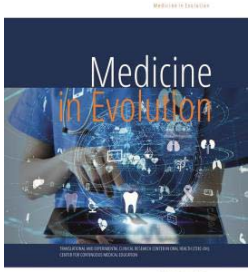
Dynamic strategies for mechanical dental plaque removal



Stana O.L.[1], Lile I.E.[1*], Freiman P.[1], Vaida L.[2], Popovici R.A.[3], Oalriu I.[1], Stana A.[4], Marian D.[1], Ilyes I.[1], Berari A.[1], Hosszu T.[1]

[1]*Department of Dental Medicine, Faculty of Dentistry, "Vasile Goldis" Western University of Arad, Romania*
[2]*Department of Dentistry, Faculty of Medicine and Pharmacy, University of Oradea, Romania*
[3]*Department 1, Faculty of Denatal Medicine, University of Medicine and Pharmacy "Victor Babeş", Timişoara,*
[4]*Department of Medicine, Faculty of Medicine, "Vasile Goldis" Western University of Arad, Romania*

Correspondence to:
Name: Ioana Elena Lile
Address: Department of Dental Medicine, Faculty of Dentistry, "Vasile Goldis" Western University of Arad, Romania, Arad, Str. Liviu Rebreanu, nr. 86, Campusul Universitar „Vasile Goldiş"
Phone: +40 745305221
E-mail address: lile.ioana@uvvg.ro

Abstract

In order to maintain an adequate oral and dental health, oral hygiene is an important factor, and its implementation by appropriate methods and techniques it is imperative for the removal of the bacterial plaque. The removing of the bacterial plaque it is done by mechanical methods, the use of toothpaste and toothbrush must be supplemented by the use of dental floss. In this study, we measure the effectiveness of the use of the toothbrush and the auxiliary means for the toothbrush, in particular we analyzed the dental floss. Thus, the study participants were divided into several groups. Initially the bacterial plaque was revealed, and then they were asked to use several methods of removing the bacterial plaque, either by brushing, using dental floss or using a combination of these. Through the Quigley and Hein plaque index, the final results were evaluated by comparing them with the initial ones and by showing which method is the most efficient. Each of the two bacterial plaque removal techniques provided optimal plaque removal results, but the dental brushing succeeded in removing the dental plaque from the vestibular, oral and occlusal surfaces of the teeth, and the dental flap removed the plaque from the proximal surfaces of the plaque. Although many of our patients use only one of the two methods, especially only brushing without using dental floss, the combination of the two gives the best results, and the practicing dentist should insist on recommending the use of the two methods together.

Keywords: bacterial plaque, dental health, dental floss, toothbrushing, gingivitis

INTRODUCTION

Bacterial plaque-induced gingivitis is a prevalent oral challenge affecting individuals across the lifespan—children, teens, and adults alike. In certain populations, the prevalence of gingivitis in adults can soar to 100% [1][2]. The manifestation of gingivitis runs the gamut, with some experiencing a mild form of inflammation while others contend with a more severe presentation [3]. Intriguingly, the presence of subgingival microorganisms like C. gingivalis, P. intermedia, and P. micros has been discerned in individuals grappling with gingivitis, hinting at their potential role in driving the condition's development and progression [4]. Also, between vitamin D deficiency and gum disease, like gingivitis, has been shown in a study [5]. Nurturing solid oral hygiene practices, involving the faithful ritual of regular brushing and flossing, emerges as a cornerstone in the battle against gingivitis. Yet, the landscape of potential solutions warrants deeper exploration. Research avenues beckon to unravel the efficacy of adjunctive treatments, such as the traditional use of miswak, in elevating periodontal health among those navigating the challenges of gingivitis.

The importance in prevention, early diagnosis, treatment of gingivitis in adults is necessary to prevent the transformation in to advanced periodontal disease. The role of dental plaque in transforming periodontal disease has been emphasized in several studies. the best method is prevention, used for diagnosis and treatment in the early stages. [6]

Prevention can be done by daily by brushing and using dental floss to remove the bacterial plaque before inflammation develops. mechanical brushing remains the primary method for maintaining satisfactory oral hygiene and it is the cheapest method for most people. The toothbrush has been declared for the most effective prevention method that can be used by the patient at home. Mechanical brushing with a toothbrush stands as the foremost and most efficient technique in upholding optimal oral hygiene [7]. This method is not only cost-effective but also easily executable by individuals within the comfort of their homes [8]. Brushing serves the crucial purpose of eradicating bacterial plaque before it can lead to inflammation, thereby diminishing the risk of oral diseases [9].

Furthermore, the utilization of dental floss is strongly advocated to address plaque in interdental areas where the reach of a toothbrush may be less effective. The utilization of dental floss is strongly advocated to address plaque in interdental areas where the reach of a toothbrush may be less effective. Dental floss is the only way to remove interproximal plaque biofilm that can accumulate between teeth [10]. Flossing teeth is usually recommended because toothbrushes do not effectively clean bacterial plaque from interproximal spaces alone [11]. In a study comparing plaque control efficacy, interdental brushes were found to be slightly better in reducing interproximal plaque accumulation in patients with gingivitis compared to dental floss [12]. Another study compared the clinical efficacy for plaque removal between dental floss with soft ellipsoidal knots and conventional floss and found that floss with knots showed similar efficacy to remove plaque, especially among patients with less experience of flossing [13]. The appropriate interproximal cleaning aid, including dental floss, is determined by the ease of use, the size of the interproximal space, and the individual's acceptability and motivation [14]. The adoption of these preventive measures, when integrated into a routine, significantly contributes to the maintenance of robust oral health and acts as a deterrent against the onset of oral diseases.

Dental floss plays a fundamental role in oral hygiene because it removes the plaque between the tooth and under the gingival areas where it cannot be reached but the brush; these are the areas of the tooth where the carious process and periodontal disease begin. Dental floss serves a critical role in upholding oral hygiene by adeptly eliminating plaque from regions inaccessible to a toothbrush, particularly between teeth and beneath the gums—

where the onset of caries and periodontal disease may initiate [15] [16]. The design of dental floss represents a domain warranting further investigation, given its relatively limited exploration [17]. Distinct types of dental floss exhibit diverse morphological properties and performance characteristics, underscoring the need to grasp these nuances before suggesting a specific variant to patients [18]. Moreover, the landscape of dental floss has witnessed innovative strides. Notable among these is a dental floss designed to integrate seamlessly with other dental hygiene devices, offering users a comprehensive suite of oral hygiene solutions [19]. Another inventive development involves a specialized dental floss device crafted to simplify and enhance the cleaning of interdental gaps, thereby improving cleaning efficacy while saving time and effort. This underscores the dynamic evolution of oral care technologies, enhancing traditional oral hygiene practices.

Effective removal of interproximal plaque is pivotal for upholding gingival and preventive health. Research indicates that gingival inflammation can manifest within a span of 10-21 days if subgingival dental plaque remains on the tooth surface [20]. Plaque prevention emerges as a potent strategy for both treating and preventing periodontal diseases, positioning it as a vital element in the primary management of gingival and periodontal conditions [21]. Diverse devices and techniques, such as the evidence-backed Bass intrasulcular technique of toothbrushing, and the application of dental floss or dental tape, have demonstrated effectiveness in plaque removal [22]. Moreover, the utilization of mouthwashes, such as extracts from Mimusops elengi and Chlorhexidine, has proven effective in chemical plaque control and the treatment of gingivitis [23]. In essence, the maintenance of proper oral hygiene practices, including the regular elimination of interproximal plaque, stands as a fundamental prerequisite for preserving gingival and preventive health.

While most toothbrushes are not inherently designed to effectively tackle interproximal plaque, necessitating the use of supplementary products like dental floss [24], there have been notable strides in toothbrush design aimed at enhancing plaque removal. Research indicates that toothbrushes with smaller head sizes, reduced filament diameters, larger cutting heights, softer filaments, and greater interdent-height differences prove more efficacious in plaque removal [25]. Additionally, interdental brushes have shown a slight edge over dental floss in reducing interproximal plaque accumulation, particularly in patients with gingivitis [26]. Short-headed toothbrushes boasting a higher bristle count have demonstrated comparable efficacy to conventional toothbrushes, with the added benefit of being preferred by subjects [27]. Moreover, rotating-type interdental toothbrushes have exhibited a commendable plaque elimination rate even with fewer reciprocal movements [28]. These findings underscore the existence of toothbrush options specifically engineered to effectively address interproximal plaque, potentially lessening the reliance on dental floss.

Aim and objectives

This study is focused on delving into and tackling the challenges within traditional toothbrush design concerning the efficient elimination of interproximal plaque. This often results in depending on additional products like dental floss. Our goals encompass scrutinizing toothbrush design inadequacies, investigating auxiliary plaque removal products, contrasting the effectiveness of diverse plaque removal tools, exploring patient preferences and adherence, and putting forth suggestions for achieving optimal plaque removal. The research strives to emphasize the importance of proficient interproximal plaque elimination for sustaining gingival and preventive health. In essence, the study aspires to provide valuable perceptions that can guide enhancements in oral hygiene practices and refine strategies for plaque elimination.

MATERIAL AND METHODS

The primary aim of this investigation is to conduct a comparative analysis of the eradication of bacterial plaque through the utilization of a toothbrush and a dental floss. The aforementioned study was carried out within the premises of the Aurel Vlaicu Polyclinic, encompassing the active participation of a total of 28 students. These students comprised both males and females, falling within the age range of 20 to 30 years.

To ensure equitable distribution, the 28 students were divided into three groups, with two groups consisting of 9 individuals each, and one group encompassing 10 students (fig.1).

Within this research endeavour, the Quigley Hein dental plaque index method was employed for the evaluation of plaque.

This particular assessment method entails assigning a score ranging from 0 to 5 to each non-stored surface of the teeth, excluding the third molars. A score of 0 is designated when no visual traces of plaque are present, while a score of 1 is assigned when separate sections of plaque are observed. Furthermore, a score of 2 is given when a uniform amount of plaque, less than 1mm in thickness, is detected on the tooth. In cases where a band of plaque wider than 1mm is present, but covers less than one-third of the tooth's crown, a score of 3 is recorded. Similarly, if the plaque covers at least one-third but less than two-thirds of the crown, a score of 4 is assigned. Lastly, if the plaque covers two-thirds or more of the crown, a score of 5 is allotted.

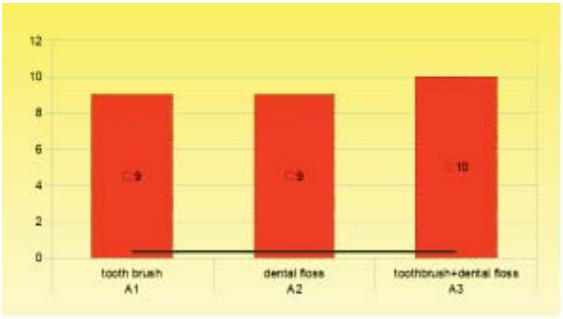


Figure 1. The groups included in the study

RESULTS

The initial group exclusively used the toothbrush, while the subsequent group solely utilized the dental floss, and the ultimate group was instructed to utilize both. The materials employed in this investigation included the toothbrush, dental floss, and erythrosine, which served as a plaque detector, enabling a macroscopic estimation of the quantity of residual plaque present on the teeth (fig. 1).

Following the consumption of a complete breakfast, each respective group was directed to adhere to the subsequent procedure: the initial group employed solely the toothbrush, the second group employed solely a dental floss, and the last group was instructed to employ both. In order to facilitate the analysis of the outcomes, the initial group was denoted as A1, the second group as A2, and the third group as A3.

The initial group, denoted as A1, successfully eliminated bacterial plaque residues in two-thirds of the teeth (Quigley index = 3). In actuality, as depicted in the illustration, residual plaque can still be observed in the interproximal region of the tooth (fig. 2).

Figure 2. Residual plaque observed in the interproximal region

The second group, by means of employing dental floss, successfully eradicated the remnants of bacterial plaques in the three inferior regions, specifically in the gingival toothbrush alongside the auxiliary tools and interproximal areas. However, it is evident that they were unable to cleanse the dental plaque on the oral, lingual/palatal, and occlusal surfaces through tooth brushing, particularly with the use of dental floss (fig. 3).

Figure 3. Quigley Hein dental plaque index = 4

The dental plaque was successfully eliminated in a satisfactory manner by the third group. They achieved complete removal of the bacterial plaque from all tooth surfaces. The Quigley index recorded a value of 0 (fig. 4).

Figure 4. Quigley Hein dental plaque index = 0

The initial group successfully eradicated 60% of the plaque, whereas the second group managed to eliminate merely 30-40%. Conversely, the third group achieved a removal rate of approximately 90% of the bacterial plaque. It is noteworthy that a significant proportion of

adults, approximately 75%, suffer from gingivitis due to the misconception that using a toothbrush alone can eliminate all bacterial plaque. This study demonstrates that the sole means of effectively eliminating a substantial quantity of plaque, exceeding 90%, is to combine the utilization of a specific method.

DISCUSSIONS

The findings of this study demonstrate distinct outcomes based on the oral hygiene means of removing bacterial plaque employed by different groups. Here is a summary of the results:

Group A1 that exclusive used the Toothbrush effectively eliminated bacterial plaque residues in approximately two-thirds of the teeth. The Quigley index yielded a value of 3, indicating satisfactory removal in the majority of regions. Residual plaque was still evident in the interproximal region of the tooth.

Group A2 that exclusive used the dental floss successfully eradicated bacterial plaque remnants in the three lower regions, specifically in the gingival, toothbrush-accessible areas, and interproximal zones. Unable to cleanse dental plaque on the oral, lingual/palatal, and occlusal surfaces through tooth brushing, particularly when dental floss was employed. The Quigley index recorded a value of 4, signifying incomplete removal in specific facial and surface areas.

Group A3 that used simultaneous the toothbrush and dental floss achieved complete removal of bacterial plaque from all tooth surfaces. The Quigley index recorded a value of 0, indicating optimal cleanliness with no observable plaque residues.

In conclusion, the combined utilization of both a toothbrush with a dental floss in group A3 proved to be the most efficacious technique, leading to complete plaque removal from all tooth surfaces. The individuals that used either a toothbrush or dental floss exhibited limitations in accessing specific areas, thus underscoring the significance of a comprehensive approach to oral hygiene.

This study highlights several important aspects that significantly improve our understanding of oral hygiene practices. In the combined use of toothbrush toothpaste and interdental floss as used by group 3 in the present study, this combination was shown to be the best in terms of plaque removal from all dental surfaces. Some studies show that the use of tooth brushing but also the application of correct techniques for removing bacterial plaque is effective in maintaining a proper oral health condition [29-30]. The importance of adopting a comprehensive technique of an oral hygiene routine is also emphasized by an improved strategy of plaque removal.

The exclusive use of toothpaste and toothbrush as used by group A1 or the exclusive use of interdental floss as used by group A2 shows certain limitations in removing plaque from certain areas which causes plaque to remain on certain tooth surfaces. This highlights the fact that limited use of plaque removers rather than their full use results in insufficient plaque removal.

New avenues of research in this regard are opened by this study in order to improve and optimize oral hygiene practices. Further studies should also be done to bring innovations and improve oral hygiene practices supporting proper plaque removal.

CONCLUSIONS

In conclusion, this study shows us and emphasizes the fact that a combined use of the means to remove bacterial plaque (paste and toothbrush and interdental floss) have clearly superior effects than the use of one alone. The individualization of plaque removal techniques

emphasizes the complexity of plaque removal strategies, emphasizing the need to approach complex strategies. The third group managed to remove about 90% of the bacterial plaque. Most adults suffer from gingivitis because they believe that using the toothbrush can remove all the bacterial plaque. As this study shows, the only way to remove an adequate amount of plaque, or more than 90%, is to combine the various methods of removing bacterial plaque.

REFERENCES

1. Ayshe, Salim., Sirma, Angelova., Bogdan, Roussev., Todorka, Sokrateva., Yoana, Kiselova-Kaneva., Stefan, Peev., Diana, Ivanova. Salivary Interleukin-6, Interleukin-1β, and C-Reactive Protein as a Diagnostic Tool for Plaque-Induced Gingivitis in Children. Applied Sciences, (2023). doi: 10.3390/app13085046
2. Hristina, Tankova., Nadezhda, Mitova., Zornitsa, Lazarova. Clinical and microbiological diagnosis of plaque-induced gingivitis in children and adolescents. Journal of IMAB, (2022). doi: 10.5272/jimab.2022283.4501
3. Saba, Arshad., Syed, Jaffar, Abbas, Zaidi. Vitamin D levels among children, adolescents, adults, and elders in Pakistani population: a cross-sectional study. BMC Public Health, (2022). doi: 10.1186/s12889-022-14526-6
4. Haslinda, Ramli., Khairun, Nain, Nor, Aripin., Shahida, Mohd, Said., Rohazila, Mohamad, Hanafiah., Tuti, Ningseh, Mohd, Dom. The effectiveness of miswak (Salvadora persica L. and Azadirachta indica A.Juss.) practices in reducing plaque and gingivitis among adults: A systematic review and meta-analysis.. Journal of Ethnopharmacology, (2022). doi: 10.1016/j.jep.2022.115598
5. Michaela, Bartošová., Petra, Borilova, Linhartova., Kristína, Musilová., Z, Broukal., Martina, Kukletová., Lubomír, Kukla., Lydie, Izakovičová, Hollá. Association of the CD14 -260C/T polymorphism with plaque-induced gingivitis depends on the presence of Porphyromonas gingivalis.. International Journal of Paediatric Dentistry, (2021). doi: 10.1111/IPD.12847
6. Alonso-Coello, P., Oxman, A.D., Moberg, J. et al, GRADE Evidence to Decision (EtD) frameworks: a systematic and transparent approach to making well informed healthcare choices, part 2: clinical practice guidelines. BMJ. 2016; 353: i2089
7. Dwis, Syahrul., Surwandi, Walianto. The use of chlorhexidine mouthworks can reduce the accumulation of dental plak in users of fixed orthodontic devices. Interdental Jurnal Kedokteran Gigi (IJKG), (2023). doi: 10.46862/interdental.v19i1.6095
8. Giovanna, Mosaico., Cinzia, Casu. A primary prevention strategy: oral hygiene and correct lifestyles among patients at risk of developing drug-related osteonecrosis of the Jaw. (2021). doi: 10.32388/BGMWYJ
9. Helen, V, Worthington., Laura, MacDonald., Tina, Poklepovic, Pericic., Dario, Sambunjak., Trevor, M, Johnson., Pauline, Imai., Janet, E., Clarkson., Janet, E., Clarkson. Home use of interdental cleaning devices, in addition to toothbrushing, for preventing and controlling periodontal diseases and dental caries. Cochrane Database of Systematic Reviews, (2019). doi: 10.1002/14651858.CD012018.PUB2
10. Apsara, Ramesh., Divvi, Anusha., Shivashankar, Kengadaran. Attitude and Knowledge Regarding Flossing Technique among Dental Students. International Journal of Social Rehabilitation, (2022). doi: 10.56501/intjsocrehab.v7i2.573
11. Smruti, Divate., Zac, Morse. Dental floss design: a protocol for a scoping review. International Journal of Scientific Reports, (2022). doi: 10.18203/issn.2454-2156.intjscirep20221342
12. Madiha, Sultan., Saima, Qureshi., Asher, Jamelle., Saqib, Rashid., Mehwish, Ali., Umair, Khero. Plaque Control Efficacy: Interdental Brushes versus Dental Floss. Journal of pharmaceutical research international, (2022). doi: 10.9734/jpri/2022/v34i46a36373
13. Antonio, Roa, López., Gerardo, Moreu, Burgos., Antonio, Aguilar, Salvatierra., Javier, Fernández, Delgado., Manuel, Bravo., Maximino, González, Jaranay. Efficacy of dental floss with ellipsoidal knots vs conventional dental floss for plaque removal: A split-mouth randomized trial. International Journal of Dental Hygiene, (2021). doi: 10.1111/IDH.12473

14. Sonali, A., Gholap., Amit, Mani., Shivani, Sachdeva., Harpreet, Singh, Manaktala., Hiral, R., Vora., Jasleen, K., Sodhi. Interdental Aids – A review. IP international journal of periodontology and implantology, (2022). doi: 10.18231/j.ijpi.2021.035
15. Apsara, Ramesh., Divvi, Anusha., Shivashankar, Kengadaran. Attitude and Knowledge Regarding Flossing Technique among Dental Students. International Journal of Social Rehabilitation, (2022). doi: 10.56501/intjsocrehab.v7i2.573
16. Smruti, Divate., Zac, Morse. Dental floss design: a protocol for a scoping review. International Journal of Scientific Reports, (2022). doi: 10.18203/issn.2454-2156.intjscirep20221342
17. Adrian, K., Stavrakis., Sanja, Kojić., Bojan, Petrovic., Isidora, Nešković., Goran, Stojanovic. Performance Evaluation of Dental Flosses Pre- and Post-Utilization. Materials, (2022). doi: 10.3390/ma15041522
18. Lee, Kyoung, Bok. Dental floss provided with dental hygiene device. (2020).
19. Liang, Ruizhen., Wu, Daming., Chen, Chen., Yuan, Miao., Nie, Rongping. Special dental floss for cleaning oral interdental slits. (2020).
20. Plaque Removal. (2022). doi: 10.1002/9781119583967.ch9.1
21. Tarun, Vyas., Garima, Bhatt., Abhishek, Gaur., Chetan, Sharma., Akshya, Sharma., Ravleen, Nagi. Chemical plaque control - A brief review. Journal of family medicine and primary care, (2021). doi: 10.4103/JFMPC.JFMPC_2216_20
22. Apoorva, Salve., Salman, Ansari., Prajakta, Heda., Rutuja, Dani., Apeksha, Gajghate., Yugeshwari, Rathod. Rinsops; Towards better gingival health. Archives of dental research, (2023). doi: 10.18231/j.adr.2022.018
23. Julie, Grender., Ralf, Adam., Yuanshu, Zou. The effects of oscillating-rotating electric toothbrushes on plaque and gingival health: A meta-analysis. American Journal of Dentistry, (2020).
24. Impact of Manual Toothbrush Design on Plaque Removal Efficacy. (2023). doi: 10.21203/rs.3.rs-2616557/v1
25. Madiha, Sultan., Saima, Qureshi., Asher, Jamelle., Saqib, Rashid., Mehwish, Ali., Umair, Khero. Plaque Control Efficacy: Interdental Brushes versus Dental Floss. Journal of pharmaceutical research international, (2022). doi: 10.9734/jpri/2022/v34i46a36373
26. Umadevi, P., Nair., S, Ravindra., R., Naveen, Reddy. Assessment of plaque control efficacy using two types of toothbrushes in young adults: an interventional crossover study. International Journal of Dental Hygiene, (2022). doi: 10.1111/idh.12621
27. Pindobilowo., Grace, Monica., Dwi, Ariani. Comparison of the Effectiveness of U-Shape Toothbrushes and Conventional Toothbrushes for Cleaning Dental Plaque: A Narrative Review. Jurnal Multidisiplin Madani, (2023). doi: 10.55927/mudima.v3i6.3906
28. Kun-Ok, Lim. A comparison of the elimination rate of artificial dental plaque between reciprocating- and rotating-interdental toothbrushes. Journal of Korean Society of Dental Hygiene, (2021). doi: 10.13065/JKSDH.20210003
29. Lile IE, Osser G, Negruțiu BM, Valea CN, Vaida LL, Marian D, et al. The Structures–Reactivity Relationship on Dental Plaque and Natural Products. Applied Sciences [Internet]. 2023 Aug 10;13(16):9111. Available from: http://dx.doi.org/10.3390/app13169111
30. Brouwers, M.C., Kerkvliet, K., Spithoff, K., AGREE Next Steps Consortium. The AGREE Reporting Checklist: a tool to improve reporting of clinical practice guidelines. (published correction appears in BMJ. 2016; 354: I 4852.) BMJ. 2016;352: i1152