REACTIVITY OF THE THERMOREGULATORY CENTERS OF ANIMALS IN A STATE OF AMYTAL HYPOTHERMIA

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The reaction of the heat regulating centers to pyrogens during amytal hypothermia was studied in intact dogs and in dogs with destruction of the main distance receptors by V. S. Galkin's method [1].

The experiments were performed regularly every 2 weeks. A 5 % solution of sodium amytal was injected subcutaneously in different doses in different experiments — 50, 60 and 75 mg of the drug per 1 kg body weight of the animal.

Injection of sodium amytal in a dose of 50 mg/kg in one of the operated dogs produced in all 6 experiments a more profound sleep so that the dog failed to react at all to the prick of a needle. In a second operated dog in which the sleep was less profound, amytal in a dose of 50 mg/kg caused deepening of sleep in only one of three animals and in the two remaining experiments, after injection of the narcotic, by contrast a sharp stimulation was observed which lasted for 3-5 hours (the dog began to walk and on attempting to make it lie down, to measure its temperature or to put on its muzzle it clenched its teeth, growled and tried to bite).

In experiments on intact dogs an injection of 50 mg/kg of sodium amytal caused deepening of the sleep in only one dog, while the other two dogs showed only some degree of sluggishness. In order to produce a deeper sleep, in later experiments the dose of the narcotic was increased.

After injection of sodium amytal a considerable degree of hypothermia was observed in all the dogs [2, 5]. From Table 1 it is seen that the degree of lowering of the rectal temperature after injection of sodium amytal differed in different dogs, as well as in the same dog in repeated experiments after injection of the same dose of narcotic. However by increasing the dose of sodium amytal the hypothermia was more marked. The hypothermia was less pronounced and less prolonged in the majority of the operated dogs than in the intact animals.

In order to explain the features of the reaction of the heat regulatory centers to pyrogens at different stages of hypothermia, we injected animals subcutaneously with a vaccine of B. mesentericus (at the rate of 0.5 ml/kg or 1 ml/kg) simultaneously with sodium amytal during the first hour after administration of the narcotic or 4 hours after injection of sodium amytal, during developing sleep and the most pronounced hypothermia. It can be seen from Table 2 that in animals receiving pyrogen within one hour of the injection of the narcotic, just as in experiments in which sodium amytal was injected alone, hypothermia developed in the great majority of cases (10 out of 12), but mostly lasting only for a short time (from 1 to 4 hours in 7 experiments), it was then replaced by hyperthermia this replacement taking place very quicly. In some experiments the maximum rise of temperature exceeded the original level by 1-2° C. In 2 experiments there was no hypothermia at all, and in only 3 experiments out of 12 was the hypothermia at all prolonged.

It must also be mentioned that in these experiments there was a more rapid change from hypothermia to raised temperature, and this reached a higher level eventually in experiments on operated dogs.

TABLE 1

Change in the Rectal Temperature of Dogs After Injection of Sodium Amytal

Name of dog	Date of experiment	Initial temperature	Dose of narcotic (mg/kg)	Deviation of rectal temperature from original level (time from the moment of injection of sodium amytal)									
				1 hr	2 hrs	3 hrs	4 hrs	5 hrs	6 hrs	7 hrs	8 hrs	9 hrs	10 hrs
Operated dogs													
Mishka	16/II 1954	38.2°	50	—1.0°	—1.0°	—0,7°	0.1°	0.3°	0.6°	0.9°	0.3°		
»	6/VII 1954	37.8°	50	—0.9°	—1.4°	—1,5°	—1.4°	—0.8°	—0.3°				
»	21/XII 1954	38.3°	50	—1.0°	—1.1°	—0,6°	0.0	0.4°	0.4°	0.5°	0.6°		
»	18/I 1955	37.8°	50	—1.2°	—1.0°	—0.8°	—0.3°	—0.3°	—0.2°	0.3°	0.2°	0.4°	0.4°
»	29/III 1955	37.9°	50	—0.3°	—1.2°	—1.7°	—1.9°	—2.2°	—1.9°	—2.1°	—2.0°	—	—2.1°
»	5/VII 1955	37.4°	50	—0.6°	—1,4°	—1.9°	—1.9°	—1.6°	—1.3°	—1.0°	—0.8°	—	—0.5°
Katyah	16/II 1954	38.3°	50	—0.8°	—1.1°	—1.3°	—1.5°	—0.4°	0,1°	0,7°	—0.1°		
»	6/VII 1954	38.2°	50	—	—	—0.3°	—0.7°	—0.9°	—1.5°				
»	29/III 1955	38.2°	60	—	—	—0.2°	—0.3°	—1.0°	—0.8°	—0.6°	—0.2°	—	—0.4°
»	5/VII 1955	38.2°	60	—0.6°	—0.6°	—2.0°	—2.1°	—2.1°	—2.1°	—1.8°	—1.6°	—	—0.9°
Intact dogs													
Dumka	6/VII 1954	38,5°	50	—0.7°	—0.7°	—1.7°	—2.2°	—2.7°	—3.3°	—	—	—	—
Dianka	21/XII 1954	39.1°	50	—0.4°	—0.8°	—1.5°	—1.8°	—1.8°	—1.4°	—1.2°	—1.1°		
»	18/I 1955	38.5°	75	—0.8°	—1,9°	—3.2°	—3.5°	—6.5°	—7.5°	—6.5°	6.5°	—6.5°	—4.5°
»	9/III 1955	38.9°	60	—2.0°	—3.9°	—4.2°	—3.8°	—3.5°	—2.0°	—1.3°	—0.6°	—	—1.1°
»	5/VII 1955	38.1°	60	—1.2°	—2.5°	—3.1°	—3.1°	—3.4°	—4.1°	—3.4°	—4.1°	—	—2.1°
Dinka	21/XII 1954	38.9°	50	—0.4°	—0.7°	—1.4°	—1.8°	—1.5°	—1.6°	—1.4°	—1.2°		
»	18/I 1955	38,9°	75	—1.3°	—2.1°	—2.4°	—2.4°	—2.4°	—2.4°	—1.2°	—1.3°	—1.5°	—1.4°
»	29/III 1955	39.3°	60	—2.6°	—2.7°	—3.3°	—3.1°	—2.9°	—1.9°	—1.7°	—1.6°	—	—1.8°
»	5/VII 1955	38.6°	60	—1.0°	—2.3°	—3.0°	—3.1°	—3.1°	—3.2°	—3.9°	—3.2°	—	—2.9°

TABLE 2

Change in the Rectal Temperature of Dogs After Injection of Sodium Amytal and Pyrogen (Vaccine of B. mesentericus)

Name of dog	Date of experiment	Initial temperature	Dose of narcotic (mg/kg)	Dose of pyrogen (ml/kg)	Interval between injection of narcotic and pyrogen (in min.)	Deviation of rectal temperature from original level after injection of sodium amytal and pyrogen, after							
						1 hr	2 hrs	3 hrs	4 hrs	5 hrs	6 hrs	7 hrs	8 hrs
Operated dogs													
Mishka	16/III 1954	37.8°	50	0.5	40	—0.6°	0.7°	1.4°	2.0°	1.8°	1.6°		
»	3/VIII 1954	38.0°	50	0.5	50	—1.2°	—0.6°	0.6°	1.2°	1.3°	1.2°		
»	15/II 1955	38.1°	50	0.5	1—2	—1.2°	0	1.4°	1.4°	1.5°	0.5°	—0.1°	
»	26/IV 1955	37.7°	50	0.5	1—2	—0.5°	—0.4°	—0.7°	0.8°	1.3°	1.2°	0.9°	0.7°
Katysh	16/III 1954	38.0°	50	0.5	75	0.7°	1.2°	1.2°	1.5°	0.9°			
»	9/II 1955	38.0°	60	0.5	1—2	—1.2°	—1.4°	0	1.0°	1.4°	1.3°	1.3°	
»	26/IV 1955	38.0°	60	1.0	1—2	0.1°	0.5°	0.7°	1.2°	0.2°	0.4°	0	—0.3°
Intact dogs													
Dinka	15/II 1955	38.6°	75	0.5	1—2	—0.9°	—2.1°	—0.7°	—0.5°	—0.4°	—0.8°		
»	26/IV 1955	39.0°	60	1.0	1—2	—1.2°	—2.8°	—3.5°	—4.5°	—5.0°	—5.0°	—3.9°	—3.0°
Dianka	15/II 1955	38.4°	75	0.5	1—2	—1.2°	—2.3°	0	0.3°	0.1°	0.1°		
»	26/IV 1955	38.7°	60	1.0	1—2	—1.1°	—2.1°	—2.1°	—1.5°	—1.1°	—1.1°	—0.8°	—0.5°
Dumka	3/VIII 1954	38.3°	50	0.5	45	—1.9°	—1.4°	0.5°	0.7°	0.7°	0.6°		

TABLE 3

Change in the Body Temperature of Dogs After Injection of Pyrogen (Culture of B. mesentericus) 4 Hours After Injection of Sodium Amytal

Name of dog	Date of experiment	Initial temperature	Dose of narcotic mg/kg	Deviation of body temperature from original level after injection of sodium amytal after: 1 hr	2 hrs	3 hrs	4 hrs	Dose of pyrogen, ml/kg	Deviation of body temperature from original level after injection of pyrogen after: 1 hr	2 hrs	3 hrs	4 hrs	5 hrs	6 hrs
Operated dogs														
Mishka	7/VI 1955	37.8°	50	—0.7°	—1.4°	—1.7°	—1.4°	1.0	—0.9°	0.3°	1.3°	2.0°	1.8°	1.5
Katyah	7/VI 1955	38.1°	60	—0.9°	—1.4°	—1.6°	—1.9°	1.0	—2.1°	—1.4°	0.4°	1.1°	1.2°	1.3
»	2/VIII 1955	38.5°	60	—0.6°	—1.3°	—1.9°	—2.7°	1.0	—1.7°	—1.2°	—0.7°	—0.3°	±0°	0.4
Intact dogs														
Dinka	7/VI 1955	38.6°	60	—2.1°	—3.4°	—4.1°	—4.3°	1.0	—3.6°	—2.3°	—0.5°	0.5°	0.6°	0.5
»	2/VIII 1955	38.3°	60	—1.1°	—2.4°	—3.2°	—3.6°	1.0	—2.8°	—2.4°	0	0.9°	1.1°	0.8
Dianka	7/VI 1955	38.8°	60	—1.0°	—3.7°	—4.5°	—5.1°	1.0	—4.8°	—5.8°	—4.8°	—3.0°	—1.6°	0.5
»	2/VIII 1955	38.3°	60	—1.2°	—2.5°	—3.3°	—3.8°	1.0	—3.3°	—3.4°	—1.7°	0.1°	0.8°	0.9

The changes in the body temperature after injection of pyrogen in these doses 4 hours after sodium amytal, at a time when the temperature was lowered (from 1.4 to 5.1 °C in different experiments) are shown in Table 3. In all 7 experiments injection of pyrogen into animals already in a state of amytal hypothermia caused a considerable increase in the body temperature, the greatest increase of temperature in 4 experiments exceeding the original (before injection of sodium amytal) level by 0.9-2° C.

Preservation, and even pronounced degree (relative to the orginal level of the temperature at the moment of injection of pyrogen) of the temperature reaction to the injection of pyrogen during amytal hypothermia is of great interest. Whatever may be the cause there is no doubt that the rise in the body temperature of animals in a state of amytal hypothermia, after injection of pyrogen, of 3-4° C and even 5-6°, which is several times greater than the rise in temperature of dogs in control experiments to the same pyrogen (the greatest rise in body temperature after injection of pyrogen in control experiments in different dogs was 1.1-2°), does not accord with the idea of a depressed state of the thermoregulatory centers due to the effect of sodium amytal. On the other hand, hypothermia shows the considerable derangement of heat regulation. For instance as a result of sodium amytal the ability of the animal to maintain a normal level of body temperature is greatly reduced while at the same time its power to react to an "extreme" pyrogenic stimulus by a rise of temperature is not only preserved but is intensified. The question arises, what is the physiological nature of this change in the state of the thermoregulatory center due to amytal, in which its "tonus" is greatly reduced, but its excitability to "extreme" stimuli, on the contrary, is increased. For an explanation of this problem it is necessary to determine accurately during narcosis the excitability of the thermoregulatory centers in relation to adequate stimuli and to compare the results with the character of the disturbance of heat regulation in other types of narcosis. This is particularly important at the present time in connection with the suggestion which has been put forward of the differences in the principle of the action on the central nervous system of narcotics of the

fatty group (lowering the level of lability of the nerve centers) and of the barbiturates (increasing the level of lability [6, 7]).

The results confirm our previous [3, 4] conclusions on the increase during sleep of the reactivity of the thermoregulatory centers of dogs deprived of the three main distance receptors.

SUMMARY

The temperature reaction to the introduction of a pyrogenic agent (killed culture of B. mesentericus) was studied in condition of sodium amytal sleep. The work was carried out on 3 intact dogs and 2 dogs in which 3 distant receptors were removed. Hypothermia after introduction of this narcotic was prolonged, less pronounced and dissimilar to that of the intact dogs. Introduction of pyrogen decreased the hypothermia and brought about increase of the body temperature to the initial level and even higher. The relative degree of increase of the body temperature was 2 to 3 times higher than the rise of the temperature in the control group. The data which were obtained point to the decrease of the tone (hypothermia) of the thermoregulating centers during amytal sleep and their relatively increased excitation to the pyrogenic stimulation. The results of these experiments likewise, support the fact that the decrease of activity of the brain cortex is connected with a certain disinhibition of the subcortical thermoregulating centers.

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