

CHANGES IN REGENERATED AND NORMAL LIVER IN RATS DURING THE LACTATION PERIOD

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Extensive partial hepatectomy leads to the disruption of a number of liver function indices, but as the result of recuperative processes of the organ many of these return to normal values [1, 5, 6, 9, 13]. In addition, some indices remain changed for a long time [9, 11]. It is also known that cells and lobules of regenerated liver are hypertrophied in comparison with these parts of the intact organ [3, 4].

Certain atypical features in the structure of the regenerated organ do not appear, evidently, to have significant effect on the vital capacity of animals: they may live to a great age despite the more rapid appearance of aging changes in their liver [2]. It is interesting to ascertain to what degree liver which has undergone regenerative hypertrophy, is capable of carrying a functional load. This question has not been answered in the literature available to us.

During pregnancy, and in particular in the lactation period, significant changes in liver function occur which are expressed in its morphological and biochemical features. The weight of the organ increases. Cell size increases; the content of protein, phospholipids, glycogen, arginase, ribonucleic acid in the liver of the lactating animal is subjected to considerable quantitative variation [7, 8, 10, 12].

In this article the effect of an increased functional load on the morphologic features of the regenerated liver is elucidated. Pregnancy and lactation were selected as the factors which increase the function of the organ.

METHODS

In the experiment we used 45 female white rats weighing 160-200 g. In 25 animals partial hepatectomy was carried out according to the method of Higgins and Andersen: about 64% of hepatic tissue was removed (Group I) and 20 animals did not undergo operation (Group II). At 1 month after operation, when hepatic regeneration was mainly completed, 19 operated and 14 unoperated female rats were mated. Six control animals from each group were isolated from males. Some of the animals in Groups I and II did not become pregnant and some of the females ate their young. Subsequent investigations were made on 17 partially hepatectomized and 17 unoperated rats.

On the 12th day after the cessation of lactation 5 partially hepatectomized rats which had lactated and 5 non-operated rats which had lactated were killed. The dead rats and their livers were weighed, the livers were fixed in 10% formalin. Sections were stained with hematoxylin-eosin and, for measurement of the size of the liver cells, a portion of the sections were stained by a special method [14] which permits clear definition of cell borders. The stained preparations of liver were sketched with a drawing apparatus (magnification 350 times, 200 liver cells in each organ). Then the mean area occupied by 1 liver cell was determined.

RESULTS

An increase in the weight of the liver on the 14th day of lactation was noted in the partially hepatectomized and nonoperated animals. In Table 1 are presented the data from study of the hepatic weight in experimental and control animals. As follows from Table 1, on the 14th day of lactation the hepatic weight in the partially hepatectomized rats was increased in comparison to hepatic weight in the nonlactating operated rat by 3.5 g (42%). In the

TABLE 1. Body and Liver Weight in Partially Hepatectomized and Nonoperated Rats at 14th Day of Lactation

Nonoperated rats									
nonlactating					lactating				
No. of expt.	body wt. (in g)	liver wt. (in mg)	relative wt. of liver (in %)	No. of expt.	body wt. (in g)	liver wt. (in mg)	relative wt. of liver (in %)	No. of expt.	body wt. (in g)
1	210	9000	3.9	1	230	12300	5.3	1	300
2	250	9500	3.8	2	260	11000	4.2	2	280
3	260	9200	3.6	3	260	11700	4.5	3	210
4	288	8800	3.0	4	255	12500	4.9	4	205
5	295	8200	2.9	5	305	14400	4.0	5	260
6	235	8000	3.3	6	240	12000	5.0	6	270
Mean	260	8800	3.4		258	12300	4.4		259
						9230	3.7		15800
									6.0

nonoperated lactating animals the increase in hepatic weight was more significant—6.5 g (71%).

Thus, during the lactation period the liver which has undergone regenerative hypertrophy does not reach the size of the liver from nonoperated animals ($P = 0.02$), although the initial weight of the organ (before pregnancy) in operated and nonoperated rats was similar; in the former 8800 mg and in the later 9230 mg.

The hepatic weight of operated and nonoperated rats fell at the end of lactation. Thus, in partially hepatectomized animals on the 12th day after cessation of lactation the liver weighed 7800 mg and in the nonoperated animals—8900 mg (Table 2).

Thus, after cessation of the action of an increased functional load the regenerated and intact organs (liver) again possessed initial weight.

The increase in hepatic weight during pregnancy and lactation is accompanied by an increase in the size of liver cells both in operated and in nonoperated animals.

However, the hepatic cells in partially hepatectomized rats are not so markedly hypertrophied as in the nonoperated animals. In the operated nonlactating rat the mean area of one hepatic cell (magnification $350\times$) is 31 mm^2 , during the lactation period it reaches 32.3 mm^2 , whereas in nonoperated lactating animals the mean area of the hepatic cell rises from 28.5 to 34.3 mm^2 (Table 3).

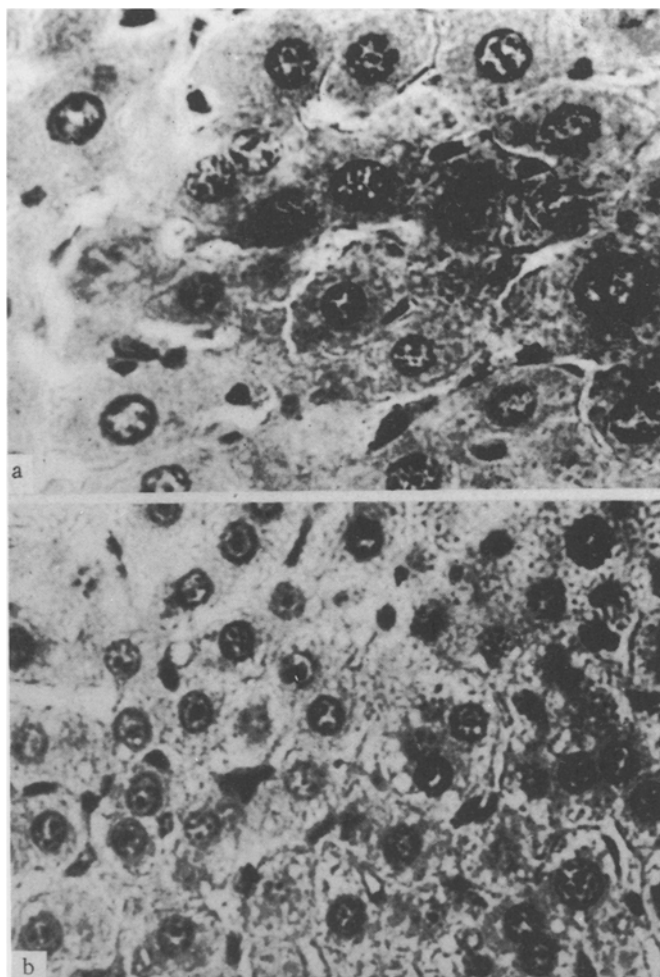
The difference between the sizes of cells in the regenerated liver in lactating and nonlactating animals appears not to be statistically significant ($P = 0.5$), as a result of considerable individual variation; in the control it is significant ($P = 0.004$).

After conclusion of the lactation period in partially hepatectomized and nonoperated animals the size of hepatic cells decreases (see Figure), which appeared valid only in the nonoperated animals ($P = 0.005$) and was not significant in the operated ones ($P = 0.3$).

Consequently, in partially hepatectomized animals the liver cells appear less labile in relation to changes in their size during lactation, than in nonoperated animals. Upon histological study of sections of the liver from partially hepatectomized animals during lactation and at its cessation, we did not detect in the organ any kind of pathological change. The regenerated liver appeared capable of carrying a greater physiological load: the size of the liver and its cells, which rose in the lactation period, returned to their initial values when the function of the organ returned to normal.

SUMMARY

In female rats weighing 160–200 g two-thirds of the liver were excised after Higgins' and Andersen's technique. A month after the operation, upon completion of the regeneration process, a study was made of the influence of functional load (pregnancy and lactation) on the regenerated and normal liver in the rats.



Increased size of liver cells in partially hepatectomized animals during the lactation period (a) with return to the initial size at its termination (b). Magnification: Obj. 40 x, ocular 10 x.

TABLE 2. Body and Liver Weight in Partially Hepatectomized and Nonoperated Rats at 12 Days after Termination of Lactation

Partially hepatectomized rats				Nonoperated rats			
No. of expt.	body wt. (in %)	liver wt. (in mg)	relative wt. of liver (in %)	No. of expt.	body wt. (in %)	liver wt. (in mg)	relative wt. of liver (in %)
1	210	7 000	3,3	1	295	10 000	3,7
2	200	7 000	3,5	2	2,5	10 000	4,2
3	190	6 500	3,4	3	200	7 000	3,5
4	230	10 700	4,1	4	220	9 000	4,0
5	250	8 500	3,6	5	217	8 500	3,9
Mean	222	7 900	3,6		233	8 900	3,8

TABLE 3. Mean Area of Single Hepatic Cells
in Partially Hepatectomized and Nonoperated
Animals During Lactation and After its Cessation
(in mm² at magnification of 350 times)

Group of animals	Partially hepatect- omized rats	Intact rats
Non-lactating	31,0	28,5
Lactating (14th day)	32,3	34,3
Post-lactation (12th day after cessation of lactation)	29,2	27,8

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All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.
