Analysis of indicators of the neuromuscular apparatus and kinematic characteristics of the running technique of track and field athletes of sports persons with intellectual disabilities

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Abstract

Objective of the study was to reveal the features of bioelectrical activity and viscoelastic properties of the muscles of the lower extremities in relation to the kinematic characteristics of the 100-meter run technique in athletes with intellectual disabilities.

Methods and structure of the study. With the participation of 23 athletes with a mild degree of mental retardation, studies were carried out using non-invasive methods of electromyography, myotonometry and the calculation of the asymmetry coefficient to assess the functional capabilities of the muscles of the lower extremities, indicators were analyzed at rest and during static muscle tension. A video analysis of the 100-meter running technique and a correlation analysis were carried out.

Results and conclusions. The features of bioelectrical activity and viscoelastic properties of the muscles of the lower extremities at rest and under static load were revealed. At rest, high values of the amplitude of muscle contraction, asymmetry of the indicators of tone and stiffness of the studied muscle groups on the left are noted. Under static load, muscle asymmetry to the left was revealed, higher functional reserves of the studied muscle groups of the lower extremities on the left were shown. Correlation analysis showed a high degree of interdependence of running technique indicators with bioelectrical activity and stiffness of the studied muscles of the left lower limb.

Keywords: *neuromuscular apparatus, viscoelastic properties, kinematic indicators, running technique, athletes with intellectual disabilities.*

Introduction. Sports activity is associated with functional changes in all body systems, including the neuromuscular system (hereinafter referred to as NMS). At the same time, the continuity of morphological, biochemical, functional rearrangements in the NMS forms the basis for the correct implementation of motor action techniques and the development of special physical qualities [2-6]. Changes in the functional capabilities of an athlete's NMS during training and competitive activities are primarily aimed at maintaining muscle balance when performing competitive exercise techniques and improving motor functions [5, 9, 11].

The results of scientific research in the field of Paralympic sports confirm the need to study the characteristics of the functional state of athletes with disabilities. At the same time, the functional features of the NMS, which primarily determine the effectiveness of performing a competitive exercise technique, have been studied to a lesser extent [3, 7, 8, 9, 11]. Consequently, determining the parameters of the functional state of the NMS and analyzing their characteristics in Paralympic athletes in connection with the kinematic characteristics of running technique will make it possible to substantiate scientific and methodological proposals for increasing the effectiveness of training and competitive activities in the Paralympic disciplines of athletics.

Objective of the study was to reveal the features of bioelectrical activity and viscoelastic properties of

the muscles of the lower extremities in relation to the kinematic characteristics of the 100-meter run technique in athletes with intellectual disabilities.

Methods and structure of the study. The scientific work was carried out in the preparatory period of the annual training cycle with the participation of 23 athletes with mild mental retardation, aged 15-20 years, training at the stage of improving sports skills. Using electromyography ("Neuro MEP Micro") and myotonometry (MyotonPro technology) [1], the bioelectrical activity and viscoelastic properties of the muscles of the lower extremities were studied. The measurements were carried out in two modes: at rest and when performing a maximum static load for 10-15 s. Indicators were recorded on the right and left sides; the following muscles were examined: the rectus femoris muscle (RFM), the long head of the biceps femoris (LHBF) and the lateral head of the gastrocnemius muscle (LHGM).

To analyze the kinematic parameters of the athletics running technique, video recording was carried out using a stationary video camera Sony HDR CX 550 E, recording signals at a frequency of 50 frames per second. Biomechanical analysis of athletics running technique was carried out using Dartfish Pro Suite 10 software. Indicators of support time and running speed were analyzed.

Statistical processing of the results was performed on a PC using the data analysis package in Excel 10. The statistical significance of the differences was determined by the Wilcoxon test, at $p<0.05$. The correlation analysis used the calculation of the Spearman rank correlation coefficient at a significance level of $p<0.01$.

The asymmetry index was calculated using the formula: IS=[(XR-XL): (XR+XL)]x100, where IS is the symmetry index, XR is the results on the right side, XL is the results on the left side. A positive value of the asymmetry index indicates asymmetry to the right, a negative value indicates asymmetry to the left [10].

Results of the study and discussion. The table presents the results of electromyographic parameters of the examined athletes. The maximum amplitude of bioelectrical activity of muscle tone at rest was higher than in healthy athletes, which reflects the tension of the NMS. There is also an asymmetry in the tone of the studied muscles of the lower extremities on the left.

With a static load, a smaller amplitude of the tone of the studied muscles on the left is recorded, significant differences in the rectus femoris muscle and the lateral head of the gastrocnemius muscle ($p<0.05$). Relative to rest, a large difference in the maximum amplitude on the right was observed, which may indicate higher functional reserves of the studied muscles of the lower extremities on the right.

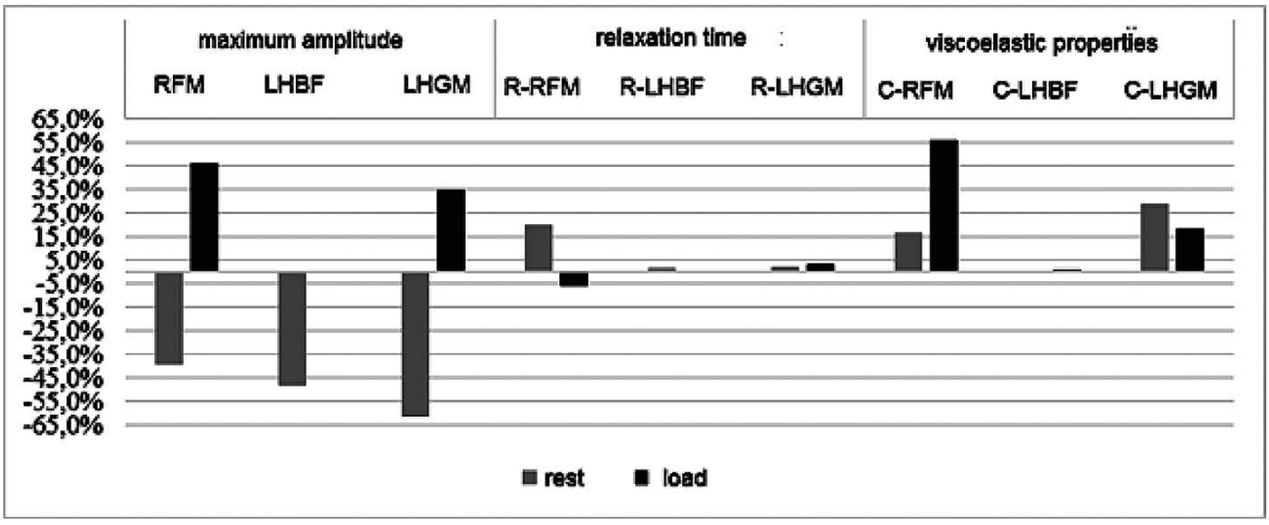
Indicators of visco-elastic properties of the muscles of the lower extremities at rest, judging by all myotonometric parameters studied, were normal. There is asymmetry to the left, judging by the tone and stiffness, as well as lower relaxation times and fluidity, especially of the rectus femoris muscle ($p<0.05$), which indicates greater functional reserves at rest in the muscles of the lower limb on the left.

At the maximum static load, asymmetry and imbalance of all the studied muscles were determined, since the indicators of tone and stiffness are higher on the right in the rectus femoris muscle, and in other muscle groups of the LHBF and LHGM these same indicators are higher on the left.

The asymmetry index (see figure) based on the maximum amplitude of bioelectrical activity of muscle tone at rest showed a significant asymmetry to the left of all studied muscles by 39.5-61.6%. The viscoelastic properties of the muscles of the lower extremities at rest indicate a slight asymmetry to the left in the relax-

Condition of the muscles of the lower extremities in athletes with intellectual disabilities at rest and at maximum static load according to electromyography data

Muscle examined		Maximum amplitude, μV	
		rest	load
RFM	right	96,90±23,69	737,12±137,92
	left	144,57±44,44	460,29±56,62
P		<0,05	<0,05
LHBF	right	116,07±31,94	674,90±107,35
	left	189,78±69,32	673,61±71,72
P		<0,05	>0,05
LHGM	right	68,20±19,90	915,07±208,44
	left	128,89±56,61	640,21±87,24
P		<0,05	<0,05



Asymmetry index based on the maximum amplitude of bioelectrical activity of muscle tone and viscoelastic properties of muscles at rest and under static load, in %

ation time of the rectus femoris muscle (20.2%) and the fluidity of the rectus femoris muscle (16.7%).

With a static load, there is a significant asymmetry of the rectus femoris muscle (46.2%) and the lateral head of the gastrocnemius muscle (35.3%) to the right in terms of the maximum amplitude of the bioelectric activity of the muscle tone and the indicator of the fluidity of the visco-elastic properties of the rectus femoris muscle (55.9%) and lateral head of the gastrocnemius muscle (18.4%).

Correlation analysis of the kinematic characteristics of the 100 m running technique and the state of the neuromuscular system showed high two-sided significance at the level of $p<0.01$ between the indicators of bioelectric activity of the muscles of the long head of the biceps femoris, the lateral head of the gastrocnemius muscle on the left, the stiffness of the lateral head of the gastrocnemius muscle on the right and support time, and There is also a high negative interdependence between the indicators of bioelectrical activity of the muscles of the long head of the biceps femoris, the lateral head of the gastrocnemius muscle, the rectus femoris muscle on the left, the stiffness of the lateral head of the gastrocnemius muscle on the right and running speed.

Conclusions. Thus, in the course of this study, the features of bioelectrical activity and viscoelastic properties of the muscles of the lower extremities and the relationship with the kinematic characteristics of the 100-meter running technique in athletes with intellectual disabilities were identified. In the training activities of track and field athletes with intellectual disabilities, it is necessary to provide for the use of training tools aimed at maintaining muscle balance when performing competitive exercise techniques and improving the motor functions of athletes.

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