three months. To ensure blinding of the investigators, one of the three examiners allocated the participants into respective

groups based on the randomization method, scheduled the review visits, and recorded the bristle flaring. While the other two investigators recorded the plaque scores and adverse event form.

Clinical procedure

During the review visits at the end of the first, second, and third months, toothbrush bristle flaring was verified and recorded using Conforti Index x29[7] and O'Leary Plaque Index were recorded. (Fig 1)

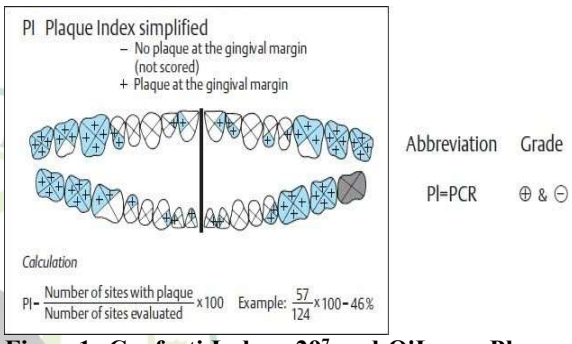

Figure1: Conforti Index x29[7] and O'Leary Plaque Index were recorded

Standardized photographs of each toothbrush head were obtained to further evaluate the wear of toothbrushes after 1 month from baseline according to the Conforti index 29 [7]: (Fig 2)

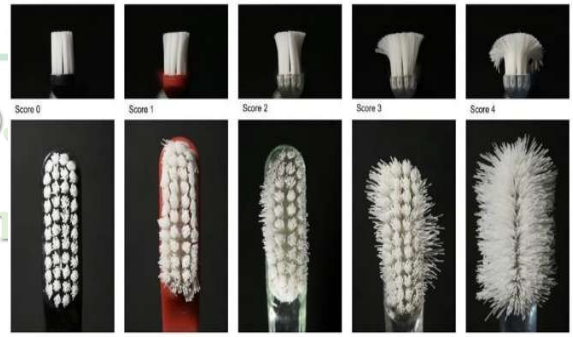

Figure 2: Standardized photographs of each toothbrush head were obtained to further evaluate the wear of toothbrushes

Score 0 (No wear): No visible signs of wear, inner and outer tufts are intact Score 1 (Light wear): Outer tufts begin to splay, inner tufts are still intact

Score 2 (Medium wear): Outer tufts are splayed beyond and base of the toothbrush,

inner tufts begin to splay
Score 3 (Heavy wear): Outer and inner tufts are splayed
Score 4 (Extreme wear): Outer and inner tufts are splayed whereby no distinction can be made between

New toothbrushes were then distributed to Group 1 participants while participants of Group 2 continued using the initial toothbrush until the end of the study period.[8] (Fig 3)

Figure 3: Flowchart of groups

Results

Only 44 out of 56 participants completed the full term of the research. Few participants were excluded for not using the given toothbrush while others did not complete the research due to other reasons unrelated to the research. The tabulation and data analysis were done for the remaining 44 participants. Group 1 (New toothbrush) consisted of 11 males and 10 females, while Group 2 consisted of 9 males and 12 females.

The plaque scores were compared within each group across the three visits using the Kruskal-Wallis test. The results are presented in Tables 1 and 2.

Table 1: Comparison of Plaque Scores within Group 1 (Changed Toothbrushes Monthly) at the 1st, 2nd and 3rd visit

Visit	Median	Interquartile Range	P Value
1st	58	30	0.888
2nd	60	30	0.097
3rd	55	34	0.513

Within Group 1, where participants changed their toothbrushes every month, there were no statistically significant differences in median plaque scores across the three monthly visits (p-values 0.888, 0.097, and 0.513, respectively). The group exhibited relatively stable plaque levels across all three visits. This suggests that regularly replacing toothbrushes helps maintain consistent plaque removal capability throughout their usage lifetime before flaring can occur.

Table 2: Comparison of Plaque Scores within Group 2 (Used Same Toothbrush for 3 Months) at the 1st, 2nd and 3rd visit.

Visit	Median	Interquartile Range	P Value
1st	53	27	0.205
2nd	52	37	0.045
3rd	54	46	0.002

In contrast, Group 2, where participants used the same toothbrush for three months, showed a statistically significant increase in median plaque scores from the first to the third month visit (p-values 0.205, 0.045, and 0.002, respectively). This indicates a worsening of plaque removal efficacy with continued use of the same toothbrush over three months.

Discussion

Studies showed there is a relationship between plaque accumulation and chronic inflammatory periodontal disease and plaque accumulation increases with increase surface roughness, [9] while mechanical plaque

removal using toothbrushes with dental floss helped to remove the plaque/biofilm on the tooth surface.[2] Previous studies showed that the toothbrush flaring condition might vary, depending on the user's habits, including brushing technique, forces used for brushing, frequency and duration of toothbrush usage.[3] Hence, all the users should practice proper oral hygiene instruction and brushing technique to maintain the optimum toothbrush efficacy.

Focusing on the present study, results showed that using a toothbrush for an extended period can lead to a reduction in plaque removal efficacy, likely due to bristle flaring and wear over time. In the participants (Group 2) who change toothbrushes every month, there is an Increase in plaque score and wear condition over the period of 3 months.

While proper brushing technique is essential for good oral hygiene, the state of the toothbrush itself plays a crucial role. The findings align with previous studies that indicate worn

Tooth brushes have reduced plaque removal ability compared to new ones. Interestingly, changing the toothbrush monthly in Group 1 did not significantly improve plaque scores, implying that a shorter replacement interval may not provide additional benefits.

From the present study, we believe that the flaring in toothbrush bristles is one of the important factors causing loss of its plaque removal efficacy. Hence, we recommended that the users should consider the period of replacing a new toothbrush every three months to establish the maximum plaque removal efficacy.

The findings align with previous studies that indicate worn toothbrushes have reduced plaque removal ability compared to new ones. Interestingly, changing the toothbrush monthly in Group 1 did not significantly improve Plaque scores, implying that a shorter replacement interval may not provide additional benefits.

In the present study, we took the chance to study the association between the gender and flaring of the toothbrush and we found that there are no significant differences between the toothbrushes used by different genders (Males and Females). This shows that gender does not affect the flaring of a toothbrush.

Conclusion

As a conclusion, the study conducted found that there is an association and link between longer toothbrush use and reduced plaque removal efficacy due to toothbrushes bristle wear. While replacing a toothbrush every month is not necessary, changing toothbrushes every 2 to 3 months is advisable and recommended before some degree of toothbrush bristle flaring starts. Based on the study, we can justify and prove that it is not a marketing strategy for the toothbrush company to sell more toothbrushes by changing toothbrushes every two to three months but to ensure that optimal plaque removal can be achieved by everyone.

Additionally, along the study surprisingly gender differences bring no effect on the tendency to bristle flaring. Most importantly, it is the way of toothbrush technique, time of toothbrush usage and duration of tooth brushing that bring about the effect of plaque removal efficacy of the toothbrushes. By reinforcing oral hygiene instruction and motivation, encouraging everyone to take care of oral hygiene maintenance, efficient plaque removal can be achieved.

Funding

Self-Funded Study

Ethics approval and consent to participate

Ethics approval was obtained for this study under the number of RMC/DEC/2023/EC02 approved by institutional ethical committee

and all participants were taken consent before participating in the study

Data availability

The data is available upon the considerable request to the corresponding author

Competing interests

Authors declares that, there is no competing interests

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