Cleveland Clinic Quarterly

Volume 32 OCTOBER 1965 No. 4

PORTAL-SYSTEMIC SHUNTS IN THE TREATMENT OF PORTAL HYPERTENSION

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PORTAL-SYSTEMIC shunts are now recognized by most physicians as the most effective means of relieving portal hypertension complicated by bleeding esophageal varices or by medically resistant ascites. The term 'portal-systemic shunt' includes all types of surgical venovenous anastomoses that divert portal venous blood into the systemic circulation; it thus includes portacaval, splenorenal, and mesenteric-caval shunts.

The two major deterrents to the surgical relief of portal hypertension by shunt procedures are the mortality rate of the operation and early postoperative period, and the morbidity that may occur in survivors. In an effort to identify the major factors that contribute to mortality and to morbidity, an analysis was made of the clinical course of patients with portal hypertension who underwent portal-systemic shunt procedures at the Cleveland Clinic Hospital in the period from 1947 through 1964. This report presents the results of the analysis.

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Clinical Material

During the 17 years from 1947 through 1964, 76 portal-systemic shunt procedures were performed on 74 patients at the Cleveland Clinic Hospital. There were 44 males and 30 females, a ratio of 1.5 to 1. The ages ranged from 6 months to 73 years; the largest group of patients were in the fourth decade.

Four types of portal-systemic shunts were employed in this series of patients: (1) end-to-side portacaval, (2) side-to-side portacaval, (3) splenorenal, and (4) superior mesenteric vein to inferior vena cava (*Fig. 1*). We have believed and con-

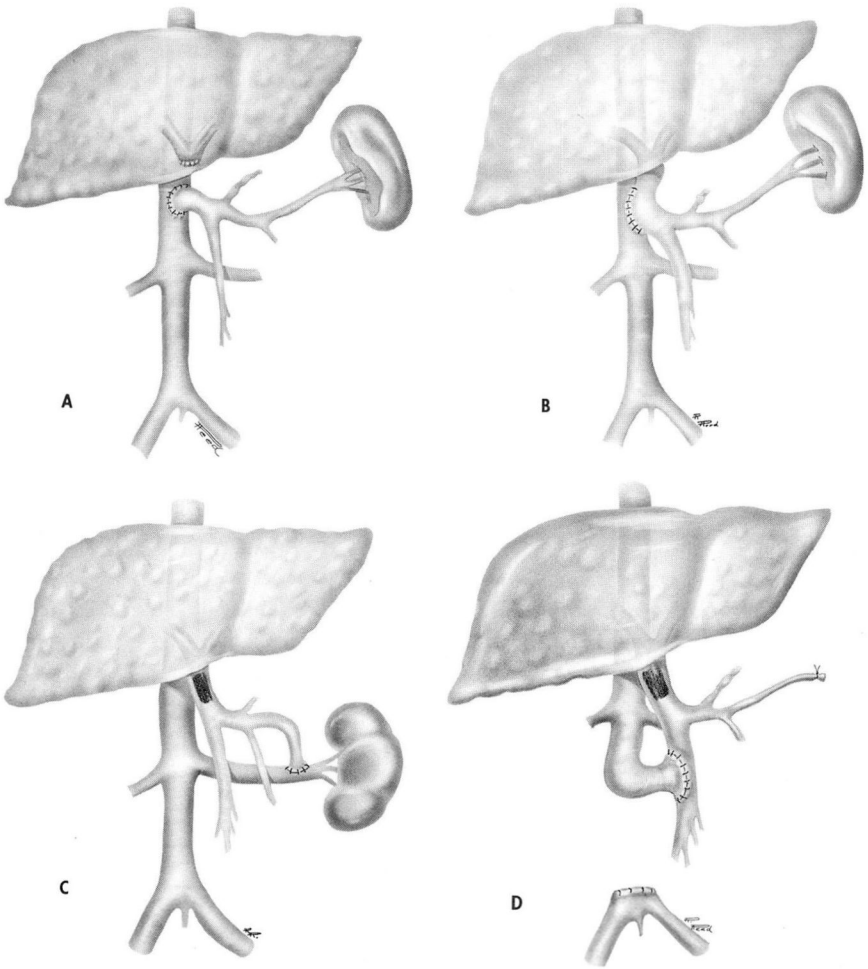

Fig. 1. Sketches of the four types of portal-systemic shunts performed on this series of patients: A, end-to-side portacaval; B, side-to-side portacaval; C, splenorenal; and D, mesenteric-caval shunt.

tinue to believe that the portacaval shunt is superior to other types of shunts in decreasing portal hypertension; portal pressures consistently fall to a normal range and the incidence of shunt thrombosis is slight. The splenorenal and the mesenteric-caval shunts were utilized, therefore, only when the portal vein was not adequate for a portacaval anastomosis.

The primary indication for operation in more than two thirds of the cases was gastrointestinal hemorrhage from varices (*Table 1*). Ascites was the indication in 11

Table 1.—*Types of shunt and indications for surgery*

	Portacaval				
	End-to-side	Side-to-side	Splenorenal	Mesenteric-caval	Total
Indication	Number of procedures				
Bleeding	40	12	4	3	59
Ascites	4	7	—	—	11
Prophylaxis	5	—	1	—	6
Total	49	19	5	3	76

cases. Most of the shunts performed for intractable ascites, however, were done early in the series; only one has been performed since 1960. With greater understanding of the pathophysiology of liver function and the need for rigid salt restriction, and with the effective diuretic and aldosterone-inhibiting agents now available, it is our belief that ascites is now rarely an indication for a portal-systemic shunt.

In six of the cases the shunts were performed as a prophylactic measure. These patients had a histologic diagnosis of cirrhosis and demonstrable esophageal varices, but did not have a history of upper gastrointestinal bleeding or ascites. The value of performing a portal-systemic shunt for prophylaxis is still open to question. In this regard, two recent controlled studies of this problem[1,2] have indicated that patients on whom portal-systemic shunts are performed for prophylactic reasons alone, do not have a survival rate demonstrably higher than that of patients treated medically.

Operative Mortality

The careful evaluation of operative mortality is especially important in regard to portal-systemic shunts, since these procedures may be technically difficult, require exposure to anesthesia for periods of time up to four hours, and involve major changes in hepatic blood flow in patients with limited hepatic reserve. An operative death in this study is defined as the death of any patient during or after the operation before discharge from the hospital or in the initial 30 days after operation. Twenty patients did not survive this operative period, an overall operative mortality rate of 26 percent. With few exceptions, the majority of these patients

survived the operative procedure but died during the second to fourth week postoperatively.

The most common cause of death in the operative period was progressive hepatic failure (*Table 2*). In four of the 10 patients who died of hepatic failure, renal failure

Table 2.—*Causes of death of the 20 patients who died during the operative period*

Cause	Number of patients	
Hepatic failure		10
Hepatic failure alone	6	
Hepatorenal failure	4	
Coagulation dyscrasia		4
Gastrointestinal bleeding		3
Perforated duodenal ulcer		1
Pulmonary embolus		1
Cardiac failure		1
Total		20

also occurred to complicate the problem further. Postoperative bleeding accounted for seven deaths: in four of these patients a coagulation dyscrasia developed, secondary to hepatic malfunction and to massive blood transfusion; three patients died from persistent gastrointestinal bleeding. Three patients died of other problems.

Sixty-two shunts were performed as elective procedures. In this group of patients ten of the operative deaths occurred. In 14 patients, however, the shunt was performed on an urgent basis. These patients were operated upon during an episode of bleeding; all attempts to stop the bleeding by means of a Sengstaken-Blakemore tube had failed or the bleeding had recurred after an initial period of control. Of these 14 patients, 10 patients died. The operative mortality for an elective shunt was thus 16 percent, while that for one performed on an urgent basis was 71 percent (*Fig. 2*). This difference in mortality is striking and emphasizes the rapid deterioration in hepatic function which occurs in the cirrhotic patient during an episode of massive gastrointestinal hemorrhage.

Preoperatively, each patient was categorized as a good or poor operative risk, according to the clinical and laboratory assessment of his liver function. The criteria used were a modification of those of Wantz and Payne[3] (*Table 3*). A good-risk patient was defined as one with adequate nutrition, having had no recent coma, with minimal ascites, a serum albumin value of more than 3 gm. per 100 ml., a total serum bilirubin level of less than 2 mg. per 100 ml., a prothrombin time of more than 40 percent of normal, and a sulfobromophthalein retention of less than 25 percent at 45 minutes. On the basis of these criteria alone, 53 patients were classified as good risks, their operative mortality was 17 percent (*Fig. 2*). Among the 23

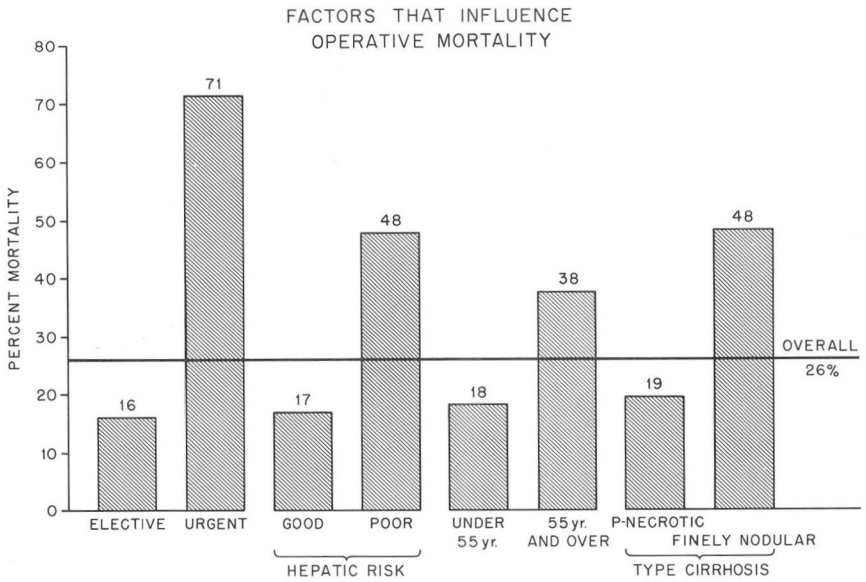

Fig. 2. Graph comparing the four major factors affecting operative mortality. The ordinate represents operative mortality in percent. The factors involved are listed on the abscissa.

Table 3.—*Classification of operative risk on the basis of hepatic function*

Factor	Good	Poor
Serum albumin, gm. per 100 ml.	> 3.0	< 3.0
Serum bilirubin (total), mg. per 100 ml.	< 2.0	> 2.0
Sulfobromophthalein retention, % in 45 min.	<25	>25
Prothrombin time, % of normal	>40	<40
Ascites	Minimal	Moderate
Neurologic examination	Normal	Abnormal
Nutrition	Adequate	Poor

patients classed as poor risks, the mortality for the operative period was 48 percent. This difference represents almost a threefold increase in mortality associated with these criteria of hepatic function.

The effect of the age of patients on operative mortality was also evaluated. Forty-four shunts were performed in patients less than 55 years of age, eight of whom died, an operative mortality of 18 percent (*Fig. 2*). Conversely, 32 shunts in patients of 55 years of age or older were undertaken, with 12 deaths, an operative mortality of 38 percent. The operative mortality appeared to increase steadily with increasing age.

The importance of the type of pathologic change in the liver and its effect on the prognosis after portal-systemic shunt has not been clearly defined. One of the main reasons is that a specific classification of the pathologic changes of cirrhosis of the liver, upon which all pathologists can agree, has not been formulated. One of us (L.J.M.) reviewed all liver biopsy specimens on each of the patients in this study. The microscopic changes in the liver were classified into four categories: (1) periportal fibrosis (minimal evidence of cirrhosis), (2) postnecrotic or coarsely nodular cirrhosis, (3) nutritional or Laennec's cirrhosis, and (4) finely nodular cirrhosis.

An attempt was made to correlate the clinical history of alcoholism or hepatitis, the microscopic type of hepatic pathologic changes, and the operative mortality (*Table 4*). The highest operative mortality occurred in the groups with finely nodular

Table 4.—*Correlation of pathologic diagnosis, history, and operative mortality**

Pathologic diagnosis	Alcoholism	Hepatitis	Neither	Both	Total	Operative mortality, %
	Number of patients					
Normal liver† or periportal fibrosis (minimal evidence of cirrhosis)	—	—	9	1	10	0
Postnecrotic cirrhosis	16	9	13	1	39	19
Finely nodular cirrhosis	14	—	8	—	22	45
Nutritional cirrhosis	3	—	—	—	3	67
Total	33	9	30	2	74	26

*Operative mortality includes deaths that occurred during and after operation before discharge from the hospital or in the initial 30 days after operation.

†Patients with obstruction of extrahepatic portal vein.

and with nutritional cirrhosis. These groups also had the highest percentage of patients with a clinical history of alcoholism. In such patients, the combined operative mortality was 48 percent. In patients with a diagnosis of postnecrotic or coarsely nodular cirrhosis the operative mortality was 19 percent. Among patients with normal livers, who had extrahepatic obstruction or those with slight periportal fibrosis alone, there were no operative deaths.

Long-Term Survival and Morbidity

During the first year after the portal-systemic shunt operation, an additional 12 patients (15 percent) in the group died. The major precipitating cause of death was again progressive hepatic failure, the cause of death in two thirds of these patients. Six of the 12 patients who died in the first year after operation had a clinical history of alcoholism and were in the poor-risk category. Postnecrotic cirrhosis was the most common type of histologic diagnosis in this group. This is in contrast to those patients who died during the 30-day operative period, the majority of whom had finely nodular or nutritional cirrhosis.

In each succeeding year after the first, the survival rate increased. The overall five-year survival rate for patients operated on between 1947 and February 1960, was 45 percent. *Figure 3* shows a graphic representation of the cumulative survival in our group of patients over a five-year period, utilizing the life table method of analysis.[4] The survival in this group is more than twice that obtained by Ratnoff and Patek[5] in their classic study of a similar group of patients with cirrhosis not treated surgically after the first hematemesis.

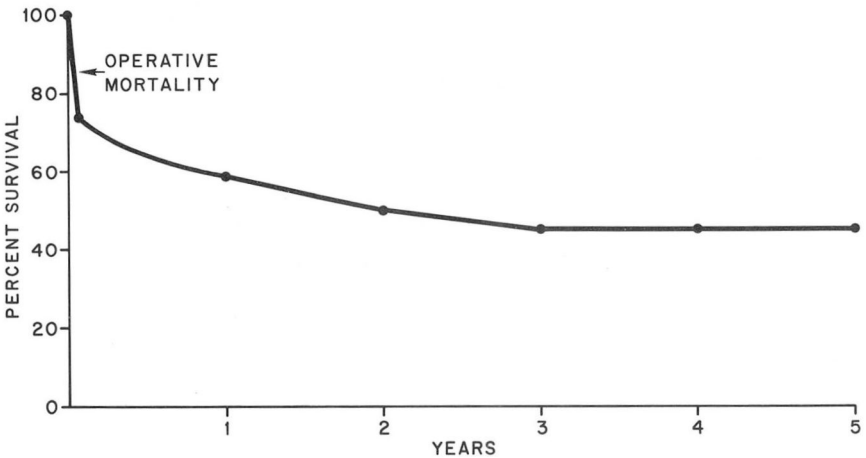

Fig. 3. The five-year cumulative survival in our series.

Postshunt morbidity was assessed in the 54 patients who survived the operative period. The majority of surviving patients were able to return to a reasonably normal life and to resume most activities. The most serious problem in this group has been further gastrointestinal bleeding; this occurred in nine of the patients (17 percent). Bleeding in three of these patients was due to recurrent esophageal varices, secondary to thrombosis of the shunt; in six patients it was due to peptic ulceration, either gastric or duodenal. Portal-systemic ammonia intoxication with neurologic changes, confusion, and stupor, occurred to some extent in 18 patients at some time during the postoperative period. In all but a few this was readily controlled by a strict low-protein diet, neomycin taken orally and, rarely, by therapy with arginine-glutamate combinations. Postoperative ascites occurred in six (11 percent) of the patients. In almost all, the ascites was easily controlled by salt restriction, diuretic agents, and aldosterone-inhibiting agents.

Conclusions and Summary

The management of patients through the critical period of bleeding from esophageal varices, and the prevention of further bleeding continue to be among

the most difficult problems in medicine. The mortality rate from an episode of bleeding from esophageal varices is accepted to be in the range of from 50 to 80 percent;[6] the prevention of further bleeding episodes is essential. Portal-systemic shunt decompression of portal hypertension is the best method by which such prevention can be achieved.

This study has confirmed the fact that the leading cause of death after portal-systemic shunts is progressive deterioration of the liver, frequently complicated by renal failure. The greatest number of deaths occurred in the operative and early postoperative periods. With each succeeding year thereafter, survival rates improved. Although portal-systemic shunt procedures are effective in the reduction of portal hypertension and decrease the risk of death from variceal hemorrhage, the procedure does not improve hepatic function, and a careful assessment of liver function is essential in the selection of patients for the operation.

No single clinical or laboratory test of liver function will detect with certainty which patients will not tolerate a shunt procedure because of limited hepatic reserve. Coordinated studies of liver function, at present, provide the best guide to the selection of patients for shunt procedures. The operative mortality of patients with poor hepatic reserve (48 percent) is almost three times higher than that of patients with good hepatic function (17 percent). The consideration of additional factors, however, combined with liver function studies will help to improve the selection of patients. Most striking is the fact that patients in whom shunts must be undertaken on an urgent or emergency basis in the presence of active bleeding, constitute a greatly increased risk with an operative mortality more than four times that in patients after an elective shunt. This undoubtedly reflects the rapid deterioration in liver function which occurs during massive bleeding from esophageal varices, a deterioration not always indicated by liver function tests at the time of the bleeding episode. A preoperative biopsy of the liver may prove valuable in the selection of patients for shunt operations; it is essential that pathologists reach agreement on a classification of the histologic changes seen in the diseased liver of patients with portal hypertension. In this series, patients with finely nodular or nutritional cirrhosis had a significantly higher operative mortality rate (48 percent) than that of patients with postnecrotic or coarsely nodular cirrhosis (19 percent).

The long-term survival after shunt in this group indicates that patients with varices that have bled who have undergone a portal-systemic shunt have a better overall prognosis than similar patients who have received medical therapy alone. Five-year survival was 45 percent in those protected from further bleeding by a portal-systemic shunt, whereas it has been less than 20 percent in other studies of patients not so protected. To improve these survival rates further, there must be continued emphasis on refining the criteria for selection of patients for shunt operations.

Acknowledgment

The authors wish to acknowledge and give credit to the many members of the staff of the Cleveland Clinic who have participated in the care of the patients studied. We especially wish to recognize the care given by Dr. Charles H. Brown and Dr. B. H. Sullivan, Jr., of the Department of Gastroenterology, and Dr. Richard C. Britton, formerly of the Department of General Surgery, whose present address is: Columbia-Presbyterian Medical Center, New York, New York.

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