CLINICAL STUDY

Radiologically Placed Peritoneovenous Shunt is an Acceptable Treatment Alternative for Refractory Ascites Due to End-Stage Liver Disease

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ABSTRACT

Purpose: To compare patients treated with large-volume paracentesis (LVP), transjugular intrahepatic portosystemic shunt (TIPS), and peritoneovenous shunt (PVS) for ascites.

Materials and Methods: A retrospective study of 192 patients treated with LVP (94), TIPS (75), or PVS (23) was performed. Records were reviewed for patient characteristics and outcomes. The patients' age differed (LVP, 59.5 years; TIPS, 58.8 years; and PVS, 65.6 years; $P = .003$). Nonalcoholic steatohepatitis was the most common etiology in the PVS cohort (11/23, 47%), and hepatitis C in the TIPS (27/75, 36%), and LVP cohorts (43/94, 46%) ($P = .032$). The model for end-stage liver disease score was significantly different (LVP, 14; TIPS, 13; and PVS, 8; $P = .035$). Hepatocellular carcinoma was higher in the PVS cohort (6/23 patients, 25%) than in the TIPS (4/75, 5%), and LVP (12/94, 12%) cohorts ($P = .03$).

Results: Emergency department visits and hospital readmissions were the highest in the LVP cohort (40%, $\geq$2 readmissions, $P < .001$). Patients required fewer LVPs after TIPS (1.5 to 0.14, $P < .001$) or PVS (2.1 to 0.5, $P = .019$). In an unadjusted Cox model, patients in the TIPS cohort were found to have a 58% reduction in the risk of death compared with patients in the LVP cohort ($P = .003$). Transplant-free survival (PVS, 44 days; TIPS, 155 days; and LVP, 213 days) differed (log rank = 0.001).

Conclusions: The survival in the PVS and TIPS cohorts was similar, with less healthcare utilization than the LVP cohort. PVS is a satisfactory alternative to LVP.

ABBREVIATIONS

ED = emergency department, HCC = hepatocellular carcinoma, LVP = large-volume paracentesis, MELD = model for end-stage liver disease, PVS = peritoneovenous shunt, TIPS = transjugular intrahepatic portosystemic shunt

The development of ascites is the most common complication of end-stage liver disease and is associated with a poor prognosis (1). Ascites refractory to diuretics is associated with high morbidity (2) and a 1-year mortality rate of as high as 50% for individuals between 50 and 60 years of age (3,4). Palliative interventions include serial large-volume paracentesis (LVP), transjugular intrahepatic portosystemic shunt (TIPS) creation, and peritoneovenous shunt (PVS) placement (4). A 2014 meta-analysis (5) and a 2017 prospective randomized study (6) found that patients

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RESEARCH HIGHLIGHTS

- Treatment options for patients with refractory, nonmalignant ascites were compared retrospectively. Large volume paracentesis (LVP), peritoneovenous shunt (PVS) placement, and transjugular intrahepatic portosystemic shunts (TIPS) creation were compared.
- Patients in the PVS cohort were older and had a higher incidence of hepatocellular carcinoma.
- Patients in the TIPS cohort had the longest median survival and required fewest healthcare encounters; patients in the LVP cohort had shortest survival and the most encounters.
- Patients not eligible for TIPS creation may be offered PVS, which is associated with lower morbidity.

STUDY DETAILS

Study type: Clinical Study
Study phase: Retrospective, observational, cohort study

who underwent TIPS creation had improved transplant-free survival compared with patients who underwent serial paracentesis. Comparisons of TIPS and PVS have found that although PVS improves ascites accumulation sooner, TIPS reduces ascites in the long term (7).

Less data exist comparing the outcomes of serial LVP, TIPS creation, and PVS placement, performed by interventional radiologists (8). This study was a retrospective analysis of patients who underwent serial LVP alone, TIPS creation, or PVS placement for nonmalignant ascites at a tertiary care hospital between 2009 and 2017 and compared baseline characteristics, healthcare utilization, overall survival, and transplant-free survival across the cohorts, and also compared the requirement for paracentesis and the primary patency rates between the TIPS and PVS cohorts.

MATERIALS AND METHODS

Study Population and Clinical Data

Institutional review board approval was obtained, and informed consent was waived. Data on patient characteristics, disease etiology and severity, as well as survival and clinical outcomes were gathered from a review of electronic medical records. The study data were collected and stored using REDCap electronic data capture tools hosted at the University of Pennsylvania (9,10). The study population included patients who underwent serial LVP (defined as $\geq$3 procedures over 6 months or 2 procedures within 6 weeks) or underwent TIPS creation or PVS placement between April 2009 and December 2017 for the treatment of refractory ascites secondary to cirrhosis (n = 192). The study timeframe corresponded with the year in which the authors' institution began performing radiologic PVS placement. Patients were included from the date of the first procedure (LVP, PVS, or TIPS) until the time of death, last healthcare encounter, or liver transplant. Patients who underwent LVPs prior to TIPS creation or PVS placement were included in the study from the date of the first paracentesis. Refractory ascites was defined as ascites that could not be mobilized or prevented by medical therapy (11). Patients who underwent LVP or PVS placement exclusively for the management of malignant ascites or TIPS creation for the management of variceal bleeding were excluded (n = 836).

The patients were categorized based on treatment: serial LVP, 94 patients; TIPS creation, 75 patients; and PVS placement, 23 patients. The electronic medical records were reviewed for the following information: age, sex, race, etiology of liver disease, medical comorbidities, and transplant eligibility. The dates of all LVPs, revisions, outpatient visits, deaths, emergency department (ED) visits, and hospital readmissions were recorded. Laboratory values used to calculate model for end-stage liver disease (MELD) and Child–Turcotte–Pugh scores were recorded based on all healthcare encounters.

Baseline Characteristics. Table 1 summarizes the baseline characteristics of the patient population.

Age at the time of the first procedure differed significantly among the 3 cohorts, with PVS recipients being the oldest (median age, 65.6 vs 59.5 years for LVP alone and 58.8 for TIPS, $P = .003$). Nonalcoholic steatohepatitis was the most common etiology of liver disease in the PVS cohort (11/23 patients, 48%), whereas hepatitis C virus infection was the most common in the TIPS (27/75 patients, 36%) and LVP (43/94 patients, 46%, $P = .032$) cohorts. The PVS cohort had the greatest proportion of patients with hepatocellular carcinoma (HCC) (6/23, 26%, $P = .03$). The MELD score at the time of the first procedure was significantly different ($P = .035$), with the highest MELD score in the LVP cohort (median, 14), followed by that in the TIPS (median, 13) and PVS (median, 8) cohorts. The median Child–Turcotte–Pugh scores were significantly different between the cohorts (TIPS and LVP, 10; PVS, 9; $P = .043$).

No significant differences were found in terms of sex, transplant candidacy, history of variceal bleeding, baseline hepatic encephalopathy, or comorbidities, including heart failure, pulmonary hypertension, and diabetes mellitus.

Procedures

PVS Placement. PVS was placed with the patients under general anesthesia, with local anesthesia using 1% lidocaine with epinephrine. All equipment used was supplied in the PVS placement kit (BD, Franklin Lakes, New Jersey). The abdomen, chest wall, and lower neck were prepared and draped in a sterile fashion. Under ultrasound guidance, an 18-gauge needle was inserted into the ascites. A 0.035-inch

Table 1. Baseline Characteristics

N	PVS	TIPS	LVP	*P* value
	23	75	94	
Age, median (IQR)	65.6 (61.4, 73.6)	58.8 (52.7, 64.9)	59.5 (53.9, 66.1)	.003
Etiology				
HCV	4 (17%)	27 (36%)	43 (46%)	.032
NASH	11 (48%)	19 (25%)	17 (18%)	
Alcohol	7 (30%)	17 (23%)	27 (29%)	
Other*	2 (8%)	12 (16%)	7 (7%)	
Hepatocellular carcinoma				
Yes	6 (26%)	4 (5%)	12 (13%)	
No	18 (74%)	71 (95%)	82 (87%)	.030
MELD score (median, IQR)	8.0 (7.0, 15.0)	13.0 (7.0, 19.0)	14.0 (8.5, 19.5)	.035
CTP (median, IQR)	9 (8.0,11.0)	10.0 (9.0,11.0)	10.0 (9.0,12.0)	.043

CTP = Child–Turcotte–Pugh; HCV = hepatitis C virus; IQR = interquartile range; LVP = large-volume paracentesis; MELD = model for end-stage liver disease; NASH = nonalcoholic steatohepatitis; PVS = peritoneovenous shunt; TIPS = transjugular intrahepatic portosystemic shunt.
*Autoimmune hepatitis, hepatitis B virus, primary biliary cirrhosis, primary sclerosing cholangitis, and cryptogenic cirrhosis.

guide wire was advanced into the peritoneal cavity under fluoroscopic guidance. A multiside hole drainage catheter was inserted and connected to wall suction. Following ascites drainage, 1–2 L of warmed sterile saline was administered into the peritoneal cavity through the drainage catheter. A pump pocket was created overlying the lower ribs using a blunt dissection. Using real-time ultrasound guidance, the internal jugular vein was accessed using a 21-gauge needle and micropuncture set (Cook Medical, Bloomington, Indiana), and a 0.035-inch guide wire was advanced into the superior vena cava. The PVS was primed by pumping it 10 times with a venous limb submerged in the sterile saline. The pump was placed into the pump pocket, the peritoneal portion was tunneled under the skin toward the site of peritoneal access, and the jugular portion was tunneled subcutaneously to the site of jugular vein access. The peritoneal drainage catheter was removed, and the peritoneal limb of the PVS was inserted through a 16-F peel-away sheath into the peritoneal cavity. The pump chamber was pumped until fluid ran freely from the venous limb. A 12-F or 16-F peel-away sheath was inserted into the jugular vein over the 0.035-inch guide wire, and the jugular limb of the shunt was inserted with the tip into the mid right atrium. The skin incisions were closed using a 4-0 absorbable suture and skin glue. The PVS was pumped 20 times after skin closure.

TIPS Creation. TIPS creation was performed with the patients under general anesthesia with real-time ultrasound guidance for jugular vein access using a previously described technique (12). For all TIPS creations, the Rosch-Uchida transjugular liver access set (Cook Medical) was used.

LVP. LVPs were performed with the patients under local anesthesia using real-time ultrasound guidance. The abdominal wall was punctured along the paracolic gutter containing a greater amount of ascites, determined using preliminary ultrasound. All therapeutic paracenteses were performed using the 6-F Safe-T-Centesis Drainage System (BD). Patients who underwent therapeutic paracentesis had a minimum of 1.5 L of ascites drained. Patients who had >5 L of ascites drained received intravenous albumin repletion.

Statistical Analysis

An analysis of variance or the Kruskal-Wallis test was performed to compare continuous baseline characteristics and healthcare utilization across the 3 cohorts. The chi-square test was performed to compare the number of patients in each cohort who had ≥2 ED visits or hospital readmissions. The paracentesis requirement before and after TIPS creation or PVS placement was calculated as the total number of paracenteses divided by the number of months of follow-up.

An unadjusted Cox proportional hazards model was used to compare the hazard of death across the cohorts. An adjusted Cox proportional hazards model was used to compare the hazard of death across the cohorts while controlling for differences. Unadjusted Kaplan–Meier survival curves were generated to compare the time to the first paracentesis and primary patency between the TIPS and PVS cohorts as well as the overall and transplant-free survivals among all the cohorts. All statistical analyses were performed using Stata, version 15, for Mac OsX (StataCorp, College Station, Texas).

Study Endpoints

Primary Endpoints. Healthcare utilization was measured based on ED visits and hospital readmissions. The overall survival was calculated as the time from the first procedure to the time of death. The transplant-free survival was calculated as the number of days from the first LVP, TIPS

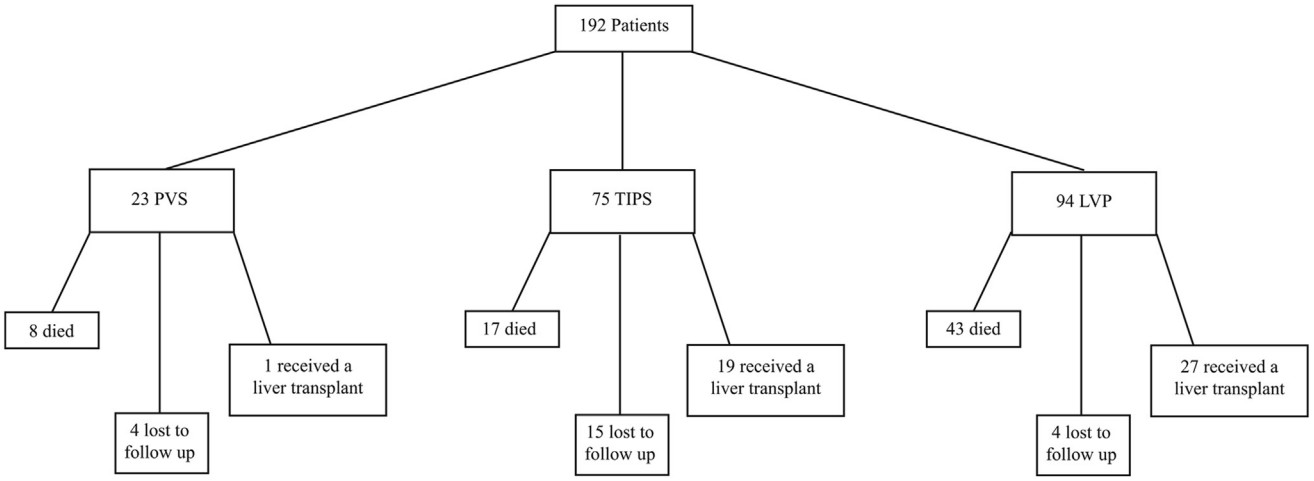

Figure 1. Patient inclusion and follow-up. LVP = large-volume paracentesis; PVS = peritoneovenous shunt; TIPS = transjugular intrahepatic portosystemic shunt.

Table 2. Adverse Events

N	PVS	TIPS	LVP	*P* value
	23	75	94	
SBP	2 (9%)	6 (8%)	9 (10%)	.938
Encephalopathy				
Lactulose	5 (22%)	14 (19%)	10 (11%)	.007
Rifaximin	2 (9%)	19 (25%)	19 (20%)	
Hospital admission	3 (13%)	19 (25%)	10 (11%)	
Bacteremia or sepsis	1 (4%)	4 (5%)	6 (6%)	.915

LVP = large-volume paracentesis; PVS = peritoneovenous shunt; SBP = spontaneous bacterial peritonitis; TIPS = transjugular intrahepatic portosystemic shunt.

creation, or PVS placement until transplant or death. Patients were considered lost to follow-up if they had no healthcare encounters for half of the study period or if the date of their death was unknown. The survival analysis was censored for these patients and for patients who underwent a liver transplant during the study period.

Secondary Endpoints. The total number of LVPs required before and after TIPS creation or PVS placement was calculated. The time to the first paracentesis was defined as the number of days from TIPS creation or PVS placement to the first LVP for ascites reaccumulation. Primary patency was defined as the time from TIPS creation or PVS placement to the first revision or removal. Primary patency rate was defined as the absolute number of patients who did not require a revision or removal after TIPS creation or PVS placement at a given point in time.

RESULTS

The median follow-up time was 273 days (95% CI, 228–350). Of the 192 patients, 69 (36%) died. Seventy-two (37%) patients were eligible for liver transplant, and of these, 48 (67%) underwent a transplant during the study period. Twenty-two (11%) patients were lost to follow-up (Fig 1).

Adverse Events

The adverse events included hepatic encephalopathy and infection, such as spontaneous bacterial peritonitis. The new incidence of hepatic encephalopathy significantly differed between the cohorts. A total of 10 (43%) of 23 patients in the PVS cohort had an episode of hepatic encephalopathy, which was treated with lactulose (5 patients), rifaximin (2 patients), or hospital admission (3 patients). A total of 52 (69%) of 75 patients in the TIPS cohort had an episode of hepatic encephalopathy, which was treated with lactulose (14 patients), rifaximin (19 patients), or hospital admission (19 patients). Patients with TIPS who had encephalopathy were also treated with TIPS reduction. A total of 39 (41%) of 94 patients in the LVP cohort had an episode of hepatic encephalopathy, which was treated with lactulose (10 patients), rifaximin (19 patients), or hospital admission (10 patients) ($P = .007$) (Table 2).

Healthcare Utilization

Patients in the LVP cohort required the most ED visits, involving 44 (47%) patients compared with 15 (20%) patients in the TIPS cohort and 7 (30%) patients in the PVS cohort ($P = .001$) (Fig 2a). In the LVP cohort, 37 (40%) patients had ≥ 2 hospital readmissions compared with 8 (11%) patients in the TIPS cohort and 3 (13%) patients in the PVS cohort ($P < .001$) (Fig 2b).

The reasons for ED visits among patients with PVS were ascites (3 visits, 17%), encephalopathy (3 visits, 17%), and infections (2 visits, 11%). Patients with TIPS visited EDs for encephalopathy (12 visits, 23%) and ascites (6 visits, 11%). Patients in the LVP cohort visited EDs for ascites (25 visits, 20%), encephalopathy (19 visits, 16%), and infection, most

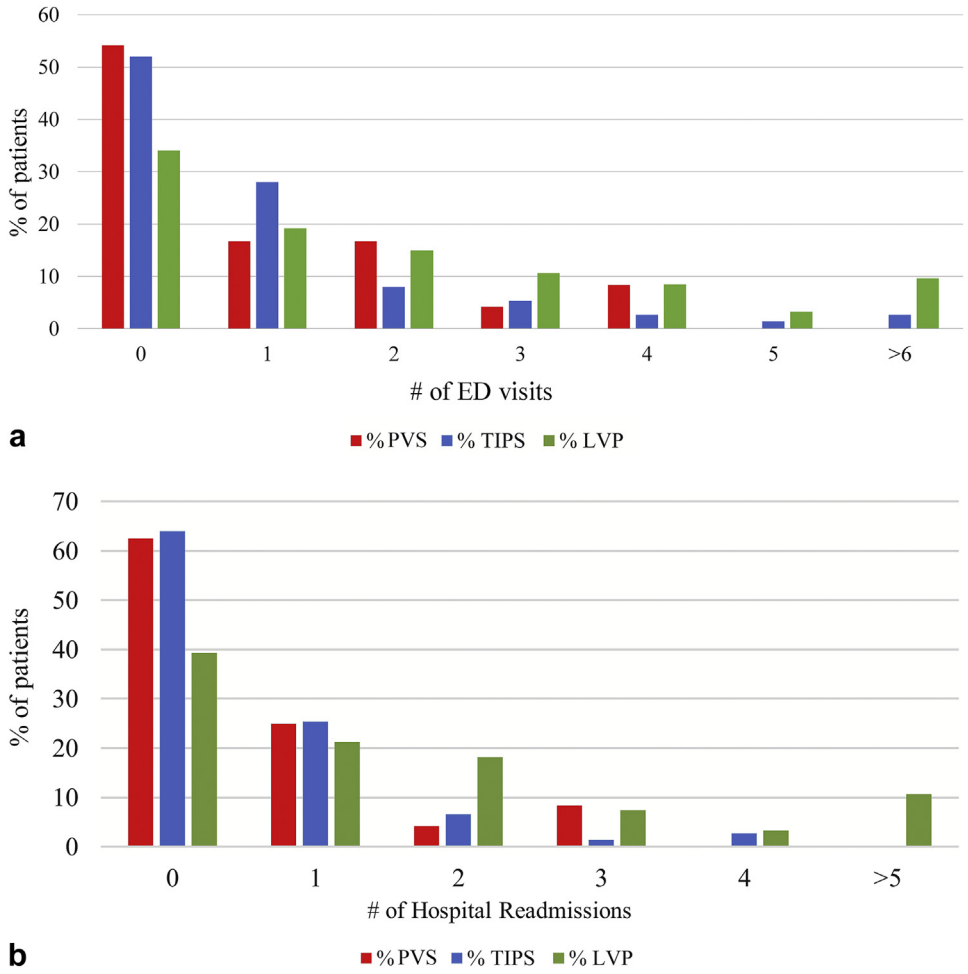

Figure 2. Emergency department visits based on cohort **(a)**. Hospital readmissions based on cohort (**b**). ED = emergency department; PVS = peritoneovenous shunt; LVP = large-volume paracentesis; TIPS = transjugular intrahepatic portosystemic shunt.

Table 3. Reasons for Emergency Department Visits, Based on Cohort

Reason	PVS	TIPS	LVP
N	23	75	94
Ascites	3 (17%)	6 (11%)	25 (20%)
Encephalopathy	3 (17%)	12 (23%)	19 (16%)
Kidney injury	0 (0%)	3 (6%)	7 (6%)
Edema	0 (0%)	1 (2%)	2 (2%)
Jaundice	0 (0%)	1 (2%)	0 (0%)
Infection	2 (11%)	0 (0%)	14 (11%)
Other	10 (56%)	30 (57%)	55 (45%)
Total no. of visits	18	53	122

LVP = large-volume paracentesis; PVS = peritoneovenous shunt; TIPS = transjugular intrahepatic portosystemic shunt.

Table 4. Reasons for Hospital Readmissions, Based on Cohort

Reason	PVS	TIPS	LVP
N	23	75	94
Ascites	14 (22%)	43 (23%)	37 (19%)
Encephalopathy	9 (14%)	31 (17%)	31 (16%)
Kidney injury	6 (9%)	14 (8%)	15 (8%)
Edema	3 (5%)	3 (1.6%)	3 (2%)
Jaundice	1 (2%)	1 (0%)	0 (0%)
Infection	8 (12%)	20 (11%)	24 (12%)
Other	24 (37%)	74 (40%)	87 (44%)
Total no. of readmissions	65	186	197

LVP = large-volume paracentesis; PVS = peritoneovenous shunt; TIPS = transjugular intrahepatic portosystemic shunt.

commonly spontaneous bacterial peritonitis (14 visits, 11%) (Table 3). The number of patients with at least 2 ED visits differed significantly (PVS, 7; TIPS, 15; and LVP, 44; $P = .001$).

Patients with PVS were admitted to the hospital for ascites (14 readmissions, 22%), encephalopathy (9 readmissions, 14%), and infection (8 readmissions, 12%). Patients with TIPS were admitted to the hospital for ascites

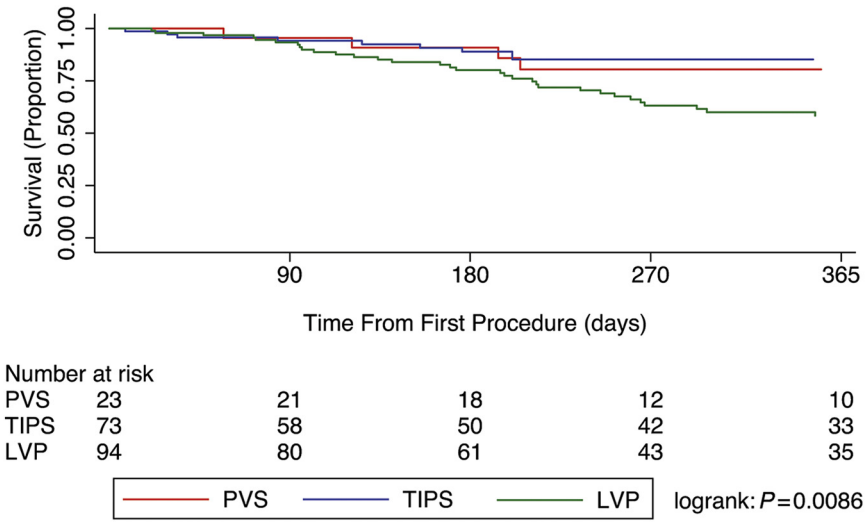

Figure 3. Overall patient survival based on cohort. LVP = large-volume paracentesis; PVS = peritoneovenous shunt; TIPS = transjugular intrahepatic portosystemic shunt.

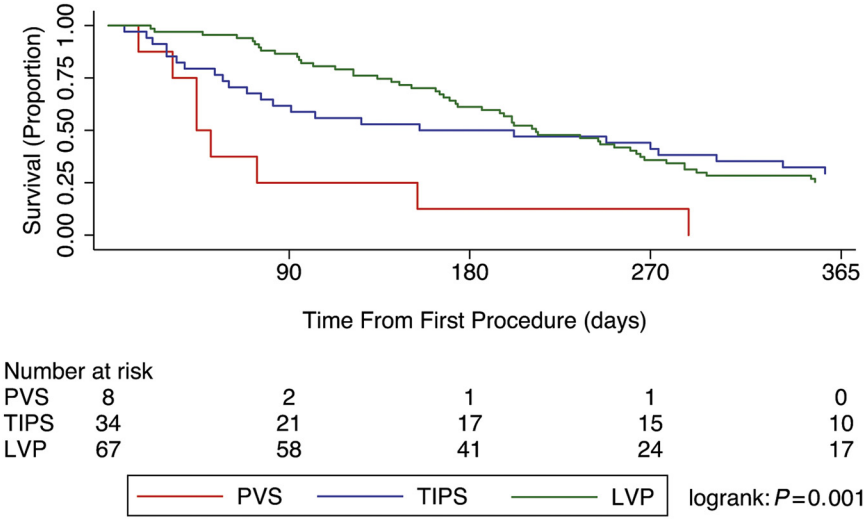

Figure 4. Transplant-free survival based on procedure type. LVP = large-volume paracentesis; PVS = peritoneovenous shunt; TIPS = transjugular intrahepatic portosystemic shunt.

(43 readmissions, 23%), encephalopathy (31 readmissions, 17%), and infection (20 readmissions, 10%). The most common reasons for hospital readmission among patients in the LVP cohort were ascites (37 readmissions, 19%), encephalopathy (31 readmissions, 16%), and infection (24 readmissions, 12%) (Table 4).

Survival Analysis

The survival analysis was censored for patients who underwent a liver transplant during the study period and patients who were lost to follow-up. Patients in the TIPS cohort had the longest median survival (2,042 days), followed by those in the PVS (922 days) and LVP (627 days) cohorts (log rank test: $P = .0086$) (Fig 3). The median overall survival was 1,105 days (95% CI, 724–2,136) The 90-day transplant-free survival rate was 50% (1/2), 71% (21/31), and 84% (31/37) in the PVS, TIPS, and LVP cohort, respectively. The 2-year transplant-free survival rate was 50% (1/2), 26% (8/31), and 14% (5/37) in the PVS, TIPS, and LVP cohort, respectively. The median transplant-free survival was 200 days (95% CI, 155–252). The transplant-free survival significantly differed between the cohorts (PVS, 44 days; TIPS, 155 days; and LVP, 213 days) (log rank: $P = .001$) (Fig 4).

In the unadjusted Cox proportional hazards model, the TIPS cohort had a 58% reduction in the risk of death compared with the LVP cohort ($P = .003$), but no significant difference was observed when the TIPS cohort was compared with the PVS cohort ($P = .442$). Age, HCC, and Child–Turcotte–Pugh score were significantly associated with the risk of death. Sex, the etiology of disease, liver

Table 5. Unadjusted Cox Proportional Hazards Model for Mortality

Variable	Unadjusted hazard ratio	95% CI	*P* value
Cohort: TIPS	0.424	0.24–0.75	.003
Cohort: PVS	0.753	0.37–1.5	.442
Age	1.054	1.03–1.08	<.001
Female sex	0.590	0.33–1.64	.079
Etiology			
HCV	Reference	Reference	Reference
NASH	1.376	0.77–2.47	.286
Alcohol	0.762	0.41–1.42	.393
HCC	2.072	1.13–3.81	.019
Transplant candidate	0.566	0.33–0.97	.039
Variceal bleed	1.507	0.92–2.46	.102
Heart failure	1.60	0.94–2.71	.085
Pulmonary hypertension	1.387	0.69–2.81	.363
Encephalopathy: lactulose	0.460	0.20–1.04	.062
Encephalopathy: rifaximin	0.658	0.34–1.26	.204
Encephalopathy: admission	0.587	0.29–1.19	.142
T2DM	1.064	0.66–1.72	.801
MELD score	1.030	0.98–1.08	.200
CTP score	1.250	1.02–1.54	.035
Outpatient visits	0.786	0.73–0.85	.000
Emergency department visits	0.951	0.88–1.02	.182
Hospital readmissions	0.993	0.88–1.11	.899

CTP = Child–Turcotte–Pugh; HCC = hepatocellular carcinoma; HCV = hepatitis C virus; MELD = model for end-stage liver disease; NASH = nonalcoholic steatohepatitis; PVS = peritoneovenous shunt; T2DM = type 2 diabetes mellitus; TIPS = transjugular intrahepatic portosystemic shunt.

Table 6. Adjusted Cox Proportional Hazards Model for Mortality

Variable	Adjusted hazard ratio	95% CI	*P* value
Cohort: TIPS	0.533	0.26–1.10	.089
Cohort: PVS	0.364	0.13–1.01	.053
Age	1.067	1.03–1.10	<.000
HCC	3.166	1.48–6.75	.003
Transplant candidate	0.536	0.27–1.08	.082
Heart failure	1.202	0.60–2.40	.601
Encephalopathy: mild	0.453	0.20–1.05	.065
Encephalopathy: moderate–severe	0.480	0.18–1.27	.138
CTP score	1.250	1.02–1.54	.035

CTP = Child–Turcotte–Pugh; HCC = hepatocellular carcinoma; PVS = peritoneovenous shunt; TIPS = transjugular intrahepatic portosystemic shunt.

disease manifestations, comorbidities (heart failure, pulmonary hypertension, and diabetes mellitus), MELD score, and healthcare utilization were not associated with the risk of death.

In the adjusted Cox proportional hazards model, when all variables with a *P* value of <.1 in the univariable analysis and known confounders between treatment assignment and mortality were incorporated, there was no difference when the LVP and PVS cohorts were compared with the TIPS cohort. Age at the time of the first procedure, a history of HCC, and Child–Turcotte–Pugh score remained significant predictors of mortality (**Tables 5, 6**).

Paracentesis Requirement and Primary Patency

The average number of LVPs per month significantly decreased after TIPS creation or PVS placement. The patients in the TIPS cohort required an average of 1.5 LVPs per month (95% CI, 0.93–2.06) before TIPS creation and 0.14 LVPs per month (95% CI, 0.03–0.24) following TIPS creation ($P < .001$). Similarly, patients who received PVS required an average of 2.1 LVPs per month (95% CI, 0.57–3.70) before PVS placement and 0.5 LVPs per month (95% CI, 0.08–0.9) following PVS placement ($P = .019$) (**Fig 5**).

Fourteen patients with TIPS required a revision within the initial year after TIPS creation, and 19 required a revision during the study. Of these, 6 (32%) required multiple revisions. The indications included hepatic encephalopathy (2 patients, 11%), recurrent ascites (7 patients, 37%), and stent stenosis or thrombosis (5 patients, 26%).

Among patients with TIPS, the primary patency rate was 96% (72/75), 88% (66/75), and 83% (62/75) at 30 days, 6 months, and 12 months, respectively. Of 24 patients who received PVS, 8 patients required a revision or removal within the first year after placement because of a shunt occlusion or recurrent ascites. The primary patency rate was 88% (21/24), 75% (18/24), and 67% (16/24) at 30 days, 6 months, and 12 months, respectively. The time to the first paracentesis and primary patency did not significantly differ between the TIPS and PVS cohorts (log rank, $P = .500$; log rank, $P = .393$) (**Fig 6**).

DISCUSSION

Refractory ascites is a complication of end-stage liver disease, with high morbidity and a predicted 1-year mortality of 50% (3). Serial LVP and TIPS creation are common therapies. A substantial amount of literature has examined how these therapies perform individually and comparatively (13–16). The underuse of PVS stems from complications and poor technical outcomes observed in the surgical era (7,17). However, PVS insertion has been refined and is now performed by interventional radiologists.

This study found that the PVS cohort was older than the TIPS or LVP cohort, but with less severe liver disease. The discrepancy in age between the TIPS and PVS cohorts is understandable because increasing age is a known risk factor for TIPS-associated encephalopathy (18).

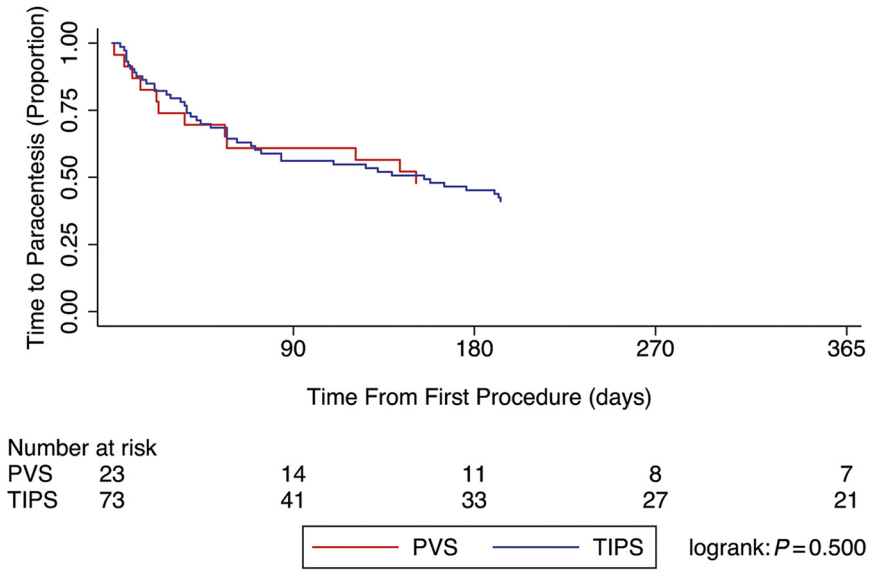

Figure 5. Time to the first postprocedural paracentesis. PVS = peritoneovenous shunt; TIPS = transjugular intrahepatic portosystemic shunt.

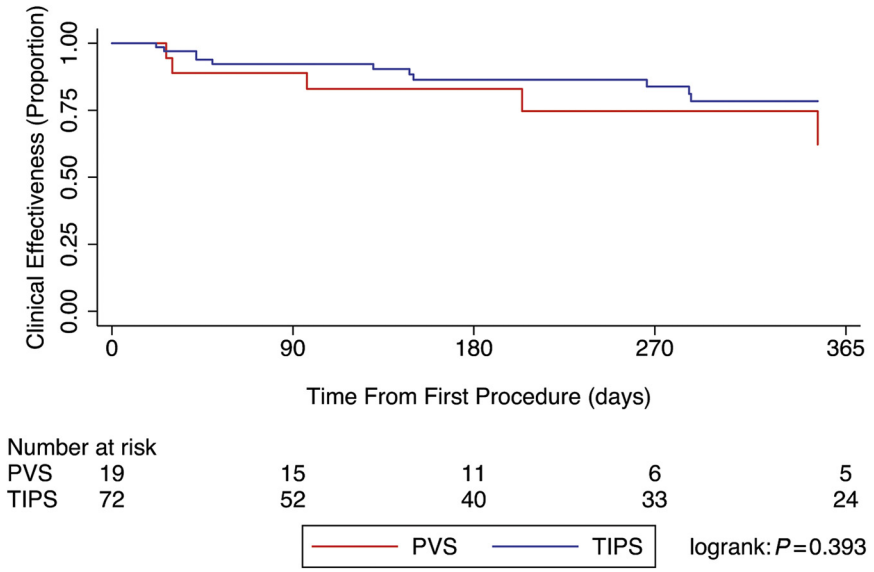

Figure 6. Primary patency of transjugular intrahepatic portosystemic shunt and peritoneovenous shunt. PVS = peritoneovenous shunt; TIPS = transjugular intrahepatic portosystemic shunt.

Patients in the LVP cohort had worse liver disease and more healthcare encounters than patients in the other cohorts. The overall survival differed between the 3 cohorts, with the greatest median survival in the TIPS cohort. Patients in the TIPS cohort were younger and had fewer ED visits and hospital readmissions than patients in the other cohorts. These factors may support a higher median survival. Despite being older and having higher rates of HCC, patients with PVS had better survival than those who underwent serial LVP.

Compared with the LVP cohort, both the TIPS and PVS cohorts had worse transplant-free survival, although the TIPS cohort showed improved survival of approximately 250 days.

It has been documented that patients who undergo TIPS creation have improved transplant-free survival compared with those who undergo serial LVP (5,6). PVS placement may not reduce mortality but appears to reduce morbidity and healthcare utilization.

Although the comorbidities did not differ among the cohorts, it may be anticipated that a diagnosis of HCC is highest among the PVS cohort, because PVS has been demonstrated to be safe and effective in the management of comorbid malignant ascites (19,20).

In the authors' institution, patients are evaluated for a definitive intervention once they require >1 LVPs per month. TIPS is the preferred intervention because of its technical success rate and minimal requirement for subsequent intervention, but has been reported to have only a 66% complete response (21). Studies have reported that TIPS results in improved ascites control among patients with a lower frequency of pre-TIPS paracentesis (22). Some patients have relative contraindications to TIPS, including baseline hepatic encephalopathy, portal vein thrombosis, right heart failure, and pulmonary hypertension. These factors, along with age and HCC, guide clinical decision making. Given the paucity of the literature comparing TIPS and PVS, these criteria likely vary across institutions. Further research is needed to characterize patient populations chosen for each intervention to inform a therapeutic choice.

Patients considered poor candidates for TIPS are triaged to PVS. The advantages include the ease of placement and the lack of adverse effect on liver function. The limitations include the need for maintenance because PVS malfunction typically occurs within a year. PVS dysfunction is managed using a standard outpatient algorithm to restore patency.

The present study found that TIPS and PVS perform similarly in terms of managing ascites and minimizing morbidity, with the suggestion of improving overall survival. This study suggests that PVS is a reasonable alternative to LVP and may be considered in patients with contraindications to TIPS.

There are a number of limitations in this study. This was a retrospective study, and there is a concern about the possibility of selection, confounding, and information biases. Even though the patients belonged to the same source population, there were differences among the patients in the 3 cohorts, including differences in age, etiology, and the severity of liver disease. Moreover, 22 (11%) patients were lost to follow-up, limiting the accuracy of the findings. This study might not have captured all factors that influenced treatment choice and health outcomes, including alcohol use and adherence to a low-sodium diet. This study collected data on procedures and healthcare encounters at the author's institution, creating a potential measurement bias by not capturing data on follow-up with other providers. Lastly, the PVS cohort was particularly small because the radiologic placement of PVS is a relatively new therapy.

This study suggests that PVS can be considered as an alternative therapy for patients with less severe liver disease. Given the decreased morbidity associated with PVS, it is reasonable to offer this treatment option to any patient with refractory ascites who is not eligible for TIPS.

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