TIME COURSE OF POSTSTRESS RECOVERY OF PORTAL VEIN CONTRACTILITY AND ADRENOREACTIVITY

E. B. Manukhina and V. G. Pinelis

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KEY WORKDS: portal vein; emotional-painful stress; adrenoreactivity.

Emptional-painful stress (EPS) is known to cause marked depression of spontaneous contractility and to reduce the adrenoreactivity of portal vein smooth muscle [3, 6]. These phenomena are accompanied by a sharp decrease in the noradrenalin (NA) content in the portal vein [4]. A previous investigation of the time course of recovery of the NA content after stress showed that this process is fluctuating in character, with gradually decaying waves of NA level [14]. However, the relations between changes in the NA content in the portal vein and its adrenoreactivity have not hitherto been studied.

The aim of this investigation was accordingly to study the time course of contractility and adrenoreactivity of portal vein smooth muscle after EPS.

EXPERIMENTAL METHOD

Experiments were carried out on male Wistar rats weighing 200-230 g, divided into two groups: 1) control animals, 2) rats with EPS.

EPS was produced in the form of an anxiety neurosis by the method in [8] in the course of 6 h. The animals were decapitated 2 h and 1, 2, 4, and 8 days after the end of exposure to stress, i.e., at times used previously to study the time course of the NA concentration [4]. The portal veins were immediately removed and transferred into thermostatically controlled working chambers filled with oxygenated Krebs' solution at 32°C and subjected to a load of 400 mg. The portal veins remained under these conditions for 1 h before the experiment began to allow stabilization of spontaneous contractions.

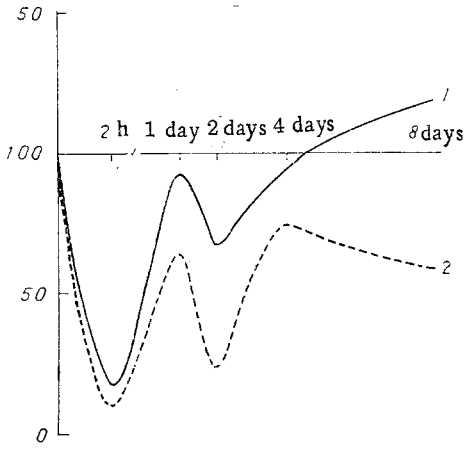

Fig. 1. Time course of poststress recovery of adrenoreactivity and NA concentration in portal vein. Abscissa, time after end of EPS; ordinate, changes in parameters studied (in % of initial value). 1) NA concentration (taken from Manukhina et al. [4]); 2) adrenoreactivity (1/K).

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TABLE 1. Time Course of Recovery of Contractility and Adrenoreactivity of Portal Vein after EPS (M ± m)

Parameter studied	Control	Time after end of EPS				
		2 h	1 day	2 days	4 days	8 days
Developed tension, mg	145±7,5	18±0,8*	59±17*	76±15*	155±16	153±16
Frequency of spontaneous contractions per minute	7,0±0,2	9,5±0,3*	7,1±1,3	6,6±0,9	7,8±0,9	7,6±1,0
IFS, mg/(mg·min)	404±17	67±4,5*	135±25*	198±34*	496±89	410±38
Rate of development of tension, mg/sec	94±3,9	15±0,4*	42±6,7*	59±9,6*	101±14	91±18
Rate of relaxation of smooth muscle, mg/sec	117±1,5	18±0,5*	54±15*	59±9,1*	149±25	107±13
$K(\cdot 10^{-7})$, g/ml	4,8±0,2	55±3,5*	7,7±2,6	23±2,4*	6,5±1,6	8,2±1,9*

Legend. *P < 0.05 compared with control.

Contractions were recorded on a two-channel apparatus from Ugo Basile, Italy. The following parameters of portal vein contractility were calculated: developed tension, frequency of spontaneous contractions, intensity of functioning of structures (IFS; the product of the developed tension and frequency of spontaneous contractions, expressed per unit weight of portal vein), the rate of development of tension, and the rate of relaxation of the smooth muscle.

Adrenoreactivity of the portal vein smooth muscle was assessed from the tonic response to increasing concentrations of NA: 1×10^{-7}, 3×10^{-7}, 6×10^{-7}, and 1×10^{-6} g/ml. To assess the sensitivity of the vascular adrenoreceptors, values of the apparent dissociation constants (K) of the NA–adrenoreceptor complex were calculated. Numerically K is equal to the NA concentration evoking a reaction equal to half of the maximal response. The reciprocal of K (1/K, ml/kg) characterizes adrenoreactivity of the portal vein quantitatively [2].

EXPERIMENTAL RESULTS

Maximal depression of contractility of the portal vein, expressed as a decrease of all parameters tested except frequency of contraction, to approximately 15% of the control level occurred 2 h after EPS (Table 1). On the fourth day contractility was a little higher than initially, and not until the eighth day was contractility of the vein finally restored with respect to all the parameters studied.

Restoration of adrenoreactivity, like restoration of the NA concentration, takes place in waves of decaying oscillations; the direction of the changes in these processes was the same until the eight day (Fig. 1). The fact that on the eighth day the increase in NA concentration was accompanied by a decrease in adrenoreactivity of the portal vein can evidently be explained by gradual normalization of the state of the adrenoreceptors and restoration of reciprocal relations between concentration of the agonist and sensitivity of the receptors [1].

Stress is known to be accompanied by activation of the sympathetic nervous system and secretion of large quantities of catecholamines [5]. One result of this is activation of lipid peroxidation and of lipases and phospholipases in the cells, leading to marked changes in the lipid environment of the membrane proteins [5, 7]. Considering that the state of the lipid bilayer of the membrane has a great influence on function of the adenylate cyclase complex [9], it can be postulated that the processes mentioned above can give rise to changes in adrenoreceptor sensitivity, which were indeed observed in the present experiments. The duration of normalization of adrenoreactivity and contractility of the portal vein indicates that EPS induced very considerable disturbances of these parameters. This may be the cause of the reduced efficiency with which the sympathicoadrenal system mobilizes blood stored in the portal system, and may thus contribute to the development of arterial hypovolemia and of states resembling collapse.

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CORTICAL ELECTRICAL ACTIVITY OF HUNGRY DOGS WITH NORMAL AND DISTURBED GASTRIC INNERVATION

N. N. Lebedev and T. B. Bogdanova

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KEY WORDS: electrocorticogram; peristaltic movements of the stomach; hunger motivation.

Chronic experiments on hungry waking dogs in an ordinary laboratory situation have revealed a periodic increase in activation of the cerebral cortex which corresponds to periods of gastric contractions [4, 9, 12]. Under conditions of relative isolation from external stimuli activation of the electrocorticogram (ECoG) in such dogs was found only during periods of gastric contractions, whereas at rest slow-wave high-amplitude activity predominated [6, 8].

The level of nutrient substances in the blood, controlled by subcortical structures of the food center [11], and interoceptive impulses from the stomach and intestine [1, 2, 5] are considered to be the trigger stimuli which modify electrical activity of different parts of the cortex in hungry animals.

Considering the possible role of the vagus nerves in regulation of the level of hunger motivation, the dynamics of changes in cortical electrical activity was analyzed in dogs with intact and disturbed gastric innervation, and in a state of prolonged physiological hunger.

EXPERIMENTAL METHOD

Altogether 700 electrocorticograms obtained in chronic experiments on six hungry dogs were analyzed. All the dogs had fistulas of the gastric fundus, and bipolar electrodes implanted symmetrically into the cranial bones on the right and left sides. Automatic analysis of ECoG frequencies was carried out with an MAF-4 analyzer connected with an encephalograph (Nihon Kohden, Japan), with electrodes corresponding to projections of the motor cortex of the right and left hemispheres (RH and LH respectively) in two channels simultaneously. ECoG frequencies were analyzed in five bands: 2-4, 4-8, 8-12, 12-20, and 20-30 Hz, which will subsequently be called bands I, II, III, IV, and V. During continuous monitoring of peristaltic movements of the stomach (PMS) on a kymograph, 3-5 ECoGs were recorded during contractions and 6-8 ECoGs during rest of the stomach. In experiments which lasted from 10 a.m. to 6 p.m., 4-6 cycles of PMS and no fewer than 30 RCoGs, each in 3-5 10-sec epochs, were recorded. The dogs were fed at 11 a.m. on the previous day but not on the day of the experiment.

Selective distal vagotomy (SDV) was performed on two of the six dogs 5 months before the experiments [3, 10]. A full description of the method, the experimental conditions, technique of the SDV operation, and analysis of the results will be found elsewhere [3, 6, 8, 10].

The results were subjected to statistical analysis in two versions. In the first (190 ECoGs obtained in experiments on three healthy dogs and 230 ECoGs in experiments on two dogs after SDV) ECoGs of RH and LH were grouped together, without reference to PMS, during each

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