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Peritoneovenous Denver Shunt

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Peritoneovenous Shunt History

Peritoneovenous shunts have been used to treat ascites with Interventional Radiology (IR), for over 50 years. Being the first in a line of shunts, the Hyde shunt was used from 1964-1974. It was improved and renamed the LeVeen shunt, being used from 1974-1979. The LeVeen shunt was then modified, creating the popular Denver shunt in 1979. (Ilda, et al, 2017) Peritoneovenous shunts have been used for the same purpose since first developed; treating ascites by pumping the fluid within the peritoneal cavity into the superior vena cava. This allows the body to naturally retain the nutrients within this fluid while also expelling it from the peritoneal cavity.

Why the Denver Shunt?

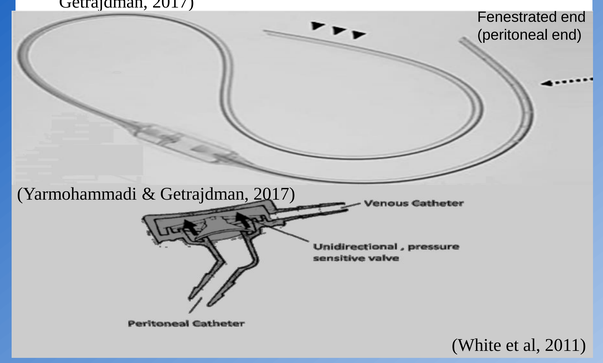
Ascites is the retention of fluid in the peritoneal cavity and is one of the most frequent complications of liver cirrhosis (failure), occurring in approximately 50% of patients with severe liver disease (Caly et al, 2017).

There are many treatment methods for ascites, some of which include multiple paracentesis, a special diet, the transjugular intrahepatic portosystemic shunt procedure, as well as peritoneovenous shunts. (Caly et al, 2017)

How it Works…

The Denver shunt is available in two sizes. The 11.5 French shunt is used when the saphenous or subclavian veins are used. The 15.5 French shunt is used with the internal jugular vein is used.

The Denver shunt works by having one end of the catheter in the peritoneal cavity and the other leading to the inferior vena cava. There is then a one way valve within a subcutaneous pump that is placed anterior to a rib so it can be compressed to move the fluid (Farrell & Dennison, 2016, p336). The subcutaneous pump is either a single or double valve, the single valve provides a faster flow rate than the double valve.; though the double valve is more efficient in preventing reflux. The double valve, 15.5 French shunt is the most commonly used. (Yarmohammadi & Getrajdman, 2017)



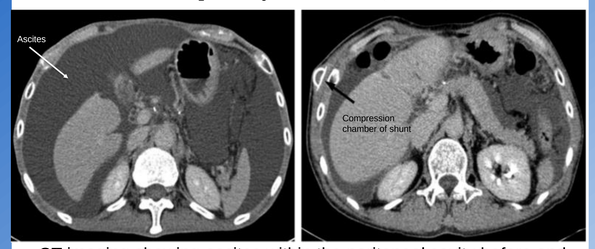
(Yarmohammadi & Getrajdman, 2017)

(White et al, 2011)

Indications and Contraindications

Indications	Relative Contraindications	Absolute Contraindications
Intractable malignant or cirrhotic ascites not responding to medical treatment and large volume paracentesis	Compensated congestive heart failure	Blood ascites
Life expectancy of more than 3 months	Loculated ascites or peritoneal adhesions	Renal failure if the patient is not on dialysis
Chylous ascites	Peritoneal disease, i.e., peritoneal mesothelioma	History of varicose vein bleeding
None of the contraindication exists	Massive pleural effusion	Grade ¾ esophageal varices
	Varices with no history of bleeding	CHF or advanced cardiac disease
	Portal hypertension	Respiratory failure with pulmonary edema
	Positive cytology of the ascites fluid	Liver failure (T Bili > 2.0 mg/dL)
	Simultaneous gastrointestinal surgery	Coagulation disorders (Low platelet counts < 50 x 10^9 or high INR > 2.0
		Peritonitis or history of spontaneous bacterial peritonitis
		Evidence of nonsterile ascites (from bile leak or urine leak)
		Poor performance status
(Yarmohammadi & Getrajdman, 2017)		Anasarca or hypoalbuminemia (serum albumin < 2.5 g/dL)

A patient is considered a good candidate if; they meet the indications in the chart above, none of the contraindications are present, and have healthy cardiac and respiratory functions. (Ilia et al, 2017)



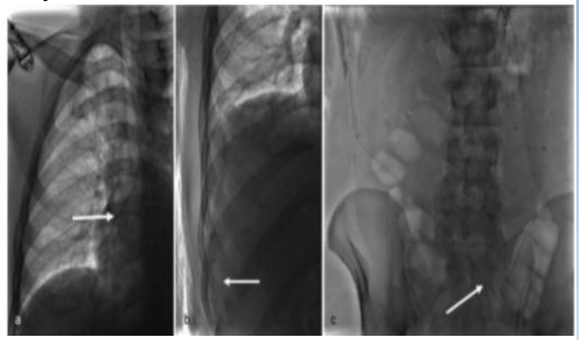
CT imaging showing ascites within the peritoneal cavity before and after the placement of the Denver shunt. (Won et al, 2008)

Pre-op

Patients lab values are examined at different intervals prior to the procedure. These lab values consist of blood urea nitrogen (BUN), albumin levels, platelet count, bilirubin levels, creatinine levels, lymphocyte count, cholesterol levels, exedra (Iida et al, 2017). Lab values are taken at 3 weeks preop, one week preop, 48 hours preop, and finally at 12 hours preop. This is to ensure the patient is in good health and remains in good health prior to the procedure. It also creates a baseline for these values that can be compared to after the procedure. The patient has to fast prior to the procedure due to the use of conscious sedation. (Yarmohammadi et al, 2017)

Placement

The procedure is performed with the patient supine and under conscious sedation using local anesthesia. Starting with lidocaine, an incision is made above the lowest rib on the right, followed by another incision 8-10 cm below the right hypochondrium. This second incision is for access into the peritoneal cavity and is determined using sonography. The subcutaneous pocket is created on the lowest right rib. The peritoneal cavity is drained of ascites to almost completion, leaving enough to prime the shunt. If too much fluid is drained, saline can be used to prime the shunt. The Fenestrated side of the Denver shunt is inserted into the peritoneum using a peel-away sheath. Venous access of the right subclavian, saphenous, or jugular vein is achieved and the catheter is tunneled from the subcutaneous pocket to whichever vein is used. Fluoroscopy is used to ensure correct length and position. (Ilda et all, 2017) often times an antibiotic is also given to the patient to prevent any infection.



In the left image the arrow is showing the tip of the catheter proximal to the right atrium. In the middle image the arrow is showing the compression chamber or pump. In the right image the arrow is demonstrating the end of the catheter. (Yarmohammadi & Getrajdman, 2017)

Post-op and Follow up

Patients will often be admitted after the procedure for a short time, this is to ensure that no life threatening complications present. The patient is told to compress the pump 20 times, twice a day in the supine position (Yarmohammadi et al, 2017). If no signs of complications present the patient will be discharged 72 hrs after the completion of the procedure. Within these 72 hours the patient's lab values are checked at 12 hours, 24 hours, 48 hours, and finally at 72 hours. The patient's lab values are then checked again one week and one month after the procedure. Follow-up CT imaging is also performed every 3 months to ensure the shunt is still in the correct position without any visual complications, this is done at least twice and then as needed. Patients are informed of signs and symptoms to watch for and to contact the IR department immediately if they believe something is wrong with the shunt. (Yarmohammadi et al, 2017)

Possible complications

- The most severe complications include pulmonary embolism and central venous thrombosis. Both of these complications can be life threatening, though some can be treated effectively.
- Disseminated intravascular coagulation or DIC is a complication that is often most discussed in relation to the Denver shunt. DIC occurs when the ascites alters the coagulation in the blood, causing either hyperactive or underactive clotting throughout the blood stream. (Tamagawa et al, 2020)
- Occlusion of the shunt happens often, being the most common complication through various studies (White et al, 2011). The use of thrombolytic therapy or the replacement of the shunt may be the only two solution for occlusion (Tamagawa et al, 2020). The 15.5 French Denver shunt is less likely to occlude (Yarmohammadi & Getrajdman, 2017) .

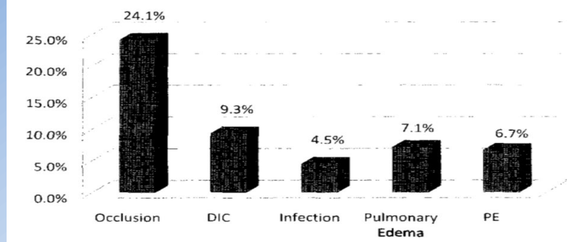


FIG. 3. Complication rates. (White et al, 2011)

Successes and Removal of Denver Shunt

The Denver shunt has been known to be successful in many ascites patients. Due to the shunt being placed subcutaneously, the patient is free to shower, swim, and perform daily activates once the incisions have healed. Many patients need this shunt for many years to manage their ascites, though "if imaging can confirm the resolution of ascites the shunt can be removed" (Yarmohammadi et al, 2017). The removal of the shunt is fairly easy with a minimal recovery time. (Yarmohammadi et al, 2017)

Conclusion

The findings of this research conclude that the Denver shunt, when used on patients who meet the correct criteria, is effective in the treatment for ascites. As scientists continue to research, there is new technology that builds off of the Denver shunt. Instead of pumping the ascites fluid into the blood stream, it is drained into the bladder. This shunt is still experimental, though may be the next step of improvement when regarding the treatment of ascites using peritoneal shunts. (Jain et al, 2019) IR has used the Denver shunts successfully since 1979, it continues to bring patients relief of their ascites and give them hope of an ascites free future.

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