SIZE AND NUMBER OF ADIPOCYTES IN THE PERINEPHRIC FAT DURING PREGNANCY AND THE POSTPARTUM PERIOD IN RATS

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Changes in the weight of the perinephric fat during pregnancy in rats were shown by the morphometric method of Sjöström et al. to be connected with changes in the size but not in the number of the adipocytes. In the postpartum period the character of the changes in the perinephric fat depended mainly on whether the rats fed their young or not. During normal feeding on the 7th to 14th day after birth of the young, hypoplasia of the adipose tissue was observed; conversely, if the mothers were separated from their progeny an increase in the weight of perinephric fat was observed at that time on account of an increase in the number of adipocytes.

KEY WORDS: adipocytes; pregnancy; postpartum period; perinephric fat.

The gain in body weight during pregnancy is known to be largely determined by an increase in the content of body fat [10, 11]. The problem of whether this process arises through a change in the size or in the number of fat cells has not been adequately studied. Yet it is important for an explanation of the role of hyperinsulinemia and other endocrine and metabolic changes observed during pregnancy [4, 17], and in the development of diseases of compensation [2, 3] and pathogenetically related states, notably various forms of adiposity [6, 15]. According to indirect evidence based on determination of the DNA content in the lumbar adipose tissue, the increase in body fat in pregnant rats probably takes place through an increase in size of the adipocytes [13]. This problem was studied in the present investigation by direct morphometry of adipose tissue, and the investigation was not confined to pregnancy but extended also to the immediate postpartum period.

EXPERIMENTAL METHOD

Experiments were carried out on 40 female rats from the "Rappolovo" nursery. At the beginning of the experiments the weight of the rats varied between 180 and 220 g. The time of beginning of pregnancy was determined as described previously [1]. Throughout the experiments the animals fed ad libitum, and after the first day of pregnancy they were kept in individual cages. On the 7th-8th, 13th-14th, and 21st days of pregnancy, and also on the 1st, 7th-8th, 13th-14th, and 28th days after the birth, the rats (3-5 in a group) were weighed and decapitated. The perinephric fat, bounded above by the upper border of the kidney and below by the inguinal region, was removed from the animals (always on the right side). This tissue was weighed and the diameter of the adipocytes in it was measured [16]; as a rule not less than 80-100 cells were measured. The triglyceride content in the adipocytes, another characteristic of their size (volume), was calculated by the known formula [9]. The number of cells in the perinephric fat was calculated by dividing the weight of the tissue (in mg) by the mean triglyceride content in the adipocytes (in μg), and the content of perinephric fat relative to body weight was determined by dividing the weight of the fat (in mg) by the body weight (g). Some of the mothers were separated from their young immediately after birth, whereas the others were kept together with the young until the end of the experiment in order to study the effect of lactation and feeding on the state of the adipose tissue.

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TABLE 1. Changes in Perinephric Fat in Rats during Pregnancy and in the Postpartum Period (M ± m)

Index	Nonpregnant rats	Period of pregnancy, days			Days of postpartum period			
		7—8	13—14	21	1	7—8	13—14	28
Body weight, g	203±11 (6)	216±4 (4)	219±11 (4)	261±7 (5)	226±13 (4)	205±8/210±27 (3)	187±14/231±25 (4) (3)	201±15 (4)
Weight of perinephric fat, mg	573±82	838±35	940±128	686±80	494±64	253±115/845±253	350±130/803±275	316±75
Diameter of adipocytes, μ	65,9±3,5	75,4±3,6	78,6±6,9	71,7±2,3	67,1±1,9	67,0±12,0/64,1±7	62,5±5,4/58,1±1,9	55,9±1,7
Triglyceride content in adipocytes, μg/cell	0,148±0,017	0,218±0,031	0,262±0,048	0,181±0,016	0,149±0,011	0,173±0,080/0,137±0,040	0,127±0,030/0,095±0,010	0,088±0,009
Content of perinephric fat in body, $\% \cdot 10^{-3}$	2,82±0,40	3,88±0,23	4,27±0,45	2,67±0,31	2,18±0,19	1,22±0,56/3,77±1,58	1,80±0,70/3,86±1,23	1,59±0,36
Number of adipocytes in perinephric fat $\times 10^6$	3,95±0,03	4,02±0,05	3,89±0,06	3,80±0,03	3,52±0,07	2,50±1,04/5,31±1,57	2,50±0,50/8,11±2,10	3,62±0,9

Legend. Numerator gives results for feeding rats, denominator results for separated rats. Number of animals used in experiment shown in parentheses.

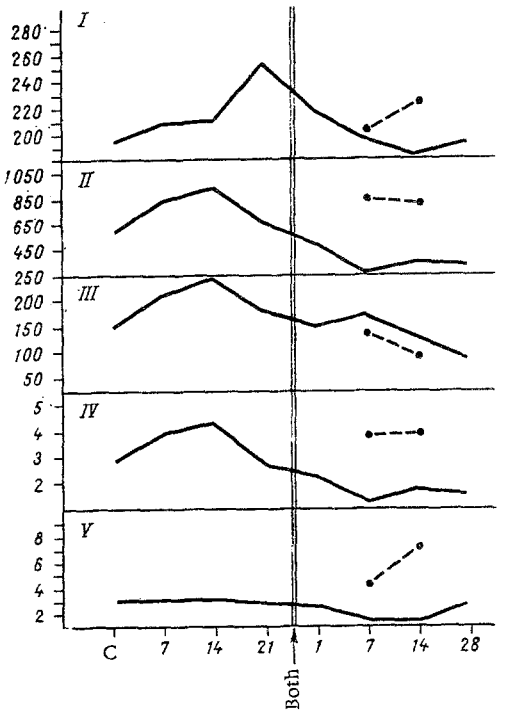

Fig. 1. Dynamics of body weight and characteristics of perinephric fat during pregnancy and in postpartum period in rats. Broken line shows results obtained in rats not feeding their young; C) control. Abscissa, days of pregnancy and postpartum period; ordinate: I) body weight (in g); II) weight of fat (in mg); III) triglyceride content in cells; IV) content of fat (in $\%\cdot10^{-3}$); V) number of cells$\cdot10^{6}$.

EXPERIMENTAL RESULTS

It follows from Table 1 and Fig. 1 that whereas the body weight of the rats rose steadily until the last day of pregnancy the weight of the perinephric fat increased only until a certain period (for the differences in weight of the fat on the 13th-14th days of pregnancy and its weight in nonpregnant control rats $P < 0.05$), after which it fell to the 21st day of pregnancy ($P > 0.2$ compared with the control). This confirms previous observations on the biphasic character of lipid synthesis during pregnancy [5, 14] and suggests that the changes in weight of the perinephric fat follow the dynamics of the total weight of fat in the body.

The data showing the weight of perirenal fat as a percentage of the total body weight and the size (volume) of the adipocytes at different periods of pregnancy agreed completely with the results of determination of the weight in the perinephric fat. It can accordingly be concluded that the increase in the fat content in the body of rats during normal pregnancy (as Knopp et al. suggested [13]) and its decrease until parturition are due to changes in the size of the adipocytes, as is confirmed by the absence of any change in their number (Table 1). In other words, to judge from the perinephric fat, normally replication of adipocytes does not take place in the mother, by contrast with their behavior in the "adipose organ" of the fetus [7, 8], and the changes mentioned above are due to hypertrophy (and not hyperplasia) of the adipose tissue. This suggests the possibility of measures aimed at excessive putting on of fat, for hyperplastic adipose tissue is much less amenable to dietetic and pharmacological control [12].

On the other hand, in the postpartum period substantial changes were observed in both the size and the number of the adipocytes, and the results suggest that these were dependent on the way in which the rats were kept. In animals which fed their young the weight of the perinephric fat decreased, and this was accompanied by a decrease in the number of adipocytes (7th-14th days after birth).* The number of adipocytes in the mothers gradually returned to normal by the 28th day after birth, whereas their size decreased a little. In rats separated from their young from the 1st day after birth, at the times chosen for investigation there was a significant

*A decrease in the total body fat is observed during intensive lactation in mice also [11].

increase in weight of the perinephric fat, coupled with a statistically significant increase in the number of adipocytes (Table 1). These differences in the character of the changes in the adipose tissue of the two groups of rats are perhaps connected with differences in the pattern of secretion and peripheral effects of prolactin, growth hormone, and insulin associated with different conditions of feeding; this is a fact of great interest for human physiology and pathology and requires further study.

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