

Acetylcholine Content and Tissue Cholinesterase Activity in Rats with Different Motor Activity

R. A. Abzalov, R. R. Nigmatullina, and I. G. Khuramshin

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The content of acetylcholine and activity of cholinesterases in the heart and blood of 21, 30, 42, 49, 70, and 100-day-old rats were measured using standard biochemical methods. It is shown that functional activity of cholinergic system is lower in hypokinetic rats than in normokinetic age-matching controls.

Key Words: *acetylcholine; acetylcholinesterase; cholinesterase; unrestrained motor activity; hypokinesia*

Numerous studies have demonstrated an increased content of acetylcholine (ACh) and reduced acetylcholinesterase (AChE) activity in the myocardium of young animals [4,5,8]. It was shown that regular physical exercises lead to a rise of cholinergic activity and ACh in the myocardium [4].

It is known that ACh acts as a transmitter and participates in metabolic processes. However, the state of the ACh—cholinesterase (ChE) system in animals with restrained motor activity is poorly studied. This was the aim of the present study.

MATERIALS AND METHODS

Experiments were carried out on random-bred albino rats aging of 21, 30, 42, 49, 70, and 100 days. The animals were divided into 2 groups. Group 1 rats (6-8 animals per cage) were maintained under standard vivarium conditions without restraining their motor activity. Group 2 animals were subjected to gradual restriction of motor activity in case cages [3]: by day 42 and up to day 100, the duration of immobilization constituted 23 h.

The content of ACh and ChE activity were measured as described elsewhere [11] with some modifications [7,10]. Optical density was measured in a

KFK-3 photometer. The animals were narcotized with urethane (800 mg/kg, intraperitoneally).

RESULTS

Hypokinesia started on day 21 led to a slight (insignificant) rise of ACh content (Table 1), while AChE activity in the myocardium of 30-day-old hypokinetic rats considerably surpassed that of normokinetic controls (50.79 ± 2.27 $\mu\text{g/g/h}$).

Concentration of ACh and AChE activity in the myocardium of 42-day-old hypokinetic rats are considerably higher than in normokinetic rats. In 49-day-old hypokinetic rats, the concentration of ACh was 2-fold lower than in animals with unrestrained motor activity. AChE activity in the heart of hypokinetic rats was considerably lower than in age-matching controls. In 70-day-old rats with restrained motor activity AChE activity did not differ from that of the control group, while the concentration of ACh in them was by 62.23 $\mu\text{g/g}$ lower than in animals with unrestrained motor activity. In 100-day-old hypokinetic rats, the concentration of ACh and AChE activity were much lower than in age-matching controls.

Cholinergic index in 30, 42, 49, and 70-day-old rats with restrained motor activity surpassed that in age-matching controls, while in 100-day-old hypokinetic rats this parameter was by 0.008 lower than in rats with unrestrained motor activity.

The ACh content in hypokinetic rats aged 30 and 42 days was lower ($p<0.001$) than in rats with normal motor activity (Table 2).

Experiments revealed no substantial differences in ACh content between restrained and unrestrained rats at the age 49 and 70 days ($p>0.05$). In 100-day-old hypokinetic rat, the content of ACh was by 170 $\mu\text{g/g}$ lower than in controls ($p<0.001$). Consequently, the ACh content in the blood of hypokinetic rats aged 30, 42, and 100 days is much lower than in rats with normal motor activity. However, no intergroup differences in ACh content were found in 49 and 70-day-old rats.

In 30-day-old hypokinetic rats, blood ChE activity considerably surpassed that of unrestrained controls ($p<0.001$), while in 42 and 49-day-old hypokinetic rats this parameter was higher by 2.61 and 2.55 $\mu\text{g/g/h}$, respectively, than in the corresponding controls ($p<0.001$). In 70-day-old rats ChE activity was similar in hypokinetic and control animals. In 100-day-old hypokinetic rats, blood ChE activity was by 1.1 $\mu\text{g/g/h}$ higher than in the control group ($p<0.01$). Thus, blood ChE activity in hypokinetic rats of all studied ages except for 70 days was significantly higher than in age-matching rats with unrestrained motor activity.

Blood AChE activity in 30 and 42-day-old hypokinetic animals was higher than in unrestrained controls by 1.17 ($p<0.01$) and 1.22 $\mu\text{g/g/h}$ ($p<0.001$), respectively. In 70-day-old rats, this parameters in hypokinetic group was by 1.23 $\mu\text{g/g/h}$ higher than in controls ($p<0.001$). At the age of 100 days, blood AChE activity in hypokinetic animals considerably surpassed that of control rats.

Thus, blood AChE activity in hypokinetic rats of all studied ages was significantly higher than in age-matching animals with unrestrained motor activity.

ChE cholinergic index in 30-day-old hypokinetic rats 1.9-fold surpassed that in animals with unrestrained motor activity. In 42-day-old hypokinetic rats, ChE cholinergic index was by 0.021 higher than in controls. In 49-day-old rats this parameter decreased to 0.014, but remained higher than in unrestrained controls by 0.004. In 100-day-old hypokinetic rats, ChE cholinergic index was higher than in age-matching controls.

Thus, in all age groups, ChE cholinergic index of the blood in animals with restrained motor activity was higher than in unrestrained controls.

Similarly, AChE cholinergic index of the blood in 30-day-old rats with restrained motor activity was 1.8-fold higher than in unrestrained controls. In 42-day-old hypokinetic rats, this parameter surpassed that in control animals by 0.015, while hypokinetic and control 49-day-old animals had the same AChE cholinergic index, 0.012. However, in 70 and 100-day-old hypokinetic rats AChE cholinergic index again surpassed that of unrestrained controls.

The AChE cholinergic index in rats subjected to hypokinesia surpassed that of unrestrained controls at all ages except for 49 days, when this parameter was the same in hypokinetic and control group.

Thus, ACh concentration in the blood and myocardium of hypokinetic animals is lower than these parameters in the control animals. ACh concentration in blood and myocardium increased with age in

TABLE 1. Concentration of ACh ($\mu\text{g/g}$), AChE activity ($\mu\text{g/g/h}$) and Cholinergic Index in the Heart of Rats with Different Motor Activity ($M\pm m$)

Age, days		Unrestrained motor activity			Restrained motor activity			
		<i>n</i>	parameter	cholinergic index	<i>n</i>	parameter	cholinergic index	
21	ACh	12	139.51±7.92	0.899	13	202.92±6.77	0.250	
	AChE		125.45±5.74			50.79±2.27**		
30	ACh	14	222.98±10.14	0.146	12	273.68±22.82*	0.126	
	AChE		32.61±0.85			34.59±2.30**		
42	ACh	12	203.87±13.67	0.111	19	243.06±9.99**	0.047	
	AChE		22.55±0.74			11.48±0.89**		
49	ACh	16	453.85±12.13	0.043	19	349.83±16.2*	0.060	
	AChE		19.59±0.69			21.29±1.25		
70	ACh	16	412.06±25.57	0.053	15	405.77±11.24*	0.013	
	AChE		21.67±0.91			5.39±0.39**		
100	ACh	20	455.73±16.90	0.021				
	AChE		9.42±0.55					

Note. * $p<0.05$, ** $p<0.001$ compared with animals with unrestrained motor activity. Here and in Table 2: *n* is the number of animals.

TABLE 2. Concentration of ACh ($\mu\text{g/g}$), AChE and ChE activity ($\mu\text{g/g/h}$) and Cholinergic Index in the Blood of Rats with Different Motor Activity ($M \pm m$)

Age, days		Unrestrained motor activity			Restrained motor activity		
		<i>n</i>	parameter	cholinergic index	<i>n</i>	parameter	cholinergic index
21	ACh	12	182.81 \pm 22.08				
	ChE		18.67 \pm 0.12	0.102			
	AChE		14.37 \pm 0.09	0.079			
30	ACh	14	382.89 \pm 18.24		13	224.05 \pm 11.63***	
	ChE		12.56 \pm 0.33	0.033		14.24 \pm 0.54*	0.064
	AChE		12.34 \pm 0.36	0.032		13.51 \pm 0.18**	0.060
42	ACh	12	304.00 \pm 16.03		12	237.27 \pm 20.63*	
	ChE		10.77 \pm 0.34	0.035		13.38 \pm 0.45***	0.056
	AChE		11.43 \pm 0.21	0.038		12.65 \pm 0.05***	0.053
49	ACh	16	511.56 \pm 14.15		19	546.06 \pm 17.67	
	ChE		4.94 \pm 0.34	0.010		7.49 \pm 0.31***	0.014
	AChE		5.99 \pm 0.13	0.012		6.53 \pm 0.18**	0.012
70	ACh	16	389.49 \pm 15.79		19	350.18 \pm 12.27	
	ChE		13.13 \pm 0.49	0.034		14.27 \pm 0.70	0.041
	AChE		11.54 \pm 0.24	0.030		12.77 \pm 0.29**	0.036
100	ACh	20	550.77 \pm 14.53		15	380.41 \pm 11.78***	
	ChE		4.57 \pm 0.23	0.008		5.70 \pm 0.21**	0.015
	AChE		5.27 \pm 0.17	0.010		7.28 \pm 0.22***	0.019

Note. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$ compared with animals with unrestrained motor activity.

both groups, but in hypokinetic rats this dynamics was less pronounced.

Blood AChE activity in rats subjected to hypokinesis was higher than in the control. AChE activity in the blood and myocardium gradually decreased with age (from 21 to 100 days) in both hypokinetic and control groups.

At the age of 42 and 49 days functional rearrangements related to sexual maturation occur in rats [1,2,4,6,9]. We also revealed specific changes in ACh content and ChE activity in 42 and 49-day-old rats with restrained motor activity.

Thus, cholinergic activity of blood and myocardium increases with age. Our data suggest that functional activity of the cholinergic system in hypokinetic rats is lower than in age-matching unrestrained controls.

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