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## Assessment of Oral Health in Patients with Fixed Appliances

### Ocena stanu zdrowia jamy ustnej u pacjentów leczonych za pomocą aparatów stałych

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#### Abstract

**Background.** Recent years have seen an increase in the number of patients of different age who decide to commence orthodontic treatment.

**Objectives.** The aim of the work was to assess the oral health condition in patients treated with fixed appliances in two-year clinical studies.

**Material and Methods.** Patients were divided into groups A, B and C, 15 persons each. The patients whose orthodontic treatment was commenced were randomly assigned to group A or B, whereas patients whose treatment was postponed were put into group C. All of the patients received the same oral hygiene training except for the frequency with which the recommendations were reminded about. In group A the hygienic recommendations were repeated during every orthodontic appointment, in groups B and C the training was provided only once, at the beginning. The oral health condition was assessed based on the level of oral hygiene indices (PII and API) and gingival indices (GI, SBI) at the following time points: baseline (T0), after 3 months (T1), 9 months (T2) and 12 months (T3). The final assessment (T4) was performed 3 months after the completion of the orthodontic treatment or 2 years after the first consulting appointment in the case of non-treated patients.

**Results.** The analysis of the mean values of all the indices in group A showed statistically significant changes indicating an improvement of the oral health condition during the orthodontic treatment and after its completion (T1–T4). In group B the best oral health condition was recorded after 3 months (T1). In group C, the oral health condition did not improve significantly in the follow-up study (T4).

**Conclusions.** The effect of the elements of a fixed appliance on the condition of the oral cavity requires further studies in order to develop special prevention programmes (*Dent. Med. Probl.* 2014, 51, 4, 506–512).

**Key words:** orthodontic treatment, oral hygiene, gingival index, oral hygiene index.

#### Streszczenie

**Wprowadzenie.** W ostatnich latach obserwuje się zwiększenie liczby pacjentów w różnym wieku, którzy decydują się na podjęcie leczenia ortodontycznego.

**Cel pracy.** Ocena stanu zdrowia jamy ustnej u pacjentów leczonych za pomocą aparatami stałymi w dwuletniej obserwacji klinicznej.

**Materiał i metody.** Utworzono grupy pacjentów: A, B i C, po 15 osób w każdej. W przypadku rozpoczęcia leczenia ortodontycznego pacjenta losowo przydzielano do grupy A lub B, a w sytuacji odroczenia leczenia do grupy C. Instruktaż higieny jamy ustnej był przeprowadzony w sposób jednolity. Różnica dotyczyła częstości powtarzania zaleceń. W grupie A zalecenia higieniczne powtarzano podczas każdej wizyty ortodontycznej, w grupach B i C instruktaż przeprowadzono jednorazowo podczas pierwszej wizyty. Stan zdrowia jamy ustnej oceniano poziomem wskaźników higieny jamy ustnej PII, API oraz wskaźników dziąsłowych GI, SBI w przedziałach czasowych: wyjściowo (T0), po 3 miesiącach (T1), po 9 miesiącach (T2) i 12 miesiącach (T3). Kończącą ocenę (T4) przepro-

wadzano po 3 miesiącach od zakończenia leczenia ortodontycznego, a w przypadku osób nieleczonych po 2 latach od pierwszej wizyty konsultacyjnej.

**Wyniki.** Analiza średnich wartości wszystkich wskaźników w grupie A wskazała na istotne statystycznie zmiany świadczące o poprawie stanu zdrowia jamy ustnej w trakcie leczenia ortodontycznego i po jego zakończeniu (T1–T4). W grupie B najlepszy stan zdrowia jamy ustnej uzyskano w badaniu po 3 miesiącach (T1). W grupie C w badaniach odległych (T4) stan zdrowia jamy istotnie się nie poprawił.

**Wnioski.** Wpływ elementów aparatu stałego na stan jamy ustnej wymaga dalszych badań w celu opracowania specjalnych programów profilaktycznych (*Dent. Med. Probl.* 2014, 51, 4, 506–512).

**Słowa kluczowe:** higiena jamy ustnej, leczenie ortodontyczne, wskaźnik higieny jamy ustnej, wskaźnik dziąsłowy.

Malocclusion is conducive to plaque retention. It also hampers cleaning of the interdental spaces and reduces access to them during professional hygienic procedures. Recent years have seen an increase in the number of patients of different age who decide to commence orthodontic treatment [1]. It should be emphasized that non-treated dental and occlusion disorders may intensify malocclusion and periodontopathy, which may lead to health, speech and aesthetic problems [2]. A successful therapy, satisfactory both to the doctor and the patient, is possible only if both parties fully cooperate [3]. The treatment is often a compromise between the expectations of the patients or their legal guardians and feasible treatment options [4].

A review of the literature concerning the popularity of orthodontic therapy with a fixed appliance revealed that orthodontic treatment not only enables the improvement and restoration of correct occlusion, but also enhances the aesthetic quality of the dentition [5]. Therefore, it is vital to maintain proper oral health condition throughout the entire life.

The aim of this work was to assess the oral health condition of patients following orthodontic surgery in 2-year clinical studies.

## Material and Methods

Out of the patients seeking orthodontic consultation due to dental and occlusion disorders, we selected to the study children who expressed the willingness to participate in non-invasive clinical trials and their parents/legal guardians granted written consent for the child's participation in all stages of the research project planned for the span of 2 years. The patients were divided into 3 groups: A, B and C. If the orthodontic treatment was commenced, the patient was randomly assigned to group A or B, if the treatment was postponed, the patient was assigned to group C – Table 1.

Three groups were formed, 15 persons each, in which educational programme was launched to maintain the required oral hygiene level. All of the patients received the same oral hygiene training except for the frequency with which the recom-

**Table 1.** Division of the patients into 3 groups

**Tabela 1.** Podział pacjentów na 3 grupy

Group	Patients 10–15 years old	Number
A	hygienic recommendations were repeated during every orthodontic appointment	15
B	orthodontically treated, hygienic training was provided only once	15
C	orthodontically non-treated, hygienic training was provided only once	15

mendations were reminded about. In group A hygienic recommendations were repeated during every orthodontic appointment, in groups B and C the training was provided only once, at the beginning. The following hygienic action plan was adopted for all of the examined patients:

- 1) assess the oral hygiene,
- 2) discuss the brushing technique,
- 3) list the basic means of oral hygiene (fluoride toothpaste, tooth brush, mouth wash),
- 4) recommend additional accessories to maintain hygiene in the interdental spaces (dental floss, single and interdental toothbrushes, toothpicks).

Hygienic recommendations were provided to every patient individually, both verbally and in writing. The hygienic procedure was also demonstrated on a model to a child who was then to repeat it in practice.

The oral health condition was assessed based on the analysis of the condition of oral hygiene, with the use of the Plaque Index (PII) and Aproximal Plaque Index (API), and of the gingival condition (Gingival Index and Sulcus Blending Index).

The oral health condition was assessed in all 3 groups at the baseline (T0), then after 3 months (T1), 9 months (T2) and 12 months (T3). The final assessment (T4) was performed 3 months after removing the fixed appliance in patients treated orthodontically or 2 years after the first consulting appointment in patients not treated orthodontically. The research project was approved by the Bioethical Commission at the Poznań University of Medical Sciences.

Descriptive statistics parameters were calculated for all PII, API, GI, SBI results. The Shapiro-Wilk test was used to verify the consistency of the study results with the normal distribution. No significant differences were identified between the study results and the Gaussian distribution; therefore, further statistical assessment of the oral health indices was continued by means of parametric tests. Differences between the results of groups A, B and C at T0, T1, T2, T3 and T4 were evaluated based on the results of the single-factor analysis of variance (ANOVA) and then the least significant difference test (LSD). In every group (A, B, C), the results were compared between T0 and T1, T0 and T2, T0 and T3, T0 and T4 by means of the Student's *t*-test for dependent groups. The results were considered statistically significant if the significance level was below 0.05. Statistical computations were conducted by means of STATISTICA PL v. 9.0. Statistical analyses were performed in the Department of Bioinformatics and Computational Biology of the Poznań University of Medical Sciences.

## Results

The comparative analysis of the mean values of all the indices in group A (treated orthodontically, in which the hygiene instructions were repeated during every appointment) at T0, T1, T2, T3 and T4 over 2 years, indicated statistically significant differences in the plaque indices and gingival indices. Table 2 presents the relevant mean differences and levels of statistical significance.

In group B, treated orthodontically with a one-off hygiene training, the comparative analysis of the mean plaque indices (PII and API) obtained during the baseline examination (T0) and other examinations (T1, T2, T3, T4) revealed a statistically significant reduction of the mean PII values. The remaining differences between T0 and the other times (T1–T4) were found unchanged. In group B, the mean gingival indices (GI and SBI) were recorded to be lower at T1, T2, T3 and T4 than at T0. The highest fall of the GI mean values was recorded at T1 vs. T0. It was stated that the differences between the mean values of the studied index attained the required statistical significance level of  $p < 0.05$ , although it differed over the analysed period of 2 years. Table 3 presents the relevant mean differences and levels of statistical significance, showing statistically significant changes over time.

In group C, not treated orthodontically, the comparison of the mean values of both hygiene indices (PII, API) and gingival indices (GI, SBI) between T0 and T1, T2, T3, T4 indicated statistical-

ly significant differences with the exception of T4. The difference between T0 and T4 was not statistically significant, which has been shown in Table 4.

## Discussion

Zimmer et al. [6] examined 80 teenage patients in an active phase of the treatment with a fixed orthodontic appliance. They assessed, among others, PII, API and GI. The second objective of the researchers was to define the extended prevention procedure. The authors demonstrated an elevated level of the indices and higher risk of teeth decalcification in patients with fixed appliances. In their opinion, the initial prevention programme, regular motivation provided to the patients and additional fluoride therapy was an accurate method to prevent decalcification during the orthodontic treatment. Decalcification and discoloration of enamel created during the therapy with a fixed appliance, as well as the effectiveness of using fluoride, were examined by Lovrov et al. [7]. Based on the plaque index and the papilla bleeding index (PBI), as well as the gingival recession (GR), the scientists assessed the development of white discoloration/decalcification of the enamel and the rationale behind using fluoride in 53 young patients undergoing therapy with fixed appliances. In the authors' opinion, slower development of discoloration is related rather to the frequency of brushing the teeth than to the effect of fluoride, and the plaque level indicates a strong correlation with the number and size of enamel discoloration spots during the therapy with fixed appliances. Our results prove that regular monitoring of the oral health condition protects the patient against pathological conditions concerning both the hard dental structures and the marginal periodontium, i.e. gingiva.

The growth of plaque around metal ligatures and traditional elastic ligatures fixing orthodontic archwires was analysed by Pellegrini et al. [8]. They examined 14 patients at the age of 11 to 17 in the 1<sup>st</sup> and 5<sup>th</sup> week of the active phase of the orthodontic treatment. The patients had traditional elastic ligatures installed on one side of the mouth and metal ligatures on the other. The scientists collected samples to assess the type of the bacterial flora and measured PII. They found that plaque cumulated much less around metal ligatures. Chaussain et al. [9] focused on the risk of caries in adolescents during the active phase of the orthodontic therapy. They selected 110 patients at the age of 10 to 25 for orthodontic treatment. The authors measured the parameters (e.g. the level of PII, bacteria and caries) before the active phase of the orthodontic treatment as well as in the 3<sup>rd</sup>, 6<sup>th</sup> and

**Table 2.** Mean changes PII, API, GI, SBI in the group A**Tabela 2.** Zmiany średnich wartości wskaźnika PII, API, GI, SBI w grupie A

Index	Time	Mean	SD	Differen.	SD Differen.	P
PII	T0	1.72	0.61	0.77	0.43	< 0.0001
	T1	0.95	0.36			
	T0	1.72	0.61	0.87	0.37	< 0.0001
	T2	0.85	0.45			
	T0	1.72	0.61	0.83	0.45	< 0.0001
	T3	0.89	0.36			
	T0	1.72	0.61	1.24	0.51	< 0.0001
	T4	0.47	0.22			
API	T0	1.64	0.60	0.72	0.51	< 0.0001
	T1	0.92	0.35			
	T0	1.64	0.60	0.86	0.42	< 0.0001
	T2	0.77	0.42			
	T0	1.64	0.60	0.81	0.51	< 0.0001
	T3	0.83	0.39			
	T0	1.64	0.60	1.12	0.50	< 0.0001
	T4	0.52	0.44			
GI	T0	1.55	0.61	0.72	0.39	< 0.0001
	T1	0.83	0.39			
	T0	1.55	0.61	0.81	0.49	< 0.0001
	T2	0.74	0.48			
	T0	1.55	0.61	0.70	0.61	< 0.0005
	T3	0.85	0.50			
	T0	1.64	0.60	1.00	0.54	< 0.0001
	T4	0.55	0.25			
SBI	T0	2.20	0.98	0.87	0.58	< 0.0001
	T1	1.33	0.83			
	T0	2.20	0.98	0.86	0.56	< 0.0001
	T2	1.34	0.81			
	T0	2.20	0.98	0.75	0.76	0.0019
	T3	1.45	0.74			
	T0	2.20	0.98	1.10	0.74	< 0.0001
	T4	1,10	0,73			

12<sup>th</sup> month of the therapy with a fixed appliance. In the observed period, they identified the development of at least one carious lesion in 54 patients. In 16 patients, lesions developed prior to the lapse of 3 months, in 27 patients between the visits in the 3<sup>rd</sup> and 6<sup>th</sup> month and in 11 persons between the 6<sup>th</sup> and 12<sup>th</sup> month. The percentage of patients with a high risk of developing dental carries was 70% in the initial period and it grew to 80% at the end of the trial. Martignon et al. [10] assessed the level of plaque and the hygienic habits of young people treated with fixed appliances. They selected a group of 74 patients at the age of 12 to 29, who

had been treated for at least one year with fixed appliances, and the control group of 63 persons at the age of 12 to 29, who were to commence the orthodontic therapy. The authors evaluated ortho-plaque-index (OPI) and demonstrated that the hygiene level was considerably higher in the control group. Moreover, they suggested that the results pointed to the need to develop prevention programmes. Our research indicated that, after 2 years, the hygiene level and gingival condition in the population of Polish children with postponed therapy was not better than in the children treated orthodontically.

**Table 3.** Mean changes of PII, API, GI, SBI in the group B**Tabela 3.** Zmiany średnich wartości wskaźnika PII, API, GI, SBI w grupie B

Index	Time	Mean	SD	Differen.	SD Differen.	P
PII	T0	1.51	0.50	0.59	0.52	0.0006
	T1	0.92	0.38			
	T0	1.51	0.50	0.49	0.54	0.0033
	T2	1.02	0.43			
	T0	1.51	0.50	0.40	0.37	0.0009
	T3	1.11	0.57			
	T0	1.51	0.50	0.56	0.40	0.0001
	T4	0.95	0.43			
API	T0	40.33	11.99	16.93	11.52	< 0.0001
	T1	23.40	6.36			
	T0	40.33	11.99	11.67	10.77	0.0009
	T2	28.67	7.09			
	T0	40.33	11.99	9.73	9.32	0.0012
	T3	30.60	13.45			
	T0	40.33	11.99	16.00	8.60	< 0.0001
	T4	24.33	8.65			
GI	T0	1.36	0.49	0.63	0.38	< 0.0001
	T1	0.73	0.26			
	T0	1.36	0.49	0.48	0.40	0.0004
	T2	0.89	0.35			
	T0	1.36	0.49	0.28	0.39	0.0146
	T3	1.09	0.34			
	T0	1.36	0.49	0.56	0.52	< 0.0010
	T4	0.81	0.47			
SBI	T0	1.57	0.54	0.73	0.37	< 0.0001
	T1	0.84	0.28			
	T0	1.57	0.54	0.56	0.48	0.0005
	T2	1.02	0.25			
	T0	1.57	0.54	0.31	0.32	0.0020
	T3	1.26	0.36			
	T0	1.57	0.54	0.66	0.49	0.0001
	T4	0.92	0.45			

Neglecting oral hygiene leads to a change and increase in the pathogenic bacterial flora, which compromises the natural protective barrier and may result in inflammations and periodontium problems, as well as the angular cheilitis. The most recent studies indicate that the angular cheilitis is a multi-factor condition, which may develop in a small percentage of patients undergoing the therapy with fixed appliances. Cross et al. [11] examined 660 teenage patients treated orthodontically. They assessed the plaque index as well as the clinical features of the angular cheilitis. The authors diagnosed 11% of the examined patients with the

angular cheilitis; however, they found that in the group of patients with good oral hygiene the risk of that condition was low.

Van Gastel et al. [12] evaluated the periodontium condition in patients treated with fixed appliances, assessing, among others, the depth of gingival pockets (PD) and gingival bleeding (BOP) in 24 persons (at the age of  $14.6 \pm 1.1$  year) after the placement of a fixed appliance as well as 18, 20, 24 and 36 weeks later. The scientists demonstrated the upward trend of the indices, which was the result of incorrect dental hygiene. The published results indicate that a correctly conducted ortho-

**Table 4.** Mean changes of PII, API, GI, SBI in the group C**Tabela 4.** Zmiany średnich wartości wskaźnika PII, API, GI, SBI w grupie C

Index	Time	Mean	SD	Differen.	SD Differen.	P
PII	T0	1.55	0.35	0.50	0.42	0.0004
	T1	1.05	0.39			
	T0	1.55	0.35	0.41	0.37	0.0007
	T2	1.14	0.40			
	T0	1.55	0.35	0.26	0.40	0.0276
	T3	1.30	0.38			
	T0	1.55	0.35	0.09	0.29	0.2524
	T4	1.46	0.42			
API	T0	44.07	9.73	9.40	7.82	0.0004
	T1	34.67	9.24			
	T0	44.07	9.74	9.13	6.80	0.0001
	T2	34.93	10.40			
	T0	44.07	9.73	7.00	9.64	0.0139
	T3	37.07	9.85			
	T0	44.07	9.73	2.00	6.28	0.2377
	T4	42.07	11.29			
GI	T0	1.64	0.32	0.56	0.47	0.0004
	T1	1.08	0.33			
	T0	1.64	0.32	0.48	0.46	0.0013
	T2	1.16	0.41			
	T0	1.64	0.32	0.25	0.44	0.0399
	T3	1.39	0.39			
	T0	1.64	0.32	0.08	0.34	0.3933
	T4	1.56	0.39			
SBI	T0	1.83	0.38	0.61	0.53	0.0005
	T1	1.22	0.44			
	T0	1.83	0.38	0.39	0.34	0.0005
	T2	1.44	0.34			
	T0	1.83	0.38	0.36	0.42	0.0055
	T3	1.47	0.38			
	T0	1.83	0.38	0.08	0.40	0.4597
	T4	1.75	0.45			

dontic treatment with a fixed appliance is safe for the periodontium tissues. Our research also confirmed the above; however, as other scientists point out, the biggest problem is posed by the failure to maintain correct oral hygiene. Constant monitoring of the oral hygiene and using professional hygienic procedures protects the periodontium and hard dental structures against damage during orthodontic therapy [13–17].

The effect of the elements of a fixed appliance on the condition of the oral cavity requires further studies in various age groups of patients treated orthodontically, and the identified changes need to be analysed in order to develop more specific prevention programmes to accompany the use of fixed appliances, especially in the case of patients undergoing a long-standing orthodontic therapy due to a congenital disorder.

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