DELIPIDIZATION BY CONTINUOUS PLASMA EXTRACTION

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To remove hydrophobic compounds from the blood the possibility of extracting them from the plasma is being examined. One probable field of application of plasma extraction is delipidization of the patient in the treatment of atherosclerosis [1]. Experiments on animals with delipidization by plasma extraction have been described [2]. In those experiments the animal's plasma was mixed with diethyl ether in the ratio of 1:15 at 4°C for 16-20 h, after which the denatured protein was removed, the plasma was dialyzed against a large volume of 0.9% sodium chloride solution, heated to room temperature, and reinjected into the animal. This method of extraction has important disadvantages: contact of the plasma with a large volume of ether leads to denaturation of protein; the relatively high toxicity of the solvent (diethyl ether); the long duration of the process. Moreover, the to-and-fro procedure used in the investigation cited [2] requires the removal of a large volume of blood each time, which considerably complicates the operation, and does not allow it to be automated.

TABLE 1. Continuous Plasma Extraction on Samples of Native Human Plasma

Characteristics of sorbent		Volume of plasma, cm^3	Ratio of volume of plasma to volume of chloroform, cm^3/cm^3	Duration of contact of plasma with sorbent, sec	Results of biochemical analysis					
content of divinylbenzene, %	concentration of chloroform in sorbent, %				cholesterol, $M \cdot 10^{-3}$		triglycerides, %		total protein, %	
					C_0	C_{15}	C_0	C_{15}	C_0	C_{15}
8	23	100	25	80	8,56	7,60	0,168	0,039	8,0	7,9
8	37	70	11	100	4,29	4,01	0,112	0,096	6,1	6,1
8	37	90	15	80	4,29	4,11	0,278	0,240	6,2	6,2
3	54	50	4	140	3,03	2,72	0,080	0,058	—	—
3	54	70	6	100	4,29	3,91	0,112	0,096	—	—
3	54	65	6	105	3,75	3,62	0,118	0,103	—	—
"Polysorb"	70	70	5	100	2,92	2,46	0,073	0,059	—	—
"Polysorb"	70	70	5	100	4,29	3,91	0,112	0,086	—	—
"Polysorb"	70	105	7	65	3,65	3,52	0,112	0,107	—	—

Legend. Here and in Table 2: C_0) initial concentration of substance, C_{15}) concentration of substance after adsorption for 15 min.

TABLE 2. Continuous Plasma Extraction in Experiments on Animals

Sex of dog	Weight of dog, kg	Characteristics of sorbent		Volume of plasma, cm^3	Ratio of volume of plasma to volume of chloroform, cm^3/cm^3	Duration of contact of plasma with sorbent, sec	Results of biochemical analysis			
		content of divinylbenzene, %	concentration of chloroform in sorbent, %				cholesterol, $M \cdot 10^{-3}$		triglycerides, %	
							C_0	C_{30}	C_0	C_{30}
Female	16	8	37	150	19	110	3,34	3,21	—	—
Female	12	8	37	590	37	50	5,09	4,34	—	—
Male	6	8	37	80	10	200	3,83	3,21	—	—
Female	6	8	37	100	13	160	4,47	4,24	—	—
Female	6	8	37	50	8	270	4,09	3,67	—	—
Female	8	8	37	105	16	130	4,47	2,77	0,073	0,038
Female	5	8	37	70	11	200	5,17	4,45	0,076	0,051

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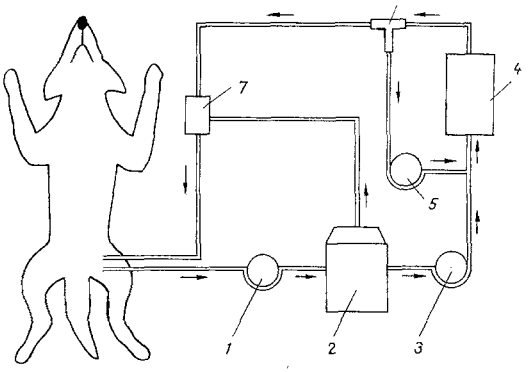

Fig. 1. Diagram of apparatus for continuous plasma extraction. Explanation in text.

In the investigation described below a method of continuous plasma extraction based on the use of a solvent in the immobilized state is examined. Binding of the solvent is achieved by swelling an insoluble polymer in it [3].

It is easy to fill columns with particles of swollen polymer. Virtually no emulsification of the immobilized solvent takes place and the swollen granules have only low hydrodynamic resistance to the flow of fluid passed through the column. The use of an immobilized solvent eliminates the stage of phase partition, thus greatly shortening the duration of the operation.

Of the wide range of solvents and polymers available the most suitable pair is chloroform and a copolymer of styrene with divinylbenzene. The reason is that chloroform successfully combines low denaturing action with high solvent capacity. By choosing the appropriate w/w ratio of styrene monomer and divinylbenzene, different degrees of cross-linkage of the copolymer and, consequently, of ability to swell in the solvent, can be obtained.

The extraction of lipids was studied in bench tests on plasma obtained from blood donors and also in experiments on animals. The concentrations of substances in the blood were determined by the AA-2 automatic analyzer (from Technikon).

In the bench tests plasma circulated in a system containing a column filled with the copolymer, swollen in chloroform. The results obtained by this method are given in Table 1.

The experiments provided for removal of the blood, its separation into plasma and cells, plasma extraction, mixing the delipidized plasma with the blood cells, and returning the processed blood to the animal.

The scheme of the arrangements for plasma extraction is shown in Fig. 1. Blood from the femoral artery was transmitted by the pump 1 to the centrifuge 2, where it was separated into a suspension of cells and plasma. By means of the pump 3 the plasma was directed to column 4 containing granules of swollen polymer, from which it passed to the shunt 6, with two outlets. The first led to the recirculating pump 5 and joined the flow from pump 3. The second flow was directed to the receiver 7, in which it was mixed with a suspension of cell particles. The blood thus treated was reinjected into the animal.

The coefficient of recirculation of the plasma (K_r), equal to the ratio of the volumes of plasma passing through the column and delivered from the centrifuge, depends on the output of the pumps 3 and 5 (Q_1 and Q_2 respectively):

$$K_p = \frac{Q_1 + Q_2}{Q_1}$$

and it determines the duration of contact between plasma and solvent.

Some biochemical parameters of plasma extraction in accordance with this scheme are given in Table 2.

It will be clear from Tables 1 and 2 that plasma extraction does not affect the protein composition of the plasma but reduces the concentration of lipids, especially triglycerides, in it. Depending on the character of the change in concentration it can be postulated that only lipids weakly bound with proteins are extracted by this method.

Objective physiological parameters (ECG, blood pressure, rheologic characteristics of the blood) in animals treated by plasma extraction were virtually indistinguishable from controls. Observation on the animals for 1 week showed that they tolerated the operation quite satisfactorily. The method of continuous plasma extraction using immobilized solvents is thus practicable, in principle, for the removal of hydrophobic compounds from blood.

LITERATURE CITED

1. Yu. M. Lopukhin and M. N. Molodenkov, Hemoperfusion [in Russian], Moscow (1978).
2. A. N. Klimov, L. G. Petrova-Maslakova, G. G. Khechinashvili, et al., Kardiologiya, No. 6, 23 (1978).
3. A. A. Tager, Physical Chemistry of Polymers [in Russian], Moscow (1978), pp. 268-278.

EXPERIMENTAL EVERTED MECHANICAL INTESTINAL SUTURE

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In the last two decades instruments for mechanical suture have been introduced on a wide scale in abdominal surgery. Most Soviet suturing instruments (the NZhKA-60, PKS-25, KTs-28, SPTU) and their American counterparts (YIA, EEA) are designed to form anastomoses with an invested suture. Besides their undoubted advantages, these instruments also have certain disadvantages due to the character of the suture they form: difficulty in examining the region of anastomosis, making it difficult to assess whether the suture has been correctly applied, and that hemostasis is satisfactory, the need to introduce the working part of the instrument into the lumen of the organs to be sutured, making the operation less aseptic, and the possibility of development of stenosis in the region of anastomosis [3, 5, 6, 8].

The SK-60 and SZhK-60 instruments, developed by the All-Union Research and Testing Institute for Medical Engineering, Ministry of Health of the USSR, jointly with the Professional Surgical Clinic, I. M. Sechenov First Moscow Medical Institute, for use in operations for enteroenterostomy and gastroenterostomy by means of an everted staple suture [1], are free from these disadvantages. The first report of the experimental and clinical use of the SK-60 instrument was published by Shkrob et al. [4]. These workers used the instrument for enteroenterostomy and they buried the mechanical suture line with knotted sutures.

The possibility of forming anastomoses between the hollow viscera of the gastrointestinal tract by means of a single row of mechanical sutures, including those of the everted type, has been widely discussed in recent years and definite advantages of mechanical suture in a single row without peritonization have been described [2, 7]. The possibility and desirability of using the SK-60 and SZhK-60 mechanical suturing instruments for enteroenterostomy by means of an everted intestinal suture without peritonization of the mechanical suture line accordingly calls for urgent solution.

EXPERIMENTAL METHOD

In experiments on 15 mongrel dogs 32 anastomoses were performed. They included 18 on the small intestine, 11 on the large intestine, and three between the large and small intestines; 23 anastomoses were of the end-to-end and nine of the side-to-side type. The state of the anastomoses was analyzed during the operation, immediately after suture, during repeated operations on the animals at a later stage, and at autopsy. The animals were killed after 3,

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