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THE INFLUENCE OF CHRONIC STRESS ON PERIODONTAL TISSUES IN ORTHODONTIC PATIENTS IN CONDITIONS OF MARTIAL LAW

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Ключові слова: *зубощелепна аномалія, ортодонтичне лікування, періотестометрія, стрес, війна в Україні, здоров'я ротової порожнини*

Abstract. The influence of chronic stress on periodontal tissues in orthodontic patients in conditions of martial law. Vyzhenko Ye.Ye., Kuroiedova V.D., Korobov P.S., Halych L.B. *There is a close relationship between the condition of periodontal tissues and malocclusion. Timely functional diagnosis of changes that occur in periodontal tissues during orthodontic tooth movement is an important link in the prevention of periodontal diseases during orthodontic treatment. At the present time, special attention is paid to the problem of the influence of "war stress" on the maxillo-facial system of a human. Aim of the was work to study the changes in the state of periodontal supporting tissues in orthodontic patients according to periotestometry data during the last 15 years and in the conditions of martial law. Periotestometry of teeth in orthodontic patients was performed before the start of treatment with the Periotest device. All patients were divided into 4 groups according to the results in different years of the study. A total of 136 patients participated in the study. The biggest discrepancies when comparing periotestometry indicators were found between the data of the control and fourth group (in conditions of martial law) and an increase in the indicators of tooth mobility with a statistically significant difference of $p<0.001$ was proven. When comparing the indicators of groups 2 and 4 for most teeth, the statistically significant difference was from $p<0.05$ to $p<0.001$. When comparing the data of the tooth periotest in patients of groups 3 and 4, the indicators of tooth mobility also increased, although within the limits of statistical error ($p>0.05$). Over the past 15 years, a steady trend to increase in the mobility of all teeth on both jaws has been established. The largest changes in indicators were found in the dynamics of the fifteen-year follow-up (2008 to 2023) between people with an orthognathic bite of the control group and patients of the 4th group with malocclusion. Such changes may be related to the social and psycho-emotional stress that a person constantly experiences in conditions of martial law.*

Реферат. Вплив хронічного стресу на тканини пародонта в ортодонтичних пацієнтів в умовах воєнного стану. Виженко Є.Є., Куроєдова В.Д., Коробов П.С. Галич Л.Б. *Існує тісний зв'язок між станом тканин пародонта та зубощелепними аномаліями. Своєчасна функціональна діагностика змін, які відбуваються в тканинах пародонта під час ортодонтичного переміщення зубів, є важливою ланкою профілактики захворювань пародонта при ортодонтичному лікуванні. У теперішній час особливої уваги потребує питання впливу воєнного стресу на зубощелепну систему. Метою дослідження було вивчити зміни стану опорних тканин пародонта в ортодонтичних пацієнтів за даними періотестометрії протягом останніх 15 років та в умовах воєнного стану. Періотестометрію зубів проводили ортодонтичним пацієнтам до початку лікування апаратом Periotest. Усі пацієнти були розподілені на 4 групи за даними результатів у різні роки дослідження. Усього в дослідженні взяли участь 136 пацієнтів. Найбільші розбіжності при порівнянні показників періотестометрії встановлено між даними контрольної та четвертої груп (умови воєнного стану) та доведено збільшення показників рухливості зубів зі статистично достовірною різницею $p<0,001$. На верхній щелепі для фронтальних та латеральних різців різниця показників між 1 та 4 групами у бік збільшення становила до 5,8 раза більше, ніж у контрольній групі, на нижній щелепі найбільша різниця виявлена між премолярами – до 6,4 раза. При аналізі показників пацієнтів із зубощелепними аномаліями за 15 років (2008-2023 роки) між 2, 3 та 4 групами також простежується динаміка збільшення показників рухливості зубів. При порівнянні показників 2 та 4 груп для більшості зубів статистично достовірна різниця становила від $p<0,05$ до $p<0,001$. При порівнянні даних періотесту зубів у пацієнтів 3 та 4 груп показники рухливості зубів також збільшені, хоча й у межах статистичної похибки ($p>0,05$). За останні 15 років установлено стійку тенденцію до збільшення показників рухливості всіх зубів на обох щелепах. Найбільші зміни показників встановлено в динаміці п'ятнадцятирічного спостереження (2008-2023 роки) між особами з ортогнатичним прикусом контрольної групи та пацієнтами 4 групи із зубощелепними аномаліями. Такі зміни можуть бути пов'язані із соціальним та психоемоційним стресом, який людина постійно відчуває в умовах воєнного стану.*

The prevalence of periodontal tissue diseases is a significant problem today [1, 2, 3]. An unfavorable environmental situation, stress, socio-economic problems of the population and other factors affect general somatic diseases and diseases of the oral cavity, disrupting metabolism in periodontal tissues [4, 5, 6].

Among the many etiological factors in the pathogenetic mechanism of the development of periodontopathies, malocclusion plays an important role [7, 8, 9].

At the present time, special attention is paid to the problem of the influence of "war stress" on the maxillo-facial system of a human [10, 11, 12, 13].

In the basis of the progression of periodontal diseases are the processes of bone tissue metabolism disorders [14]. During orthodontic treatment, the movement of teeth under the influence of the forces of orthodontic devices occurs against the background of bone tissue "weakening". In addition to physiological and pathological mobility of teeth, there is mobility of teeth that occurs during orthodontic treatment and depends on both: the state of the periodontal tissues and on the size of the force of orthodontic apparatus.

According to Kovach et al., from 20% to 62% of patients who underwent orthodontic treatment had complications in the form of bleeding or gum recession, increased tooth sensitivity [15].

Therefore, timely functional diagnosis of changes that occur in periodontal tissues during orthodontic tooth movement is a very important link to the prevention of periodontal diseases during orthodontic treatment.

In orthodontics, periotestometry is used to assess the condition of periodontal tissues before the beginning, at the stages of orthodontic treatment and in the retention period, as a criterion for its results, to determine the stability of orthodontic mini-implants [16, 17].

At the department of postgraduate education of orthodontists of the Poltava State Medical University, periodontal tissues in orthodontic patients were assessed using periotestometry. Nesterenko (2008) [18] studied the mobility of the teeth in the dynamics of orthodontic treatment with the bracket technique and in the retention period. Dovzhenko (2018) et al. [19] evaluated the mobility of teeth in orthodontic patients during the adaptation.

Therefore, the purpose of our research was to study the changes in the state of periodontal supporting tissues in orthodontic patients according to periotestometry data during the last 15 years and in the conditions of martial law.

At the same time, we tried to solve several problems: firstly, to study the dynamics of changes in the indicators of tooth mobility in patients with malocclusion over the past 15 years; secondly, to determine the difference in the readings of tooth mobility in patients with malocclusion in comparison with an orthognathic bite in a state of chronic stress, to which a person is exposed during war.

MATERIALS AND METHODS OF RESEARCH

Periotestometry of teeth of the upper jaw (UJ) and lower jaw (LJ) was performed in orthodontic patients before the start of treatment with the Periotest device.

Periotest is a modern electromechanical device manufactured by Gulden (Germany). The principle of the device operation is based on measuring the response of the periodontium to the shock wave. The frequency of mechanical pulses is 4 oscillations per 1 s, the duration of the entire measurement cycle for each tooth is 4 sec or 16 impulses.

The results of periotestometry are a quantitative indicator of periodontal health, which is a biophysical value, so this method of assessing tooth mobility is important as an objective criterion of the degree of bone loss in the diagnosis of periodontal diseases.

Normally, healthy periodontal tissues have more elastic properties compared to those that have undergone pathological changes or when bone tissue is rebuilt during orthodontic treatment, so the damping of mechanical vibrations during periotestometry in healthy tissues occurs faster than in pathology. This is the difference that is used to assess bone remodeling.

Percussion of the teeth was performed according to the instructions at the level between the equator and the cutting edge, placing the striker at a distance of 0.5-2.5 mm from the crown at an angle of 90° [18, 19].

According to the Gulden company, the interpretation of periotestometry results is as follows: indicators from -08 to +09 conditional units (CU) correspond to the norm; 10-19 – I degree of tooth mobility; 20-29 – II degree; 30-50 – III degree.

All patients were divided into 4 groups. The following criteria were used in the selection of patients: 1) presence of malocclusion; 2) absence of facial deformities; 3) absence of pathological periodontal diseases; 4) lack of orthodontic treatment.

The first control group consisted of 25 women with an orthognathic bite, whose average age was 21±2.8 years (Table 1) [18].

The second, third, and fourth group included patients with a permanent bite with malocclusion before the start of orthodontic treatment (different years of the study).

The second group included studies performed 15 years ago. Periotestometry was performed on 56 female patients with malocclusion, the average age was 20.5±3.2 years: 28 with Angle's class I pathology, 26 patients – with class II and 2 – with class III (2008). The data are given in Table 2 [18].

Table 1

Indicators of periotestometry of the teeth of the upper jaw (UJ) and lower jaw (LJ) in orthognathic bite, Mean±Standard deviation (M±SD), conditional units (CU), 2008

n=25	Dental formula											
	6	5	4	3	2	1	1	2	3	4	5	6
UJ	-0.28	2.00	2.04	-1.28	2.04	1.48	1.20	2.44	-1.56	1.50	1.36	-0.80
M±SD	0.51	0.59	0.51	0.43	0.39	0.52	0.49	0.44	0.42	0.46	0.54	0.55
LJ	-1.08	-0.61	-1.36	-2.20	1.40	2.12	2.16	1.44	-2.08	-1.12	-0.13	-1.48
M±SD	0,52	0.46	0.49	0.49	0.46	0.46	0.46	0.53	0.49	0.38	0.47	0.53

The third group consisted of 30 patients with Angle's class I pathology, the average age was 17.7±3.9 years: 13 men and 17 women who underwent periotestometry of the teeth of the upper jaw in 2018 before the start of orthodontic treatment, Table 3 [19].

The fourth group consisted of 25 patients (10 men and 15 women) with an average age of 14.7±2.5 years with class I and II pathology according to Engle before the start of orthodontic treatment in 2023. The research was conducted in January-April 2023, in conditions of war in Ukraine.

Table 2

Indicators of periotestometry of the teeth of the upper jaw (UJ) and lower jaw (LJ) in patients with malocclusion before the start of orthodontic treatment, Mean±Standard deviation (M±SD), conditional units (CU), 2008

n=56	Dental formula											
	6	5	4	3	2	1	1	2	3	4	5	6
UJ	2.20	3.00	3.07	0.71	3.14	3.53	3.79	3.47	0.07	2.75	2.60	1.20
M±SD	0.42	0.33	0.35	0.38	0.56	0.46	0.66	0.67	0.27	0.49	0.39	0.39
LJ	0.60	1.33	0.27	-0.80	3.00	4.27	4.14	3.00	-0.67	0.40	0.87	0.60
M±SD	0.38	0.39	0.46	0.40	0.35	0.40	0.38	0.52	0.37	0.42	0.38	0.51

The studies were approved by the biomedical ethics commission of the Poltava State Medical University No. 217 from 22.06.2023 and were conducted in accordance with the written consent of the participants. The materials of the scientific work comply with the Rules of Humane Treatment of Patients in accordance with the requirements of the Tokyo Declaration of the World Medical Association, the international recommendations of the Helsinki Declaration on Human Rights, the Council of Europe Convention on Human Rights and Biomedicine, the Laws of Ukraine, the orders of the Ministry of Health of Ukraine and the requirements of the Code of Ethics of the Doctor of Ukraine.

Table 3

Indicators of periotestometry of the teeth of the upper jaw (UJ) in patients with malocclusion before the start of orthodontic treatment, Mean±Standard deviation (M±SD,), conditional Units (CU), 2018

n=30	Dental formula											
	6	5	4	3	2	1	1	2	3	4	5	6
UJ	1.83	3.92	3.33	1.42	4.25	3.75	4.17	4.08	1.33	3.09	3.58	2.17
M±SD	1.29	1.27	1.72	1.29	1.80	2.29	2.96	1.86	1.48	1.97	1.86	1.70

Statistical processing was carried out using the Microsoft Excel 2010 data analysis package (product No. 02260-018-0000106-48551) – t-test with non-parametric Welch's correction for comparing the average data of two independent samples [20, 21]. Differences were considered significant at $p<0.05$. The age of the subjects in the control group was significantly higher. Therefore, the alternating method was used for statistics instead of randomization.

RESULTS AND DISCUSSION

The results of the study of orthodontic patients under conditions of chronic stress of martial law before the start of treatment in 2023 (fourth group) with defined criteria for differences in periodontal tests between groups are shown in Table 4.

When analyzing indicators by gender in the fourth group, it was found that indicators of women are increased by 0.1-3.6 CU, although they are within the limits of statistical error $p>0.05$ (Table 5).

According to Dovzhenko et al. 2018 also found no statistically significant difference between men and women mobility indicators [19]. Which confirms the data of Popovych et al., 2016 [22].

Table 4

Indicators of periotestometry of the teeth of the upper jaw (UJ) and lower jaw (LJ) in patients with malocclusion before the start of orthodontic treatment, Mean±Standard deviation (M±SD), conditional units (CU), 2023

n=25	Dental formula											
	6	5	4	3	2	1	1	2	3	4	5	6
UJ M±SD	3.36 0.57	5.83 0.91	4.48 0.63	2.96 0.46	6.79 0.69	8.58 0.79	7.88 0.80	5.42 0.57	2.83 0.59	4.65 0.54	5.46 0.86	2.63 0.61
$p_1<$	.001*	.001*	.001*	.001*	.001*	.001*	.001*	.001*	.001*	.001*	.001*	.001*
$p_2<$	>.05	.001*	>.05	.001*	.001*	.001*	.001*	.05*	.001*	.001*	.001*	>.05
$p_3>$	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05
LJ M±SD	2.58 0.74	4.38 0.85	1.91 0.44	1.13 0.35	5.5 0.56	5.92 0.54	5.96 0.52	4.75 0.50	1.04 0.31	1.96 0.45	3.35 0.78	2.2 0.53
$p_1<$	.001*	.001*	.001*	.001*	.001*	.001*	.001*	.001*	.001*	.001*	.001*	.001*
$p_2<$	.05*	.01*	.05*	.001*	.001*	.05*	.01*	.05*	.001*	.05*	.01*	.05*

Notes: $p<0.05$*, $p<0.01$*, $p<0.001$* – significant difference; $p>0.05$ – not a significant difference; p_1 – the difference between the periotestometry data of groups 1 and 4; p_2 – the difference between the periotestometry data of groups 2 and 4; p_3 – the difference between the periotestometry data of groups 3 and 4.

Therefore, we consider it correct to compare the data of group 1, which consisted entirely of women, with the data of other groups, and further analysis of the obtained results was carried out without gender emphasis.

The biggest discrepancies when comparing periotestometry indicators were found between the data of the control and fourth groups (wartime conditions) and an increase in the indicators of tooth mobility with a statistically significant difference of $p<0.001$ was proven.

Thus, on the upper jaw for the central and lateral incisors, the indicators of tooth mobility in group 4 under conditions of chronic stress were by 3.3-5.8 times higher than in the control group ($p<0.001$); for canines, it is almost by 3.8 times higher ($p<0.001$), for premolars – by 2.2-2.9 times ($p<0.001$), and for first molars – by 4.4 times ($p<0.001$).

On the lower jaw, the mobility of frontal teeth exceeded the control group by 2.8-3.9 times, the mobility of canines – by 1.5 times, premolars – by 2.9-6.4 times, first molars – by 3.4 times. A significant difference of $p<0.001$ was established for all groups of teeth.

Thus, in the current wartime, Ukrainian orthodontic patients begin treatment already with increased tooth mobility on both jaws, while the indicators of the central incisors reach the upper limit of the norm (7.88-8.58 CU).

Table 5

Indicators of periotestometry of the teeth of the upper jaw (UJ) and lower jaw (LJ) in men and women of the fourth group with malocclusion before the start of orthodontic treatment, Mean±Standard deviation (M±SD), conditional units (CU), 2023

n=10	Men											
	dental formula											
	6	5	4	3	2	1	1	2	3	4	5	6
UJ M±SD	2.5 0.5	3.7 0.4	4.44 0.51	2.3 0.46	6.2 0.63	8.3 0.78	6.9 0.74	4.9 0.61	2.9 0.77	3.66 0.39	4.5 0.84	1.9 0.39
LJ M±SD	1.1 0.28	3.1 0.50	1.77 0,43	0.7 0.36	5.6 0.70	5.1 0.56	4.9 0.47	3.5 0.32	0.8 0.34	1 0.29	1.8 0.41	0.5 0.31
n=15	**Women**											
	dental formula											
UJ M±SD	4 0.59	7.35 1.05	4.5 0.72	3.42 0.45	7.21 0.74	8.78 0.82	8.57 0.83	5.78 0.54	2.78 0.44	5.07 0.6	6.14 0.87	3.14 0.72
LJ M±SD	3.64 0.89	5.28 1.01	2 0.45	1.42 0.33	5.42 0.45	6.5 0.51	6.71 0.51	5.64 0.52	1.21 0.29	2.57 0.49	4.53 0.91	3.42 0.51
p_1>	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05
p_2>	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05

Notes: p>0.05 – not a significant difference; p_1 – the difference between the data of periotestometry of the teeth of the upper jaw of men and women in the 4th group; p_2 – the difference between the data of periotestometry of the teeth of the lower jaw of men and women and in the 4th group.

To our opinion the years of COVID restrictions and the second year of war in Ukraine, as a general social stress, have a significant impact on the life and health of our citizens.

Analyzing the indicators of patients with malocclusion for 15 years (2008-2023) between groups 2 and 4, the dynamics of increasing indicators of tooth mobility can also be traced.

On the upper jaw, for the group of incisors, the indicators in group 4 increased from 2.2 (p<0.05) to 2.4 times (p<0.001) in relation to the data on tooth mobility of patients in group 2. For canines, the difference was up to 4.2 times (p<0.001), for premolars – by 1.5-1.9 times (p>0.05 for tooth 14, and p<0.001 for other premolars) and first molars – by 1.5 times (p>0.05).

On the lower jaw, the mobility indicators for incisors increased from 1.4 (p<0.05) to 1.8 times (p<0.001), for canines the difference was 2.4 times (p<0.001), for premolars – by 4-7 times (p<0.05 and p<0.01) and first molars – by 4.3 times (p<0.05).

Therefore, when comparing data of tooth mobility in patients of group 4 with an orthognathic bite, as well as when comparing with patients who had malocclusion in 2008, the periotestometry indicators are increased. This confirms the general dynamics of the growth of indicators against the background of a chronic state in wartime conditions.

When comparing the indicators of the periotest of the teeth of the upper jaw in patients of groups 3 and 4, the indicators of tooth mobility also increased, although within the limits of statistical error (p>0.05). The greatest increase, up to 2 times, was established between the indicators of the central incisors.

So, analyzing the results of periotestometry studies in 2023 and comparing them with the data of studies in 2008 and 2018, we can establish a steady trend in increasing the mobility indicators of each tooth on the upper and lower jaw, although they are within the normal range. The graphs below show the dynamics of tooth periotestometry changes on the example of the right half of the upper and lower jaw (Fig. 1, 2).

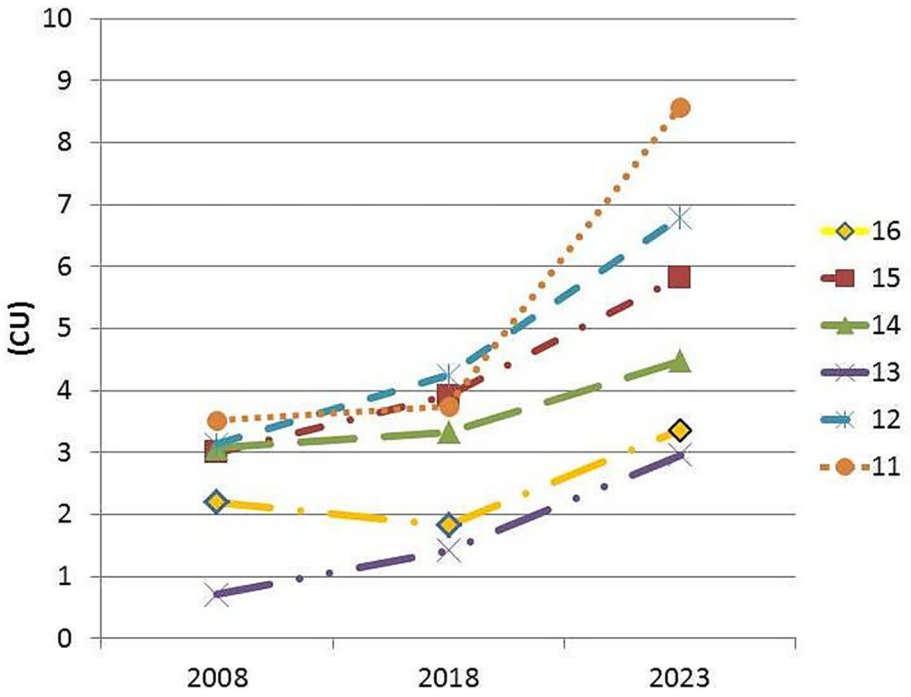

Fig. 1. Dynamics of changes in the mobility of teeth of the upper jaw in malocclusion according to the data of periotestometry in CU

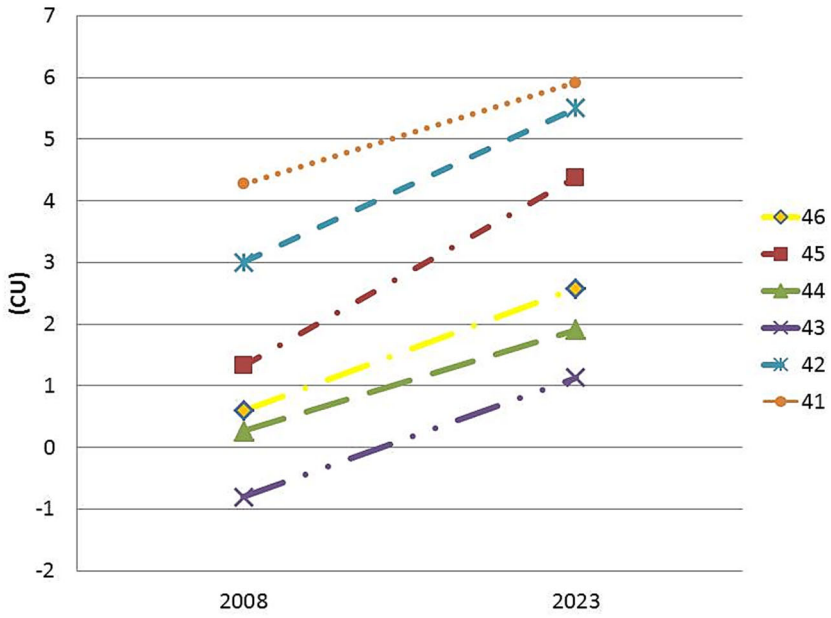

Fig. 2. Dynamics of changes in the mobility of teeth of the lower jaw in malocclusion according to the data of periotestometry in CU

Analyzing modern scientific literature over the past 5 years, we found only one reference to the use of periodontal testing in orthodontic patients [23]. Thus, Kučera et al. 2022 aimed to compare the direct effect of four commonly used retainers on tooth mobility after orthodontic treatment and in comparison with a control group – individuals with a physiological bite. According to the results of the study tooth mobility after orthodontic treatment was significantly increased. While canines remained

within normal range of tooth mobility, indicators for incisors increased on average to the first degree of tooth mobility. After attachment of the retainer in all four groups, mobility of teeth was reduced to indicators which were not significantly different form normal physiological ones found in the control group ($p>0.05$).

We were interested in the indicators of the control group, whose average age was 25 years, interquartile range (IQR) 24-29 years. According to the authors, the periotest index for maxillary canine was -1.4 on average with an IQR from -0.8 to -2.5 CU, which is by 4.36 CU lower than the values of our studies conducted in 2023; for lateral incisors – 2.7 with (3.9-1.7), which is also less by 4.09 CU; for central incisors – 4.8 (6.3-3.5), lower by 3.08 CU.

On the lower jaw for the canine, the periotest indicator was on average -1.3 (-0.5 to -2.1), which is 2.33 CU lower than the indicators of group 4; for lateral incisors – 2.9 (3.9-1.8), also lower by 2.6 CU; for central incisors – 4.0 (6.2-2.9), which is also less by 4.58 CU.

Such a comparison also indirectly indicates the impact of external factors on human health, such as stress during martial law.

Therefore, the obtained data are important for the objective assessment of the degree of tooth mobility and the deterioration of supporting functions of the periodontium in patients with malocclusion. This makes it possible to correct orthodontic treatment even before it begins, during hardware intervention and after its completion, as well as during the transition to the retention period.

CONCLUSIONS

1. Periotestometry is an objective method of assessing the condition of periodontal supporting tissues, which can be used for diagnosis before the beginning, during orthodontic treatment and in the retention period.
2. Over the past 15 years, a steady trend of increase in the mobility of all teeth on both jaws has been established.
3. The largest changes in indicators were found in the dynamics of the fifteen-year follow-up from 2008 to 2023 between individuals with an orthognathic bite of the control group and patients of the 4th group with malocclusion. On the upper jaw for frontal and lateral incisors, the difference in indicators between groups 1 and 4 in the upward direction was up to 5.8 times more than in the control group ($p<0.001$), on the lower jaw the biggest difference was found between premolars – up to 6.4 times ($p<0.001$).
4. Such changes may be related to the social and psycho-emotional stress that a person constantly experiences in the conditions of martial law.

Contributors:

Vyzhenko Ye.Ye. – data curation, writing – original draft;

Kuroiedova V.D. – conceptualization, writing – review and editing;

Korobov P.S. – investigation, methodology;

Halych L.B. – supervision, validation.

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