Peritoneovenous Shunt Scintigraphy to Assess Shunt Patency in Patients with Refractory Ascites

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Peritoneovenous shunt scintigraphy is an infrequently performed study to non-invasively assess shunt patency in patients with recurrent or refractory ascites in cirrhotic patients. We describe two patients of chronic liver disease in whom ^{99m}Tc -macroaggregated albumin scintigraphy was performed to assess the patency of peritoneovenous shunt. Visualization of lung activity was interpreted as indicative of shunt patency. While both lungs were visualized almost immediately in the first patient, they were visualized by 30 min in the second patient. Visualization of radiolabeled peritoneal fluid in the entire length of the shunt tubing may be variable, and was seen in only one patient. Scintigraphy also helped in excluding communication between the ascites and right groin collection in the second patient. (J CLIN EXP HEPATOL 2013;3:347–350)

Denver shunt is a surgically created peritoneovenous shunt (PVS), in cirrhotic patients with intractable ascites, to drain the ascitic fluid into the venous circulation. The LeVeen shunt was the first clinically used design of PVS with a reported postoperative mortality and morbidity of 20% and 50% respectively.¹ More recently, the Denver shunt (DS) has become increasingly popular because of its subcutaneous compressible valve chamber that can be flushed manually and has a better patency rate. Both have been found to be effective in treating refractory ascites and improve patient's quality of life, although it does not affect the natural course of cirrhosis and its complications. Potential complications associated with PVS include shunt malfunction, with occlusion occurring in 5–15% of patients.² Some studies have mentioned a high occlusion rate of 40–60% of patients during first year of follow up.^{3,4} There are many techniques for assessing shunt patency which includes Doppler ultrasound, direct contrast radiography and radionuclide scintigraphy procedures, amongst which PVS scintigraphy is a simple and reliable technique with no documented false positives or false negatives. PVS scintigraphy has not been reported so far in our country. Hence we describe the first two patients with

postoperative refractory ascites who underwent ^{99m}Tc -macroaggregated albumin (MAA) scintigraphy to assess the shunt patency.

CASE REPORT

Case 1

A 63 years old male with alcoholic decompensated chronic liver disease (child pugh grade C) underwent PVS procedure using DS for refractory ascites. Postoperatively, his liver function tests were stable. He had a low serum albumin level of 2.8 g/dl. Ascitic fluid protein and albumin were 2.7 g/dl and 1.4 g/dl respectively. After an initial clinical improvement, he developed recurrent ascites six months later, necessitating paracentesis on three occasions. He underwent PVS scintigraphy to look for patency of the shunt. 5 mCi of ^{99m}Tc -MAA was injected intraperitoneally and the patient was gently rolled from one side to the other to facilitate mixing of the radioactive injection with the ascitic fluid (Figure 1). Early image at 5 min acquired for 5,00,000 counts over the anterior abdomen showed distribution of the radioactivity in the abdomen, confirming peritoneal fluid uptake following an appropriate injection. Subsequent static images of the abdomen and chest acquired at serial intervals for 5,00,000 counts showed transit of the tracer through the shunt and trapping into the lungs by 30 min. Delayed images acquired at intervals till 4 h showed increasing intensity of tracer activity in both lungs, excluding any mechanical obstruction of the shunt. Images also showed visualization of the radiolabelled peritoneal fluid in the entire length of the shunt tubing extending from the peritoneal end to the right side of the neck (Figure 1), with relatively more activity in the valve chamber. Patient was hence managed conservatively with modification of his medical

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Abbreviations: PVS: peritoneovenous shunt; DS: Denver shunt; MAA: macroaggregated albumin

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Figure 1 63 years old male with alcoholic decompensated chronic liver disease (child pugh grade C). Following an intraperitoneal administration of 5 mCi Tc-99m MAA, serial images acquired at regular interval shows peritoneal distribution of the radioactivity with movement of tracer through the DS and trapping into the lungs by 30 min. Subsequent images show increasing intensity of the lung activity excluding any mechanical obstruction of DS. The entire length of the shunt tubing is visualized.

management and adjustment of diuretics. Patient showed clinical improvement and was discharged.

Case 2

A 78 years old female with cryptogenic chronic liver disease (child pugh B status) underwent PVS using DS for refractory ascites. Postoperatively her liver functions were stable with total bilirubin of 1.21 mg/dl; Albumin: 2 g/dl; Globulin: 4.4 g/dl; serum alkaline phosphatase: 236 U/L; SGOT/SGPT: 29/42 U/L respectively and GGT: 134 U/L. Her ascitic fluid protein and albumin were less than 2 g/dl and 1.4 g/dl respectively. She developed recurrent ascites three months later causing abdominal distension and breathlessness. An ultrasound guided paracentesis was done and approximately 9000 ml of ascitic fluid was drained and compensated with albumin. She also presented with a collection in her right groin; clinically suspecting a possible communication with the peritoneal ascites. She was therefore referred for PVS scintigraphy to look for shunt patency. Imaging was performed as per the same protocol described for the previous patient. Immediate static images of the anterior abdomen showed distribution of the tracer in the peritoneal cavity, with appearance of tracer activity in both lungs almost immediately after tracer administration (Figure 2). Subsequent images acquired at regular intervals showed intensification of the lung activity with time. The shunt tubing was not visualized in this patient. However, there was focal tracer accu-

mulation at the peritoneal end of the shunt and in the pump chamber (Figure 2). The scintigraphy revealed no communication between the ascites and the collection in the right groin (Figure 3). This was diagnosed to be lymphocele of right groin and treated with sclerotherapy. Patient was managed conservatively and advised to manually compress the valve chamber more frequently to reduce buildup on the valves and to prevent small fibrous particles from adhering to the catheter lumen. Patient improved symptomatically.

DISCUSSION

DS is a surgically created PVS in cirrhotic patients with intractable ascites, to drain the ascitic fluid into the venous circulation. It is surgically placed in the peritoneal cavity and traverses subcutaneously into the patient's jugular vein, which then empties into the superior vena cava.⁵ There is a pressure sensitive valve at the peritoneal end of the shunt to ensure unidirectional flow and prevents reflux of blood into the tubing and peritoneum. A distensible chamber is subcutaneously placed on the chest wall overlying the lower rib cage that needs to be compressed manually at regular intervals. Silicone miter valves located in the pump chamber permit flow unidirectionally.⁶ The inner surface of the valves coapt when the pressure gradient between the peritoneal cavity and the venous system falls below 3–5 cm H₂O, slide against each other when manually pumped to reduce buildup on the valves and open to allow

Figure 2 78 years female with cryptogenic chronic liver disease (child pugh B status). PVS scintigraphy using Tc-99m MAA showed distribution of the tracer in the peritoneal cavity and almost immediate visualization of both lungs after tracer administration, which intensifies with time. The shunt tubing is not visualized in this patient except for focal tracer accumulation at the peritoneal end of the shunt and in the valve chamber.

continuous flow when the peritoneovenous pressure gradient exceeds 5 cm H₂O. This procedure appears to provide effective palliation in majority of patients. Potential complications associated with PVS include shunt malfunction, with occlusion occurring in 5–15% of patients.² Some studies have mentioned a high occlusion rate of 40–60% of patients during first year of follow up.^{3,4} Other complications include peritoneal infection, ascitic fluid

leak, bleeding, disseminated intravascular coagulation, pneumothorax and pneumoperitoneum.⁶

While there are other techniques to assess shunt patency, PVS scintigraphy proves to be a simple and reliable technique most commonly used to assess shunt patency. Contrast radiography is performed by direct puncture of the shunt and administration of contrast to determine exact cause of malfunction and location of the obstruction.^{5,7} Despite its

Figure 3 SPECT CT of the pelvis shows accumulation of tracer in the abdomen and no tracer activity in right groin collection (arrows) suggestive of no communication between the ascites and the collection.

advantages of locating the exact site of obstruction, it carries a potential risk of contrast reaction and possibility of dislodging tubal or vena caval clots resulting in pulmonary embolization. There is also a higher risk of radiation exposure following radiography. Doppler sonographic flow studies allow non-invasive assessment of the shunt patency by picking up signals selectively in the venous tube and measuring the peak velocity at forced inspiration.^{5,8} This technique however needs patience and expertise. The most reliable radionuclide study for evaluation of PVS patency involves intraperitoneal injection of ^{99m}Tc-MAA followed by sequential imaging of lung activity. ^{99m}Tc-labeled macroaggregated albumin is a lung perfusion tracer, which is clinically used in studying patients with suspected pulmonary embolism. Once injected into the peripheral vein, it travels intravenously through the right atrium and right ventricle and is then trapped in the pulmonary capillary bed. In PVS scintigraphy, ^{99m}Tc-MAA distributed in the peritoneal fluid passes through the patent PVS, reaches the systemic circulation and the particles are lodged in the pulmonary capillary bed. MAA is an ideal agent for assessing PVS patency as it is preferentially taken up by lungs. No other extrapulmonary tracer activity is seen to interfere in the interpretation of the study. Therefore visualization of lungs is a specific finding for patency of PVS. Lungs are not visualized in cases of non-patent PVS.

Assessment of shunt patency has clinical implication in guiding appropriate patient management. In the absence of shunt occlusion as demonstrated by scintigraphy, other causes of non-alleviation or subsequent recurrence of ascites, such as further decompensation in cirrhosis, excessive salt intake, inadequate diuretic therapy, congestive heart failure or development of liver malignancy needs to be identified for guiding appropriate medical management.^{5,9,10} Both our patients had clinical improvement following shunt implantation and developed recurrent ascites after 3–6 months, raising clinical suspicion of shunt occlusion. PVS scintigraphy using ^{99m}Tc-MAA in both cases showed shunt patency by demonstrating visualization of lung activity. An alternative cause for intractable ascites was hence suggested. Modification of medical management by adjusting the dose of diuretics resulted in clinical improvement of the first patient. Visualization of the efferent shunt tubing could be variable on scintigraphy and is an unreliable criteria of shunt patency, which is dependent on the flow rate through the shunt tubing.^{2,5} Maximum visualization of the tubing occurs with intermediate flow rates; very high or low flow rates results in non-visualization of the tubing.² Non-visualization of lung activity indicates non-patency; however, the disadvantage of this technique is that the exact site of obstruction cannot be determined. The second patient showed almost immediate visualization of lungs suggestive of a patent shunt. However, there was focal tracer accumulation at the

peritoneal end of the shunt and at the valve chamber. This may be due to collection of fluid at the valve chamber as the peritoneal fluid traverses the shunt and adhesion of fibrous particles at the tip of catheter lumen. Patients are therefore advised to manually pump the shunt chamber frequently at regular intervals to keep the valve clean and prevent proteinaceous debris from forming in the shunt tubing.

Literature survey showed a single study reporting their clinical experience of PVS scintigraphy in 66 cases of suspected PVS obstruction. In this study, ^{99m}Tc-MAA scintigraphy showed a sensitivity of 100%, specificity of 92.2% and accuracy of 98.5%² using the appearance of lung activity as the sole criteria of patency. No false negatives were reported. A single questionable false positive was demonstrated due to a probable small obstructing clot, which got dislodged² after contrast administration during direct contrast radiographic procedure done 2 days later.

^{99m}Tc-MAA scintigraphy done in both our cases showed patent shunts, demonstrating that this technique is a simple and definite imaging with high sensitivity, specificity and accuracy and should be considered in the non-invasive assessment of patency of PVS. Scintigraphy also helped in excluding a communication between the ascites and collection in the right groin, which was subsequently diagnosed as a lymphocele and treated appropriately.

CONFLICTS OF INTEREST

All authors have none to declare.

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