EFFECT OF PROLONGED STIMULATION OF AFFERENT FIBERS ON CHANGES IN EFFERENT BIOPOTENTIALS IN FROGS

Yu. A. Darinskii

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After stimulation of the dorsal root (pair IX-X) of the spinal cord of a frog anesthetized with hexobarbital with pulses of different frequency but constant strength, the amplitude of biopotentials in the ventral root is decremental in character. The decrement takes place in two phases: an initial, rapid one (during the 1st second) followed by a slow phase. With an increase in frequency of stimulation, the degree of decrease in amplitude of the efferent impulse activity also increases. The rate of recovery of efferent impulse activity is directly dependent on the frequency of the preceding stimulation.

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Prolonged stimulation of the afferent part of the somatic reflex arc leads to a decrease in the reflex response [1-5]. However, most investigations in this direction have been undertaken on warm-blooded animals. It is therefore interesting to investigate this phenomenon in cold-blooded animals.

In the present investigation an electrophysiological analysis was made of changes in amplitude of biopotentials in the central part of the somatic reflex arc of frogs anesthetized with hexobarbital during prolonged dorsal root stimulation.

EXPERIMENTAL METHOD AND RESULTS

Experiments were carried out on 20 frogs (Rana temporaria). The dorsal root was stimulated and biopotentials recorded from the corresponding ventral root (pairs IX-X) of the spinal cord. The duration of the stimulating pulse was 0.2 sec and its strength twice the threshold level. Each experiment consisted of two series of successive 2-min stimulations with frequencies of 1, 5, 10, 20, 50, and 100/sec. Intervals between stimuli were 15-20 min. After dorsal root stimulation with impulses of a particular frequency the excitability of the reflex arc was tested for 2-3 min by test pulses at frequency of 1/min.

After dorsal root stimulation for 2 min with pulses of different frequencies but constant strength and duration, the efferent impulse activity was decremental in character. However, a limit was found during dorsal root stimulation below which no decrease in amplitude took place. Usually this limit was 1/sec (Fig. 1, 1). Sometimes, however, it was displaced to a higher or lower frequency of stimulation.

A frequency of 5/sec caused a very slight decrease in amplitude of the ventral root responses (Fig. 1, 2). The number of after-oscillations on the descending part of the biopotential was reduced. From 1 to 2 min after the change to test pulses, the initial amplitude of the potentials was restored and oscillations reappeared.

With an increase in frequency of stimulation to 10-20/sec, a sharp decrease in amplitude of the biopotentials was observed in the responses to the first few stimuli. During the next 2 min of stimulation changes in amplitude were very slight. During the 2 min after the end of stimulation complete recovery of amplitude and shape of the biopotentials was observed (Fig. 1, 3 and 4).

During stimulation at frequencies of 50-100/sec (Fig. 1, 5 and 6), the amplitude of the biopotentials fell still further in the 1st second. At the beginning of stimulation, moreover, the number of oscillations increased, but later they disappeared completely. Whereas toward the end of 2-min stimulation at a

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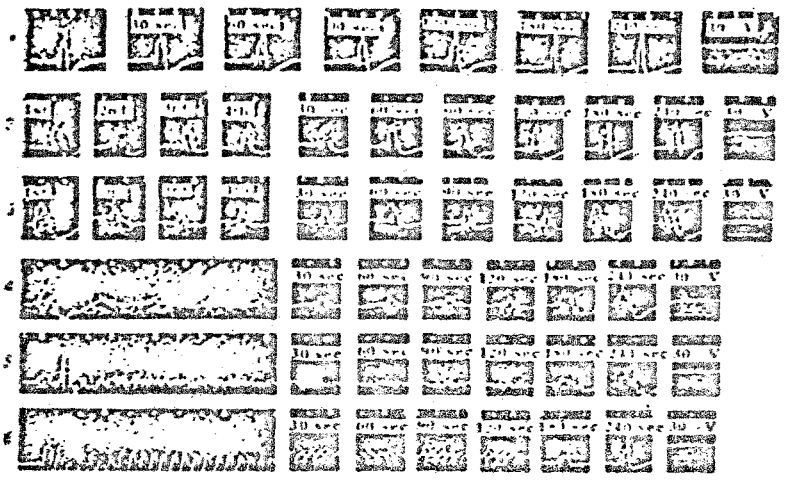

Fig. 1. Efferent impulses from ventral root of frog's spinal cord during stimulation of dorsal root (pair IX-X) for 2 min at frequencies of 1/sec (1), 5/sec (2), 10/sec (3), 20/sec (4), 50/sec (5), and 100/sec (6). Frames 180 and 240 show efferent impulse activity during 2 min after end of stimulation. Anesthetized frog. Time maker 20 msec.

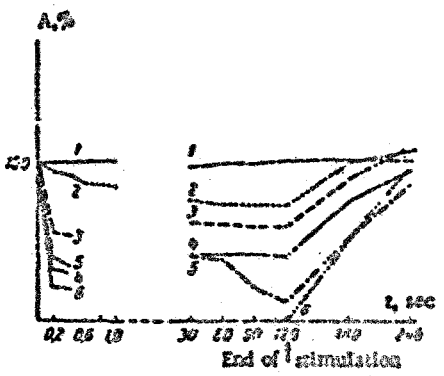

Fig. 2. Graph showing changes in amplitude of biopotentials during stimulation for 2 min and 2 min after end of stimulation. Abscissa, time of stimulation and recovery (in sec); ordinate, amplitude of potential (in percent of initial value). Amplitude of potential obtained in response to first stimulating pulse taken as 100. 1) frequency of stimulation 1/sec, 2) 5/sec, 3) 10/sec, 4) 20/sec, 5) 50/sec, 6) 100/sec.

frequency of 50/sec biopotentials were still recorded in the ventral root, at a frequency of 100/sec they disappeared at the 30th second of stimulation. With the change from a high frequency of stimulation to a frequency of 1/min, the amplitude of the biopotentials was restored within 2 min.

A combined graph showing the change in amplitude of the responses as a function of the frequency of the 2-min stimulation was plotted from the experimental results (Fig. 2). Analysis of this graph shows certain differences in the course of the response. For instance, starting at a frequency of 10/sec, the decrease in amplitude of the responses takes place in two phases: fast and slow. The fast phase develops during the 1st second of stimulation, and the higher the frequency of stimulation the greater the decrease in amplitude of the response. In the slow phase of decrease in amplitude of the ventral root potential, as a rule the decrease in the response is very slight. Furthermore, the rate of recovery of amplitude of the response after the end of stimulation is directly dependent on the frequency of preceding stimulation.

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