

Comparative Study

COMPARISON OF THE EFFICACY OF PIPES CLEANER AND TUFTED FLOSS IN PATIENTS WITH FIXED ORTHODONTIC APPLIANCES: A COMPARATIVE STUDY

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ABSTRACT

To compare the efficacy of pipe cleaners (PC) and tufted floss (TF) over a one-month period to determine which device is more effective in plaque removal and the reduction of gingival inflammation in orthodontic patients with fixed multi-bracket appliances. This randomized controlled trial compared two study groups: the pipe cleaners' group (n=10, mean age 12.6 ± 2.02 years) and the tufted floss group (n=10, mean age 12.4 ± 2.88 years). Both groups were evaluated at baseline (T0) and 1 month later (T1). At T0, patients received instruction and motivation regarding Home Oral Hygiene (HOI) and the correct use of their assigned device. The indices recorded at both T0 and T1 were the Bonded Bracket Plaque Index (BBPI), Gingival Bleeding Index (GBI), and Gingival Index (GI). Statistical analysis was performed using independent- and paired-samples t-tests to evaluate clinical improvements and overall outcomes. A statistically significant difference was observed at T1, favoring the pipe cleaners' group regarding the bleeding index ($p = 0.012$). No statistically significant differences were found for the other parameters analyzed. Within the limits of this study, it can be concluded that the pipe cleaners reduce gingival bleeding on probing more effectively than tufted floss in patients with fixed orthodontic appliances.

INTRODUCTION

Fixed orthodontics presents significant challenges in maintaining proper at-home oral hygiene (1). Vestibular multibracket orthodontics is widely used to correct pathological malocclusions and to improve functional outcomes and facial esthetics in adolescents and adults. However, these appliances can promote the development of white spot lesions

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that may progress to cavitated carious lesions (2). They can also favor plaque accumulation and gingival inflammation, potentially leading to gingivitis and, in susceptible patients, progression toward periodontitis, a chronic disease that may necessitate more rigorous long-term follow-up for the remainder of the patient's life (3, 4). In addition, fixed orthodontic therapy may be part of multidisciplinary management for patients with more complex syndromic diseases; in these patients, maintaining adequate oral hygiene can be even more challenging, and the risk associated with poor oral hygiene is proportionally greater (5, 6).

The onset of gingivitis and its more severe manifestation, periodontitis, is primarily attributed to the accumulation of plaque and dental tartar (7); therefore, it is of paramount importance to provide orthodontic patients with meticulous care, comprehensive instructions, and optimal motivation to reduce the risk of these pathologies. Accurate oral hygiene, especially in orthodontic patients, is essential to prevent oral pathologies (1). While existing studies confirm the efficacy of pipe cleaners (PC) and tufted floss (TF) in cleansing and removing interproximal plaque, thus reducing the risk of white spot lesions and gingivitis (8-10), there is a lack of specific research comparing which of these two devices is more effective for the home oral hygiene of orthodontic patients. These patients exhibit increased plaque and dental tartar accumulation even in areas generally less susceptible to bacterial biofilm formation (11, 12).

The objective of the present study is to determine whether the pipe cleaners or tufted floss is more indicated for use in orthodontic patients.

MATERIALS AND METHODS

A total of 20 patients were selected for the study: 10 were assigned to the Pipe Cleaners (PC) group and 10 to the Tufted Floss (TF) group. Among these, 11 were female, and 9 were male (TF group: F=5, M=5; PC group: F=6, M=4). The mean age for the PC group was 12.6 ± 2.02 years. The TF group presented a mean age of 12.4 ± 2.88 years.

Adolescents were primarily selected as the target population, since studies confirm that only 30.2% of this demographic adheres to the follow-up visits prescribed by their practitioners (13). Given that many orthodontic treatments occur within this age range, it is imperative to educate patients and raise awareness of the importance of proper home oral hygiene. Patient allocation into the experimental groups was performed using a computer program.

Participants were randomly assigned to either the pipe cleaners group or the tufted floss group. All patients were randomly assigned to their respective groups regardless of age, gender, or baseline compliance with provided recommendations. Afterwards, the correct use of the tool was demonstrated on a dental model using the Tell-Show-Do technique (14).

The trial commenced with periodontal charting of the vestibular arch where brackets were present, recording the Gingival Index (GI) (15), Bonded Bracket Plaque Index (BBPI) (16), and Gingival Bleeding Index (GBI) (17) values using a PCP UNC (North Carolina) periodontal probe at baseline (T0). As mentioned, the subsequent step involved providing instruction and motivation to the patients, utilizing a dental model, a demonstration toothbrush, and a sample of either tufted floss or a pipe cleaner, depending on the assigned group.

All patients were asked to use a manual toothbrush, as studies confirm that these are less effective at maintaining oral health than electric toothbrushes; furthermore, the latter may compensate for missed dental flossing (18). If patients were already using an electric toothbrush prior to study enrollment, they were instructed to discontinue its use for the entire duration of the study. The recommended brushing technique was the Modified Bass technique, as it has been demonstrated to be superior at removing supragingival plaque compared to horizontal and vertical techniques (19). The efficacy of dental floss as an interdental cleaning tool is established by studies confirming its utility, particularly when used in synergy with a toothbrush (20). The dental floss selected for this study is a specific type known as 'tufted floss', which features a rigid end that facilitates easier access around orthodontic brackets than traditional dental floss. Pipe cleaners are an oral hygiene tool primarily used to clean interproximal spaces; their effectiveness has been demonstrated by studies showing that combining a toothbrush with a pipe cleaner can improve the health of the gingival tissues where they are applied (21).

No specific products, such as mouthwashes to be used in conjunction with the toothbrush and PC/TF, were recommended, nor was a specific brand of interdental devices prescribed. Throughout the trial, no dropouts occurred. Each patient received periodic follow-up and motivational visits weekly, for an average duration of 30 days. This protocol was implemented to maximize patient compliance and to ensure that neither the brushing technique nor the use of the assigned interdental device was performed incorrectly. During the second re-evaluation (T1), patient feedback, including doubts, comments, and suggestions regarding the treatment, was recorded, with particular focus on satisfaction or difficulties encountered with the interdental cleaning devices.

Patients were instructed to refrain from Professional Oral Hygiene (POH) throughout the study. This restriction was necessary because professional deep cleaning via scaling (manual or mechanical), combined with polishing or air polishing, significantly improves BBPI, GBI, and GI indices, potentially eliminating bleeding, inflammation, and plaque in ideal cases. Patients also avoided third molar surgery during the observational period to avoid periodontal and microbial changes (22). The second data collection visit involving periodontal charting (T1) was conducted by a second operator who was blinded to the patient's group assignment. This single-blind approach was adopted to ensure greater objectivity and prevent potential operator bias. Upon completion of data collection, statistical analysis was performed, including descriptive statistics and independent-samples t-tests, with a significance threshold of $p < 0.05$.

The inclusion criteria for the study were as follows: mean age of approximately 12 years, presence of fixed orthodontic appliances, and clinical evidence of plaque accumulation, inflammation, and gingival bleeding upon objective examination, with no other potential confounding factors. Patients were required to use a manual toothbrush throughout the study.

The exclusion criteria were: presence of oral pathologies that could alter the oral mucosa (23, 24); smoking habit; concurrent pharmacological therapy; specific allergies or intolerances to dental products; regular use of mouthwash and inability or refusal to discontinue the use of electric toothbrushes for the duration of the trial. All procedures were conducted in accordance with the Helsinki Declaration and the Good Clinical Practice guidelines for research involving human subjects.

RESULTS

Descriptive analysis showed that the mean age was comparable between groups (PC: 12.6 ± 2.02 years; TF: 12.4 ± 2.88 years (Table I).

Table I. Descriptive statistics.

	Group	Age	GI_1	Plaque_1	BOP_1 (%)	GI_2	Plaque_2	BOP_2 (%)
N	PC	10	10	10	10	10	10	10
	TF	10	10	10	10	10	10	10
Mean	PC	12.6	0.932	1.08	57.1	0.496	0.612	24.2
	TF	12.4	0.891	1.06	53.4	0.784	0.717	47.1
Standard deviation	PC	2.02	0.500	0.374	28.5	0.356	0.434	18.1
	TF	2.88	0.495	0.347	25.6	0.330	0.314	11.9

(N, mean, and SD) for the PC and TF groups at baseline (T0) and follow-up (T1).

As illustrated in Table II, at T0, the patients exhibited highly similar baseline conditions for all three studied indexes as evidenced by the p-values, which were all substantially higher than the established significance threshold ($p < 0.05$).

Table II. *Between-group comparison at baseline.*

	<i>t(df)</i>	<i>p</i>
<i>GI_0</i>	0.161(14.0)	0.874
<i>Plaque_0</i>	0.088 (14.0)	0.931
<i>BOP_0</i>	0.272 (14.0)	0.789

(T0) for gingival inflammation, plaque, and bleeding indices (PC vs TF). Independent-samples *t* tests are reported as *t(df)* with two-tailed *p* values ($\alpha = 0.05$) comparing PC group against the TF group. *GI_0* = Gingival Index at T0; *Plaque_0* = Bonded Bracket Plaque Index (BBPI) at T0; *BOP_0* (%) = Gingival Bleeding Index (GBI; bleeding on probing) at T0.

At T1, the PC group showed greater improvement across the analyzed indices than the TF group, which nonetheless showed progress in reducing gingival inflammation (GI), plaque control (Plaque), and bleeding on probing (BOP). Specifically, the only parameter that reached the predetermined statistical significance for this study was the 'BOP_1' (GBI) value for the PC group, with a *p*-value of 0.012 ($0.012 < 0.050$) (Table III).

Table III. *Between-group comparison at 1-month follow-up.*

	<i>t(df)</i>	<i>p</i>
<i>GI_1</i>	-1.676 (14.0)	0.116
<i>Plaque_1</i>	-0.554 (14.0)	0.588
<i>BOP_1</i>	-2.869 (14.0)	0.012

(T1) for gingival inflammation, plaque, and bleeding indices (PC vs TF). Independent-samples *t* tests are reported as *t(df)* with two-tailed *p* values ($\alpha = 0.05$) comparing PC group against the TF group. *GI_1* = Gingival Index at T1; *Plaque_1* = Bonded Bracket Plaque Index (BBPI) at T1; *BOP_1* (%) = Gingival Bleeding Index (GBI; bleeding on probing) at T1.

Comparing the PC and TF groups at T1, the PC group showed greater improvement across the analyzed indices than the TF group, which nonetheless showed progress in reducing gingival inflammation (GI), plaque control (Plaque), and bleeding (BOP). Specifically, the only parameter that reached the predetermined statistical significance for this study was the 'BOP_1' (GBI) value for the PC group, with a *p*-value of 0.012 ($0.012 < 0.050$).

DISCUSSION

Since the PC and TF experimental groups displayed very similar index values at T0, Professional Oral Hygiene (POH) was not performed. While POH would have standardized the patients' initial oral conditions, it was deemed unnecessary as these conditions were already sufficiently uniform, and the detrimental effect of smoking was avoided by intentionally excluding those subjects (25). Patients in both groups showed a general improvement in oral health (the *p*-values for 'GI_0', 'Plaque_0', and 'BOP_0' at T0 were higher than the respective indices at T1) but statistical significance

at T1 in comparison with of both groups statistical significance was reached for the GBI (BOP_0 = 0.789 at T0, BOP_1 = 0.012 at T1, which is below the established p-value threshold of 0.005). Consequently, it cannot be concluded that the PC is more effective than TF in absolute terms for orthodontic patients.

In 2006, Jackson et al. demonstrated that both tools can achieve significant improvements in the evaluated indices (Plaque Index, Eastman Interdental Bleeding Index, and Bleeding On Probing) (26). That study found both devices to be effective in plaque removal and in reducing bleeding and probing depth (PD), with p-values < 0.001 within the first 6 weeks. Similar results were observed at the subsequent 12-week follow-up, with a slight change in the PI p-value (p-value T1 < 0.001; p-value T2 = 0.006), which remained highly significant. The results differ from those of the present research because the study design was different.

The above study presents several differences in comparison to the present research: the sample size (N) analyzed by was larger (N=77) than that of the current study (N=20); different indices were employed (EIBI, PD, and PI); and the participants were affected by periodontal disease rather than being orthodontic patients. Furthermore, the floss recommended to them was a standard type, rather than tufted floss (26).

In a study conducted by Graziani et al. (27), the combined use of four different study groups was compared. In the comparison between the second group (manual toothbrush + dental floss) and the third group (manual toothbrush + pipe cleaner), it was observed that the pipe cleaner did not exhibit the same capacity for bleeding reduction as dental floss.

The differences with that study include the use of different indices (AngBI, FMBS, FMPS), a distinct methodology, a larger sample size, the inclusion of non-orthodontic patients, and the performance of POH at baseline (T0).

In 2024, Mirza et al. conducted a study demonstrating that, among four cleaning modalities, dental floss was slightly superior to the pipe cleaner in reducing the Gingival Bleeding Index (GBI) (28). However, these differences were not statistically significant, with a GBI reduction of 2.60% for the interdental brush group and 2.82% for the dental floss group. This study also presents differences, including the use of the Rustogi Modified Navy Plaque Index (RMNPI), a significantly larger study population (N=364), a broader age range (18-65 years), and the inclusion of patients with gingivitis who were not undergoing orthodontic treatment.

In the comparison between T0 and T1, a general improvement in the indices was observed for both the PC and TF groups. However, the only statistically significant difference deemed relevant to the study was the reduction in bleeding within the PC group. A possible explanation for the superior results observed with the pipe cleaner compared to tufted floss may be patient feedback. Participants using the PC commented on the instrument's ease of use and practicality, whereas those in the TF group highlighted difficulties with its correct application, leading to decreased patient compliance.

CONCLUSIONS

An independent-samples t-test of the data comparing the two study groups (PC and TF) on the analyzed indices (GI, BBPI, and GBI) at T0 and T1 showed a statistically significant result for the bleeding index in the PC group only. Both the BBPI and GBI demonstrated improvements in both the PC and TF groups. Furthermore, although the BBPI and GBI values showed greater improvements at T1 in the PC group than in the TF group, these differences did not reach statistical significance.

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