A COMPARISON OF PARACENTESIS AND TRANSJUGULAR INTRAHEPATIC PORTOSYSTEMIC SHUNTING IN PATIENTS WITH ASCITES

MARTIN RÖSSLE, M.D., ANDREAS OCHS, M.D., VEIT GÜLBERG, M.D., VOLKER SIEGERSTETTER, M.D., JOSEPH HOLL, M.D., PETER DEIBERT, M.D., MANFRED OLSCHEWSKI, PH.D., MAXIMILIAN REISER, M.D., AND ALEXANDER L. GERBES, M.D.

ABSTRACT

Background In patients with cirrhosis and ascites, creation of a transjugular intrahepatic portosystemic shunt may reduce the ascites and improve renal function. However, the benefit of this procedure as compared with that of large-volume paracentesis is uncertain.

Methods We randomly assigned 60 patients with cirrhosis and refractory or recurrent ascites (Child–Pugh class B in 42 patients and class C in 18 patients) to treatment with a transjugular shunt (29 patients) or large-volume paracentesis (31 patients). The mean (±SD) duration of follow-up was 45±16 months among those assigned to shunting and 44±18 months among those assigned to paracentesis. The primary outcome was survival without liver transplantation.

Results Among the patients in the shunt group, 15 died and 1 underwent liver transplantation during the study period, as compared with 23 patients and 2 patients, respectively, in the paracentesis group. The probability of survival without liver transplantation was 69 percent at one year and 58 percent at two years in the shunt group, as compared with 52 percent and 32 percent in the paracentesis group ($P=0.11$ for the overall comparison, by the log-rank test). In a multivariate analysis, treatment with transjugular shunting was independently associated with survival without the need for transplantation ($P=0.02$). At three months, 61 percent of the patients in the shunt group and 18 percent of those in the paracentesis group had no ascites ($P=0.006$). The frequency of hepatic encephalopathy was similar in the two groups. Of the patients assigned to paracentesis in whom this procedure was unsuccessful, 10 received a transjugular shunt a mean of 5.5±4 months after randomization; 4 had a response to this rescue treatment.

Conclusions In comparison with large-volume paracentesis, the creation of a transjugular intrahepatic portosystemic shunt can improve the chance of survival without liver transplantation in patients with refractory or recurrent ascites. (N Engl J Med 2000;342: 1701-7.)

REFRACTORY or recurrent ascites is a clinical challenge frequently encountered in patients with cirrhosis.[1-3] The treatment options are repeated large-volume paracentesis, creation of a peritoneovenous shunt, creation of a portosystemic shunt, and liver transplantation.

Elevated portal-vein pressure is a main factor in the pathogenesis of ascites. A reduction in pressure by means of the surgical creation of a portosystemic shunt[4-6] or transjugular intrahepatic portosystemic shunt[7-15] has been shown to be followed by decreased formation of ascites. With the exception of a small, randomized study[16] that found an increased rate of death among patients with ascites who were in Child–Pugh class C and who received a transjugular shunt, the results with this approach have been promising.[17] Large-volume paracentesis is a safe and effective procedure[18-20] and is often regarded as the treatment of choice for patients with severe ascites. The drawbacks of this option, however, are numerous and include the need for frequent punctures, tense ascites during intervals between punctures, adverse effects from diuretics, the risk of spontaneous bacterial peritonitis, and the risk of the hepatorenal syndrome. To compare transjugular shunting with large-volume paracentesis, we conducted a prospective, randomized study of these two treatments in patients with refractory or recurrent ascites.

METHODS

Protocol

The study was approved by the local ethics committees of the university hospitals of Freiburg and Munich. Written informed consent was obtained from all patients. The primary end point of the study was survival without transplantation. Secondary end points were the response to treatment and the occurrence of procedure-related complications. The number of patients needed in the study was calculated on the basis of one-year rates of survival without transplantation of 35 percent among patients undergoing paracentesis[21] and 65 percent among patients receiving treatment with a transjugular shunt.[7] To detect such a difference in survival, a minimum of 60 patients were needed (type I error, 5 percent; type II error, 20 percent), with a recruitment period of two years and a follow-up period of one year, allowing for a dropout rate of 10 percent. Randomization was performed in blocks, with stratification according to sex and age (≤60 years vs. >60 years).

Patients with cirrhosis who had refractory ascites (33 patients) or recurrent ascites (27 patients) were included. Patients were considered to have refractory ascites if they had tense ascites that did not respond to at least four weeks of standard treatment (<60 mmol of sodium per day, 300 to 400 mg of spironolactone per day, and 120 mg of furosemide per day) or if they had evidence

From the Medizinische Klinik II (M.R., A.O., V.S., P.D.) and the Department of Medical Biometry (M.O.), Albrecht-Ludwigs-Universität, Freiburg, and the Medizinische Klinik II (V.G., J.H., A.L.G.) and the Institute of Diagnostic Radiology (M.R.), Klinikum Grosshadern, Ludwig-Maximilians-Universität, Munich — both in Germany. Address reprint requests to Dr. Rössle at the Albrecht-Ludwigs-Universität, Department of Gastroenterology, Hugstetterstr. 55, 79106 Freiburg, Germany, or at roessle@mm21.ukl.uni-freiburg.de.

of intolerance of this treatment (a serum sodium concentration of <125 mmol per liter or a serum creatinine concentration of >1.5 mg per deciliter [133 μmol per liter]). Recurrent ascites was defined as tense ascites that recurred on at least three occasions within a 12-month period despite standard treatment.[1]

Exclusion criteria were the presence of hepatic encephalopathy of grade 2 or more (indicated by somnolence), a serum bilirubin concentration greater than 5 mg per deciliter (86 μmol per liter), a serum creatinine concentration greater than 3 mg per deciliter (265 μmol per liter), portal-vein thrombosis, hepatic hydrothorax, advanced cancer, or failure of paracentesis (defined as the continued presence of ascites after treatment by this method or the need for large-volume paracentesis more than once per week).

Patients

Sixty of 155 consecutive patients admitted with refractory or recurrent ascites between February 1993 and July 1997 underwent randomization at one of the two centers (Freiburg or Munich). Seventy-two patients were not included because they met one or more of the exclusion criteria, and 23 were eligible but refused to participate in the study.

Care before and after Randomization

The diagnostic evaluation before and after randomization included analyses of urine and ascitic fluid, assessment of hepatic encephalopathy, and duplex sonography of the abdomen. After the creation of a shunt, the doses of diuretic agents were adjusted according to clinical need (assessed in terms of urine production, body weight, and the presence or absence of edema). Patients were discharged when their hepatic function and renal function were stable or improving; they were seen after 1, 3, 6, 9, and 12 months and then every 6 months or when clinically indicated. The shunts were examined by duplex sonography. In the case of shunt insufficiency, reestablishment of the shunt was performed only when severe ascites recurred.

The patients assigned to paracentesis received dietary treatment and treatment with diuretics given at tolerable doses. Large-volume paracentesis (of 4 or more liters) was followed by the administration of albumin (8 g per liter of ascitic fluid removed) only when clinically indicated. The patients were seen on the same schedule as those who received a shunt. All the patients were instructed not to drink alcohol.

Shunt Procedure

The technique of shunting and postprocedural care, including anticoagulant therapy with intravenous heparin (with doses adjusted to achieve a partial-thromboplastin time of 40 to 60 seconds) for one week and low-molecular-weight heparin (0.3 to 0.4 ml) for four weeks, have been described previously.[22] A puncture needle was advanced transjugularly into a hepatic vein. After successful puncture of the portal vein, a balloon-expandable Palmaz–Schatz stent (Johnson & Johnson Interventional Systems, Warren, N.J.) was implanted in 21 patients, and a self-expandable nitinol stent (Memotherm, Bard–Angiomed, Karlsruhe, Germany) in 8 patients. The mean (±SD) duration of the intervention was 76±38 minutes, and the fluoroscopy time 22±15 minutes.

Definitions

Survival without the need for transplantation was defined as the time from randomization to death or liver transplantation. A complete response was defined as the elimination of ascites, and a partial response as the presence of ascites not requiring paracentesis. Absence of a response was defined as the persistence of ascites requiring paracentesis. These definitions were used both for patients in the shunt group and for those in the paracentesis group. Failure of paracentesis was defined as the inability to remove the ascitic fluid or the need for large-volume paracentesis more than once per week. In the case of failure of paracentesis, the shunt procedure could be offered as a rescue treatment. Failure of the shunt treatment was defined as a lack of success in establishing the shunt or in reestablishing an effective shunt when required. Insufficiency of the shunt was identified when the gain in the portal-vein flow velocity, which was determined one to three days after the shunting procedure, decreased by more than 50 percent.

Latent hepatic encephalopathy was assessed with use of the number-connection test (Reitan A, >40 seconds).[23] Clinically overt encephalopathy was graded on a scale from 1 to 4 (where 1 indicates hypersomnia, 2 somnolence, 3 severe somnolence or stupor, and 4 severe stupor or coma) according to the method of Conn and Lieberthal[23] and was regarded as debilitating when it was classified as grade 2 or higher and was chronically present or frequently recurred.

Statistical Analysis

Data are presented as means ±SD for quantitative variables and as frequencies for qualitative variables. Comparisons between treat-

Table 1. Base-Line Characteristics of the 60 Patients.*

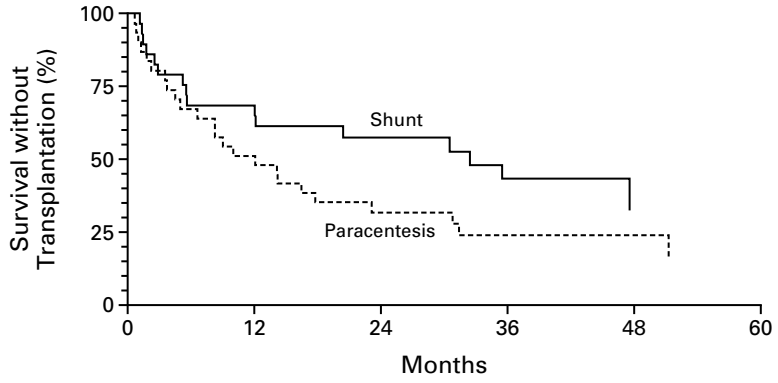
Variable	Transjugular Shunt (N = 29)	Paracentesis (N = 31)
Ascites — no.		
Refractory	17	16
Recurrent	12	15
Age — yr		
Mean	57.8±10.6	61.2±8.4
Range	40–74	44–76
Age ≤60 yr — no. (%)	16 (55)	16 (52)
Female sex — no. (%)	8 (28)	10 (32)
Alcoholic liver disease — no. (%)	24 (83)	23 (74)
Child–Pugh classification†		
Score	9.1±1.9	8.7±1.2
Class C — no. (%)	11 (38)	7 (23)
Bilirubin — mg/dl	1.8±1.2	1.8±1.0
Bilirubin concentration ≤3 mg/dl — no. (%)	23 (79)	26 (84)
Albumin — g/dl	3.5±0.6	3.5±0.4
Prothrombin time — sec‡	1.8±0.5	1.0±0.3
Serum creatinine — mg/dl	1.27±0.45	1.44±0.91
Serum sodium — mmol/liter	130.3±6.2	131.2±6.1
Serum sodium ≥125 mmol/liter — no. (%)	24 (83)	27 (87)
Urinary sodium excretion — mmol/day	45.0±61.0	61.3±52.1
Urinary sodium <10 mmol/day — no. (%)§	10 (40)	3 (10)
Duration of refractory or recurrent ascites before randomization — mo	7.8±8.4	9.6±9.3
Ascitic fluid		
White-cell count — per mm³	245±141	604±665
Protein — g/dl	1.74±0.94	1.90±0.95
Maximal flow velocity in portal vein — cm/sec	17.2±8.8	12.5±6.9

*Plus–minus values are means ±SD. Other values are numbers of patients (with percentages in parentheses). There were no differences between the groups in any variable except the white-cell count in the ascitic fluid. To convert the values for bilirubin to micromoles per liter, multiply by 17.1. To convert the values for creatinine to micromoles per liter, multiply by 88.4.

†The Child–Pugh classification is a measure of liver function on a scale of 5 to 15, where a score of 10 or higher defines class C, indicating advanced disease, severely decreased liver function, and increased mortality.

‡Values are given as seconds above the normal value.

§Urinary sodium excretion could be evaluated in 25 patients in the shunt group and 29 patients in the paracentesis group.



No. at Risk						
Shunt	29	20	15	9	3	0
Paracentesis	31	16	9	6	5	1

Figure 1. The Probability of Survival without Transplantation among Patients Assigned to Undergo Transjugular Intrahepatic Portosystemic Shunting or Paracentesis.

ment groups were based on the intention-to-treat principle and were performed with Wilcoxon rank-sum tests for quantitative data and with Fisher's exact test for qualitative data. The probability of survival without the need for transplantation was estimated by the Kaplan–Meier method. The prognostic value of the treatment assignment and of selected clinical variables with respect to the primary end point was assessed in univariate analyses with the log-rank test and in multivariate analyses with the Cox proportional-hazards model.[24] Quantitative covariates were dichotomized according to predefined, clinically relevant cutoff points and were entered into the multivariate model when the P value was less than 0.2 by the univariate log-rank test. The results of the multivariate analysis are presented as estimated relative risks with corresponding 95 percent confidence intervals and P values calculated with Wald's test.[24] The assumptions of the Cox model were checked by introducing time-dependent covariates into the model.

All tests of significance were two-sided, and a P value of less than 0.05 was considered to indicate statistical significance. Data processing and analysis were performed with SAS software (SAS Institute, Cary, N.C.).

RESULTS

There were 29 patients in the shunt group and 31 in the paracentesis group. The base-line characteristics were similar in the two groups (Table 1). The two groups differed with respect to the white-cell count in the ascitic fluid because of lymphocytic ascites in two patients in the paracentesis group (1500 and 2500 white cells per cubic millimeter, respectively, constituting 6 and 2 percent of the polymorphonuclear cells), with ascitic-fluid cultures negative for bacteria. The mean duration of follow-up was 45±16 months in the shunt group and 44±18 months in the paracentesis group. No patients were lost to follow-up. The mean shunt diameter, determined sonographically, was 9±0.2 mm, resulting in a reduction of 58 percent in the portosystemic pressure gradient, from 24±6 mm Hg at base line to 10±4 mm Hg at the time of shunt placement. During follow-up, 13 patients had shunt insufficiency; 11 (38 percent of the patients in the shunt group) underwent reestablishment of the shunt after 10±16 months. A second reestablishment was required in five patients (17 percent). There were no procedure-related deaths or long-term illnesses related to technical problems with the shunting procedure.

Survival

Fifteen patients in the shunt group and 23 patients in the paracentesis group died. In most of these patients (60 percent of those in the shunt group who died and 70 percent of those in the paracentesis group who died) death was due to multiorgan failure. Other causes of death were variceal bleeding (one patient in the shunt group and four in the paracentesis group), other diseases (two in the shunt group [lung cancer and heart disease] and one in the paracentesis group [myocardial infarction]), and unknown causes (three in the shunt group and two in the paracentesis group). One patient in the shunt group and two in the paracentesis group received a liver transplant and were alive 4, 8, and 60 months, respectively, after transplantation.

As shown in Figure 1, the estimated probability of survival without transplantation was 69 and 58 percent at one and two years, respectively, in the shunt group and 52 and 32 percent in the paracentesis group (P=0.11 by the log-rank test). Ten patients in the paracentesis group required rescue shunt treatment. Within this subgroup, the probability of survival without transplantation at one and two years was 70 and 38 percent, respectively.

To evaluate the independent prognostic effect of the treatment assignment and clinically relevant variables on the primary end point, we developed a multivariate Cox proportional-hazards model and entered

TABLE 2. FACTORS PREDICTING SURVIVAL WITHOUT THE NEED FOR TRANSPLANTATION.*

VARIABLE	UNIVARIATE ANALYSIS		MULTIVARIATE ANALYSIS	
	RELATIVE RISK (95% CI)	P VALUE	RELATIVE RISK (95% CI)	P VALUE
Assignment to treatment with transjugular shunt	0.60 (0.32–1.13)	0.11	0.44 (0.22–0.87)	0.02
Age ≤60 yr	0.48 (0.26–0.90)	0.02	0.35 (0.18–0.71)	0.003
Female sex	0.57 (0.27–1.18)	0.13	0.38 (0.17–0.85)	0.02
Bilirubin ≤3 mg/dl	0.43 (0.21–0.89)	0.02	0.38 (0.18–0.83)	0.02
Serum sodium ≥125 mmol/liter	0.29 (0.13–0.65)	0.003	0.27 (0.11–0.61)	0.002

*To convert the value for bilirubin to micromoles per liter, multiply by 17.1. CI denotes confidence interval.

into it covariates with a P value of less than 0.2 by the univariate log-rank test. These covariates included an age of 60 years or less, female sex, cirrhosis of Child–Pugh class B, a bilirubin concentration of 3 mg per deciliter (51.3 μmol per liter) or less, and a serum sodium concentration of 125 mmol per liter or greater (Table 2). The other characteristics in Table 1 were associated with P values of 0.2 or higher and were therefore not included in the multivariate analysis.

According to the multivariate analysis, transjugular shunting had an independent effect on survival without the need for transplantation (P=0.02) (Table 2). In addition, an age of 60 years or less, female sex, a bilirubin concentration of 3 mg per deciliter or less, and a serum sodium concentration of 125 mmol per liter or greater had independent effects on survival without transplantation. The Child–Pugh class did not have a significant effect in the multivariate analysis (P=0.51).

TABLE 3. RATES OF RESPONSE ACCORDING TO THE INTENTION TO TREAT.*

RESPONSE	TRANSJUGULAR SHUNT	PARACENTESIS
	no. of patients (%)	
At three months		
Complete†	14 (61)	4 (18)
Partial	6 (26)	3 (14)
None	3 (13)	15 (68)
At six months		
Complete‡	15 (79)	5 (24)
Partial	1 (5)	4 (19)
None	3 (16)	12 (57)

*The response at three months was evaluated in 23 patients in the shunt group and 22 patients in the paracentesis group, and the response at six months was evaluated in 19 patients and 21 patients, respectively. (The 10 patients who died during the first three months after randomization were not included. In addition, follow-up information was missing for three patients in the paracentesis group and two patients in the shunt group.)

†P=0.006 for the comparison between groups.

‡P=0.001 for the comparison between groups.

Response

During the first six months of follow-up, the patients in the shunt group required a total of 21 large-volume paracenteses (0.7 per patient), whereas the patients in the paracenteses group required 280 (9 per patient), with a mean of 63 liters removed. Patients' body weight did not change during the first six months of follow-up (68±12 kg at base line and 66±13 kg after six months in the shunt group; 70±15 kg and 71±14 kg, respectively, in the paracentesis group). The use of spironolactone during this period decreased from 253±92 to 167±101 mg per day in the shunt group and remained almost unchanged in the paracentesis group (174±81 mg per day at base line and 168±82 mg per day at six months; P=0.04 for the difference between groups).

At three months the rate of complete response was significantly greater in the shunt group than in the paracentesis group (Table 3). In two patients in whom shunt treatment failed, paracentesis was performed until the time of death (170 and 370 days after randomization). Although these shunts were insufficient, they were not reestablished, in order to avoid exacerbating the patients' overt hepatic encephalopathy and severe liver insufficiency. In one patient in the shunt group, the implantation failed when first attempted but was successful 15 months later. The six-month response rates were similar to the three-month rates (Table 3).

During follow-up, 3 patients in the shunt group and 15 in the paracentesis group did not have a response to treatment. Ten of the 15 patients without a response in the paracentesis group received a shunt as rescue treatment a mean of 5.5±4 months after randomization. Four of these 10 patients (40 percent) had a partial or complete response to the rescue shunt procedure (a figure equivalent to the 44 percent of 9 patients with a partial or complete response in the

TABLE 4. EFFECT OF THE TREATMENTS ON LIVER FUNCTION.*

VARIABLE	BASE LINE (ALL PATIENTS)		BASE LINE (PATIENTS AT RISK)		FOLLOW-UP AT SIX MONTHS	
	SHUNT (N=29)	PARACENTESIS (N=31)	SHUNT (N=19)	PARACENTESIS (N=21)	SHUNT (N=19)	PARACENTESIS (N=21)
Child–Pugh score	9.0±1.9	8.7±1.2	8.5±1.7	8.4±1.0	6.6±1.7	7.0±1.5
Bilirubin (mg/dl)†	1.8±1.2	1.8±1.0	1.7±1.1	1.4±0.8	2.9±3.7	1.7±1.0
Albumin (g/dl)	3.5±0.6	3.5±0.4	3.6±0.6	3.6±0.4	3.9±0.6	3.8±0.6
Prothrombin time (sec)‡	1.8±0.5	1.0±0.3	2.2±0.4	1.1±0.4	2.1±0.3	0.9±0.2

*Liver function was assessed in 19 patients in the shunt group and 21 patients in the paracentesis group before randomization and at six months of follow-up. For comparison, base-line liver-function data for all patients are also presented. The changes observed during the six-month interval did not differ statistically between the treatment groups.

†To convert the values for bilirubin to micromoles per liter, multiply by 17.1.

‡Values are given as seconds above the normal value.

paracentesis group). One of the four patients with a response to rescue shunting had a relapse but had a response to reestablishment of the shunt four years later. In two of the six patients who did not have a response to the rescue shunt treatment, overt hepatic encephalopathy developed; in these two patients, a reduction in the shunt flow was achieved by the implantation in the former shunt tract of an hourglass-shaped stent with a minimal inner diameter of 4 mm.[25]

Hepatic and Renal Function

Among the patients surviving at six months, measurements of hepatic function at base line and follow-up were similar in the two groups, as were the changes in these values during this period (Table 4). Within each group the Child–Pugh score improved significantly, by 22 percent in the shunt group and 17 percent in the paracentesis group ($P<0.001$). The other measurements did not change significantly.

In the shunt group, the incidence of hepatic encephalopathy increased from 46 percent (12 of 26 patients who could be evaluated) at base line to 58 percent (15 of 26) during follow-up. Of these 26 patients, 3 (12 percent) had improvement and 6 (23 percent) had new or worsened hepatic encephalopathy. In the paracentesis group, the incidence of hepatic encephalopathy increased from 39 percent (12 of 31 patients who could be evaluated) at base line to 48 percent (11 of 23) during follow-up. Of these 23 patients, 3 (13 percent) had a deterioration in condition and 1 (4 percent) improved. In three patients (one in the shunt group and two in the paracentesis group who received a rescue shunt), debilitating hepatic encephalopathy developed. In these patients, the shunt flow was reduced 7, 180, and 185 days, respectively, after implantation.[25] There were no significant differences between the groups in the results of tests of liver function or in the incidence of hepatic encephalopathy during follow-up.

At the six-month follow-up, data on urinary variables were obtained for 11 patients in the shunt group and 12 patients in the paracentesis group. Among patients in the shunt group, the creatinine clearance rate increased from 41±27 ml per minute at base line to 61±36 ml per minute at six months, and the urinary sodium excretion increased from 56±87 to 112±62 mmol per day. Among the patients who underwent paracentesis, these variables remained unchanged over six months (creatinine clearance, 55±33 and 56±44 ml per minute; urinary sodium excretion, 64±51 and 63±47 mmol per day). The change in urinary sodium excretion was larger in the shunt group than in the paracentesis group ($P=0.05$).

Hospitalization

During follow-up after randomization, the patients in the shunt group spent a total of 52±29 days in the hospital, as compared with 72±48 days among those in the paracentesis group ($P=0.33$).

DISCUSSION

We found that, as compared with large-volume paracentesis, transjugular shunting can improve the rate of survival without transplantation among patients with refractory or recurrent ascites. Although the difference between treatment groups was not significant in a univariate analysis, it was significant in a multivariate analysis that adjusted for slight differences in clinical variables that have a prognostic effect and that favor the paracentesis group. Although none of these differences were significant when the base-line characteristics of the groups were compared, in aggregate they may have affected the difference between treatment groups in the rate of survival without transplantation in the univariate comparison. However, the results of the multivariate analysis should be interpreted with caution, since they are based on data from a relatively small number of patients.

In addition to the shunt treatment, factors significantly related to survival without the need for transplantation were age (≤60 years), sex (female), bilirubin concentration (≤3 mg per deciliter) and serum

sodium concentration (≥125 mmol per liter) but not the Child–Pugh class. The correlation with sex may be due to a difference between men and women in the causes of liver disease that make nonalcoholic liver disease more likely to occur in women.

The one-year probability of survival without the need for transplantation in the paracentesis group was similar to that described in other reports.[21,26-29] In our study, in contrast to those studies, however, rescue therapy by shunting was an option for patients in whom paracentesis failed. In the subgroup of patients who received rescue treatment (32 percent of the paracentesis group), survival was somewhat better than in the overall paracentesis group, suggesting that this rescue option may have improved survival. Our results are in clear contrast to those of the randomized study by Lebrec et al.[16] The one-year survival in their shunt group was 29 percent, whereas the survival among patients in their paracentesis group was significantly greater, at more than 70 percent. The difference may be due to the small number of patients (25) in their study and to the high rate of failure of the shunt procedure (3 of 13 patients).

The response to treatment was evaluated three months or more after randomization. This interval was chosen because it was regarded as adequate to allow both stabilization of the patient's condition and assessment of the out-of-hospital course of the disease. Patients who died within the three-month period were not included in the analysis of response. Response rates at six months and during the remainder of follow-up were similar to the three-month rates.

In contrast to the treatment of variceal bleeding,[17,30] shunt treatment was not associated with a significantly increased incidence of hepatic encephalopathy. Nine of the patients assigned to paracentesis (about one third) had a partial or complete response to treatment at six months. However, four of these nine patients had received rescue treatment with a shunt after paracentesis failed.

Intention-to-treat analysis showed that both treatments had a positive effect on the Child–Pugh score, an effect that was mainly due to improvement in ascites. With respect to hepatic encephalopathy, our finding that the incidence was similar in the two groups was surprising. As demonstrated previously,[7,8] the incidence of hepatic encephalopathy among patients with refractory ascites is more than 40 percent. This high rate may be due to factors such as hypovolemia, renal impairment, and electrolyte imbalance. All these factors improve after the shunt is established and may compensate for a negative effect of shunting. With regard to renal function, our most prominent finding was a significant increase in sodium excretion after shunting. This effect correlates inversely with liver function, supporting our view that shunting may also be beneficial for patients with more advanced disease.[31]

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