CIRCADIAN RHYTHM OF RED BLOOD PARAMETERS IN RATS AFTER CAROTID GLOMECTOMY

L. V. Shevchenko and A. I. Elfimov

UDC 616.132.1-089.87-092.9-089.168-07:616.155.1"52"

KEY WORDS: hypoxia; resistance; blood; chemoreceptors

The aim of the investigation was to study the circadian rhythm of the most important red blood parameters and resistance to acute hypoxia in animals before and after bilateral carotid glomectomy.

EXPERIMENTAL METHOD

Experiments were carried out on 42 noninbred male albino rats weighing 180-220 g. Every 4 h during the 24-h period (midnight, 4 and 8 a.m., noon, 4 and 8 p.m.) before and 14 days after bilateral carotid glomectomy [3] the following red blood parameters were determined: erythrocyte count (millions/μl), on a "Celloscope" microparticle counter, hemoglobin concentration (in g%) on a hemoglobinometer (Linson Instrument), and hematocrit index (%) on a microcentrifuge. The following morphometric parameters were calculated: mean erythrocyte hemoglobin content (MEHC, pg) and mean erythrocyte hemoglobin concentration (MEHC, %), and the mean erythrocyte volume (MEV, μ^3). The animals' resistance to acute hypoxia was assessed from the time (TP, sec) of preservation of the postural reflex of the body during static exercise in a pressure chamber at an "altitude" of 12,000 m [5].

EXPERIMENTAL RESULTS

The resistance of the glomectomized animals to high altitude was significantly reduced compared with preoperative values, in agreement with previous results [1]. Our own investigations revealed that the resistance of intact animals to acute hypoxia was significantly higher in the morning (8 a.m.) than in the evening (8 p.m.): 1131.0 ± 60.9 and 416.8 ± 210.9 sec respectively. After carotid glomectomy, the highest and lowest values of altitude resistance were observed at the same times, when they amounted to 918.0 ± 64.2 and 60.0 ± 10.3 sec respectively. The results of investigation of the state of the red blood, given in Table 1, showed a small but significant decrease in the erythrocyte count, hemoglobin concentration, and hematocrit index in the glomectomized animals, evidence of anemization, unaccompanied by any disturbance of hemoglobin synthesis, for the mean erythrocyte hemoglobin content and concentration were unchanged. The appearance of anemia after denervation of the carotid sinus reflexogenic zones and carotid glomectomy is associated with intensification of hemolysis. When the circadian rhythm of parameters characterizing the state of the red blood in intact rats is examined, the identical trend in changes in the erythrocyte count, hemoglobin concentration, and hematocrit index will be noted: highest values in the evening (4-10 p.m.) and a fall in the morning (4-10 a.m.). The time course of the mean erythrocyte hemoglobin content and concentration and also of the mean erythrocyte volume was similar, but with a shift of 2-4 h. The operation of carotid glomectomy introduced essential changes into the amplitude and phase characteristics of the circadian rhythm of red blood parameters, and this was most clearly manifested as a decrease in amplitude of fluctuations of the hemoglobin concentration, hematocrit index, and mean erythrocyte hemoglobin concentration. Considering the fact that the amplitude and phase structure of biological rhythms is an important characteristic of the functional state of the animal, determining its resistance

Department of Normal Physiology, Patrice Lumumba Peoples' Friendship University, Moscow. (Presented by Academician of the Academy of Medical Sciences of the USSR T. T. Berezov.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 113, No. 3, pp. 232-233, March, 1992. Original article submitted June 11, 1991.

0007-4888/92/0003-0292$12.50

TABLE 1. Circadian Rhythm of Altitude Resistance and Red Blood Parameters of Rats before and after Bilateral Carotid Glomectomy (M ± m)

Parameters	Clock time						Mean values for 24-h period
	midnight	4 a.m.	8 a.m.	noon	4 p.m.	8 p.m.	
TP C	584,2±289,2	846,2±243,9	1131±65,9	413,5±142,0	920,0±185,2	416,8±210,9	665,0±96,38
E	510,0±271,1	231,0±158,5	910,0±64,16	120,1±16,95	112,6±36,60	60,00±10,27	268,6±71,98
Er C	8,234±0,336	7,982±0,344	7,680±0,180	7,818±0,197	8,168±0,358	8,511±0,272	8,095±0,131
E	7,485±0,200	7,667±0,209	8,426±0,149	7,778±0,201	7,985±0,384	7,216±0,100	7,703±0,116
Hb C	15,10±0,420	12,77±0,588	14,30±1,416	16,95±0,360	15,88±0,433	15,70±0,335	15,40±0,315
E	14,40±0,504	14,30±0,823	14,36±0,495	13,85±0,407	14,26±0,525	14,30±0,141	14,22±0,203
Ht C	48,90±1,479	43,25±2,019	44,60±5,080	49,71±0,999	49,83±1,115	46,28±1,336	47,61±0,849
E	46,08±1,72	46,87±0,990	47,70±1,040	45,35±0,690	44,95±0,943	47,50±1,476	46,22±0,540
MEHC pg C	18,42±0,050	16,17±1,340	18,46±1,550	21,68±0,440	19,56±0,830	18,50±0,610	19,10±0,440
E	19,20±0,270	18,52±0,680	17,00±0,440	17,55±0,250	17,91±0,390	19,81±0,410	18,46±0,220
MEHC % C	31,00±1,010	29,50±0,600	32,40±2,730	34,15±0,860	31,83±0,550	33,98±0,650	32,39±0,500
E	31,30±0,510	30,42±1,450	30,10±0,940	30,54±0,990	31,68±0,920	30,33±1,090	30,80±0,420
MEV C	59,92±3,464	54,72±4,044	58,00±6,398	63,61±0,838	61,31±1,682	54,63±2,376	59,14±1,301
E	61,38±1,016	61,10±0,725	56,53±0,381	58,44±1,425	56,93±2,607	65,66±1,534	60,21±0,880

Legend. C) Before operation, E) after operation.

TABLE 2. Coefficients of Correlation (r) between Red Blood Parameters and Altitude Resistance of Rats (n = 42) before and after Bilateral Carotid Glomectomy

Experimental conditions	Er	Hb	Ht	MEHC, pg	MEHC, %	MEV
Before operation	+0,051	—0,162	—0,237	—0,165	+0,057	—0,213
After operation	+0,375	+0,383	+0,366	—0,025	+0,069	—0,106

to various external environmental factors [2], the reduction of altitude resistance of glomectomized animals against the background of their anemization and the decrease in amplitude of the circadian fluctuations of the basic parameters of the red blood, in our view, are not accidental.

Mathematical analysis of correlation between altitude resistance and red blood parameters in rats before and after carotid glomectomy is given in Table 2. In the glomectomized animals, unlike intact rats, significant correlation was found between resistance to hypoxia and the erythrocyte count in the blood, hemoglobin concentration, and hematocrit index. The fact will be noted that correlation of altitude resistance with parameters characterizing hemoglobin formation (MEHC, pg; MEHC, %) were unchanged after glomectomy. Consequently, in glomectomized animals resistance to acute hypoxia was closely linked with the absolute hemoglobin concentration and the erythrocyte count. Thus the decrease in altitude resistance of glomectomized animals was not accompanied by any disturbance of the circadian rhythm of this parameter, whereas the circadian rhythm of the principal red blood parameters showed significant changes, pointing to the important role of the carotid sinus reflexogenic zone in the formation of the physiological mechanisms of regulation of functional parameters of the red blood and its dependence on the time of day.

LITERATURE CITED

1. N. A. Agadzhanyan and A. I. Elfimov, Functions of the Body during Hypoxia and Hypercapnia [in Russian], Moscow (1986).

2. N. R. Deryapa, M. P. Moshkin, and V. S. Posnyi, Problems in Medical Biorhythmology [in Russian], Moscow (1985).
3. A. I. Elfimov, Current Problems in Space Biology and Medicine [in Russian], Moscow (1971), pp. 109-110.
4. V. N. Chernigovskii, S. Yu. Shekhter, and A. Ya. Yaroshevskii, Regulation of Erythropoiesis [in Russian], Leningrad (1967).
5. Yu. V. Farber, A. Yu. Grifor'ev, and A. I. Elfimov, Kosm. Biol., No. 5, 85 (1981).