

17137. Increased Portal Pressure and Ascites in Rats Following Ligation of Portal Vein.

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Numerous reports have appeared in the literature¹⁻³ concerning the failure to produce ascites in animals by ligation of the portal vein. These results have caused some people to minimize the importance of increased portal pressure as a factor in the mechanism of ascites in patients with cirrhosis of the liver. Recently Blakemore⁴ and Linton⁵ have demonstrated that ascites sometimes disappears following anastomoses between the portal and the general venous circulation. Portal pressures 3 and 4 times the normal range have been found at operation in patients with cirrhosis accompanied by ascites. However, the exact role of elevated portal pressure in the production of ascites is not clear.

The present experiments were undertaken to assess the influence of hypoproteinemia, increased Na intake and antidiuretic substances on the production of ascites in rats with elevated portal pressure. It was found that partial ligation of the portal vein alone produced some ascites in a large percentage of the rats. These animals were demonstrated to have increased portal pressure. The additive effect of the other procedures on ascites will be described in another communication.

Experimental Procedure and Results. Adult rats weighing 200-300 g were operated on under ether anesthesia and the portal vein above the splenic vein was ligated to approximately $\frac{1}{4}$ its original circumference. This was carried out by exteriorizing the portal vein and tying it off completely. Then a small probe was inserted in the loose knot and it

was dilated to the desired circumference. If the ligation was complete, all animals died within a few hours. The portal pressure in such animals reached values as high as 1,000 mm H₂O and numerous small vessels were ruptured. In addition, there was marked engorgement of blood, giving a dark red color to the intestines. In the partial ligation an effort was made to allow just enough portal blood to pass to prevent the death of the animal. The color of the intestines helped to determine the degree of obstruction. It was possible to raise the portal pressure as much as 200 mm of water by the partial ligation and still obtain 85% survival. Complete ligation of the portal vein was carried out in 2 stages in 42 rats by the method of Whitaker.⁶ This was a somewhat cumbersome procedure and did not give significantly higher portal pressures than the one-stage partial ligation. A 60% survival rate was obtained for the 2-stage complete ligation.

Following partial ligation of the portal vein, ascites was carefully sought both by laparotomies and by placing a needle in the abdomen. Ascites was found in 69% of the animals. Table I shows the incidence of ascites in 110 rats which received the partial ligation as compared to a control group which received only intestinal manipulation at the time of operation. The fluid obtained resembled human ascitic fluid with a slightly higher protein content (an average of 2.2%). The ascites was found to develop usually on the second day after the operation, reach a peak at approximately the 6th day and then gradually disappear so that few of the rats had any ascites after the 14th day. The ascites could easily be missed and was often not evident from the weight changes of the animals. Massive ascites requiring removal of fluid from the

¹ Eck, N. V., *Voyena Med. J.*, 1877, **130**, 1.

² Bollman, J. L., *Trans. Liver Injury Conference*, Josiah Macy, Jr. Foundation, 1948, **7**, 21.

³ Milnes, R. F., and Child, C. G., *Proc. Soc. Exp. Biol. and Med.*, 1949, **70**, 332.

⁴ Blakemore, A. H., *New York State J. Med.*, 1947, **47**, 479.

⁵ Linton, R. R., Hardy, I. B., and Volwiler, W., *Surg., Gynec. and Obst.*, 1948, **87**, 129.

⁶ Whitaker, W. L., *Proc. Soc. Exp. Biol. and Med.*, 1946, **61**, 420.

TABLE I.
Comparison of the Amount of Ascites Formed in a Group of Rats with Partial Ligation of the Portal Vein and in an Operated Control Group.

Operation	No. of rats	Rats with ascites			
		1-4 cc		>4 cc	
		No.	%	No.	%
Intestinal manipulation	26	0	0	0	0
Portal vein ligation	110	60	55	16	14

abdomen developed in only 3 of the rats. The 2-stage complete ligation of the portal vein did not cause a higher incidence of ascites.

In view of the fact that the occurrence of ascites appeared to be quite unpredictable in the rats with partial ligation of the portal vein, the pressure in the portal circuit was determined. This was carried out by means of a simple small diameter manometer that was connected to a needle which was inserted into branches of the mesenteric veins. Heparinized saline was used in the manometer and the results obtained were corrected for capillarity. Anaesthesia was found to increase considerably the pressure in the portal system and the pressure could be made to rise and fall according to the degree of anesthesia. It was possible, however, to bring all the animals to a constant stage of anaesthesia so that the pressures could be compared. Normal animals gave pressures ranging from 100-160 mm H₂O. All animals with partial ligation showed values which were higher than the highest normal. Table II shows the portal pressure in 9 rats along with the amount of ascites. It is evident that there is no direct correlation. However, there was a general tendency for the animals with the higher pressures to have more ascites. The cause of the large amount

TABLE II.
Comparison of the Portal Pressure and the Volume of Ascitic Fluid in 9 Rats Operated on 6 Days After Partial Ligation of the Portal Vein.

Rat No.	Portal pressure, mm H ₂ O (Normal 100-160)	Ascites, cc
1	350	4
2	320	2
3	310	3
4	280	0
5	270	10
6	250	0
7	230	2
8	220	0
9	210	0

of ascites in some of the animals was not clear. It appeared as though other factors were operating in these animals in addition to increased pressure. With time the portal pressure gradually declined and usually fell to a level just above normal at the end of 3 weeks.

Summary. Partial ligation of the portal vein resulted in the development of a small amount of ascites in 69% of a group of 110 rats. All rats showed an increase in portal pressure but the degree of increase did not correlate well with the amount of ascites.

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