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ORIGINAL ARTICLE

Continuous Peritoneal Drainage of Large-Volume Ascites

David H. Van Thiel · Christopher M. Moore · Moises Garcia · Magdalena George · Abdul Nadir

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Abstract
Background With the increasing population of individuals with cirrhosis, many of whom are not liver transplant candidates, large volume paracentesis as a medical therapy for ascites resistant to diuretic therapy has become increasingly utilized.
Aim To determine the safety and efficacy of continuous peritoneal drainage of large-volume ascites in Child Class-C cirrhosis. Subjects with no current clinical or laboratory findings of spontaneous bacterial ascites were studied. Each had a complete medical evaluation to document the etiology and severity of their liver disease as well as the identification of any confounding medical illness. A triple-phase abdominal CT of the abdomen was obtained in each individual to rule out any hepatoma. Upon completion of the above, a pericardiocentesis catheter was placed in the abdomen using the Seldinger technique and the ascites was drained continuously (to gravity) until no additional ascitic fluid could be removed or the total time of drainage was 72 h. The patient's weight, volume of ascitic fluid removed, ascitic fluid cell counts, ascitic fluid cultures, complete blood count and comprehensive metabolic profile were obtained immediately before and after the peritoneal catheter was removed.
Results HCV cirrhosis accounted for 12 cases and alcoholic liver disease accounted for 8 cases (half the total of 40 cases), with 6 other diseases accounting for the remaining half. The ascitic fluid was drained continuously for 2.5 ± 0.08 days, with a removal of 13.3 ± 0.5 l of ascitic fluid. No clinically significant change in the serum creatinine or ascitic fluid cells count occurred as a result of the procedure. The adverse effects of the procedure were minimal. 63% of the patients experienced some mild discomfort at the catheter insertion site, or local abdominal pain just prior to the removal of the catheter. Two patients developed a small abdominal wall hematoma that required no therapy. No patients experienced peritoneal hemorrhage, infection or renal dysfunction.
Conclusion (1) Continuous large-volume peritoneal drainage by gravity is safe and effective; (2) if the procedure is limited 72 h, no cases of ascitic fluid contamination/infection occur; and (3) it reduces the time between subsequent paracentesis based upon historical data.

Keywords Ascites · Anasarca · Cirrhosis · Portal hypertension · Renal dysfunction · Hyponatremia

D. H. Van Thiel (✉) · C. M. Moore · M. George
Hepatology Suite 158 POB, Department of Medicine, Rush University Medical Center, 1725 W Harrison, Chicago, IL 60612, USA
e-mail: david_vanthiel@rush.edu

M. Garcia
Aurora St. Lukes Medical Center, Milwaukee, WI, USA

A. Nadir
Phoenix, AZ, USA

Introduction

Cirrhotic individuals with advanced end-stage liver disease frequently become diuretic resistant [1, 2]. In addition, some have co-existing renal disease such that diuretics are ineffective or cannot be used without further impairing renal function [1–3]. In such cases, either repetitive large-volume paracentesis or a transvenous intrahepatic portal systemic shunt (TIPS) procedure have been utilized to manage the ascites [4–11]. Recently, the placement of an indwelling peritoneal catheter with continuous drainage of ascitic fluid

has been reported as an alternative approach to manage this clinical problem [12]. Moreover, when coupled with regular albumin replacement, continuous peritoneal fluid drainage also eliminates anasarca [13]. The major problem with the procedure has been the potential for the development of peritoneal infection with prolonged drainage [12].

Here, we describe an experience with continuous peritoneal drainage for a maximum of 72 h that documents both its safety and efficacy when limited to this time period.

Methods and Procedures

Subjects

The experience with continuous peritoneal drainage of ascitic fluid in Child's class C cirrhotics with massive ascites at this institution was reviewed. Forty consecutive patients, who had no clinical or laboratory findings consistent with spontaneous bacterial peritonitis at the time of catheter insertion, were identified and their records reviewed retrospectively. Only the first large-volume continuous peritoneal drainage procedure for each subject was utilized for this report. For each case, the etiology of the individual's liver disease was determined from the medical record and the criteria utilized to identify each case as being a Child's class C was confirmed.

Clinical Records Reviewed

(a) Laboratory studies present for all 40 cases: a complete blood count, complete metabolic panel (electrolytes, blood urea nitrogen, creatinine, prothrombin time, total bilirubin, alkaline phosphatase, alanine and aspartate transaminase and serum albumin levels). Hepatitis serologies to include HCV antibody, HbsAg, HbcAb (total), HBV-DNA, HCV-RNA, ceruloplasmin, HFE, alpha-1 antitrypsin phenotype and alpha-fetoprotein.
(b) Records documenting the presence or absence of coronary artery disease, diabetes mellitus, hyperlipidemia, obesity, hypertension, gout, sleep apnea, polycystic ovary disease (components of the metabolic syndrome) in those cases believed to have NAFLD/NASH as the cause of their liver disease.
(c) Imaging procedures: a triple-phase CT scan was obtained within 6 months of the paracentesis was available and reviewed for each subject studied.

Procedures

(a) Immediately prior to each paracentesis, a complete blood count (CBC) and complete metabolic panel (CMP) were obtained as well as the weight of each patient. There were no hematologic cut-off values, such as platelet count or INR, for denying an individual a large-volume paracentesis. The abdominal wall was cleansed with a commercial surgical scrub in ether the right or left lower quadrant based on anatomical issues identified at the time of procedure [14]. A site within the center of the cleansed area was anesthetized with 2% xylocaine from the skin to the peritoneum [15]. After making a small incision in the skin and using the Seldinger technique, a pericardiocentesis catheter was inserted in the abdominal cavity and the initial 30–60 ml of ascitic fluid removed was sent for a complete cell count, albumin and cultures in both aerobic and anaerobic culture bottles [15]. The pericardiocentesis catheter was then converted using a 3-setting stopcock in a retrograde manner with a macrodrip intravenous tubing set up without a filter and a sterile 3-l parenteral feeding bag used as an ascitic fluid collection bag. Ascitic fluid cell counts and cultures (aerobic and anaerobic blood culture bottles) were inoculated at the bedside and delivered immediately to the microbiology section of the hospital's pathology department at the initiation of the procedure and at the time of catheter removal.
(b) Ascitic fluid was removed by gravity at the rate of 3 l every shift (8 h) in individuals without edema/anasarca and at a rate of 3 l every 6 h in those with moderate or more edema or gross anasarca. After each 6- or 8-h collection interval, the fluid collected was measured and discarded with a new sterile IV tubing and parenteral feeding collection bag being utilized for the next collection interval. The ascitic fluid was drained continually until no more ascitic fluid was recoverable or until a total of 72 h (3 days) of fluid collection was accomplished. With each tubing and collection bag change, the fluid removed was replaced with 25 g of 25% intravenous albumin to maintain the individual's vascular volume, increase the plasma oncotic pressure and prevent a catabolic state as a result of ascitic fluid protein losses. At the termination of the collection period, the catheter was removed with 5–10 ml of residual fluid being collected for cell counts and culture and the patient was re-weighed.

Consenting Procedures

All patients signed an informed written consent for the paracentesis procedure with the understanding that the catheter would be left in place for up to 72 h. In addition, this retrospective study was approved by the IRB at Aurora Health Care, Milwaukee, Wisconsin, USA.

Data Presentation and Statistical Analysis

All numerical data are presented as mean values ± SEM. Data compared pre- and post-paracentesis were compared using a 2-sided Student's *t* test and linear regression analysis. A *P* value less than 0.05 was considered as being significant.

Results

The 40 subjects included in this study are characterized in Tables 1 and 2. The largest demographic group was chronic hepatitis C followed by alcoholic liver disease and non-alcoholic fatty liver disease, respectively.

The values for serum creatinine, white blood cell (WBC) count, weight, volume of ascitic fluid removed and amount of ascitic fluid removed are shown in Table 3. The volume of ascitic fluid removed was almost identical to the reduction in body weight over the 3 days of the study. Little or no change in the values for ascitic fluid, WBC counts and creatinine were observed over the 3 days of study.

The relationships between the amount of ascitic fluid removed and the change in body weight was excellent with a *P* value of 0.97. There was no relationship between the value of the ascitic fluid removed and the change in serum creatinine over the time period of peritoneal drainage. A small but statistically significant increase in the peritoneal WBC was observed with the volume of ascitic fluid removed but not with the duration of peritoneal drainage. No patient experienced a neutrophilic ascitic fluid count greater than 250 cells/μl^3 during the peritoneal drainage procedure up to a maximum of 72 h.

No relationship between the change in creatinine from the pre-and post-paracentesis values, the duration of ascitic fluid removed in days and the volume of ascitic fluid removed in liters was observed.

Most importantly, no patient was noted to have developed a peritoneal infection as a result of the paracentesis and continuous peritoneal drainage for a period up to 72 h. Moreover, no case of loculated or bloody ascites occurred.

The complications experienced with this procedure in these 40 subjects are reported in Table 4. As expected, slight to moderate abdominal wall discomfort and local hematomas were not uncommonly seen. However, no serious complications occurred. Moreover, no episodes of hypotension (consisting of a decline in systolic blood pressure greater than 5 mmHg) were observed during this procedure. In fact, as a result of the albumin infusions the systolic blood pressure actually presumably increased between 5 and 10 mmHg in each of the subjects studied. Importantly, the duration between the immediate prior three paracentesis procedures for each patient was 2.2 ± 0.3 weeks as compared to 6.6 ± 0.1 weeks for the next procedure after the procedure discussed in this report.

Table 1 Characteristic of the 40 subjects studied (mean values ± SEM)

Characteristic	Values
Number	40
Sex (male/female)	25/15
Age (years)	53 ± 1.3

Table 2 Hepatic disease etiology

Disease	Prevalence
Alcoholic liver disease	8
Hepatitis C virus	12
NASH/NAFLD	7
Cryptogenic disease	4
Autoimmune disease	3
Hepatitis B virus	3
Alpha 1-antitrypsin deficiency	2
Primary sclerosing cholangitis	1

Table 3 Laboratory studies, volume of ascites removed, and duration of peritoneal drainage in the 40 subjects studied (mean values ± SEM)

Parameter	Values
Initial weight (kg)	78.8 ± 1.1
Final weight (kg)	65.0 ± 1.1
Volume of ascites removed (l)	13.3 ± 0.5
Duration of peritoneal drainage (days)	2.5 ± 0.08
Initial creatinine (mg/dl)	0.80 ± 0.03
Final creatinine (mg/dl)	0.80 ± 0.04
Initial blood WBC count (cells × $10^3/\mu l$)	2.26 ± 0.1
Final blood WBC count (cells × $10^3/\mu l$)	2.37 ± 0.1
Initial ascitic fluid WBC count (cells × $10^3/\mu l$)	301 ± 35
Final ascitic fluid WBC count (cells × $10^3/\mu l$)	1,010 ± 50
Initial serum albumin level (g/dl)	2.3 ± 0.1
Final serum albumin level (g/dl)	3.5 ± 0.2
Initial ascitic fluid albumin level (g/dl)	1.1 ± 0.1
Final ascitic fluid albumin level (g/dl)	3.3 ± 0.1
Initial platelet count (cells/μl)	53,000 ± 12,500
Initial INR (no units)	1.65 ± 0.21
Initial total bilirubin (mg/dl)	3.2 ± 0.2

Discussion

Large-volume paracentesis for diuretic resistant cirrhotics has become a common clinical procedure practiced in both an in-hospital and an outpatient setting [1, 2, 4, 6, 13]. Typically, a maximum of 6–8 l of ascitic fluid is removed

Table 4 Complications experienced in these 40 subjects during or following the paracentesis until the next clinically indicated paracentesis procedure

Complication	*n*	%
Abdominal wall discomfort	25	63
Abdominal wall hematoma	2	5
Peritoneal hemorrhage	0	0
Peritoneal infection	0	0
Clinically significant renal dysfunction	0	0
Deaths	0	0

per procedure which can be repeated on a weekly basis depending upon the degree of sodium restriction, underlying renal function and individual compliance with diuretic therapy. Usually, but not always, a colloid infusion is coupled with the ascitic fluid drainage procedure.

Although this procedure is generally perceived as being safe and is not contra-indicated in cirrhotics with either a coagulopathy or thrombocytopenia, complications of the procedure have been reported, and coagulation studies, typically consisting of a prothrombin time and platelet count, are frequently obtained before each procedure at most centers [5, 15–17].

The most common complications reported consist of local abdominal wall discomfort [5, 17], a subcutaneous or intra-muscular hematoma, and rarely peritoneal hemorrhage and bowel perforation [4, 15–17]. These risks ought to apply to the use of an indwelling peritoneal catheter and potentially at a greater frequency because of the larger bore size of the drainage instrument (needle vs. peritoneal catheter) and duration of the procedure. This was not the case, however, in this study of Childs class C cirrhotic patients undergoing ascitic fluid drainage for uninfected ascites over a continuous period no longer than a maximum of 72 h.

The advantage of the procedure here reported are:

1. The slower rate of ascites drainage that be removed often with the resolution of coexistant anasarca;
2. The slower rate of ascites drainage as a results of gravity drainage over days as opposed to suction drainage over 1–2 h;
3. The more aggressive use of colloid administration utilized to avoid the catabolic consequences of large amounts of ascitic fluid protein loss;
4. The use of albumin replacement therapy to reduce the likelihood of renal hypoperfusion as a result of hypovolemia; and,
5. The use of albumin to assist in the mobilization of edema fluid in cases of coexistant anasarca.

In this study, the complications of this procedure were actually less than those reported to occur in standard short-term (1–2 h) large-volume paracentesis performed using suction as opposed to gravity to remove ascitic fluid. No cases of peritoneal infection occurred in this series, presumably in part as a result of the increase in peritoneal fluid protein content with progressive time of drainage and albumin replacement and resultant enhanced opsonic activity. Of note, a small increase in ascites WBC count did occur within the timeframe of ascites drainage but in no cases did the ascitic fluid polymorphonuclear cell count exceed a value of 250 cells/μl^3, and no fluid nor catheter was found to be culture positive for infection at the termination of the procedure.

These results may be because the study was designed to discontinue the peritoneal drainage procedure after a maximum of 72 h of peritoneal drainage, as a previous study had reported an increase in peritoneal infections with the procedure when continued for more than this time period [12].

In addition, a previous study consisting of individuals awaiting liver transplantation with spontaneous bacterial peritonitis reported that such patients could be transplanted successfully after receiving 72 h of antibiotics if they demonstrated a reduction in their ascitic fluid WBC count [18].

The present study documents the fact that a large volume of ascites (13.3 ± 0.5 l) can be removed safely without acquisition of a peritoneal infection using a indwelling catheter for periods up to 72 h. The data also document that, with albumin replacement on a scheduled basis, no change in renal function manifested by an increased creatinine value was observed between pre- and post-large-volume paracentesis procedures. In addition, the data document little or no inflammatory response to the catheter and for the procedure for periods up to 72 h, as evidenced by the lack of an increase in the ascitic fluid WBC count over the 72-h period of continuous drainage.

The real value of this procedure is that its application not only allows for the ascitic fluid removal but it also enables the excess extra-peritoneal fluid that accumulates in individuals with advanced end-stage liver disease evidenced by edema/anasarca to be removed without adversely affecting renal function. In effect, the scheduled administration of albumin enabled mobilization of the edema fluid by transiently increasing plasma colloid oncotic pressure; increasing the serum and ascitic fluid albumin levels (data not shown) and thereby enhancing opsonic function mechanisms that reduce the risk of peritoneal infection. Moreover, by utilizing the peritoneal membrane as a dialysis membrane, the excess water, electrolytes (especially sodium) and potential nitrogenous small- and medium-sized molecules, that accumulate in the patients with chronic liver disease and contribute to the development of hepatic encephalopathy and/or organ dysfunction, are removed.

As a result of the large volume of ascitic and edema fluid removed, subsequent paracentesis procedures are delayed (i.e., the time between consecutive procedures is extended) as a more complete removal of both ascites and intracellular water is achieved. In addition, the albumin replacement helps to limit ascitic fluid re-accumulation, and by increasing ascitic fluid albumin levels, reduces the risk of ascitic fluid infection by enhancing innate opsonification mechanisms.

Finally, although not evaluated as part of this study, this procedure may be useful in individuals with ascites due to right heart failure, chronic kidney disease and those with neoplastic ascites, including those in hospices. The results in each of these unique cases, however, needs to be evaluated in future studies.

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