CONCENTRATION OF TRACE ELEMENTS IN THE BLOOD IN EXPERIMENTAL ATHEROSCLEROSIS

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The changes in a number of enzyme processes in the blood vessel wall observed during recent years in atherosclerosis have attracted the attention of investigators to the study of the mineral metabolism, and especially the metabolism of trace elements present in the composition of many enzymes or acting as activators or inhibitors of these enzymes. In most of the experimental investigations so far carried out, the effect of the salts of various elements—sodium, potassium, calcium, magnesium, copper, manganese, cobalt, vanadium, etc—added to an atherogenic diet or administered parenterally, on the level of the blood cholesterol and the degree of lipoidosis of the blood vessels has been studied. Far less attention has been paid to the study of the changes in mineral metabolism appearing during development of experimental atherosclerosis.

An increase in the blood calcium concentration of rabbits has been observed [3, 4] for two months during feeding on cholesterol, followed by a decrease two months after the administration of cholesterol to the animals was discontinued. It has also been reported [1] that the serum potassium level rises in rabbits during the first two months that they are kept on an atherogenic diet, after which its level falls, and that the dynamics of the changes in the serum sodium concentration follow the opposite course, although to a less marked degree. Conversely, other authors [2] found no changes in the concentration of sodium and potassium in the serum in similar experiments. In a number of investigations [5-9] a depressed serum magnesium level was found against the background of hypercholesteremia in rabbits and rats.

In the present investigation the concentration of various elements was studied in the blood of rabbits with experimental atherosclerosis.

EXPERIMENTAL METHOD

The method of emission spectrography was used to study the concentrations of copper, aluminum and magnesium in the whole blood and heparinized plasma in the course of development of experimental atherosclerosis produced in the classical manner in 8 male rabbits weighing 3-4 kg and receiving cholesterol in sunflower oil by N. N. Anichkov's method in a dose of 0.2 g/kg body weight/day. At the end of the observations five animals survived; in those dying after 6 months marked lipoidosis of the aorta was found. Parallel investigations were made of the potassium and sodium concentrations in the erythrocytes by flame photometry.

The plasma cholesterol concentration was determined by Levchenko's method. The numerical results were analyzed by statistical method. The investigation was carried out before the beginning of the experiment, after feeding with cholesterol after 3 and 6 months, and 3 months after administration of cholesterol was discontinued.

EXPERIMENTAL RESULTS

The results obtained are shown graphically (see figure) and the following conclusions may be drawn from them.

The concentration of copper in the whole blood remained essentially unchanged throughout the period that the animals were kept on an atherogenic diet, and it rose three months after they were put back on a normal diet. The concentration of copper in the plasma (index of the ceruloplasmin level) fell during the first 3 months that the animals received cholesterol, rose slightly until the 6th month, and exceeded its initial level 3 months after the diet had been discontinued. The difference between the copper concentrations in the plasma during and after cholesterol feeding is statistically significant ($P < 0.05$).

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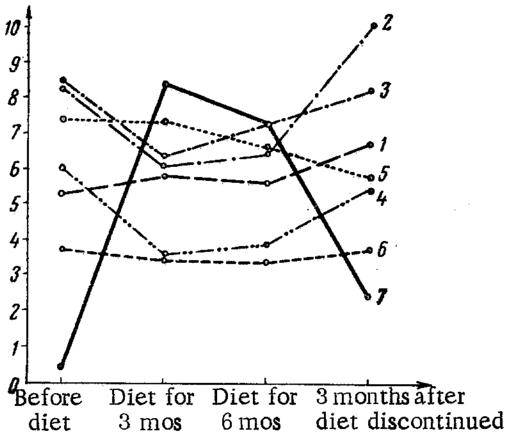

Mean level of copper and magnesium in the blood and plasma, of sodium and potassium in the erythrocytes, and of cholesterol in the plasma of rabbits before, during and after administration of an atherogenic diet. 1) Cu (blood); 2) Cu (plasma); 3) Mg (blood); 4) Mg (plasma); 5) Na (erythrocytes); 6) K (erythrocytes); 7) Cholesterol. Along the axis of ordinates—concentration of electrolytes and cholesterol (one scale division is equivalent of 0.01 mg % Cu, 1.0 mg % Mg, 10 mg % Na, and 100 mg % K and cholesterol).

The magnesium level in the whole blood and plasma fell as the cholesteremia increased, and returned almost to its initial value after the animals had been transferred to an ordinary diet and the cholesterol concentration in the plasma had fallen. The difference between the concentration of magnesium in the plasma before and during cholesterol feeding is statistically significant ($P < 0.05$).

The concentration of sodium in the erythrocytes showed a tendency to decrease throughout the period of observation. The potassium concentration in the erythrocytes fell slightly while the animals were on an atherogenic diet, and 3 months after cholesterol feeding was discontinued it exceeded the initial level.

A parallel tendency was found in the changes in concentration of copper in the plasma (ceruloplasmin) and of magnesium in the blood and plasma, and these changes were inversely dependent on the blood cholesterol level.

The determination of the aluminum concentration in the blood and plasma revealed greater individual differences in the concentration of this element in the rabbits, so that no conclusions could be drawn regarding the principles governing the changes in its concentration.

The facts described above demonstrate that the mineral metabolism is definitely disturbed in experimental atherosclerosis.

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