RELATIONSHIP OF CHANGES IN THE CENTRAL HEMODYNAMICS TO THE DEVELOPMENT OF POSTHYPOXIC CEREBRAL EDEMA IN THE POSTRESUSCITATION PERIOD

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A syndrome of low cardiac output developed between the first and third hours after resuscitation in 16 dogs subjected to circulatory arrest for 15 min. In half of the cases its development was preceded by an increase in the cardiac output in the initial period of resuscitation. Without hyperperfusion at the beginning of resuscitation, the animals died 9-23 h after the beginning of the experiment. Among the surviving animals, edema of the cerebral cortex always developed in dogs with a reduced cardiac output 24 h after resuscitation, but no cerebral edema was observed in dogs with a high cardiac output.

KEY WORDS: *terminal state; central hemodynamics; edema of the cerebral cortex.*

The causes of development of posthypoxic cerebral edema and the associated encephalopathy in the early resuscitation period after clinical death still remains unknown. The importance of the elucidation of this phenomenon will be evident. On the other hand, the presence of marked disturbances of the central hemodynamics during this period has been observed [1, 4].

The object of the present investigation was to compare indices of the central hemodynamics with the development of edema of the cerebral cortex in the postresuscitation period after prolonged circulatory arrest.

EXPERIMENTAL METHOD

Sixteen dogs of both sexes, anesthetized with Pantopon (6 mg/kg) and pentobarbital (10-15 mg/kg), were used. The circulation was arrested for 15 min by electric shock, causing ventricular fibrillation. The animals were resuscitated by intraarterial injection of 10-50 ml of physiological saline with adrenalin (0.1 ml of the 1:1000 solution/kg body weight), external cardiac massage, electrical defibrillation, and artificial ventilation of the lungs with 50-60% oxygen by means of the RO-2 apparatus for 1 h [2]. The following parameters were recorded before electric shock, during the 3 h of the postresuscitation period, and 24 h later: the cardiac output (by the thermodilution and Fick method); the mean arterial blood pressure, heart rate, velocity of blood flow in the carotid artery (by means of a flow meter), and the oxygen balance of the body (by gas chromatography); the total peripheral vascular resistance was calculated. The animals were killed by electric shock 24 h after resuscitation and the degree of hydration of the cortical tissue was determined by drying to constant weight. A previous investigation showed that it is during this period that cerebral cortical edema develops in animals after clinical death caused by mechanical asphyxia [3].

EXPERIMENTAL RESULTS

Depending on the outcome of the experiments, the animals as a whole were divided into two groups: those surviving for 24 h (group 1, 8 animals) and those dying between 9 and 23 h

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TABLE 1. Changes in Central Hemodynamics in Early Postresuscitation Period in Animals after Circulatory Arrest for 15 min (M ± m)

Parameter studied	Initial period	Postresuscitation period					
		surviving for 24 h (group 1)			dying after 12-23 h (group 2)		
		30 min	60 min	180 min	30 min	60 min	180 min
Arterial blood pressure, mm Hg	116±2 (6)	137±8* (7)	132±15 (7)	113±5 (6)	67±4* (7)	92±6 (7)	113±5 (5)
Heart rate, beats/min	100±20 (7)	189±12 (5)	170±10 (5)	163±25 (5)	178±5 (6)	150±6 (6)	150±16 (6)
Cardiac output, ml/min/kg	124,2±17,5 (7)	284,6±43,1* (4)	147,0±55,3 (4)	59,6±18,1 (4)	141,4±29,9* (4)	108,3±16,7 (4)	57,6±9,2 (4)
Total peripheral vascular resistance, dynes·cm·sec^{-5}	5784±522 (8)	3436±161 (4)	5633±1211 (4)	8809±1341 (4)	3616±316 (4)	5925±1272 (4)	7040±1265 (4)

Legend. 1) Number of observations in parentheses; 2) $P < 0.05$ for comparison between groups 1 and 2.

TABLE 2. Comparison of Development of Cerebral Cortical Edema and Changes in Central Hemodynamics in Postresuscitation Period in Animals after Prolonged Circulatory Arrest (M ± m)

Subgroup and number of experiments	Cardiac output, ml/min/kg	Blood flow in carotid artery, ml/min	Stroke volume, ml/min	Heart rate, beats/min	Arterial blood pressure, mm Hg	Total peripheral vascular resistance; dynes·cm·sec^{-5}	Total oxygen consumption, ml/min/kg	Arteriovenous oxygen difference, vol. %
Subgroup 1 – cerebral cortical edema (4)	90,0±21,6	15±5	0,49±0,09	187±2	108±7	5946±167	11,61±1,43	11,80±0,59
Subgroup 2 – no edema (4)	257,6±31,4*	35±8*	1,43±0,33*	208±18	110±9	2532±187*	16,77±2,23*	6,8±1,59*

*$P = 0.05$ for differences between subgroups.

after the beginning of the experiment (group 2, 8 animals). During resuscitation, recovery of stable cardiac activity, respiration, and the corneal reflexes in the animals of group 1 took place after 2.7 ± 0.3, 5.2 ± 0.6, and 15.6 ± 7 min, respectively; and in the animals of group 2 after 3.2 ± 0.1, 5 ± 0.1, and 20.4 ± 0.8 min, respectively. In the animals of group 1 the corneal reflexes recovered earlier. In the course of 3 h after resuscitation changes in the central hemodynamics differed in the two groups (Table 1).

A sharp increase in the cardiac output was observed in the animals of group 1 30 min after the beginning of the recovery period, whereas in the animals of group 2 it was the same as initially. Meanwhile, in the animals of group 2, transient hypotension occurred in the early stages of resuscitation and could not be corrected by vasoconstrictor drugs. The differences between the central hemodynamics in the two groups mentioned above became less marked and ceased to be significant 1 h after resuscitation. After 3 h the animals of both groups developed a syndrome of low cardiac output, fully described previously [1, 4]. Failure of the cardiac output to rise in the initial period of resuscitation was accompanied by death of the animals between 9 and 23 h after the experiment. The development of hyperperfusion at the beginning of the recovery period in the animals which survived evidently helped to ensure more effective compensation of the hypoxic changes in the internal milieu of the animal in consequence of the terminal state.

The surviving animals (group 1) were divided into two subgroups, depending on changes in their central hemodynamics and degree of hydration of the cerebral cortex, 24 h after circulatory arrest (Table 2). If cerebral cortical edema was present (hydration of the brain substance 84.5 ± 0.7%; subgroup 1), much lower values were obtained for the cardiac output (by 64%), the blood flow in the carotid artery (by 75%), and the total oxygen consumption; the total peripheral vascular resistance and the arteriovenous oxygen difference were higher than in the absence of cerebral edema (hydration of the brain substance 81.3 ± 0.5%; $P < 0.01$; subgroup 2). The blood pressure, heart rate, and partial pressure of oxygen in the arterial

blood did not differ significantly. It is important to note that after 24 h, the indices of the hemodynamics in the surviving animals were better than 3 h after resuscitation. At the same time, if cerebral cortical edema was present after 24 h, the indices of the hemodynamics were only approaching their initial levels, whereas in the absence of cerebral edema considerable hyperperfusion was observed. It can be postulated on the basis of the facts described above that the prolonged reduction in the volume blood flow is a factor of considerable importance in the formation of cerebral edema associated with posthypoxic states. This conclusion is in agreement with data in the literature [5-8], and it emphasizes the need for the correction of hemodynamic disturbances during the first day of the resuscitation period after clinical death.

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EFFECT OF ANTRECTOMY ON GASTRIC SECRETION INDUCED BY INSULIN HYPOGLYCEMIA IN DOGS

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Antrectomy causes a sudden and lasting depression of reflex secretion of the gastric fundal glands in response to insulin hypoglycemia in dogs. The reduction in the secretion of acid and pepsin is on average twice that observed after histamine stimulation. A tendency for the indices of secretion to recover is observed after 3-5 months, and during the next 7 months secretion is maintained at a constant level.

KEY WORDS: *antrectomy; gastric secretion; insulin hypoglycemia; histamine.*

The extent to which antral gastrin participates in the secretory response of the fundal glands to vagal stimulation is not yet clear. In patients with duodenal ulcer, positive correlation has been found between the blood gastrin level and the gastric acid secretion in response to insulin [10]. According to observations described by other workers, the correlation between these parameters is less definite [4, 15]. There is evidence that secretion of acid in response to insulin, 2-deoxyglucose, and sham feeding is reduced in dogs after antrectomy [12]. The same effect has been found in antrectomized patients with duodenal ulcer. Antrectomy caused a significant decrease in acid secretion in a Pavlov's gastric pouch in dogs following injection of small doses of insulin (0.2 unit/kg), but in response to larger doses (0.6 unit/kg), secretion was substantially unchanged [12]. Antroneurolysis or vagal

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