CHANGES IN THE RECRUITMENT OF SKELETAL NEUROMOTOR UNITS UNDER THE CONDITIONS OF ANDROGEN DEFICIENCY

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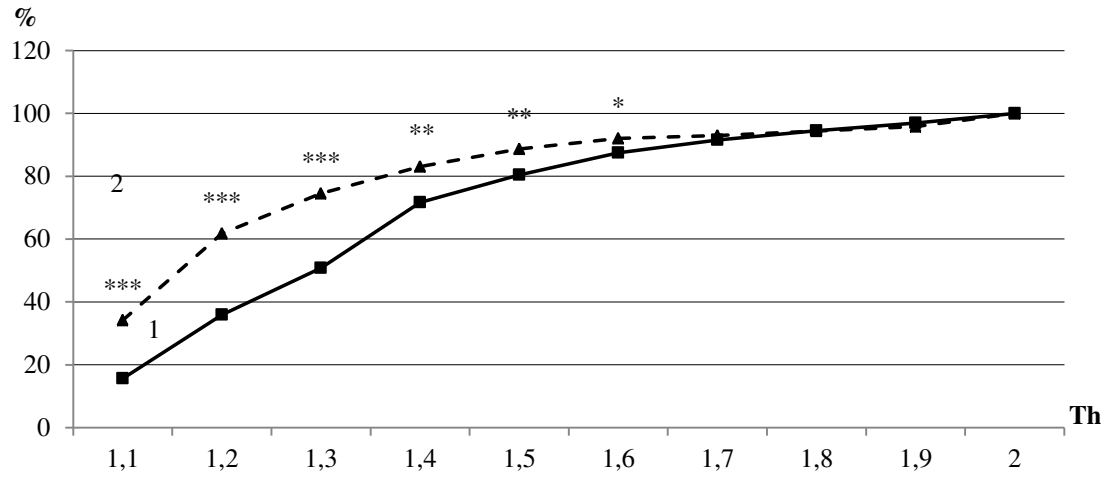
Introductions. Testosterone deficiency, which occurs acutely as a result of trauma or surgical castration as the part of some oncological diseases treatment, can lead to various forms of nerve degeneration, including their morphological changes. A genetically determined defect of androgen receptors causes spinal muscular atrophy, manifested by neuromuscular dysfunction and proximal muscle weakness. It is known about the neuroprotective effect of testosterone in spinal injuries. However, there are almost no studies, especially electrophysiological ones, characterizing the modification of the bioelectric activity of the somatic reflex arc links in the remote periods of the post-castration syndrome.

Aim. The aim was to investigate the effect of a long-term lack of androgens in the post-castration period on the dynamics of the calf muscle neuromotor units excitation.

Materials and methods. Hypoandrogenemia was modeled by bilateral orchiectomy on male Wistar rats aged 5-6 months and weighing 180-260 g. Motor neuron activity was studied by stimulating the isolated dorsal root, deriving the evoked action potential from the isolated ventral root of the spinal cord. When examining the ventral root, evoked responses were diverted from the sciatic nerve, irritating the fibers of the ventral root isolated from the spinal cord. In order to study the dynamics of the recruitment for reflex arc links, stimulation with rectangular pulses of increasing intensity from the threshold (Th) value to twice its value with a step of 1/10 and a duration of 300 μs was used [1].

Results and discussion. In the study of monosynaptic discharges of the ventral

root in the animals of the experimental group, an increase in the threshold value of the stimulus by 35.29±8.7% ($p<0.01$, $n=10$) was observed in relation to the same indicator of the intact group. Chronoxia in androgen-deficient rats decreased by 6.2±2.66% ($p<0.05$, $n=10$). Irritation of the dorsal root fibers with pulses of increasing intensity revealed a faster increase in the integral response amplitude of motoneurons in animals with experimental hypoandrogenemia in the range from 1.1 Th to 1.6 Th, especially up to 1.3Th inclusive. Thus, at the intensity of irritation 1.1 Th the difference was 117.8±18.72%, 1.2 Th – 72.2±10.97%, 1.3ThP – 46.6±6.52% ($n= 10$, $p<0.001$) (Fig. 1).

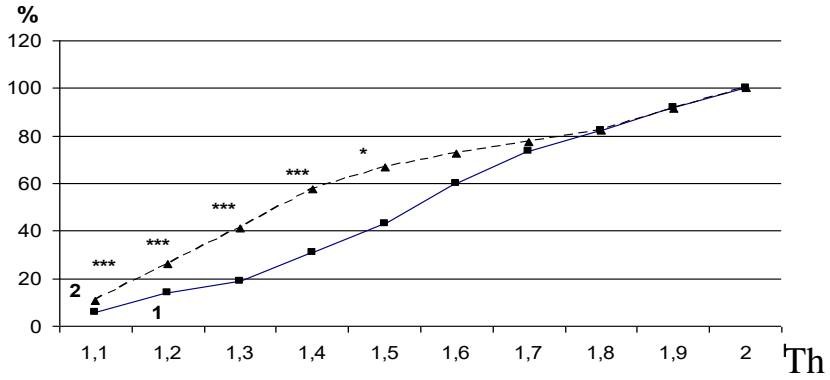


1 – control group; 2 - experimental group.

Fig. 1. Dynamics of changes in the amplitude of monosynaptic discharges of the ventral root of the spinal cord in response to stimulation of increasing intensity

As for the excitability parameters of the ventral root fibers, the threshold was 664.29±0.75%, and the chronaxia was 71.90±1.94% compared to the control group indicators. The study of the recruitment of nerve fibers also showed a faster increase in the amplitude of the evoked total action potential in the animals of the experimental group, especially when stimulated with a force 1.1 – 1.6 Th (Fig. 2). A significant difference that was recorded when using stimuli from 1.1 to 1.5 Th may indicate a relative increase in the excitability of high- and medium-threshold fibers in the composition of the ventral root. These deviations can be caused by a change in the ultrastructure of the neurites of the anterior horn motoneurons of the spinal cord [2, 3], which actually form this ventral root, as well as by demyelinating processes

that could lead to ephaptic propagation of excitation within this root [3, 4].

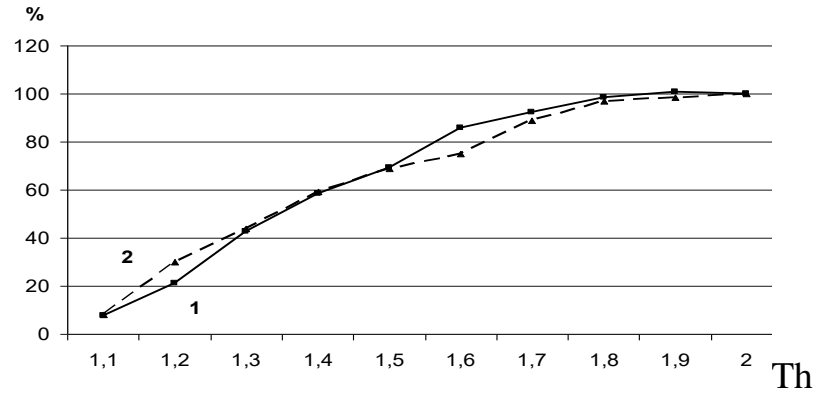


1 – control group; 2 - experimental group.

Fig. 2. Recruitment of fibers of the ventral root of the spinal cord in response to stimulation of increasing intensity

Probability level * – $p<0.05$, *** – $p<0.001$ in relation to the corresponding values of the control group

The value of the calf muscle excitation threshold during indirect stimulation was equal to 0.053±0.0125 mA (n=10), in animals with experimental hypoandrogenemia it increased significantly ($p<0.001$) to 433.96% (0.23±0.02; n=14). The chronaxia has not undergone any significant changes. During the analysis of changes in the amplitude of evoked action potentials, taken from the calf muscle, no significant influence of androgen deficiency was detected, although a tendency to decrease the excitability of high-threshold muscle fibers and a decrease in the excitation threshold for medium-threshold muscle fibers was observed (Fig. 3) [5].



1 – control group; 2 - experimental group.

Fig. 3. Recruitment of motor units of the calf muscle under conditions of stimulation of the sciatic nerve with stimuli of increasing intensity

Conclusions. Long-term androgen deficiency in the case of its sudden onset in the reproductive age is able to modify the process of recruitment of neuromotor units, relatively increasing the excitability of medium-threshold motoneurons and their axons, that leads to the early activation of a larger number of neuromotor units against the background of a general absolute decrease in the excitability of nerve structures of the segmental somatic reflex arc. The above can explain the development of muscle weakness and convulsions in the long term of post-castration syndrome. This pathological condition has a greater effect on the bioelectrical activity of the central link of the reflex arc, while the dynamics of the excitation of multithreshold muscle fibers under indirect irritation did not undergo significant changes.

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