# STATE OF INTRAMURAL ARTERIES AND EXTRAVASCULAR CONNECTIVE TISSUE IN DOGS WITH ATHEROSCLEROSIS

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Marked changes in the intramural arteries and connective tissue of the capsule of various organs, in the wall of the renal pelvis, the chordae of the papillary muscles, the cusps of the heart valves and, in particular, in the parodontal tissues were observed in dogs with experimental atherosclerosis. Similar changes were found in the vessels and tissue of the parodontium in spontaneous parodontosis. The state of the parodontium can evidently be regarded as an index of the general state of the vascular system.

In investigations of the morphogenesis of atherosclerosis attention has usually been paid principally to the state of the blood vessel walls [1-3, 6, 8, 9, 12, 13].

The object of the present investigation was to study the state of the vascular system and connective tissue of various organs in experimental atherosclerosis. Particular attention was paid to changes in the arteries and parodontal tissues. It has recently been shown that the trophic disturbance of the pardontium lying at the basis of parodontosis [10] develops against the background of pathological conditions such as atherosclerosis, hypertension, hepatitis, cirrhosis of the liver, and so on [5]. Results indicating the identical character of the biochemical and immunological changes in parodontosis and experimental atherosclerosis have been obtained [4, 8]. With these facts in mind, it was therefore decided to compare these pathological forms under experimental conditions.

## EXPERIMENTAL METHOD

Experiments were carried out on 24 male dogs for periods ranging from 6 months to 3 years. Experimental atherosclerosis was induced by the use of atherogenic diets [11]: 1) cholesterol (2 g/kg), methylthiouracil (1.5 g), and vitamin $D_2$ (500 i.u.) – 12 dogs (group 1); 2) yolks of 5 eggs and vitamin $D_2$ – 6 dogs (group 2); 3) the control group of 6 dogs with spontaneous parodontosis.

Arterial trunks and intramural arteries and the connective tissue of the following organs were investigated: myocardium, kidneys, liver, thyroid gland, parodontium. Survey and histochemical methods (Sudan III, Sudan black B, Weigert–Hart method for elastic tissue, with picrofuchsin by Van Gieson's, Mallory's, and Shueninov's methods) were used. To detect and differentiate mucopolysaccharides (MPS) sections were stained with toluidine blue by the method of Kramer and Windrum and with 1% alcian blue solution in 0.01 N NCl at pH 2.2, by Hale's method, and by the methods of McManus and Hotchkiss with the corresponding controls [7].

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## EXPERIMENTAL RESULTS

In the animals of group 1 the blood cholesterol was raised to 400-1500 mg% (normal 105-250 mg%), and the lecithin to 250-500 mg% (normal 160-250 mg%) subsequently diminishing, with a decrease in the lecithin/cholesterol ratio to 0.6. Similar changes in lipid metabolism were observed in the animals of group 2, but they were much less pronounced [11]. Atherosclerotic changes in various stages were found in the vascular system of the animals of group 1. The changes were most marked in the small intramural arteries of muscular type: in the myocardium, kidneys, spleen, and thyroid gland (Fig. 1a, b). In the early periods of the experiment (6-8 months), lipid infiltration was preceded by the accumulation of acid MPS in the ground substance of the vascular walls. A noteworthy feature was the appearance of lipids in the smooth-muscle cells of the media in arteries of various calibers. With an increase in the duration of the experiment (12-24 months), changes also were found in the ground substance of various organs, in the form of mucoid edema and a selective accumulation of acid MPS, as shown by the definite metachromasia and Hale-positive staining. At these times, diffuse fatty infiltration of the ground substance was observed in the capsule of the adrenal and thyroid glands, the wall of the renal pelvis, the chordae of the papillary muscles, and the cusps of the heart valves (Fig. 1d). Besides the small intramural arteries, vessels of elastic-muscular type were also involved in the process. Typical atheromatous plaques appeared in these arteries, deforming the vessel wall and sharply constricting its lumen (Fig. 1c). Definite changes also were found in the vasa vasorum of the aorta. Atherosclerotic plaques in the aorta were found mainly in its abdominal portion.

Analysis of the character of the vascular changes at different stages of the experiment revealed the following types of lipoidosis of the vessel walls.

1) Plasma lipoidosis: diffuse sudanophilia of the ground substance and smooth-muscle cells. This type of lipoidosis is evidently characteristic of small vessels with high permeability (vessels of the myocardium and spleen, vasa vasorum of the aorta, etc.).

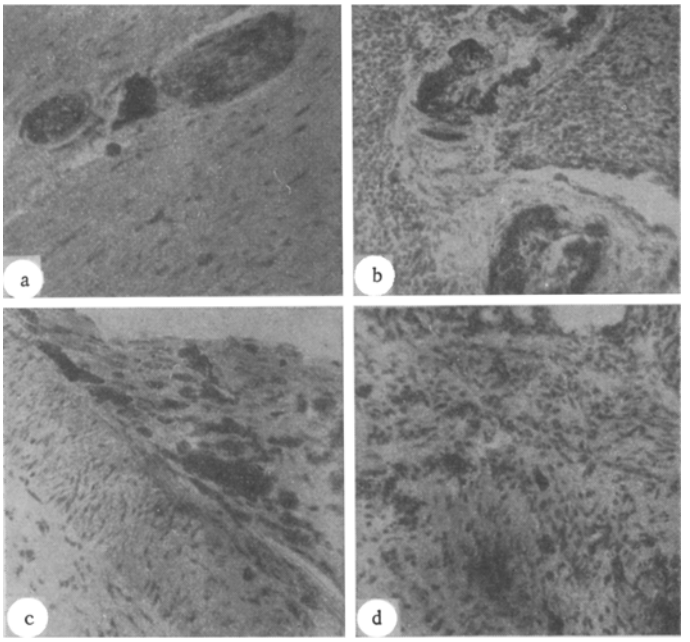


Fig. 1. Changes in intramural arteries and extravascular ground substance in experimental atherosclerosis: a) infiltration of wall of small myocardial arteries by lipids (Sudan III, 140×); b) infiltration of intima and media of arteries of splenic follicles by lipids (Sudan III, 140×); c) atherosclerotic plaque in artery of thyroid gland (Sudan III, 56×); d) lipoidosis of ground substance of thyroid capsule (Sudan III, 56×).

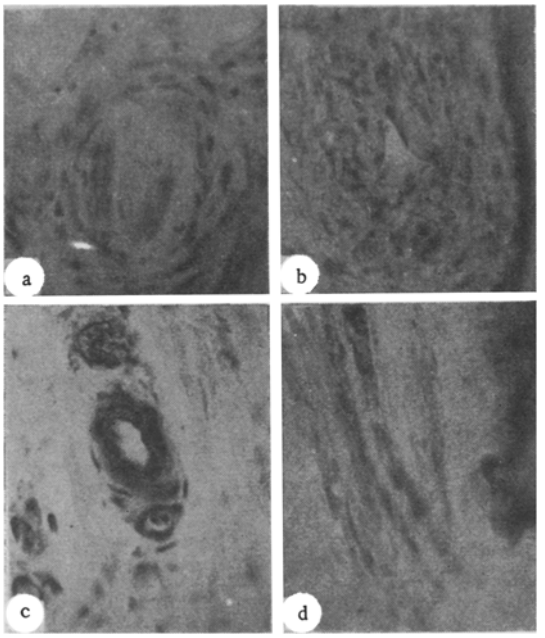


Fig. 2. Morphological changes in the parodontium in experimental atherosclerosis: a) hyalinosis and fibrosis of a small artery in the parodontium (Van Gieson, 320×); b) lipoidosis of all layers of the wall of an arterial in the pericement (Sudan III, 280×); c) large-droplet infiltration of a parodontal arteriole with lipids (Sudan III, 80×); d) diffuse deposition of lipids in small arteries of the pericement (Sudan III, 80×).

2) Macrophagal lipoidosis, focal lipoidosis of the macrophages of the intima, media, and adventitia of arteries of medium and large caliber (aorta, splanchnic, mesenteric, and thyroid arteries).

3) Small- and large-droplet lipoidosis of the paraplastic substances with destruction of atheromatous type. This type of lipoidosis in dogs is found in the media of the aorta, in arteries of elastic type (extra- and intramural), and also in the paraplastic substances outside the vessel wall.

Morphological studies of the parodontium were preceded by roentgenologic examination [10]. Straight and contrast roentgenography showed that spontaneous paradontosis is revealed by a marked loss of bony tissue of the alveoli, by the presence of deep bony pockets, and sometimes by a uniform atrophy of the whole alveolar process.

Examination of roentgenograms of the jaws in the initial stage of atherosclerosis likewise revealed resorption of the bony tissue of the parodontium, although to a lesser degree. In spontaneous parodontosis the changes found consisted of hyalinosis of the wall of the arterioles and fibrosis of the surrounding tissues (Fig. 2a). Disturbances of the elastic skeleton of the vessels were of the reduction and hyperproduction types. A regular feature was widespread lipoidosis of all layers of the walls of arteries of the pericement and of blood vessels in the medullary space (Fig. 2b). Histochemically, deposition of acid and neutral MPS was found in the intima and media of the parodontal arteries.

Examination of blocks of the teeth of animals with experimental atherosclerosis (group 1) likewise revealed hyalinosis of the vessel walls in the parodontium, thickening of the intima, and fibrosis of the surrounding connective and adipose tissue. Changes in the elastic tissue consisted of separation and coarsening of the fibers of the inner elastic membrane. Another morphological feature distinguishing the parodontosis in this series of experiments was the small-droplet lipoidosis of all layers of the vascular walls of the parodontal arteries (Fig. 2c). Diffuse deposition of lipids in the walls of the overwhelming majority of arterioles was observed experimentally (Fig. 2d). Similar changes likewise were found in the animals of group 2, although these were less pronounced.

Hence, in dogs with spontaneous parodontosis, atherosclerotic changes were found in the small intramural arteries of the parodontium. Changes of a similar character also were found in animals with experimental atherosclerosis. These changes were more marked in the animals of group 1, especially at late periods of observation. In the animals of all 3 groups, the process of loss of bony tissue of the parodontium followed a similar course. The changes in the terminal vessels of the parodontium in the animals of group 1, described above, were combined with distinct atherosclerotic changes in other intramural arteries, thus suggesting a link between these pathological forms.

Profound changes also were found in the connective tissue of the capsule of several organs, the chordae of the papillary muscles, the cusps of the heart valves and, in particular, in the parodontal tissues. In the last case the changes evidently arose as the result of resorption of lipids or of a disturbance of the physiochemical properties of the collagen, and also secondarily following involvement of the vasa vasorum.

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