Risks in Therapeutic Portacaval and Splenorenal Shunts

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Analyses of the records of 120 patients who underwent portacaval shunting (PCS, 57%) or splenorenal shunting (SRS, 43%) from 1966–1973 disclosed that patients in each group undergoing elective shunts had the same preoperative physical condition and postoperative mortality rates (~20%). Although the postoperative death rate from emergency shunts was 48%, patients having these procedures were poorer risks. Long-term incidences of encephalopathy were the same, irrespective of the type of shunt (PCS, 46%; SRS 36%, $P > 0.5$). Despite comparisons of data most unfavorable for PCS, 5-year survival rates were also the same after either type of shunt (all PCS, 29 ± 7.5%, SRS, 42.0 ±7.4%, $P = 0.23$). The survival rate after elective PCS was also the same as after SRS during the entire 5-year period. However, the survival after all elective PCS and SRS was significantly greater than after emergency PCS (P range = 0.005–0.038); the poorer results of emergency shunting could be partly attributed to the poorer condition of patients selected. A numerical score based on serum bilirubin concentrations, ascites, and urgency of shunting reliably predicts postoperative mortality. Long-term encephalopathy is predicted by a history of encephalopathy and the urgency of shunting.

IN THE ABSENCE of rigorous trials comparing the efficacy and complications of portasystemic shunts, a surgeon's personal experience selects the operation for a patient who has bled from esophageal varices. Discriminating observers make different recommendations. Some find portacaval and splenorenal shunts equivalent in terms of postoperative rates of death and encephalopathy.[3,42] Others find differences, but can explain them by selection of the patients to be operated upon, rather than by advantages inherent in the type of shunt.[2] Still others report distinct functional advantages of splenorenal or mesocaval shunts compared with portacaval shunts.[9,13,23,40,43]

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From the results of portacaval and splenorenal shunts at this hospital over an 8-year period, computerized analysis of variables has permitted inferences otherwise not easily obtainable. Elective portacaval and splenorenal shunts produced the same incidences of death and encephalopathy. A six-point scale derived from correlating the preoperative condition of patients with postoperative survival is a useful predictive index of the risk of death; a four-point scale is an index of the risk of postoperative encephalopathy.

Materials and Methods

Patients. A survey of discharge diagnoses and lists of operations from 1 January 1966 to 31 December 1973 indicated 142 portasystemic shunts. Records of the 120 patients with adult-onset intrahepatic (parenchymal) portal-bed blockage undergoing transabdominal portacaval or thoracoabdominal splenorenal anastomoses were analyzed. Followup was 99.2% complete; the status of only one patient (portacaval shunt) could not be defined on 31 December 1975. Postmortem examination was performed in 79% of operative fatalities.

Data. Laboratory values analyzed were the last ones recorded before an operation was performed. Encephalopathy was defined by criteria of the individual attending physicians and surgeons. The presence of hepatomegaly was established by physical examination and of splenomegaly by physical or radiological examination. An emergency operation was one undertaken within 48 hours of a bleeding episode uncontrollable by balloon tamponade or

TABLE 1. *Types of Portasystemic Shunts for Parenchymal Hepatic Disease, 1966–1973*

Operation		Number
Portacaval		68
Elective	35	
Emergency	33	
Splenorenal		52
Mesocaval		8
		128

Shunts for preparenchymal disease = 14 additional patients.

intra-arterial infusion of vasopressin or both. An operative mortality was death within four weeks of the time of shunting (27 patients) or during hospitalization (6 additional patients: 4 portacaval, 2 splenorenal).

Statistical techniques. In addition to ordinary parametric techniques, non-parametric,[4] non-additive,[14] and multivariate[20] models were employed as required. Split-half cross-validation was performed on predictive scales. Survival curves were constructed according to Cutler and Ederer[8] and were analyzed using their methods and those of Alling.[1] *P* values were two-tailed unless otherwise specified.

Results

Patients. This report concerns the 120 patients who had a portacaval shunt (57%) or splenorenal shunt (43%) for treatment of proved or inferred bleeding esophageal varices from alcoholic cirrhosis (45%), postnecrotic cirrhosis (35%), or cirrhosis of unknown cause (20%) (Table 1). Almost half (49%) of all portacaval shunts were emergency operations (Table 1). The age and sex distributions of patients between the two kinds of shunts were the same (Table 2). Seven patients with side-to-side portacaval shunts were included in the portacaval group and two patients with side-to-side splenorenal shunts in the splenorenal group since analysis showed that they represented the same statistical populations.

TABLE 2. *Distribution of Age and Sex by Operation (Per Cent) (120 Patients)*

	Male		Female	
Years age	Portacaval (%)	Splenorenal (%)	Portacaval (%)	Splenorenal (%)
30–39	8.7	18.8	0	10.5
40–49	30.4	18.8	18.2	15.8
50–59	32.6	43.8	50.0	47.4
60–69	21.7	15.6	27.3	15.8
70–79	6.5	3.1	4.5	10.5
Total	99.9	100.1	100.	100.
No. patients	46	33	22	19

Portacaval vs. splenorenal by age, $P = 0.4$.
Portacaval vs. splenorenal by sex, $P > 0.5$.

Clinical examinations. Splenomegaly, leukopenia, and thrombocytopenia were more common in the group selected for splenorenal shunting (Tables 3 and 4). Since only 44% of all patients had an esophagoscopic examination, the diagnosis of bleeding varices was more often made by induction than by proof (Table 3).

Chemical examinations. Patients selected for emergency portacaval shunting were entirely responsible for the higher serum bilirubin concentrations in the whole group selected for portacaval shunting compared with that selected for splenorenal shunting (Table 4). Chemical estimations were the same for elective shunts of both types.

Preoperative therapy. Patients undergoing splenorenal shunting compared with those undergoing portacaval shunting had fewer trials of balloon tamponade (27% vs 60%, $P = 0.002$) and of intra-arterial vasopressin (10% vs 27%, $P = 0.049$). They had a greater incidence of transthoracic variceal ligations (19% vs 7%, $P = 0.048$, one tail).

Postoperative mortality. The incidence of overall postoperative mortality was 28% (33/120 patients)—20% (17/87) after elective operations and 48% (16/33) after emergency operations ($P = 0.004$). Three of the five estimates of hepatic reserve enumerated by Child[7] correlated individually with the mortality rate: serum bilirubin ($P < 0.001$) and albumin concentrations ($P = 0.037$) and the presence of ascites ($P = 0.002$) (Fig. 1). Neurological disorder did not correlate ($P = 0.28$). The nutritional state of our patients was not assessed. Multiple discriminant analysis of the four Child's predictors studied showed that information about operative mortality rates was derived chiefly from assessments of the serum bilirubin level and the presence of ascites. Once these were considered, no significant new information was derived from the serum albumin level or the presence of encephalopathy.

The utility of the more parsimonious predictors (bilirubin and ascites) could be improved by regrouping the bilirubin levels. An optimization procedure[10] re-

TABLE 3. *Assessments by Historical Review, Physical Examination, and Other Studies*

Variable	Portacaval (%)	Splenorenal (%)	Combined (%)
History varices	60	79 ($P = 0.16$)	68
History encephalopathy	37	29 ($P = 0.47$)	33
Concurrent diabetes	14	14 ($P > 0.5$)	14
Hepatomegaly	48	39 ($P = 0.42$)	44
Splenomegaly	52	88 ($P < 0.001$)	68
Ascites	69	60 ($P > 0.5$)	65
Spider angiomas	44	49 ($P > 0.5$)	46
Esophagoscopy	50	35 ($P = 0.16$)	44
Barium GI Series	68	65 ($P > 0.5$)	66
Angiography	16	18 ($P > 0.5$)	17
Not studied	6	10 ($P > 0.5$)	8

TABLE 4. *Chemical and Cytological Estimations in Serum and Blood (medians)*

Shunt	Bilirubin (mg/dl)	Protein (g/dl)	Albumin (g/dl)	Globulin (g/dl)	Prothrombin (sec)	Leukocytes (per mm³)	Platelets × 10^{-3} (per mm³)
Portacaval (all)	1.84	6.12	3.28	2.63	15.04	7454	142
Elective	1.56	6.36	3.31	2.86	15.12	7410	150
Emergency	2.29	5.56	3.22	2.34	14.89	7501	133
Splenorenal	1.34	6.38	3.40	2.77	14.53	5414	091
Total Shunts	1.65	6.21	3.32	2.72	14.82	6790	115
			P Values				
SRS vs. all PCS	0.034	0.241	0.396	0.122	0.086	<0.001	0.012
SRS vs. elective PCS	0.450	>0.5	>0.5	>0.5	0.087	<0.001	0.008
All elective vs. all emergency	<0.001	0.013	0.480	0.004	0.492	<0.001	>0.5

grouped bilirubin levels as ≦0.99 mg/dl, 1.0–1.99 mg/dl, and ≧2.0 mg/dl. Besides dividing the population of patients more nearly into thirds, this grouping correlated with our operative death rates better than other categorizations (Fig. 1). Presence of intra-operative clotting disturbances also was closely associated with death rates ($P < 0.001$).

Predictors based on serum bilirubin concentrations, the degree of ascites, and the urgency of operation each added unique predictive information (Fig. 2). Summed points from the scale in Table 5 correlated well with mortality rates (Table 6 and Fig. 3). Sharp increments in mortality were found between two and three points on the scale and between three and four points.

Emergency shunt mortality rate. The 48% death rate of emergency shunts (16/33 patients) was more than double that of elective shunts (20%, 17/87) ($P = 0.004$).

The poor condition of patients chosen for emergency operations was partly responsible for the greatly increased mortality rate. Compared with patients having elective operations, patients undergoing emergency operations had higher serum bilirubin concentrations and lower serum protein and globulin concentrations (Table 4). Albumin concentrations and the degree of ascites were the same. The average point-score of patients having emergency shunts was higher than that of patients having elective shunts (6.26 ± 0.17 (S.E.) vs 4.74 ± 0.13, $P < 0.001$).

Elective shunt mortality rate. The incidences of death and of encephalopathy following portacaval and splenorenal shunts were statistically identical whether the data were corrected by eliminating the poor-risk patients who had emergency shunts or not. The corrected operative mortality rate after elective portacaval shunting was 20% (7/35) and 19% (10/52) after spenorenal shunting ($P > 0.5$). Uncorrected for emergency shunting the death

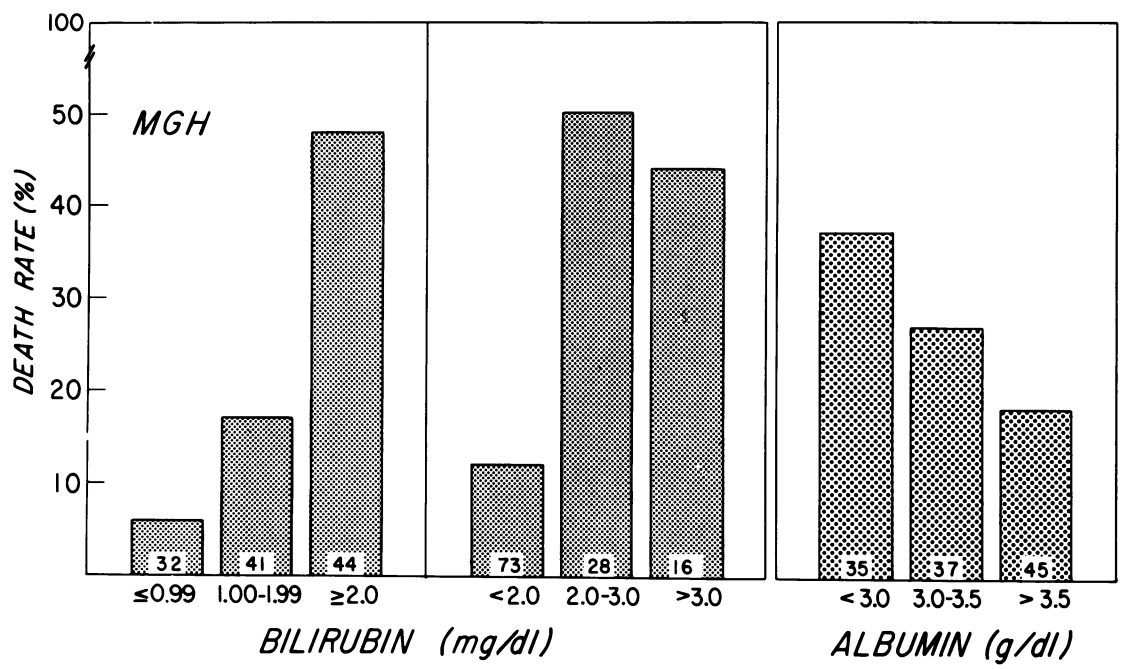

FIG. 1. Mortality rates associated with preoperative concentrations of bilirubin and albumin in serum. The panel labeled *MGH* shows the effect of regrouping bilirubin levels as proposed in the text. Numbers within the bars show the number of patients at risk in each category.

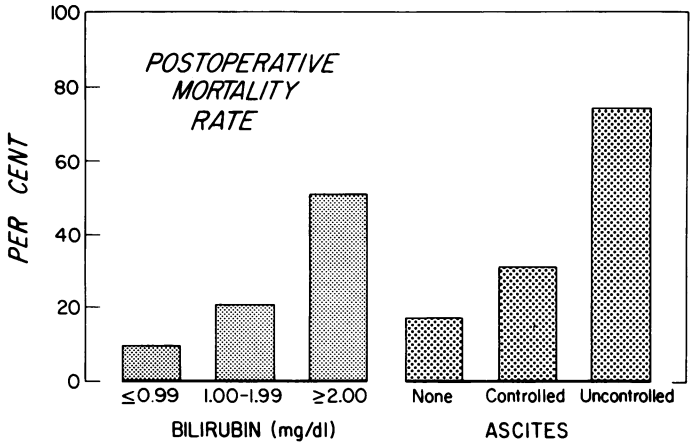

FIG. 2. Correlation of bilirubin levels and ascites with mortality rate.

rates were also the same (34% vs 19%, $P = 0.117$). There was no association between presence of diabetes and operative mortality ($P > 0.5$).

Patients undergoing splenorenal shunts had lower serum bilirubin levels than all patients undergoing portacaval shunts (Table 4). Their lower leukocyte counts and platelet counts were probably signs of hypersplenism. Splenomegaly was not correlated with the incidences of operative death or of postoperative encephalopathy ($P > 0.5$).

Postoperative encephalopathy. Since almost every immediate postoperative death was associated with hepatic coma, the incidence of encephalopathy was analyzed only in patients who were not operative mortalities (N = 87). Differences in survival of patients with the two kinds of shunts was not a determinant of the incidence of encephalopathy because survival did not correlate with the type of elective shunt performed ($P > 0.5$).

Encephalopathy occurred in 47% (41/87) of patients who were not operative mortalities. The incidences corrected for the effects of emergency shunting were 36% (15/42) for splenorenal shunting and 46% (13/28) after portacaval shunting ($P > 0.5$).

The best single predictor of post-shunt encephalopathy was a history of (pre-shunt) encephalopathy. Of patients with a history of encephalopathy, 85% (23/27) developed encephalopathy after shunting, in contrast with 30% of patients without preoperative encephalopathy ($P < 0.001$). After emergency operations the incidence of encephalopathy was 76% (13/17) vs 40% (28/70) after elective shunts ($P = 0.016$).

TABLE 5. *Scale for Predicting Operative Mortality*

Predictor	Points Assigned		
	0	1	2
Bilirubin (mg/dl)	≦ 0.99	1.00–1.99	≧ 2.0
Ascites	none	controlled (stable)	uncontrollable
Operative urgency	elective	emergency	—

Score is the sum of points assigned for each predictor: minimum = 0, maximum = 5.

TABLE 6. *Operative Mortality Predicted by Score*

	Points Scored					
	0	1	2	3	4	5
Deaths (Per cent)	0	9	14	38	61	100
Deaths/N	(0/16)	(2/23)	(4/28)	(11/30)	(7/18)	(2/2)

A scale of zero to 3 points for predicting the likelihood of postoperative encephalopathy was devised (Table 7). Zero points defined 25% chance of encephalopathy and each successive step on the scale was associated with ~25% greater risk of encephalopathy (Table 8 and Fig. 4).

Hepatic failure present more than four weeks postoperative was associated with a greater frequency of admitted history of alcoholism ($P = 0.024$). There was no association between the presence of diabetes mellitus and of post-shunt encephalopathy ($P = 0.151$) or between age and encephalopathy ($P = 0.36$).

Long-term survival rate. Five-year survival rates calculated by the actuarial methods showed no difference between patients after splenorenal shunting (42.0 ± 7.4%) compared with those after portacaval shunting (29.4 ± 7.5%) ($P = 0.23$) (Fig. 5). Even two years after shunting, when the separation between the survival curves was greatest at an even-year interval, the difference was not significant. Confirmation was found by testing the curves by the Alling[1] method, which compared the entire curves, not just isolated yearly points. The survival rate was the same after elective portacaval shunting as after splenorenal shunting (two-tail, P range = 0.18 to

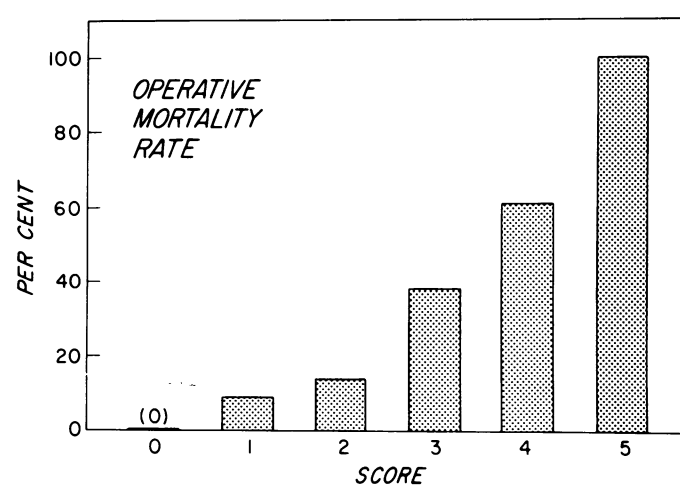

FIG. 3. Mortality rates associated with preoperative score (Table 6).

TABLE 7. *Scale for Predicting Encephalopathy after Shunting*

Predictor	Points Assigned		
	0	1	2
History encephalopathy	none	—	yes
Operative urgency	elective	emergency	

Score is the sum of points assigned for each predictor: minimum = 0, maximum = 3.

TABLE 8. *Postoperative Encephalopathy Predicted by Score (87 Survivors)*

	Points Scored			
	0	1	2	3
Per cent	25	55	79	100
Enceph/N	(9/51)	(5/9)	(15/19)	(8/8)

0.90). The difference between all elective shunts and emergency shunts was significant (one-tail, P range = 0.005 to 0.038).

Discussion

During the 8 years surveyed, mortality rates—short-term or long-term—were independent of the type of shunt. Two groups totalling 87 patients with equivalent indices of hepatic function were chosen for elective portacaval or splenorenal shunting by criteria that differed arbitrarily among the individual staff and resident surgeons. In these circumstances, which apply to many large hospitals, the postoperative mortality rate correlated with the degree to which hepatic function was preserved. Long-term mortality rates also correlated by reason of the effects of postoperative mortality.

Surgical skill does not appear to be an overwhelming determinant of survival rate. The comparison of results from this hospital from 1959–1965 likewise showed no difference in survival rates after portacaval and splenorenal shunting.[2] The preponderance of splenorenal shunts in that survey were done by two surgeons and the number of surgeons doing all portasystemic venous shunts was fewer than at present. Other studies show no differences in 5-year survival rates between the two kinds of shunts whether the number of surgeons involved is few[3] or many,[42] although the experience of a single expert surgeon may differ from that of surgeons in general.[23]

Selection of patients is a major determinant of results. When poor-risk patients are picked for splenorenal shunting because of physiological advantages attributed to this shunt, the mortality rate and the incidence of encephalopathy exceed those of portacaval shunting.[37] If patients are chosen for splenorenal shunting only after they have survived transthoracic ligation of esophageal varices or another operation,[33,45] the results should be especially good. Patients with splenorenal shunts in our group had a greater incidence of transthoracic variceal ligations. Presumably because of selection, survival data in this paper are inferior to those recently reported from Paris.[3] In that study the 5-year survival rate after portacaval shunting calculated by actuarial means was 70% and after splenorenal shunting, 65%. The greater ease with which the French patients were dissuaded from alcoholism after operation may contribute to the superior results, although abstemiousness confers no benefit after portacaval shunting in Boston.[39] At Columbia-Presbyterian Medical Center, the actual 5-year survival rate was 43%[42] (calculated from data in the paper), but survival rates based on actuarial principles would allow a more valid comparison with our data.

Indices of hepatic function predicted the chance of survival in the present study and was associated with survival in most others[6,12,15,18,21,22,31,41,44] despite some evidence to the contrary.[24,32] A new scale devised by regrouping serum bilirubin concentrations and considering only the presence of ascites and the urgency of shunting in addition produced a continuously predictive scale of high reliability. Preoperative encephalopathy was omitted from the scale because it predicts encephalopathy per se rather than operative mortality. Orloff[32] and Prandi[35] and their coworkers evaluate ascites in their predictors of survival rate after emergency shunting, but also include other elements such as encephalopathy, nutritional state, and hepatic size.

No patient with a normal bilirubin level and without

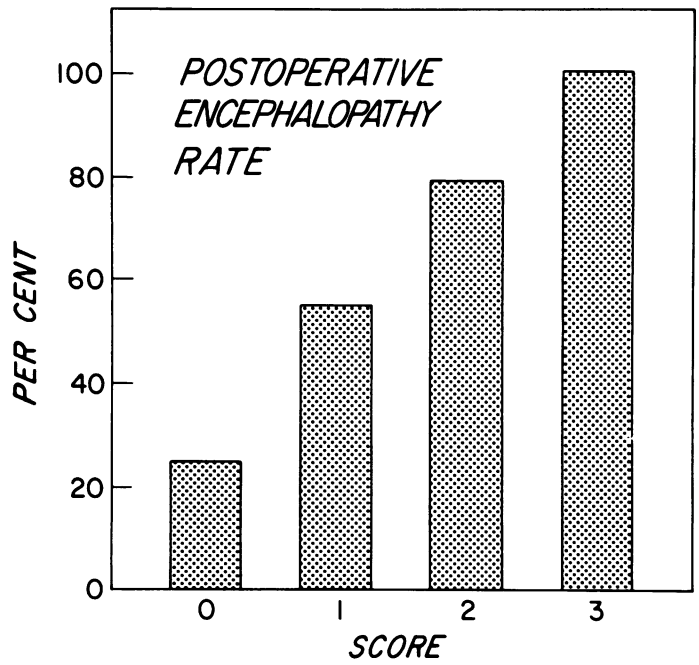

FIG. 4. Incidence of postoperative encephalopathy associated with score (Table 7).

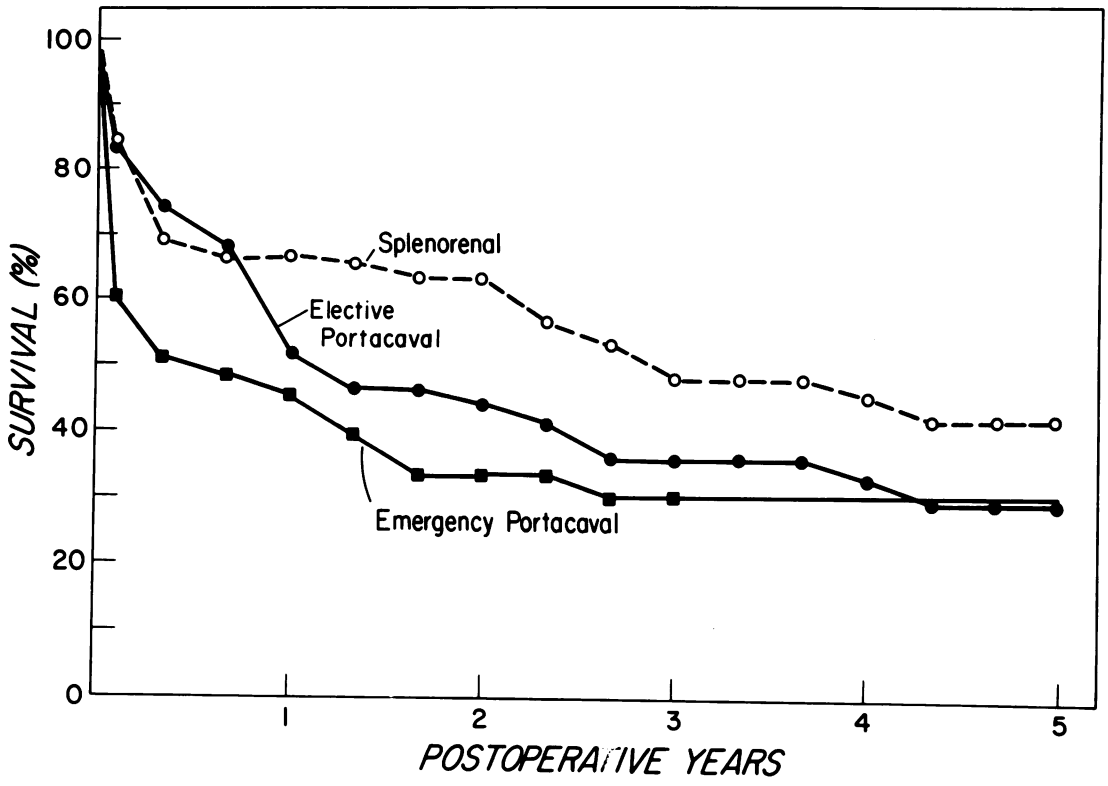

FIG. 5. Survival rates after shunting. There was no significant difference between the curves showing the results of splenorenal shunting and elective portacaval shunting. The significant difference after emergency shunting was a result of faster attrition during the early postoperative period.

ascites died after an elective shunting procedure. Even a slight deviation from normality or an emergency shunt instead of an elective shunt raised the risk of postoperative death to ⅛, a category that for these operations might be called "modest risk." More advanced abnormalities of hepatic function totalling three points on the scale put the patients at "moderate risk": ~⅓. "High risk" patients, with four or five points, had a >½ chance of death. In an earlier study of prognosticators of death in cirrhotic patients requiring emergency surgery for non-variceal sources of gastrointestinal bleeding, the serum bilirubin level was also the strongest predictor, but was enhanced by evaluation of the serum albumin level, the prothrombin time, and the presence of encephalopathy.[46]

The prognostic scale described here was based on the last laboratory values and clinical evaluation before an operation was done. For elective shunts these assessments were usually made one to three days before, thereby reflecting hepatic and systemic integrity when they were as good as likely. For emergency shunts, the assessments were influenced by disequilibrium of the vascular compartment resulting from hemorrhage and by dilution with electrolyte and colloid infusions and transfusions of stored blood.

Although selection of poor-risk patients contributed to the 48% postoperative death rate from emergency shunting, performing the shunt as an emergency itself increased mortality. Moreover, the death rate for the first few years was appreciably greater, despite the similarity of the 30% 5-year survival rate to the 36% rate at the University of California at San Diego, where emergency shunting is routine.[32] Patients with appreciable hepatic decompensation survive there and elsewhere (reviewed in ref. 25), but at our hospital the risk is not less than 61%, and at the Hôpital Beaujon, Paris,[35] the mortality rate is over 80%. Older data from a randomized study of emergency shunting at the Massachusetts General Hospital, indeed, showed a 73% overall mortality rate.[26] Evidence of hepatic decompensation reflected in the presence of alcoholic hyaline copious enough to be recognized on a frozen-section biopsy specimen from the liver of a patient undergoing an emergency shunt also increases the chance of death.[28]

In choosing between an emergency portacaval shunt or trying to stabilize a patient with bleeding varices long enough to permit an elective shunt, our scale (Table 5) might be a useful discriminant. Patients rating zero or one point would seem to be reasonable risks for emergency shunts (raising their scores to one or two points), thereby sparing costs of hospitalization in "preparing" them for elective shunts. Patients rating four points might be weighed only as desperate risks for emergency shunting or be allowed to follow their fate with all reasonable support, without being subjected to an operation. A randomized though perhaps untenable study is implicit in these suggestions.

Conclusions from such a study could not be unequivocal without mandatory verification of variceal bleeding by esophagogastroscopy. That only a minority of patients

in the present review had endoscopic examination is a product, first, of the era surveyed and, second, of many patients having stopped bleeding before they arrived from the referring hospital; death before arrival of those with hemorrhage obviously represents a bias in selection. At present the combination of endoscopic examination and preliminary angiographic control of bleeding is nearly routine.

Survival from bleeding varices is not enough. Freedom from recurrent hemorrhage and from disabling encephalopathy ideally should co-exist. Since randomized studies testify to the protective effect of patent portacaval shunts against recurrent hemorrhages,[17,36] and since conclusions from a retrospective study of the magnitude and frequency of hemorrhage are likely to be specious, no attempt was made in the present study to assess the effect of shunts on bleeding. The last review from this hospital found that the incidence and prevalence of gastrointestinal bleeding was greater after splenorenal shunting than after portacaval shunting, but that patients with splenorenal anastomoses tolerated the hemorrhages with less chance of portasystemic encephalopathy.[2] Whether the better hepatic function of patients with splenorenal shunts was responsible for their tolerance to bleeding could not be settled.

Encephalopathy was tallied as an all-or-non phenomenon in the present review. A statistically similar incidence among survivors of splenorenal shunts (36%) and elective portacaval shunts (46%) is two-to-three times the 16% overall incidence in Bismuth's[3] study. In the last report from this hospital the incidences were 25% for splenorenal shunts and 33% for portacaval shunts.[2]

Because of the variables in diagnosing and recording portasystemic encephalopathy resulting in incidences of 5-to-83%,[25] retrospective evaluations should be ignored. In the only prospective (but "unblinded") study of encephalopathy, the incidence was 38% for controls and 53% for patients with end-to-side portacaval shunts, but the difference was insignificant.[29] Severe encephalopathy was much commoner after shunting, however (3% vs 20%, $P < 0.001$). Any report showing less encephalopathy after any shunt than the 38% incidence of controls in that study must explain its criteria and conclusions with especial care.

More credible than the low incidence of encephalopathy we record is the strong predictive value of a history of encephalopathy before shunting; this seems to be a variable less subject to error. Eighty-five per cent of our surviving patients having had preoperative encephalopathy had it postoperatively as well. Only 30% of patients with no preoperative encephalopathy had it later. Failure to confirm earlier reports of a rising incidence of postoperative encephalopathy with age[19,27,34,38] doubtless reflects the vagaries of assessing encephalopathy and different populations of patients, but presenting the incidence by age by the life-table method shows no difference either.[24]

The totality of data in our study identify no overwhelming balance in favor of one shunt or the other—portacaval or end-to-side splenorenal. An argument could be made in favor of the splenorenal shunt, since patients survived as long as those with portacaval shunts and did at least as well in terms of encephalopathy despite a longer and more formidable thoracoabdominal operation that per se might be expected to worsen results. Alternatively, since the portacaval anastomosis is easier to do, surer to stop bleeding, and more likely to remain open, in the absence of controlled trials preference for it seems a bit surer except in select circumstances. One of these would be the presence of appreciable hypersplenism (platelet count $\leqq 50{,}000$ per mm^3, leukocyte count $\leqq 3{,}000$ per mm^3), because a portacaval anastomosis relieves not more than 60% of cases of hypersplenism associated with portal hypertension.[11,30] Another would be preparenchymal ("extrahepatic") blocks, for total diversion of portal blood in patients with normal hepatocellular function yields an unacceptable incidence of portasystemic encephalopathy. Still other indications would be thrombosis of the portal vein or inaccessibility of the right subhepatic space.[25]

The coronary-caval shunt[16,23] may be the ideal for decompressing esophageal varices while disturbing the already-damaged portal circulation as little as possible. Because of the technical and anatomic problems it presents, it may not be widely feasible. Although wholesale endorsement would be premature, the selective or distal splenorenal shunt[5,43] promises a practical compromise between technical difficulty and excellence of results. Considerable expense, time, and effort are worthwhile to arrive at the optimal answer since at this hospital in 1975 the average cost of a hospitalization involving a portasystemic anastomosis was $15,000.

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Discussion

Dr. Robert R. Linton (Boston, Massachusetts): I greatly admire Dr. Malt's skill as a surgeon since he saved my life two years ago after an automobile accident.

In my opinion too much emphasis has been placed on the necessity of producing a large caliber portal systemic venous shunt to prevent further esophageal bleeding, completely ignoring the fact that they result in a higher incidence of postshunt encephalopathy and liver failure than smaller caliber shunts. If they are "done right" they control esophageal bleeding and prevent postshunt encephalopathy and liver failure.