EFFECT OF LATENT TETANUS ON EXCITABILITY OF THE NERVOUS SYSTEM IN ASEPTIC INFLAMMATION

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Phasic changes in the excitability of the nervous system during aseptic inflammation were demonstrated in experiments on rabbits with latent tetanus (as reflected in the results of investigation of the neuromuscular chronaxie and the complete "strength–duration" curve of electrical excitability). These changes are evidently important in determining the changing pattern of relations between reactivity and resistance of the animal to an inflammation-inducing agent.

KEY WORDS: tetanus; excitability; inflammation.

Latent tetanus (LT), which modifies the functional state of the nervous system and causes the development of neurodystrophic changes [2, 3-7, 14], lowers the resistance of the body and its adaptability to the action of extremal environmental factors [1, 9, 11, 13].

To continue the study of the mechanisms of the changes in reactivity and resistance of the body in LT the excitability of the nervous system was analyzed in the presence of superadded aseptic inflammation.

EXPERIMENTAL METHOD

Experiments were carried out on 65 chinchilla rabbits weighing 2.5-3.5 kg. LT was produced [11, 12] with the aid of glycerol tetanus toxin, batch 15, obtained from Perm' Scientific-Research Institute of Vaccines and Sera. The toxin was injected into the anterior chamber of the animal's right eye in a dose of 0.2 ml (2 MLD). Instead of the toxin, the control rabbits received an injection of 0.2 ml physiological saline. The presence and degree of development of LT was judged from the presence in the blood serum of tetanus toxin and of specific antitetanus antibodies, revealed by biological tests on mice and by the indirect hemagglutination test [8]. Inflammation was evoked 2 weeks after the injection of tetanus toxin by immersing the rabbit's ear in water at a temperature of 56°C for 3 min, or by spraying ethyl chloride on the upper third of the ear for 2 min [7]. The criteria of development of inflammation were an increase in the volume of the ear (to $124 \pm 3.4\%$; $P < 0.001$), elevation of the body temperature (from 38.4 ± 0.09 to 38.9 ± 0.10°C; $P < 0.01$), an increase of the peripheral blood leukocyte count (from 9.1 ± 0.2 to 13.9 ± 0.4 thousands/mm^3; $P < 0.001$), and changes in the leukocyte formula. The rheobase and chronaxie of the gastrocnemius muscle of both hind limbs were investigated with the ISÉ-01 chronaximeter [10]. The curve of electrical excitability (strength–duration) of the auricularis muscle was determined by means of a type UÉI-1 electrical stimulator by means of which the intensity of pulses applied to the muscle could be varied from 0 to 200 V and their duration from 0.02 to 10 msec.

Excitability also was assessed from the value obtained by summation of the threshold quantities of electricity for all the pulse durations used. The appropriate measurements were made three times before injection of the toxin (background), on the 14th day after its injection, and at intervals during development of the inflammatory process (3-120 h after burning and 2-10 days after freezing the ear).

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TABLE 1. Changes in Rheobase (in V) and Chronaxie (in msec) of Gastrocnemius Muscle of Rabbits after Burning of the Ear Superposed on LT (M ± m)

Experiment or control	Background	After injection of toxin or physiological saline	Time after burning, h					
			3	7	24	48	72	120
Rheobase on right								
Experiment	4,4	3,9±0,5	3,8±0,4	2,8±0,3	2,5±0,1	3,3±0,1	3,4±0,1	3,8±0,2
Control	4,1	4,1±0,6	4,0±0,4	3,2±0,4	3,3±0,1	3,7±0,1	4,1±0,1	4,1±0,3
P	—	>0,5	>0,5	>0,5	<0,001	<0,01	<0,001	>0,5
Chronaxie on right								
Experiment	0,07	0,06±0,003	0,08±0,002	0,09±0,002	0,08±0,003	0,07±0,006	0,05±0,006	0,05±0,003
Control	0,07	0,06±0,020	0,07±0,004	0,07±0,001	0,07±0,002	0,06±0,004	0,05±0,007	0,06±0,003
P	—	—	<0,02	<0,001	>0,02	>0,1	—	<0,02
Rheobase on left								
Experiment	4,3	3,8±0,4	3,7±0,2	3,2±0,3	3,3±0,2	3,6±0,2	3,7±0,2	4,1±0,1
Control	3,7	3,7±0,3	4,2±0,4	3,6±0,3	3,1±0,1	3,8±0,2	4,6±0,1	4,9±0,1
P	—	>0,5	>0,25	>0,25	>0,25	>0,5	<0,001	<0,001
Chronaxie on left								
Experiment	0,07	0,05±0,006	0,06±0,003	0,05±0,006	0,05±0,003	0,07±0,003	0,05±0,003	0,05±0,006
Control	0,08	0,07±0,010	0,08±0,003	0,08±0,004	0,07±0,004	0,08±0,004	0,04±0,007	0,04±0,004
P	—	<0,05	<0,001	<0,001	<0,001	>0,05	<0,25	<0,25

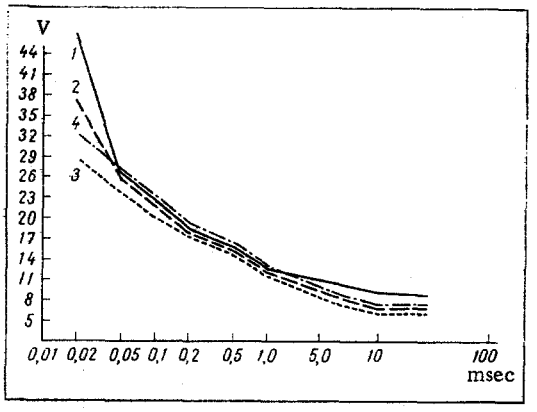

Fig. 1. Curve of electrical excitability during inflammation superposed on LT: 1) background; 2) after injection of toxin; 3) at height of development of inflammation (second day); 4) on seventh day of inflammation. Abscissa, duration of pulses (in msec); ordinate, strength of current (in V).

EXPERIMENTAL RESULTS

After injection of tetanus toxin into the anterior chamber of the eye a tendency was observed for the rheobase to be reduced in both the right and left hind limbs (Table 1). The reduction in the rheobase after injection of tetanus toxin was accompanied by some shortening of the chronaxie.

In the course of aseptic inflammation the state of excitability and the time of onset of the response to stimulation on the side of injection of the toxin diverged: Excitability increased whereas the response arose more slowly. On the opposite side there was an even more marked increase of excitability, and the response to stimulation arose more rapidly.

The action of a high temperature on the tissue at a time when the reactivity of the body was modified by the latent pathological process was thus accompanied by very early phasic changes in the excitability and lability of the neuromuscular system.

Analysis of the strength–duration curve showed that in the experimental animals on the 14th day after injection of tetanus toxin (Fig. 1) excitability was increased in the zones of both long and short pulses. The increase in excitability was even more marked at the height of development of inflammation (the second day after freezing of the ear). As the acute manifestation of inflammation subsided (7th-10th day after freezing) the level of excitability gradually returned to normal. Restoration of the threshold quantity of electricity (compared with

TABLE 2. Dynamics of Excitability During Aseptic Inflammation Superposed on LT (M ± m)

Experiment or control	No. of animals	Threshold quantity of electricity, V							
		background	after injection of toxin or physiological saline on 14th day	after freezing of the ear, days					
				2nd	3rd	4th	6th	7th	10th
Expt.	25	165,8±3,5	145,1±4,7	130,7±5,2	115,3±7,4	137,8±3,1	129,5±2,0	143,9±7,2	167,1±3,7
P		—	<0,001	<0,001	<0,001	<0,001	<0,001	<0,01	>0,5
Control	20	166,3±6,2	160,3±5,6	107,5±4,4	128,2±5,7	150,3±4,0	154,1±5,1	162,8±3,6	184,9±4,1
P			>0,5	<0,001	<0,001	<0,5	>0,5	>0,5	<0,02
P_1			<0,05	<0,001	>0,25	<0,02	<0,001	<0,05	<0,002

Legend. P) Compared with background; P_1) comparison between experiment and control.

the results on the second day) was particularly marked in the zone of short pulses. Consequently, the action of a low temperature against the background of modification of the reactivity of the body by LT was thus also accompanied by an increase in excitability.

In the control animals injection of physiological saline into the anterior chamber of the eye caused no significant changes in excitability (Table 2). At the height of development of inflammation (the second day after freezing of the ear), just as in the experimental animals, the total of the threshold quantities of electricity was reduced, i.e., excitability was increased. This increase in the control animals was greater, but as the acute manifestations of inflammation subsided, excitability returned to normal faster in the control than in the experimental animals.

After injection of tetanus toxin into the anterior chamber of the eye excitability increased. The inflammation thereby produced was accompanied by an even more marked increase in excitability.

It can be concluded that it is the increase in excitability of the nervous system which is responsible for the disturbance of the resistance of the body to the action of the inflammation-producing agent, as the writers demonstrated previously.

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