

# Are Plaque Disclosing Agents Effective for Improving Self-Performed Dental Hygiene in Patients with Space Maintainers? A Randomized Controlled Clinical Trial

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International License.**ABSTRACT**

**Objective:** In the event of premature loss of primary teeth, the placement of a space maintainer is the safest option for preserving dental arch length; however, the appliances and bands of space maintainers can change the contours of the teeth, causing plaque accumulation and making it difficult to maintain oral hygiene. The aim of this study was to evaluate changes in dental plaque accumulation and the effectiveness of a plaque disclosing agent (PDA) in providing oral hygiene with the use of space maintainers.

**Methods:** Patients were divided into two groups (Group A: intervention; Group B: control) and the study was carried out in four stages. At each stage, pocket depth (PD), gingival index (GI), and plaque index (PI) were measured.

**Results:** There was an increase in PD, GI, and PI after space maintainers were placed. Following oral hygiene education (with and without the use of a PDA), PD, GI, and PI significantly decreased in both groups.

**Conclusion:** PDAs are effective for improving oral hygiene, especially in young children; however, training should be repeated at frequent intervals to maintain good, continuous oral hygiene.

**Keywords:** dental plaque, gingival index, oral hygiene, plaque index, space maintainer

**INTRODUCTION**

Although preventive dental procedures are now widespread, epidemiological studies have shown that early childhood caries still occur frequently and lead to early tooth loss [1]. Decay or premature loss of primary teeth leads to the mesialization of adjacent teeth, resulting in a decrease in arch length, which can lead to malocclusions in permanent teeth. In the case of premature loss of primary teeth, placing a space maintainer is the safest option for preserving dental arch length [2].

Removable and fixed space maintainers are routinely used in children. The bands of fixed space maintainers, placed on the crowns of the teeth, or the clasps of removable space maintainers that are used for retention can sometimes extend slightly to the gingival sulcus and adversely affect gingival health. The appliances and bands of space maintainers can change the contours of the teeth, causing plaque accumulation and making it difficult to maintain oral hygiene, which can result in gingivitis and dental caries [3].

Space maintainers are in direct contact with oral microflora; thus, microbial biofilms can easily develop [4]. For this reason, patients with space maintainers may require more careful maintenance of oral hygiene. In particular, patients in younger age groups may need extra motivation to acquire and maintain good oral hygiene habits. Plaque disclosing agents (PDAs) can have a highly motivating effect as they can enable patients to better visually identify dental plaque [5]. Various studies have shown the effectiveness of PDAs in oral hygiene education programs [6] and professional dental prophylaxis practices [7]. However, there are no studies evaluating the effectiveness of PDAs in providing oral hygiene in areas of the mouth that may increase plaque accumulation, such as space maintainers. It is thought that visualizing the plaque accumulated around the space maintainers with PDA and showing to patients and their parents will increase oral hygiene motivation, by the way reduce plaque accumulation. Considering the motivational effect of PDAs on children's oral hygiene education, the aim of this study was to evaluate the effectiveness of PDA in improving oral hygiene in young children with space maintainers at different time intervals.

## MATERIALS AND METHODS

This study was conducted in the Department of Pediatrics, Karabük University Oral and Dental Health Training and

Research Hospital. The study was approved by the ethics committee of the Karabük University (approval no 2023/1519) and was conducted in full accordance with the World Medical Association Declaration of Helsinki. Written consent was obtained from participants' legal guardians.

### Study Design

This interventional prospective study was conducted with 74 patients aged 4–9 years. The participants were selected by simple random drawing method from a group of patients who were recruited from the pedodontics clinic and needed space maintainers due to early tooth extraction.

### Sample Size

According to the G Power analysis, the power of the study was found to be 90% when there were 34 people in each group. Due to possible issues, 80 pediatric patients were included in our study if the sample size decreased. As 6 patients could not continue the study, 74 participants were included in the study, of which 34 were girls and 40 were boys. A total of 40 participants were selected for the intervention group and received oral hygiene training using a PDA. The remaining 34 participants were included in the control group and received oral hygiene training without a PDA.

The sample size of the study was determined as a result of the power analysis performed in the G-power program. As there are no previous studies evaluating the effectiveness of PDAs in removing plaque accumulated around space maintainers, the sample size was calculated based on a study evaluating the role of PDAs in professional biofilm removal [8]. With an effect size of 1.2 and a standard deviation of 0.05 for pocket depth (PD), gingival index (GI), and plaque index (PI), 68 participants were required to provide 90% power. The required sample size was 80 to account for participants who did not attend their appointments. Six children were excluded from the study because they missed their follow-up appointments, reducing the sample size to 74.

### Inclusion and Exclusion Criteria

Patients were included in the study if they were aged 4–9 years, if their families agreed to their participation, if they were cooperative in clinical examination, if they didn't have systemic disorders or disabilities and periodontal disease or gingival hyperplasia. Patients were excluded from the study if their families did not consent to their participation, if they were not cooperative in clinical examination, or if they had mental or

#### Main Points;

- Because of the colour similarity of the tooth surface and dental plaque, it may be challenging to distinguish dental plaque, even on smooth surfaces. For this reason, making plaque visible, by using plaque-disclosing tablets or liquids, may be effective to ensure oral hygiene.
- In the case of premature loss of primary teeth, placing a space maintainer is the safest option for preserving dental arch length.
- Space maintainers are in direct contact with oral microflora, so they are ideal places for biofilm formation. For this reason, patients with space maintainers may require more careful maintenance of oral hygiene.
- It is thought that visualizing the plaque accumulated around the space maintainers with PDA and showing to patients and their parents will increase oral hygiene motivation, by the way reduce plaque accumulation.

physical disabilities that may complicate their adaptation to the space maintainer and oral care.

### Measurement Methods

Dental examination was performed using sterile examination kits containing a mirror (LS456 480/5, Carl Martin GmbH, Solingen, Germany), dental explorer (LS1091/33, Carl Martin GmbH, Solingen, Germany), and perio-probe (LS973/80 WHO, Carl Martin GmbH, Solingen,

Germany). PD, GI, and PI were measured from mesial, distal, buccal and lingual/palatal for each tooth. Pocket depth was measured in millimeters. The mean value for a tooth is the average of the values on the four surfaces. The mean index value for a patient was obtained by dividing the total value by the number of teeth.

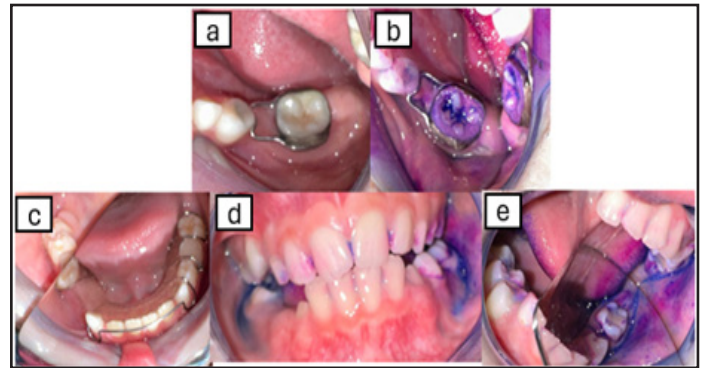
According to Silness and Løe's plaque index [9]; 0 indicates no plaque; 1 indicates a thin layer of plaque present along the gingival margin that can be detected with an examination probe; 2 indicates a moderate layer of plaque along the gingival margin that can be detected visually; and 3 indicates an excessive layer of plaque along the gingival margin, and a layer of plaque can be observed in the interdental areas.

According to Løe and Silness's gingival index [10]; 0 indicates no visible signs of inflammation; 1 indicates a change in the colour and consistency of the gingiva, with no bleeding upon probing (by perio-probe / LS973/80 WHO, Carl Martin GmbH, Solingen, Germany); 2 indicates visible inflammation and bleeding upon probing; and 3 indicates pronounced redness, edema, and a tendency for spontaneous bleeding.

### Data Collection

The included patients were randomly divided into two separate groups. For randomization, an opaque envelope included cards with text, control group or PDA group was used to determine which group the child would be allocated at the beginning of the study. For Group A (N 40 / intervention group), a PDA (TePe Plaq-Search™ Tablets -TePe Oral Hygiene Products AB, Malmö, Sweden) was used as a guide for patients and families to show dental plaque (Figure 1). The PDA was placed in the patient's mouth and the patient is asked to rub it against the teeth with the tongue until the tablet dissolves. All stained areas were shown to the patient and his/her parents. After the procedure, the areas stained with PDA were cleaned with water and a brush. For

Group B (N=34 / control group), patients and their parents were shown the plaque accumulated around the space maintainers in front of the mirror (Figure 2). Then for both groups, they informed how to clean dental plaque. The study was carried out in four stages. Patients had a total of four appointments: the first for the installation of the space maintainer and the remaining three follow-up appointments for PDA application and other measurements.



**Figure 1.** Intraoral images of Group A, **a.** Space maintainer was fixed, **b.** using PDA, **c.** removable space maintainer was placed, **d** and **e)** using PDA



**Figure 2.** Intraoral images of Group B **a.** Space maintainer was fixed, **b** and **c.** control session, **d.** removable space maintainer was placed, **e.** control session

The entire study was performed by a single pedodontics (the pedodontics installed all the space maintainers and was present at all the appointments for PDA application and other measurements). To ensure investigator standardization; PD, GI, and PI were assessed twice, 30 minutes apart, in 15 pediatric patients who were not part of the investigated sample. PD, GI, and PI measurements were repeated one week later at 30-minute

intervals in the same way. The kappa values for PD, GI, and PI were 0.87, 0.92, and 0.89, respectively.

**Stage 1 (appointment for space maintainer installation and first index measurements)**

The space maintainers of the patients were fixed, and in the same session, the PD, GI, and PI of the supporting teeth (in which the bands or clasps of the space maintainers were placed) were noted.

**Stage 2 (1 month after first index measurements)**

The patients were called upon for a follow-up appointment one month after the placement of their space maintainers. In this appointment, the PD, GI, and PI of the supporting teeth were measured. Then, a PDA was applied to the patients in Group A so that they could observe the dental plaque accumulated around their space maintainers and supporting teeth. In Group B, without the use of a PDA, dental plaque accumulated around the space maintainers and supporting teeth was shown to patients and their

parents/caregivers with a mirror. In both groups, the patients and their parents/caregivers were informed about how to clean these dental areas with a visual demonstration.

**Stage 3 (1 month after second index measurements)**

The patients were called one month after their second index measurements. In this appointment, the PD, GI, and PI of the supporting teeth were measured. At this stage, any short-term differences in plaque accumulation between the groups were measured and recorded.

**Stage 4 (3 months after third index measurements)**

Patients were called three months after their third index measurement (five months after the placement of space maintainers). The PD, GI, and PI of the supporting teeth were measured. At this stage, any long-term differences in plaque accumulation between the groups were examined. The flow chart of the study is given in Figure 3.



Figure 3. Flow chart of the study

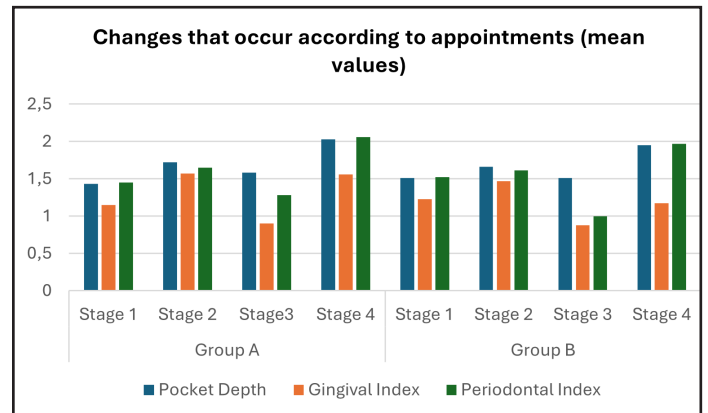
**Statistical Analysis**

The data were analysed using the SPSS (SPSS Inc., Chicago, Version 20) program. Comparisons of PD, GI, and PI between groups were made using dependent t-tests and the McNemar test. The statistical significance level was taken as  $p < 0.05$ .

**RESULTS**

The mean age was  $6.8 \pm 3.4$  years. Demographic information about the patients and their space maintainers is given in Table 1.

Increases in PD, GI, and PI were observed in Stage 2 after the space maintainers were installed in the patients. These increases were greater in the mandible than in the maxilla, in boys than in girls, in the 7–9 age group than in the 4–6 age group, and for fixed space maintainers than for removable space maintainers. The mean PD, GI, and PI values of the patients are given in Figure 4, and their statistical evaluations are given in Table 2. In Stage 2, PD, GI, and PI increased in both groups. While PD and GI increased significantly ( $p=0.01$  both PD and GI) in Group A, the increase in Group B was not significant (p values for PD, GI and PI were 0.14, 0.12, 0.06 respectively) In Stage 3, it was observed that PD, GI, and PI decreased in both groups. While this decrease was not significant in Group A (p values for PD, GI and PI were 0.11, 0.09, 0.2 respectively), there was a significant decrease in GI and PI in Group B (p values for GI and PI were 0.03 and, 0.01 respectively). In Stage 4, it was observed that all values increased significantly for both groups (p values for PD, GI and PI were 0.0001, 0.01, 0.01 respectively for Group A and 0.008, 0.03 and, 0.03 respectively for Group B).



**Figure 4.** Changes that occur according to appointments (mean values)

The changes seen in Stage 2 according to the type of space maintainer used are given in Table 3. Fixed space maintainers caused a significant increase in PD, GI, and PI (p values for PD, GI and PI were 0.04, 0.005, 0.01 respectively).

After oral hygiene training was delivered to Groups A and B, decreases in PD, GI, and PI were observed. There was a significant decrease in GI and PI in patients with fixed space maintainers (p values for GI and PI were 0.001 and, 0.04 respectively) (Table 4).

At the last follow-up, it was observed that PD, GI, and PI increased significantly for those who used space maintainers in Group B (p values for PD, GI and PI were 0.03, 0.04, 0.000 respectively for fixed space maintainers and 0.01, 0.04, 0.02 respectively for removable space maintainers) (Table 5).

**Table 1.** Study Groups

		Group A (N)	Group B (N)
Gender	Girl	19	15
	Boy	21	19
Age group	4-6	17	17
	7-9	23	17
Type of space maintainers	Fixed space maintainers	25	25
	Removable space maintainers	9	6
	Fixed and removable space maintainers	6	3
Jaws	Mandibula	23	20
	Maxilla	10	9
	Both of the jaws	7	5

**Table 2.** Changes that occur according to appointments (p values)

	Group A			Group B		
	1-2. Stage	1-3. Stage	1-4. Stage	1-2. Stage	1-3. Stage	1-4. Stage
Pocket Depth	<b>0.01</b>	0.11	<b>0.0001</b>	0.14	0.5	<b>0.008</b>
Gingival Index	<b>0.01</b>	0.09	<b>0.01</b>	0.12	<b>0.03</b>	<b>0.03</b>
Plaque Index	0.18	0.2	<b>0.001</b>	0.06	<b>0.01</b>	<b>0.03</b>

Statistical significance level was accepted as  $p < 0.05$

Bold numbers indicate statistically significant values

**Table 3.** Changes in the 2nd session according to the type of space maintainers (mean values)

	Type of spacemaintainers	Stage 1	Stage 2	p value
Pocket Depth	Fixed	<b>1.46</b>	<b>1.78</b>	<b>0.04</b>
	Removale	1.39	1.47	0.07
	Both	1.61	1.86	0.22
Gingival Index	Fixed	<b>1.16</b>	<b>1.58</b>	<b>0.005</b>
	Removale	1.13	1.4	0.21
	Both	1.44	1.44	0.5
Plaque Index	Fixed	<b>1.4</b>	<b>1.96</b>	<b>0.01</b>
	Removale	1.73	1.66	0.43
	Both	1.55	1.44	0.40

Statistical significance level was accepted as  $p < 0.05$

Bold numbers indicate statistically significant values

**Table 4.** Changes in the 3rd session according to the type of space maintainers (mean values)

	Type of spacemaintainers	Grup A			Grup B		
		Stage 2	Stage 3	p value	Stagee 2	Stage 3	p value
Pocket Depth	Fixed	1.79	1.62	0.19	1.57	1.48	0.30
	Removale	1.71	1.58	0.26	1.62	1.33	0.22
	Both	1.5	1.41	0.40	2.58	2.16	0.32
Gingival Index	Fixed	1.68	0.88	<b>0.001</b>	1.48	0.84	<b>0.001</b>
	Removale	1.44	1.22	0.25	1.33	1	0.29
	Both	1.33	0.66	<b>0.02</b>	1.66	1	0.18
Plaque Index	Fixed	1.76	1.22	<b>0.05</b>	1.56	1	<b>0.04</b>
	Removale	1.66	1.44	0.34	1.66	1	0.21
	Both	1.16	1.33	0.39	2	1	0.14

Statistical significance level was accepted as  $p < 0.05$

Bold numbers indicate statistically significant values

**Table 5.** Changes in the 4th session according to the type of space maintainers

	Type of spacemaintainers	Grup A			Grup B		
		Stage 3	Stage 4	p value	Stage 3	Stage 4	p value
Pocket Depth	Fixed	1.62	1.92	0.05	1.48	1.86	<b>0.03</b>
	Removale	1.58	1.71	0.4	1.33	2	<b>0.01</b>
	Both	1.41	2	0.10	2.16	2.66	0.33
Gingival Index	Fixed	0.88	1.02	0.07	0.84	1.58	<b>0.04</b>
	Removale	1.22	1.55	0.3	1	1.56	<b>0.04</b>
	Both	0.66	1.33	0.09	1	2	0.14
Plaque Index	Fixed	1.22	2.22	<b>0.002</b>	1	2	<b>0.000</b>
	Removale	1.44	2.07	0.09	1	2.1	<b>0.02</b>
	Both	1.33	2.1	0.18	1	2.66	<b>0.03</b>

Statistical significance level was accepted as  $p < 0.05$

Bold numbers indicate statistically significant values

## DISCUSSION

Plaque accumulation is frequently observed and difficult to clean in areas where space maintainers are installed. Since space maintainers are in direct contact with oral microflora, they are ideal places for biofilm formation. The material from which space maintainers are made is also suitable for microorganism adhesion and biofilm formation [11]. In addition, the bands placed on the supporting teeth of fixed space maintainers and the retention clasps of removable space maintainers can promote plaque accumulation and gingival disease [12]. However, due to the colour similarity of the tooth surface and dental plaque, it may be challenging to distinguish dental plaque, even on smooth surfaces [13]. For this reason, making plaque visible, by using plaque-disclosing tablets or liquids, is considered the most effective way to ensure oral hygiene [14].

In this study, the effectiveness of plaque-disclosing tablets in preventing increased plaque accumulation and ensuring oral hygiene in patients aged 4-9, using space maintainers was evaluated.

The bands placed on supporting teeth for fixed space maintainers have sharp edges and penetrate deeper in the gingival sulcus than the Adams clasps of removable space maintainers. Additionally, food that becomes stuck under the loops can cause periodontal problems. It is known that the Adams clasps of removable space maintainers are positioned higher than the bands of fixed space maintainers and are placed in the free gum, which does not lead to

an increase in PD [12]. In this study, a significant increase in PD was observed in patients with fixed space maintainers. Similar to this study, Arıkan et al. [15] reported a significant increase in PD after the placement of a fixed space maintainer. Similarly, in this study, a significant increase in GI was observed in patients using fixed space maintainers. In a study by Hosseini-pour et al. [12], a significant increase in the GI of the support teeth of both removable and fixed space maintainers at the end of the sixth month was observed. Fixed space maintainers change the contours of the teeth on which they are placed, which can promote food retention and make oral hygiene practice difficult. In this study, plaque accumulation increased in patients with fixed space maintainers while it decreased in those with removable space maintainers. This might be because removable space maintainers were not in the mouth when the user is eating or brushing their teeth.

In the literature, there are some limitations in eliminating dental plaque via routine tooth brushing [16-18]. A study involving 127 participants, including dentists, dental assistants, and dental students, reported that dental plaque remained on at least 10% of the tooth surfaces in all groups [19]. This shows that despite having high amounts of knowledge about dental and oral hygiene, it is still difficult to ensure that plaque is sufficient. In a study conducted by Van der Weijden and Hioe [18], mechanical plaque removal was more effective in individuals who were given oral hygiene training than in those who were not. Oral hygiene education is particularly important in controlling plaque

accumulation and oral hygiene, especially in patients using space maintainers or orthodontic appliances. In the present study, the effect of oral hygiene training on plaque accumulation around space maintainers was evaluated. Consistent with other studies, a decrease in PD, GI, and PI was detected in both the intervention and control groups in the present study. Soder et al. [20] stated that maxillary teeth were better cleaned than mandibular teeth in terms of the removal of dental plaque. Similarly, in our study, it was observed that the increase in plaque accumulation was greater after a space maintainer was placed in the mandible.

The studies report that PDAs increase children's oral hygiene motivation to maintain their oral hygiene [14,21]. In this study, significant decreases in GI and PI were observed in both groups one month after the patients were given oral hygiene education. The decrease in both groups showed that oral hygiene training without the use of PDA produces successful results. In the fourth session, in which the long-term effects of oral hygiene training were evaluated, a significant increase was observed only in PI for Group A, while a significant increase was observed in PD, GI, and PI for Group B. Although not all of the results were significant, the increase in PD, GI, and PI in both groups revealed the need to repeat oral hygiene training frequently. The fact that the increase in PD, GI, and PI in Group A was not significant shows that the use of the PDA produces effective results in oral hygiene maintenance. Similar to this study, Alencar et al. [7] reported that using a PDA effectively shows the accumulation areas of dental plaque; therefore, it ensures effective oral hygiene. The difficulty of reaching the palatal/lingual surfaces of the teeth while brushing and the developmental grooves on the occlusal surfaces can make cleaning plaque challenging [22]. Alencar et al. [7] reported that the use of a PDA was not very effective in cleaning the plaque on the palatal/lingual surfaces. In this study, fixed space maintainers increased the contours of the teeth and created recessed areas, making plaque accumulation difficult. This explains the increase in PD, GI, and PI in the second session.

### Limitations

The major limitation of this study was that the study sample was selected from patients in a young age group. In young children, effective tooth brushing is more difficult due to poor mind-muscle coordination, and plaque accumulation may be higher in these patients. Thus, parental support is needed to ensure oral hygiene. Therefore, the cooperation of the parents was effective in the results of the study. It was also observed that the effectiveness of oral hygiene education decreased as time

passed, resulting in increases in PD, GI, and PI. Thus, studies evaluating the effectiveness of oral hygiene training repeated at regular intervals are warranted.

### Recommendations

It was observed that oral hygiene education with the help of a PDA increased the patient's ability to effectively control plaque accumulation. The use of PDAs may provide useful results in ensuring oral hygiene in patients who do not use any appliances.

### CONCLUSION

The application of a PDA improves patients' ability to see the plaque and subsequently remove it, especially in areas that are difficult to access, such as areas around space maintainers. Oral hygiene education repeated at frequent intervals will be more effective for controlling dental plaque.

**Conflict of interest:** None

**Funding:** None

**Ethical Approval:** Karabuk University Non Invasive Ethical Committee / Protocol No: 2023/1519 Informed Consent: Verbal consent for intraoral examination was obtained from the children participating in the study, and written consent was obtained from their legal guardians on behalf of both themselves and their children.

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