EFFECT OF AGE ON THE DEVELOPMENT OF ALIMENTARY CHOLESTEROL ATHEROSCLEROSIS IN BIRDS

P. P. Chayalo

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Age differences in the development of experimental cholesterol atherosclerosis were studied in cockerels aged 1-1.5 and 9-10 months. A significant increase in the total lipids, phospholipids, total cholesterol, and cholesterol fractions in the blood serum was observed starting from the 15th day after the beginning of cholesterol feeding. These disturbances were more marked in the older group of birds. No age differences were found by determining the degree of atherosclerotic changes in aorta by a planimetric method. A high content of total lipids in the tissues of the aorta was found in the cockerels aged 1-1.5 months; the total cholesterol content was closely similar in the birds of the two age groups.

Age differences in experimental atherosclerosis have been studied chiefly in rabbits [1-4]. The use of birds for such research appears particularly interesting, for fibrous thickenings with deposition of lipids are formed in the aortic wall of birds after the age of 5-6 months and, according to some authorities [7, 14, 16], these lesions bear a close resemblance to atherosclerotic changes in human blood vessels.

Indices of lipid metabolism and the severity of atherosclerotic changes in the aorta of cockerels of different ages with cholesterol atherosclerosis were studied.

EXPERIMENTAL METHOD

Sexually immature (1-1.5 months) and mature (9-10 months) cockerels of the Russian White breed were used. Atherosclerosis was produced by the daily administration of cholesterol in vegetable oil (2 g/kg body weight) for 4 months.

Before the administration of cholesterol began and throughout the period of investigation the total lipids [8], phospholipids [15], total cholesterol, and cholesterol fractions [13] were determined in the blood of the cockerels; the total cholesterol/phospholipids ratio was calculated. To assess the severity of the atherosclerotic changes in the aorta a combined gravimetric and planimetric method [5] was used, after which the total lipids and total cholesterol were determined in the aortic wall [9].

EXPERIMENTAL RESULTS

Administration of cholesterol led to hyperlipemia from the 15th day after the experiment began (Table 1). High indices of lipid metabolism persisted significantly unchanged throughout the remainder of the experiment. Disturbances of lipid metabolism, however, were more marked in the sexually mature than in the immature cockerels. This applies to the total lipids (on the 30th and 120th days), total cholesterol (on the 30th day), free cholesterol (on the 30th day), and to the total cholesterol/phospholipids ratio (on the 30th day). The serum phospholipid concentration in the birds of the two age groups was similar throughout the period of cholesterol feeding. It is interesting to note that the increase in the phospholipid content in the birds of the two age groups occurred some time after the increase in the total cholesterol level. The total choleste-

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TABLE 1. Changes in Indices of Lipid Metabolism in the Blood Serum of Cockerels of Different Ages Fed with Cholesterol (M ± m)

Index studied	Cockerels aged 1–1½ months						Cockerels aged 9-10 months					
	before administration of cholesterol	15-th	30-th	60-th	90-th	120-th	before administration of cholesterol	15-th	30-th	60-th	90-th	120-th
	day of administration						day of administration					
Total lipids (in mg %)	412,9±15,9	1099,7±41,1	992,3±98,6	1139,4±67,1	1249,9±61,2	914,6±81,4	447,5±37,1	1275,3±±104,8	1778,8±338,3*	1174,1±37,4	1204,6±135,8	1528,3±±192,2*
Total cholesterol (in mg %)	172,6±10,4	498,8±16,8	436,0±27,8	605,1±43,5	676,1±50,8	517,1±59,2	126,4±5,6*	541,2±27,2	674,1±58,2*	632,3±66,2	620,3±75,4	610,3±±96,2
Cholesterol esters (in mg %)	117,1±7,4	269,4±11,9	208,2±18,3	306,0±24,3	251,1±35,1	259,6±25,2	86,0±4,9*	274,3±13,0	262,5±37,2	282,5±28,6	237,8±12,7	259,4±±22,3
Free cholesterol (in mg %)	55,6±2,7	229,3±8,4	227,8±24,0	299,1±31,6	424,9±50,1	257,5±46,6	40,4±2,9	266,9±16,7	411,5±56,2*	350,1±64,7	382,5±64,3	350,9±±82,5
Phospholipids (in mg %)	126,0±4,6	157,5±7,5	267,0±12,1	326,4±30,9	323,1±17,1	237,4±23,7	123,1±6,1	187,7±24,3	299,3±43,4	315,6±29,2	330,2±38,9	284,7±±43,3
Total cholesterol/phospholids ratio	1,39±0,08	3,30±0,18	1,66±0,09	1,96±0,15	2,09±0,09	2,20±0,15	1,06±0,09	3,20±0,26	2,40±0,14	2,19±0,24	1,90±0,10	2,23±±0,21

Note. Values with an asterisk marked differ significantly ($P < 0.05$) from indices for sexually immature birds at corresponding stages of cholesterol feeding.

TABLE 2. Content of Total Lipids and Total Cholesterol in Aortic Tissue of Control and Experimental Cockerels of Different Ages (M ± m)

Age at start of expt. (months)	Tot. lipids (mg/100 mg wet tissue)		Significance of differences	Tot. cholesterol (mg/100 mg wet tissue)		Significance of differences
	control	experiment		control	experiment	
I. 1–1½	4,67±0,35	11,03±1,1	$P_{K-0} < 0,001$	0,240±0,015	0,928±0,1	$P_{K-0} < 0,001$
II. 9–10	5,29±0,38	6,43±0,3	$P_{K-0} < 0,001$ $P_{I-II} < 0,001$	0,279±0,015	0,998±0,2	$P_{K-0} < 0,001$ $P_{I-II} > 0,1$

rol/phospholipids ratio was thus highest at the beginning of the experiment (15th day). This fact can possibly be attributed to the gradual activation of the mechanisms responsible for the fixation of surplus quantities of exogenous cholesterol.

The degree of the atherosclerotic changes in the aorta of the birds, judging from the area affected (as a percentage of the total area of the inner surface of the aorta), was independent of age. The mean values were 11.6% for the birds aged 1-1.5 months and 11.9% for those aged 9-10 months.

The results of determination of the total lipids and total cholesterol in the aortic wall are given in Table 2.

They show considerable deposition of cholesterol and total lipids in the blood vessels during the development of experimental cholesterol atherosclerosis in cockerels. The total cholesterol content increased by almost the same amount in both age groups whereas the content of total lipids increased more in the aortic tissues of the birds aged 1-1.5 months. To explain this fact the possibility of local synthesis of lipids in atherosclerosis [12] and the diminution of synthetic processes in the aortic tissue of birds with an increase in age [10] must be taken into account. There is evidence that marked fibrotic changes in the arterial wall may to some extent prevent the development of lipoidosis and atherosclerosis [6, 11].

These results confirm that atherosclerosis can develop in the early stages of ontogeny through a disturbance of lipid metabolism.

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