Allergic Alteration in the Organism is Associated with Disturbances in Lipid Composition of the Lymph

M. M. Minnebaev, L. G. Zakharova, and F. I. Mukhutdinova

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Anaphylactic shock causes changes in the transport chain of lipid metabolism in the blood—tissue—lymph—blood system. During the early periods of shock, the changes in lipid composition of the lymph and blood result from increased permeability of the blood-tissue barriers, while at later terms, these processes are primarily determined by metabolic changes.

Key Words: *lymph; blood; anaphylactic shock; lipids*

Despite numerous publications on the pathogenesis of different types of shock, the role of the lymphatic system and functional changes in this system during shock are poorly understood. The lymphatic system is an important component of lipid transport [1,2,5,7, 10,11,14]. At the same time, its role as a transport component of lipid metabolism during shock characterized by enhanced permeability of the blood-tissue barrier and impaired resorption and transport functions of the lymphatic system remains unclear.

The aim of the present study was to examine lipid composition of the lymph from the thoracic duct, and composition of arterial and venous blood during sensitization and anaphylactic shock (AS) in dogs.

MATERIALS AND METHODS

The experiments were performed on 24 mongrel dogs of both genders weighing 6-22 kg, under intravenous thiopental narcosis (25 mg/kg body weight). The animals were sensitized by 3 subcutaneous injections of normal horse serum (3 ml/kg body weight). AS was induced by intravenous injection of a permissive dose of the antigen (0.5 ml/kg body weight). Classical shock developed in all animals. The lymph was obtained via a cannula inserted into the thoracic lymphatic duct close to the venous angle. Venous and arterial blood was obtained from the femoral artery and femoral vein, respectively. In the lymph, venous and arterial blood the contents of total lipids [4], triglycerides (TG), cholesterol (on FP-901 analyser, Labsystems), phospholipids (PL) [4], malonic dialdehyde (MDA) [13], and unesterified fatty acids (NEFA) were measured [6]. The animals were sacrificed by narcotic overdose.

Kazan' State Medical University

RESULTS

Protein sensitization decreased the content of total lipids, NEFA, cholesterol, MDA and increased the content of TG in the lymph; in the arterial and venous blood it decreased the levels of total lipids, TG, cholesterol, and NEFA (Table 1).

Hypotension and developing circulatory hypoxia in AS were accompanied by significant changes in the lipid compositions of biological fluids (Table 2). The content of total lipids, PL, and, especially, NEFA in the lymph increased. Maximum changes in NEFA and total lipid content in the lymph were observed 30-60 min after AS modeling, while PL content was increased throughout the entire observation period (3 h). Since the lymph flow rate increased during AS, the net transport of total lipids, NEFA, MDA, PL and cholesterol to the circulation was considerably enhanced [3].

In the venous blood, the increase in the content of PL and total lipids occurred later than in the lymph, while in the arterial blood the total lipid content transiently decreased and 2 h later increased again. Pro-

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TABLE 1. Effect of Sensitization (Day 21) on Lipid Composition of the Lymph and Blood (*M*±*m*)

Parameters	Lymph		Blood			
			arterial		venous	
	normal	sensitization	normal	sensitization	normal	sensitization
Total lipids, g/liter	5.07±0.16	2.48±0.33*	3.94±0.32	3.36±0.30***	4.08±0.38	3.66±0.24***
PL, mmol/liter	2.47±0.17	2.87±0.16	3.26±0.24	3.77±0.20	3.23±0.37	3.34±0.36
TG, mmol/liter	2.91±0.15	3.42±0.25***	0.55±0.06	0.34±0.03**	0.56±0.08	0.31±0.02**
MDA, nmol/liter	6.35±0.23	5.61±0.31***	5.69±0.31	6.03±0.24	5.60±0.31	5.82±0.26
Cholesterol, mmol/liter	2.44±0.21	1.81±0.15***	3.63±0.36	2.59±0.17***	3.91±0.37	2.73±0.14***
NEFA, μmol/liter	498.14±27.21	288.14±16.64*	301.57±19.23	241.00±13.57***	372.42±17.53	193.57±7.38*

Note. *p<0.001, **p<0.01, ***p<0.05 compared to normal.

gressive accumulation of NEFA and, to a lesser extent, TG in the blood was observed. In the lymph, TG content sharply decreased 5 min after shock modeling and then remained below the initial level throughout the experiment.

The concentration of LPO end-product MDA more early and progressive increased in the lymph than in the blood.

Thus, AS-induced changes in the content of some lipids in the lymph appeared earlier and were more pronounced than in the blood.

It should be noted that, biochemistry of the lymph mirrors metabolic processes in organs and tissues and functional state of the blood-tissue barrier [8]. It is known that biochemical composition of thoracic duct lymph is determined mainly by intestine and liver activity.

TABLE 2. Effect of AS on Lipid Composition of the Lymph (L), Arterial (AB) and Venous (VB) Blood (*M*±*m*)

Parameter	Biological fluid	Before injection of permissive dose	Time after administration of permissive dose of antigen, min		
			5	30	60
Total lipids, g/liter	L	2.48±0.33	2.81±0.30***	3.42±0.47**	2.88±0.49***
	AB	3.36±0.30	3.02±0.36	3.86±051	3.93±0.42***
	VB	3.06±0.24	3.29±0.39	3.11±0.37	3.49±0.37
NEFA, μmol/liter	L	288.14±16.64	410.52±31.42**	540.00±27.74**	561.85±26.03*
	AB	241.00±13.57	370.33±27.52***	338.00±16.06*	362.14±30.29**
	VB	193.57±9.39	248.05±7.39*	380.57±27.19*	409.14±22.27*
MDA, nmol/liter	L	5.61±0.31	6.37±0.20**	6.85±0.25**	7.26±0.31*
	AB	6.03±0.24	6.46±0.32	6.47±0.23	7.12±0.34**
	VB	5.82±0.26	5.97±0.34	6.76±0.35***	6.59±0.27***
TG, mmol/liter	L	3.42±0.25	0.59±0.11*	1.04±0.06*	1.05±0.11*
	AB	0.34±0.03	0.37±0.04	0.55±0.08***	0.59±0.10***
	VB	0.31±0.02	0.38±0.07	0.56±0.09***	0.59±0.09***
Cholesterol, mmol/liter	L	1.81±0.15	2.06±0.18	1.97±0.12	1.93±0.12
	AB	2.59±0.17	2.36±0.09	2.34±0.11	2.36±0.16
	VB	2.73±0.14	2.36±0.14***	2.34±0.11**	2.29±0.13**
PL, mmol/liter	L	2.87±0.16	3.33±0.22**	3.41±0.20**	3.61±0.21**
	AB	3.77±0.20	3.75±0.26	3.62±0.11	3.75±0.11
	VB	3.34±0.36	3.54±0.27	3.96±0.29	4.17±0.26**

Note. *p<0.001, **p<0.01, ***p<0.05 compared to values before administration of a permissive dose of the antigen.

Since changes in the lipid composition of the lymph and blood during allergic alteration show significant quantitative and, sometimes, qualitative differences, they cannot be explained by changed permeability of the blood-tissue barrier under the effect of immediate allergy. It can be assumed that disturbances in lipid metabolism accompanying allergic reaction occur at different levels starting from enzymatic hydrolysis, resorption in the intestine, formation of species-specific lipids in the intestinal wall and culminating in lipid metabolism in organs and tissues, especially, in the liver.

A key role in the pathogenesis of AS is played by massive release of biologically active transmitters, sharp impairment of blood circulation, circulatory and respiratory insufficiency associated with general hypoxia, impairment of metabolism, *etc.* [2]. Therefore, we assume that at the early stages of AS changes in lipid composition of the lymph and blood are determined by impaired transport of high-molecular-weight molecules in the system blood capillary—extracellular space—tissue—lymphatic vessel. Later, these disturbances are aggravated by changes in lipid metabolism. The effect of adrenosympathetic and pituitary-renocortical systems on lipolysis, lipid transformation and catabolism, as well as indirect qualitative and quantitative changes in their tissue metabolism play the leading role in these changes. Thus, changes in lipid composition of the lymph are directed at correction of AS-induced shifts in blood composition, mobilization of endogenous energy and plasticity reserves (with their subsequent delivery to damaged organs and systems), and the maintenance of optimal conditions of metabolism in the extracellular space.

Thus, impairment of lipid homeostasis is a components of AS-induced pathophysiological process. These data suggest that the lymphatic system plays an important role in the mobilization and subsequent redistribution of lipids in biological fluids during immediate allergy.

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