ERYTHROPOIETIC FUNCTION OF THE KIDNEYS DURING EXPOSURE TO INCREASED OXYGEN PRESSURE

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UDC 612.46:612.119.014.41

Erythropoietin disappears from the plasma of both arterial and venous blood from the kidneys 3-5 h after exposure of rabbits for 5 h to a raised oxygen pressure (2 atm). Meanwhile, an erythropoiesis inhibitor appears in blood flowing from the kidneys. The erythropoiesis inhibitor cannot be found in either arterial or venous blood from the kidneys 24 h after exposure to hyperoxia.

KEY WORDS: hyperbaric hyperoxia; erythropoiesis; kidneys; erythropoiesis inhibitor.

Direct proof of the secretion of a humoral stimulator of erythropoiesis (erythropoietin) under hypoxic conditions has been obtained (see the survey in [2]). Hyperoxia would be supposed to inhibit this function of the kidney.

The erythropoietic activity of plasma from blood flowing from and to the kidney was studied under conditions of a raised oxygen pressure.

EXPERIMENTAL METHOD

Experiments were carried out on 36 male rabbits weighing 2-3 kg, of which 24 were kept for 5 h in a hyperbaric chamber with pure oxygen under a pressure of 2 atm. Carbon dioxide and moisture in the chamber were absorbed with soda lime and silicagel. One half of the "hyperoxic" rabbits was investigated 3-5 h after their removal from the chamber and the other half 24 h after removal. The remaining 12 rabbits served as the control. In all the animals samples of arterial blood (puncture of the left ventricle) and venous blood from the renal vein (by laparotomy) were taken. The erythropoietic activity of the plasma was determined from the mitotic activity of a bone marrow culture in liquid medium in the presence of colchicine [8, 9]. It was assessed from the difference between the stathmokinetic indices of the erythroblasts determined after the additon of the test plasma to the culture and after addition of Hanks's solution (control), ex-

TABLE 1. Mean Erythropoietin Content in Arterial Blood and Blood Flowing from Kidneys in Rabbits before and after Hyperoxia (O_2 at 2 atm)

Blood	Erythropoietin concentration (conventional units)							
	before hyperoxia		3-5 h after hyperoxia			24 h after hyperoxia		
	n	$M \pm m$	n	$M \pm m$	P	n	$M \pm m$	P
Arterial	11	+48±7	12	−5±6	<0,001	11	+8±1	<0,001
From renal vein	11	+53±8	11	−16±7	<0,001	10	+1±12	<0,01

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TABLE 2. Peripheral Red Blood Composition in Rabbits before and after Hyperoxia

Index	Before hyperoxia		3-5 h after hyperoxia		Before hyperoxia		24 h after hyperoxia	
	n	$M \pm m$	$M \pm m$	P	n	$M \pm m$	$M \pm m$	P
Hemoglobin (g %)	12	11,8±0,2	11,6±0,3	>0,5	12	11,8±0,3	11,3±0,2	>0,1
Erythrocytes (millions/mm³)	12	4,28±0,10	4,55±0,18	>0,2	12	4,30±0,13	4,11±0,10	>0,2
Reticulocytes (‰)	12	1,2±0,1	1,2±0,1	1,0	12	1,1±0,1	1,1±0,1	1,0
Hematocrit (%)	12	36±1	36±1	1,0	12	36±1	37±1	>0,5

pressed in conventional units. The term stathmokinetic index of the erythroblasts means the number of dividing erythroblasts per thousand erythroid cells capable of division. The hemoglobin concentration, erythrocyte and reticulocyte counts, and the hematocrit index also were determined in all the animals.

EXPERIMENTAL RESULTS AND DISCUSSION

The arterial and venous blood of the intact rabbits possessed approximately equal erythropoietic activity (48 ± 7 and 53 ± 8 conventional units, respectively; $P > 0.5$). Not only were no substances stimulating erythropoiesis detectable 3-5 h after exposure of the rabbits to a raised oxygen pressure in the blood plasma obtained either from the left ventricle or from the renal vien, but the plasma actually had an inhibitory action on mitotic activity of the erythroblasts in a bone marrow culture. The mean erythropoietic activity of the arterial blood plasma was −5 ± 6 conventional units, and in plasma obtained from blood flowing directly from the kidneys it was −16 ± 7 conventional units (Table 1).

The writers showed previously [3] that after exposure to hyperoxia with a normal atmospheric pressure (90% O_2 in the inspired air) the blood flowing from the kidneys also contained an erythropoiesis inhibitor. These facts suggest that under hyperoxic conditions the kidneys not only cease to secrete substances stimulating erythropoiesis, but they also begin to produce an erythropoiesis inhibitor.

Erythropoietins began to appear in the arterial blood plasma 24 h after exposure to hyperbaric hyperoxia, but only in very small amounts ($P < 0.001$). No erythropoiesis inhibitor could yet be detected in the plasma from the venous blood from the kidneys ($P > 0.5$). However, 24 h after exposure to less severe hyperoxia (90% O_2 at normal atmospheric pressure) the erythropoietic activity of plasma from arterial and venous blood was already back to normal [3].

No definite changes in the peripheral blood indices were observed during exposure to hyperbaric hyperoxia (Table 2). These results differ from those of earlier investigations [1, 4-7, 10] and they are probably connected with the shorter period of exposure of the animals to hyperoxia.

Keeping rabbits for 5 h in an atmosphere of almost pure oxygen at a pressure of 2 atm thus leads to the cessation of secretion of substances stimulating erythropoiesis by the kidneys and to their starting to produce an erythropoiesis inhibitor.

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