INTRODUCTION

According to the law of interdependence of morphology and function, any structural changes at different levels of system organization of living organisms are accompanied by functional disorders, and vice versa [1]. Pathological abrasion of hard dental tissues refers to diseases that are accompanied by serious morphological and functional disorders. The prevalence of pathological abrasion of hard dental tissues varies from 4% to 57% at young age, reaches 91% in older people and is accompanied by both morphological and functional disorders of the dentofacial system. [2, 3]. Functional disorders in the form of changes in the bioelectrical activity of the masticatory muscles and biodynamic equilibrium are in direct dependence on the clinical form and severity of pathological abrasion of teeth [4, 5].

The study of electromyographic characteristics of the masticatory muscles allows us to determine the degree of functional changes in the pathological conditions of the chewing system [6, 7] and subsequently to control the degree of functional rehabilitation of patients after prosthetics, which determines the relevance of our research.

THE AIM

The aim was to study the electromyographic characteristics of the masticatory muscles in patients with pathological abrasion of hard dental tissues of varying degrees of severity.

MATERIALS AND METHODS

To reach the aim, we have clinically examined and conducted electromyographic studies of masticatory muscles (m. Masseter) in 89 patients aged 18 to 59 with pathological abrasion of hard dental tissues, including the control group of the same age period in the number of 17 patients with physiological forms of abrasion of teeth within the enamel with intact dentitions and physiological forms of occlusion.

Depending on the degree of pathological abrasion, the examined individuals were divided into the following clinical groups: Group I – 35 patients with pathological abrasion of 1 degree (up to 1/3 of the crown height); Group II – 37 patients with a lesion depth of 2 degree (from 1/3 to 2/3 of the crown height). Group III included 17 patients with physiological forms of abrasion within the enamel.

Patients with a lesion depth of the third degree (from 2/3 of the crown height to the gum level) were not included in the study because in most cases the clinical picture was accompanied by a significant loss of the anatomical shape of the teeth, sometimes a complete loss of the tooth crown, defects of the dentition of a significant size complicated by dentofacial deformations with the loss of antagonist teeth and the impossibility of full chewing, which made it impossible in principle to conduct functional tests “maximum compression of dentition in the position of central occlusion” and “volitional chewing”.

The functional state of the masticatory muscles by the method of functional electromyography was determined in patients from the I, II clinical groups and the III control group. It consisted in recording the bioelectric potentials of the muscles before the beginning of the prosthesis.

The electromyographic study was performed using a computer neuroelectromyograph M-Test, produced by the association “DX-Systems” (Ukraine) and a computer system for the analysis of electromyographic records. The method of conducting the study included fixing on the motor points of the right and left masticatory muscles (m. Masseter) of the skin silver electrodes in diameter of 5 mm with a constant interelectrode distance of 15 mm, to which a gel was applied for electrophysiological studies. Daily bread quota in at the amount of 1 cm³ and weight of 1.5 gr. was used as food stimulus. Electromyograms were recorded in the following sequence: calibration signal – relative physiological resting position – volitional three-second compression of the jaws – relative physiological resting position – volitional chewing – swallowing.

Bioelectric activity of the masticatory muscles during electromyographic studies was evaluated qualitatively and quantitatively. In particular, the nature of the inclusion of motor units in the process of functioning of the masticatory muscles, the lack of activity in the state of relative physiological rest and the nature of the alternation of periods of bioelectric activity and rest in the process of chewing were determined. During quantitative processing of electromyograms, the following indicators were taken into account: the amplitude of compression and chewing (μV); the bioelectrical activity time (ms); the resting phase duration (ms) and the coefficient “K”. The frequency indicator of biopotential oscillations (F in Hz) was also of interest.

**RESULTS AND DISCUSSION**

Analysing the degree of functional disorders of the masticatory muscles caused by pathological abrasion and the change in the anatomical shape of the teeth, we certainly based on the physiological norm. The results of conducted electromyographic studies in the control group showed that the maximal three-second volitional jaw compression was normally characterized by the instantaneous inclusion of motor units, which was expressed in the structure of the record by high-amplitude oscillations of biopotentials of approximately the same magnitude. Muscle relaxation was

<table>
<thead>
<tr>
<th>Studied Electromyographic Indicator</th>
<th>Masticatory Muscle</th>
<th>Average Indicators of Group III (Control Group) (n=17)</th>
<th>Patients with pathological abrasion of hard dental tissues</th>
<th>Group I (n=35)</th>
<th>Probability of Differences with Control Group (P)</th>
<th>Group II (n=37)</th>
<th>Probability of Differences with Group I (P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Compression Amplitude (μV)</td>
<td>right</td>
<td>756±21,9</td>
<td>511±9,5</td>
<td>&lt;0,01</td>
<td>443±8,8</td>
<td>&lt;0,01</td>
<td></td>
</tr>
<tr>
<td></td>
<td>left</td>
<td>782±29,4</td>
<td>522±11,0</td>
<td>&lt;0,01</td>
<td>451±7,9</td>
<td>&lt;0,01</td>
<td></td>
</tr>
<tr>
<td>Average Chewing Amplitude (μV)</td>
<td>right</td>
<td>815±15,5</td>
<td>548±8,2</td>
<td>&lt;0,01</td>
<td>531±9,3</td>
<td>&lt;0,01</td>
<td></td>
</tr>
<tr>
<td></td>
<td>left</td>
<td>804±19,3</td>
<td>561±10,4</td>
<td>&lt;0,01</td>
<td>519±10,1</td>
<td>&lt;0,01</td>
<td></td>
</tr>
<tr>
<td>Oscillation Frequency while Compression (Hz)</td>
<td>right</td>
<td>290±10,5</td>
<td>323±4,4</td>
<td>&lt;0,01</td>
<td>350±3,6</td>
<td>&lt;0,01</td>
<td></td>
</tr>
<tr>
<td></td>
<td>left</td>
<td>283±8,4</td>
<td>320±4,1</td>
<td>&lt;0,01</td>
<td>345±4,1</td>
<td>&lt;0,01</td>
<td></td>
</tr>
<tr>
<td>Oscillation Frequency while Chewing(Hz)</td>
<td>right</td>
<td>280±7,9</td>
<td>295±3,8</td>
<td>&lt;0,01</td>
<td>300±3,2</td>
<td>&lt;0,01</td>
<td></td>
</tr>
<tr>
<td></td>
<td>left</td>
<td>277±9,3</td>
<td>297±3,1</td>
<td>&lt;0,01</td>
<td>306±3,3</td>
<td>&lt;0,01</td>
<td></td>
</tr>
<tr>
<td>Active Phase Duration (Ms.)</td>
<td>right</td>
<td>298±14,8</td>
<td>430±5,4</td>
<td>&lt;0,01</td>
<td>471±6,6</td>
<td>&lt;0,01</td>
<td></td>
</tr>
<tr>
<td></td>
<td>left</td>
<td>301±14,1</td>
<td>421±5,6</td>
<td>&lt;0,01</td>
<td>480±6,1</td>
<td>&lt;0,01</td>
<td></td>
</tr>
<tr>
<td>Resting Phase Duration (Ms.)</td>
<td>right</td>
<td>280±15,4</td>
<td>239±5,3</td>
<td>&lt;0,01</td>
<td>221±6,1</td>
<td>&lt;0,01</td>
<td></td>
</tr>
<tr>
<td></td>
<td>left</td>
<td>172±12,9</td>
<td>241±6,3</td>
<td>&lt;0,01</td>
<td>218±5,1</td>
<td>&lt;0,01</td>
<td></td>
</tr>
<tr>
<td>“K”</td>
<td>right</td>
<td>1,04±0,04</td>
<td>1,59±0,03</td>
<td>&lt;0,05</td>
<td>1,72±0,03</td>
<td>&lt;0,05</td>
<td></td>
</tr>
<tr>
<td></td>
<td>left</td>
<td>1,05±0,04</td>
<td>1,55±0,02</td>
<td>&lt;0,05</td>
<td>1,79±0,04</td>
<td>&lt;0,05</td>
<td></td>
</tr>
</tbody>
</table>
represented by a rapid transition to a state of rest. Volitional chewing was characterized by a clear division of the structure of records, that is, expressed by alternating “firings” of bioelectric activity with rest periods. The amplitude of oscillations of biopotentials, appearing at the beginning of the “firing”, rises to its middle and gradually decreases in the end. One of the main features of volitional chewing in patients of the control group was a change in chewing sides in the process of one chewing test. This happened reflexively and indicated a high degree of coordination activity of the masticatory muscles. When conducting a test with a volitional chewing, periods of activity alternated with periods of rest. At first high-amplitude oscillations were observed, which at the end of the chewing became less pronounced.

In patients of Groups I and II, there was an extension of the chewing period, a decrease in the chewing rhythm and a deterioration of chewing efficacy. Particularly noticeable changes took place within individual dynamic cycles: the correlation between excitatory and inhibitory processes sharply deteriorated with an increase in the duration of activity by reducing the period of relative bioelectric rest, and the magnitude of the biopotential amplitude decreased relative to the norm.

To establish the degree of functional disorders of the masticatory muscles of patients with pathological abrasion of hard dental tissues of varying degrees of severity, a quantitative analysis of the obtained electromyographic indicators was carried out. The results are shown in Table I.

As can be seen from Table 1 in patients of the control group, high-amplitude oscillations of biopotentials of approximately the same magnitude were observed during the test of a three-second voluntary compression of the jaws on the electromyograph. The average compression amplitude was 756 ± 21.9 and 782 ± 29.4 μV, respectively for the right and left masticatory muscles. In case of pathological abrasion of hard dental tissues, a significantly lower difference in patients of the control group was a change in chewing against the background of the pathological abrasion of hard dental tissues of varying severity. In particular, in patients with pathological abrasion of the two study groups, compared with the norm, there is a prolongation of the chewing period, a change in the chewing rhythm and a decrease in chewing efficacy, the correlation between the excitatory and inhibitory processes is sharply deteriorating, the bioelectric activity period increases due to the reduction of the relative bioelectric rest period, the masticatory muscles of both sides generally function irrationally. The obtained results confirm the relationship between the degree of pathological abrasion of hard dental tissues and the degree of functional disorders of the masticatory muscles.

**CONCLUSIONS**

The results of electromyographic studies of masticatory muscles make it possible to determine the degree of functional changes in their activity in patients with pathological abrasion of hard dental tissues of varying severity. In particular, in patients with pathological abrasion of the two study groups, compared with the norm, there is a prolongation of the chewing period, a change in the chewing rhythm and a decrease in chewing efficacy, the correlation between the excitatory and inhibitory processes is sharply deteriorating, the bioelectric activity period increases due to the reduction of the relative bioelectric rest period, the masticatory muscles of both sides generally function irrationally. The obtained results confirm the relationship between the degree of pathological abrasion of hard dental tissues and the degree of functional disorders of the masticatory muscles.

**Prospects for further research.** The prospect of further research is the need for further in-depth study of the functional changes in the masticatory muscles against the background of the pathological abrasion of hard dental tissues in order to find the best ways to rehabilitate such patients.

**REFERENCES**

1. Strukov AI, Hmel’nickij OK, Petlenko VP. Morfologicheskij ekvivalent funkci (Metodologicheskie osnovy) [Morphological equivalent of the function (Methodological foundations)]. Moskva: Medicina; 1983. 208 s.
3. Bida VI. Patologichne stryannja tverdykh tkuniv zubiv ta osnovni pryncypy jogo likuvannja (navchal’no-metodychnij posibnyk) [Pathological abrasion of hard tissues of teeth and basic principles of its treatment (educational manual)]. Kyiv: Kyiv’ska pravda; 2002. 96 s.


Authors’ contributions: According to the order of the Authorship.

ORCID numbers:
Aleksey V. Bida - 0000-0003-1764-9669
Volodymyr I. Struk - 0000-0002-1127-1485
Vitaliy I. Bida - 0000-0002-1786-2032
Serhii M. Hermanchuk - 0000-0002-9927-564X

Conflict of interest:
The Authors declare no conflict of interest.

CORRESPONDING AUTHOR
Serhii M. Hermanchuk
Chekhov street 24, apartment 21, 08200 Irpen, Kyiv region, Ukraine
tel: +380506059241
e-mail: shermanchuk@ukr.net

Received: 17.04.2019
Accepted: 20.08.2019