CHANGES IN BRAIN CHOLINE ACETYLASE AND CHOLINE ESTERASE DURING GENERALIZED HYPOTHERMIA

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Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny,
Vol. 54, No. 12, pp. 47-50, December, 1962
Original article submitted April 28, 1962

Much attention is presently being devoted to the study of neurohumoral factors, and, in particular, to acetylcholine metabolism. Numerous authors [1, 2, 3, 8, 9, 13 and others] have reported changes in choline esterase activity during the course of various pathological processes, and in association with changes in the functional state of the central nervous system. A number of workers have studied the conditions of synthesis of acetylcholine [5, 20, 21, 24, 26, 29], and the distribution of choline acetylase in various tissues [16, 18, 19, 23]. No attention has been paid, however, to the effect of changes in the functional state of the central nervous system on the activity of this enzyme. Hypothermia causes drastic changes in the functional state of the nervous system [4, 7, 14, 17]. There are a few references in the literature to changes in choline esterase activity associated with hypothermia [6], but no analogous work on choline acetylase has been published. Our earlier researches [10-12] showed that serum choline esterase activity falls in hypothermia. We thought it would be of interest to ascertain what effects hypothermia has on the synthesis and hydrolysis of acetylcholine in the brain.

In the present paper we report on the changes found in choline acetylase and esterase activities in brain during ether anesthesia, during generalized hypothermia, and in the post-hypothermic period.

EXPERIMENTAL METHODS

Generalized hypothermia was induced by packing anesthetized rats in ice. Choline acetylase activity was investigated for brain tissue by the method of Nachmansohn, as modified by Smallman [25], involving biochemical determination of acetylcholine according to Hestrin [22]. Brain choline esterase activity was determined in a Warburg apparatus, by Ammon's manometric method [15].

The animal material consisted of 114 male and female white rats, of body weight 180-220 g. These were divided into 4 groups: 1) control rats, the enzyme activities of which were taken as 100%; 2) anesthetized rats; 3) rats cooled to 17-18°; 4) rats which had been kept at 17-18° and studied during the elevation of body temperature to 22-24°.

EXPERIMENTAL RESULTS

A sharp rise in choline acetylase activity was observed in most of the animals while they were under ether anesthesia (see table and Fig. 1). Generalized cooling while under ether anesthesia was invariably associated with fall in the activity of this enzyme. Choline acetylase activity rose during emergence from the hypothermic state in most of the animals, but two rats exhibited a further fall in the activity of this enzyme.

Brain choline esterase activity rose under ether anesthesia (table; Fig. 2), but fell in 6 of the 10 animals during hypothermia. It rose during emergence from the hypothermic state in only 3 of the group, continuing to fall in the remainder.

A comparison of the choline acetylase and choline esterase activities of the brain of anesthetized rats and of those under generalized hypothermia shows that rise in activity of the former enzyme, synthesizing acetylcholine,

Choline Acetylase and Choline Esterase Activities (as percentages)

Date of experiment (1961)	Group of experimental animals *		
	second	third	fourth
Choline acetylase			
1/III	—	34	—
8/III	144	50	—
13/III	65	—	—
15/III	210	100	—
20/III	100	44	103
24/III	149	105	—
5/IV	400	83	100
11/IV	200	80	58
12/IV	120	41	74
17/IV	—	33	100
19/IV	78	63	84
8/V	70	12	72
17/V	44	24	94
16/VI	84	89	160
28/VI	230	85	—
29/VI	60	—	—
	70		
11/IX	168	78	105
18/IX	164	58	—
20/IX	166	48	48
	300		
25/IX	111	55	91
27/IX	116	50	21
Choline esterase			
4/X	187	180	—
9/X	107	90	88
13/X	87	148	199
20/X	111	84	22
27/X	95	74	99
30/X	117	98	72
2/XI	210	71	90
8/XI	120	129	98
16/XI	132	99	100
23/XI	130	148	124

* The first group of rats, the controls, gave choline acetylase and esterase activities which were taken as 100%.

was accompanied by rise in the activity of the latter enzyme, catalyzing its hydrolysis, and that fall in choline acetylase activity was accompanied by a fall in choline esterase activity. It should, however, be noted that the rise in choline acetylase activity observed during ether anesthesia exceeded the rise in choline esterase activity. This observation suggests that the parallel fluctuations in the activities of these enzymes may indicate the presence of an adaptive-compensatory mechanism. These activity changes may, by affecting acetylcholine metabolism, influence the functional state of the nervous system, leading, under appropriate conditions, to dissociation of these two components of acetylcholine metabolism. The possibility cannot be excluded that changes in the activities of the enzymes connected with acetylcholine metabolism can, by affecting the acetylcholine content of the tissues, play an important part in development of the general parabiotic state of the nervous system during hypothermia.

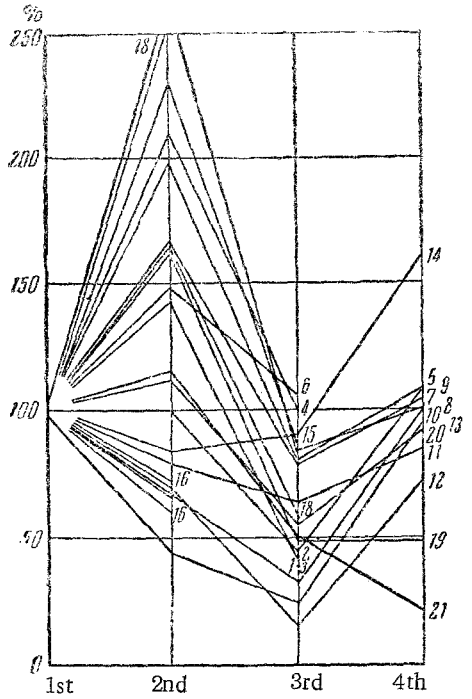

Fig. 1. Brain choline acetylase activity (as percent of controls).

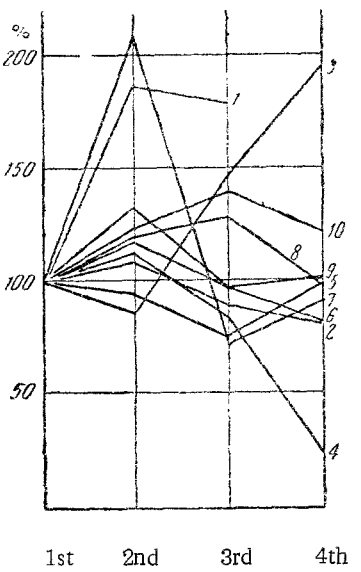

Fig. 2. Brain choline esterase activity (as percent of controls).

SUMMARY

A study has been made of the choline acetylase and esterase activities of brains of rats under ether anesthesia, in hypothermia, and during emergence from hypothermia. Ether anesthesia was associated with a considerable rise in choline acetylase, and a smaller rise in choline esterase, activity. Generalized hypothermia of ether-anesthetized rats was invariably associated with fall in choline acetylase activity, as well as, in most cases, in choline esterase activity. During recovery from the hypothermic state rises in the activity of both enzymes were noted. The parallelism of the changes in the activities of the two enzymes suggests that they may have an adaptive-compensatory nature. Disturbances in the correlation of the two activities may lead to changes in acetylcholine metabolism.

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All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.
