TURKISH JOURNAL of ORTHODONTICS

DOI: 10.5152/TurkJOrthod.2019.18084

Original Article

The Effects of Using Plaque-Disclosing Tablets on the Removal of Plaque and Gingival Status of Orthodontic Patients

Mehmet Ali Yavan[1], Sayad Kocahan[2,3], Serhat Özdemir[4], Oral Sökücü[5]

[1]Department of Orthodontics, Adıyaman University School of Dentistry, Adıyaman, Turkey
[2]Department of Physiology, Adıyaman University School of Medicine, Adıyaman, Turkey
[3]International Scientific Center, Baku State University, Baku, Azerbaijan
[4]Department of Orthodontics, Gaziantep University School of Dentistry, Gaziantep, Turkey
[5]Private Orthodontist, Gaziantep, Turkey

Cite this article as: Yavan MA, Kocahan S, Özdemir S, Sökücü O. The Effects of Using Plaque-Disclosing Tablets on the Removal of Plaque and Gingival Status of Orthodontic Patients. Turk J Orthod 2019; 32(4): 207-14.

ABSTRACT

Objective: The aim of this study was to investigate the effects of using plaque-disclosing tablets (PDTs) on the plaque and gingival index scores of patients wearing fixed orthodontic appliances.

Methods: In group A (n=16), the subjects were motivated by conventional oral hygiene instructions, including verbal information about tooth brushing. The patients in group B (n=17) were motivated using PDTs used in the dentists' office to show the locations of biofilms in addition to the instructions given to group A. Both the chairside demonstration performed in group B and the at-home use of disclosing tablets were undertaken by those in group C (n=15). The periodontal parameters were recorded before applying the fixed appliance (T0) and after the first (T1) and third (T2) months.

Results: The plaque index (PI) scores of group C were significantly lower ($p<0.05$), when compared to groups A and B, after the first (T1) and third months (T2); however, no significant differences ($p>0.05$) were found between groups A and B. The gingival status of group C did not change significantly ($p>0.05$) over the three months and was statistically lower when compared to groups A and B.

Conclusion: The use of PDTs at home may enhance the plaque removal efficiency and gingival health stability, by facilitating self-examination.

Keywords: Plaque-disclosing tablets, oral hygiene, orthodontics

INTRODUCTION

Dental plaque is a predisposing factor for hyperplastic gingivitis, white spots, periodontal breakdown, and carious lesions (1, 2). Fixed orthodontic appliances cause greater plaque accumulation due to the creation of plaque-retentive sites, especially in the areas between the brackets and around the gingival margins (3). Therefore, the removal and control of dental plaque is very important for oral health maintenance in orthodontic patients. Poor oral hygiene can lead to unsatisfactory outcomes, such as white spot lesions and premature termination of the treatment, as reported in 5%-10% of orthodontic patients (4, 5).

Clinicians should motivate orthodontic patients to acquire satisfactory, steady oral hygiene at each appointment, and several oral hygiene motivational techniques have been evaluated and compared in numerous studies. These methods can be classified into verbal (6, 7), written (8), and supplemental visual techniques, such as showing illustrations and videos (9), the application of phase-contrast microscopy (10), or dyeing teeth with disclosing agents (6, 10-12).

Address for Correspondence: Sayad Kocahan, Department of Physiology, Adıyaman University School of Medicine, Adıyaman, Turkey; International Scientific Center, Baku State University, Baku, Azerbaijan
E-mail: skocahan@adiyaman.edu.tr

Received: November 08, 2018
Accepted: April 07, 2019

Disclosing agents, including dye (erythrosine, fluorescein, and iodine), are available in solution, swab, and tablet forms, and these agents allow clinicians to show the localization of the biofilm on the patient's teeth. Specifically, plaque-disclosing tablets (PDTs) can be used after brushing to allow a self-examination of the brushing quality. In the literature, the effects of using disclosing agents as motivational factors in orthodontic patients at the clinic have been investigated in numerous studies (6,10-12). However, no studies were found comparing the effects of using PDTs at the clinic and at home on the plaque index (PI) and gingival index (GI).

The aim of the present study was to compare the effects of using PDTs at the clinic and at home on the PI and GI scores during a fixed orthodontic treatment.

METHODS

This study was conducted at the Department of Orthodontics (Gaziantep University School of Dentistry, Turkey, from February 2015 to October 2015) and approved by the Ethics Committee of Gaziantep University (No.: 44). The patients and their parents were given information about the study design, and they signed informed consent forms at the beginning of the study. Forty-eight patients were selected according to the following inclusion criteria: requirement of a non-extraction fixed orthodontic treatment, 12–18 years of age, crowding under 5 mm in the incisors, presence of at least 20 natural permanent teeth and a completely healthy periodontal tissue, and the absence of dental caries. The exclusion criteria were the presence of systemic or chronic diseases, physical or mental disorders, previous orthodontic treatment, dental fluorosis, use of antibiotics during the previous six months, and smoking. According to the calculations performed using GPOWER 3.1, the minimum sample size, which would guarantee a power equal to 0.80, was 42 for the total of three groups.

Study Design

This study was conducted as a double-blind randomized clinical trial. A computer program was used to randomly distribute each patient to one of the three groups. Random sequencing was managed by a statistician. The baseline balance was tested after randomization among the treatment groups. Concealed allocation was performed using opaque, sealed envelopes that contained each group's patient listing; these were provided by another researcher before the initial bonding session. During the study, the examiner, data collector, and random sequence statistician were all blinded in terms of patient groupings.

Conventional 0.022 slot stainless steel brackets (MBT system; Opal, Utah, USA) were applied only to the maxillary arch to compare the differences between the arches with and without brackets. The examinations were conducted by the same researcher for three months. The mandibular arch was bonded after the study ended (three months).

Motivational Interviewing Protocol

The researcher informed the patients and their parents about the study. All of the groups received conventional oral hygiene instructions, including verbal information about tooth brushing (modified Bass technique) and daily dietary suggestions. The cleaning of the bracket walls and teeth using a toothbrush and interdental brush was demonstrated on a model and in the patient's mouth. The oral health biofilm risks and the importance of eliminating dental plaque were emphasized, and the oral hygiene instructions were repeated by the same blinded examiner at each appointment.

Each of the patients used the same toothbrush and toothpaste during the study, and each was instructed to brush their teeth at least three times a day for 3 minutes. The brushing techniques of the patients were checked at each appointment, and stainless steel ligatures were used to ligate the orthodontic arch wires.

The patients were then randomly distributed to one of the following three intervention groups:

Group A: Conventional motivational techniques were used in group A (control group), including oral hygiene instructions, a model demonstration, and self-application by the patient (T0).

Group B: The patients were motivated by a chairside technique in addition to the techniques used for group A. PDTs (GUM Red Cote Disclosing Tablets; Sunstar, Chicago, IL, USA) were used twice during the chairside appointments. The first PDT showed the quantity and location of the biofilm and the second one showed the brushing efficiency. The patient chewed each tablet for two minutes and then rinsed with water.

Group C: The PDTs were provided for at-home use in addition to the chairside motivations given to group B. The patients were instructed to use the tablets at home, once a day, after dinner. They were instructed to chew the tablets before and after brushing. A compliance chart was provided to each patient to assess the use of PDTs. The patients and their parents signed this chart after each time they used the tablets. Patients with a compliance rate lower than 90% were excluded.

Periodontal Evaluation

A calibrated examiner, blinded to the group allocations, measured the periodontal parameters at each time point. He was trained by a periodontist to calculate the Loe and Silness GI and the Silness and Loe PI, and was allowed to perform two PI measurements on 20 dentistry student volunteers before the study. The measurements were taken before the appointment and they were forbidden to brush until the measurement time.

The second and third molars were not included in the PI and GI measurements. The PI and GI scores of the maxillary and mandibular arches were calculated separately, and the maxillary arch was separated into anterior and posterior sections. The average scores of the anterior (canine to canine) and posterior teeth were detected separately, whereas those of the mandibular teeth were calculated without separating the anterior from the posterior.

The periodontal parameters were recorded before applying the fixed appliance (T0), after both the first (T1) and third (T2) months.

Statistical Analyses

The statistical analyses were performed using Statistical Package for Social Sciences for Windows, version 20.0 (IBM Corp., Armonk, NY, USA). The Shapiro-Wilk test was used to assess the normal distribution of the continuous variables, the Kruskall-Wallis H test was used to assess the discontinuous (non-parametric) data, and the

Mann-Whitney U test was used to assess the non-normally distributed variables. A post-hoc multiple comparison test was also used. When examining the differences between two dependent, normally distributed variables, the Wilcoxon signed rank test was used. A P value of <0.05 was considered to indicate statistical significance. A two-proportion *z*-test was used to compare the drop-out rates; additionally, a Bonferroni test was performed, and any α value lower than 0.143 was considered to indicate statistical significance.

RESULTS

Fifty-four patients were initially included in the study; however, six patients (in group A, n=2; in group B, n=1; and in group C, n=3) were lost after the three-month follow-up, at stages T1 and T2 (Figure 1). Four of six patients were lost (in group A, n=2; in group B, n=1; and in group C, n=2) because of inconsistent appointment attendance. Additionally, one patient from group C was excluded on account of a lack of cooperation in using PDTs. No significant differences were found among the three groups in terms of drop-out rates (α>0.143). Patients were excluded from the study if measurements were not performed within the week of the appointment, or if the compliance was under 90% according to the compliance chart provided for group C. The final sample included 48 patients who had completed all of the study measurements (Table 1).

PI and GI scores between the groups

PI Scores

No significant differences were observed in the PI scores at the baseline (T0) between the three groups (Table 2). At T1 and T2, no differences were found between groups A and B (p>0.05) in the maxillary anterior and posterior PI scores. However, group C exhibited lower PI scores than groups A and B at T1 and T2 (p<0.05) in the maxillary anterior and posterior PI scores.

In the mandible, no differences were found between the groups at T0 and T1 (p>0.05). Group C had significantly lower scores than groups A and B (p<0.05) at T2, but no statistically significant differences were observed between groups A and B (p>0.05) at T2.

GI Scores

For the anterior and posterior maxillary teeth, group C exhibited statistically lower scores than groups A and B at T1 and T2 (p<0.05) (Table 2). In addition, group B showed lower GI scores for the maxillary teeth than group A at T1 and T2 (p<0.05). For the mandibular GI scores, statistically lower scores were observed in group C when compared to groups A and B at T1 and T2 (p<0.05). Group B also had significantly lower scores than group A at T1 and T2 (p<0.05).

Table 1. Baseline age, gender characteristics, and periodontal scores of groups

	Group A	Group B	Group C	p
Age (years) (mean±SD)	15.4±2.9	15.7±2.6	16.1±2.8	0.503
Gender (n) (F/M)	8 / 8	9 / 8	8 / 7	0.773
Maxillary anterior PI	0.85±0.45	0.75±0.37	0.70±0.38	0.891
Maxillary posterior PI	1.01±0.43	0.87±0.43	0.94±0.32	0.791
Mandibular PI	0.87±0.38	0.78±0.39	0.76±0.36	0.696
Maxillary GI	1.33±0.18	1.20±0.32	1.10±0.18	0.082
Mandibular GI	1.16±0.20	1.17±0.15	1.11±0.17	0.279

SD: standard deviation; F: female; M: male; PI-plaque index; GI-gingival index

Table 2. Intergroup comparison of the mean plaque and gingival scores

		Group A Mean±sd	Group B Mean±sd	Group C Mean±sd	p
Maxillary anterior PI	T0	0.85±0.45	0.75±0.37	0.70±0.38	0.891
	T1	0.95±0.56 [c]	0.81±0.31 [c]	0.59±0.24 [ab]	0.041
	T2	1.09±0.64 [c]	0.90±0.50 [c]	0.29±0.24 [ab]	0.001*
Maxillary posterior PI	T0	1.01±0.43	0.87±0.43	0.94±0.32	0.791
	T1	1.04±0.50 [c]	0.92±0.33 [c]	0.65±0.20 [ab]	0.015*
	T2	1.17±0.40 [c]	1.04±0.73 c	0.51±0.35 [ab]	0.001*
Mandibular PI	T0	0.87±0.38	0.78±0.39	0.76±0.36	0.696
	T1	0.82±0,34	0.69±0.36	0.54±0.27	0.072
	T2	0.76±0.29 [c]	0.84±0.61 [c]	0.38±0.28 [ab]	0.003*
Maxillary GI	T0	1.33±0.18	1.20±0.32	1.10±0.18	0.082
	T1	1.34±0.19 [bc]	1.20±0.36 [ac]	1.10±0.17 [ab]	0.011*
	T2	1.34±0.19 [bc]	1.21±0.38 [ac]	1.10±0.17 [ab]	0.013*
Mandibular GI	T0	1.16±0.20	1.17±0.15	1.11±0,17	0.279
	T1	1.29±0.24 [bc]	1.16±0.24 [ac]	1.10±0.21 [ab]	0.016 *
	T2	1.37±0.23 [bc]	1.23±0.50 [ac]	1.10±0.17 [ab]	0.023*

[a]Significantly different from group A, [b]significantly different from group B, and [c]significantly different from group C. PI-Plaque Index, GI-Gingival Index, *P ≤ 0.05.

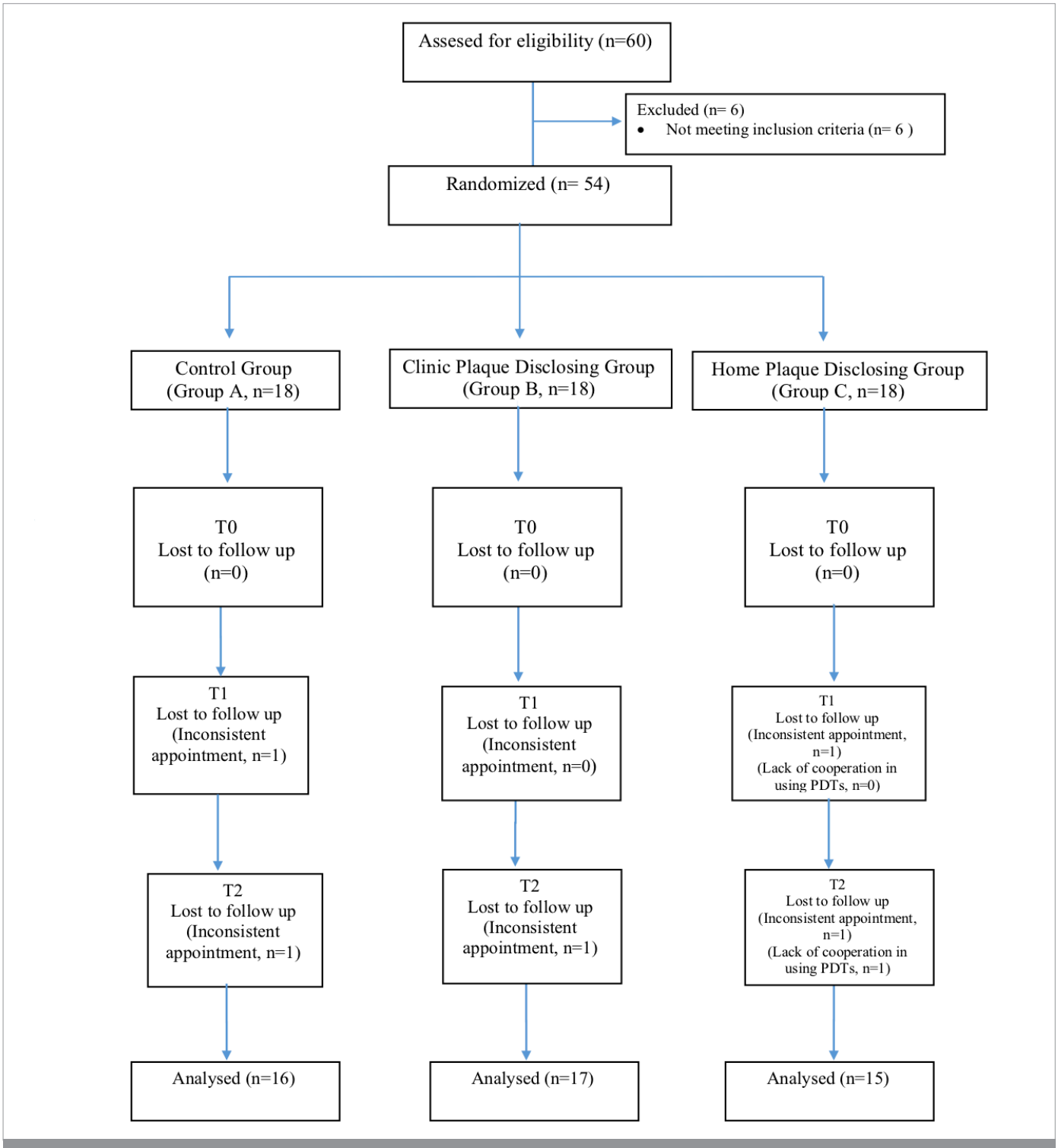

Figure 1. Study flow chart

PI and GI Scores Among the Groups

PI Scores

According to the PI scores, there were no significant differences between the time points (T0-T1, T0-T2, and T1-T2) in group A ($p>0.05$) and group B ($p>0.05$) (Table 3). However, the PI scores were significantly decreased in group C ($p<0.05$). The decreases were observed in the anterior maxillary teeth (T0-T2 and T1-T2), posterior maxillary teeth (T0-T1 and T0-T2), and mandibular teeth (T0-T1 and T0-T2).

GI Scores

The GI scores were statistically increased for the mandibular teeth between T0 and T2 in group A ($p<0.05$); however, the other groups did not show significant differences between the time points ($p>0.05$) (Table 3).

PI Scores Between Bonded and Non-Bonded Jaws and Between Anterior and Posterior Maxillary Teeth

No significant differences were found between the bonded and non-bonded jaws ($p>0.05$) in any of the groups (Table 4). In addition,

Table 3. Comparison of the plaque and gingival scores among the groups

		Group A	Group B	Group C
		p	p	p
Maxillary anterior PI	T0 vs T1	0.414	0.695	0.102
	T0 vs T2	0.065	0.311	0.001*
	T1 vs T2	0.293	0.334	0.003*
Maxillary posterior PI	T0 vs T1	0.826	0.776	0.008*
	T0 vs T2	0.182	0.345	0.004*
	T1 vs T2	0.201	0.798	0.099
Mandibular PI	T0 vs T1	0.691	0.256	0.048*
	T0 vs T2	0.532	0.615	0.006*
	T1 vs T2	0.730	0.394	0.061
Maxillary GI	T0 vs T1	0.173	0.394	0.916
	T0 vs T2	0.173	0.594	0.916
	T1 vs T2	0.173	0.594	0.916
Mandibular GI	T0 vs T1	0.136	0.900	0.969
	T0 vs T2	0.036*	0.345	0.969
	T1 vs T2	0.173	0.594	0.916

PI-Plaque Index, GI-Gingival Index, *p ≤ 0.05.
PI-Plaque Index, GI-Gingival Index.

Table 4. Comparison of the plaque and gingival scores between maxillary anterior and posterior and between maxillary and mandibular arches

	Group A (p)			Group B (p)			Group C (p)		
	T0	T1	T2	T0	T1	T2	T0	T1	T2
Maxillary anterior PI vs. posterior PI	0.213	0.074	0.395	0.381	0.723	0.361	0.074	0.493	0.061
Maxillary PI vs. mandibular PI	0.384	0.678	1.000	0.520	0.756	0.852	0.173	0.184	0.309
Maxillary GI vs. mandibular GI	0.074	0.254	0.756	0.785	0.395	0.818	0.528	0.587	1.000

there were no significant differences in the PI scores between the anterior and posterior maxillary teeth in any of the groups (p>0.05).

GI Scores Between Bonded and Non-Bonded Jaws and Between Anterior and Posterior Maxillary Teeth

There were no significant differences in the GI scores between the jaws in any of the groups (p>0.05) (Table 4). In addition, there were no significant differences in the GI scores between the anterior and posterior maxillary teeth (p>0.05).

DISCUSSION

The influences of the use of PDTs at the clinic and at home on the PI and GI scores were compared in this study. Patients aged 12–18 years old were included in this research because adolescents are commonly referred for orthodontic treatment, and studies have shown that their PI and GI scores are higher than in adults (12, 13). In addition, the continued maintenance of good oral hygiene during orthodontic treatment in adolescents is a very big problem in the field of orthodontics (14). Six patients were lost after the three-month follow-up. Patients were excluded because of inconsistency in keeping appointments, and one patient in group C was excluded because of a lack of cooperation in using PDTs. No significant differences were found among the groups in terms of drop-out rates (α>0.143).

The mandibular arches were not bonded in the present study to investigate the differences between bonded and non-bonded arches in the PI and GI scores. After three months, we applied braces to the mandibular arch to prevent prolonging the patient's total treatment period. Additionally, previous research has indicated that plaque retention shows peak values three months after applying fixed appliances (12). According to the social psychology literature, 66 days are required to turn a behavior into an automatic habit, which means that routine brushing for three months is adequate to gain good brushing habits (15). Therefore, the present study lasted for three months. The Silness and Loe PI scores show the quantity of the dental plaque on the gingival margin of the teeth (16).

In the literature, plaque indicator solutions, including erythrosine, have been used generally to show the quantity and location of the biofilm (6, 10, 11, 17, 18). However, PDTs were chosen for the present study because of their ease of application chairside and at home. Stainless steel ligature wires were used for the ligation because they create less plaque retention than elastic ligatures (19).

In this study, the PI scores of groups A and B did not change significantly during the observation period. The conventional oral hygiene instructions and chairside motivational techniques, including PDTs, did not make differences in the plaque accumulation. These findings are in accordance with those of Acharya et al. (10), who showed that the PI scores did not change significantly over three months

in orthodontic patients undergoing conventional plaque control techniques (i.e., the plaque was disclosed with 2% mercurochrome). Contrary to our results, Marini et al. (18) demonstrated that patients who received conventional repeated oral hygiene motivation and chairside motivational techniques, including a plaque indicator solution and manual toothbrush, showed significant decreases in their PI scores after three months. Peng et al. (12) reported that the PI scores of their control group (routine oral hygiene instructions only) and biofilm-disclosing group (biofilm-disclosing tablets) increased significantly after three months when compared with the baseline. These differences may have been related to the different demographic characteristics of patients, measuring methods, and motivational techniques. However, in the present study, the use of the PDTs at home in group C caused significant decreases in the PI scores over three months. Therefore, the use of PDTs at home may help reduce plaque accumulation.

The PDTs were used to show the localization of plaque and brushing quality at the clinic in group B. However, there were no significant differences in the PI scores between groups A and B. This could have been related to patient stress at the clinic, and providing education only once per month may have been inadequate. Previous studies using plaque-disclosing agents as chairside motivational techniques have reported different results. For example, Boyd (6) showed that using a disclosing solution for motivation was more effective than plaque control instructions only in the overall removal of plaque. However, Peng et al. (12) and Acharya et al. (10) indicated that the use of disclosing agents was not effective as a motivational technique in plaque control when compared with the control group.

In the present study, the self-application of PDTs at home in group C seemed to be more effective in decreasing the PI scores. This may have been related to the oral hygiene self-education at home, and the daily repetition of the procedure. Seeing the plaque-retentive areas regularly may have made the patients more aware of these areas and may have enhanced their visual memory and brushing ability. Research has indicated that the repetition of oral hygiene helps improve plaque elimination (18, 20).

The GI scores indicate the gingivitis status (16), and there were no significant differences between the time points in groups B and C. This may have been related to the PI scores, which did not change significantly in groups A and B or decrease significantly in group C. These findings are similar to those of Acharya et al. (10) but contrary to those of Peng et al. (12) who reported that the control group and plaque-disclosing group showed significant increases in their GI scores after three months. However, the mandibular teeth in group A showed significant increases after three months when compared to the baseline. These results may have been related to the focus on the bonded upper arch and extra due diligence when brushing, while neglecting the lower arch. Clinically, these results implied that PDTs could positively affect gingival health during the treatment period on the non-bonded arch in groups B and C by raising awareness of brushing activity.

Group C exhibited statistically lower scores than the other two groups at T1 and T2 in the GI scores of the maxillary and mandibular arches. This shows the efficiency of self-examination of the use of PDTs on the gingival health (15, 21, 22). In addition, group B showed lower GI scores than group A at T1 and T2 ($p<0.05$) in the maxillary and mandibular arches. These findings are contrary to those of previous studies (10, 12) showing no differences between the control group and chairside motivation group. The significantly lower GI scores in group B, when compared to group A, may have been related to the extra brushing activity of the study subjects in group B. The repeated PI and GI scoring may have been a motivational factor (23). In the literature, this is described as the Hawthorne effect, meaning that when the patients were awake they were being examined and evaluated, and this awareness could influence their behavior (24, 25). Feil et al. (25) investigated the influences of the Hawthorne effect on oral hygiene compliance in orthodontic patients. They indicated that there was significant improvement in the oral hygiene compliance of the experimental group, when compared to the control group, and significant quantitative differences between the two groups at the 3-month and 6-month evaluations.

No significant differences were found between the maxillary anterior and posterior areas in any of the groups or times. These unexpected results may relate to similar conditions in the anterior and posterior areas, such as the presence of fixed appliances and the same brushing activity in the same mouth. The mandibular arch was not separated into anterior and posterior sections because evaluation of fixed orthodontic appliances on periodontal health was the primary aim of this study. The mandibular arch was bonded after the study ended.

Previous studies have shown that fixed orthodontic appliances promote the accumulation and enlargement of microbial dental plaque (19, 22). However, there were no significant differences between the bonded maxillary and non-bonded mandibular arches in any of our groups. These results may have been related to the instructions insisting on careful brushing near the gingival third of the teeth. The Silness and Loe PI technique may also have led to this lack of difference because of the inclusion of only the gingival third and not the retentive areas of the brackets. These results imply that patients who are motivated regularly at the clinic may not demonstrate significant difference in the gingival status between bonded maxillary and non-bonded mandibular arches.

Orthodontists use PDTs to help educate their patients about plaque-retentive areas and to ease brushing after orthodontic bonding (26). However, one of the principal aims in orthodontics is the maintenance of continuous good oral hygiene to decrease undesirable treatment outcomes. Therefore, clinicians may advise patients undergoing fixed orthodontic treatment to use PDTs at home regularly during the first few months of treatment to determine the biofilm-retentive areas and increase the quality of brushing.

The Silness and Loe PI system (16) was used to measure the plaque quantity in this study. Similar to previous studies (10, 27-29) conducted on orthodontic patients, the bonded maxillary and non-bonded mandibular arches were compared using this system. Further investigations should be performed with specific systems for quantifying the plaque scores showing the retentive areas of orthodontic patients (27).

Individual handedness was not considered and evaluated, which is another limitation of the study. Tezel et al. (30) indicated that right-handed individuals cleaned their left jaws better than their right jaws, and left-handed people were more successful with the right jaw than the left jaw. In the present study, quadrants were not evaluated between times and groups, as they were included in the study by Tezel et al. (30). In the same study, they found that left-handed subjects were more successful in pro-

viding oral hygiene than right-handed subjects. Future studies should be performed considering subjects' handedness.

One of the biggest limitations of this study is its short, three-month observation period, which cannot suffice in undertaking a PDT efficiency assessment (on account of the Hawthorne effect). Abdulraheem and Bondemark (24) indicate that to minimize the risk inherent in the Hawthorne effect, studies should be designed with observation periods longer than six months. This study's relatively small sample size is another limitation; further studies should be designed so as to feature a larger sample size.

CONCLUSION

The self-application of disclosing tablets at home during treatment in addition to repeated oral hygiene motivation may be effective in improving oral hygiene and motivating the patient. However, the application of disclosing tablets at the clinic may not be as effective as a good oral hygiene aid.

Ethics Committee Approval: Ethics committee approval was received for this study from the Ethics Committee of Gaziantep University (No.: 44).

Informed Consent: Written informed consent was obtained from the patients and the parents' of patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - M.A.Y.; Design - M.A.Y.; Supervision - O.S.; Materials - M.A.Y.; Data Collection and/or Processing - S.Ö.; Analysis and/or Interpretation - O.S.; Literature Search - M.A.Y.; Writing Manuscript - M.A.Y.; Critical Review - S.K.

Conflict of Interest: The authors have no conflict of interest to declare.

Financial Disclosure: The authors declared that this study has received no financial support.

REFERENCES

1 Fejerskov O, Kidd E. Dental caries: the disease and its clinical management: John Wiley & Sons; 2009.
2. Shibly O, Rifai S, Zambon JJ. Supragingival dental plaque in the etiology of oral diseases. Periodontol 2000 1995; 8: 42-59. [CrossRef]
3. Alstad S, Zachrisson BU. Longitudinal study of periodontal condition associated with orthodontic treatment in adolescents. Am J Orthod 1979; 76: 277-86. [CrossRef]
4. Featherstone J. The continuum of dental caries-evidence for a dynamic disease process. J Dent Res 2004; 83: 39-42. [CrossRef]
5. Ogaard B, Rolla G, Arends J, ten Cate JM. Orthodontic appliances and enamel demineralization. Part 2. Prevention and treatment of lesions. Am J Orthod Dentofacial Orthop 1988; 94: 123-8. [CrossRef]
6. Boyd RL. Longitudinal evaluation of a system for self-monitoring plaque control effectiveness in orthodontic patients. J Clin Periodontol 1983; 10: 380-8. [CrossRef]
7. Yeung SC, Howell S, Fahey P. Oral hygiene program for orthodontic patients. Am J Orthod Dentofacial Orthop 1989; 96: 208-13. [CrossRef]
8. McGlynn FD, LeCompte EJ, Thomas RG, Courts FJ, Melamed BG. Effects of behavioral self-management on oral hygiene adherence among orthodontic patients. Am J Orthod Dentofacial Orthop 1987; 91: 15-21. [CrossRef]
9. Lees A, Rock W. A comparison between written, verbal, and videotape oral hygiene instruction for patients with fixed appliances. J Orthod 2000; 27: 323-8. [CrossRef]
10. Acharya S, Goyal A, Utreja AK, Mohanty U. Effect of three different motivational techniques on oral hygiene and gingival health of patients undergoing multibracketed orthodontics. Angle Orthod 2011; 81: 884-8. [CrossRef]
11. Mortensen MG, Kiyak HA, Omnell L. Patient and parent understanding of informed consent in orthodontics. Am J Orthod Dentofacial Orthop 2003; 124: 541-50. [CrossRef]
12. Peng Y, Wu R, Qu W, Wu W, Chen J, Fang J, et al. Effect of visual method vs plaque disclosure in enhancing oral hygiene in adolescents and young adults: a single-blind randomized controlled trial. Am J Orthod Dentofacial Orthop 2014; 145: 280-6. [CrossRef]
13. Boyd RL, Leggott PJ, Quinn RS, Eakle WS, Chambers D. Periodontal implications of orthodontic treatment in adults with reduced or normal periodontal tissues versus those of adolescents. Am J Orthod Dentofacial Orthop 1989; 96: 191-8. [CrossRef]
14. Anderson GB, Bowden J, Morrison EC, Caffesse RG. Clinical effects of chlorhexidine mouthwashes on patients undergoing orthodontic treatment. Am J Orthod Dentofacial Orthop 1997; 111: 606-12. [CrossRef]
15. Cohen DW, Stoller NH, Chace R Jr, Laster L. A comparison of bacterial plaque disclosants in periodontal disease. J Periodontol 1972; 43: 333-8. [CrossRef]
16. Loe H, Silness J. Periodontal Disease in Pregnancy. I. Prevalence and Severity. Acta Odontol Scand 1963; 21: 533-51. [CrossRef]
17. Arnim SS. The use of disclosing agents for measuring tooth cleanliness. J Periodontol 1963; 34: 227-45. [CrossRef]
18. Marini I, Bortolotti F, Parenti SI, Gatto MR, Bonetti GA. Combined effects of repeated oral hygiene motivation and type of toothbrush on orthodontic patients: a blind randomized clinical trial. Angle Orthod 2014; 84: 896-901. [CrossRef]
19. Garcez AS, Suzuki SS, Ribeiro MS, Mada EY, Freitas AZ, Suzuki H. Biofilm retention by 3 methods of ligation on orthodontic brackets: a microbiologic and optical coherence tomography analysis. Am J Orthod Dentofacial Orthop 2011; 140: 193-8. [CrossRef]
20. Emler BF, Windchy AM, Zaino SW, Feldman SM, Scheetz JP. The value of repetition and reinforcement in improving oral hygiene performance. J Periodontol 1980; 51: 228-34. [CrossRef]
21. Chounchaisithi N, Santiwong B, Sutthavong S, Asvanit P. Use of a disclosed plaque visualization technique improved the self-performed, tooth brushing ability of primary schoolchildren. J Med Assoc Thai 2014; 87: 88-95.
22. Ristic M, Vlahovic Svabic M, Sasic M, Zelic O. Effects of fixed orthodontic appliances on subgingival microflora. Int J Dent Hyg 2008; 6: 129-36. [CrossRef]
23. Al-Jewair TS, Suri S, Tompson BD. Predictors of adolescent compliance with oral hygiene instructions during two-arch multibracket fixed orthodontic treatment. Angle Orthod 2011; 81: 525-31. [CrossRef]
24. Abdulraheem S, Bondemark L. Hawthorne effect reporting in orthodontic randomized controlled trials: truth or myth? Blessing or curse? Eur J Orthod 2017; 40: 475-9. [CrossRef]
25. Feil PH, Grauer JS, Gadbury-Amyot CC, Kula K, McCunniff MD. Intentional use of the Hawthorne effect to improve oral hygiene compliance in orthodontic patients. J Dent Educ 2002; 66: 1129-35.
26. Hobson R, Clark J. How UK orthodontists advise patients on oral hygiene. Br J Orthod 1998; 25: 64-6. [CrossRef]
27. Al-Anezi SA, Harradine NW. Quantifying plaque during orthodontic treatment: a systematic review. Angle Orthod 2011; 82: 748-53. [CrossRef]
28. Rafe Z, Vardimon A, Ashkenazi M. Comparative study of 3 types of toothbrushes in patients with fixed orthodontic appliances. Am J Orthod Dentofacial Orthop 2006; 130: 92-5. [CrossRef]
29. Wenderoth CJ, Weinstein M, Borislow AJ. Effectiveness of a fluoride-releasing sealant in reducing decalcification during orthodontic treatment. Am J Orthod Dentofacial Orthop 1999; 116: 629-34. [CrossRef]
30. Tezel A, Orbak R, Çanakçi V. The effect of right or left-handedness on oral hygiene. Int J Neurosci 2001; 109: 1-9. [CrossRef]