Effect of Exercise upon Liver Following Partial Hepatectomy in Albino Rats. (17947)

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(Introduced by Paul György)

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This communication reports a study of the effect of exercise upon liver restoration in white rats following partial hepatectomy. The study was undertaken because of the uncertainty concerning the optimum time for resumption of physical activity by patients convalescing from acute hepatitis(1).

Procedure. Forty-two albino rats (Sprague-Dawley strain) averaging 170 (150-200) g were caged in groups of 3 and given access to unlimited amounts of a powdered stock diet. This ration contains 75% yellow corn, 16% linseed oil meal, 5% crude casein, 2% alfalfa, 0.5% sodium chloride, 0.5% calcium carbonate and 2% yeast. Body weight and food consumption were recorded daily for a few days before operation and throughout the experimental period. An estimated 70% of the liver was removed under light ether anesthesia by the method of Higgins(2). Great care was taken to leave a minimum of liver tissue distal to the ligature. The removed lobes were weighed after free blood was removed with a gauze sponge. The weight was multiplied by 1.441 to obtain the estimated total liver weight at the time of operation(3). Gurd, Vars and Ravdin found this factor to give a very accurate estimate of total liver weight by this technic. In 35 sacrificed animals we found a close approximation of their results. Twenty-four hours after the operation one half of the animals were exercised for 2 hours and thereafter for 2 hours twice a day. The rats walked approximately 200 meters per hour in a rotary, motor-driven cage. While the experimental animals were being exercised, food was removed from the cages of the controls. Thus both groups of animals had access to food for equal periods. On the third, fifth, seventh, tenth, twelfth, and fourteenth days after operation an equal number of control and experimental rats were exsanguinated under ether anesthesia. The livers were immediately removed, sponged dry and weighed. The per cent of restoration was expressed as the ratio of the estimated liver weight at the time of operation to the weight of the remnant at necropsy.

Results. The exercised animals consistently consumed a little less food than did the controls, and the gain in body weight was slower in the experimental group (Table I). Nevertheless liver restoration in the two groups was almost identical (Table I). By the tenth postoperative day an estimated 100% restoration had occurred in both groups. To gross inspection, the liver tissue present at autopsy appeared to be normal.

None of the animals failed to gain weight and eat well. At autopsy the only sign of reaction to the trauma of operation was fibrous encapsulation of the ligature knot.

Discussion. The data indicate that the amount of exercise to which the animals were exposed did not interfere with the rate or degree of liver restoration following partial hepatectomy. The nature of the restoration and character of the challenge are, of course, different from the situation presented by infectious hepatitis, where the lesion usually consists of diffuse cellular damage. In these experiments the factor of infection was absent.

It was somewhat surprising that the exercised animals ate less food than did the controls. In a separate experiment 21 non-operated rats were exercised in the same manner as were the operated group. The same

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TABLE I.
Effect of Exercise on Food Consumption, Body Weight, and Liver Restoration After Partial Hepatectomy in 42 Rats.

Days following operation	Food consumption per rat in g*		Avg body wt in g†		% liver restoration‡	
	Exercised	Control	Exercised	Control	Exercised	Control
0	15.0	14.7	169	172		
1	5.5	5.6	158	160		
2	10.2	10.3	160	165		
3	9.6	14.1	167 (±5.0)	170 (±4.1)	60.5 (±2.0)	67.5 (±4.0)
4	13.6	16.3	164	179		
5	16.8	17.7	165 (±3.7)	181 (±6.0)	79.0 (±3.5)	76.3 (±2.7)
6	15.4	19.3	170	184		
7	17.3	20.2	175 (±2.0)	186 (±3.1)	89.7 (±1.3)	94.3 (±1.1)
8	17.3	18.7	182	190		
9	15.9	16.7	187	195		
10	15.1	19.7	193 (±4.2)	201 (±1.7)	96.7 (±2.1)	95.7 (±1.7)
11	16.7	21.8	195	210		
12	19.2	20.0	197 (±10.0)	213 (±7.2)	110.0 (±3.0)	120.0 (±2.6)
13	18.8	22.5	205	216		
14	19.0	20.0	206 (±3.6)	220 (±5.0)	120.0 (±2.1)	122.0 (±1.6)

* The average difference in mean food consumption of the 2 groups was 2.31 g. The stand. dev. of the difference between the means was 1.78.

† The figures in parentheses are the stand. dev. of the cumulative wts of the animals autopsied on the days indicated.

‡ Stand. dev. in parentheses.

TABLE II.
Effect of Exercise on Food Consumption and Body Weight of 21 Non-Operated Rats.

Days	Food consumption per rat, g*		Avg body wt, g†	
	Exercised	Controls	Exercised	Controls
1	15.4	14.2	191	187
		(Exercise begun)		
2	9.3	10.2	192	191
3	11.0	13.0	196	195
4	13.3	14.5	192	191
5	11.0	13.3	192	193
6	13.7	15.0	192	196
7	12.0	13.8	193	198
8	11.0	13.5	194	193
9	14.0	14.6	195	195
10	10.7	12.0	192	201
11	10.3	13.3	198	202
12	11.3	13.5	196	203
13	15.7	16.3	194	205
14	13.0	14.3	195 (±2.9)	207 (±4.7)
		(Exercise stopped)		
15	16.5	14.5	197	208

* The average difference in mean food consumption of the 2 groups was 1.69. The stand. dev. of the difference between the means was 0.79.

† Stand. dev. for cumulative weights in parentheses.

slight but consistent decreased food consumption was apparent (Table II). The exercise appears to have been sufficiently exhausting to prevent normal eating despite the fact that exercise theoretically created a demand for additional calories. Signs of exhaustion were observed in the rats as they walked in the treadmill. The animals moved forward only when the cage rotated them to the point of discomfort.

Summary. 1. Exercise in a revolving cage did not retard liver restoration in white rats

subjected to partial hepatectomy.

2. The daily food consumption of exercised animals, both operated and non-operated, was slightly less than that of non-exercised animals.

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Chymotrypsin Inhibition by Human Serum in Health and Disease.*† (17948)

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The antiproteolytic power of blood serum in the diagnostic application to cancer has been considered(1-3). Serum also inhibits the milk clotting power of pepsin and rennin. Proteinase inhibitors may be prepared from the gastric mucosa of various animals(4), and from soy beans and lima beans as reported first by Tauber(4). Two inhibitors were recently isolated from legumes in crystalline form(5,6). The present study was well in progress when West and Hilliard(7) presented a procedure for the estimation of rennin and chymotrypsin inhibitors in blood serum, using unbuffered milk, as a diagnostic method for malignant neoplasia. In the present study strongly buffered homogenized milk of a constant pH of 5.0 is employed. This substrate produces a readily recognizable flocculant precipitate with chymotrypsin. Rennin inhibition is not included in this study.

Materials and methods. (a) *Chymotrypsin solution.* 2 mg of crystalline chymotrypsin (Worthington Biochemical Laboratory) is dissolved per cc of distilled water. (b) *Acetate buffer.* To 42 g of sodium hydroxide in 700 cc of distilled water, 115 cc of an 80% acetic acid solution is added. The mixture is cooled to 20°C and diluted to 1 liter with distilled water. (c) *Buffered milk.* Equal volumes of homogenized milk (ordinary milk may also be used but not powdered milk) and acetate buffer are mixed. The pH of the buffered milk is 5.00. (d) *Standardization of chymotrypsin solution.* All solutions are placed into a constant temperature water bath and adjusted to 20°C. 0.2 cc of distilled water and 1 mg of chymotrypsin in 0.5 cc of distilled water are placed in a 102 x 13 mm test tube. The contents of the tube are mixed. Three cc of buffered milk are added and the contents of the tube are rapidly mixed. The tube is placed in the water bath and the time necessary until a flocculent precipitate appears in the buffered milk is noted. Precipitation usually appears in 4 minutes. If the chymotrypsin solution is more or less active a new enzyme solution must be made up having a clotting time of exactly 4 minutes. The several chymotrypsin samples used in the present work appeared to be of quite constant activity. *Chymotrypsin inhibition test.* 0.2 cc of fresh serum or serum stored in the re-

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