CHANGES IN THE TOTAL HEPATIC BLOOD FLOW SOON AFTER RESUSCITATION

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The total hepatic blood flow during the first 2 hours after resuscitation was studied by local thermodilution and obturating catheter methods in experiments on cats anesthetized with pentobarbital. Changes in the blood flow occurred in stages. The brief increase in volume velocity of perfusion immediately after resumption of cardiac contractions was replaced by a rapid fall below the control level, after which the blood flow continued to decrease gradually. Changes in the total hepatic blood flow correspond largely to changes in the minute volume of the heart. Drip infusion of dextran in doses maintaining the central venous pressure at its initial level restored the normal hepatic blood flow and arterial pressure during the period after resuscitation.

KEY WORDS: hepatic blood flow; postresuscitation period; infusion of plasma expander.

The period after resuscitation is marked by disturbance of the functions of the liver, the activity of which must be maintained in order to ensure successful resuscitation [6, 8, 11, 12]. Information on the character and mechanisms of the disturbances of the hepatic circulation is evidently insufficient although it is known that the integrity of the functions of the liver in shock and terminal states is determined primarily by its adequate blood supply [10, 14, 15]. The possibility of a disturbance of the hepatic circulation during resuscitation has been demonstrated by the study of the mesenteric [7] and portal [1] circulations.

The object of this investigation was to study the total hepatic blood flow during the first 2 hours of resuscitation after lethal blood loss.

EXPERIMENTAL METHOD

Experiments were carried out on 33 cats of both sexes, weighing 2-3.6 kg and anesthetized with pentobarbital (40-45 mg/kg, intraperitoneally). In the experiments of series I on animals exsanguinated by the local thermodilution method [4], the total hepatic blood flow was determined as the difference between the blood flows in the inferior vena cava cranially and caudally to the point of entry of the hepatic veins. The blood flows were determined by recording the thermodilution curves simultaneously by two instruments. In the experiments of series II, the hepatic blood flow was determined for 2.25 h by the same method in 8 animals that were not exsanguinated. In the experiments of series III on 8 exsanguinated animals, the effect of drip infusion of dextran on the hepatic blood flow was studied. Dextran was infused into the femoral vein in doses maintaining the central venous pressure at its initial level. The infusion usually began 15-20 min after the restoration of cardiac activity. Since constant fluctuations in the blood temperature during the infusion of the plasma expander complicated the use of the thermodilution technique, the total hepatic blood flow in the cats of this series was determined by the obturating catheter method [9, 13]. Since an open circuit was used for the measurement (the number of drops of blood flowing from the catheter and subsequently reinjected into the femoral vein was counted), so that the effect of the changing central venous pressure in the postresuscitation period was excluded, six control experiments were carried out in which the total hepatic blood flow was recorded similarly but without injection of dextran (experiments of series IV). The systemic arterial pressure was recorded in all the animals. To prevent the blood from clotting, heparin was injected intravenously (500 units/kg). Clinical death (4 min)

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TABLE 1. Total Hepatic Blood Flow (in ml/kg/min) in Cats in the Early Postresuscitation Period (M ± m)

Series of experiments	No. of animals	Initial values	Minutes of postresuscitation period											
			2nd	3rd	5th	15th	30th	45th	60th	90th	120th			
I	11	36,9±2,2	52,3±6,7*	54,1±5,2*	43,6±5,1	26,7±3,1*	30,6±2,5*	30,0±2,5*	28,0±2,5*	25,9±2,7*	22,7±2,5*			
			Minutes after beginning of investigation											
			15th	30th	45th	60th	75th	90th	105th	120th	135th			
II	8	39,2±5,0	37,6±5,3	32,7±3,6†	33,9±5,2†	33,6±5,3†	31,2±5,6†	34,2±5,4†	31,2±7,0†	31,7±6,1†	30,8±6,3†			

*P < 0.05 by Student's criterion.
†P < 0.05 by Wilcoxon's criterion, compared with initial values.

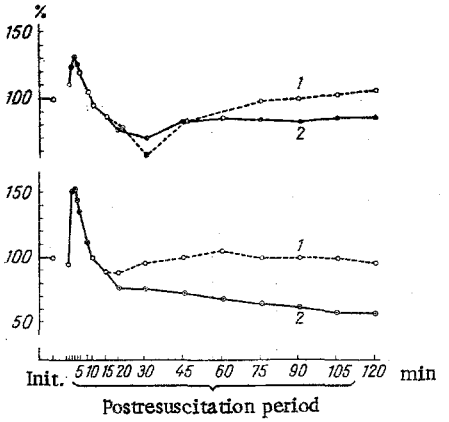

Fig. 1. Arterial pressure (top curves) and total hepatic blood flow (bottom curves) in early postresuscitation period (percentages of initial level): 1) experiments with; 2) without dextran infusion. Before infusion (15 min inclusive) data for both series are combined. Circles with dots denote significant difference (P < 0.05) from initial level.

was produced by unrestrained arterial bleeding and resuscitation was carried out by Negovskii's method without the use of stimulants. The body temperature of the animals was maintained during the experiment at close to the initial level. Statistical analysis of the results was carried out using Student's and nonparametric criteria.

EXPERIMENTAL RESULTS

Of the 25 exsanguinated animals, in 23 the cardiac activity was restored during infusion of blood and in 2 after additional indirect massage. The course of the recovery processes, as reflected by clinical tests (respiration, arterial pressure, ocular reflexes) was assessed as favorable.

The total hepatic blood flow in the initial period averaged 36.9 ± 2.2 ml/kg body weight/min, and according to data obtained previously [3], its fraction of the minute volume of the circulation was 25.6%. Statistics reflecting the dynamics of the hepatic drainage in the postresuscitation period are given in Table 1. After restoration of the cardiac contractions the blood flow increased to reach a maximum in the 3rd minute. Then it fell, and by the end of the investigation it was only 62% of its initial value.

The total hepatic blood flow in the control experiments fell gradually. However, the degree of its decline was much less than in the experimental series and by the end of the period of study the blood flows in the experimental and control series differed significantly (U criterion, P < 0.05).

When the total hepatic blood flow was measured by the obturating catheter method, similar changes were observed in the resuscitation period (Fig. 1). The slight differences compared with the results obtained by the thermodilution method (a rather longer period of hyperperfusion, a slight decrease in the blood flow in the 15th minute) were evidently connected with measure-

ment of the free blood flow from the liver, which ruled out any possible effect of changes in the central venous pressure during the postresuscitation period. In 4 of 6 experiments the outflow of blood was increased in the 30th-35th minute, although this was not reflected in the mean data.

Considering that in the early postresuscitation period there is a marked decrease in plasma volume [2], in eight experiments dextran was given by intravenous drip, with monitoring of the central venous pressure, in order to correct the deficit. The total volume of dextran injected during the experiment averaged 19.4 ± 3.6 ml/kg. Under these conditions, the normal hepatic blood flow was restored after 30 min of the postresuscitation period and it thereafter remained at the control level (Fig. 1). The arterial pressure rose at the same time, and starting from the 90th minute its level differed significantly from that in the corresponding experiments in which no dextran was given (127 ± 6.5 and 106 ± 5.9 mm Hg, respectively; $P > 0.05$).

Changes in the total hepatic blood flow in the early postresuscitation period thus show a number of clearly defined stages: the maximal increase in blood flow after 2-3 min was followed by a rapid decrease below the control level until 15 min, after which the volume velocity of perfusion gradually decreased in the course of 2 h.

Comparison of the results of this study of the total hepatic blood flow with earlier observations on the dynamics of the portal blood flow and the cardiac output in the postresuscitation period [1, 3] shows that the changes in these parameters are directly related. The portal blood flow as a fraction of the total hepatic blood flow, and the total hepatic blood flow as a fraction of the minute volume of the heart remained virtually constant throughout the period of study. Like the minute volume of the heart [5], the total hepatic blood flow was restored to normal if the deficit of the circulating blood volume was made good. This suggests that disturbances of the hepatic circulation in the early postresuscitation period are determined chiefly by changes in the minute volume of the heart and, consequently, the first step toward the correction of these disturbances must be restoration of the normal systemic hemodynamics.

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