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Effects of Fixed and Removable Space Maintainers on Dental Plaque and DMFT/dft Values

Efecto de los mantenedores de espacio fijos y removibles en la placa dental y en los valores de los índices DMFT/dft

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ABSTRACT: Purpose: Space maintainers are important for the health and placement of children's primary and permanent teeth. However, plaque and caries levels can be negatively affected when a dental appliance is in the mouth. This study aims to evaluate the oral health of pediatric patients that have space maintainers applied as a result of early tooth loss. Methods: This study included 100 systemically healthy patients between the ages of 4-15 years that were treated with space maintainers due to early loss of teeth. Decayed, missing, filled tooth index values and dental plaque status of the participants were recorded. Controls were performed in the 6th and 12th month. The index results were compared and evaluated statistically using ANOVA and paired-t-tests. Results: A total of 116 space maintainers, including 36 band and loops, 16 lingual arches, 21 palatal arches, 43 removable appliances, were evaluated in the study. Statistically significant differences were found between the pre-treatment and post-treatment index values ($p<0.001$). In the group of band and loops and removable space maintainers; the increases in DMFT/dft values of 6th month and 12th month according to initial DMFT/dft values were statistically significant ($p<0.05$). For plaque index, the increase in 12th month of all types of appliances were found statistically significant ($p<0.001$). The greatest increase in plaque index level was seen in the teeth of patients that had been treated with a lingual arch. Conclusions: Incompatible space maintainers can lead to caries, increased plaque accumulation, demineralized areas, and periodontal problems. The accumulation of plaque and difficulty of cleaning the teeth, especially in the fixed space maintainers, negatively affects the health of teeth. For this reason, good oral hygiene should be provided to patients and controls should be regularly performed.

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KEYWORDS: Dental plaque; Dental caries; Dentition; Dental arch; Pediatric dentistry; Gingiva; Oral health.

RESUMEN: Los mantenedores de espacio son importantes para la salud y la colocación de la dentición primaria y permanente de los niños. Sin embargo, los niveles de placa y caries pueden verse afectados negativamente cuando se coloca un aparato dental en la boca. Este estudio tiene como objetivo evaluar la salud bucal de pacientes pediátricos a los que se les aplicó mantenedores de espacio como resultado de la pérdida temprana de los dientes. Métodos: Este estudio incluyó a 100 pacientes sistémicamente sanos entre las edades de 4 a 15 años que fueron tratados con mantenedores de espacio debido a la pérdida temprana de dientes. Se anotaron los valores del índice de dientes cariados, faltantes y el estado de la placa dental. Los controles se realizaron en el 6 ° y 12 ° mes. Los resultados del índice se compararon y evaluaron estadísticamente mediante ANOVA y pruebas t pareadas. Resultados: Un total de 116 mantenedores de espacio, incluyendo 36 bandas y bucles, 16 arcos linguales, 21 arcos palatinos, 43 dispositivos removibles, fueron evaluados en el estudio. Se encontraron diferencias estadísticamente significativas entre los valores de los índices en el pretratamiento y postratamiento ($p<0.001$). En el grupo de bandas, bucles y mantenedores de espacio removibles los aumentos en los valores de DMFT/dft en el sexto mes y el 12º mes fueron estadísticamente significativos ($p<0.05$). Para el índice de placa, el aumento en el 12º mes de todos los tipos de aparatos se encontró estadísticamente significativo ($p<0,001$). El mayor aumento en el nivel del índice de placa se observó en los pacientes que habían sido tratados con un arco lingual. Conclusiones: los mantenedores de espacio pueden provocar caries, aumento de la acumulación de placa, áreas desmineralizadas y problemas periodontales. La acumulación de placa y la dificultad de limpiar los dientes, especialmente en los mantenedores de espacio fijos, afecta negativamente la salud dental. Por esta razón, se debe proporcionar una buena higiene bucal a los pacientes y se deben realizar controles regularmente.

PALABRAS CLAVE: Placa dental; Caries dental; Dentición; Arco dental; Odontología Pediátrica; Salud bucal.

INTRODUCTION

Crowding and disarrays are the most common kinds of malocclusion in dental patients, and early loss of primary molars can cause drifting and a loss of space (1, 2). In these patients, space maintainers are used to preserve length of arch and prevent malocclusion (3).

Space maintainers are applied when primary teeth are lost prematurely for a variety of reasons, such as tooth decay, trauma, or lack of a germ of a permanent tooth (4). Space problems play an important role in the practice of dentistry, and understanding dental development in primary and mixed dentitions could help to intercept or prevent malocclusion (1).

Space maintainers are applied based on the size and location of the extraction space. They are divided into two types: fixed (band and loop, palatal arch, lingual arch) and removable (with or

without teeth) and each have their advantages and drawbacks. It has been reported that a high level of patient compliance is an advantage for band and loops, but the disintegration of cement, solder failure, caries formation and long construction time are disadvantages (5,6,7). It has also been reported that properly designed fixed space maintainers inflict less damage on the oral tissues, and the requirement of patient compliance and convenience and the risk of breakage or missing are disadvantages of removable space maintainers (5).

All space maintainers have the potential to cause periodontal, dental, and gingival problems. Periodontal problems include periodontal pockets, infection, and abnormal mobility. Gingival problems are gingival bleeding, erythema, ulcerations, and soft tissue damage resulting from the comppression of the space maintainer. Dental problems are tooth decay, plaque accumulation, pain, or the inhibition of alveolar growth (4,8).

Multifactorial causes affect the durability of a space maintainer. The patient's systemic health, nutrition, mealtimes, and brushing habits and the space maintainer's type and duration of use are some of these factors.

The aim of this study was to evaluate the effects of space maintainers on dental health.

MATERIALS AND METHODS

INCLUSION CRITERIA

Only systemically, mentally, physically, and periodontally healthy patients were included in this study. Participants were selected from patients who had been applied fixed or removable space maintainers in the pediatric dentistry clinic.

EXCLUSION CRITERIA

Systemically, mentally, physically and periodontally unhealthy patients excluded from the study.

At the beginning of the study, 104 patients were included, but four patients were excluded due to systemic or genetic disorders: two were excluded due to heart disease, one patient was excluded due to an immune disease, and one was excluded due to ectodermal dysplasia. Ultimately, the study continued with 100 patients.

STUDY DESIGN

Ethical approval was taken from the Ethics Committee of the Istanbul University Faculty of Dentistry, and the study was carried out in agreement with the Declaration of Helsinki principles. All patients included in the study were under the age of 18, so written consent was obtained from their parents as required by the Ethics Committee.

A total of 100 patients (55 girls and 45 boys) were included in this study. The age of the patients was between 5 and 14 and their mean age was 7.98±1.82. A total of 125 space maintainers were applied.

Patients were given instructions on maintaining oral health and dental hygiene after the application of the space maintainers, as it is routine in the treatment of patients receiving space maintainers.

A file on each patient was created containing the following information:

- Personal information (first name and surname, age, health status);

- Cause of tooth loss
- Type of applied space maintainer;
- Number of space maintainers and information about applied jaw.

When evaluating the space maintainers:

For analysis, patients were divided into three groups according to the type of space maintainer: fixed, removable, or fixed+removable. The fixed space maintainers group included patients with band and loops, lingual arch, or palatal arches. The removable group included patients with removable space maintainers with or without tooth, and in the fixed+removable space maintainer group, patients had both fixed and removable space maintainers.

Patients were also divided into four groups according to the appliance: band and loop, lingual arch, palatal arch, or removable space maintainer.

The sample size achieved a level of confidence of 95% and a power of 80% for statistical significance.

In this study, the Silness-Loe plaque index (9), the decayed, missing and filled teeth (DMFT) index and the decayed and filled teeth (dft) index were used in accordance with the World Health Organization (WHO) (10).

In the Silness-Loe plaque index, degree '0' means 'no plaque on the tooth'; degree '1' means 'plaque covering up to one third of the surface'; degree '2' means 'plaque covering more than one third but less than two thirds of the tooth surface' and degree '3' means 'plaque covering more than two thirds of the tooth' (9).

Patients were controlled at the first appointment, at 6th month and 12th month intraorally and index values were saved. An evaluation form was created for the space maintainers. Two researchers examined the dental plaque, DMFT and dft indexes. Intra-examiner calibration was provided before the study by the researchers and the values were found the same.

The dft index was used in primary and mixed dentition, whereas the DMFT index was used in permanent dentition. The duration of use in the mouth, and the number of new developing caries were evaluated, and the DMFT/dft and plaque indexes were compared.

STATISTICAL METHOD

When evaluating the findings obtained in this study, IBM SPSS Statistics 22 for statistical analysis (SPSS, IBM, Turkey) program was used. The normal distribution of parameters was evaluated by the Shapiro Wilks test. The Kruskal Wallis test was used for comparison of non-normative parameters in comparison of descriptive statistical methods (mean, standard deviation, frequency). The Mann Whitney U test was used to determine the group that caused the difference. The Student t-test was used for comparison of a normal distribution of the two groups, the Mann Whitney U test was used for comparison of two groups of non-normal distribution parameters. The Paired Sample t-test was used for intragroup comparison of quantitative data showing normal distribution and the Wilcoxon Signed Ranks Test was used for intragroup comparison of parameters without normal distribution. The Pearson's correlation analysis was used when the relations between the parameters with normal distribution suitability were examined. Significance was assessed at $p < 0.05$ level. The total number of samples detected was n: 60 according to power analysis to determine the success rate.

RESULTS

A total of 76 patients had 1 space maintainer, 23 patients had 2 space maintainers and 1 patient had 3 space maintainers in their mouth. In patients, 53 teeth were lost due to abscess, 38 teeth were lost due to damage of tooth crown, 7 teeth were lost due to avulsion. A total of 125 space maintainers, including 40 band and loops, 16 lingual arches, 23 palatal arches, 46 removable appliances was evaluated in the study. In 43% of the children, the space maintainers performed in mandible, while 33% of them were in the maxilla and 24% of them were in both maxilla and mandible.

In the group of band and loops, the increases in DMFT/dft values of the 6th month (p:0.014) and 12th month (p:0.003), according to initial DMFT/dft values were statistically significant ($p<0.05$) (Table 1). In the group of lingual arches and palatal arches, the increases in DMFT/dft values of the 6th month and 12th month, according to initial DMFT/dft values weren't statistically significant ($p>0.05$) (Table 2 and Table 3). In the group of removable space maintainers; the increases in DMFT/dft values of the 6th month (p:0.017) and 12th month (p:0.007), according to initial DMFT/dft values were statistically significant ($p<0.05$) (Table 4). In the fixed space maintainer group; the increases in the DMFT/dft values of the 6th month (p:0.014) and 12th month (p:0.003), according to the initial DMFT/dft values were statistically significant ($p<0.05$) (Table 5).

For the band and loops, the lingual arches, the palatal arches and the removable space maintainers, the increase in the 12th-month plaque index values, according to the initial plaque index values were statistically significant (p:0.016; p:0.002; p:0.001; p:0.000 respectively) ($p<0.05$) (Table 1,2,3,4).

In the removable space maintainer group; the increases in DMFT/dft values of the 6th month (p:0.017) and 12th month (p:0.007), according to the initial DMFT/dft values were statistically significant ($p<0.05$) (Table 5).

In the fixed + removable space maintainer group; there was no statistically change in DMFT/dft values at 6th month and 12th month, according to initial DMFT/dft values ($p>0.05$). There was no statistically significant difference between space maintainer in terms of the initial, 6th and 12th-month plaque index values ($p>0.05$). In the fixed space maintainer group; the increase in the 12th-month plaque index values according to the initial plaque index values was statistically significant (p:0.000, $p<0.05$) while there was no significant change in plaque index values at 6th-month according to initial plaque index values ($p>0.05$) (Table 5).

For the removable space maintainer group; the increases in plaque index values at 6th-month (p:0.015) and 12th-month (p:0.001) according to the initial plaque index values were statistically significant ($p<0.05$). In the fixed + removable space maintainer group; the increase in plaque index values at 6th-month (p:0.016) and 12th-month (p:0.020), according to initial plaque index values was statistically significant ($p<0.05$).

There was no statistically significant difference between space maintainer groups in terms of the increase in 12th-month DMFT/dft values compared to the initial DMFT/dft values ($p>0.05$).

There was a statistically significant difference between the space maintainer groups in terms of the amount of change in the 12th-month plaque index values compared to the initial plaque index values (p:0.004; $p<0.05$). As a result of the binary comparisons made for the determination of the difference; the amount of change in the 12th-month plaque index values was significantly higher than that of the fixed space maintainer group ($p<0.05$).

Table 1. DMFT/dft and plaque index values of patients applied band and loop before the treatment and after the treatment.

		Band and loop		p[1]
		-	+	
		Mean±St.D	**Mean±St.D**	
DMFT/dft (median)	Initial	5.25±2.74 (5)	4.25±2.71 (5)	[1a] 0.080
	6 th month	5.47±2.8 (5)	4.61±2.99 (5)	[1a] 0.142
	12 th month	5.53±2.81 (5)	4.69±3.03 (5)	[1a] 0.150
	Initial -6 th month p^{2a}	0.017*	0.014*	
	Initial -12 th month p^{2a}	0.007*	0.003*	
Plaque index	Initial	0.98±0.61	0.59±0.43	[1b] 0.001*
	6 th month	1.13±0.78	0.67±0.42	[1b] 0.000*
	12 th month	1.31±0.81	0.79±0.6	[1b] 0.001*
	Initial -6 th month p^{2b}	0.036*	0.158	
	Initial -12 th month p^{2b}	0.000*	0.016*	

[1a]Mann Whitney U Test [1b]Student t-test [2a]Wilcoxon Sign Test [2b]Paired Samples t-test *$p<0.05$

Table 2. DMFT/dft and plaque index values of patients applied lingual arch before the treatment and after the treatment.

		Lingual arch		p[1]
		-	+	
		Mean±St.D	**Mean±St.D**	
DMFT/dft (median)	Initial	4.39±2.54 (4)	7.5±2.42 (8)	[1a] 0.000*
	6 th month	4.71±2.76 (5)	7.5±2.42 (8)	[1a] 0.001*
	12 th month	4.8±2.8 (5)	7.5±2.42 (8)	[1a] 0.001*
	Initial -6 th month p^{2a}	0.001*	1.000	
	Initial -12 th month p^{2a}	0.000*	1.000	
Plaque index	Initial	0.78±0.56	1.15±0.61	[1b] 0.020*
	6 th month	0.87±0.66	1.46±0.76	[1b] 0.010*
	12 th month	1±0.67	1.78±0.98	[1b] 0.007*
	Initial -6 th month p^{2b}	0.076	0.062	
	Initial -12 th month p^{2b}	0.000*	0.002*	

[1a]Mann Whitney U Test [1b]Student t-test [2a]Wilcoxon Sign Test [2b]Paired Samples t-test *$p<0.05$

Table 3. DMFT/dft and plaque index values of patients applied palatal arch before the treatment and after the treatment.

		Palatal arch		p[1]
		-	+	
		Mean±St.D	**Mean±St.D**	
DMFT/dft (median)	Initial	4.43±2.59 (4)	6.62±2.73 (7)	[1a] 0.002*
	6 th month	4.77±2.81 (5)	6.62±2.73 (7)	[1a] 0.012*
	12 th month	4.86±2.85 (5)	6.62±2.73 (7)	[1a] 0.017*
	Initial -6 th month p^{2a}	0.001*	1.000	
	Initial -12 th month p^{2a}	0.000*	1.000	
Plaque index	Initial	0.71±0.53	1.31±0.53	[1b] 0.000*
	6 th month	0.88±0.66	1.3±0.78	[1b] 0.014*
	12 th month	0.97±0.69	1.69±0.83	[1b] 0.000*
	Initial -6 th month p^{2b}	0.005*	0.944	
	Initial -12 th month p^{2b}	0.000*	0.001*	

[1a]Mann Whitney U Test [1b]Student t-test [2a]Wilcoxon Sign Test [2b]Paired Samples t-test *$p<0.05$

Table 4. DMFT/dft and plaque index values of patients applied removable space maintainers before the treatment and after the treatment.

		Removable space maintainer		p[1]
		-	+	
		Mean±St.D	**Mean±St.D**	
DMFT/dft (median)	Initial	5.04±2.94 (5)	4.7±2.51 (4)	[1a] 0.681
	6 th month	5.26±3.05 (5)	5.02±2.68 (4)	[1a] 0.790
	12 th month	5.32±3.07 (5)	5.12±2.71 (4)	[1a] 0.831
	Initial -6 th month p^{2a}	0.014*	0.017*	
	Initial -12 th month p^{2a}	0.003*	0.007*	
Plaque index	Initial	0.83±0.55	0.86±0.62	[1b] 0.800
	6 th month	0.89±0.67	1.07±0.75	[1b] 0.208
	12 th month	1.13±0.83	1.11±0.71	[1b] 0.910
	Initial -6 th month p^{2b}	0.650	0.007*	
	Initial -12 th month p^{2b}	0.000*	0.000*	

[1a]Mann Whitney U Test [1b]Student t-test [2a]Wilcoxon Sign Test [2b]Paired Samples t-test *$p<0.05$

Table 5. Evaluation of DMFT/dft and plaque index values between groups of space maintainers.

		Space Maintainer			p[1]
		Fixed	Removable	Fixed + Removable	
		Mean±St.D (median)	Mean±St.D (median)	Mean±St.D (median)	
DMFT/dft (median)	Initial	5.04±2.94 (5)	4.17±2.28 (4)	7±2.27 (8)	0.031*
	6 th month	5.26±3.05 (5)	4.57±2.58 (4)	7±2.27 (8)	0.097
	12 th month	5.32±3.07 (5)	4.69±2.64 (4)	7±2.27 (8)	0.112
	Initial -6 th month *p*[2]	0.014*	0.017*	1.000	
	Initial -12 th month *p*[2]	0.003*	0.007*	1.000	
Plaque index	Initial	0.83±0.55 (0.8)	0.85±0.64 (0.7)	0.87±0.57 (1)	0.830
	6 th month	0.89±0.67 (0.8)	1.03±0.79 (0.8)	1.24±0.52 (1.1)	0.219
	12 th month	1.13±0.83 (0.8)	1.09±0.74 (1)	1.21±0.6 (1)	0.799
	Initial -6 th month *p*[2]	0.157	0.015*	0.016*	
	Initial -12 th month *p*[2]	0.000*	0.001*	0.020*	

[1]Kruskal Wallis Test [2]Wilcoxon Sign Test *$p<0.05$

Table 6. Evaluation of changes in DMFT/dft and plaque index values of initial and 12 th-month between space maintainers.

	Space Maintainer			p
	Fixed	Removable	Fixed + Removable	
	Mean±St.D (median)	Mean±St.D (median)	Mean±St.D (median)	
DMFT/dft Initial-12 th month difference	0.28±0.8 (0)	0.51±0.95 (0)	0±0 (0)	0.187
Plaque index Initial-12 th month difference	0.24±0.45 (0)	0.06±0.34 (0)	-0.03±0.16 (-0.1)	0.004*

*$p<0.05$

DISCUSSION

It is important to guide the position, presence, and correct formation of the roots and crowns of teeth before extraction (8). After tooth extraction, the space maintainer's effects on the oral mucosa and teeth beside its position in the arch should be controlled.

Various studies have examined the survival rates of space maintainers and no effect on the survival of the appliance according to gender, age, and type of dentition was found (4,11). By contrast, studies on the effects of space maintainers on dental health are limited. Thus, this question was investigated in this study.

In a study, the effects of space maintainers on plaque accumulation, periodontal health, and oral microflora were evaluated by researchers (12). Arikan *et.al*. created a numbering plan wherein the insertion of space maintainers was

named T0 (baseline); 1st-month control, T1; 3rd-month control, T2; and 6th-month control, T3. The insertion of space maintainers was named as T0 (baseline), the 1st-month control was named as T1, the 3rd-month control was named as T2 and the 6th-month control was named as T3. A positive correlation was found between the plaque index values for the fixed space maintainers. In our study, the 12th-month plaque index values of the removable space maintainers, band and loops, lingual arches, and palatal arches exhibited a statistically significant increase relative to the initial plaque index values. This result was consistent with Arikan's study (12). A possible reason for this similarity is the existence of additional apparatus in the mouth in both studies.

Keriş *et al*. (13) assessed the effects of fixed and removable space maintainers on halitosis and the plaque, gingival, and periodontal screening indexes. Similar to Arikan (14), they created a numbering plan. They stated that fixed and removable space maintainers do not significantly affect oral health and halitosis, and there is no statistically significant difference between the types of space maintainers in this regard. This study found no statistically significant difference between the space maintainer groups in terms of the initial, 6th-month, and 12th-month plaque index values. In the fixed space maintainer group, the 12th-month plaque index values exhibited a statistically significant increase relative to the initial values. Meanwhile, in the removable and fixed + removable space maintainer groups, the 6th- and 12th-month plaque index values showed a statistically significant increase compared with the initial values (Table 6).

In another study, children who had fixed and removable appliances were evaluated in terms of plaque, bleeding index, and mean pocket depth scores. According to that study, 1st-month and 3rd- month plaque index values were significantly different from the initial levels while no significant difference was between initial and 6th -month levels. Consistent with that in our study, the plaque index was found to be high at the 3rd-, 6th- month controls (14). Controls were in the 6th and 12th months in present study.

In a study by Torkan *et al*. (15), effects of two types of retainers on the periodontium were evaluated. The plaque index, calculus index, gingival index, and bleeding on probing were used to identify patients' periodontal health status. The evaluations of all groups worsened after six months. As in our work, the additional appliance in the mouth affected periodontal health negatively.

The success and survival rates of three different fixed space maintainers were investigated in another study (16). There was no significant difference between the space maintainers in survival time. Band and loop fixed space maintainers were found superior to composite and wire and Sannerud's space maintainers in terms of both survival time and success rates. In the current study, patients were followed for one year. Survival time in the oral cavity wasn't examined; instead, the initial and 12th- month plaque index values were evaluated. In all groups, statistically significant increases were found between the initial and 12th-month plaque index values.

Kundu *et al*. (17) reported that the oral bacterial counts of patients who have fixed space maintainers or removable appliances were increased at the end of 6th-month controls. *Streptococcus mutans* counts were found higher than those of *Lactobacillus sp*. and *Candida albicans*. An increase in these bacteria enhances the risk of dental caries, and an increase in candida affects periodontal health. Therefore, space maintainers may degrade oral health.

Aydinbelge *et al*. also stated that after the space maintainer application, the accumulation of plaque increased significantly, this result is also compatible with the current study (18).

Different from other studies, DMFT/dft values were evaluated in this study and the importance of that, it is the first to assess the effect of space maintainers on such values. In the group of fixed and removable space maintainers, the DMFT/dft values in the 6th and 12th months exhibited statistically significant increases relative to the initial values. There were no significant differences in the plaque indexes and DMFT/dft values between girls and boys. Hence, the effects of the usage of space maintainers are independent of gender. Finally, there were no significant differences between children of various ages.

CONCLUSION

Space maintainers rehabilitate the spaces vacated by teeth and prevent space loss, but they can lead to caries, increased plaque accumulation, demineralized areas, and periodontal problems. The accumulation of plaque and difficulty of cleaning teeth affect dental health negatively. Moreover, space maintainers are not the only factor for these problems; they can accelerate existing issues.

Regarding the application of space maintainers, oral hygiene is more important than other factors, such as gender and age, for dental health. To prevent additional plaque accumulation and caries, such patients should be given excellent oral hygiene training. Moreover, regular controls should be performed, and the periodontal and dental health of patients should be monitored continuously. This research encourages the conduct of further studies involving greater numbers of patients and longer follow-up periods.

ABBREVIATIONS

DMFT: the decayed, missing and filled teeth
Dft: the decayed and filled teeth
WHO: World Health Organization

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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