EFFECT OF SUPPLEMENTARY ADMINISTRATION OF TRACE ELEMENTS ON VANADIUM METABOLISM IN EXPERIMENTAL ATHEROSCLEROSIS

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UDC 616.13-004.6-092.9-008.928.8

During development of experimental atherosclerosis the vanadium concentration in the tissues of rabbits falls. Supplementary administration of manganese and, in particular, zinc counteracts the decrease in vanadium concentration in the tissues and organs examined.

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According to some reports, vanadium inhibits cholesterol and fatty acid synthesis in rat liver homogenates, and if given to rabbits fed with cholesterol it sharply inhibits the development of hypercholesteremia and lowers the lipid content in the liver, aorta, and coronary arteries [2, 5, 6].

The object of the present investigation was to study the vanadium concentration in the tissues and cholesterol metabolism in experimental atherosclerosis and to examine the effect of some trace elements on these indices.

EXPERIMENTAL METHOD

Experiments were carried out on 30 chinchilla rabbits weighing from 2.3 to 3.2 kg. The animals were divided into six groups with 5 rabbits in each group: 1) control; 2) rabbits receiving cholesterol with carrot in a daily dose of 0.2 g/kg; 3-6) animals receiving cholesterol in a dose of 0.2 g/kg on alternate days and intravenous injections of trace elements as a solution of their salts in the following concentrations (calculated as metal): animals of group 3) copper sulfate, 500 μg/kg; 4) zinc sulfate, 500 μg/kg; 5) cobalt sulfate, 100 μg/kg; 6) manganese sulfate, 500 μg/kg.

Every 5 days throughout the 50 days of the experiment, the following indices of lipid metabolism were investigated in the animals' blood: total lipids by Bloor's method [4], total cholesterol by the method of Engel'gardt and Smirnova, and its fractions by precipitation of free cholesterol with digitonin [3], phospholipids

TABLE 1. Blood Concentration of Lipids and Vanadium in Normal Rabbits and Rabbits with Experimental Atherosclerosis (M±m)

Duration of cholesterol feeding (in days)	Total lipids	Total cholesterol	Cholesterol esters	Free cholesterol	phospholipids	Vanadium (in μg%)
	in mg %					
Before expt.	283,2±32,5	68,2±5,2	53,6±4,3	14,6±1,5	84,4±7,3	1,82±0,2
10	347,4±40,3 $P<0,01$	133,6±10,3 $P<0,001$	87,8±7,4 $P<0,001$	45,8±5,6 $P<0,001$	103,9±9,5 $P<0,01$	1,46±0,3 $P<0,01$
20	488,5±40,3 $P<0,001$	154,5±12,3 $P<0,001$	128,0±10,4 $P<0,001$	26,5±2,2 $P<0,001$	125,6±10,5 $P<0,001$	1,08±0,08 $P<0,001$
30	647,3±52,3 $P<0,001$	181,6±12,4 $P<0,001$	149,0±12,5 $P<0,001$	32,6±2,9 $P<0,001$	119,8±8,8 $P<0,001$	—
40	746,8±70,3 $P<0,001$	194,4±14,3 $P<0,001$	159,3±12,8 $P<0,001$	35,1±3,2 $P<0,001$	139,9±10,3 $P<0,001$	0,82±0,07 $P<0,001$
50	829,6±75,3 $P<0,001$	336,7±24,3 $P<0,001$	287,1±24,5 $P<0,001$	49,6±4,3 $P<0,001$	163,4±12,3 $P<0,001$	0,52±0,05 $P<0,001$

Department of Medical Chemistry, Ivano-Frankovsk Medical Institute. (Presented by Academician of the Academy of Medical Sciences of the USSR S. E. Severin.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 67, No. 6, pp. 72-74, June, 1969. Original article submitted March 7, 1968.

TABLE 2. Vanadium Concentration (in μg% of Fresh Substance) in Blood of Rabbits Receiving Cholesterol and Some Trace Elements (M±m)

Time of investigation	Rabbits receiving				
	cholesterol	cholesterol + copper	cholesterol + zinc	cholesterol + cobalt	cholesterol + manganese
Before experiment	1,82±0,05	1,74±0,07	1,92±0,08	1,96±0,08	1,78±0,06
10th day of expt.	1,46±0,08 $P<0,02$	1,52±0,07 $P<0,02$	1,74±0,09 $P>0,02$	1,58±0,07 $P<0,02$	1,66±0,07 $P<0,02$
25-th day	0,84±0,04 $P<0,001$	0,88±0,06 $P<0,001$	1,58±0,07 $P>0,02$	0,56±0,03 $P<0,001$	1,42±0,06 $P<0,02$
50-th day	0,52±0,03 $P<0,001$	0,66±0,04 $P<0,001$	1,76±0,06 $P=0,05$	0,48±0,03 $P<0,001$	1,06±0,05 $P<0,02$

TABLE 3. Vanadium Concentration (in μg% of Fresh Substance) in Aorta, Liver, and Muscles of Rabbits Receiving Cholesterol and Some Trace Elements (M±m)

Animals	Aorta	Liver	Muscles
Healthy	4,2±0,3	12,8±1,3	1,6±0,12
Receiving cholesterol	2,3±0,22 $P<0,001$	4,8±0,42 $P<0,001$	3,9±0,34 $P<0,001$
Receiving cholesterol + copper	1,8±0,1 $P<0,001$	4,2±0,35 $P<0,001$	4,4±0,41 $P<0,001$
Receiving cholesterol + zinc	4,4±0,34 $P>0,2$	13,1±1,2 $P>0,1$	1,9±0,12 $P>0,5$
Receiving cholesterol + cobalt	1,9±0,12 $P<0,001$	1,3±0,12 $P<0,001$	4,2±0,44 $P<0,001$
Receiving cholesterol + manganese	3,2±0,26 $P<0,02$	13,8±1,2 $P=0,02$	2,2±0,26 $P=0,02$

after extraction with ether and alcohol as inorganic phosphorus by the Bell–Doisy–Briggs method; vanadium in the blood was estimated quantitatively by emission spectral analysis before the experiment and on its 10th, 20th, 30th, 40th, and 50th days, after which the animals were sacrificed and the vanadium concentration studied in the aorta, liver, and muscles.

EXPERIMENTAL RESULTS

The serum lipid concentration of rabbits receiving cholesterol for 50 days was increased, while the vanadium concentration was lowered (Table 1).

Administration of cholesterol together with some trace elements caused changes not only in lipid metabolism, but also in vanadium metabolism (Table 2).

The blood vanadium concentration of rabbits receiving cholesterol and copper or cholesterol and cobalt was lowered and almost indistinguishable from its blood concentration in animals receiving cholesterol only.

Administration of cholesterol and manganese to some extent prevented the decrease in blood vanadium concentration, while in animals receiving cholesterol and zinc, the blood vanadium concentration was almost unchanged and the same as before the experiment (difference not statistically significant).

Investigation of the effects of administration of cholesterol alone, and in combination with the trace elements studied, on the vanadium concentration in the tissues and organs showed that it was about the same as in healthy rabbits only when cholesterol was given together with zinc salts (Table 3).

The results of this study of changes in the vanadium concentration in the tissues during development of experimental atherosclerosis, and also changes in the total lipids, cholesterol and its fractions, and phospholipids indicate that changes in vanadium metabolism are causatively connected with changes in the studied indices of lipid metabolism.

With an increase in the cholesterol concentration in the tissues and organs, the vanadium concentration falls. The choice elements manganese and zinc, which have been shown [1] to counteract the development

and onset of atherosclerosis, if added to the diet along with cholesterol, promote retention of vanadium in the body tissues.

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