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REVIEW

Drainage of ascites in cirrhosis

Jia-Xing Yang, Yue-Ming Peng, Hao-Tian Zeng, Xi-Min Lin, Zheng-Lei Xu

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Abstract

For cirrhotic refractory ascites, diuretics combined with albumin and vasoactive drugs are the first-line choice for ascites management. However, their therapeutic effects are limited, and most refractory ascites do not respond to medication treatment, necessitating consideration of drainage or surgical interventions. Consequently, numerous drainage methods for cirrhotic ascites have emerged, including large-volume paracentesis, transjugular intrahepatic portosystemic shunt, peritoneovenous shunt, automated low-flow ascites pump, cell-free and concentrated ascites reinfusion therapy, and peritoneal catheter drainage. This review introduces the advantages and disadvantages of these methods in different aspects, as well as indications and contraindications for this disease.

Key Words: Liver cirrhosis ascites; Large-volume paracentesis; Transjugular intrahepatic portosystemic shunt; Peritoneovenous shunt; Automated low-flow ascites pump; Cell-free and concentrated ascites reinfusion therapy; Peritoneal catheter drainage

Core Tip: For cirrhotic refractory ascites, peritoneovenous shunt is rarely used due to its high complication rate. Initial treatment for most refractory ascites prioritizes large-volume paracentesis combined with albumin infusion and peritoneal catheter drainage. If these treatments are ineffective or result in severe complications, transjugular intrahepatic portosystemic shunt or automated low-flow ascites pump may be considered. Cell-free and concentrated ascites reinfusion therapy requires further validation for suitability.

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INTRODUCTION

Ascites denotes the accumulation of excess free fluid in the abdominal cavity, with cirrhosis being the predominant cause, responsible for over 60% of cases. The onset of ascites is a critical marker in the progression of cirrhosis, often signaling a transition from a stable to a more severe clinical phase. This condition frequently accompanies acute decompensation events, such as acute-on-chronic liver failure, bacterial infections, and recurrent hospitalizations, significantly impacting overall treatment outcome[1]. Ascites is associated with multiple interrelated pathogenic mechanisms involving visceral and systemic hemodynamics, as well as dysfunctions in both liver and extrahepatic organs, primarily the kidneys and heart[2]. Portal hypertension is the primary and initiating factor of ascites formation in cirrhosis[3], causing reduced tissue fluid reabsorption and leakage into the abdominal cavity. Additionally, decreased serum albumin levels lead to reduced plasma colloid osmotic pressure, causing fluid to seep into the abdominal cavity or interstitial spaces. Systemic inflammatory response syndrome also significantly contributes to ascites formation. The primary mechanism involves interactions between bacterial products or pathogen-associated molecular patterns and their respective receptors, promoting the formation and release of inflammatory cytokines. This inflammation stimulates the production of endogenous vasodilators, such as endotoxins, vasoactive intestinal peptides, and nitric oxide, leading to vasodilation[4]. This vasodilation results in effective circulating volume (ECV) deficiency, reduced renal blood flow, and activation of the renin-angiotensin system, exacerbating sodium and water retention, thereby promoting ascites formation. Furthermore, the impaired hepatic processing function in cirrhotic patients weakens the inactivation of aldosterone and antidiuretic hormone, further promoting sodium and water retention. Increased pressure within the hepatic sinusoids in cirrhotic patients leads to increased lymph formation. When the volume of returning lymph exceeds the drainage capacity of the thoracic duct, it can seep from the liver surface into the abdominal cavity, forming ascites[5].

METHODS OF DRAINAGE OF ASCITES

Currently, managing and controlling refractory ascites and its related complications remains a significant clinical challenge. Pharmacotherapy, commonly using diuretics (furosemide or spironolactone) combined with albumin and vasoactive drugs, is the first-line choice for ascites management[6]. However, its therapeutic effects are often limited, and most refractory ascites do not respond to drug treatment, necessitating consideration of drainage or surgical interventions. Liver transplantation remains the only curative treatment method. For some patients with refractory ascites, liver transplantation is an option. However, due to various contraindications and the lack of liver donors, it is not feasible for many patients[7]. Consequently, numerous drainage methods for cirrhotic ascites have emerged, including large-volume paracentesis (LVP), transjugular intrahepatic portosystemic shunt (TIPS), peritoneovenous shunt (PVS), automated low-flow ascites pump (alfapump), cell-free and concentrated ascites reinfusion therapy (CART), and peritoneal catheter drainage (Table 1).

LVP

LVP combined with human serum albumin (HSA) supplementation remains the cornerstone of current ascites management (Figure 1)[8]. Defined as the removal of more than 5 L ascites in a single session, LVP can significantly alleviate patient discomfort, such as abdominal distension, by draining 4-6 L per day. Studies indicate that patients undergoing paracentesis exhibit lower in-hospital mortality rates compared to those who do not[9]. Compared with diuretics, LVP rapidly controls large volumes of ascites and shortens hospital stays[10], with fewer complications, such as electrolyte abnormalities, renal dysfunction, and hemodynamic instability[11]. However, LVP requires repeated punctures and has limitations, as it does not address the underlying pathophysiology of ascites formation, leading to rapid recurrence. The reduction in intra-abdominal pressure after LVP often increases the pressure gradient between the liver and abdominal cavity, causing rapid ascites refilling. Thus, repeated LVP is typically necessary, with most patients needing another paracentesis within two weeks. Martin *et al*[12] found that repeated LVP increases the risk of complications, including hepatorenal syndrome, hepatic encephalopathy, gastrointestinal bleeding, peritoneal infection, electrolyte disorders, and paracentesis-induced circulatory dysfunction (PICD), which can lead to renal failure. The sudden decrease in intra-abdominal pressure and insufficient blood volume after repeated LVP can cause redistribution of circulating volume, reducing effective arterial blood volume and increasing the risk of renal dysfunction, dilutional hyponatremia,

Table 1 Methods and characteristics of ascites drainage in cirrhosis

Ascites drainage methods	Characteristics
LVP	In the majority of patients suffering from refractory ascites, the preferred treatment approach involves the prioritization of LVP in conjunction with HSA administration. An advisable frequency for this therapeutic regimen is approximately once every two weeks, ensuring that the maximum volume of fluid removed during a single paracentesis does not surpass 5 L. It is imperative to note that repetitive LVP procedures heighten the potential for the development of complications.
TIPS	For patients who require frequent paracentesis procedures, frequent hospitalizations, or are awaiting liver transplantation, TIPS can act as a vital bridge therapy, facilitating the transition to definitive liver transplantation. However, due to its associated complications and contraindications, TIPS is typically reserved as a second-line therapeutic option, employed subsequent to the failure of LVP treatment. This approach ensures that the most appropriate and safe treatment pathway is pursued for each individual patient's unique circumstances.
PVS	When addressing refractory ascites, PVS has not demonstrated superiority over repeated LVP in terms of treatment outcomes. Furthermore, the risk of severe complications associated with PVS has rendered this approach virtually obsolete, as it has led to its near-complete abandonment in clinical practice.
Alfapump	The alfapump system holds significant potential in drastically reducing the reliance on LVP for patients. Nonetheless, it is important to acknowledge that the complication rate associated with this treatment modality remains relatively high. For those individuals diagnosed with non-malignant refractory ascites who are deemed ineligible for alternative therapies, such as TIPS or liver transplantation, the implantation of an alfapump represents an efficacious and viable treatment option.
CART	CART exhibits remarkable efficacy in swiftly alleviating abdominal distension, mitigating the burden of ascites, and enhancing nutritional intake for patients. Nevertheless, this innovative therapy is not without its challenges, including substantial equipment costs, intricate procedural requirements, and potential allergic reactions. Presently, CART is predominantly utilized in Japan, and its universal applicability across global healthcare settings remains an area of ongoing investigation and verification.
Peritoneal catheter drainage	The adoption of peritoneal catheter drainage as a management strategy for cirrhotic ascites boasts a high rate of symptom alleviation, coupled with low financial costs and a minimal incidence of associated complications. This approach significantly diminishes the necessity for repeated LVP procedures, positioning it as a potential cornerstone in the evolving landscape of cirrhotic ascites management. Nevertheless, meticulous attention must be paid to minimizing the duration of catheter retention, as this is paramount in preventing the emergence of complications.

LVP: Large-volume paracentesis; HAS: Human serum albumin; TIPS: Transjugular intrahepatic portosystemic shunt; PVS: Peritoneovenous shunt; Alfapump: Automated low-flow ascites pump; CART: Cell-free and concentrated ascites reinfusion therapy.

and death. This condition is known as PICD[13]. Larger LVP volumes are associated with higher PICD risks. When LVP is performed without volume expanders, up to 80% of cases may develop PICD, whereas intravenous albumin as a volume expander can reduce the PICD incidence to 15-35%[14]. Therefore, many studies recommend infusing 6-8 g of albumin per L of ascites drained after LVP > 5 L to prevent PICD[15-17]. The benefits of HSA infusion stem from its colloid osmotic and non-colloid osmotic properties[18]. The former improves effective hypovolemia by expanding plasma volume, while the latter offers anti-inflammatory, antioxidant, and immunomodulatory effects[19]. Studies show that routine HSA use and limiting LVP to 8 L can prevent renal function impairment[20]. Early HSA therapy reduces ascites incidence[21,22], benefits the prognosis of cirrhotic patients, and significantly lowers mortality in patients with mild cirrhosis[23]. Additionally, HSA treatment decreases the incidence of hepatic encephalopathy, hepatorenal syndrome, spontaneous bacterial peritonitis (SBP), and non-SBP infections[24]. The baseline model for end-stage liver disease score (MELD)-Na score of LVP patients is associated with acute kidney injury (AKI), necessitating caution for those with high MELD-Na scores considering therapeutic paracentesis. In summary, for most patients with refractory ascites, LVP combined with HSA is prioritized, but the frequency of paracentesis should be controlled. A reasonable treatment frequency is about once every two weeks, with a single maximum paracentesis volume not exceeding 5 L.

TIPS

TIPS involves inserting a stent to bridge the portal vein branch and hepatic vein, effectively creating a portosystemic shunt to treat cirrhotic ascites (Figure 2). Unlike paracentesis, this procedure targets the elimination of portal hypertension and its complications rather than merely alleviating symptoms[25]. Successful TIPS insertion lowers portal vein pressure, enhances circulatory function in ascites patients[26], increases visceral blood flow to systemic circulation, mitigates effective arterial blood volume deficiency, and improves heart and kidney functions[27]. Two types of stents are used in TIPS: bare metal stents and covered stents. Approximately 70% of patients with bare metal TIPS stents develop stenosis due to excessive endothelial growth within the stent, narrowing the lumen[28]. TIPS stenosis can be treated by balloon dilatation of the stent, and new stent insertion is required if this fails. Covered stents, coated with polytetrafluoroethylene (PTFE), significantly reduce TIPS stenosis by preventing bile leakage into the shunt lumen and providing a smoother internal surface, allowing uniform endothelial growth and preventing neointimal proliferation and subsequent stent stenosis[29,30]. Bare stents have a higher incidence of shunt dysfunction[31], while covered stents significantly improve long-term shunt patency[32], reduce shunt dysfunction, and enhance clinical outcomes[33]. In patients with cirrhosis and variceal bleeding, covered stents have improved the 1-year survival rate[34]. A randomized controlled trial [35] found that covered stents in TIPS result in lower recurrence rates of ascites and higher long-term patency compared to bare stents, reducing the need for repeat interventions and possibly requiring less frequent monitoring[36]. Covered

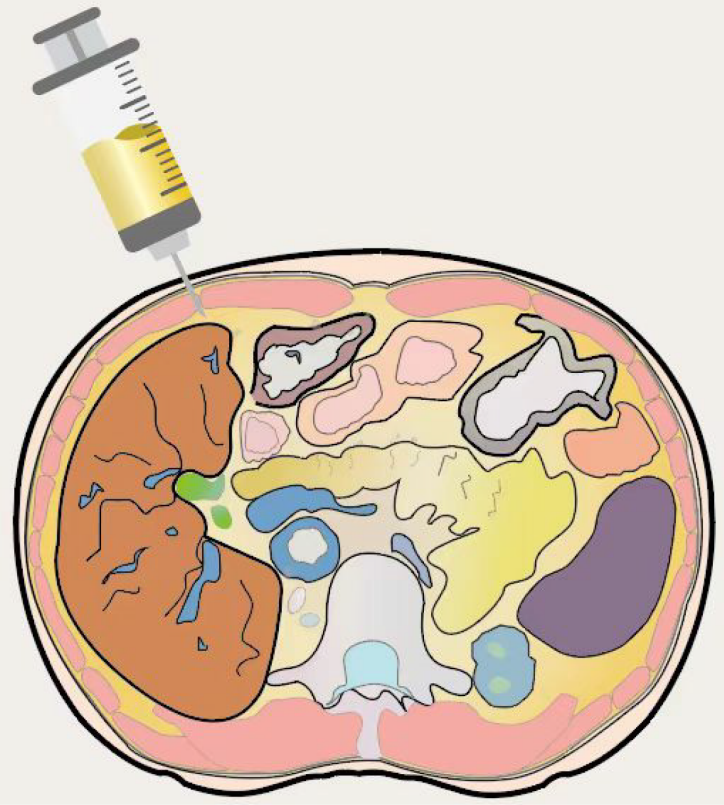

Figure 1 Schematic diagram of large-volume paracentesis.

stents are also more cost-effective[37]. The diameter of covered stents affects clinical outcomes. Using under-expanded, smaller diameter covered stents can significantly reduce hepatic encephalopathy incidence[38]. Patients with 8-mm covered stents showed improved survival rates compared to those with 10-mm stents[39], though some studies suggest that 10- mm stents better control ascites without increasing hepatic encephalopathy[40]. Therefore, initially using small-diameter stents aiming for a modest reduction in portal vein pressure with gradual expansion to a maximum of 10 mm is recommended if an adequate clinical response is not achieved[41]. TIPS can serve as a bridge to liver transplantation for patients needing frequent paracentesis, hospitalizations, or those awaiting liver transplantation[42]. However, TIPS placement can result in complications related to the procedure, stent, or the portosystemic shunt. Procedural complications include bleeding, arrhythmias, hemoperitoneum, liver capsule rupture, and biliary fistulas. Stent-related complications include stent migration, stenosis, hemolytic anemia[43], and stent infection[44]. Portosystemic shunt complications include hepatic encephalopathy[45], progressive liver failure, and heart failure due to exacerbated hyperdynamic circulatory state[46]. TIPS is contraindicated for patients with advanced liver failure, and with serum bilirubin ≥ 45 mg/dL, Child-Pugh score ≥ 11, MELD score ≥ 18, or a history of hepatic encephalopathy. Renal failure, sepsis, and portal vein thrombosis also contraindicate TIPS[47,48]. TIPS placement is not recommended for patients at a high risk of heart failure or severe pulmonary hypertension. High right-sided pressures can eliminate the necessary pressure gradient between the portal and systemic venous systems, rendering TIPS ineffective. In such cases, TIPS placement may exacerbate heart failure[49]. Patients with intrahepatic malignancies should avoid TIPS due to the risk of tumor spread[50]. TIPS has shown significant efficacy in treating ascites[51]. A meta-analysis by Deltenre *et al*[52] confirmed TIPS's superiority over LVP in controlling ascites and improving survival rates. Additionally, studies show that TIPS significantly improves survival rates in patients with refractory ascites[53], reduces recurrent ascites and hepatorenal syndrome, but increases hepatic encephalopathy risk[54]. Furthermore, it is necessary to consider the inclusion of bare stents in some studies, as they carry a higher risk of hepatic encephalopathy, which may consequently impact the outcomes. Other studies indicate that compared to LVP, TIPS with covered stents better controls ascites without higher rates of new-onset hepatic encephalopathy in PTFE-TIPS patients[55]. In summary, compared to LVP, TIPS treatment in patients with recurrent ascites can reduce complications and improve survival rates[56], making it a viable alternative. Current clinical guidelines consider TIPS as a second-line treatment, recommending its use only when frequent LVP or other treatments are ineffective[57], due to the high risk of TIPS-related hepatic encephalopathy in decompensated cirrhosis, which has high mortality rates [58]. However, with advancement and experience, especially in self-expanding PTFE-covered stents, TIPS-related complications have been significantly reduced[59], leading to increased TIPS use for refractory ascites. Additionally, TIPS effectively prevents variceal rebleeding, potentially becoming the preferred treatment for cirrhotic ascites in the future.

PVS

PVS (LeVeen or Denver), first employed in the 1970s for refractory ascites, has been shown to reduce hospitalization duration, the number of hospitalizations, and diuretic dosage. This method involves implanting a device in the

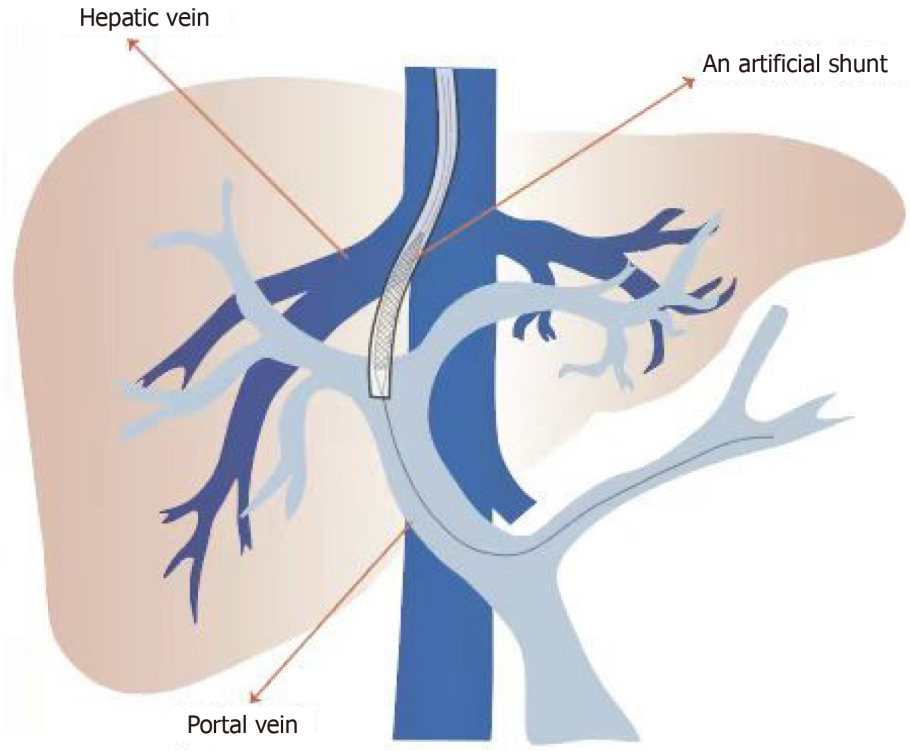

Figure 2 Transjugular intrahepatic portosystemic shunt. Establishing an artificial shunt between the hepatic vein and portal vein.

abdominal cavity to collect and filter blood from the peritoneal cavity based on the pressure gradient between the peritoneal cavity and central veins, directing it to the heart for further processing. The primary mechanism aims to reduce ascites volume while expanding plasma volume[60]. Ginès *et al*[61] have demonstrated that PVS effectively controls ascites compared to LVP combined with albumin infusion. Additionally, PVS has been reported to improve the glomerular filtration rate (GFR) in cirrhotic patients with refractory ascites, particularly those with moderate to severe renal impairment[62]. However, other studies indicate that PVS does not surpass repeated LVP and albumin infusion in treating refractory ascites[63]. Despite its relatively simple operation, PVS can cause serious, even fatal, complications, including infections[64], device blockage, shunt dysfunction, thrombosis, volume overload, disseminated intravascular coagulation, heart failure[65], air embolism, and complications related to surgical insertion[66]. These complications significantly increase patient mortality. Moreover, PVS placement can hinder TIPS procedures and cause peritoneal adhesions, complicating liver transplantation surgery. Although PVS can be used for refractory ascites patients ineligible for TIPS or liver transplantation, its high risk of adverse outcomes has led to its near-total abandonment[67].

Alfapump

Alfapump is currently an alternative therapy for patients with refractory ascites (Figure 3)[68]. This implanted, battery-powered pump includes two silicone catheters: One in the peritoneum to collect ascites and the other in the bladder to deliver the ascites. The alfapump has four pressure sensors that monitor abdominal and bladder pressure, providing information on flow rates and system behavior. Generally, the pumping cycle starts when bladder pressure is below a certain threshold and stops immediately when peritoneal cavity pressure decreases significantly. This control allows the alfapump to manage the volume of ascites drained as well as the timing and frequency of pump activity. The alfapump's purpose is to transfer ascites from the abdominal cavity to the bladder, allowing elimination through urination[69], effectively performing continuous small-volume, low-rate paracentesis daily. Despite requiring daily battery charging for less than 20 min, the pump operates for about 16 hours, with an expected battery life of over three years[70]. In managing cirrhotic ascites, the alfapump can significantly reduce the need for LVP[71,72]. A meta-analysis revealed that 62% of patients no longer needed LVP after alfapump implantation, and the number of required LVPs was significantly reduced [73]. Compared to repeated LVP, alfapump is more acceptable to patients with refractory ascites and improves their quality of life[74-76]. Studies show that the alfapump system offers advantages over LVP by reducing or eliminating the need for paracentesis and enhancing quality of life and nutritional status[77]. Although the alfapump system's implantation cost is high, it stabilizes after intervention, unlike the continually increasing cost of repeated LVP. Therefore, for cirrhotic patients with refractory ascites, the alfapump system can effectively reduce the need for paracentesis and improve health quality. While its impact on survival has not been formally studied, the alfapump controls ascites as effectively as LVP combined with HSA[78]. However, the complication rate is high, including pump system infections, pump failures, catheter displacements, electrolyte abnormalities, and renal complications[79]. Infections are the most common complication, with an incidence exceeding 40%. These include bacterial peritonitis, urinary tract infections, sepsis, and surgical site infections[80], with cellulitis at the pump or catheter site being the most frequent. Hyponatremia is the most common electrolyte abnormality, which is reported to occur due to high pump rate settings, and resolves

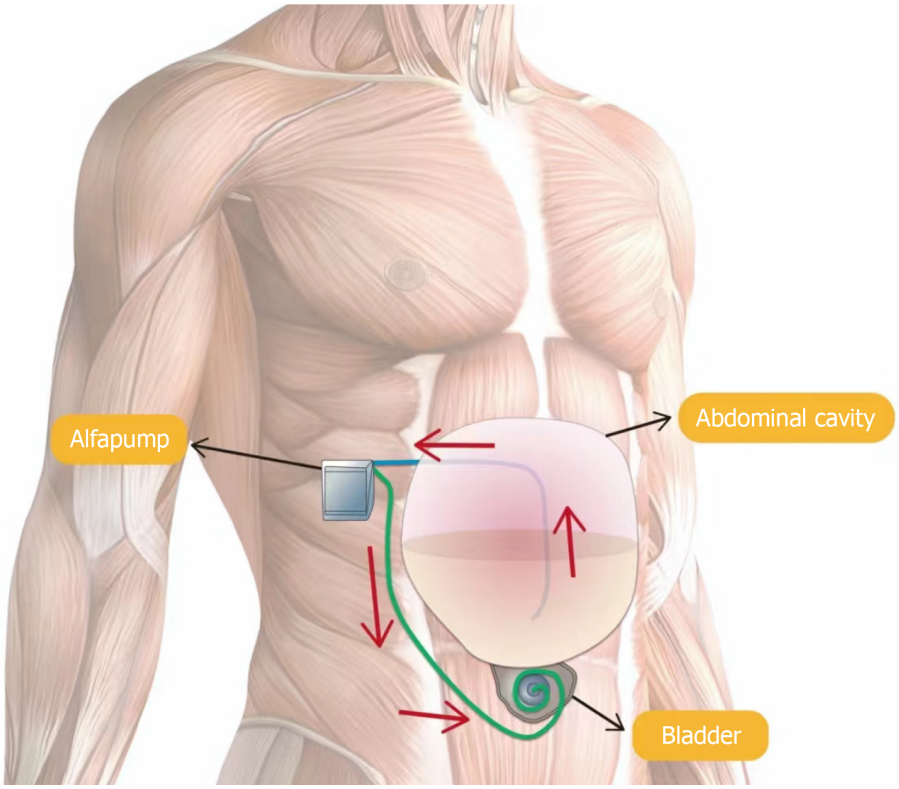

Figure 3 Schematic presentation of the automated low-flow ascites pump system. Ascitic fluid is aspirated through a catheter placed into the abdominal cavity and further transported into the bladder through a subcutaneous catheter. The battery-driven pump is implanted in the right middle quadrant of the abdomen.

after lowering the pump rate[81]. Alfapump treatment may significantly activate the endogenous vasoconstrictor system and impair renal function, with up to 30% of patients experiencing AKI[82]. Studies have noted a gradual decline in GFR after alfapump implantation, potentially affecting ECV and leading to vasoconstrictor system activation, similar to circulatory dysfunction after paracentesis[83]. Administering intravenous albumin during alfapump treatment may inhibit vasoconstrictor system activation and prevent renal injury. Bellot *et al*[84] found that even small continuous removal of ascites without albumin supplementation might further reduce ECV in patients with refractory ascites. Patients with renal insufficiency, serum creatinine > 132 μmol/L, or estimated GFR < 30 mL/min/1.32 m should avoid alfapump implantation. Other contraindications include recent infection, recent abdominal surgery, a history of bladder cancer, a history of solid organ transplantation, and bilirubin levels > 85 μmol/L[85]. Thus, ideal candidates for alfapump treatment are patients with refractory ascites in relatively good nutritional status, with normal liver and kidney function, and no concurrent infection[86]. The total daily volume drained by the alfapump should not exceed 1 L, and dietary measures may be taken to reduce ascites production if necessary. Continuous ascites drainage and increased intra-abdominal pressure in refractory ascites patients can lead to AKI, necessitating albumin infusion during ascites drainage [87]. In cases of suspected infection, immediate antibiotic treatment is recommended to reduce complications. In conclusion, for patients with non-malignant refractory ascites who are unsuitable for alternative treatments such as TIPS or liver transplantation, alfapump implantation is an effective treatment option[88].

CART

CART was first reported in 1977[89]. It is mainly used for treating patients with ascites due to decompensated cirrhosis (Figure 4). The purpose of CART is to maintain plasma colloid osmotic pressure by reinfusing proteins recovered from ascites[90]. The CART procedure includes several steps: First, paracentesis is performed to remove ascites into a drainage bag. Next, filtration is used to remove pathogens and small molecular harmful substances such as urea nitrogen, creatinine, and bilirubin. Then, excess water is removed through concentration. Finally, the liquid obtained from these steps, including useful proteins like albumin and globulin, is reinfused intravenously[91]. This method avoids the loss of proteins contained in the ascites, reduces the cost of using large amounts of albumin, and avoids the risk of infection from using blood products. The main indication for CART is ascites due to cirrhosis, but it has also been used to treat malignant ascites. Compared to LVP, CART significantly increases the amount of ascites that can be removed in a single session, up to a maximum of 8000 mL. The treatment process lasts about 2-3 hours and can quickly relieve abdominal distension, reduce the burden of ascites, and increase nutritional intake[92]. CART therapy has been reported to reduce abdominal circumference, improve diuretic resistance, and enhance the patients' quality of life[93]. Compared to continued use of diuretics, CART reduces the risk of complications and increases serum albumin levels[94]. Studies have found that CART prevents the loss of albumin and globulin, thereby improving nutritional and immune status[95]. Yamada *et al* [96] reported that CART raised albumin levels more effectively than simple paracentesis or albumin infusion alone. The

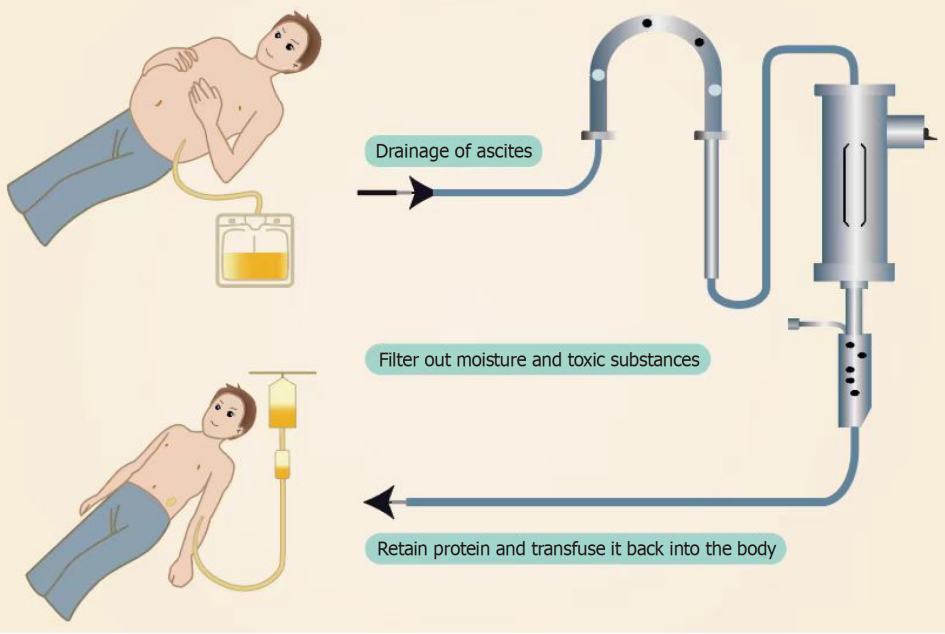

Figure 4 Schematic illustration of the concentrated ascites reinfusion therapy process.

reinfusion of albumin increases plasma colloid osmotic pressure, corrects insufficient renal blood perfusion, improves renal function, and promotes diuresis[97]. Jatoi *et al*[98] showed significant increases in albumin, total protein, and eGFR after concentrated ascites reinfusion, suggesting a better effect than LVP alone. CART has better safety com-pared to previous ascites reinfusion or PVS surgeries, with efficacy comparable to LVP combined with albumin[99]. Moreover, Matsusaki *et al*[100] developed a new CART system with a membrane cleaning function (KM-CART) that can handle larger volumes of refractory ascites. Since most patients with decompensated cirrhosis also have chronic kidney disease, large-volume ascites drainage can quickly reduce intra-abdominal pressure, worsening effective blood volume circulation. Thus, it is crucial to shorten the dehydration time as much as possible[101]. KM-CART operates at high speed, shortening the dehydration time caused by large-volume ascites drainage, reducing the impact on renal function, and increasing urine output. However, CART also has disadvantages such as high equipment costs, complex procedures, and allergic reactions[102]. Complications may include hypotension, decreased fibrinogen, and fever[103]. Fever is a relatively common adverse event after concentrated ascites reinfusion, but pre-treatment with steroids and/or nonsteroidal anti-inflammatory drugs can prevent it[104]. CART should be used with caution in patients with severe cardiac disease, electrolyte imbalances, renal failure, severe abdominal or peritoneal skin infections, bleeding tendencies, and hepatic encephalopathy. Overall, CART maintains plasma colloid osmotic pressure, improves nutrition, and enhances the quality of life for patients with refractory ascites due to decompensated cirrhosis without significantly impacting renal function, making it an effective palliative treatment[105]. However, CART is currently mainly used in Japan, and its global applicability remains to be verified[106].

Peritoneal catheter drainage

Peritoneal catheter drainage serves as an effective method for managing cirrhotic ascites. Studies suggest that long-term abdominal drainage provides a safe and effective palliative intervention for end-stage liver disease (Figure 5)[107]. Various catheter placements have been recommended as an alternative to traditional treatments for refractory ascites [108]. This approach involves inserting a peritoneal puncture catheter kit into the abdominal cavity under local anesthesia guided by ultrasound. The drainage amount is adjusted based on the patient's condition, along with basic treatments such as liver protection, diuretics, and albumin supplementation. The catheter is removed once ascites is no longer present or ultrasound indicates near-total absorption. Typically, daily drainage is limited to 5 hours, with volumes controlled between 800 and 1500 mL over 3 to 7 days. Research indicates that peritoneal indwelling central venous catheters can provide continuous drainage, reducing the need for multiple punctures[109,110]. Adjusting the drainage volume according to the patient's blood volume and renal function helps avoid circulatory dysfunction and the complica-tions of repeated punctures, thereby minimizing patient discomfort. This method significantly alleviates symptoms like abdominal distension, poor appetite, and dyspnea, improving quality of life. Compared to LVP, continuous drainage *via* peritoneal catheter reduces the number of punctures, prevents ascites accumulation, and avoids circulatory dysfunction, thus decreasing the incidence of complications. Studies confirm that peritoneal catheter drainage does not increase the risk of renal function impairment, and plasma blood urea nitrogen levels decrease significantly after two weeks of catheterization[111]. The soft texture and high compatibility of the indwelling catheter with human tissue minimize damage to abdominal organs. Connecting the catheter to a drainage bag and monitoring blood pressure and intra-abdominal pressure enables slow, continuous ascites drainage, leading to gradual reduction in abdominal pressure. This approach prevents sudden fluctuations in blood volume and internal environment, making the procedure safer and more reliable, reducing patient discomfort, and improving tolerance. Faster resolution of ascites and better control of abdominal

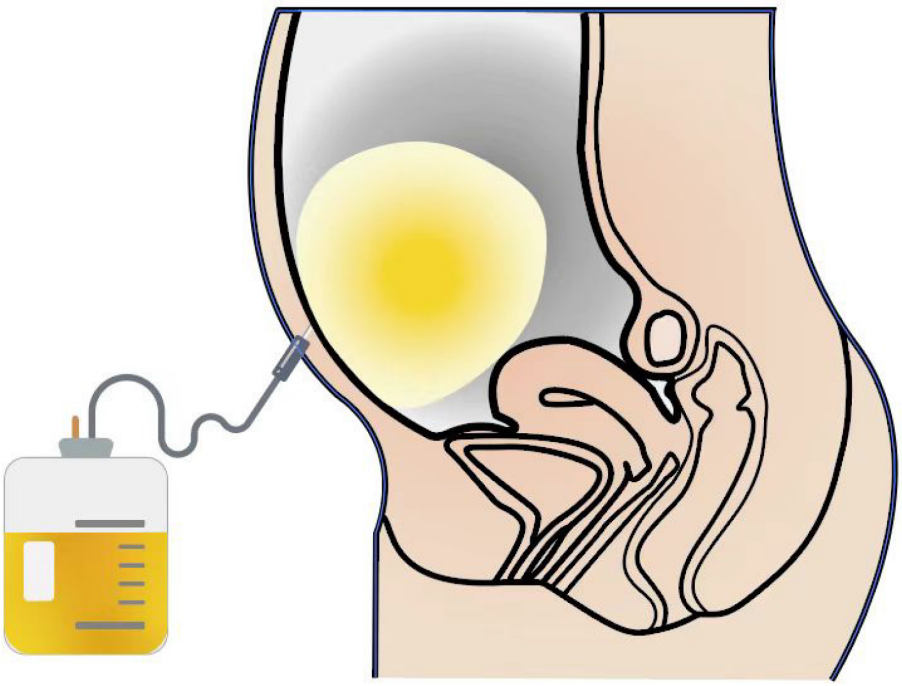

Figure 5 Peritoneal catheterization for the drainage of ascites.

infections can shorten hospital stays. Active volume expansion therapy, such as daily supplementation with 10 g human albumin after ascites drainage, effectively prevents puncture-induced circulatory dysfunction. Studies show no significant changes in renal function, indicated by stable creatinine levels, before and after puncture with regular albumin supplementation[112]. Given these advantages, peritoneal catheter drainage has significant clinical application value. However, complications such as abdominal infection, hyponatremia, hepatic encephalopathy, and subcutaneous or intramuscular hematoma hematomas can occur[113]. The most critical issue is the risk of SBP due to prolonged drainage [114]. Ascitic fluid serves as an excellent culture medium for bacteria, and cirrhotic patients have weakened immunity, leading to a higher incidence of SBP. Studies indicate that draining ascites for more than 24 hours increases the risk of ascites-related bacterial peritonitis and AKI. Therefore, completing ascites drainage within 24 hours is recommended, especially for cirrhotic patients with a Child-Pugh C grade or higher MELD score[115]. Stratmann *et al*[116] suggest a maximum catheter retention time of 72 hours, although they found no direct link between retention time and infection complications. Other studies confirm the theoretical adverse effects of prolonged catheter retention on infection and survival in cirrhotic patients[117]. Repeated monitoring of white blood cell and neutrophil counts in drained ascites is necessary during catheter retention, and prophylactic antibiotics may be required to prevent infection. In conclusion, peritoneal catheter drainage for cirrhotic ascites offers a high symptom relief rate, low cost, and low incidence of related complications, reducing the need for repeated paracentesis procedures[118]. It can effectively remove ascites before procedures like TIPS or liver transplantation, potentially becoming a cornerstone in the future management of cirrhotic ascites. However, minimizing catheter retention time is crucial to prevent complications.

CONCLUSION

Different drainage methods for cirrhotic ascites have their advantages and disadvantages. PVS is rarely used currently due to its high complication rate. Initial treatment for most refractory ascites should prioritize LVP combined with albumin infusion and peritoneal catheter drainage. If these treatments are ineffective or cause severe complications, TIPS or alfapump may be considered. CART, primarily used in Japan, requires further validation for suitability in other populations. Clinicians must evaluate the patient's specific condition and circumstances to determine the most appropriate treatment.

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FOOTNOTES

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