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CASE REPORT

Complications of Denver Shunt

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ABSTRACT

Hepatic hydrothorax secondary to transdiaphragmatic spread of peritoneal fluid can cause respiratory discomfort to the patient. Draining of hydrothorax helps relieve these symptoms. Pleurovenous shunt (Denver shunt) is a relatively non-invasive method of shunting the pleural fluid to the central venous system. Reported complications of pleurovenous shunts are shunt failure, pulmonary edema, post shunt coagulopathy, deep vein thrombosis, and infection. We report a rare case of a leak at the venous end of the catheter that was placed within the right internal jugular vein, resulting in a large collection in the neck.

Key words: Denver shunt, hepatic hydrothorax, peritoneovenous shunt, pleurovenous shunt

INTRODUCTION

Hepatic hydrothorax is an uncommon complication of cirrhotic patients with ascites. It causes serious respiratory distress in these patients whose ventilation is usually already compromised by the elevated diaphragm caused by ascites. Denver pleurovenous shunt insertion is a minimally invasive alternative to other surgical procedures such as repeated thoracentesis, tube thoracostomy, chemical and mechanical pleurodesis, and Transjugular Intrahepatic Portosystemic Shunts (TIPS). Placement of Denver pleurovenous shunt with a pump chamber allows unidirectional flow of fluid from the pleural cavity to the central venous system. It helps replace the lost plasma volume in the central venous system by shunting the pleural fluid to the superior vena cava. The pump chamber is placed subcutaneously within the chest wall and allows daily manual compression and movement of fluid across a less favorable pressure gradient created between the pleural cavity and the central venous system. Potential complications of the procedure are bleeding, air embolism, infection and occlusion, and leakage. Here, we present a complication of the Denver shunt in the form of a leak presenting as a neck mass.

CASE REPORT

A 56-year-old male patient presented to the Emergency Ultrasound Department with a mass on the right side of the neck. He had a history of end stage liver disease and had undergone placement of a pleurovenous Denver shunt to relieve hydrothorax. The chest radiograph taken at the Emergency Department shows the venous end of the catheter in the right internal jugular vein [Figure 1a]. A line diagram depicts the normal placement of the Denver pleurovenous shunt and the direction of flow [Figure 1b]. Gray-scale ultrasound scan of the neck was performed and the venous end of the catheter was seen within the right internal jugular vein [Figure 2]. Pleural end of the catheter was in the right pleural cavity

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and was detected subcutaneously in the right chest wall, lateral to the sternum [Figure 3]. A septated collection measuring 4.6 cm × 5.6 cm × 3.5 cm was identified anterior to the venous end of the catheter within the soft tissues of the neck as a result of the leaked pleural fluid from the Denver shunt inserted in the internal jugular vein [Figure 4]. Transabdominal ultrasound scan confirmed the presence of a cirrhotic liver and a significant amount of ascites [Figure 5]. The patient was surgically explored for non-functional shunt. There was no break in the shunt. It was felt to be malfunctioning secondary to acute bend.

DISCUSSION

Pathophysiology of hepatic hydrothorax

Patients with chronic liver disease manifest various pulmonary complications such as hepatopulmonary syndrome, portopulmonary hypertension, intrathoracic portosystemic collaterals, hepatic hydrothorax, bacterial infections, pulmonary manifestations of hepatocellular carcinoma, and drug-induced diffuse interstitial lung disease.[1] Pleural effusion or hepatic hydrothorax in patients with chronic liver disease is an uncommon presentation and is reported to have an incidence of 5% to 10% in cases with end stage liver disease.[1] Hepatic hydrothorax is defined as significant pleural effusion of more than 500 ml without any evidence of primary pulmonary or cardiac diseases. It is more common on the right side (85%), less common on the left side (13%), and bilateral in only 2% of cases.[1] Many reasons have been postulated for this accumulation of pleural fluid in cirrhotic patients. These are:

1. Decreased colloidal osmotic pressure as a result of hypoalbuminemia;
2. Leakage of plasma from the hypertensive azygos vein;
3. Lymphatic leak from thoracic duct;
4. Passage of fluid from the abdominal cavity to the pleural cavity by way of lymphatic channels and
5. Direct transfer of peritoneal fluid through the diaphragmatic defects. This is the most accepted theory which has been proved in different studies.[2]

Role of diaphragm in hepatic hydrothorax

Several studies using thoracoscopy and thoracotomy have proved that there are microscopic and macroscopic defects or transdiaphragmatic lymphatic channels that permit the passage of intraperitoneal fluid to the pleural cavity.[3] The diaphragmatic defects are classified into four types according to their morphology [Table 1].[4] Pressure created from below the diaphragm causes the pleural blebs to rupture. These ruptured blebs and fenestrations act as ball valves and allow the flow to be exclusively unidirectional. The higher rate of right side pleural effusion is explained by the pleural defects being more common on the right side and because of the physiologic

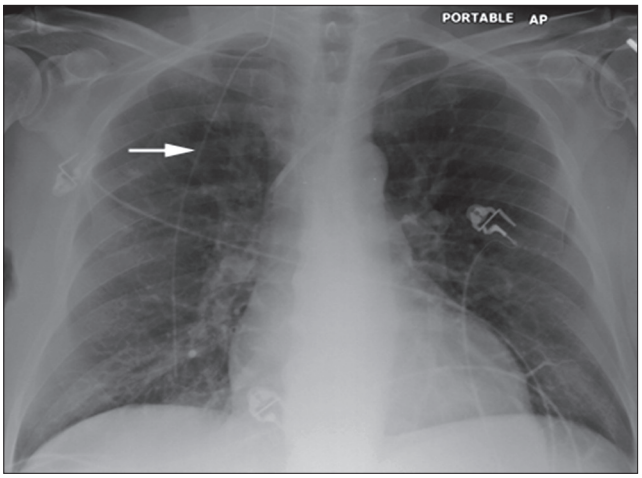

Figure 1a: Plain radiograph of the chest shows the Denver shunt placed in the pleural cavity (arrow) and the venous end directed toward the right internal jugular vein.

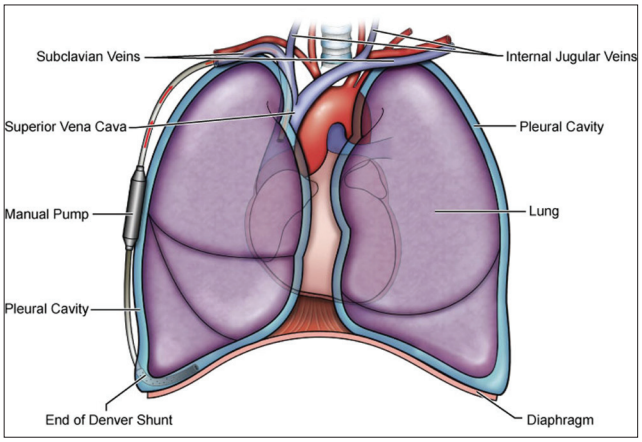

Figure 1b: A line diagram of the Denver pleurovenous shunt shows the proximal part of the tube within the pleural cavity and the distal or venous end of the catheter inserted into the internal jugular vein, with its distal end extending to the superior vena cava. The pump within the chest wall allows manual compression and creates a unidirectional flow of fluid from the pleural cavity to the central venous system (arrows).

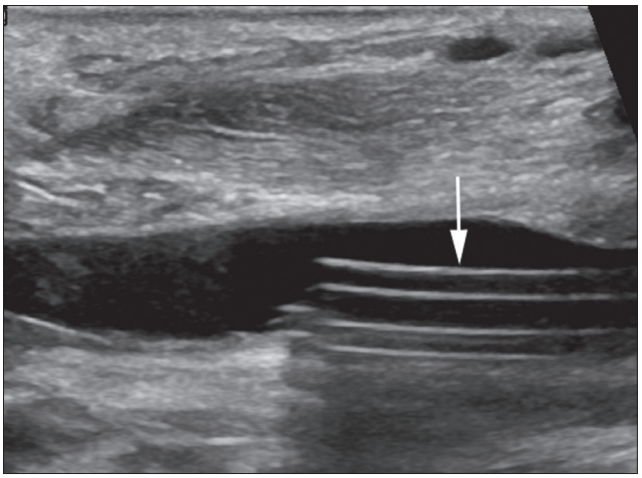

Figure 2: Gray-scale ultrasound scan of the right side of the neck shows the venous end of the Denver shunt (arrow) within the right internal jugular vein.

Table 1: Morphological subtypes of diaphragmatic defects	
Type 1	No obvious defects
Type 2	Diaphragmatic blebs
Type 3	Broken defects or fenestrations
Type 4	Multiple gaps in the diaphragm

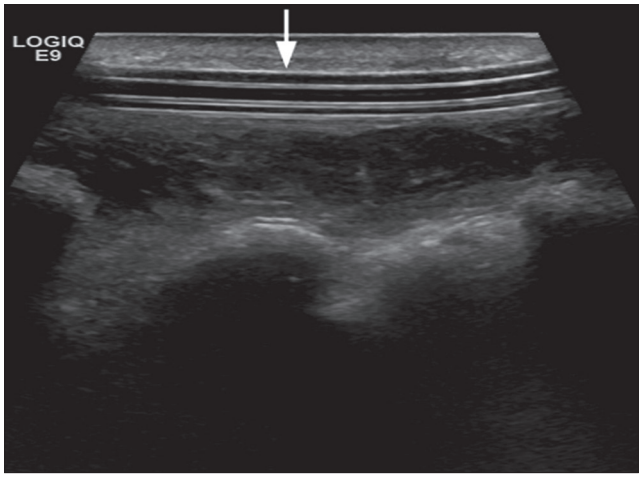

Figure 3: Ultrasound scan of the right chest wall demonstrates the pleural end of the Denver shunt catheter placed subcutaneously (arrow).

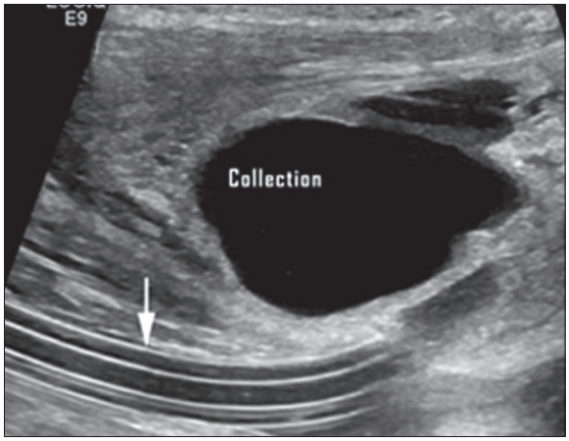

Figure 4: Transverse ultrasound scan over the lump on the right side of the neck shows fluid collection measuring 5.5 cm × 3.4 cm anterior to the internal jugular vein. Catheter is seen within the right internal jugular vein (arrow).

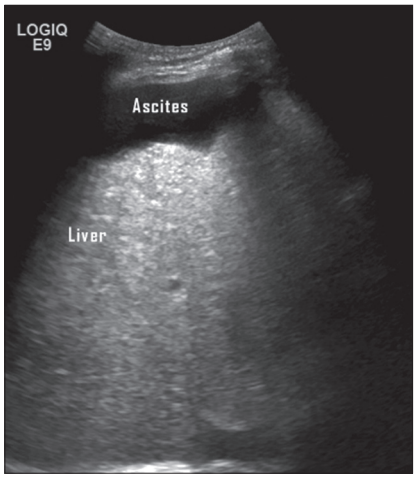

Figure 5: Transabdominal ultrasound scan demonstrates the echogenic and irregular outline of the cirrhotic liver and significant amount of ascites.

flux of the peritoneal fluid toward the right side.[5,6]

Management of hepatic hydrothorax

Patients with hepatic hydrothorax present with various symptoms such as dyspnea, non-productive cough, and pleurisy. Rarely, they may present with respiratory failure due to tension hydrothorax.[1] The aim of treating hepatic hydrothorax is to eliminate recurrent pleural effusion and to provide permanent relief from respiratory symptoms. Treatment methods available are thoracocentesis, tube thoracostomy, chemical or mechanical pleurodesis, placement of pleurovenous shunts, pleurectomy, and TIPS. Thoracentesis and tube thoracostomy are considered the first method of choice in treatment and diagnosis of hepatic hydrothorax. Pleurodesis can be performed by using either mechanical or chemical methods. Mechanical pleurodesis is done by abrading the pleural surface and chemical pleurodesis done by introducing tetracycline or talc to the pleural cavity through a pleural tube.[5, 7]

Surgical management: Pleurovenous shunts

Failure to respond to a salt restricted diet is considered a main indication for Peritoneovenous or Pleurovenous shunt insertion.[6] Pleurovenous shunt is a minimally invasive and a prolonged way of treating hepatic hydrothorax. The first use of pleurovenous shunt was demonstrated by Pollock in 1975.[8] The shunt serves as a method for returning the lost plasma volume through the shunt placed in the pleural or peritoneal cavity to the central venous system.[6] Two types of peritoneovenous shunts are described: The Le Veen shunt and the Denver shunt. In 1974, Le Veen introduced a peritoneovenous shunt (Harry H. Le Veen, Medical University of South Carolina).[6] The shunt moves the peritoneal fluid to the central venous circulation via a unidirectional valve. The basic principle of a shunt is to create a pathway between the peritoneal or the pleural cavity and the central venous system using a relatively non-compressible tube with a one-way valve. Le Veen shunts function due to the pressure gradient across the pleural or peritoneal cavity and the central venous system. Denver shunt was introduced in 1979 (Denver Biomedical Colorado, USA). The shunt can be inserted into the pleural or peritoneal cavity. The venous end is inserted into a preferred vein via a subcutaneous tunnel that is created.[9] The Denver shunt has a unidirectional pump that is placed subcutaneously over the ribs. This allows use of external manual compression to move fluid from the peritoneal or pleural space to the central venous system. Denver shunt has a higher success rate as a pleurovenous shunt due to the use of manual compression that allows fluid movement against a less favorable pressure gradient of the pleural cavity and the venous system.[8,9]

Complications of pleurovenous shunts

Pulmonary edema and development of respiratory distress syndrome is reported as an early complication due to fluid overload in the early post shunt replacement period.[6]

Post shunt coagulopathy is reported in up to 5% of patients following shunt placement. Coagulopathy is presumed to be initiated by a large amount of tissue plasminogen factors being introduced to the blood from the peritoneal or the pleural fluid. [6]

Infection is reported to have a lower incidence due to use of prophylactic antibiotics and wound irrigation with aminoglycosides.[6]

Deep vein thrombosis involving the upper extremity, ipsilateral to the shunt insertion has also been reported.

Shunt failure is the most common complication and is reported in 10% to 15% of the patients. Failure can be due to mal-positioning of the venous tip of the shunt or mechanical obstruction such as a kink or a thrombus.[6] The main cause of Denver shunt occlusion is the accumulation of fibrin and cellular debris that often get impacted after each manual compression.[10]

Air embolism as a complication is uncommon and has been reported in the literature. To prevent air embolism, pleural or peritoneal fluid should not be aspirated to its fullest extent and a residue amount should always be left in pleural or peritoneal cavity.[9]

Although catheter leakage is a known entity, the leakage encountered in our patient led to the formation of a collection within the soft tissue that presented as a neck mass.

CONCLUSION

Reported complications of the Denver shunt are shunt occlusion, infection, post shunt coagulopathy, deep vein thrombosis, catheter breakage, and leaks. The current report demonstrates that leaks can present as neck masses. Careful evaluation of neck masses including ultrasound evaluation is recommended for patients with Denver shunts presenting with neck masses.

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