

Estimated Hepatic Blood Flow and Hepatic Venous Oxygen Content in Cirrhosis of the Liver.

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The hepatic blood flow in patients with cirrhosis is generally believed to be reduced because of destruction and distortion of the liver's vascular bed. Experiments designed to test this belief have been carried out by perfusing cirrhotic livers (obtained at necropsy) with saline solution or kerosene, but the results have been inconsistent. Working with large cirrhotic livers, Herrick¹ and Dock² concluded that the capacity for total blood flow in such livers is only moderately decreased and that the arterial inflow may even exceed the normal value. McIndoe,³ who apparently used small, fibrotic livers, believed that hepatic blood flow is greatly reduced by increased resistance to flow in both hepatic arterial and portal venous systems. We have studied the problem in 14 patients with Laennec's cirrhosis, 11 of them with a history of chronic alcoholism, and 3 patients with cirrhosis due respectively to Schistosomiasis, syphilis, and chronic periportal inflammation (biliary cirrhosis).

Methods. Hepatic blood flow (EHBF) was estimated on the basis of the hepatic Bromsulfalein (BSP) clearance.⁴ Hepatic venous blood samples were obtained by means of a venous catheter⁵ placed in an hepatic vein of the right lobe of the liver under fluoroscopic control. Arterial blood was sampled simultaneously through an indwelling arterial needle from a brachial or femoral artery. Oxygen was determined in blood after the method of Van Slyke and Neill⁶ and BSP was measured colorimetrically.⁴ Oxygen

concentrations were corrected on the basis of average arterial oxygen capacities. The subjects, selected from the wards of the Evans Memorial Hospital, Boston, and the Presbyterian Hospital, New York, were studied in the fasting basal state.

Results and Comment. Estimated hepatic blood flow was found definitely below normal (1000 to 2000 ml per minute) in 7 of 17 subjects, regardless of the etiology of the cirrhosis (Table I). In only 3 was EHBF significantly increased, whereas in 7 patients EHBF lay within the normal range.

The high values for EHBF obtained in K.M., B.M., and D.M. cannot be accepted without qualification, because the difference between the concentrations of BSP in hepatic and peripheral blood was so small that even a minor analytical error could have affected the EHBF significantly. Furthermore, in patients with severely damaged livers, the total amount of BSP removed by the liver may be over-estimated. In normal subjects, the removal is so efficient that any extra-hepatic removal is probably negligible, but in cirrhotics impairment of removal by the liver makes possible a proportionally greater removal extra-hepatically. Thus the error introduced by ascribing extra-hepatic removal of BSP to the liver would operate to yield falsely high values for EHBF. Hence, the preponderance of low values among the patients studied becomes more significant.

The data on oxygen content of hepatic venous blood is best discussed in terms of the arterio-venous difference. In all but 2 cases (see Table II) the oxygen A-V difference was greater than the normal difference between arterial and hepatic venous blood (2.5-4.5 ml %). Since only one of 5 subjects

¹ Herrick, F. C., *J. Exp. Med.*, 1907, **9**, 91.

² Dock, W., *Trans. Assn. Am. Phys.*, 1942, **57**, 302.

³ McIndoe, A. H., *Arch. Path.*, 1928, **5**, 23.

⁴ Bradley, S. E., Ingelfinger, F. J., Bradley, G. P., and Curry, J. J., *J. Clin. Invest.*, 1945, **24**, 890.

⁵ Cournand, A., and Ranges, H. A., *Proc. Soc. Exp. Biol. and Med.*, 1941, **46**, 462.

⁶ VanSlyke, D. D., and Neill, J. M., *J. Biol. Chem.*, 1924, **61**, 523.

TABLE I.
Estimated Hepatic Blood Flow (EHB_F) in Patients with Hepatic Cirrhosis.

Subject	Age	Sex	Peripheral venous plasma concentration BSP, mg/100 cc	Change in peripheral venous concentration BSP, mg/100 cc/min.	Hepatic extraction* BSP, %	Total BSP removal, mg/min.	EHB _F , ml/min.
Laennec's Cirrhosis, History of Chronic Alcoholism.							
I.C.	46	F	3.74	.000	12.0	2.39	850
W.P.	49	M	1.31	+.005	22.2	1.46	876
R.W.	54	M	2.53	— .005	18.7	2.20	932
E.Me.	67	F	2.15	+.005	15.8	1.85	983
R.B.	40	M	1.32	+.006	36.4	2.76	990
J.C.	61	M	1.48	+.005	21.4	2.72	1320
L.F.	56	M	0.86	.000	24.0	2.16	1690
F.F.	43	M	0.48	— .002	42.5	1.91	1735
D.C.	39	F	1.55	+.010	10.3	1.85	1906
O.H.	38	M	1.09	.000	22.9	2.54	1995
D.M.†	66	M	1.96	.000	3.4	2.06	4020
Laennec's Cirrhosis, Without History of Alcoholism.							
K.N.†	38	F	1.85	+.026	11.9	1.35	1026
K.M.	46	F	2.07	+.003	5.5	1.87	2325
B.M.†	46	M	0.83	+.002	8.4	2.28	4620
Schistosomiasis—Periportal Fibrosis.							
M.D.†	34	M	0.72	.000	59.4	2.00	842
Biliary Cirrhosis (Hanot's)—Periportal Fibrosis.							
F.G.†	52	F	1.90	+.010	12.1	1.45	1025
Syphilitic Cirrhosis—Hepar Lobatum.							
J.L.†	49	M	3.00	.000	18.4	1.71	492

* Hepatic extraction of Bromsulfalein was calculated as the difference between peripheral and hepatic venous concentrations divided by the peripheral venous concentration.

† Diagnosis proved by biopsy or necropsy.

TABLE II.
Oxygen Content and Capacity of Peripheral Arterial and Hepatic Venous Blood in Patient with Hepatic Cirrhosis.

Subject	Arterial		Hepatic venous		Oxygen
	Oxygen content, vol. %	Oxygen saturation, %	Oxygen content, vol. %	Oxygen saturation, %	Arterio-venous difference, vol.
Laennec's Cirrhosis with History of Chronic Alcoholism.					
A.A.	14.0	89.6	8.3	52.6	5.7
R.W.	19.4	94.6	13.9	67.5	5.5
F.F.	17.4	95.0	12.0	65.2	5.4
D.C.	14.6	96.7	9.5	62.4	5.1
D.M.	7.3	84.5	6.0	69.0	1.3
Laennec's Cirrhosis Without History of Alcoholism.					
K.N.	15.9	93.4	12.5	73.2	3.4
B.M.	11.8	100.0	6.6	55.2	5.2
Schistosomiasis—Periportal Fibrosis.					
M.D.	14.8	96.0	7.8	50.0	7.0
Biliary Cirrhosis (Hanot's)—Periportal Fibrosis.					
F.G.	15.6	96.2	10.8	66.2	4.8
Syphilitic Cirrhosis—Hepar Lobatum.					
J.L.	14.3	95.9	8.6	57.1	5.7

with alcoholic cirrhosis exhibited a low A-V difference, our results do not support Dock's² suggestion that arterial flow tends to be greater in alcoholic than in non-alcoholic cirrhosis.

Summary. The hepatic blood flow tends to be low or normal in cirrhosis of the liver, regardless of etiology. The hepatic oxygen A-V difference is usually increased.