Hemorheological and Cerebroprotective Activity of *Lychnis chalcedonica L.* Extract in Rats with Cerebral Ischemia

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Considerable hemorheological changes and depression of EEG parameters were revealed in rats with cerebral ischemia. Course peroral treatment with scarlet lightning extract in a daily dose of 150 mg/kg for 5 days reduced the severity of hemorheological disorders. It manifested in a decrease in whole blood viscosity, plasma viscosity, erythrocyte aggregation, and fibrinogen concentration and increase in deformability. The extract of lightning extract improved EEG activity in rats with cerebral ischemia.

Key Words: *scarlet lightning extract; cerebral ischemia; hemorheology; EEG*

The development of hemorheological disorders is a key pathogenetic mechanism for brain deficiency. A close correlation was revealed between hemorheological disorders and severity of cerebral dysfunction [2]. The methods for pharmacological correction of pathological changes in hemorheology are low effective [11]. The search for new preparations reducing the degree of hemorheological disorders and normalizing blood circulation and oxygenation in damaged organs is of considerable importance.

Plant preparations containing ecdysteroids and modulating hemorheological characteristics under conditions of cardiovascular dysfunction hold much promise in this respect [7]. One of these preparations is the extract of scarlet lightning (*Lychnis chalcedonica L.*, ESL). Our previous studies on the model of cardiovascular diseases revealed hemorheological activity of this preparation [6,10].

Here we studied the effect of ESL on electrical activity of the brain and hemorheological indexes in rats with cerebral ischemia.

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MATERIALS AND METHODS

Experiments were performed on 34 male Wistar rats. The animals were euthanized with diethyl ether.

To study hemorheological characteristics, the blood was taken from the common carotid artery on day 5 after modeling of ischemia (ether anesthesia). Viscosity of the blood and plasma was measured on an AKR-2 rotational viscometer. Spontaneous aggregation of erythrocytes was studied by the method of syllectometry with modifications [8]. Hematocrit was assayed by centrifugation of the blood in glass capillaries on a MGTs-8 centrifuge. Plasma fibrinogen concentration was measured gravimetrically [1]. Erythrocyte deformability was determined by laser diffractometry or ectacytometry.

To study electrical activity of the brain, nichrome electrodes with a diameter of 150 μ were implanted into the visual cortex (AP=+5, DS=2, H=1.5) of rats narcotized with sodium ethaminal 5 days before the experiment. The reference electrode was fixed on the nasal bones [5].

EEG was analyzed by the method of compression spectral analysis. Electrograms were recorded on an ERA-9 electroencephalograph and 1296 magnetograph (OTE-Biomedica). Fourier transform analysis was performed on a spectrograph (OTE-Biomedica).

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The total spectral power, dominant frequency, and power of individual spectra were estimated [3]. The results of Fourier analysis were processed using Superkal'k-4 software.

Cerebral ischemia in rats was produced by occlusion of the left carotid artery and 50% reduction of blood flow in the right carotid artery [9]. ESL was administered intragastrically in a daily dose of 150 mg/kg for 5 days.

The results were analyzed by Student's *t* test.

RESULTS

Cerebral ischemia in rats led to the development of increased blood viscosity syndrome (IBVS): increase in viscosity of the blood (shear rate 3-300 sec^{-1}, Fig. 1) and plasma, hyperfibrinogenemia (plasma fibrinogen concentration exceeded the control by 2.2 times), rise in aggregation activity of erythrocytes, and decrease in erythrocyte deformability at various shear rates (Table 1). The course of treatment with ESL decreased blood viscosity by 22-45% at shear rates of 3-300 sec^{-1} (Fig. 1). Plasma viscosity, erythrocyte aggregation, and fibrinogen concentration decreased by 11, 39, and 20%, respectively, compared to the control. Erythrocyte deformability was improved at shear rates of 90 and 180 sec^{-1} (Table 1).

These data show that the course of treatment with ESL decreased the severity of IBVS in rats with cerebral ischemia.

EEG recording showed that cerebral ischemia in rats is accompanied by profound changes in the cortex of both cerebral hemispheres. The initial spectral power distribution in the left (LH) and right hemispheres (RH) of control animals was the following: δ-band — 22 and 24%, respectively; θ-band — 36 and 40%, respectively; α-band — 15 and 16%, respectively; and β-band — 13 and 14%, respectively (Fig. 2).

Suppression of the basic rhythm on day 2 of ischemia was confirmed by a decrease in the dominant

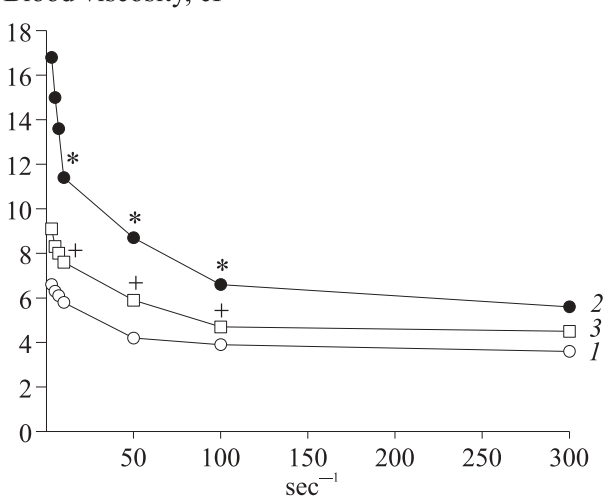

Fig. 1. Effect of repeated intragastric treatment with scarlet lightning extract (ESL) in a dose of 150 mg/kg for 5 days on blood viscosity in rats with cerebral ischemia: intact animals (*1*), control (*2*), and ESL (*3*). $p<0.05$: *compared to intact rats; +compared to the control.

θ-band power (Fig. 2). These changes were accompanied by an increase in the relative contribution of δ-band to the total spectral power in LH and RH. The observed changes serve as a criterion of hypoxia [4]. Electrical activity of the brain cortex was depressed by the 2nd and 5th days. It manifested in a decrease in the total spectral power, power of individual EEG spectra, and dominant frequency (Fig. 2, Table 2). The power of δ-, θ-, α-, and β-bands decreased in LH (by 49, 68, 59, and 50%, respectively) and RH (by 41, 44, 33, and 32%, respectively; Fig. 2, Table 2).

The observed changes in functional activity of the brain are consistent with published data on patients with ischemic insults [4].

The initial spectral power distribution in the parietal cortex of LH and RH of ESL-treated rats was the following: δ-band — 30 and 33%, respectively; θ-band — 29 and 34%, respectively; α-band — 10 and 12%, respectively; and β-band — 8 and 10%,

TABLE 1. Effect of Repeated Treatment with ESL on Hemorheological Characteristics of Rats with Cerebral Ischemia ($\bar{X}\pm m$)

Parameter		Intact (n=10)	Control (n=6)	ESL (n=6)
Plasma viscosity, rel. units		1.5±0.1	1.8±0.1*	1.6±0.1+
Erythrocyte aggregation half-time, sec		9.3±0.5	3.4±0.4*	5.0±0.2*+
Hematocrit		44±1	43±1	43±1
Plasma fibrinogen concentration, mg%		215±12	471±18*	377±16*+
Erythrocyte deformability index, rel. units	90 sec^{-1}	0.128±0.010	0.097±0.005*	0.113±0.006+
	180 sec^{-1}	0.250±0.016	0.176±0.009*	0.194±0.004*+
	360 sec^{-1}	0.384±0.021	0.279±0.010*	0.274±0.009*
	890 sec^{-1}	0.535±0.014	0.359±0.011*	0.365±0.014*

Note. $p<0.05$: *compared to intact rats; +compared to the control.

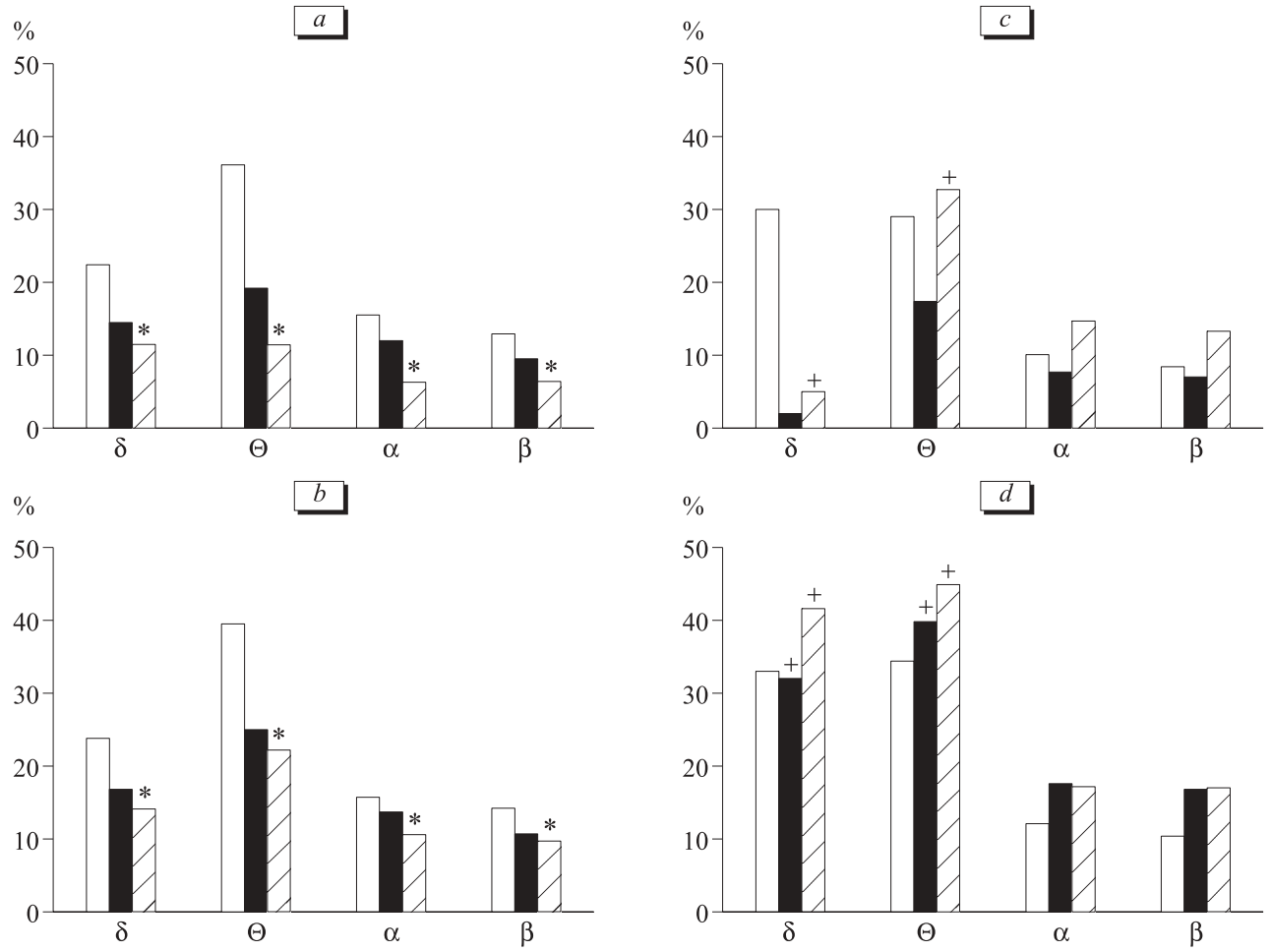

Fig. 2. Effect of repeated intragastric treatment with scarlet lightning extract (ESL) in a dose of 150 mg/kg for 5 days on the power of individual EEG spectra in the parietal cortex of rats with cerebral ischemia. *a*, *b*) control; *c*, *d*) ESL. *a*, *c*) left hemisphere; *b*, *d*) right hemisphere. Light bars: before ischemia. Dark bars: 2nd day of ischemia. Shaded bars: 5th day of ischemia. $p<0.05$: *compared to the baseline level; +compared to the control.

respectively (Fig. 2). The power of individual spectra and total power of EEG in RH of ESL-treated animals returned to normal 2 days after the onset of ischemia. However, the basic rhythm was depressed in the cortex of LH (site of carotid artery occlusion; Fig. 2, Table 2). In ESL-treated rats the power of EEG spectra progressively increased up to the 5th day. An increase in the power of individual EEG spectra resulted in a

TABLE 2. Effect of Repeated Treatment with ESL on the Total Spectral Power of EEG and Dominant Frequency of the Visual Cortex in Rats with Cerebral Ischemia ($\bar{X}\pm m$, $n=6$)

Group		LH		RH	
		total power, %	dominant frequency, Hz	total power, %	dominant frequency, Hz
Baseline	control	88.7±2.9	6.5±0.1	93.4±1.9	6.4±0.1
	experiment	77.5±9.0	6.4±0.1	90.0±15.1	6.4±0.1
2nd day of ischemia	control	50.5±6.4*	5.1±0.1*	50.5±6.4*	5.1±0.1*
	experiment	50.4±8.9*	5.1±0.2*	106.1±15.4+	5.1±0.3*
5th day of ischemia	control	66.6±9.2*	4.2±0.1*	66.6±9.2*	4.2±0.1*
	experiment	95.4±12.1+	6.4±0.2+	120.7±14.9+	6.4±0.4+

Note. $p<0.05$: *compared to baseline level; +compared to the control.

statistically significant rise in the total power of RH and LH (by 23 and 34%, respectively, compared to the baseline level; Fig. 2, Table 2). The dominant frequency in ESL-treated animals returned to normal by the 5th day (Table 2).

Our results indicate that the course of treatment with ESL in a daily dose of 150 mg/kg for 5 days reduced the severity of hemorheological disorders and normalized EEG activity. Hence, ESL possesses cerebroprotective activity and decreases the inhibitory effect of ischemia on electrical activity of the brain.

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