Treatment of Budd-Chiari Syndrome by Side-to-Side Portacaval Shunt: Experimental and Clinical Results

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The Budd-Chiari syndrome caused by occlusion of the major hepatic veins, often of unknown etiology, is typically characterized by massive ascites, hepatomegaly and abdominal pain due to intense congestion of the liver. The outcome has almost always been fatal. This report describes an evaluation of side-to-side portacaval shunt in dogs with experimental Budd-Chiari syndrome and in six patients with hepatic vein thrombosis. In the animal studies, side-to-side portacaval shunt was very effective in relieving massive ascites, hepatomegaly, hepatic congestion and portal hypertension produced by ligation of the hepatic veins. Only one of 24 dogs with side-to-side anastomosis reformed ascites, 67% of the animals survived until the study was concluded after one year, and liver biopsies showed reversal of the severe pathologic abnormalities. In contrast, all 20 control dogs subjected to a sham laparotomy, and all 20 dogs that underwent end-to-side portacaval shunt reformed massive ascites and died within six months with continued hepatic congestion and necrosis.

All six patients with the Budd-Chiari syndrome due to hepatic vein occlusion had massive ascites (4.4–15.9 l), hepatomegaly, abdominal pain and disturbed liver function. In all six, angiography demonstrated occlusion of the hepatic veins with a patent inferior vena cava (IVC) and a normal IVC pressure, and liver biopsy showed intense centrilobular congestion and necrosis. The most valuable diagnostic study was angiography of the IVC and hepatic veins with pressure measurements. Side-to-side portacaval shunt was performed from four to 14 weeks after the onset of symptoms, and produced dramatic and sustained relief of ascites in five of the six patients during follow-up periods of from eight months to seven years. Liver function returned to normal, hepatosplenomegaly disappeared, none of the survivors developed portal-systemic encephalopathy, and follow-up liver biopsies showed disappearance of congestion and necrosis, but mild to moderate fibrosis. One patient died following an emergency IVC thrombectomy and portacaval shunt, which was undertaken when, during the course of his workup, his condition deteriorated suddenly because the thrombotic process extended from the hepatic veins into the IVC. The everpresent risk of this complication, and the dangers associated with delaying operation were emphasized by this case. It is concluded that side-to-side portacaval shunt, which decompresses the liver by converting the portal vein into an outflow tract, provides effective treatment of the Budd-Chiari syndrome when the occlusive process is confined to the hepatic veins.

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THE CLINICAL DISORDER caused by occlusion of the major hepatic veins or the inferior vena cava at the level of the hepatic vein ostia is known as the Budd-Chiari syndrome. Although a brief discussion of this disorder first appeared in the book by Budd in 1845, the first case is said to have been reported by Lambron in 1842.[9] In 1899, in a report of ten collected cases and three personal cases, Chiari[11] presented the first thorough clinical and pathological description of the syndrome, including the hypothesis that it is caused by endophlebitis of the hepatic veins. However, the weight of evidence and current opinion favors the view that the primary process is usually thrombotic rather than inflammatory. Since publication of the initial description, over 500 cases have been reported in the medical literature.

The clinical manifestations of hepatic vein occlusion usually consist of ascites, hepatomegaly and abdominal pain due to intense congestion of the liver caused by obstruction of hepatic venous outflow. Depending on the rapidity and extent of hepatic vein occlusion, the course of the syndrome may be rapid or chronic, progressing to death in a matter of weeks or leading to death from liver failure or bleeding esophageal varices after an illness of months or occasionally years. A rapid course is more common, and the outcome has been fatal in the great majority of reported cases.[21,45,46,58,60]

No cause of the hepatic vein occlusion has been identified in 60–70% of the reported cases.[21,45,56,58,60] In the relatively small number of cases in which the etiology has been proven or suspected, the primary etiologic conditions have included polycythemia rubra vera, invasion of the inferior vena cava and hepatic

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veins by malignant neoplasms, paroxysmal nocturnal hemoglobinuria, ingestion of oral contraceptives, trauma, pregnancy, leukemia, sickle cell anemia, ulcerative colitis, hydatid disease and schistosomiasis.[2,25,26,45–47,52,58,62] Membranous obstruction of the inferior vena cava just below the level of the diaphragm has been reported recently with considerable frequency, mainly from Japan, as a cause of a chronic form of Budd-Chiari syndrome.[16,24,27,51,63] The therapeutic implications of this condition as well as of other forms of inferior vena cava occlusion are distinctly different from those of occlusion confined to the major hepatic veins.

Use of side-to-side portacaval shunt, or its hemodynamic equivalents such as splenorenal shunt, mesocaval shunt and mesocaval H-graft, to relieve the Budd-Chiari syndrome caused by occlusion of the hepatic veins has been described sporadically during the past three decades.[4,5,18–20,30,35,40,48,54] The rationale for the use of this procedure is based on substantial evidence that the valveless portal vein can be converted to an outflow tract by an in-continuity anastomosis with the systemic venous system, thereby decompressing the obstructed hepatic vascular bed.[6,7,9,10,31,32,37–39,41,57,61] However, a thorough trial of side-to-side shunt in the treatment of the Budd-Chiari syndrome has not been conducted, mainly because the condition is uncommon and often the diagnosis has not been made until near or after death.

This report describes the results of an experimental evaluation of side-to-side portacaval shunt in the Budd-Chiari syndrome produced in dogs by ligation of the hepatic veins. On the basis of the experimental results, side-to-side portacaval anastomosis has been used to treat six patients with hepatic vein thrombosis, and the clinical studies in these patients are described. Although the number of patients is small, this report describes the largest clinical experience to date with the use of side-to-side portacaval shunt in the therapy of Budd-Chiari syndrome.

Materials and Methods

Production of Budd-Chiari Syndrome

Our method of producing the Budd-Chiari syndrome in dogs by direct ligation of the hepatic veins has been described in detail in previous reports.[42,43,56] Briefly, it consisted of ligation and division of all hepatic veins except the large left hepatic vein (superior hepatic vein), which was loosely surrounded by an ameroid constrictor (Fig. 1). The ameroid constrictor consisted of a hygroscopic casein plastic disc 22 mm in diameter, 8 mm thick and containing a triangular opening that was 15

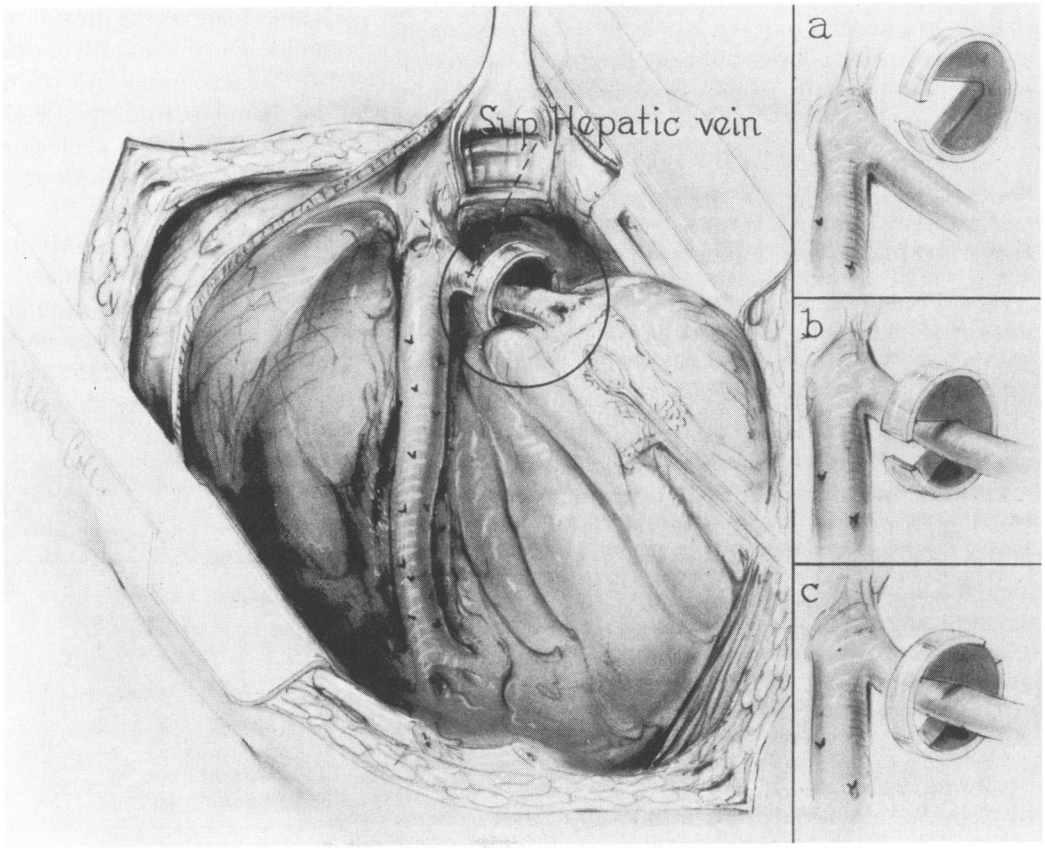

FIG. 1. Technique of induction of Budd-Chiari syndrome in dogs by ligation and division of all hepatic veins except the large superior hepatic vein (left hepatic vein) which was surrounded by an ameroid constrictor.

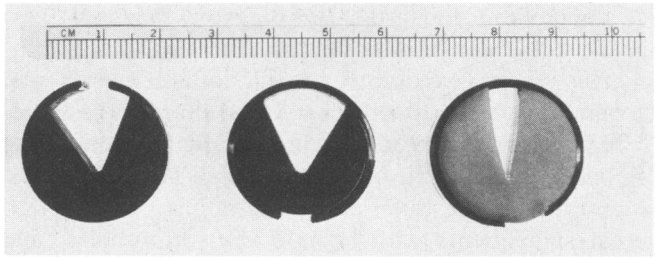

FIG. 2. Ameroid constrictor made of a casein plastic disc surrounded by a stainless steel rim used for gradual occlusion of the left hepatic vein. On the left the ameroid is in position for insertion around the vein. In the middle the ameroid is in the locked position (after insertion around the vein) with the plastic disc rotated so that its slit is at a distance from the slit in the steel rim. On the right is an ameroid removed 35 days after insertion in a dog; the hygroscopic casein plastic has swelled resulting in narrowing of the slit and occlusion of the vein.

mm wide at the periphery and 15 mm deep to accomodate the left hepatic vein. The solid casein plastic disc was encased in a stainless steel rim 2 mm in wall thickness with a 5 mm-wide slit to allow placement around the intact vein (Fig. 2). After insertion of the ameroid around the vein, it was locked in place by rotation of the opening in the plastic disc to a point distant from the slit in the steel rim. At the time of insertion, the ameroid did not initially constrict the left hepatic vein. However, the lumen in the ameroid gradually narrowed as the hygroscopic casein plastic swelled centrally so that severe hepatic outflow block, portal hypertension and massive, intractable ascites developed within several weeks. Previous studies in over 200 dogs showed that the left hepatic vein was completely occluded within 35–53 days, and that every animal developed massive ascites.

Experimental Groups

Hepatic vein ligation was performed in 70 mongrel dogs that weighed from 20 to 29 kg. Six dogs died within one month after operation. Two months postoperatively, when ascites was well-established in all animals, the remaining 64 dogs were randomly divided into three groups as follows:

Group I was made up of 20 dogs that underwent a *sham laparotomy* which involved dissection of the portal vein and inferior vena cava and all other technical maneuvers preparatory to performance of a portacaval anastomosis without actual construction of the shunt. Five of these animals died within one month postoperatively, all with massive ascites, and 15 were long-term survivors.

Group II consisted of 20 dogs that were subjected to an *end-to-side portacaval shunt* which was designed by delineation with calipers to measure 2.0 × 0.5 cm. Five of these dogs died within one month after the shunt procedure, all with massive ascites, and 15 were long-term survivors.

Group III contained 24 dogs that underwent a *side-to-side portacaval shunt* of identical size to the end-to-side anastomosis. Six of these animals died within one month after operation and 18 were long-term survivors. None of the dogs in this group that died during the early postoperative period had ascites.

Animals that survived for one year after sham laparotomy or portacaval shunt underwent a sacrifice operation. The volume of ascites was measured at the time of the second operation and again at the time of death or sacrifice. Pressures in the portal vein and abdominal inferior vena cava were measured by needle puncture, using a saline manometer, at the beginning and end of each operation, and at the time of sacrifice in surviving dogs. The level of the inferior vena cava was used as the reference baseline. Liver biopsies were obtained for microscopic examination at each operation and at death. Autopsies were performed in all animals and included determinations of the completeness of hepatic vein occlusion and the patency and size of the portacaval shunts.

Results

Mortality Rate

Table 1 shows the mortality rates in the three groups of dogs. The one month or operative mortality rate was 25% in each group. All of the dogs that died shortly after sham laparotomy or end-to-side portacaval shunt had massive ascites, while none of the animals that died within one month of side-to-side portacaval shunt reformed ascites.

The 15 long-term survivors in Group 1 died within 60 to 185 days after sham laparotomy, a six month mortality rate of 100%. Similarly, the six month mortality rate after end-to-side portacaval shunt in Group II was 100%, with all of the 15 long-term survivors dying within 50 to 172 days after the operation. In contrast, of

TABLE 1. *Mortality Rates in Dogs with Budd-Chiari Syndrome Following Sham Laparotomy, End-to-side Portacaval Shunt and Side-to-side Portacaval Shunt*

Group	No. Dogs	Operative (1 month) Mortality Rate-%	One Year Mortality Rate-% (excludes operative deaths)
I Sham laparotomy	20	25%	100%
II End-to-side shunt	20	25%	100%
III Side-to-side shunt	24	25%	33%

TABLE 2. *Reaccumulation of Ascites in Dogs with Budd-Chiari Syndrome Following Sham Laparotomy, End-to-side Portacaval Shunt and Side-to-side Portacaval Shunt*

Group	No. Dogs	Ascites at Operation			Ascites at Autopsy		
		% of Group	Volume-L		Reaccumulation % of Group	Volume-L	
			Mean	Range		Mean	Range
I Sham laparotomy	20	100	3.2	2.2–5.3	100	3.4	1.4–7.2
II End-to-side shunt	20	100	3.0	2.0–5.7	100	3.8	1.6–6.8
III Side-to-side shunt	24	100	3.3	2.5–6.2	4	1.4	1.4

the 18 long-term survivors of side-to-side portacaval shunt in Group III, 12 lived until the time of sacrifice one year postoperatively, a one year mortality rate of 33%. The period of survival of the six dogs in Group III that failed to live for one year ranged from 94 to 324 days.

Ascites

All of the dogs developed substantial ascites following hepatic vein ligation, and the volume measured at the time of sham laparotomy or portacaval shunt was similar in the three groups. All dogs rapidly reformed ascites following either sham laparotomy or end-to-side portacaval shunt and the ascites persisted until death (Table 2). The mean volume of ascites at the time of autopsy was 3.4 L. in Group I and 3.8 L. in Group II. In striking contrast, only one of the 24 dogs in Group III reaccumulated ascites following side-to-side portacaval shunt. This animals died 182 days postoperatively and no distinct cause for the ascites was identified at autopsy. It is noteworthy that none of the dogs in Group III that survived to the end of the study period had ascites when they were sacrificed after one year.

Pressures

Table 3 shows the results of pressure measurements in the portal vein and inferior vena cava at each operation and, in Group III, at the time of sacrifice one year after portacaval shunt. The portal pressure was normal in all dogs at the time of hepatic vein ligation. By the time of the second operation when the Budd-Chiari syndrome was well established, all of the dogs had portal hypertension, and the magnitude was similar in the three groups. Both the end-to-side and side-to-side portacaval shunts reduced the portal pressure to the normal range. Hepatic sinusoidal pressure was not measured, although it is well established that in the presence of hepatic outflow block the side-to-side anastomosis is substantially more effective than the end-to-side shunt in overcoming intrahepatic hypertension.[50,61] At the time of the sacrifice operation one year postoperatively, the portal pressure was normal in the ten dogs with side-to-side shunt in which pressure measurements were performed.

Liver Biopsies

Prior to hepatic vein ligation the liver in all dogs was normal as shown by gross and microscopic examinations. At the time of the sham laparotomy or shunt when the Budd-Chiari syndrome was well-established, all livers were enlarged to from two to four times normal size and appeared congested and friable. Liver biopsies at this time showed intense centrilobular congestion, necrosis of cells around the central veins, dilated lymphatics and subcapsular edema (Fig. 3). In the dogs in Group I, these gross and microscopic abnormalities were unchanged at the time of death, and substantial

TABLE 3. *Portal Vein (PV) and Inferior Vena Cava (IVC) Pressures in Dogs Before and After Induction of Budd-Chiari Syndrome, and After Portacaval Shunt (Mean and range of pressures shown in mm saline)*

Group	No. Dogs	Initial		Massive Ascites		After Shunt		After 1 Year*	
		PV	IVC	PV	IVC	PV	IVC	PV	IVC
I Sham laparotomy	20	112 (82–124)	62 (28–94)	242 (204–302)	94 (82–112)	—	—	—	—
II End-to-side shunt	20	115 (76–130)	67 (32–94)	256 (198–312)	102 (78–143)	130 (112–148)	126 (102–140)		
III Side-to-side shunt	24	114 (72–128)	63 (31–90)	247 (208–300)	97 (68–132)	122 (108–142)	117 (106–139)	97 (74–112)	92 (70–110)

* 10 dogs

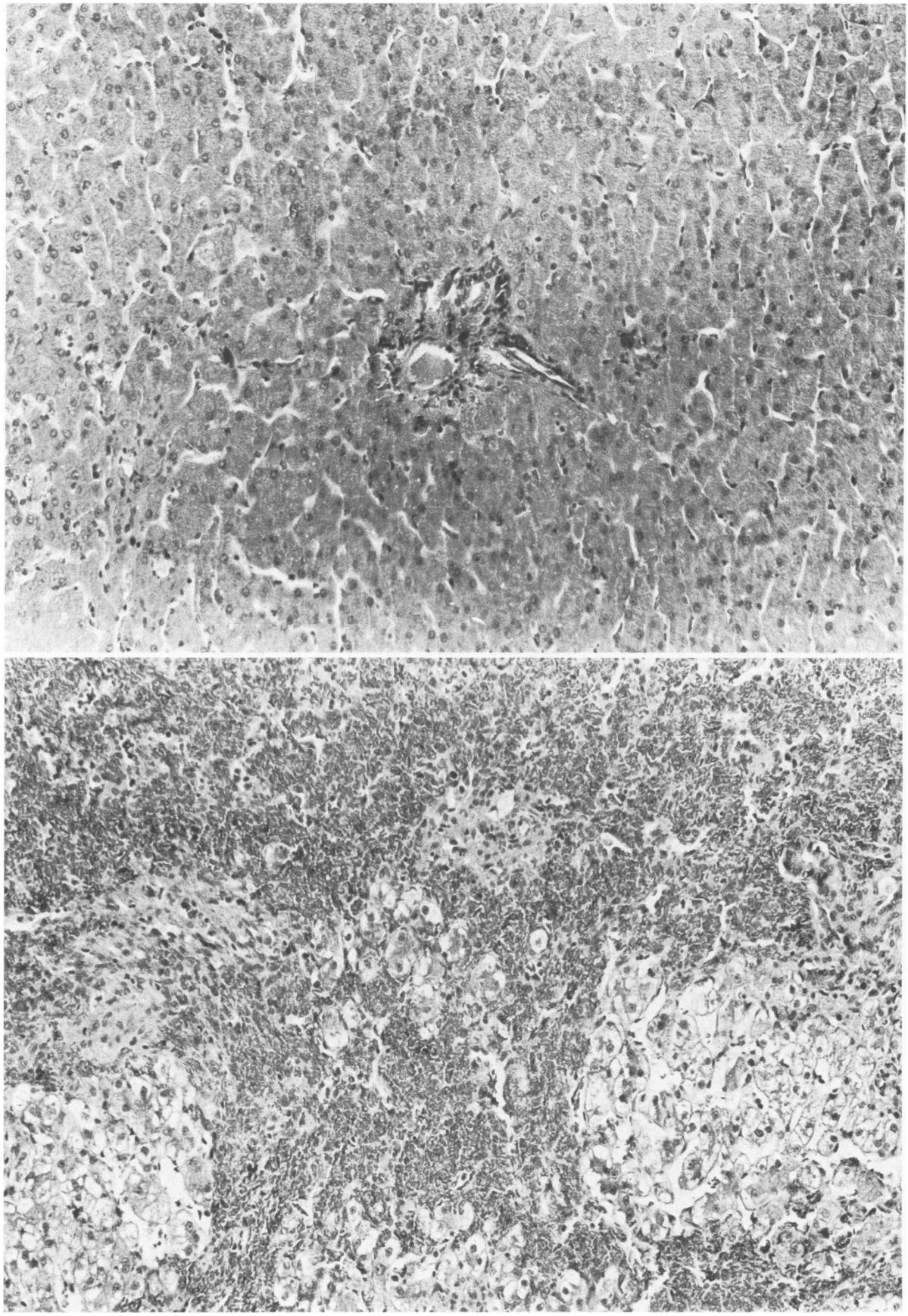

FIG. 3. Photomicrographs of liver biopsies obtained from a dog (top) before hepatic vein ligation when the liver was normal, and (bottom) at the time of portacaval shunt when the Budd-Chiari syndrome was well established and ascites was massive. There is intense congestion and necrosis of the hepatic parenchyma in the biopsy shown in the bottom panel. (×140).

fibrosis was found in many of the liver biopsies. Similarly, all of the dogs in Group II had hepatomegaly at the time of death, and severe congestion, necrosis and fibrosis were found in all liver biopsies, although in 38% of the animals, the microscopic picture was less severe than at the time of the shunt operation. Only one dog with a side-to-side shunt in Group III, the single animal with ascites, had an enlarged liver and microscopic findings of congestion and necrosis at the time of death. The other 23 dogs in Group III had a liver that was normal in size and gross appearance at autopsy; liver biopsies were normal in 35 per cent of these dogs and showed minimal fibrosis in the remaining 65 per cent.

At autopsy, the hepatic veins were occluded in every animal in the study. All portacaval shunts were found to be widely patent.

Clinical Studies

Patients

On the basis of the results of our experimental studies showing that side-to-side portacaval anastomosis was very effective in relieving hepatic outflow block, massive ascites and portal hypertension produced by occlusion of the hepatic veins, we have performed side-to-side portacaval shunt in six patients with Budd-Chiari syndrome caused by thrombosis of the hepatic veins. Four were men and two were women, and their ages ranged from 19 to 45 years. All of the patients had been in good health prior to the onset of symptoms. One patient was found to have polycythemia rubra vera and another had been taking oral contraceptives for five years. In the remaining four patients no condition known to be associated with hepatic vein thrombosis was identified.

Symptoms and Signs

Table 4 summarizes the symptoms and signs in the six patients. The initial symptom in all six was abdominal distention which increased progressively during the course of a few weeks. All of the patients had abdominal pain that was dull, nagging and chronic. The pain was localized to the right hypochondrium in one patient, diffuse in the upper abdomen in three and diffuse throughout the abdomen in two. All of the patients had anorexia and progressive weakness. One-half of the patients noticed mild jaundice, two developed intermittent vomiting, one had diarrhea and one observed fever to 101°F. The symptoms were of sufficient severity to cause the patients to consult a physician within four weeks of their onset, and usually sooner.

Physical examination performed on admission to our institution from three weeks to three months after the onset of symptoms showed massive ascites, hepatomegaly and substantial wasting due to loss of lean body mass in all patients. All of them appeared chronically and seriously ill. Three patients had mild jaundice, three had distention of the superficial veins of the anterior abdominal wall and one had low grade fever. The spleen was palpable in only two patients although it was subsequently shown to be enlarged in all six. None of the patients had edema of the lower extremities or lower trunk, a finding that indicates involvement of the inferior vena cava in the occlusive process.

Diagnostic Studies

An extensive diagnostic evaluation was performed in all patients (Table 5). The diagnostic study of greatest value was angiographic examination of the inferior vena cava (IVC) and hepatic veins, with pressure measurements. This study was combined with hepatic and superior mesenteric arteriography and indirect portography. All patients were shown to have a patent IVC with a pressure that was within the normal range for subjects with ascites (62–126 mm saline) (Fig. 4). Patency of the IVC is a prerequisite for portacaval shunt so that this finding was of crucial importance. In three patients, the IVC was moderately compressed in its intrahepatic course by the enlarged liver, a finding that has been reported previously[13,28,49,58] and usually is not of clinical significance (Fig. 6A). In all patients, hepatic venography demonstrated occlusion of the major hepatic veins, a diagnostic finding. It was not always possible to catheterize all of the hepatic veins because of complete occlusion, but at least one major hepatic vein

TABLE 4. *Symptoms and Signs in Six Patients with Budd-Chiari Syndrome*

Symptoms	% of Group	Signs	% of Group
Abdominal Distention	100	Massive Ascites	100
Abdominal Pain	100	Hepatomegaly	100
Weakness	100	Wasting	100
Anorexia	100	Jaundice	50
Jaundice	50	Abdominal Venous	
Vomiting	33	Distention	50
Diarrhea	17	Splenomegaly	33
Fever	17	Fever	17

TABLE 5. *Results of Diagnostic Studies in Six Patients with Budd-Chiari Syndrome*

	% of Group		% of Group
Angiography & Pressures		Liver Biopsy (3 patients studied)	
Patent IVC	100	Centrilobular congestion	100
Occluded hepatic veins	100	Centrilobular necrosis	100
Stretched hepatic arteries	100		
Patent portal vein	100	Abnormal Liver Function Tests	
Normal IVC pressure	100	Bromsulphalein retention (23–90%)	100
Elevated WHVP (3 patients studied)	100	Serum alkaline phosphatase (148–345 IU)	100
		Prothrombin time (13–16.5 sec.)	83
Scintiscan		Serum albumin (2.1–2.8 g/dl)	83
Decreased hepatic uptake	100	Serum bilirubin (3.9–4.5 mg/dl)	50
Inhomogeneous hepatic uptake	100	SGOT (142–540 IU)	50
Central hot spot in liver	33		
		Normal Upper Gastrointestinal X-Rays	100

was entered in every patient. Injection of dye in the wedged position demonstrated the characteristic spider web pattern of small hepatic venous collaterals in four patients (Fig. 5). In all six patients, hepatic arteriography demonstrated the nonspecific abnormality of stretching and attenuation of the branches of the hepatic artery within the liver, and indirect portography showed a patent portal vein. These findings were not of great importance but were helpful. Wedged hepatic vein pressure (WHVP) was measured in three patients and was markedly elevated in all three, ranging from 344 to 442 mm saline.

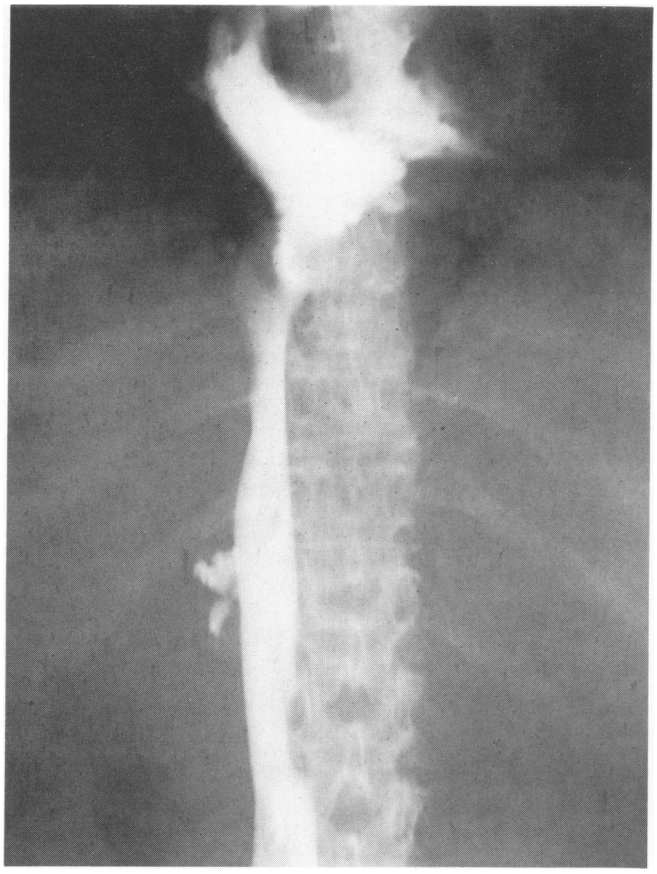

FIG. 4. Inferior venacavogram in case 3 showing a widely patent IVC. IVC presure was 62 mm saline.

Needle liver biopsy was not performed in every patient because the clinical picture and results of other studies, particularly angiography, justified confidence in the diagnosis of Budd-Chiari syndrome. However, prior to admission to our institution referring physicians performed a needle liver biopsy in two patients and an open liver biopsy in one patient, and in each instance the microscopic picture of intense centrilobular congestion and necrosis was observed. These findings strongly suggested the diagnosis of Budd-Chiari syndrome.

Scintiscans of the liver and spleen with ^{99m}Tc sulfur colloid were obtained in all patients and showed the nonspecific abnormalities of decreased and inhomogeneous hepatic uptake of radiocolloid, increased uptake of radiocolloid by the spleen and bone marrow, and hepatosplenomegaly. Central localization of radiocolloid in the liver, which has been reported to be of diagnostic importance,[36,58] was observed in only two patients.

Abnormal results of liver function tests were obtained in all patients, although the type of abnormality was somewhat variable. All patients had marked retention of bromsulphalein ranging from 23 to 90% in 45 minutes, and elevation of serum alkaline phosphatase ranging from 148 to 345 IU (normal 25–85 IU). Five of the six patients had a prolonged prothrombin time and decreased serum albumin concentration ranging from 2.1 to 2.8 g/dl. Three patients had elevation of the serum glutamic oxalacetic transaminase (SGOT) ranging from 142 to 540 IU, and three had moderate elevations of serum bilirubin ranging from 3.9 to 4.5 mg/dl.

Barium contrast upper gastrointestinal x-rays were normal in all patients.

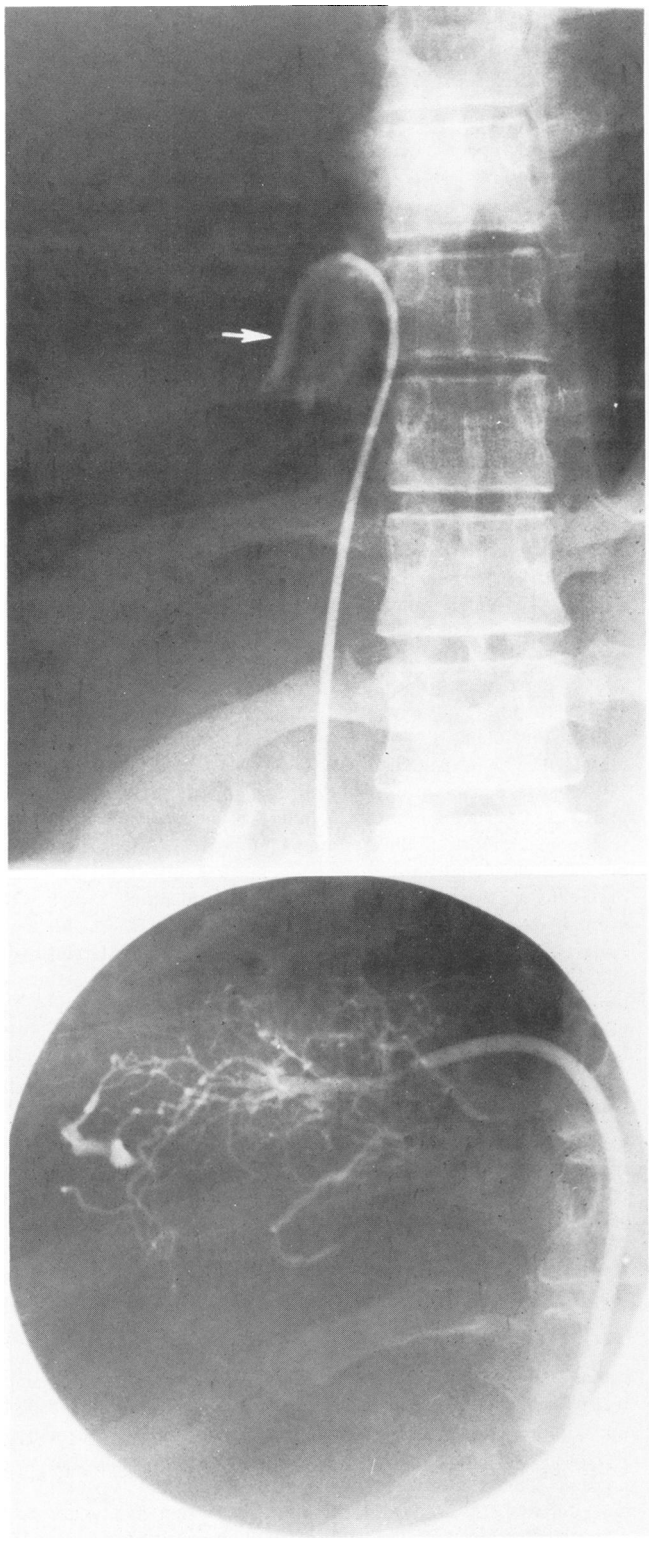

FIG. 5. Hepatic venogram in case 2 showing (top) filling defects (thrombi) in the right hepatic vein occupying much of the lumen and (bottom) a typical spider web network of small venous collaterals on injection of dye in the wedged position. The left hepatic vein was completely occluded.

Findings at Operation

Side-to-side portacaval shunt was performed from four to 14 weeks after the onset of the illness. In five of the six patients the shunt operation was straightforward, since it was demonstrated preoperatively that the IVC was patent and the thrombotic process was confined to the hepatic veins. In the remaining patient (see case 6 below) initial angiography showed a patent IVC but repeat angiographic studies, performed shortly before operation because the patient suddenly developed edema of the lower extremities and trunk, showed extension of thrombus into the IVC with sudden elevation of IVC pressure (Fig. 6). An emergency IVC thrombectomy and portacaval shunt was undertaken in a desperate attempt to reverse a rapidly downhill course.

At operation massive ascites ranging in volume from 4.4 to 15.9 l, an enlarged and congested liver and splenomegaly were found in all patients (Table 6). The IVC pressure (IVCP) was normal in five of the six patients, ranging from 74 to 120 mm saline. The sixth patient (case 6 below) was known preoperatively to have developed sudden thrombosis of the IVC and had an IVCP of 250 mm saline. All patients had portal hypertension with free portal pressures (FPP) ranging from 265 to 434 mm saline. Hepatic occluded portal pressure (HOPP) was markedly elevated in all patients, and in two it was higher than FPP. Splanchnic occluded portal pressure (SOPP) showed the usual reciprocal relationship to HOPP. Side-to-side portacaval shunt reduced the portal pressure to the normal range (134 to 175 mm saline) in the five patients whose IVC was patent. The pressure gradient across the shunt was 10 mm. saline or less in all patients.

A wedge liver biopsy obtained at operation showed intense centrilobular congestion and intense centrilobular necrosis in all patients (Fig. 7). Five of the six patients had mild to moderate hepatic fibrosis.

Results of Side-to-Side Portacaval Shunt

Table 7 summarizes the long-term results of side-to-side portacaval shunt. The patient who underwent emergency IVC thrombectomy and portacaval shunt because of sudden extension of thrombosis into the IVC (case 6 below) died six days postoperatively with multiorgan failure and recurrence of IVC thrombosis. The remaining five patients were alive and well when last seen from eight months to seven years postoperatively. A striking feature of the early recovery period was a rapid gain in lean body weight that ranged from 24 to 40 pounds in a period of three to six months.

TABLE 6. *Findings at Operation in Six Patients with Budd-Chiari Syndrome*

Case	Ascites L.	Hepato-megaly	Spleno-megaly	Pressures—mm Saline						Operative Liver Biopsy—0 to 4+		
				Preshunt				Postshunt		Centri-lobular Congestion	Centri-lobular necrosis	Fibrosis
				IVCP	FPP	HOPP	SOPP	IVCP	FPP			
1	8.4	+	+	92	428	440	420	144	150	4+	4+	0
2	7.4	+	+	86	360	364	352	152	156	4+	4+	2+
3	4.4	+	+	74	358	326	390	134	138	4+	4+	1+
4	8.7	+	+	112	342	338	348	168	176	4+	4+	2+
5	6.0	+	+	120	265	200	305	175	165	4+	4+	1+
6	15.9	+	+	250	434	486	422	284	289	4+	4+	2+

All of the survivors have remained free of ascites without requiring diuretic therapy. Results of periodic liver function tests have been consistently normal. None of the patients have developed portal-systemic encephalopathy or required restriction of dietary protein, probably because they have good hepatic function. Hepatosplenomegaly has disappeared in all patients.

Liver biopsies and angiographic studies with pressure measurements were performed periodically in the four survivors whose follow-up exceeded one year. The results are summarized in Table 8. There was no evidence of congestion or necrosis in any of the liver biopsies, but mild to moderate fibrosis was observed in all. Angiography demonstrated patency of the portacaval shunt and IVC, and pressure measurements showed a wide open anastomosis with a gradient of 14 mm saline or less across the shunt. It was not possible to catheterize the hepatic veins in any patient, presumably because they were completely occluded.

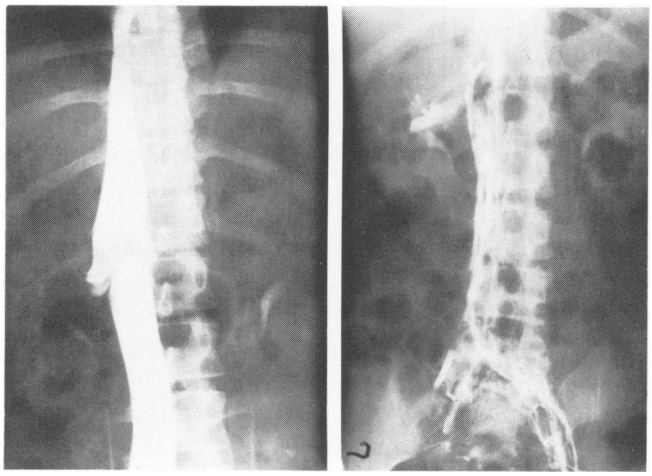

FIG. 6. Inferior venacavogram in case 6 showing (left) a widely patent IVC with side-to-side compression in its intrahepatic course by the swollen liver. Hepatic venography (not shown) demonstrated occlusion of the major hepatic veins. An angiographic study performed 12 days later (right) shows extension of thrombosis throughout the iliac veins and IVC. Extension of the thrombotic process into the IVC caused sudden deterioration of the patient's condition, and an emergency attempt at IVC thrombectomy and portacaval shunt failed.

Case Reports

Case 1. This 28-year-old previously healthy white male was admitted to the hospital with a five week history of progressive increase in abdominal girth, persistent pain in the right upper abdomen, progressive weakness and anorexia, and a one week history of jaundice and intermittent vomiting. Symptoms had progressed despite treatment with diuretics and bed rest for one month by his family physician. On physical examination he appeared chronically ill with substantial loss of lean body mass and had jaundice, marked ascites, hepatomegaly, splenomegaly and distended superficial abdominal veins. There was no peripheral edema. Extensive blood studies showed the following abnormalities: serum bilirubin 4.5 mg/dl, serum alkaline phosphatase 240 IU (normal 25–85 IU), bromsulphalein retention 42% in 45 minutes, prothrombin time 14 seconds (control 11 seconds), partial thromboplastin time 45 seconds (control 33 seconds), and serum albumin 2.3 g/dl. Scintiscans showed hepatosplenomegaly with diminished and inhomogeneous hepatic uptake of radiocolloid and an area of concentrated uptake in the center of the liver. Barium contrast upper gastrointestinal x-rays were normal. Angiogiographic studies showed a patent IVC with moderate compression in its intrahepatic course by the enlarged liver, occlusion of the major hepatic veins with a spider web pattern of abnormal vessels on wedged hepatic venography, stretching and narrowing of the branches of the hepatic artery and a normal portal vein (PV). IVCP was 104 mm saline and WHVP was 442 mm saline. A diagnosis of Budd-Chiari syndrome with thrombosis of the hepatic veins of unknown etiology was made.

A side-to-side portacaval shunt was performed six weeks after the onset of symptoms. The findings at operation were 8.4 liters of ascites, marked enlargement and congestion of the liver, splenomegaly, and the following pressures in mm saline: IVCP 92; FPP 428; HOPP 440; SOPP 420. Following construction of the portacaval anastomosis the pressures were: IVCP 144; FPP 150. A liver biopsy showed intense congestion and substantial necrosis in the center of the lobule.

The postoperative course was uncomplicated and the patient was discharged from the hospital 18 days after operation. He resumed normal activity and employment after three months, and remained free of ascites without diuretic therapy during seven years of follow-up. Within six months of operation he gained 38 pounds in lean body weight. Results of liver function tests performed each year were normal. There has been no evidence of portalsystemic encephalopathy. A needle liver biopsy performed five years postoperatively showed moderate fibrosis but no necrosis or congestion. Angiographic studies performed five years after operation showed a widely patent portacaval anastomosis and IVC, and the following pressure measurements in mm. saline: IVCP 108; FPP 114. It was not possible to catheterize the hepatic veins and it was assumed that they were completely occluded.

Case 2. This 45-year-old white female was transferred from another hospital where she had been hospitalized for three weeks. She gave a three month history of progressive abdominal distention,

TABLE 7. *Outcome of Six Patients with Budd-Chiari Syndrome Who Underwent Side-to-side Portacaval Shunt*

Case	Primary Condition	Duration—Onset to Operation (Wks.)	Follow-up				
			Years	Ascites	Need for Diuretics	Liver Function Tests	Encephalopathy
1	Unknown	6	7	0	0	Normal	0
2	Unknown	14	6	0	0	Normal	0
3	Oral contraceptives	7	4	0	0	Normal	0
4	Unknown	9	3	0	0	Normal	0
5	Unknown	4	⅔	0	0	Normal	0
6	Polycythemia vera	14	Died—6 days	—	—	—	—

persistent upper abdominal pain, anorexia and progressive weakness, and a one month history of jaundice and intermittent diarrhea. One month prior to the onset of symptoms she had an upper respiratory infection that forced her to stay home from work for one week, but otherwise she had been in excellent previous health. Treatment at the other hospital with prednisone and diuretics based on a presumptive diagnosis of viral hepatitis was unsuccessful. Referral to our institution was stimulated by a needle liver biopsy that showed marked hepatic congestion and necrosis, and was interpreted as indicating Budd-Chiari syndrome. Physical examination on admission to our institution showed marked wasting of lean body mass, jaundice, spider nevi, tense ascites, hepatomegaly and distended superficial abdominal veins. There was no peripheral edema. Extensive blood studies showed the following abnormalities: serum bilirubin 4.2 mg/dl, SGOT 260 IU, serum alkaline phosphatase 174 IU, bromsulphalein retention 38% in 45 minutes, prothrombin time 14.6 seconds (control 10.8 seconds), partial thromboplastin time 52 seconds (control 30 seconds), and serum albumin 2.1 g/dl. Scintiscans showed an enlarged liver and spleen, markedly diminished and inhomogeneous hepatic uptake of radiocolloid, and concentration of radiocolloid in a small central area of the liver. Barium contrast upper and lower gastrointestinal x-rays were normal. Angiographic studies showed a patent IVC with moderate compression of the intrahepatic segment by the enlarged liver, stretching and attenuation of the intrahepatic branches of the hepatic artery, and a normal PV. It was not possible to catheterize the left hepatic vein, but the right hepatic vein showed marked narrowing by filling defects and a network of tiny veins of small caliber. IVCP was 74 mm saline and WHVP was 344 mm saline. A diagnosis of Budd-Chiari syndrome with thrombosis of the hepatic veins of unknown etiology was made.

A side-to-side portacaval shunt was performed 14 weeks after onset of symptoms. The findings at operation were 7.4 l of ascites, an enlarged and congested liver, splenomegaly and the following pressures in mm saline: IVCP 86; FPP 360; HOPP 364; SOPP 352. Post-shunt pressures were: IVCP 152; FPP 156. A liver biopsy showed intense centrizonal congestion and loss of parenchyma and moderate fibrosis between the portal tracts and central veins.

The postoperative course was complicated by a minor wound infection and transient reformation of ascites which responded to diuretic therapy. The patient was discharged from the hospital three weeks after operation and had returned to normal activity after three months. Lean body weight gain amounted to 27 pounds within six months. During six years of follow-up the patient remained free of ascites without diuretic therapy, and repeated liver function tests gave consistently normal results. There have been no manifestations of portal-systemic encephalopathy. A needle liver biopsy performed five years after operation showed only moderate fibrosis. Angiographic studies performed three and six years after operation showed a widely patent portacaval shunt and IVC, but it was not possible to catheterize the hepatic veins, presumably because they were completely occluded. The most recent pressure measurements in mm saline were: IVCP 124; FPP 132.

Case 3. This 30-year-old previously healthy white female was admitted to the hospital because of a six week history of progressive abdominal enlargement, diffuse abdominal pain, fatigue, anorexia and occasional vomiting all of which were initially presumed to be due to pregnancy. She had been taking oral contraceptives regularly for five years. She had shown no response to two weeks of diuretic therapy and bed rest by her family physician. On physical examination she appeared seriously and chronically ill and had moderate wasting of lean body mass, marked ascites, hepatomegaly and splenomegaly. The uterus was normal in size and there was no jaundice or peripheral edema. Extensive blood studies showed the following abnormalities: serum bilirubin 2.0 mg/dl, serum alkaline phosphatase 148 IU, bromsulphalein retention 28% in 45 minutes, prothrombin time 13 seconds (control 10.2 seconds), and serum albumin 2.8 g/dl. Scintiscans showed hepatosplenomegaly with decreased and inhomogeneous hepatic uptake of radiocolloid. Barium contrast upper gastrointestinal x-rays were normal. Angiographic studies showed a widely patent IVC, occlusion of the major hepatic veins by filling defects, stretching and attenuation of the branches of the hepatic artery, and a normal PV. Pressures in mm saline were: IVCP 62 and WHVP 366. A diagnosis of Budd-Chiari syndrome with thrombosis of the hepatic veins related to oral contraceptive therapy was made. During

TABLE 8. *Results of Follow-up Liver Biopsies, Angiography and Pressure Measurements in Four Patients with Budd-Chiari Syndrome Three to Six Years After Portacaval Shunt*

Case	Liver Biopsy—0 to 4+				Angiography and Pressures (mm Saline)					
	Time (Yrs.)	Fibrosis	Congestion	Necrosis	Time (Yrs.)	Patent Shunt	Patent IVC	Occluded Hepatic Veins	IVCP	FPP
1	5	2+	0	0	5	+	+	+	108	114
2	5	2+	0	0	6	+	+	+	124	132
3	4	1+	0	0	4	+	+	+	96	110
4	3	2+	0	0	3	+	+	+	144	158

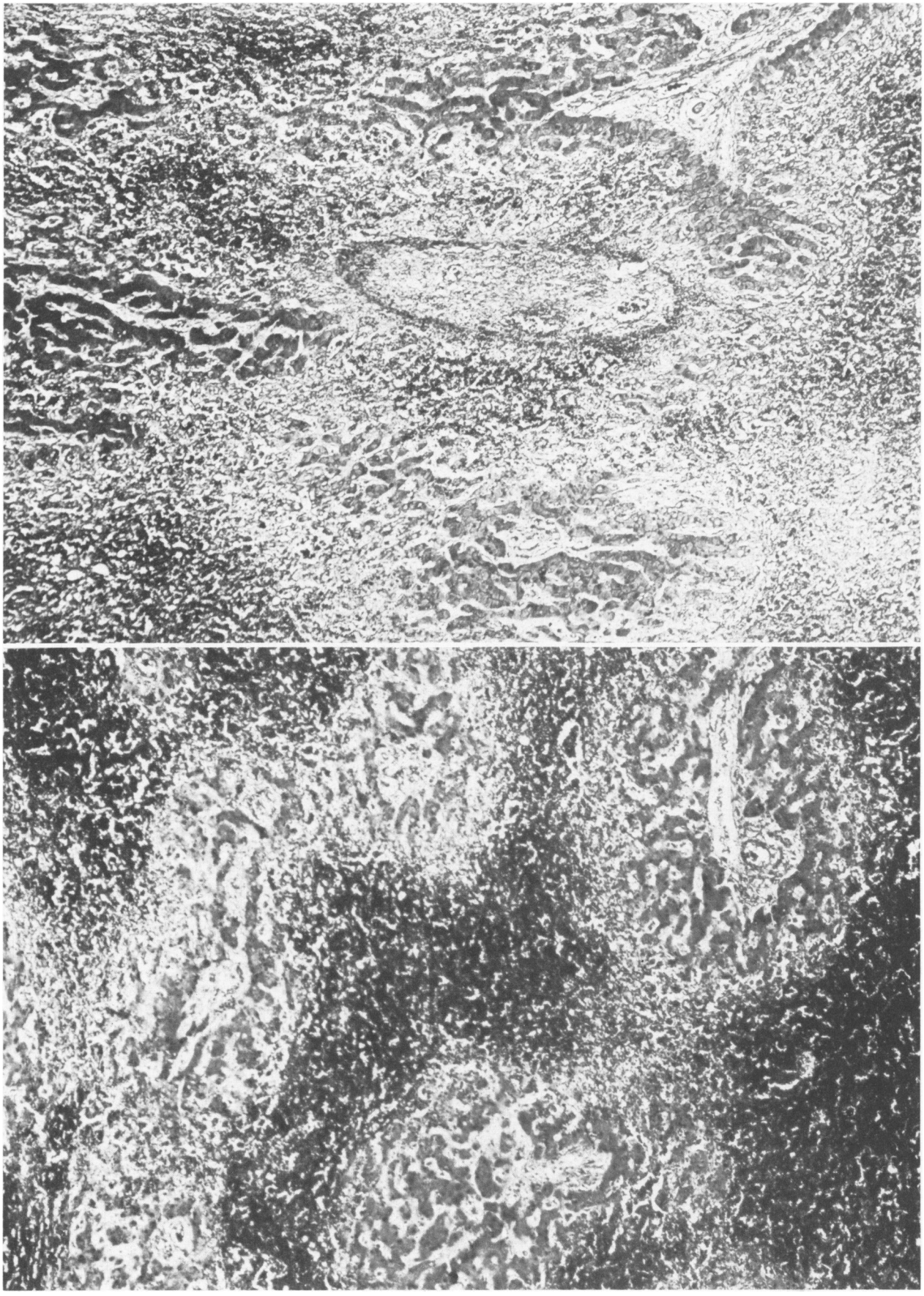

FIG. 7. Photomicrographs of liver biopsies obtained in case 4 (top) and in case 5 (bottom) showing typical picture of intense centrilobular congestion and necrosis, with widespread loss of hepatocytes. A thrombosed hepatic vein is seen in the center of the top panel. (×50)

the initial week of hospitalization her abdominal pain increased, she was unable to eat, weakness progressed and she appeared to be deteriorating.

A side-to-side portacaval shunt was performed seven weeks after the onset of symptoms. The findings at operation were 4.4 l of ascites, a markedly enlarged and congested liver, a moderately enlarged spleen and the following pressures in mm saline: IVCP 74; FPP 358; HOPP 326; SOPP 390. Pressures after construction of the portacaval anastomosis were: IVCP 134; FPP 138. A liver biopsy showed intense contrilobular congestion and necrosis with some fibrosis.

The postoperative course was uncomplicated and the patient was discharged from the hospital 19 days postoperatively. Within three months of discharge she gained 24 pounds in lean body weight and resumed normal activity. During four years of follow-up she remained free of ascites without diuretic therapy, and results of periodic liver function tests were normal. Portal-systemic encephalopathy did not develop. A needle liver biopsy performed four years postoperatively showed normal architecture except for minimal fibrosis. Angiographic studies performed four years after operation showed a widely patent portocaval shunt and IVC. Catheterization of the occluded hepatic veins was not possible despite repeated attempts. Pressure measurements in mm saline were: IVCP 96; FPP 110.

Case 4. This 34-year-old previously healthy white male was transferred from another hospital where he had been hospitalized on two occasions during the preceeding two months. He gave a two month history of progressive abdominal enlargement, intermittent upper abdominal pain, progressive weakness and anorexia. During his initial admission to the other hospital he was found to have hepatomegaly and ascites and was discharged on diuretic therapy, only to be readmitted because of unresponsiveness to treatment and worsening of his condition. A diagnosis of Budd-Chiari syndrome of unknown etiology was made during the second admission to the other hospital on the basis of a needle liver biopsy showing marked centrilobular congestion and necrosis, and angiographic studies that showed a patent IVC with a pressure of 106 mm saline, almost complete occlusion of the right and left hepatic veins with collateral vessel formation, distortion of the branches of the hepatic artery and a normal PV. Physical examination on admission to our institution showed marked wasting, tense ascites, hepatomegaly and distended superficial abdominal veins. There was no jaundice or peripheral edema. Extensive blood studies showed the following abnormalities: bromsulphalein retention 38% in 45 minutes, serum alkaline phosphatase 180 IU, SGOT 142 IU, prothrombin time 15.2 (control 11.4), serum albumin 2.4 g/dl. Scintiscans showed enlargement of the liver and spleen, and diminished and inhomogeneous hepatic uptake of radiocolloid. Barium contrast upper gastrointestinal x-rays were normal. Angiographic studies were not repeated.

A side-to-side portacaval shunt was performed nine weeks after the onset of symptoms. The findings at operation were 8.7 l of ascites, marked enlargement and congestion of the liver, splenomegaly and the following pressures in mm saline: IVCP 112; FPP 342; HOPP 338; SOPP 348. Post-shunt pressures were: IVCP 168; FPP 176. A liver biopsy showed intense congestion and necrosis around the central veins and moderate fibrosis.

The postoperative course was complicated by transient jaundice and transient reaccumulation of ascites which responded to diuretic therapy. The patient was discharged from the hospital 22 days after the shunt procedure and by four months postoperatively had resumed normal activity and employment, at which time he had gained 36 pounds in lean body weight. During three years of follow-up he remained free of ascites without diuretic therapy, and periodic tests of liver function showed normal results. There has been no evidence of portal-systemic encephalopathy. A follow-up needle liver biopsy performed three years postoperatively showed moderate fibrosis, but no other abnormalities. Angiographic studies performed after three years failed to visualize the occluded hepatic veins but showed a widely patent protacaval shunt and IVC with pressures that measured 144 mm. saline in the IVC and 158 mm saline in the PV.

Case 5. This 19-year-old white male was admitted to another hospital with a two week history of progressive abdominal distention, diffuse upper abdominal pain, weakness, anorexia and recent fever of 101°F. He had been in excellent health prior to the onset of symptoms and past history was non-contributory. He was found to have ascites, hepatomegaly and mildly disturbed liver function. Scintiscans showed diffuse mottling of the liver and an enlarged spleen. Angiographic studies showed a normal IVC and PV, and stretching of the hepatic artery branches within the liver. A laparotomy was performed for open liver biopsy and showed massive ascites and an enlarged, congested liver. The liver biopsy demonstrated intense centrilobular congestion and necrosis compatible with the diagnosis of Budd-Chiari syndrome. A Foley catheter drain was left in the peritoneal cavity and subsequently drained large quantities of ascitic fluid. The patient was transferred to University Hospital three weeks after the onset of symptoms.

On admission to our institution the positive physical findings were evidence of moderate muscle wasting, hepatomegaly and a distended abdomen draining copious amounts of ascites. The patient appeared acutely ill. There was no jaundice or peripheral edema. Bacterial cultures of the ascitic fluid showed a heavy growth of S. aureus and Klebsiella indicating that the ascites had become infected, and appropriate therapy was instituted. The only abnormal results of extensive blood studies were: bromsulphalein retention 23% in 45 minutes, serum alkaline phosphatase 170 IU, and serum albumin 2.5 g/dl. Scintiscans showed enlargement of the liver and spleen and inhomogeneous uptake of radiocolloid in the liver. Barium contrast upper gastrointestinal x-rays were normal. A second set of angiographic studies showed a patent IVC with side-to-side compression of the intrahepatic segment by an enlarged liver, occlusion of the hepatic veins with formation of spider-like webs of vessels, stretching and attenuation of the intrahepatic branches of the hepatic artery, and a normal PV. IVCP was 126 mm saline. A diagnosis of Budd-Chiari syndrome with thrombosis of the hepatic veins of unknown etiology was made.

A side-to-side portacaval shunt was performed on the seventh day of hospitalization, four weeks after the onset of symptoms. The findings at operation were an enlarged, congested liver covered by stringy adhesions, splenomegaly, six l of ascites (cultures of which grew S. aureus), and the following pressures in mm saline: IVCP 120; FPP 265; HOPP 200; SOPP 305. After construction of the portacaval shunt pressures were: IVCP 175; FPP 165. A liver biopsy showed the microscopic lesions characteristic of Budd-Chiari syndrome, namely, marked centrilobular congestion and necrosis and a modest increase in fibrous tissue.

The postoperative course was complicated by transient reaccumulation of ascites which responded to diuretic therapy, a minor wound infection, low grade fever and leucocytosis which responded to antibiotic therapy. The patient was discharged three weeks postoperatively. However, he was readmitted to the hospital one month later because of persistent low grade fever and the demonstration of a large fluid collection in the pelvis by ultrasonography which

proved to be an abscess caused by S. aureus, the same organism that was identified in the infected ascitic fluid at the time of his initial admission. Drainage of the pelvic abscess resulted in prompt recovery. When last seen eight months postoperatively the patient was free of ascites, had gained 40 pounds in lean body weight, had a normal sized liver and spleen, had normal liver function and was working full-time. There has been no evidence of portal-systemic encephalopathy.

Case 6. This 28-year-old previously healthy white male was admitted to another hospital with a two month history of progressive increase in abdominal girth, diffuse abdominal pain, fatigue and anorexia. He was found to have massive ascites, marked hepatomegaly and mild jaundice. There was no peripheral edema. Laboratory studies showed erythrocytosis, an increased blood volume, a normal plasma volume and hyperplastic bone marrow compatible with the diagnosis of polycythemia rubra vera. Liver function tests showed a total serum bilirubin of 2.7 mg/dl, serum alkaline phosphatase of 140 IU and SGOT of 177 IU. A liver scintiscan showed diffusely mottled uptake of radiocolloid. Barium contrast upper gastrointestinal x-rays were normal. The patient was treated for three weeks with phlebotomy and diuretics, but his ascites progressed, his liver function deteriorated and he grew weaker. Angiographic studies were then performed and showed a normal inferior vena cava and portal vein, and thrombotic occlusion of all of the hepatic veins with reversal of flow into the portal vein. A diagnosis of Budd-Chiari syndrome was made and the patient was transferred to University Hospital three months after the onset of symptoms.

On admission to our institution the patient had mild jaundice, marked hepatomegaly, tense ascites and evidence of severe muscle wasting and loss of lean body mass. There was no peripheral edema. Extensive hematologic studies confirmed the suspicion of polycythemia rubra vera. The results of all liver function tests were abnormal and included: prothrombin time 16.5 seconds (control 11.9 seconds), partial thromboplastin time 41.5 seconds (control 37.9 seconds), serum bilirubin 3.9 mg/dl, bromsulphalein retention 90 per cent in 45 minutes, SGOT 540 IU and serum alkaline phosphatase 345 IU. Scintiscans showed hepatosplenomegaly and abnormal uptake of radiocolloid similar to that demonstrated previously.

The patient was treated with phlebotomy and diuretics as his diagnostic workup progressed. On the evening of the eighth day of hospitalization his condition deteriorated and he developed edema of the lower extremities and lower trunk. In addition, he developed an infiltrate in the left lower lung and a left pleural effusion which raised the consideration of pulmonary embolus. Angiographic studies were repeated the next day and demonstrated extension of the thrombotic process to involve the previously patent abdominal IVC and both iliac veins (Fig. 6). Pressures in the IVC were 20 mm saline at a level above the diaphragm and 300 mm. saline at the level of entrance of the renal veins. Following the angiographic studies, edema of the lower extremities and trunk progressed rapidly, oliguria developed and blood studies showed a urea nitrogen of 47 mg/dl and creatinine of 3.1 mg/dl.

An emergency side-to-side portacaval shunt and IVC thrombectomy was undertaken. The findings at operation were 15.9 l of ascites, a large congested liver, thrombosis of the entire abdominal inferior vena cava, and the following pressures in mm saline: IVCP 250; FPP 434; HOPP 486; SOPP 422. Following the portacaval shunt the pressures were: IVCP 284; FPP 284.

The patient died six days postoperatively with reaccumulation of ascites, hepatic failure, renal failure, respiratory failure and gastrointestinal bleeding. Autopsy findings included thrombosis of the hepatic veins and entire inferior vena cava, and an embolus in the left main pulmonary artery. Microscopic sections of the liver showed severe centrilobular congestion and loss of parenchyma.

Discussion

In many if not most patients with Budd-Chiari syndrome due to occlusion of the hepatic veins, the diagnosis has not been made until the autopsy was done or the patient was near death. Nevertheless, with available diagnostic techniques it should be possible in most cases to identify the condition early in its course. The clinical picture of ascites, hepatomegaly, abdominal pain and disturbed liver function, often occurring in a patient who is below the age of 50 years and previously has been in good health, should strongly suggest the diagnosis. Most acute hepatic diseases, particularly the common ones, do not produce ascites as an early manifestation. The most valuable diagnostic study is angiography of the IVC and hepatic veins with pressure measurements. Demonstration of a patent IVC (sometimes compressed in its intrahepatic course by the swollen liver), normal or only moderately elevated IVC pressure (due to massive ascites), and occlusion of the major hepatic veins often with a spider web pattern of small collateral vessels is diagnostic of Budd-Chiari syndrome, particularly in the presence of appropriate clinical manifestations.[13,28,49,58] All six patients described in this report had these clinical and angiographic findings. An elevated wedged hepatic vein pressure strengthens the diagnosis when this measurement can be obtained, although it is not an essential procedure.

Although the diagnosis can be made with assurance in the absence of a liver biopsy, microscopic examination of the liver is another diagnostic procedure of definitive value. The findings of intense centrilobular congestion and centrilobular necrosis or loss of parenchyma in the face of a normal or only moderately elevated IVC pressure indicates hepatic venous outflow obstruction. This typical picture was observed in the liver biopsies obtained from all six of our patients, including the three who underwent preoperative biopsies.

Hepatic scintigraphy has been reported to be of value as a screening procedure in patients with the Budd-Chiari syndrome.[36,58] In addition to decreased and inhomogeneous hepatic uptake of radiocolloid, the finding of central localization of radiocolloid due to uptake by an enlarged and unobstructed caudate lobe which is drained directly into the IVC by small hepatic veins, has been reported to be of diagnostic significance.[36,58] This phenomenon was observed in only two of our six patients, so that liver scanning was not of great value in our experience.

Treatment of the Budd-Chiari syndrome by side-to-side portacaval shunt, or other shunts that are hemodynamically equivalent, is based on sound experimental and clinical evidence. The side-to-side shunt decom-

presses the obstructed hepatic vascular bed by both diverting the inflow of splanchnic venous blood and allowing retrograde egress of hepatic blood through the portal vein into the low pressure vena cava. Many studies have conclusively demonstrated that side-to-side shunt converts the valveless portal vein into an outflow tract. Animal experiments have shown that in the presence of a side-to-side shunt or its equivalent it is possible to acutely occlude hepatic venous outflow.[12,14,15] Moreover, reversal of flow in the portal vein has been documented in both animals and humans with side-to-side portacaval shunts by direct flow measurements, dye and radioisotope studies, and angiography.[6,7,10,31,32,37–39,41,57,61] Furthermore, pressure measurements in cirrhotic patients with side-to-side portacaval shunts have consistently shown a marked reduction of hepatic sinusoidal pressure, often to the normal level.[50,61]

The results of our experimental studies in dogs with Budd-Chiari syndrome produced by ligation of the hepatic veins demonstrated clearly that side-to-side portacaval shunt was very effective in relieving ascites, hepatomegaly, hepatic congestion and portal hypertension. Only one of 24 animals, 18 of which were long-term survivors, reformed ascites after side-to-side anastomosis, and 67% of the dogs were alive and well when the study was concluded after one year. Moreover, liver biopsies showed that side-to-side shunt eliminated the congestion and necrosis that are characteristic of hepatic outflow occlusion, and in one-third of the dogs caused reversion of the morphologic picture to normal. In contrast, all control dogs that were subjected to sham laparotomy and all dogs that underwent end-to-side portacaval shunt reformed massive ascites and died within six months with continued hepatic congestion and necrosis, despite the fact that the end-to-side anastomosis reduced the splanchnic portal pressure to normal. In clinical studies in cirrhotic patients, end-to-side portacaval shunt has not been as effective as side-to-side shunt in reducing sinusoidal hypertension, and high sinusoidal pressures have persisted in some patients.[22,29,59]

Successful treatments of the Budd-Chiari syndrome due to occlusion of the hepatic veins by side-by-side portacaval shunt, splenorenal shunt or mesocaval H-graft has been accomplished in at least nine patients reported by eight authors.[4,5,18–20,30,35,40,48,54] Interestingly, all of the patients were relatively young women ranging in age from 18 to 43 years. The underlying condition was polycythemia vera in three, leukemia in one, ingestion of oral contraceptives in one and unknown in four. Long-term follow-up results from three to eight years postoperatively have been reported in five of these patients. All of them have remained free of ascites. Blakemore's patient, the first reported,[4] died of leukemia eight years after operation.[5] The patient described by Eisenmenger and Nickel[18] died of a cerebral hemorrhage three years postoperatively.[5] The patient reported by Erlik and associates[19] died of a brain abscess after five years of normal life.[54] The patient of McAllister and Barker,[35] reported by Britton et al.,[5] was alive five years postoperatively, and the patient of Langer and his colleagues[30] was living and well four years after portacaval shunt. None of the deaths were related to liver disease. In only one of these patients, that of Erlik et al., was the liver examined microscopically after several years had elapsed, and the findings consisted of continued sinusoidal congestion but no fibrosis.[54] Little is known about the long-term effects on hepatic morphology of hepatic vein occlusion that has been treated by side-to-side portacaval shunt.

In at least 11 patients with Budd-Chiari syndrome reported by nine authors,[3,5,17,19,21,26,30,33,34,54] treatment by side-to-side portacaval shunt or splenorenal shunt failed and the patient died. In seven of these patients, the shunts were a technical failure and developed thrombosis or did not adequately decompress the portal system because of small size.[3,17,19,21,26,34] In one patient, the shunt was performed in the face of thrombosis of the IVC, an inappropriate undertaking.[33] Three patients were operated upon while in coma, shock or renal failure.[30,54] From the case descriptions it appears that for one reason or another all 11 of these failures were characterized by an unsatisfactory operation and/or an unsuitable patient.

The results of side-to-side portacaval shunt in our small series of six patients with Budd-Chiari syndrome due to hepatic vein thrombosis, confirmed our experimental observations regarding the efficacy of this procedure in relieving hepatic venous outflow obstruction. All five patients in whom thrombosis was confined to the hepatic veins survived the operation and remained free of ascites without requiring diuretic therapy during follow-up periods of from eight months to seven years. Hepatosplenomegaly disappeared and liver function returned rapidly to normal and has remained so. The shunt operation was followed by a rapid gain of lean body weight and return of vigor. In contrast to the 26% incidence of portal-systemic encephalopathy in our large series of alcoholic cirrhotics with portacaval shunts,[44] none of the patients have developed encephalopathy or required dietary protein restriction. Angiographic studies performed from three to six years after operation in four patients showed a patent IVC, a widely patent portacaval anastomosis, and persistent occlusion of the hepatic veins with no evidence of recanalization. The results of liver biopsies obtained from three to six years postoperatively in four patients were

particularly encouraging. They showed mild to moderate fibrosis, but no congestion or necrosis. Long-term evaluation of hepatic morphology will be of particular importance in this relatively young group of patients.

One patient in our series died, and this case deserves comment. When this 28-year-old man with polycythemia vera was admitted to our hospital there was clear clinical and angiographic evidence that the occlusive process was confined to the hepatic veins. However, during the eight-day course of his diagnostic work-up the thrombosis extended into the IVC and his condition deteriorated dramatically. Not surprisingly, an emergency attempt at vena cava thrombectomy and portacaval shunt failed. There are several potentially valuable lessons to be learned from this experience. Firstly, extension of the thrombotic process from the hepatic veins into the IVC is a well known event in the Budd-Chiari syndrome[46] and the potential for this devastating complication exists in every patient. Whether or not a portacaval shunt will prevent such extension remains to be determined by further experience, but it seems plausible to suggest that the increased blood flow in the IVC and the relief of stasis in the liver resulting from the shunt will have an antithrombosis effect. Secondly, it is important to emphasize that obstruction or occlusion of the IVC, manifested clinically by edema of the lower extremities and lower trunk and demonstrable by angiography and IVC pressure measurements, is a contraindication to portacaval shunt. Thirdly, once the diagnosis of hepatic vein occlusion has been made, it would seem unwise to delay operation. Although an occasional patient has recovered spontaneously, the overwhelming majority have not. The literature contains numerous descriptions of patients who would have been suitable candidates for portacaval shunt, but were treated nonoperatively and died. A case described by Schramek and his associates[54] is one of many that illustrate this point. A clear-cut diagnosis of Budd-Chiari syndrome due to hepatic vein occlusion was made in a 41-year-old woman. A decision was made to treat the patient nonoperatively and the report indicates that one year later the patient was doing well. However, an addendum to the report indicates that two years after the diagnosis was made, the patient was admitted to the hospital in coma with massive upper gastrointestinal bleeding (from esophageal varices) and died shortly after an attempt was made at emergency portacaval shunt.

Mention should be made of some unique forms of the Budd-Chiari syndrome, if only to emphasize that they are not suitable for treatment by side-to-side portacaval shunt and, therefore, must be ruled out by the diagnostic work-up. Membranous obstruction of the IVC just below the diaphragm has been reported sporadically from various countries around the world, including the United States, but almost all of the more than 100 cases have been reported from Japan.[16,24,27,51,63] This condition usually runs a course of many years, and a congenital etiology has been proposed. We have not encountered a case of IVC membrane or web in our 25 years of experience with a sizeable population of ascitic patients. The disorder has been treated successfully by transcardiac membranotomy, direct excision of the membrane, or bypass grafting. Some authors have included the veno-occlusive disease caused by ingestion of pyrrolizidine alkaloids,[8,55] and the peculiar veno-occlusive disease observed in children in the Near East.[1,23,53] However, the occlusive process in these chronic disorders is located mainly or entirely in the small hepatic venules within the liver so that their membership in the Budd-Chiari syndrome is questionable.

Since the time when the Budd-Chiari syndrome due to occlusion of the hepatic veins was first well described some eight decades ago, the record of treatment of this condition has been dismal and the mortality rate has been very high. The results of our experimental studies combined with our small but consistent clinical experience indicate that side-to-side portacaval shunt provides definitive treatment of hepatic vein occlusion and offers the possibility of long-term survival. Early diagnosis and prompt operation appear to be important ingredients of the therapeutic regimen.

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Discussion

Dr. Arthur B. Voorhees, Jr. (New York, New York): There seems to be, in our clinical experience, at least, in New York, two basic forms. There is what one would describe as an acute form, which is fulminating, it's rarely diagnosed anteoperatively, and most often the diagnosis is made at the post-mortem examination. It is characterized by a relatively fresh clot involving most of the hepatic outflow tract.

In the perhaps six instances that we have faced in this category, we have been able to achieve a side-to-side shunt only in one, and that was unsuccessfull in so far as patient survival is concerned.

Although at this point I draw from memory of some 2000 patients that have presented in our institution with evidence of portal hypertension, the anteoperative and the intraoperative diagnosis has been made only in three instances, where we consider this to be of a more chronic nature, as we have just heard described by Dr. Orloff.

In the three instances that I speak of, a side-to-side shunt was first achieved by Arthur Blakemore in 1948, and has been subsequently repeated on two occasions, bringing our experience to a total of three. Two of these have survived.

In brief, I agree with Dr. Orloff that when the hepatic outflow tract has been obstructed, a side-to-side portacaval shunt can be a life saving and a precisely designed therapeutic procedure.

Finally, I'd like to offer a brief word of caution, which Dr. Orloff has already described in part, but I would like to expand upon it very briefly. That is a so-called functional Budd-Chiari syndrome, originally described by Professor Fraga, of the University of Brazil. It is produced primarily by a retrohepatic vena caval narrowing, and as in Dr. Orloff's instance, where the vena cava was obstructed by clot, a side-to-side shunt in this particular instance of vena caval narrowing, due primarily to cirrhosis, of course, is ineffective.

I think it should be emphasized that Dr. Orloff has drawn our attention to a very rare problem—in our experience, approximately 0.5% in our overall group of hypertensives.

I'd like to just close my remarks by stating that I'd like to have Dr. Orloff present, perhaps, in the next few years some detailed studies of the survivors.

Dr. William V. McDermott, Jr. (Boston, Massachusetts): This excellent paper is an example of Marshall Orloff's presenting to us another of his continuing excellent clinical and experimental studies on the pathogenesis and treatment of ascites, this time based on a series of six cases of the so-called Budd-Chiari syndrome, an unusual cause of postsinusoidal block.

Basically, the pathophysiology involved in the formation of this type of ascites is similar, regardless of whether the outflow block is located in the suprahepatic or retrohepatic vena cava, the major hepatic veins, the intrahepatic small venules, (as in "bush tea" or Senechio poisoning), or is due to the changes secondary to cirrhosis, all of which involve obstruction to outflow from the central veins of the hepatic lobule.

Obviously, the first of these, an occluding diaphragm, in the suprahepatic vena cava, presents a separate problem. It's more common in the Orient than in this country. It can be, treated appropriately by transatrial fracture.

The other three causes, if nearly complete and unmanageable by medical therapy, do require the re-establishment of an outflow tract. This may occur spontaneously, but slowly, through the development of reversal of flow in the portal vein, (as in the case of the Cruveilhier-Baumgarten syndrome) or more rapidly and effectively by surgical construction of any one of the shunts which do provide combined hepatic and portal decompression. That means side-to-side, double, portacaval, interposition mesocaval shunts, etc. It's very effective in reversing the multiple metabolic and nutritional disorders.

In the era before the medical management of cirrhotic ascites was very effective, a number of reports from our unit, from Welch, Longmire and others, were concerned with this problem. As one example, I'd like to show you three slides.

(Slide) This was one of the types (a double portacal shunt) of combined decompression which provides a reversal of flow from the congested intrahepatic circulation.

(Slide) This is one of the patients who, despite—or perhaps you could say, because of four months on the medical wards—was in this terrible state of marasmus, with completely intractable ascites.

(Slide) Four months after a combined decompression, she not only lost her ascites, but most impressively, had regained an excellent state of nutrition.

In terms of long-term follow-up, this young woman eventually drank herself to death about nine years postoperatively, but never during that period of time, despite repeated bouts of so-called alcoholic hepatitis and jaundice, did she ever re-establish ascites, nor did she develop encephalopathy.

(Slide) Metabolically, the reversal occurs very rapidly, as you can see in this slide on the balance studies, particularly in terms of sodium metabolism. Characteristically, 0–3 or 5 mM/l is the level of urinary loss with an increased excretion of potassium; but within a very few days of operation, you can see the remarkable reversal in the pattern of electrolyte balance, with the re-establishment of a normal sodium/potassium ratio on a completely unrestricted salt intake.

So, decompression works very rapidly in correcting this abnormality.

Now, this particular sequence was concerned with the severe degree of postsinusoidal block one may encounter with cirrhosis—but we have seen the same syndrome with "bush tea" Senechio poisoning, a peculiar process of obliteration of the smaller hepatic venules, by Professor Brass, of the University of the West Indies, to the ingestion of toxic alkaloids in herbal teas brewed by the natives in the Jamaican highlands.

This particular case also reverted to normal after a similar type of combined decompression.

The cases of occlusion of the major hepatic veins, as described by Dr. Orloff, may well require surgical construction of an outflow tract via the portal vein. I do want to point out that these may recover spontaneously, as we have seen in two instances—young women in whom the Budd-Chiari syndrome was apparently related to the ingestion of oral contraceptives; both of them, on conservative management, appeared to re-establish an adequate collateral outflow, so the syndrome slowly reversed without the necessity of a shunt.

I would agree, however, that this does not occur regularly or predictably, and therefore it is well to keep in mind the principles which Dr. Orloff has expressed today.

There is one particular facet of this problem that I think is of particular interest, which is the absence of encephalopathy in this series, and in our own experience. With this particular syndrome