1566

The Incidence of Portal Vein Thrombosis at Liver Transplantation

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The incidence of portal vein thrombosis was examined in 885 patients who received orthotopic liver transplantations for various end-stage liver diseases between 1989 and 1990. The thrombosis was classified into four grades. Grade 1 was thrombosis of intrahepatic portal vein branches, grade 2 was thrombosis of the right or left portal branch or at the bifurcation, grade 3 was partial obstruction of the portal vein trunk, and grade 4 was complete obstruction of the portal vein trunk. Among the 849 patients without previous portosystemic shunt, 14 patients (1.6%) had grade 1, 27 patients (3.2%) had grade 2, 27 patients (3.2%) had grade 3 and 49 patients (5.8%) had grade 4 portal vein thrombosis. The incidence of portal vein thrombosis was highest (34.8%) in the patients with hepatic malignancy in the cirrhotic liver, followed by those with Budd-Chiari syndrome (22.2%) and postnecrotic cirrhosis of various causes (15.7%). The patients with encephalopathy, ascites, variceal bleeding, previous splenectomy and small liver had significantly higher incidences of portal vein thrombosis than the others. The total incidence of portal vein thrombosis among the 36 patients with previous portosystemic shunt was 38.9%, which was significantly higher than that (13.8%) of those without shunt. (HEPATOLOGY 1992;16;1195-1198.)

Thrombosis of the portal vein has been a formidable challenge to orthotopic liver transplantation (1-5). The incidence of portal vein thrombosis was examined in the orthotopic liver transplant recipients with various end-stage liver diseases, and its relationship to several clinical features was studied.

PATIENTS AND METHODS

During the 2-yr period between January 1, 1989, and December 31, 1990, 885 patients (522 males and 363 females) received the first orthotopic liver transplantation at the University Health Center of Pittsburgh. Their medical records were carefully reviewed. The ages ranged from 1 mo to 74 yr (mean ± S.D. = 41.2 ± 18.8 yr).

The liver diseases of the patients are listed in Table 1. Portal vein thrombosis was determined by operative findings and pathological examinations of the excised livers at the time of liver transplantation. It was classified into the following four grades: (a) grade 1 = a partial (greater than 50% in diameter) or total thromboembolic and/or sclerotic obliteration of the intrahepatic (segmental) portal vein branches; (b) grade 2 = a partial (greater than 50% in diameter) or total thromboembolic and/or sclerotic obliteration of the right or left portal vein branch or near the bifurcation of the portal vein trunk in which a standard end-to-end portal vein anastomosis was feasible; (c) grade 3 = a partial (greater than 50% in diameter) thromboembolic and/or sclerotic obliteration of the portal vein trunk in which an end-to-end portal vein anastomosis with or without a vein graft was feasible at the junction of the splenic and the superior mesenteric veins of the recipient; and (d) grade 4 = a complete or near complete (more than 90%) obliteration of the portal vein trunk in which an end-to-side portal-superior mesenteric vein anastomosis with a vein graft (a jump graft) or an end-to-end anastomosis at the junction of the splenic and superior mesenteric veins after thromboembolectomy of the veins was created with a vein graft (an interpositional graft).

The incidence of portal vein thrombosis in various liver diseases and its relationship to liver weight and the history of ascites, encephalopathy, spontaneous bacterial peritonitis, gastrointestinal bleeding, endoscopic sclerotherapy for esophageal varices, splenectomy and portosystemic venous shunt were examined. Statistical comparisons between the groups were made using the χ^2 test and Student t test. The difference was considered significant when the p value was less than 0.05.

RESULTS

Incidence of Portal Vein Thrombosis in the Patients Without Portosystemic Shunt. A total of 849 patients had not had the portosystemic shunt before transplantation. A total of 117 (13.8%) of the 849 patients had some degree of portal vein thrombosis. A total of 49 patients (5.8%) had complete obstruction (grade 4), and 27 patients (3.2%) had partial obstruction (grade 3) of the portal vein trunk. Thus a total of 76 patients (9.0%) had surgically significant portal vein thrombosis for orthotopic liver transplantation. The remaining 41 patients (4.8%) had portal vein thrombosis peripheral to the portal vein trunk (grade 1 and grade 2) (Table 1).

High incidences of portal vein thrombosis were observed in the patients with primary hepatic malignancy

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TABLE 1. The incidence of portal vein thrombosis in various liver diseases without previous portosystemic shunt

Diagnosis	No. of patients	No. (%) of patients with portal vein thrombosis				
		Grade 1	Grade 2	Grade 3	Grade 4	Total
Postnecrotic cirrhosis	401	8 (2.0%)	15 (3.7%)	16 (4.0%)	24 (6.0%)	63 (15.7%)[a]
Alcoholic	149	6 (4.0%)	3 (2.0%)	7 (4.7%)	11 (7.4%)	27 (18.1%)
Non-A, non-B	141	1 (0.7%)	5 (3.5%)	7 (5.0%)	8 (5.7%)	21 (14.9%)
HBsAg positive	55	1 (1.8%)	5 (9.1%)	1 (1.8%)	2 (3.6%)	9 (16.4%)
Autoimmune	21	0	1 (4.8%)	0	2 (9.5%)	3 (14.3%)
Toxic (drug induced)	4	0	0	0	0	0
Cryptogenic	21	0	1 (4.8%)	1 (4.8%)	1 (4.8%)	3 (14.3%)
Others	10	0	0	0	0	0
PBC	63	1 (1.5%)	3 (4.8%)	0	1 (1.6%)	5 (7.9%)
Primary sclerosing cholangitis	56	0	0	1 (1.8%)	1 (1.8%)	2 (3.6%)
Inborn errors of metabolism (α_1-antitrypsin deficiency, Wilson's)	40	0	0	0	2 (5.0%)	2 (5.0%)
Biliary atresia	84	0	1 (1.2%)	2 (2.4%)	1 (1.2%)	4 (4.8%)
Secondary biliary cirrhosis	32	1 (3.1%)	1 (3.1%)	0	3 (9.4%)	4 (12.5%)
Budd-Chiari syndrome	9	0	0	0	2 (22.2%)	2 (22.2%)
Hepatic malignancy with cirrhosis	87	4 (4.6%)	7 (8.0%)	8 (9.2%)	11 (12.6%)	30 (34.8%)
Hepatic malignancy without cirrhosis	47	0	0	0	4 (8.5%)	4 (8.5%)
Acute hepatic necrosis	25	0	0	0	0	0
Others	5	0	0	0	0	0
TOTAL	849	14 (1.6%)	27 (3.2%)	27 (3.2%)	49 (5.8%)	117 (13.8%)

Grade 1 = thrombosis of intrahepatic portal vein branches; grade 2 = thrombosis of the first branches of portal vein or at the bifurcation; grade 3 = partial obstruction of the portal vein trunk; and grade 4 = complete obstruction of the portal vein trunk.

[a] $p < 0.05$ vs. primary sclerosing cholangitis and $p < 0.01$ vs. biliary atresia.

TABLE 2. Portal vein thrombosis in 36 patients with portosystemic shunt

Type of portosystemic shunt	No. of patients	No. of patients with portal vein thrombosis					
		Grade 1	Grade 2	Grade 3	Grade 4	Total	Incidence
PC shunt	13	N.A.	N.A.	N.A.	4	4	N.A.
Patent	9	N.A.	N.A.	N.A.	0	0	N.A.
Occluded	4	N.A.	N.A.	N.A.	4	4	N.A.
MC shunt	7	0	0	2	0	2	28.6%
Patent	5	0	0	2	0	2	40.0%
Occluded	2	0	0	0	0	0	0%
PSR shunt	6	0	1	1	3	5	83.3%
Patent	2	0	0	1	0	1	50.0%
Occluded	4	0	1	0	3	4	100.0%
DSR shunt	10	0	0	0	3	3	30.0%
Patent	9	0	0	0	3	3	33.3%
Occluded	1	0	0	0	0	0	0%
TOTAL	36	0	1	3	9	14	38.9%

PC = portacaval; MC = mesocaval; PSR = proximal splenorenal; DSR = distal splenorenal; and N.A. = not assessed.

in the cirrhotic liver (34.8%), those with Budd-Chiari syndrome (22.2%) and those with postnecrotic cirrhosis (15.7%). Portal vein thrombosis in patients with PBC (7.9%), sclerosing cholangitis (3.6%), liver-based inborn errors of metabolism (5.0%) and biliary atresia (4.8%) were significantly less frequent than in those patients with postnecrotic cirrhosis ($p < 0.05$). The incidences of portal thrombosis were similar (14.3% to 18.1%) among various types of postnecrotic cirrhosis (Table 1).

The portal vein thrombosis was actually caused by tumor emboli in 25 (83%) of the 30 cirrhotic patients with hepatic malignancy and in all of the four noncirrhotic patients with hepatic malignancy.

Incidence of Portal Vein Thrombosis in Patients with Portosystemic Venous Shunt. A total of 36 patients had the portosystemic venous shunt before transplantation. Twenty patients had postnecrotic cirrhosis, five had PBC, four had primary hepatic malignancy with associated cirrhosis and seven had other liver diseases. Because of the small number of cases, the incidences of portal vein thrombosis were examined on the basis of types of the shunt rather than types of liver diseases.

Thirteen patients had portacaval shunts, 7 had mesocaval shunts, 6 had proximal splenorenal shunts and 10 had distal splenorenal shunts. Eleven of the 36

TABLE 3. Comparisons of liver weights (gm/kg) among four major liver diseases with or without portal vein thrombosis

Diagnosis	Liver weight (gm/kg, mean ± S.D.)						Incidence of portal vein thrombosis (%)
	Total no. of patients		Patients with portal vein thrombosis		Patients without portal vein thrombosis		
Postnecrotic cirrhosis	20.6 ± 12.5[a]	(n = 401)	17.2 ± 6.5[b]	(n = 63)	21.1 ± 13.3	(n = 338)	15.7[c]
PBC	28.4 ± 12.1	(n = 63)	23.5 ± 5.0	(n = 5)	28.8 ± 12.5	(n = 58)	7.9
Primary sclerosing cholangitis	27.9 ± 8.5	(n = 56)	21.3 ± 0.6	(n = 2)	28.1 ± 8.7	(n = 54)	3.6
Biliary atresia	50.5 ± 20.5[d]	(n = 84)	47.4 ± 18.4	(n = 4)	50.7 ± 20.5	(n = 80)	4.8

[a] $p < 0.0001$ vs. PBC, primary sclerosing cholangitis, biliary atresia.
[b] $p < 0.02$ vs. patients without portal vein thrombosis.
[c] $p < 0.02$ vs. primary sclerosing cholangitis and $p < 0.01$ vs. biliary atresia.
[d] $p < 0.0001$ vs. postnecrotic cirrhosis, PBC, primary sclerosing cholangitis.

shunts were occluded (4 portacaval, 2 mesocaval, 4 proximal splenorenal and 1 distal splenorenal).

The incidences and the grades of portal vein thrombosis were stratified by the type of shunt as shown in Table 2. Ten (27.8%) of the 36 patients had complete obstruction (grade 4), and 3 patients (8.3%) had partial obstruction (grade 3) of the portal vein.

Liver Weight and Portal Vein Thrombosis. The relationship between the liver weight and the portal vein thrombosis was examined among the patients with four of the most common liver diseases (postnecrotic cirrhosis, PBC, sclerosing cholangitis and biliary atresia) who had not had the portosystemic shunt (Table 3). The liver weights of patients with postnecrotic cirrhosis were significantly ($p < 0.0001$) lighter than those with PBC, sclerosing cholangitis and biliary atresia, and the incidence of portal vein thrombosis of the former was significantly ($p < 0.02$) higher than those of the latter. In the postnecrotic cirrhosis, the liver weights of patients with portal vein thrombosis were significantly ($p < 0.02$) lighter than those without thrombosis.

Clinical Features and Portal Vein Thrombosis. The relationship between the portal vein thrombosis and the clinical features (encephalopathy, ascites, spontaneous bacterial peritonitis, gastrointestinal bleeding, endoscopic sclerotherapy for esophageal varices and splenectomy) was examined in the patients without portosystemic shunt (Table 4). The patients with chronic encephalopathy, refractory ascites, gastrointestinal bleeding or splenectomy had a significantly higher incidence of portal vein thrombosis than those without them. The endoscopic sclerotherapy and the spontaneous bacterial peritonitis could not be statistically related to the portal vein thrombosis.

TABLE 4. Incidence of portal vein thrombosis in various clinical conditions

Condition	No. of patients	No. of thrombosis (%)	p Value
Encephalopathy			
Present	295	47 (15.9%)	< 0.02
Absent	554	70 (12.6%)	
Ascites			
Present	538	82 (15.2%)	< 0.005
Absent	311	35 (11.3%)	
Spontaneous bacterial peritonitis			
Present	77	16 (20.8%)	NS
Absent	772	101 (13.1%)	
Gastrointestinal bleeding			
Present	315	57 (18.1%)	< 0.001
Absent	534	60 (11.2%)	
Sclerotherapy in gastrointestinal bleeders			
Present	181	36 (19.9%)	NS
Absent	134	21 (15.6%)	
Previous splenectomy			
Present	23	7 (30.4%)	< 0.01
Absent	826	110 (13.3%)	

Patients with previous portosystemic shunt were excluded from the analysis.

DISCUSSION

The incidences of portal vein thrombosis in the literature range from 0.6% to 21%, as shown in Table 5 (6-13; Monarca, et al. Gastroenterology 1986;90:509, Correspondence). The reasons for this wide variation are mainly because of the differences in the methods of diagnosis, the liver diseases and the stages of cirrhosis. The lowest incidence of portal vein thrombosis in cirrhosis was 0.6% by Okuda et al. (12), in which the diagnosis was made by portography. In their report the incidence of portal vein thrombosis among the patients with Child C cirrhosis was 1.3% and that of patients after splenectomy was 22.2%. The highest incidence of 21% was reported by Sarfeh (11). In this report all of the 86 patients had had bleedings from esophageal varices and underwent portal decompression surgery after portography. The degree of portal vein thrombosis reported in the literature (6-13; Monarca, et al. Gastroenterology 1986;90:509, Correspondence) appears to be mostly complete (grade 4) or partial (grade 3) obstruction. Including mural thrombosis, Chang and McFadzean (14) reported the incidence of 64.1% (41 of 64) at autopsy.

Complete obstruction of the portal vein was once considered as a contraindication for orthotopic liver transplantation (1). Recent technical advances (2-5) have made orthotopic liver transplantation possible even for the patient with complete portal vein thrombosis. In fact, those patients have not been excluded from orthotopic liver transplantation for the last several years

TABLE 5. Incidence of portal vein thrombosis in patients with cirrhosis

Author (year of report)	Method of confirmation	No. of patients	Incidence (%)
Hunt and Wittard (Reference 6) (1954)	Unknown	111	11.0
Dye, David and Julian (Reference 7) (1960)	Operation	104	10.6
Coomaraswamy et al. (Reference 8) (1964)	Operation or autopsy	63	11.1
Ranganathan and Burch (Reference 9) (1969)	Autopsy	58	13.8
Sicot et al. (Reference 10) (1971)	Operation	250	5.2
Sarfeh (Reference 11) (1979)	Angiography, splenoportography or operation	86	21.0
Okuda et al. (Reference 12) (1985)	Angiography or percutaneous transhepatic portography	708	0.6
Belli et al. (Reference 13) (1986)	Angiography or operation	512	16.6
Monarca (Gastroenterology 1986;90:509; Correspondence) (1986)	Autopsy	483	6.0
Current study (1991)	Operation and pathological examination	849[a]	13.8 (9.0)

Number in parentheses indicates incidence of grade 3 and grade 4 portal vein thrombosis.
[a]Patients with previous portosystemic shunt were excluded.

if one of the major tributaries of the portal system has been suitable for venous allografting to supply the portal blood to the transplant liver. Thus the incidence of portal vein thrombosis reported in this study closely represents its actual incidence among the patients with end-stage liver disease who require liver replacement. We also note the high incidence (27.8%) of complete portal vein thrombosis among the patients with previous portosystemic shunt and the high incidence (85.3%) of tumor embolus as a cause of portal vein obstruction among the patients with hepatic malignancy.

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