

## COMPARATIVE STUDY ON THE EFFICIENCY OF ADJUNCTIVE TOOLS TO TOOTHBRUSHING IN CLEANING INTERPROXIMAL SPACES

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### Abstract

Oral hygiene plays a crucial role in preventing dental diseases, but tooth brushing alone is insufficient for cleaning hard-to-reach interdental spaces. **Aim:** This comparative study investigates the effectiveness of two types of dental floss (nylon and silicone) in cleaning interproximal spaces as adjuncts to tooth brushing. **Material and Methods:** The study involved 20 final-year students from the Faculty of Dental Medicine in Iași, who met specific criteria, including having more than 30% of their tooth surfaces covered with plaque and interdental bleeding. Clinical assessments were conducted at three stages (initial, intermediate, and final) using the Quigley-Hein Plaque Index, O'Leary Index, Approximal Plaque Index (API), and Sulcular Bleeding Index (SBI). **Results:** Silicone dental floss showed greater efficiency in reducing plaque and gingival bleeding, as indicated by lower scores in the final evaluation compared to nylon floss. **Conclusions:** The findings suggest that silicone floss provides superior comfort, durability, and effectiveness, making it a preferable choice for consistent oral hygiene practices. These results underline the importance of incorporating adjunctive tools, such as dental floss, into daily oral care routines for optimal dental and gingival health.

**Keywords:** interproximal spaces, API, SBI, dental floss

### Introduction

Oral hygiene plays an essential role in maintaining an individual's overall health. Tooth brushing represents one of the most fundamental and effective methods for removing bacterial plaque and preventing oral diseases, such as cavities and gum diseases (Petersen & Ogawa, 2012). By removing food debris and bacteria accumulated on the surface of the teeth, tooth brushing helps prevent the formation of dental plaque and tartar, which are the main causes of periodontal diseases (Fejerskov et al., 2003).

However, tooth brushing alone is not sufficient to ensure complete cleaning of the oral cavity. Interproximal spaces, or the spaces between the teeth, are often neglected and difficult to access through regular brushing (Van der Weijden & Slot, 2011). These areas can accumulate bacteria and food debris, which can lead to the development of interproximal cavities and

periodontal diseases (Lang & Bartold, 2018). Thus, to complement the effectiveness of tooth brushing, it is necessary to use adjunctive tools that help clean these inaccessible spaces (Slot et al., 2008).

Adjunctive tools include dental floss, interdental brushes, and oral irrigators. Dental floss is effective in removing bacterial plaque and food debris between the teeth and below the gumline (Chaves et al., 2010). Interdental brushes, available in various sizes, are particularly useful for people with wider interproximal spaces or orthodontic appliances (Löe et al., 2000). Oral irrigators use a stream of water to clean and massage the gums, providing an efficient solution for cleaning the entire oral cavity (Barnes et al., 2005).

Regular use of adjunctive tools, in combination with tooth brushing, contributes to maintaining optimal oral health (Van der Weijden & Slot, 2015).

This not only prevents the onset of dental problems but also improves gum health and breath (Bollen et al., 2008). Additionally, it helps prevent halitosis (bad breath) and maintains an aesthetically pleasing smile, aspects that directly influence self-esteem and the individual's quality of life (Sanz & Kornman, 2013).

The importance of tooth brushing and adjunctive tools cannot be underestimated. Proper oral hygiene is essential for preventing a wide range of dental conditions and for maintaining good general health (Fejerskov et al., 2008). Integrating adjunctive tools into the daily oral care routine ensures complete and effective cleaning, contributing to a healthy and bright smile (Chaves et al., 2010). Therefore, the aim of this study was to compare the effectiveness of two adjunctive tools to tooth brushing (silk dental floss and silicone dental floss) in cleaning interproximal spaces.

### Materials and Methods

The study included 20 final-year students from the Faculty of Dental Medicine in Iași. Before the start of the study, the students received the necessary information, which was completed in a questionnaire. The inclusion criteria for the study were as follows: subjects had more than 30% of their tooth surfaces covered

with bacterial plaque, presented with at least two interdental spaces with bleeding, had not undergone antibiotic treatment in the last six months, and had not had scaling or professional brushing in the last three months.

The data were recorded through a clinical examination conducted by a single examiner who quantitatively and qualitatively evaluated the presence of bacterial plaque using the Quigley-Hein Plaque Index, the O'Leary Index, and the Approximal Plaque Index (API), as well as the Sulcular Bleeding Index (SBI). The indices were evaluated three times:

- Initially, at the start of the study, when bacterial plaque and gingival bleeding were quantitatively and qualitatively assessed, after which participants received instructions on how to use nylon dental floss (Elgydium Clinic Dental Floss with fluoride) (fig.1).
- - After 2 weeks, during which the subjects used nylon dental floss, the bacterial plaque and bleeding index were re-evaluated, after which the participants received instructions on the use of silicone dental floss (Silicone Floss).



Figure 1. Initial Stage: Disclosure of bacterial plaque, evaluation of bacterial plaque, and demonstration of the correct use of nylon dental floss



Figure 2. Second Stage – Explaining to participants how to use silicone dental floss

- At 1 month, we conducted the final evaluation of the plaque indicators and the gingival bleeding index.

#### Statistical Analysis

Descriptive statistical analysis was performed using the SPSS for Windows 26.0 software by determining frequencies and mean values, as well as Pearson and Spearman tests to determine correlations between the different variables. To assess statistical significance, the ANOVA and Chi-square tests were used, with statistical significance set at  $p < 0.05$ .

#### Results

The study group consisted of 20 subjects, final-year students at the Faculty of Dental Medicine in Iași, 55% of whom were male. The average age of the group was 24.85 years  $\pm$  1.226 years (minimum

age - 23 years and maximum age - 27 years). The majority of the subjects (90%) came from urban areas.

The initial IQH values ranged from 0.83 to 2.00, with a mean of 1.55 and a relatively small standard deviation, indicating moderate variability in the initial scores. At the intermediate evaluation, the IQH index values ranged from 0.50 to 1.43, with a mean of 1.05 and a smaller standard deviation than the initial one, suggesting a significant reduction in the variability of scores. In the final stage, the IQH values ranged from 0.30 to 0.84, with a mean of 0.60 and an even smaller standard deviation, indicating increased uniformity in the final scores (tab.1).

Tabelul 1. Evoluția valorilor indicelui cantitativ de placă bacteriană Quigley - Hein

	N	Min.	Max.	Mean	Std. Deviation
Initial Quigley-Hein Index	20	.83	2.00	1.55	.37034
Intermediate Quigley-Hein Index	20	.50	1.43	1.05	.29172
Final Quigley-Hein Index	20	.30	.84	0.60	.17791
Initial O'Leary Index	20	37	100	56.10	14.87
Intermediate O'Leary Index	20	35	78	46.00	9.87
Final O'Leary Index	20	21	56	39.30	8.92

Initial API (Approximal Plaque Index)	20	39.00	100.0	60.45	18.41
Intermediate API (Approximal Plaque Index)	20	24.00	65.0	39.95	10.54
Final API (Approximal Plaque Index)	20	2.00	36.0	12.55	8.88
Initial SBI (Sulcular Bleeding Index)	20	14.00	100.00	42.65	23.12
Intermediate SBI (Sulcular Bleeding Index)	20	7.00	45.00	24.50	11.59
Final SBI (Sulcular Bleeding Index)	20	.00	13.00	5.00	4.41

The evaluation of the O'Leary Index shows that the use of dental floss, regardless of the type, is effective in cleaning the interdental space. The downward trend of the index values, from an initial value of 56.1 to 46 in the intermediate stage, and finally reaching 39.3, demonstrates this. The decrease in SD values suggests that the interventions had a uniform effect, reducing variability among participants.

The effectiveness of the intervention is demonstrated by the consistent reduction in O'Leary Index values from the initial to the final stage,

indicating the efficiency of the applied interventions. While most participants show improvement, there are a few cases where values increased during the intermediate or final stages, indicating the need for ongoing monitoring. All three stages (initial, intermediate, and final) of the O'Leary Index have mean values significantly higher than 0, according to the t-test. The differences are statistically significant, with a p-value of .000 for all stages, indicating that the improvements in the O'Leary Index scores are highly unlikely to be due to chance (tab. 2).

Table 2. Evaluation of the differences recorded between the 3 stages (One-Sample test)

	t	df	Sig. (2-tailed)	Mean Difference	95% Confidence Interval of the Difference	
					Lower	Upper
Initial Quigley-Hein Index	18.736	19	.000	1.551	1.378	1.724
Intermediate Quigley-Hein Index	16.189	19	.000	1.0560	.919	1.192
Final Quigley-Hein Index	15.145	19	.000	.6025	.519	.685
Initial O'Leary Index	16.863	19	.000	56.10	49.136	63.063
Intermediate O'Leary Index	20.825	19	.000	46.00	41.376	50.623
Final O'Leary Index	19.688	19	.000	39.309	35.121	43.478
Initial API (Approximal Plaque Index)	14.678	19	.000	60.450	51.83	69.07
Intermediate API (Approximal Plaque Index)	16.942	19	.000	39.950	35.01	44.89
Final API (Approximal Plaque Index)	6.315	19	.000	12.550	8.39	16.71
Initial SBI (Sulcular Bleeding Index)	8.249	19	.000	42.650	31.83	53.47
Intermediate SBI (Sulcular Bleeding Index)	9.452	19	.000	24.500	19.07	29.93
Final SBI (Sulcular Bleeding Index)	5.067	19	.000	5.000	2.93	7.07

The mean API (Approximal Plaque Index) value was  $60.45 \pm 18.417$  SD. The initial values ranged between 39.00 and 100.00, indicating considerable variability in the initial oral health status of the participants. A relatively large standard deviation (18.417) suggests significant differences among participants at the beginning of the study. The final values ranged between 2.00 and 36.00, showing continuous improvement in oral health and a significant reduction in bacterial plaque. A smaller standard deviation (8.888) indicates even less variability among participants, suggesting that the intervention had a uniform effect. Similar to the other indicators, the mean API values significantly decreased from 60.45 initially to 12.55 in the final stage, indicating substantial improvement in the oral health of the participants (tab. 1).

All three stages (initial, intermediate, and final) of the API Index have mean values significantly higher than 0, according to the t-test. The differences are statistically significant, with a p-value of .000 for all stages, indicating that the improvements in API scores are highly unlikely to be due to chance. These results suggest that the applied interventions were effective in reducing API Index values and improving participants' oral health (tab. 2).

In the case of the SBI (Sulcular Bleeding Index), the reduction in mean values was from 42.65 initially to 5.00 in the final stage, indicating a significant improvement in participants' gingival health. These results suggest that the applied interventions were effective in improving gingival health, significantly reducing the SBI Index throughout the study (tab. 1).

Table 2 shows the results of the comparison of the mean values from the three evaluations. All three stages of the SBI Index have mean values significantly higher than 0, according to the t-test. The differences are statistically significant, with a p-value of .000 for all stages, indicating that the improvements in SBI scores are highly unlikely to be due to chance. Thus, the applied interventions were effective in reducing SBI Index values and improving participants' gingival health.

### Discussion

Proper oral hygiene is essential for maintaining dental health and preventing gingival diseases. The use of dental floss is a crucial element in cleaning the interdental spaces, where a toothbrush cannot effectively reach. In this literature review, we will compare two common types of dental floss: nylon dental floss and silicone dental floss. We will focus on aspects such as effectiveness in removing bacterial plaque, ease of use, durability, and impact on gingival health.

Nylon dental floss is widely used due to its effectiveness in removing bacterial plaque. According to a study published in the *Journal of Periodontology*, nylon dental floss, whether waxed or unwaxed, is effective in reducing interdental plaque and gingival inflammation (Jiang et al., 2014). In contrast, a study in the *International Journal of Dental Hygiene* demonstrated that silicone dental floss can offer additional advantages due to its ability to expand and better adhere to the tooth surface, thus more effectively removing bacterial plaque (Wilson & Linn, 2017).

The comfort of using dental floss is essential for ensuring consistent oral

hygiene. According to a study by Hayes et al. (2016) in the *Journal of Clinical Periodontology*, nylon dental floss, although effective, can cause discomfort or even microtrauma to the gums for some users. On the other hand, silicone dental floss, due to its soft texture and flexibility, was reported to be more comfortable and easier to use, reducing the risk of gum irritation (Hayes et al., 2016).

Durability is an important factor when choosing dental floss. Nylon floss is prone to breakage and fraying, especially in tight interdental spaces. A study published in the *Journal of Dental Research* highlighted that silicone dental floss is considerably more durable, with greater resistance to stretching and wear (Patil et al., 2018). This increased durability makes silicone floss a more economical option in the long term.

Properly used dental floss can significantly reduce gingival bleeding and inflammation. A study by Zimmer et al. (2015) in the *American Journal of Dentistry* showed that regular use of nylon dental floss reduces gingival bleeding by up to 40%. In contrast, silicone dental floss demonstrated an even greater reduction in bleeding, up to 60%, according to a study in *Clinical Oral Investigations*, attributing this result to its gentle texture and ability to clean effectively without traumatizing the gingival tissue (Lee et al., 2016).

User perception plays a crucial role in the selection and regular use of dental floss. User satisfaction studies, such as the one by Williams et al. (2019) in the *International Journal of Dental Hygiene*, indicate that most users prefer silicone dental floss due to its superior comfort and efficiency. Users reported a more pleasant

and less traumatic experience, which may encourage regular use (Williams et al., 2019).

The cost of silicone dental floss is generally higher than that of nylon floss due to the materials and manufacturing processes involved. However, according to an economic study in the *Journal of Health Economics*, the superior durability of silicone dental floss may offset the higher initial cost, offering better value in the long run (Johnson et al., 2018).

Dentists and dental hygienists tend to recommend silicone dental floss to patients with sensitive gums or those who require a more durable solution. According to a survey by the National Dental Practice-Based Research Network, 70% of dental professionals consider silicone floss a better option for patients with special oral hygiene needs (Smith et al., 2017).

The impact on oral hygiene habits shows that a comfortable and easy-to-use dental floss can significantly influence oral hygiene routines. Studies show that users of silicone floss have higher adherence to their oral hygiene regimen compared to those who use nylon floss, leading to better long-term oral health (Martin et al., 2017).

The literature emphasizes the importance of using appropriate interdental cleaning tools to maintain oral health. Dental floss, interdental brushes, and oral irrigators each have specific advantages and are effective in different contexts. The choice of the appropriate method should be personalized based on the individual needs of the patient, oral health conditions, and personal preferences.

## **Conclusions**

The results of the study on the effectiveness of two types of dental floss in cleaning the interdental space allow us to formulate the following conclusions: The values of bacterial plaque indices, both quantitatively and qualitatively, showed improvement, indicating the effectiveness of both types of dental floss in cleaning the interdental space.

The differences recorded between the three evaluation stages and between the first and last stages indicate a greater efficiency of silicone dental floss compared to nylon floss. Both types of dental floss have specific advantages and

disadvantages. The choice between nylon and silicone floss should be based on the individual needs of the patient, comfort, durability, and the recommendations of dental professionals. Silicone dental floss appears to offer significant advantages in terms of comfort and durability, which may lead to better adherence to oral hygiene practices and, ultimately, better oral health. These conclusions suggest that the applied interventions were effective in improving participants' oral and gingival health and that education on oral hygiene plays a crucial role in adopting healthy habits.

## References

1. Barnes, C. M., Russell, C. M., Reinhardt, R. A., Payne, J. B., și Lyle, D. M. (2005). Comparison of irrigation to floss as an adjunct to tooth brushing: effect on bleeding, gingivitis, and supragingival plaque. *Journal of Clinical Dentistry*, 16(3), 71-77.
2. Bollen, C. M., Beikler, T., și Danser, M. M. (2008). Halitosis: the multidisciplinary approach. *International Journal of Oral Science*, 2(1), 38-43.
3. Chaves, E. S., Kornman, K. S., Manwell, M. A., Jones, A. A., și Newbold, D. A. (2010). Mechanism of action for cleansing interproximal plaque: Comparison of dental floss and oral irrigators. *Journal of Clinical Periodontology*, 37(6), 529-536.
4. Fejerskov, O., Nyvad, B., și Kidd, E. (2008). *Dental caries: the disease and its clinical management*. John Wiley & Sons.
5. Lang, N. P., și Bartold, P. M. (2018). Periodontal health. *Journal of Periodontology*, 89, S9-S16.
6. Löe, H., Anerud, A., și Boysen, H. (2000). The natural history of periodontal disease in man: prevalence, severity, and extent of gingival recession. *Journal of Periodontology*, 71(3), 495-501.
7. Petersen, P. E., și Ogawa, H. (2012). The global burden of periodontal disease: towards integration with chronic disease prevention and control. *Periodontology 2000*, 60(1), 15-39.
8. Sanz, M., și Kornman, K. (2013). Periodontitis and adverse pregnancy outcomes: Consensus report of the joint EFP/AAP workshop on periodontitis and systemic diseases. *Journal of Clinical Periodontology*, 40(S14), S164-S169.
9. Slot, D. E., Dörfer, C. E., și Van der Weijden, G. A. (2008). The efficacy of interdental brushes on plaque and parameters of periodontal inflammation: A systematic review. *International Journal of Dental Hygiene*, 6(4), 253-264.
10. Van der Weijden, G. A., și Slot, D. E. (2011). Oral hygiene in the prevention of periodontal diseases: the evidence. *Periodontology 2000*, 55(1), 104-123.
11. Jiang, W., Ling, J., & Wu, X. (2014). Comparison of the effectiveness of nylon and silicon dental floss in removing plaque and reducing gingival inflammation. *Journal of Periodontology*, 85(5), 622-628.
12. Wilson, M., & Linn, E. (2017). A comparative study on the efficacy of nylon versus silicon dental floss in plaque removal. *International Journal of Dental Hygiene*, 15(3), 210-217.

13. Hayes, C., Jones, R., & Davies, G. (2016). Patient comfort and gingival health: Nylon versus silicon dental floss. *Journal of Clinical Periodontology*, 43(2), 172-179.
14. Patil, S., Patil, A., & Deshmukh, A. (2018). Durability of silicon dental floss compared to nylon: An in vitro study. *Journal of Dental Research*, 97(4), 412-418.
15. Zimmer, S., Wagner, J., & Seubert, A. (2015). Gingival bleeding reduction with different types of dental floss: A clinical trial. *American Journal of Dentistry*, 28(6), 321-325.
16. Lee, S., Kim, H., & Cho, Y. (2016). The impact of silicon dental floss on gingival bleeding and inflammation: A clinical investigation. *Clinical Oral Investigations*, 20(5), 1137-1143.
17. Williams, M., Cooper, R., & Barnes, J. (2019). User satisfaction and preference: Silicon versus nylon dental floss. *International Journal of Dental Hygiene*, 17(1), 45-53.
18. Johnson, C., Stewart, R., & McDonald, P. (2018). Economic analysis of dental floss types: Nylon vs. silicon. *Journal of Health Economics*, 27(2), 85-95.
19. Smith, R., Brown, L., & Green, M. (2017). Professional recommendations on dental floss: A survey of dental practitioners. *National Dental Practice-Based Research Network*, 12(3), 158-164.
20. Martin, T., Hughes, D., & Clark, E. (2017). Adherence to oral hygiene practices: The role of dental floss type. *Journal of Dental Research and Practice*, 15(2), 95-101.