Percutaneous Peritoneovenous Shunt for Treatment of Refractory Ascites

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PURPOSE: To evaluate the usefulness of a percutaneously placed peritoneovenous shunt (PVS) in patients with refractory ascites.

MATERIALS AND METHODS: Under fluoroscopic and ultrasonographic (US) guidance, the authors placed a PVS in 55 patients (39 men and 16 women; mean age, 56 years) with refractory ascites and symptomatic abdominal distention. The cause of ascites was liver cirrhosis (n = 36), carcinomatosis (n = 17), ruptured cysts with polycystic kidney disease (n = 1), and idiopathic refractory ascites (n = 1). The authors retrospectively evaluated technical feasibility, shunt patency, complications, and clinical outcomes of each patient.

RESULTS: The technical success rate was 100%, and symptomatic improvement was achieved in all but one patient. Complications occurred in 17 of the 55 patients (31%): five patients had variceal bleeding; three patients had ascites leakage; two patients each had disseminated intravascular coagulopathy, transient abdominal pain, shunt infection, and venous thrombosis; and one patient had pulmonary thromboembolism. Thirty patients (54%) died 2–690 days after the procedure (mean, 117 days), and their lifetime shunt patency was 84%. Eight patients were lost to follow-up. Seventeen patients were alive for 60–1,200 days, and their shunt patency was 71%. There was no significant difference in shunt patency between the two groups with benign and malignant ascites.

CONCLUSIONS: The percutaneous placement of a PVS was a technically feasible and effective method for symptomatic relief of refractory ascites.

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Abbreviations: DIC = disseminated intravascular coagulopathy, PVS = peritoneovenous shunt, TIPS = transjugular intrahepatic portosystemic shunt

ASCITES resistant to various medical treatment is a vexing problem. It restricts affected patients from living a normal life and causes serious discomfort and morbidity, whether it is from dissemination of malignancy or liver cirrhosis. Patients with refractory ascites require repeated paracentesis for symptomatic relief (1,2). There are many medical and surgical methods for the control of refractory ascites, such as diuretics, dietary salt restriction, nontunneled indwelling catheters, tunneled permanent implantable catheters or ports, and surgical shunt creation for both malignant and cirrhotic ascites (1–5). Intrapertoneal chemotherapy is another option for malignant ascites and transjugular intrahepatic portosystemic shunts (TIPS) for cirrhotic ascites. Because of the temporal and limited role of the medical treatment and patients’ discomfort of maintaining an indwelling catheter, port, or TIPS, the peritoneovenous shunt (PVS) has been reported as a suitable alternative treatment modality for the control of refractory ascites (6–8).

A PVS is devised for continuous drainage of the ascites into systemic circulation and can be placed either surgically or percutaneously. Many authors have reported their experiences with surgical placement of the shunt by using an autologous saphenous vein graft (9). However, most patients with refractory ascites have variable risk factors for open surgery, such as renal dysfunction, poor liver function, and advanced malignancy.

The percutaneous PVS is an implantable device with which to drain the ascites to the systemic circulation and can be placed percutaneously in an angiographic suite. We evaluated the technical feasibility and long-term outcomes of percutaneously placed PVS in patients with refractory ascites.

MATERIALS AND METHODS

Patients

Fifty-five patients underwent percutaneous placement of a PVS (Denver...
ascites shunts; Denver Biomaterials, Golden, Colorado) for the treatment of refractory ascites between March 1999 and February 2006. The research approval of the patient group was obtained by the institutional review board. There were 39 men and 16 women aged 24–80 years (mean age, 56 years). Refractory ascites was diagnosed when ascites failed to respond to (a) bed rest; (b) fluid restriction to 1,500 mL per day and salt restriction to 80 mmol per day; (c) 400 mg per day of spironolactone or 300 mg per day of triamterene plus 120 mg per day of furosemide for 4 weeks or (d) when the patients had intolerance to medical therapy because of azotemia (4,10). All patients were debilitated from ascites because of extensive abdominal distention (n = 55) and respiratory difficulty (n = 46), which interfered with their daily lives. They received periodic paracentesis more than twice a month. The underlying diseases in the patients were liver cirrhosis (n = 36), advanced malignancy with carcinomatosis (n = 17), ruptured cysts with polycystic kidney disease (n = 1), and idiopathic refractory ascites (n = 1). Seventeen of the 36 patients with liver cirrhosis had hepatocellular carcinoma. Liver cirrhosis was classified as Child A in four patients, Child B in 11, and Child C in 21. Among the 36 patients with liver cirrhosis, 19 had paravesophageal or gastric varices either at endoscopy or preoperative computed tomography (CT) and seven had undergone endoscopic treatment of variceal bleeding more than 3 months before PVS placement.

We evaluated hemoglobin and/or hematocrit levels, platelet count, coagulation profile, blood albumin level, cardiac function, and peritoneal fluid before the procedure and excluded patients with active congestive heart failure, bloody or viscous ascites, and coagulopathy (platelet count $50 \times 10^9$/L or international normalized ratio $>2.0$).

**PVS Placement Procedure**

All patients received systemic prophylactic antibiotics (first-generation cephalosporin). The procedures were performed under local anesthesia (2% lidocaine) with preoperative intravenous analgesics (meperidine or fentanyl) in the angiographic suit. Patients were sterilized from the chin to the symphysis pubis and from the midline laterally to the posterior axillary line.

Each shunt consists of a fenestrated peritoneal catheter, venous catheter, and flexible pump chamber containing a one-way valve (Fig 1). The pump chamber site was made immediately over the lower rib cage to facilitate manual compression of the pump. After making a 5-cm-long incision at the lower rib cage, a pocket for the pump chamber was manually created with blunt dissection, gently separating the subcutaneous tissue from the fascia. Peritoneal puncture was done below the costal margin and above the iliac crest in the right lower abdomen under ultrasonographic (US) guidance. After inserting a 0.35-inch guide wire into the dependent position of the pelvic cavity, the peritoneal catheter was pulled through a subcutaneous tunnel from the pump chamber. The subcutaneous tunnel was made with use of a Denver Tunneler (Denver Biomaterials). Through the 0.35-inch guide wire, a 16-F peel-away sheath (St Jude Medical, Minnetonka, Minnesota) was inserted. We drew the ascites through the peel-away sheath, sometimes with gentle compression of the patient’s lower abdomen, and measured the amount of discarded ascites by using a scaled bottle. Then, the peritoneal end of the shunt was placed at the dependent portion of the pelvis through the peel-away sheath. In the early period of the study, we discarded a limited amount of ascites (1,000–2,000 mL; mean, 1,411 mL) to avoid hypovolemia and hypoproteinemia; later, we discarded as many ascites as possible (2,000–6,000 mL; mean, 3,194 mL). We then obtained venous access under US guidance and inserted another peel-away sheath. We used the axillary vein in 41 patients to make the subcutaneous tunnel shorter and easier. The axillary vein was not available in 14 patients, and the internal jugular vein was chosen as a venous access. The venous catheter of the shunt was pulled through a subcutaneous tunnel from the pump chamber and placed at the atrio caval junction. Each incision was closed with absorbable suture (3-0 Vicryl; Ethicon, Somerville, New Jersey). During the entire procedure, fluoroscopic monitoring was done to prevent kinking or bending and to check the proper location of the catheter tip at the dependent portion for the peritoneal end and atrio caval junction for the venous end. Procedural time from making the incision for the pump chamber to completing the suture was checked.

All patients were discharged from the hospital 2–3 days after the procedure without complications. Patients were instructed to compress the pump chamber forcibly at least 20 times, once before bedtime and once before rising in the morning to reduce the formation of thrombus within the catheter and maintain continued patency of the valve. However, during the 1st week after shunt placement, we prohibited patients from compressing the pump chamber to avoid wound contamination and complications related to abrupt volume overloading (eg, cardiac congestion and disseminated intravascular coagulopathy [DIC]).

**Follow-up and Interpretation of Results**

Retrospectively, we reviewed the patients’ charts for complications, mortality, and efficiency of shunts in providing effective palliation of ascites-related symptoms. Each patient was followed-up at outpatient clinics and asked to report back immediately to the interventional radiologic department if there were any signs of infection, ascites leakage, aggravation of abdominal distention, or other adverse effects. The duration of follow-up ranged from 2 to 1,620 days (mean, 265 days ± 383.2).

The primary endpoint of this study was a composite of the shunt occlusion and the patients’ death. Catheter patency was calculated on the basis of the time that patients were free from symptoms. Complications were categorized according to the clinical practice guidelines of the Society of Interventional Radiology. Major complications were defined as those necessitating an increased level of care, major therapy, or prolonged hospitalization and those resulting in permanent sequelae or death. Minor complications were defined as those necessitating nominal therapy or observation only (11). The cumulative patient survival and catheter patency rate were measured, and the survival of different groups was compared with the Kaplan-Meier method.
RESULTS

PVSs were successfully placed in all patients (100%) without any perioperative technical complications (eg, hematoma or malposition of the catheter). The procedure time was 40–90 minutes (mean, 75 minutes ± 31.4). Immediately after shunt placement, subjective symptoms of abdominal distention and respiratory difficulty improved in 54 of the 55 patients (98%) and paracentesis was not necessary (Fig 2). One patient with malignant ascites failed to achieve symptomatic relief. In that patient, resistance was felt with compression of the pump chamber and flow was not detected inside of the shunt catheter at Doppler US. Blockage of the shunt was suggested. We put a drainage catheter in the peritoneal cavity, and the patient’s symptoms improved.

Thirty of the 55 patients (54%) died 2–690 days after the procedure (mean, 117 days), and their lifetime shunt patency was 84%. Seventeen patients are still alive for 60–1,200 days with 71% shunt patency. The other eight patients were lost to follow-up. Survival rates of patients with benign ascites at 30 days, 180 days, and 1 year were 66.7%, 38.9%, and 22.7%, respectively, and those of patients with malignant ascites were 76.9%, 53.9%, and 43.1%. There was no significant difference in survival between the benign and malignant ascites groups (P = .3496), and the overall survival rate was 70.3% at 30 days, 44.6% at 180 days, and 30.9% at 1 year. The shunt patency rate was 91% at 30 days, 86% at 90 days, and 57% at 180 days.

Fifteen of the 55 patients (27%) had major complications. Five patients had variceal bleeding. In the early treatment group (1,000–2,000 mL of ascites removed), four of 10 patients (40%) with previous varices had recurrent variceal bleeding, whereas only one of nine patients (11%) in the late group (2,000–6,000 mL of ascites removed) had this complication. The amount of discarded ascites was significantly correlated with the frequency of postoperative variceal bleeding (P < .05). Three patients had ascites leakage through the peritoneal entry site and delayed wound healing, two had DIC, and two had shunt infection. Two patients had thrombosis of the superior vena cava around the catheter, and one patient had pulmonary thromboembolism. Two patients (3.6%) with minor complication had transient abdominal pain, which resolved spontaneously.

During the follow-up, eight shunts were removed because of ascites leakage (n = 3), shunt occlusion (n = 2), superior vena cava thrombosis (n = 1), DIC (n = 1), and wound infection (n = 1). In one patient with DIC who refused shunt removal, the peritoneal catheter of the shunt was ligated with 2-0 silk after making a small incision over the skin. In two shunts removed due to occlusion, blockage of the pump chamber with a fibrin plug was identified. In two patients, another shunt was placed at the left side after the removal of the first shunt. There was no proved malignancy dissemination during the lifetime of the patients.

There were eight cases (15%) of shunt-related mortality. Five of 19 patients with esophageal or gastric varices had massive variceal bleeding after shunt placement, all of which resulted in mortality. The duration of survival after the procedure was 5–28 days (mean, 20.5 days). One patient died of DIC 34 days after shunt placement, and two patients died of shunt infection and subsequent sepsis 22 and 56 days after shunt placement, respectively. The other causes of deaths not related to shunt placement varied and included hepatic failure, rupture of pre-existent hepatocellular carcinoma, hepatic encephalopathy, renal failure, pneumonia, and aggravation of underlying malignancy.

Figure 1. Schematic drawing of the peritoneovenous shunt. The pump chamber is created over the lower rib cage. The venous end of the shunt is inserted through the subclavian vein or the internal jugular vein. The peritoneal catheter is located in the dependent portion of the pelvic cavity. The arrowhead indicates the entry site of the venous catheter and the arrow the entry site of peritoneal catheter.
Refractory ascites is associated with abdominal distention, shortness of breath, nausea, and limited mobility, which affect patients’ quality of life. Whether the ascites is from malignancy or liver cirrhosis, these patients have a poor prognosis with an anticipated mean survival of less than a few months (3,12). Other than treatment of the underlying disease, there are no accepted guidelines for the treatment or reduction of refractory ascites. Medical treatment is known to have a limited response, and, after medical management fails, there is no consensus about which interventional therapy provides the best palliation with the least morbidity (10).

Repeated paracentesis requires frequent trips to the hospital with the risks of hypovolemia, hypotension, or hypoproteinemia from ascites removal (7). Temporal indwelling catheters are often complicated with frequent infections. Permanent drains, such as the PleurX catheter (Denver Biomedical) or a peritoneal port, require the patient to perform periodical drainage of the catheter with clean technique. In addition, all types of drainage systems can be associated with complications from ascites removal (6,7). TIPS has been applied in the treatment of cirrhotic ascites and reported to have better long-term efficacy and better survival than PVS (10). However, many debate its efficacy because TIPS is frequently complicated by issues of progressive hepatic dysfunction and encephalopathy. Furthermore, TIPS is more invasive and can induce a lot of pain during the procedure.

The PVS was introduced in 1974 by Le Veen et al (13) for the treatment of refractory ascites. The Denver PVS is a modified device that includes a flexible pump chamber containing one or two miter valves between the fenestrated peritoneal catheter and the venous catheter (14,15). The miter valve contained within the pump chamber permits flow in only one direction. When the pressure in the peritoneal cavity is approximately 3 cm water higher than central venous pressure, the valve opens and permits flow through the shunt.

The usefulness of the Denver PVS for the palliation of neoplastic ascites is still controversial. In the early period of PVS use, many authors reported discouraging outcomes with morbidity rates of 60%–70%, shunt-related mortality rates of 10%–35%, and shunt patency rates of 20%–40% (5,16,17). In recent studies, however, favorable outcomes with less mortality and morbidity have been reported (10,18). These favorable results could be achieved by introducing the percutaneous method, modifying the procedure, and carefully selecting candidates for the procedure. In our series, the overall complication rate was 31%; eight patients (15%) died of procedure-related complications. Although the complication and mortality rates still seem to be high, they are not discouraging. Apart from the deaths from variceal bleeding, which decreased significantly after modification of the procedure (discarding large amounts of ascites), procedure-related deaths occurred in three patients. Some of the complications, such as abdominal pain, were resolved with conservative care. Because we regard this procedure to be an “end-of-life” procedure for most patients, we believe that the complication and mortality rates are tolerable. In particular, among the 19 patients with noncirrhotic ascites, only one procedure-related death occurred. This result is consistent with those from other reports on the comparison of cirrhotic and noncirrhotic PVS (19,20).

PVS can be placed with three different techniques: surgical, laparoscopically assisted, and percutaneous. In the early period, each peritoneal...
and venous catheter was placed by means of surgical dissection. The laparoscopic approach is usually performed when a histologic diagnosis or peritoneal exploration for the evaluation of a potential curative procedure is necessary (15). These days, along with the remarkable development of interventional techniques and devices, the entire shunt placement procedure can be completed percutaneously. Many authors reported that they changed the method of PVS placement from surgical to percutaneous because the percutaneous method is faster, cheaper, and does not require general anesthesia (15). Our patients were hospitalized for 2 or 3 days for observation of the wound site and immediate complications such as volume overloading. None of the patients needed bed rest and could ambulate immediately after shunt placement. Optimal positioning at the cavoatrial junction of the venous catheter and the dependent portion of the pelvic cavity of the peritoneal catheter could be obtained with US and fluoroscopic guidance, which, we believe, could enable us to achieve 98% of immediate symptom relief and a low frequency of venous thrombosis rate such as 3.6%.

Delayed wound healing from ascites leakage was one of the major problems in PVS placement. In our study, all three cases of ascites leakage resulted in shunt removal. During the procedure for these three cases, a small amount of ascites (1,000 mL) was discarded. The cause of ascites leakage was suggested to be high intraabdominal pressure by large amounts of residual ascites. Therefore, we modified the procedure by discarding as many ascites as possible and, in our later experience, this complication was avoided. There was no complication of cirulatory or vascular collapse after the removal of the large amount of ascites of more than 5,000 mL. Making a long subcutaneous tunnel between the pump chamber and the peritoneal puncture site was also helpful for avoiding ascites leakage.

DIC is known as the most frequent complication of PVS, and its known incidence is about 10% (21). It may be related to the infusion of ascitic fluid into the circulation, which dilutes the clotting elements and activates coagulation (22). Cirrhotic ascites is known to be more susceptible to clinical DIC after a PVS than is malignant ascites, and two patients from our series with DIC also had cirrhotic ascites (20). To avoid this complication, removal of the large amount of ascites before shunt placement is recommended. In our study, the frequency of DIC (3.6%) was lower than that in other reports, which could be relevant to the minimal amount of residual ascites and education of patients to prohibit the vigorous pumping of the shunt for the 1st week to avoid abrupt volume overloading.

In a review of 116 PVSs inserted into 89 patients (7), 36 episodes (31%) of shunt occlusion requiring either revision or removal occurred. In our series, two shunts that were removed due to shunt occlusion showed blockage of pump chamber by fibrin plugs. Daily pumping of the shunt chamber could prevent blockage, and some authors recommend low-dose oral anticoagulant therapy in an attempt to reduce the incidence of shunt blockage (23). We placed another PVS on the opposite side without any complaints from patients or technical difficulties.

Variceal bleeding was the most catastrophic complication in our study, accounting for 63% of procedure-related mortalities. Rapid expansion of the plasma volume is known to be associated with an increase in portal pressure and recurrence of preexisted variceal bleeding. In our series, the frequency of this complication could be reduced by removing most ascites before shunt placement. The amount of discarded ascites was significantly correlated with the frequency of postoperative variceal bleeding (P < .05).

In conclusion, percutaneous placement of a PVS is technically feasible. It is effective for the relief of symptomatic refractory ascites of either benign or malignant causes. The exclusion of patients with a history of variceal bleeding should be considered, and drainage of as much ascites as possible before shunt placement could be helpful for the reduction of various complications.

References
15. Clara R, Righi D, Bortolini M, Cornaglia S, Ruffino MA, Zanon C. Role of different techniques for the placement of Denver peritoneovenous shunt

CME TEST QUESTIONS

Examination available at http://directory.sirweb.org/jvircmef

1. Which of the following potential disadvantages to percutaneous peritoneovenous shunts were noted in this study?
   a. Poorer patency rates in malignant as compared to benign ascites
   b. Symptomatic relief generally does not occur until several days after placement
   c. Higher mortality rates in patients with cirrhotic ascites as compared to cirrhotic ascites
   d. Frequent need for volume replacement with albumin

2. Causes of shunt related mortality in the study group included all of the following EXCEPT?
   a. Disseminated intravascular coagulopathy
   b. Shunt infection with sepsis
   c. Variceal bleeding
   d. Adult respiratory distress syndrome

3. The authors changed their procedural technique during the course of the study, initially discarding a relatively limited amount of ascites during shunt placement, and subsequently discarding as much as possible. The frequency of which adverse outcome decreased significantly following this change?
   a. Peritonitis
   b. Superior vena cava thrombosis
   c. Variceal bleeding
   d. Delayed wound healing

4. Which of the following technical modifications do the authors suggest in order to minimize delayed wound healing?
   a. Removal of as much ascites as possible at the time of shunt placement
   b. Entering the peritoneal cavity at a shallower angle
   c. Use of non-resorbable suture at the pump incision site
   d. Placement of the pump in a more anterior position than the peritoneal puncture site