Elective Portasystemic Shunts:
Morbidity and Survival Data

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THE experience of this hospital in elective portasystemic shunts for portal hypertension associated with variceal bleeding has been reported giving the results of operations performed in the years 1945 through 1958.[7] The recent experience of 173 elective portasystemic shunts performed in the years 1959 through 1965 is given here with results of 380 patient-years of postoperative observation. The survival figures previously reported are also updated.

Methods

Selection of Patients. Table 1 shows the total number of portasystemic shunts grouped by indication for operation. From the total experience of 250 operations the 173 elective portacaval and splenorenal shunts performed in patients with prior variceal bleeding have been selected for review. Of the 70 splenorenal shunts all but eight were in patients with intrahepatic blocks associated with hepatic disease. The 103 portacaval shunts were performed in patients with intrinsic disease of the liver, and of these 81 were end-of-portal vein-to-side of vena cava anastomoses. The remainder were either side-to-side or "double barreled" anastomoses chosen to promote retrograde drainage of the liver through the portal vein. The surgical technics have been described.[5, 6, 12]

Chart Review. Within the group of 173 elective shunts there was no selection, and all hospital experience is included. Review of the hospital records established whether or not the operation was an emergency. The emergency group of 39 patients had active esophageal bleeding at the time of operation, or had less than a 2-day interval following a gastrointestinal hemorrhage necessitating at least one transfusion, or had required balloon tamponade to control bleeding up to the moment of operation. The records were also reviewed to determine anesthetic risk, anesthetic agents, intraoperative blood replacement, cause of death, and incidence of all complications including type and severity of recurrent

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gastrointestinal bleeding and incidence of encephalopathy. Fifty-six per cent of the fatal cases had autopsy reports.

Anesthesia and Intraoperative Blood Replacement. Cyclopropane, hypotensive spinal anesthesia and N_2O-curare were the primary technics in 90% of the operations, each being used in approximately equal numbers of patients. In the remaining 10% ether-N_2O-O_2 and relaxant, cyclopropane-ether, or halothane were used.

In pulmonary disease inhalation agents such as ether, cyclopropane, or halothane, which permits high inspired oxygen concentrations are favored. Cyclopropane was frequently the agent of choice for the bleeding or hypovolemic patient. Barbiturate N_2O-curare technic is satisfactory for alcoholics despite an impression that such patients have higher tolerance to barbiturates and curare than non-alcoholic patients. Hypotensive catheter spinal technic has been used because some surgeons believe this reduces operative site bleeding.

Characteristics of Patients in Splenorenal and Portacaval Groups. In view of the interest in comparing portacaval and splenorenal shunts it is emphasized that selection of patients for these two procedures was based on clinical considerations and was not a random selection to permit subsequent comparison. The dissimilarity of patients receiving portacaval or splenorenal shunts is due to the tendency to perform portacaval shunts in patients who are severely ill because of the shorter duration of the operation and the greater incidence of ward patients in 48% of portacaval shunts in contrast to 18% of splenorenal shunts. The splenorenal patents are more affluent and enter the hospital at earlier stages of the disease. Hypotensive spinal anesthesia which is largely restricted to splenorenal shunt operations and preferences of surgeons for a particular operative procedure also preclude rigorous comparisons.

Differences in physical status and in hepatic function of the two groups of pa-

TABLE 1. *Portasystemic Shunts Grouped by Indication for Operation (1959–1965 Series)*

Indication		Number
Esophageal hemorrhage from varices:		
Elective portacaval shunt	103	
Elective splenorenal shunt	70	173
Elective mesocaval and other shunts		7
Emergency shunt		39
		219
Ascites, intractable		15
Hypersplenism		9
Prophylactic for esophageal hemorrhage		7
Total		250

TABLE 2. *Distribution of Age and Sex (1959–1965 Series)*

Age	Males		Females	
	% Splenorenals	% Portacavals	% Splenorenals	% Portacavals
20–39	17	2	8	12
40–49	14	25	25	18
50–59	38	40	49	31
60–69	22	24	18	24
70–79	9	9	0	15
	100	100	100	100
No. of patients	42	70	28	33

TABLE 3A. *Comparison of Physical Status (1959–1965 Series)*

	American Society of Anesthesiologists Physical Status Scale (1 = excellent to 4 = moribund)
	units
Mean value of preoperative status in Splenorenal shunt pt.	2.2
Mean value of preoperative status in Portacaval shunt pt.	2.6
Difference	0.4
t-test value	2.29
Degrees of freedom	141
p value	0.025

tients are important considerations that may be measured. The objective criteria employed were the American Society of Anesthesiologists Physical Status Scale [2] and standard liver function tests.[14] The physical status scale provides an appraisal that the anesthetist makes of the patient's condition prior to the induction of anesthesia.

Duration of Follow-up. Ninety-nine per cent of 173 patients had follow-ups completed in 1965 or 1966 or had the date of death established. The total period of postoperative observation is 380 patient-years and the median duration of follow-up is 3 years.

Of 237 patients having shunting procedures in the period of 1945 to 1958, 88% had follow-ups completed in 1965 or 1966. In this group, 67% of the shunts were splenorenal and 8% had extrahepatic blocks of the portal circulation. Corresponding figures for the recent group of 173 patients are 40% and 5%.

Results

Distribution of Age and Sex. Table 2 presents the distribution of sex and age at time of operation. Two thirds of the patients in all groups are over 50 years of age.

Anesthesia and Intraoperative Blood Replacement. In the few patients in whom halothane anesthesia was used, hepatic failure in the postoperative period was not encountered. There were no anesthetic

TABLE 3B. *Comparison of Liver Function Studies (1959–1965 Series)*

	Alb. (Gm./100 ml.)	Glob. (Gm./100 ml.)	B'rub. (Mg./100 ml.)	A.p'tase (B.U.)
Mean preoperative values in serum: Splenorenal shunt pt.	3.82	2.94	1.50	8.92
Mean preoperative values in serum: Portacaval shunt pt.	3.50	3.31	1.53	8.23
Difference	0.32	0.37	0.03	0.69
t-test value	3.70	3.06	0.11	0.52
Degrees of freedom	167	167	171	137
p value	<0.001	<0.005	>0.9	>0.6
	BSP %	Pro T. %	T'amin. units	
Mean preoperative values in serum: Splenorenal shunt pt.	17.3	54.1	46.4	
Mean preoperative values in serum: Portacaval shunt pt.	26.1	50.4	42.2	
Difference	8.8	3.7	4.2	
t-test value	4.11	1.21	0.57	
Degrees of freedom	101	158	99	
p value	<0.001	>0.2	>0.5	

deaths, and the hospital mortality rates reveal no grossly significant differences between the various anesthetic groups, but interpretation is limited by the fact that the patients in the groups were not similar. Operations under hypotensive spinal anesthesia require an average of 3.1 transfusions versus an average of 3.5 units with other anesthetics. Because of no significant clinical difference in the numbers of intraoperative transfusions required between the different anesthetic groups, we conclude that the type of anesthesia is not a major factor in blood loss.

Preoperative Condition of Patients in Splenorenal and Portacaval Groups. Tables 3A and 3B indicate that the average patient having a splenorenal shunt was in better physical condition preoperatively as judged by the anesthetist and had less advanced hepatic disease as judged by the function tests obtained in the immediate preoperative period. There are no data available to interpret the meaning of the accumulated differences in the liver function studies. The average values for serum albumin and globulin and for BSP retention are significantly less favorable in those undergoing portacaval shunts. The other studies do not discriminate between the two groups.

Survival Data. In the second column of Table 4A survival following all shunts performed in the 1945–1958 period is tabulated. The updating of these figures accounts in part for the difference from those previously published.[7] However, the principal cause for lack of agreement is that the total number of patients receiving portasystemic shunts is adjusted to 100% in this report. The previous report adjusted the number of patients alive at the time of hospital discharge to 100%. The first lines of survival data in Tables 4A and 4B give hospital survival, or hospital mortality if the percentages are subtracted from 100. A substantial decrease in hospital mortality from 24 to 13% is noted in recent experience. A comparison of survival rates of the two series of patients after hospital discharge reveals essentially similar results.

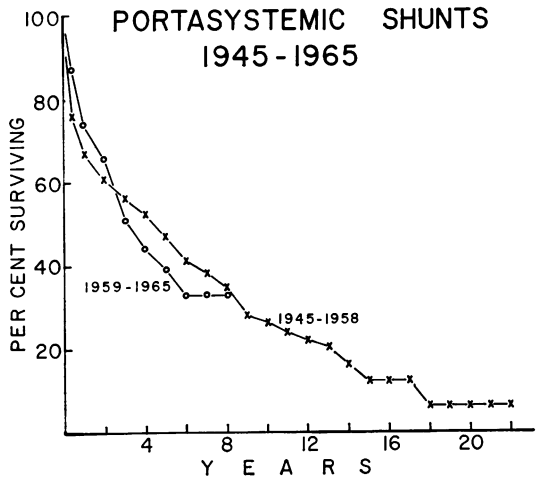

FIG. 1. Portasystemic shunts 1945–1965.

In Table 4B survival data on patients with splenorenal shunts in the 1959–1965

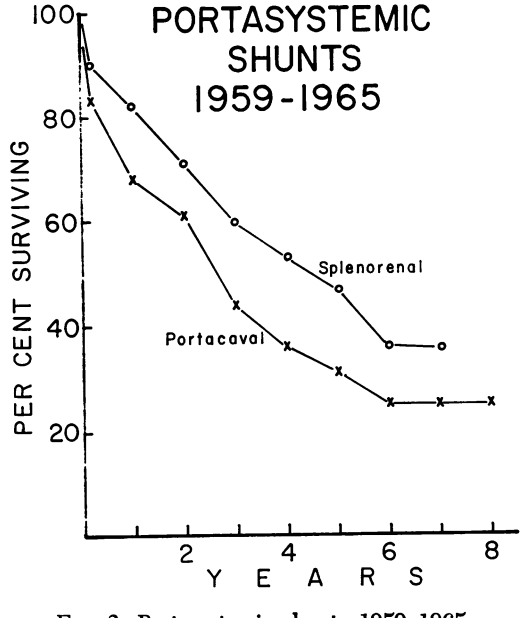

FIG. 2. Portasystemic shunts 1959–1965.

TABLE 4A.‡ *Survival Data*

End of Period	1945–1958 Shunts (N = 237) Updated Follow-up	
	Per Cent	S.E.
Hospital discharge	76*	2.0
1 year	67**	2.5
2 years	61	2.7
3 years	56	2.8
4 years	52	3.0
5 years	47	3.0
6 years	41	3.1
7 years	38	3.0
8 years	34	3.0
9 years	28	2.9
10 years	26	3.0
11 years	24	3.0
12 years	22	3.0
13 years	20	3.0
14 years	16	3.3
15 years	12	3.3
16 years	12	3.3
17 years	12	3.3
18 years	6	4.6
19 years	6	4.6
20 years	6	4.6
21 years	6	4.6
22 years	6	4.6

See footnote Table 4B.

period are based on the 62 patients with intrahepatic blocks. Patients with extrahepatic blocks, and substantially better liver function, have a more favorable prognosis and have been excluded from the splenorenal shunt survival data. The last columns on the right present the survival data on patients with portacaval shunts. Figures 1 and 2 display these survival data in graphs.

Upper Gastrointestinal Hemorrhages Following Portasystemic Shunts. In Table 5 are listed fatal and non-fatal upper gastrointestinal hemorrhages following each type of portasystemic shunt. More than one hemorrhage occurred in a number of patients. The number of bleeding episodes is divided by the collective postoperative follow-up period, and the results are expressed as number of hemorrhages per 10 patient-years of follow-up. This method of expressing the incidence of recurrent bleeding avoids the bias introduced if the duration of exposure to risk of hemorrhage is ignored. Although the incidence of upper gastrointestinal hemorrhage is larger in the splenorenal group, the proportion of hemorrhages that are *fatal* is 17% after splenorenal shunts as compared to 38% after portacaval shunts (Table 5). However, it is not possible to decide to what degree these differences are attributable to selection of patients for a particular operation or to the operation itself.

Incidence of Shunt Encephaloapthy. The incidence of incapacitating shunt encephalopathy following splenorenal and portacaval anastomoses has been reported,[1, 11, 13] and it is often impossible to distinguish the roles played by primary shunt encephalopathy and primary hepatic disease in neurological manifestations, including terminal coma. Approximately one third of patients with portacaval shunts and approximately one quarter with splenorenal shunts developed encephalopathy. These estimates are grossly correct, but not all patients were critically evaluated for more subtle neurological changes.

Causes of Death Following Portasystemic Shunts. In Table 6 deaths following portasystemic shunts are grouped according to primary causes. Primary liver failure and shunt encephalopathy are grouped together because of difficulty in separating them. Portacaval shunts are followed by higher mortality in these conditions. The other causes of death are infrequent, and no obvious interpretation is evident.

TABLE 4B.‡ *Survival Data*

End of Period	1959–1965 Shunts					
	All (N = 173)		Splenorenal Intrahepatic Block (N = 62)		Portacaval (N = 103)	
	Per Cent	S.E.	Per Cent	S.E.	Per Cent	S.E.
Hospital discharge	87*	2.6	90	3.8	83	3.7
1 year	74**	3.3	82	4.9	68	6.4
2 years	66	3.7	71	6.2	61	6.3
3 years	51	4.2	60	7.1	44	6.1
4 years	44	4.5	53	7.9	36	6.0
5 years	39	4.9	47	8.5	31	6.5
6 years	33	5.8	36	12.3	25	7.2
7 years	33	5.8	36	12.3	25	7.2
8 years	33	5.8			25	7.2

S.E. = Standard error.

‡ Computation follows published methods (4, 8).

* Determination by t-test (d.f. = ∞) of significance of difference between these survival per cents gives $p < 0.001$.

** Determination by t-test (d.f. = ∞) of significance of difference between all paired survival per cents after hospital discharge of 1945–1958 experience and 1959–1965 experience gives $p > 0.05$. Paired data limited by 8-year follow-up of 1959–1965 series.

Discussion

A recent review of shunt operations for portal hypertension in cirrhosis summarizes world-wide experience.[3] Comparisons of our results with those summarized are of interest in regard to survival data, incidence of rebleeding, and incidence of portasystemic shunt encephalopathy. The review data based on 511 elective splenorenal and portacaval shunts give survivals of 74, 40, and 27% at 1, 5, and 8 years. Inspection of Table 4 does not disclose a significant difference between these figures and those tabulated for the 1959–1965 series. The same review indicates an "operative" mortality based on 1,244 elective shunts of 15.5%. This mortality is approximately the same as the hospital mortality of 13% in the 1959–1965 series reported here.

The review does not express the incidence of post-shunt bleeding per year of follow-up, and the incidence of patients with variceal bleeding appearing after 2 months post-shunt was stated as 19% of 232 patients with splenorenal shunts and 2.8% of 762 patients with portacaval shunts. These figures may be compared to 19% ($13 \times 100/70$) and 12% ($12 \times 100/103$) calculated from Table 5, but unless the duration of follow-up is similar the interpretation of the differences is difficult. Both sets of figures are in agreement, however, in a greater incidence of bleeding following splenorenal shunts. No information is available in the literature with which our finding of a higher mortality following an upper gastrointestinal hemorrhage in patients with portacaval shunts (Table 5) may be compared. Splenorenal shunts as carried out in selected patients

TABLE 5. *Upper Gastrointestinal Hemorrhages after Portasystemic Shunts (1959–1965 Series)*

Primary Source of Hemorrhage	No. Hem.	No. Patients	No. Hem. per 10 Patient-Years Follow-up
	70 Splenorenal shunts		
Esophageal varices	22	13	1.3
Unknown source	20	9	1.2
Peptic ulcer	5	4	0.30
Gastritis	2	2	0.12
Total hemorrhages	49		2.9
Total no. bleeding patients		21*	
Fatal UGI hemorrhage	7		0.42
Mortality rate of UGI hemorrhage in patients with intra-hepatic block**	7 × 100/41 = 17%		
	103 Portacaval shunts		
Esophageal varices	13	12	0.61
Unknown source	14	9	0.66
Peptic ulcer	10	9	0.47
Gastritis	2	2	0.09
Total hemorrhages	39		1.8
Total no. bleeding patients		29*	
Fatal UGI hemorrhage	15		0.71
Mortality rate of UGI hemorrhage in patients	15 × 100/39 = 38%		

This table is based on the collective postoperative follow-up of 168 years in 70 patients following a splenorenal shunt and 212 years in 103 patients following a portacaval shunt.

* Less than total of above number of patients as some patients had more than one source.

** There were 41 bleeding episodes in patients with splenorenal shunt for intrahepatic block. None of eight bleeding episodes in patients with extra-hepatic block was fatal.

of this report are less effective in preventing hemorrhages. This may be related to less adequate portal decompression following splenorenal shunt because of the smaller venous anastomoses. On the other hand, portacaval shunts, though achieving more effective decompression of the portal circulation, leave the patient vulnerable to more lethal metabolic complications following gastrointestinal hemorrhage in patients with inferior liver function who are selected for this procedure.

In the collected world experience, 13% of 194 patients with splenorenal shunts had postoperative encephalopathy in contrast to 22% of 432 patients with portacaval shunts,[3] and the results reported here confirm the more unfavorable results in the portacaval group. The role of splenectomy in preventing shunt encephalopathy seems hardly credible in our present state of knowledge, but splenectomy might be related to the higher incidence of lethal cerebrovascular accidents noted in Table 6. In experimental animals peripheral blood levels of ammonia following ingestion of ammonium salts are proportional to the size of the portacaval venous anastomosis,[10] and clinical differences in the incidence of shunt encephalopathy are likely related to the effectiveness of portal decompression by the two anastomoses. The effect of alterations in hepatic blood flow on liver function demonstrable in experimental circumstances,[9] has not been investigated in patients in relation to the incidence of encephalopathy.

The present study and reports in the cited review indicate that portacaval shunts are more effective in decompressing the portal circulation, but have the disadvantage of a higher incidence of encephalopathy. Splenorenal shunts have the disadvantage of a higher incidence of postoperative bleeding. In view of the relative simplicity of a portacaval shunt performed entirely below the diaphragm, in contrast to splenorenal shunts, consideration should be given to the construction of portacaval shunts so that the cross sectional area of

TABLE 6. *Summary of Deaths (1959–1965 Series)*

Primary Cause of Death	Portacaval Shunt		Splenorenal Shunt	
	No.	Per Cent	No.	Per Cent
Upper gastrointestinal hemorrhage	15	15	7	10
Liver failure and/or shunt encephalopathy	21	20	3	4
Bleeding diathesis during operation or immediate postoperative period	4	4	0	0
Heart disease	4	4	3	4
Malignancy	4	4	3	4
Cerebrovascular accident	1	1	4	6
Infection	0	0	3	4
Hepatitis, infectious	3	3	0	0
Other*	7	7	3	4
Patient alive	44	42	44	64
Total Patients	103	100	70	100

* Includes: Convulsions; fractures, multiple; gangrene of small bowel; hemorrhage from extraluminal esophageal varix into mediastinum; obstruction of small bowel; pulmonary embolism; suicide; thrombosis of mesenteric vein; and two unexplained deaths.

the anastomosis between the portal and systemic circulations is about 1.0 to 1.5 cm.[2] Conceivably this limitation in size would result in a decrease in the incidence of shunt encephalopathy following portacaval shunts. With better control of shunt encephalopathy, it may be possible to construct in every case the largest possible portacaval shunt and provide maximum protection against further hemorrhage.

Conclusions

A review of 21 years of portasystemic shunts performed in 410 patients as elective operations for control of bleeding esophageal varices presents evidence for the following conclusions:

1. Clinical selection of patients for shunt operations restricts the interpretation of differences in results following splenorenal or portacaval operations.

2. Survival data of patients operated upon in 1959–1965 show a 5-year survival rate of 39% and an 8-year survival of 33%. Survival data on patients operated upon in 1945–1958 show a 5-year survival rate of 47%, an 8-year survival of 34%, and a 20-year survival of 6%. The difference between these rates is not statistically significant, but the recent reduction of hospital mortality to 13% is significant (Table 4).

3. Patients selected for splenorenal shunts have recurrent episodes of upper gastrointestinal hemorrhage over one and a half times as frequently as patients with portacaval shunts (Table 5).

4. The incidence of post-shunt encephalopathy is greater in patients selected for portacaval shunts than in those undergoing splenorenal shunts.

5. The incidence of either fatal liver failure or shunt encephalopathy or both in patients selected for portacaval shunts is five times the incidence in patients selected for splenorenal shunts (Table 6).

6. Taken collectively, these observations indicate the results of portasystemic shunting are superior in patients selected for splenorenal shunts. They cannot establish which operation would be best in a given

individual. However, certain differences in results appear to be a consequence of unequal effectiveness of portal decompression and hepatic blood flow achieved by the two procedures.

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