EFFECT OF DIFFERENT TYPES OF OVERFEEDING ON STATE OF THE VASCULAR WALL IN RATS

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From the age of 30 days male rats were overfed for a long time with an excess of fats or carbohydrates, leading to obesity. Overfeeding with carbohydrates caused a greater gain in body weight and a greater increase in the weight of the epididymal fat and in metabolism of the fat cells than overfeeding with fat, but it did not lower the lipolytic activity of the aortic wall. Prolonged overfeeding with fats greatly reduced the lipolytic activity of the aortic wall. The results thus showed that a predisposition of the aortic wall to atherogenesis does not correlate with gain in weight and depends on the character of feeding.

KEY WORDS: *Obesity; lipolytic activity; atherogenesis.*

A pathogenetic link between obesity and atherosclerosis has been widely discussed. The opinion has been expressed that common endogenous and exogenous factors lead to these diseases [1, 5, 18]. In most investigations there is talk of a role of obesity in predisposing to the development of atherosclerosis [2, 5, 8, 11, 12, 16]. However, evidence not confirming this role of obesity has been obtained, expecially in women [4, 15].

When the pathogenetic link between obesity and atherosclerosis is studied it is evidently necessary also to take into account diseases such as essential hypertension and diabetes mellitus [1, 4], which are often accompanied by obesity and which undoubtedly predispose to the development of atherosclerosis [9, 12].

Clinical and experimental investigations have shown the presence of disturbances of lipid metabolism similar to atherosclerotic disturbances in obesity [2, 3, 5, 6, 8, 10, 12].

It was decided to study the state of the vascular wall in experimental alimentary obesity. In a previous investigation, despite a significant increase in the content of free fatty acids and triglycerides in rats overfed for a long time, no deposition of lipids was found in the wall of the aorta or of the coronary arteries. In the present investigation the lipolytic activity of the aortic wall, which may change even before deposition of lipids [7, 9, 18], was studied in rats.

EXPERIMENTAL METHOD

Male rats aged 30 days (weight 50-60 g) were divided into three groups each consisting of 25 animals. The animals of the control group were kept on an ordinary laboratory diet. The rats of the two experimental groups received twice the ordinary laboratory diet and, in addition, the rats in the group on a high fat diet received lard, butter, and sunflower oil, whereas the animals of the group with a high carbohydrate diet received liver, sugar, oatmeal (as porridge), and condensed milk. The rats were fed *ad libitum*. Throughout the experiments the animals were weighed regularly. After 6 months of overfeeding they were killed. The number and dimensions of the adipose tissue cells were investigated in sections

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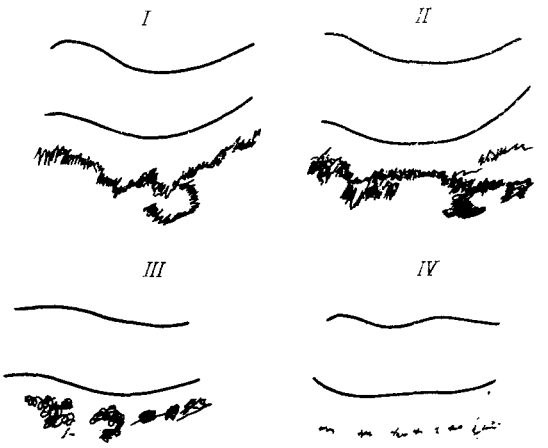

Fig. 1. Scheme of distribution of lipase in adventitia of thoracic aorta: I) in control animals; II) in overfed rats receiving high carbohydrate diet throughout experiment; III) in overfed rats receiving high fat diet during first 3 months only; IV) in overfed rats receiving high fat diet throughout experiment.

TABLE 1. Body Weight and State of Epididymal Fat Tissue in Rats Variously Overfed

Group of animals	Body weight, g	Weight of epididymal fat, g	Volume of fat cells, $\times 10^5 \mu^3$	Number of fat cells $\times 10^6$
1. Experimental group: high carbohydrate diet	484 ±20,6	4,970 ±0,45	9,8 ±0,99	6,6 ±0,58
2. Experimental group: high fat diet	418 ±5,53	4,210 ±0,54	7,0 ±0,67	6,9 ±0,55
3. Control group	348 ±25,1	2,360 ±0,30	4,9 ±0,51	5,1 ±0,48
P_{1-2}	0,001	0,001	0,001	0,05
P_{1-3}	0,001	0,02	0,02	0,02

through the epididymal fat stained with hematoxylin: The diameters of the fat cells were measured and the volume of the fat cell and the mean number of cells were calculated [4, 13, 14]. In five rats of each group pieces of aorta were taken from the ascending part, the arch, and the thoracic and abdominal parts. Pieces of aortic wall were cut into sections in a cryostat. Gomori's test for lipase with Tween-80 and Gomori's modification of the test of Nachlas and Seligman for nonspecific esterase were carried out on the sections. Sections also were stained with Oil Red and hematoxylin. A similar investigation of sections from all the above-mentioned parts of the aorta was carried out on five other rats which were overfed during the first 3 months with an excess of fats and during the next 3 months with an excessive mixed diet. The weight of the rats in which the aorta was investigated histochemically was 325-362 g in the control group before sacrifice, 414-436 g in the group with a high fat diet, 471-587 g in the group with a high carbohydrate diet, and 432-501 g in the group in which the animals received an excessive mixed diet plus an additional quantity of fat during the first 3 months of the experiment. All the histological preparations were drawn schematically. The enzyme content was estimated visually.

EXPERIMENTAL RESULTS

Tween-lipase was found in the adventitia of the aorta as confluent accumulations of dark brown grains. In rats on an excessive intake of carbohydrate and fat for the first 3

weeks of the experiment only, the distribution of the stain for lipase and its intensity were considerable and were indistinguishable from those in the control. In rats receiving an excessive intake of fat throughout the experiment, on the other hand, the distribution of lipase in the adventitia of the aorta and the intensity of its staining were sharply reduced (Fig. 1). Nonspecific esterase, in the form of confluent tiny black grains, could be detected in the media. The intensity of staining diminished toward the intima, and the outer layers of the media were particularly rich in esterase. A decrease in the intensity of staining for nonspecific esterase and some decrease in its content also were observed only in rats receiving the high fat diet for a long time. No difference was found in the content of lipase and nonspecific esterase in the different parts of the aorta. Lipids were not found in sections of the aortic wall stained with Oil Red.

In animals overfed for a long time with a high fat diet, the body weight, the weight of the epididymal fat, and the volume and number of adipocytes were less than in animals overfed with a high carbohydrate diet (Table 1). However, it was in the rats receiving an excess of fat that the lipolytic activity in the aortic wall was reduced. Possibly the longer feeding may have led to deposition of lipids in the aortic wall. There is some evidence that the resistance of the vascular wall of rats to deposition of lipids can be broken down by overfeeding with fat [8].

To produce a change in lipolytic activity in the present experiments a long time was required, for no change could be discovered before 6 months on the high fat diet.

Consequently, in these experiments the decrease in lipolytic activity of the aortic wall of rats with alimentary obesity did not correlate with the degree of obesity but depended on the character of the diet received. Prolonged feeding with a high fat diet reduced the lipolytic activity of the aortic wall of rats with experimental alimentary obesity.

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