EFFECT OF SIMULTANEOUS PARTIAL PANCREATECTOMY ON REGENERATION OF THE COCKEREL LIVER

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The many-sided functional interconnections between the liver and pancreas determine the character of interaction between regenerative processes in these organs. This is shown by the abundant data on regulation of regeneration of the liver by pancreatic hormones [2, 6, 8, 10, 11]. There is also evidence of more rapid regeneration of the liver in rats with experimental diabetes [3, 7]. Data obtained by other workers reveal inhibition of wound healing and a decrease in the rate of hypertrophy and hyperplasia of regenerating liver cells in rats with experimental diabetes [9].

Some aspects of regeneration of the liver in domestic fowls after simultaneous partial hepatectomy and pancreatectomy are described below.

EXPERIMENTAL METHOD

One-sixth of the parenchyma of the pancreas and the distal part of the right lobe of the liver, amounting to 1/6-1/5 of the weight of the organ, were resected in cockerels aged 5-6 months. Materials for histologic study was taken 3, 5, 10, 20, and 60 days after the operation and fixed in Bouin's and Carnoy's fluids. Paraffin sections were stained with hematoxylin and eosin, with picrofuchsine by Van Gieson's method and with methyl green and pyronine, and impregnated with silver. The mitotic index of the hepatocytes was determined in sections, the area of cross-section of the hepatocytes and their nuclei calculated in relative units by weighing cut out contours of sections through the cells and nuclei, drawn by means of a drawing apparatus on a standard sheet of paper. The relative volumes of parenchyma and stroma were determined by the dot counting method [1]. The numerical results were subjected to statistical analysis. Sections through the regenerating liver of fowls with an intact pancreas served as the control.

EXPERIMENTAL RESULTS

During observations for 2 months the shape of the liver of the experimental birds was not restored. However, starting with the 4th day of the experiment, the weight of the organ was a little higher than the normal average, and reached a maximum 10-20 days after the operation. The absolute and relative weight of the regenerating liver 60 days after the operation was at the control level, or more correctly, 102.5 and 101.2% respectively relative to it.

The microstructure of the regenerating liver 3 days after simultaneous partial hepatectomy and pancreatectomy showed both destructive changes and abundant infiltration by lymphocytes and activation of proliferative processes in the secretory tubules and ducts, which were far more intensive (Fig. 1) than in the regenerating liver of cockerels with an intact pancreas [4, 5]. This activation led to the formation of numerous epithelial bands and tubules which, accompanied by blood capillaries, advanced toward the wound surface. A distinguishing feature of the regenerating liver after simultaneous partial hepatectomy and pancreatectomy at this stage of the experiment was the feeble development of connective tissue on the wound surface and absence of eosinophilic leukocytes in the parenchyma.

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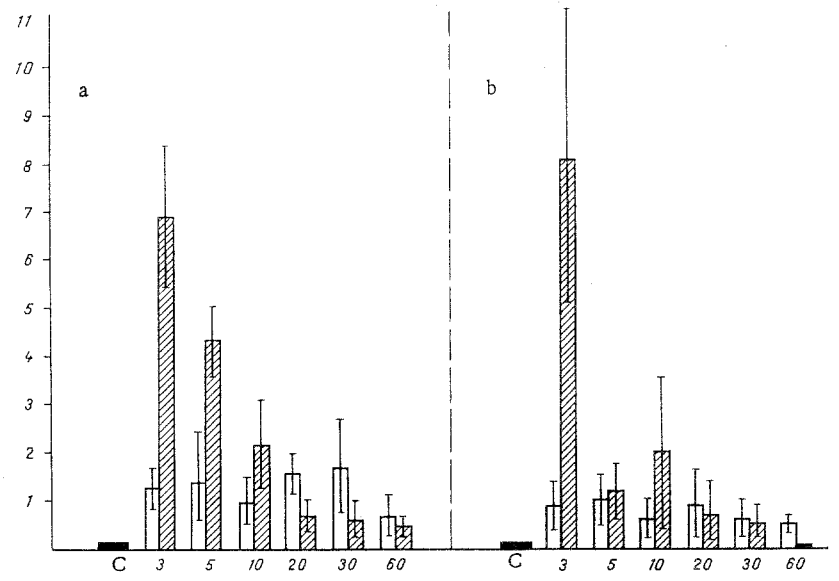

Fig. 1. Changes in mitotic activity of hepatocytes in regenerating liver of domestic fowls. Abscissa, time of experiment (in days); ordinate, MI (in $^0/_{00}$). a)Resected lobe; b) intact lobe. Unshaded column – MI of hepatocytes of cockerels with intact pancreas; shaded columns – MI of hepatocytes in cockerels with regenerating pancreas. C) Control.

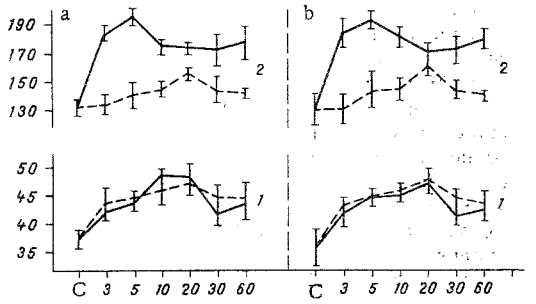

Fig. 2. Changes in area of cross section of nuclei (1) and cytoplasm (2) of hepatocytes during regeneration. Abscissa, times of experiment (in days); ordinate, area (in relative units). Continuous line – after simultaneous partial hepatectomy and pancreatectomy; broken line – after partial hepatectomy. Remainder of legend as to Fig. 1.

An important feature distinguishing post-traumatic regeneration of the liver in domestic fowls is the marked hypertrophy of the nuclei and cytoplasm of the hepatocytes, which we observed for two months of the experiment [4, 5]. Under these experimental conditions hypertrophy of the hepatocyte cytoplasm reached its greatest degree (Fig. 2). A wide band of undifferentiated connective tissue with hematopoietic foci of lymphoid tissue had already formed on the wound surface of the liver 5 days after simultaneous partial pancreatectomy and hepatectomy. Newly formed epithelial tubules and bile ducts, formed in the adjacent parenchyma, run out into the connective tissue. In the left, intact lobe of the liver epithelial structures also were being formed, some of them replacing small foci of necrotic tissue. Regeneration in the glandular parenchyma in this early stage of the experiment led to some decrease in the relative volume of the stroma (Table 1).

Between 10 and 20 days after the operation the deep layers of maturing connective tissue on the wound surface were still poorly differentiated. These proximal layers of the regenerating tissue were infiltrated with lymphocytes, macrophages and, besides proliferating areas of connective tissue they also contained numerous

TABLE 1. Changes in Relative Volumes of Parenchyma and Stroma in Regenerating Liver of Cockerels after Simultaneous Partial Pancreatectomy and Partial Hepatectomy

Zone of organ	Time of experiment, days	Relative volume, percent: of parenchyma		of stroma	
Right, resected lobe	Control	96,63±0,88	—	3,35±0,88	—
	5	96,9±0,61	$P>0,5$	3,1±0,61	$P>0,5$
	10	97,42±0,7	$0,1<P<0,2$	2,58±0,59	$0,5<P<0,1$
	20	97,6±0,57	$0,01<P<0,02$	2,4±0,57	$0,2<P<0,5$
	30	97,37±0,55	$0,05<P<0,01$	2,63±0,55	$0,05<P<0,1$
	60	97,03±0,67	$P>0,5$	2,98±0,43	$0,02<P<0,05$
Left, intact lobe	Control	95,97±2,01	—	3,89±1,95	—
	5	97±0,66	$0,2<P<0,5$	3±0,66	$0,2<P<0,5$
	10	96,76±0,91	$0,2<P<0,5$	3,24±0,91	$0,2<P<0,5$
	20	97,55±0,68	$0,5<P<0,1$	2,45±0,68	$0,05<P<0,1$
	30	96,77±1,46	$0,2<P<0,5$	3,23±1,46	$P>0,5$
		97,08±0,58	$0,1<P<0,2$	2,92±0,58	$0,2<P<0,5$

bands, tubules, and haphazard collections of epithelial cells, always located in the neighborhood of capillaries. Proliferation of the epithelial tubules continued. Layers of regenerating tissue of the same composition were found also in the region surrounding interlobular layers of connective tissue, directly connected with the wound surface. Epithelial tubules with basophilic cells grew toward the regenerating area in the underlying, deeper layers of the parenchyma, accompanied by capillaries. Regenerative processes were still visible in the intact lobe of the liver, where proliferation of bile ducts and epithelial bands could often be seen around the blood vessels. The higher RNA content in the hepatocytes compared with the control is evidence of the high level of synthesis taking place in the organ. Another distinguishing feature of this stage of the experiment was accumulation of eosinophilic leukocytes in foci of active regeneration.

The wound surface of the liver 30 days after the operation was covered with scar tissue. In the central areas of the wound surface, however, the deepest layers of connective tissue were still poorly differentiated. Concentrations of plasma cells and eosinophilic leukocytes were found there. The most distal layer of the glandular parenchyma included atypical secretory tubules with a high RNA content in the cells.

Differentiation of scar tissue was complete on the wound surface 60 days after the operation, but foci with macrophages, with large numbers of plasma cells, and with bands of adipose tissue were still present. Morphogenetic processes were complete in the surface layers of the parenchyma, but in its depth proliferation of bile ducts still continued to a slight degree. The RNA content in the hepatocytes was higher than in the control. The reactive state of the organ at this time was manifested as infiltration of layers of connective tissue with eosinophilic leukocytes and plasma cells, and with frequent foci of hematopoietic tissue, sometimes quite large in size. The considerable quantity of pyroninophilic substance in the cytoplasm of most cells indicated the development of plasma cells in these hematopoietic foci also. At this last stage of the experiment the relative volume of the stroma of the regenerating organ still remained a little reduced (Table 1).

Simultaneous partial pancreatectomy, without altering the basic principles of reparative regeneration of the liver in domestic fowls, thus introduces certain temporal and quantitative shifts into this process: Connective tissue is formed layered on the wound surface and the resected lobe of the organ is infiltrated with eosinophilic leukocytes, healing of the wound and organization of scar are somewhat delayed, and processes of hypertrophy and hyperplasia of the cells were on a more considerable scale. The more prolonged and intensive processes of formation of new epithelial structures and proliferation of secretory tubules were accordingly facilitated. By the end of the experiment the weight of the liver was fully restored. Stereologic analysis of the regenerating organ showed that this was the result mainly of regenerative growth of the glandular parenchyma on account of activation of proliferative processes and of hypertrophy of the cells.

LITERATURE CITED

1. G. G. Avtandilov, Morphometry in Pathology [in Russian], Moscow (1973).
2. V. P. Vunder, Biol. Zh. Arm., No. 2, 83 (1974).
3. K. A. Dzhivanyan, Biol. Zh., No. 1, 68 (1983).

4. K. A. Dzhivanyan, Biol. Zh. Arm., No. 2, 128 (1984).
5. N. L. R. Bucher and M. N. Swaffield, Proc. Natl. Acad. Sci. USA, 72, 1157 (1975).
6. Choi Sook Chong and J. C. Hall, Cancer Res., 34, 2351 (1974).
7. J. B. Price, Takeshige Kotohito, M. H. Max, et al., Surgery, 72, 72 (1972).
8. R. V. Shah, B. Pilo, M. V. Asnani, et al., J. Ahim. Morphol. Physiol., 21, 132 (1974).
9. K. Takeshige, H. Suzuki, Y. Fukaya, et al., World. J. Surg., 5, 441 (1981).
10. L. M. Molina Trigueras, J. A. de Diego Carmona, J. F. del Canzo Lopez, et al., Cir. Esp., 35, 69 (1981).

EFFECT OF GLUTARALDEHYDE PRESERVATION ON IMMUNOGENIC, PHYSICOMECHANICAL, AND FUNCTIONAL PARAMETERS OF ARTIFICIAL AORTIC HEART VALVES

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The use of artificial heart valves, treated with glutaraldehyde (GA), in heart surgery has been followed by publication of a number of investigations in which different concentrations of this preservative, in the composition and pH of the buffer, and in the technology and conditions of preservation, have been evaluated [3, 6, 8, 10]. However, the extremely important comparative data, whereby the optimal values of these parameters can be established, are virtually not to be found.

The aim of this investigation was to study the rate of absorption and the quantity of GA absorbed by the tissue, and also to study changes in the immunogenic properties and physical mechanical and functional parameters of artificial heart valves preserved with GA solutions of various concentrations.

EXPERIMENTAL METHOD

The effect of stabilized 0.25, 0.625, and 1% solutions of GA (from Serva, West Germany), made up in phosphate buffer at pH 7.4, on the tissue of valve prostheses made from pig aorta was investigated. The rate of absorption of GA by the artificial valve tissue was estimated by determining its concentration by iodometric titration by the method in [5]; 10 experiments were carried out with GA solutions of the same concentration.

The immunogenic properties of native and preserved tissues were studied in active anaphylaxis experiments conducted on 113 guinea pigs, and by radial immunodiffusion in agar gel with antisera obtained by immunization of four rabbits. The methods of these investigations were described previously [1]. To determine the protein concentration by Lowry's method extracts of six samples of tissue preserved in GA solutions of different concentrations were used.

As criteria of the effect of GA on the physicomechanical parameters of the prosthesis, the tensile strength and the reserve of deformability of the valve cusps, measured on an "Instrom-1122" tensile testing machine, were used. Each investigation was conducted on 43-74 tissue samples. Parameters of function of the preserved valves were assessed during work in vitro on a bench with constant flow of fluid, by the method described by the writer previously [2]. Eight valves were used in each group of tests.

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