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# SOME FEATURES OF THE BIOELECTRIC ACTIVITY OF THE MUSCLES WITH PROLONGED HYPOKINESIA

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Translation of "O nekotorykh osobennostyakh bioelektricheskoy aktivnosti myshts pri dlitel'noy gipokinezii", Voprosy kurortologii, fizioterapii i lechebnoy fizicheskoy kul'tury, No. 3, May-June 1975, pp. 238-241.




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16. Abstract

The report discusses the bioelectric activity of the muscles with prolonged hypokinesia, brought on by confinement to bed and the attendant lack of motor activity. Electromyographic measurements of the amplitude and frequency indicators of muscular bioelectric activity were used as the bases of the discussion.

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# SOME FEATURES OF THE BIOELECTRIC ACTIVITY OF THE MUSCLES WITH PROLONGED HYPOKINESIA

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In recent years, questions of the limitation of motor activity have acquired increasing general-clinical significance, in connection with the fact that the negative effect of hypokinesa on a series of physiological processes in the body has been shown in a number of special studies (L.I. Kakurin, et al.; A.M. Genin and P.A. Sorokin, and others). At the same time, the strict bed-rest regimen, which leads to the development of hypokinesia and hypodynamia, occupies an important place in the complex of treatment measures for a number of diseases. Clinical physicians often encounter induced hypokinesia in connection with cardiovascular pathology, damage to the nervous system, surgical intervention, etc. /238*

There is a series of reports on the fact that prolonged (over 10-14 days) limitation of motor activity evokes appreciable disturbances on the part of the motor sphere (L.I. Kakurin, et al.). Basic attention is given to such clinical symptoms as diffuse hypotrophy of the muscles of the pelvic girdle and legs, along with a reduction in muscle tone and static and dynamic durability.

As concerns the bioelectric activity of the muscles with prolonged hypokinesia, there are only individual indications of the reduction in the amplitude of muscular biological

*Numbers in the margin indicate pagination in the foreign text.

currents in the legs with maximum muscular effort, without a change in the frequency of oscillations (A.G. Panov, et al.) available in the literature.

In the present study, which also includes qualitative (according to Yu.S. Yusevich) analysis of the bioelectric activity of the muscles, we present the results of the electromyographic analysis of the flexors and extensors of the hands and feet by the standard method of summary or global abduction. Recording was carried out on the "Diza" three-channel electromyograph at rest, and during a series of functional tests (inhalation, indirect synergy, maximum contraction, and others).

24 healthy men from 19 to 34 years of age were examined; 18 of them were on a strict bed-rest regimen for 30 days (they were forbidden to rise and sit on the bed, and they carried out physiological functions with the help of bedpans); 6 persons, who were on a normal motor regimen, comprised the control group. The electromyograms (EMG) were recorded 4 times: in the background period, prior to the beginning of the hypokinetic effect, on the 14-15th and 29-30th days of confinement to bed, and also after a course of treatment measures, carried out for more rapid recovery of the disturbed functions.

The treatment-recovery complex used in the 2 regimens (2 groups of 9 persons each) included massage, LFK[1], and balneologic procedures. The indicated regimens of the rehabilitative course were conditionally called active and passive. During the active regimen, the persons being tested executed a series of recommendations for a training regimen and self-massage, basically independently, and during the passive regimen, the greater part of the treatment actions was carried out by medical personnel. On the whole, the

[1] LFK — lechebnaya fizkul'tura (therapeutic physical culture).

regimens were similar in volume and intensity of the actions, which was manifested in the absence of a clear-cut difference in the dynamics of recovery of a number of neurological indicators, including EMG data. This corroborated the sufficient saturation of both regimens with effective treatment-recovery measures.

Those being tested who were confined to bed were distributed into 3 groups of 6 persons each. The first group included those on cots with a downward inclination of the head at an angle of $6^{\circ}$, the second—those with the cot inclined "head upward" at the very same angle, and the third—on cots with the head angled downward at $2^{\circ}$. All of those being tested, including those in the control group, were examined according to an identical program. During analysis of the obtained EMG's, in addition to their qualitative evaluation, special attention was given to the amplitude and frequency of the biopotentials. As is common knowledge, these basic indicators of the EMG's are closely associated with the degree of synchronization and the number of stimulated neuromotor units, as well as with the intensity of the process of stimulation in them at the moment of recording. The number of actively functioning muscular fibers is also important. /239

The investigation showed that prolonged limitation of muscular activity evokes a number of quantitative, and sometimes even qualitative, changes in the electric activity of the muscles, which is displayed especially clearly through comparison with the background data. In all 24 of those being tested, the latter data showed normal muscular bioelectric activity (type I EMG, according to Yu. S. Yusevich). In those in the control group, with repeated analysis of the EMG at the end of the experiment, substantial changes were not detected in the electric activity of the muscles. With re-

spect for the basic 3 groups of those being tested, who were in a bed-rest regimen, some shifts in bioelectric muscular activity, without exceeding the limits of the type I EMG, were noted even during dynamic analysis of the EMG's conducted on the 14-15th days of confinement to bed. This tendency was primarily displayed with respect to the amplitude indicators. An atrophic process was expressed in a decrease in the thigh perimeter at the shin by an average of 1.5-2.5 cm in all 18 of those being tested; a decrease in muscular tone was noted at the same time. We observed positive dynamics of the indicated changes during the recovery period.

It is shown in figure 1 that the amplitudes of the potentials decreased with maximum contractions of the muscles being studied in those being examined in all 3 groups, at different stages of confinement to bed; however, with examination on the 29-30th days of confinement to bed, a tendency was noted towards a slight increase in the previous amplitude and frequency indicators. In spite of the clear-cut pronouncedness of the tendency towards a return of the amplitude indicators to the background magnitudes under the influence of rehabilitative measures, positive /240
dynamics were not sufficiently displayed in all of those being studied. Thus, in those examined in the 3rd group, even at the end of the recovery period 14-15 days after the end of confinement to bed, the amplitude indicators of the EMG remained low. It is possible that this is connected with the fact that 2 persons in the 3rd group had especially serious hypokinesia; the most unfavorable dynamics of bioelectric activity, on the whole, was noted in them.

With respect to the frequency indicators of the EMG's, this aspect of the bioelectric activity of the muscles proved to be more stable, and did not undergo substantial changes

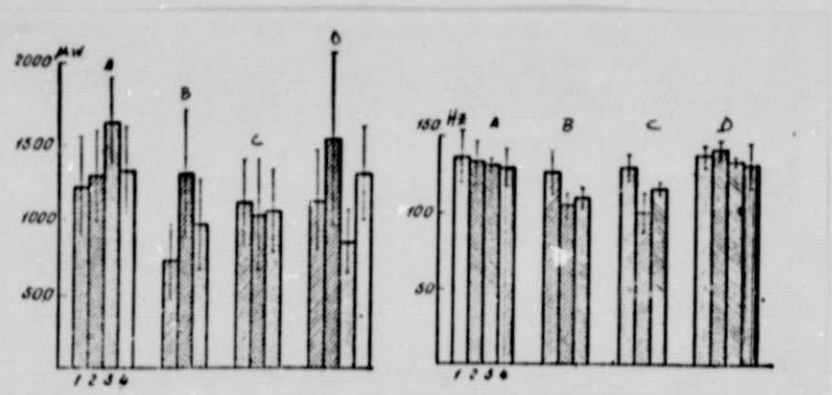


Fig. 1. Dynamics of amplitude indicators of bioelectric activity of muscles in different stages of the experiment.

Here and in fig. 2: A—initial condition, B-14-15th days, C-29-30th days confined to bed, D-14-15th days of recovery period; 1-3—basic groups; 4—control.

Fig. 2. Dynamics of frequency indicators of bioelectric activity of muscles in different stages of the experiment.

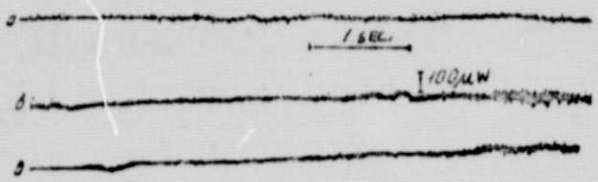




Fig. 3. Appearance of curtailed rhythmic activity on 29-30th days of confinement to bed (right gastrocnemius, test with indirect synergy)

Here and in fig. 4: a-background period; b-29-30th days of confinement to bed; c-end of confinement period.

under the influence of hypokinesia (fig. 2), and the tendency towards a relative decrease in the frequency values was expressed insignificantly. The indicated changes were displayed most appreciably in the leg muscles, especially in the group of foot extensors; however, in isolated persons, the reduction in the amplitude and frequency indicators prevailed in the foot flexors. In those examined in the control group, with background and repeated analysis of the EMG's at the end of

the experiment, substantial changes were not revealed in electrical activity.

With respect to some qualitative changes in electrical activity, recorded in individual persons as early as the 14-15th days of confinement to bed, but encountered with greater frequency with examination on the 29-30th days, they were displayed in spontaneous bioelectric discharges of the type of curtailed rhythmic activity, and somewhat more often in individual potentials of fasciculations (figs. 3 and 4).

It should be noted that the indicated changes in electric activity were detected most often in the legs, especially in the gastrocnemius. Normalization of the bioelectric activity of the muscles (interference EMG) in all of those being tested, without exception, with maximum contraction of the muscles makes it possible to think that there were no clearly pathologic changes in electric activity in even one of the groups (fig. 5).

Potentials of fasciculations prevailed phenomenologically among the detected quantitative changes in bioelectric activity in different stages of the experiment (chiefly on the 29-30th days of confinement to bed), and curtailed rhythmic activity was noted less often, never exceeding the limits of type IIb (according to Yu.S. Yusevich). As was indicated above, these bioelectric displays were observed only at rest, during respiration and synergy. /241

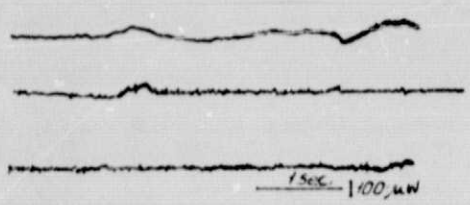


Fig. 4. Appearance of individual potentials of fasciculations on the 29-30th days of confinement to bed (left gastrocnemius, respiratory test).

With respect to the potentials of fasciculations, it is currently generally-acknowledged that they are,

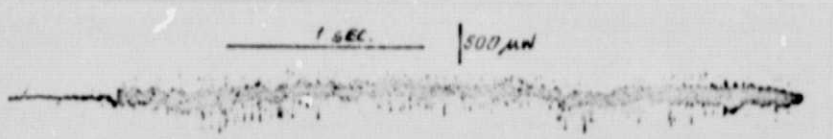


Fig. 5. Typical interference EMG, recorded with maximum contraction (right gastrocnemius, 29-30th days of confinement to bed).

as a rule, spontaneous discharges in a separate motor unit, which occur usually in a motoneuron (or a body or axone). The cause may be an increase in the excitability of the cell, evoked by its primary (in the given case, because of the changed $\gamma$-afferentation with idle musculature) or secondary (change in suprasegmental, specifically reticulospinal impulsation) stimulation.

The revealed spontaneous curtailed bioelectric activity of the muscles may indicate an increase in synchronization of stimulation of the motoneurons, which is associated with a change in the excitability and lability of their individual groups. The transient, "functional" nature of these changes is corroborated by their disappearance with maximum contraction, which indicates the absence of irreversible pathologic changes in the motor units. Attention is also drawn to the positive dynamics of bioelectric muscular activity recorded after the course of rehabilitative measures, which indicates the necessity of their implementation, with the purpose of rapid and complete recovery of the changed functions.

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