

# EFFECT OF LIGATION OF HEPATIC VESSELS ON THE FUNCTIONAL STATE OF THE LIVER

(UDC 616.36-008.6-02 : 616.136.41-089.814)

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Translated from *Byulleten' Éksperimental'noi Biologii i Meditsiny*, Vol. 59, No. 3,  
pp. 45-48, March, 1965

Original article submitted December 10, 1963

The liver is known to be highly sensitive to oxygen deficiency [1, 2, 5, 6, 7, 10]. Ischemia of the liver resulting from interference with its blood supply, has a very pronounced effect on the intermediate metabolism and energy balance of the body as a whole.

It has been demonstrated that obstruction of the common hepatic artery at various levels does not lead to any very marked trophic changes in the liver as there is a well-developed network of anastomoses and collateral vessels both outside and within the liver [3, 4, 8, 9]. Yet the mere presence of pathways for collateral circulation is not in itself evidence of complete provision for all the functional requirements of the liver.

In this investigation an attempt was made to discover what changes took place in the bile-forming function of the liver when its arterial supply was cut off.

## METHODS

The experimental animals used were 12 fully grown dogs weighing between 15 and 20 kg. Schwann gall-bladder fistulas were created under intravenous thiopental anesthesia. Two to three weeks later, bile was collected hourly for three hours daily over a period of 3-4 days. Volume of bile, quantity of cholesterol (Engel'gardt and Smirnova method), bile acid content (Shiray and Kuni's method) were recorded for each hourly specimen. Blood cholesterol, prothrombin time [11], blood sugar and hemocrit readings were also recorded. When background values had been established, the common hepatic, right gastro-epiploic and superior pancreaticoduodenal arteries were ligatured in eight of the dogs. Regular examinations were resumed 24 h after the operation and continued for seven days.

When the experiments had been completed, the dogs were killed by exsanguination; the vascular system of the abdominal cavity was filled with an aqueous suspension of lead tetroxide for subsequent dissection and angiography.

The abdomen was opened but the vascular system left intact in the four control dogs.

## RESULTS

The actual operation had no significant effect on the functional state of the liver (see Table 1) and all indices were more or less back to their original values three days after laparotomy.

Ligation of the arteries supplying the liver, on the other hand, was associated with reduction of the quantity of bile secreted, reduced cholesterol and bile acid contents, increase of blood cholesterol, hyperglycemia and reduced prothrombin time (Table 2). All that could be noted seven days after ligation was a slight tendency for some of the indices of hepatic function to move back towards normal values. Angiographic examinations revealed that the vascular system of the liver was well filled everywhere with contrast medium even on the first or second day after ligation of the common hepatic, right gastro-epiploic and superior pancreaticoduodenal arteries. The liver

TABLE 1. Changes in Indices of the Functional State of the Liver in Laparotomized Control Animals

Time of examination	Index	Bile (ml)			Bile acids (mg/ 100 ml)			Cholesterol (mg/ 100 ml)			
		1st portion	2nd portion	3rd portion	1st portion	2nd portion	3rd portion	In blood	In bile		
									1st portion	2nd portion	3rd portion
Initial	M m	4 0.86	5 0.60	4 0.60	1,348 151	1,306 114	1,172 133	160 8.1	43 0.61	43 0.78	43 0.61
After 24 h	M m p<	4 0.80 0.2	4 0.70 0.2	4 0.50 0.5	1,141 73 0.2	1,099 75 0.2	1,141 73 0.5	122 8.0 0.001	44 3.3 0.5	44 3.2 0.5	45 4.5 0.5
Average difference		—	—1	—	—207	—207	—31	—38	+1	+1	+1
After 48 h	M m p<	5 0.80 0.2	4 0.50 0.2	4 0.40 0.5	1,208 61 0.5	1,249 53 0.5	1,249 53 0.5	135 12 0.1	43 1.1 0.5	41 1.3 0.2	41 1.1 0.2
Average difference		+2	—1	—	—140	—59	+77	—25	—	—2	—2
After 72 h	M m p<	5 1.2 0.5	7 0.86 0.05	4 0.80 0.5	1,141 73 0.1	1,141 73 0.5	1,141 73 0.5	142 13 0.2	43 1.5 0.2	40 1.6 0.1	41 1.5 0.2
Average difference		+1	+2	—	—207	—165	—31	—18	—	—3	—2

TABLE 2. Changes in Indices of the Functional State of the Liver in Experimental Animals after Ligation of Hepatic Vessels

Time of examination	Index	Bile (ml)				Bile acids (mg/100 ml)				Cholesterol (mg/100 ml)			Blood sugar (mg/100 ml)	Pro-thrombin time (sec)	Hemo-crit
		1st portion	2nd portion	3rd portion	Total	1st portion	2nd portion	3rd portion	Blood	1st portion	2nd portion	3rd portion			
Initially	M m	11 1.12	11 1.12	10 1.0	32 3.42	1,748 80	1,748 80	1,748 80	157 1.0	39 0.7	39 0.7	39 0.7	97 1.8	10 0.13	42 1.6
48 h after ligation of vessels	M m p<	2 0.12 0.001	2 0.12 0.001	2 0.12	6 0.50 0.001	233 54 0.001	268 45 0.001	235 124 0.001	91 0.12 0.001	19 1.12 0.001	19 1.12 0.001	21 0.12 0.001	113 5.0 0.02	9 0.6 0.5	46 1.9 0.2
Average difference		-9	-9	-8	-26	-1,515	-1,480	-1,513	-66	-20	-20	-18	+16	-1	+4
72 h after ligation of vessels	M m p<	2 0.09 0.001	2 0.09 0.001	3 0.12	7 0.13 0.001	312 199 0.001	312 199 0.001	342 133 0.001	94 3.24 0.001	19 1.12 0.001	19 1.12 0.001	19 1.12 0.001	113 5.0 0.02	8 0.7 0.02	50 2.23 0.02
Average difference		-9	-9	-7	-25	-1,436	-1,436	-1,406	-63	-20	-20	-20	+16	-2	+8
96 h after ligation of vessels	M m p<	2 0.09 0.001	3 0.5 0.001	4 0.6 0.001	9 1.2 0.001	337 103 0.001	337 103 0.001	372 148 0.001	94 2.8 0.001	20 1.8 0.001	20 1.8 0.001	21 1.8 0.001	111 5.0 0.05	8 0.8 0.05	48 3.0 0.1
Average difference		-9	-7	-6	-23	-1,411	-1,411	-1,376	-53	-19	-19	-18	+14	-2	+6
7 days after ligation of vessels	M m p<	5 1.0 0.001	5 1.0 0.001	5 1.0 0.001	15 2.6 0.001	540 123 0.001	540 123 0.001	540 123 0.001	97 7.0 0.001	23 2.4 0.001	23 2.4 0.001	23 2.4 0.001	97 3.8 0.5	9 0.7 0.5	47 2.6 0.5
Average difference		-6	-6	-5	-17	-1,208	-1,208	-1,208	-60	-16	-16	-16	-	-2	+5

was then receiving its blood supply by way of the numerous anastomoses normally present between the arteries of the liver and those of neighboring organs (stomach, duodenum, pancreas and diaphragm). The main source of supply for the liver during the first few days after ligation of its main vessels was the right gastric artery, which soon became a trunk of considerable size.

Later, there was development of a considerable number of vessels of various sizes between the layers of the greater and lesser omenta. A retrograde flow from splanchnic and superior mesenteric arteries was established through vessels within the duodenum, pancreas and pyloric part of the stomach. There was also development of a considerable number of vessels with diameters of 0.5-1.0 mm in the hepatoduodenal and hepatodiaphragmatic ligaments and along the portal vein, inferior vena cava and common bile duct.

A dense network of short, twisting anastomotic and collateral vessels, connecting the two ends of the artery developed in the neighborhood of the ligature. A profuse arterial network developed between the vessels in the fibrous capsule of the right lobe of the liver and the right suprarenal. Connection was also established with the arteries of the diaphragm. Structural changes in the arterial system of the pancreas, seen as dilatation of arteries and an intensified general vascular pattern, were more pronounced than in other organs. The arteries became tortuous. The inferior pancreaticoduodenal artery was converted from a relatively small vessel to a trunk of considerable size. The vessels of the duodenal mesentery were greatly dilated, some having diameters of 2-2.5 mm.

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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.

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