Intravascular Ultrasound-Guided Intrahepatic Portocaval Shunt

- Complications of hepatic cirrhosis (ascites or variceal hemorrhage) can be alleviated by a shunt between the portal and systemic venous systems.
- Shunt placement under intravascular ultrasound (IVUS) guidance allows visualization of the portal vein puncture during shunt placement.
- Direct intrahepatic portosystem shunt (DIPS) creation involves a direct puncture of the portal vein from the inferior vena cava.
- Transjugular intrahepatic portosystemic shunt (TIPS) creation involves puncture of the portal vein from a hepatic vein.
- The radiation dose during these IVUS-guided procedures is lower than the traditional TIPS procedure since less fluoroscopy is needed.

Advanced liver disease can result in complications such as ascites and/or gastrointestinal bleeding due to high blood pressure in the portal vein. Transjugular intrahepatic portosystemic shunt (TIPS) creation has been in use since 1987 to alleviate these conditions. However, the fluoroscopically guided procedure is technically challenging, requiring comprehensive understanding of the hepatic vascular anatomy and its relationship to the portal vein, which must be evaluated via imaging techniques for each patient prior to the procedure. During the TIPS procedure, a needle is passed through the jugular vein and into a hepatic vein under fluoroscopic guidance, and the puncture of the portal vein is "blind." It often takes several attempts before the puncture is successful, especially in patients whose hepatic anatomy is distorted by disease. Consequently, the procedure is associated with a fairly high radiation dose due to fluoroscopy. TIPS has also been associated with complications in up to 20% of cases, including damage to the liver parenchyma, biliary puncture, hepatic artery puncture, and non-target organ puncture. Moreover, the primary patency rates of TIPS, as measured by ultrasound surveillance, have been estimated to be 1650% after one year and as low as 5% at two years due to hepatic vein stenoses, although secondary patency can be maintained with subsequent interventional procedures.

Figure 1. Image from DIPS procedure. Note accurate visualization of needle (white arrow) with tip (open arrow) within the portal vein (P). Needle track can be traced through the liver substance (L).
Direct intrahepatic portosystem shunt (DIPS) placement with the aid of IVUS guidance was first introduced in 2001 in Oregon. In this procedure, an IVUS probe is introduced into the femoral vein, advanced into the portal vein, and positioned in the caudate lobe of the liver. The inferior vena cava is accessed via the jugular vein using a portal access set with an echo-tip trocar needle that is acoustically enhanced to aid visualization with ultrasound. DIPS is usually performed using sagittal visualization with the aid of fluoroscopy to view the entire needle path in real time. This view also offers advantages for positioning of the stent graft after portal access. The trocar needle is passed through the wall of the inferior vena cava and through the liver parenchyma into the portal vein under IVUS guidance (Figure 1). After confirmation of correct placement by blood aspiration, a guidewire is inserted into the portal vein. IVUS can also be used to measure the length of the intraparenchymal tract before placement of a polytetrafluoroethylene (PTFE)-covered stent, which is then inflated via an angioplasty balloon (Figure 2). This DIPS procedure can be performed in patients with an occluded TIPS.

**Figure 2.** Placement of shunt stent. (A) Intraprocedural ultrasound image showing stent deployment in portal vein (arrows). (B) Schematic showing same with portal vein component (arrows) corresponding to US image. P, Portal Vein, H, Hepatic vein, IVC, Inferior vena cava.

**Intravascular Ultrasound (IVUS) Guided Direct Intrahepatic Portosystem Shunt (DIPS)**

Intravenous ultrasound (IVUS) probes were introduced in the late 1980s and were first used to examine atherosclerosis in coronary arteries. IVUS probes, which are mounted in a catheter, produce tomographic images by performing a series of ultrasound pulse-echo sequences directed at different vectors around the catheter.

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**Outcome and Complications**

Because the trocar needle is advanced from the inferior vena cava into the portal vein under IVUS guidance, the vein can be accessed on the first attempt in most cases. In a retrospective study of 40 patients (in whom DIPS was performed because of intractable ascites or recent variceal bleeding secondary to liver disease), stent-graft placement was successful, and the portosystemic gradient (PSG) was reduced to 15 mm Hg or lower in all cases. Eighty-four percent of the patients had continued primary patency up until the endpoints of death, liver transplantation, or the termination of the follow-up period. The primary patency rates after DIPS were 100% at six months and 75% at 12 months, with a secondary patency rate of 100%.

In this series, extrahepatic puncture of the portal vein occurred in two patients (5%) during the DIPS procedure, which resulted in intraperitoneal bleeding that required a blood transfusion in one patient. Both patients remained in stable condition, and no other procedure-related complications were observed.
Overall, this study suggests that DIPS is a safer procedure than TIPS in terms of complications. In addition, because IVUS is used during the portal vein puncture and during placement of the stent graft, radiation exposure is lower due to reduced fluoroscopy time.

**Other IVUS-Guided Transvenous Interventions**

In addition to DIPS, IVUS-guided TIPS procedures are carried out in certain patients at Massachusetts General Hospital. In these cases, the transhepatic path is between a hepatic vein and the portal vein, which may be advantageous in certain clinical situations.

Other IVUS-guided interventions have been introduced elsewhere but are not available at Mass General. For example, IVUS has been used as a biopsy aid in patients with contraindications to percutaneous access and inaccessible hepatic veins. In these cases, a biopsy needle is introduced from a transjugular approach into the inferior vena cava, and, under IVUS guidance, the needle is advanced into the caudate lobe to obtain a non-targeted biopsy. IVUS has also been used to guide biopsies of suspicious cardiac masses. In addition, IVUS has been used to guide treatment of persistent type II endoleaks in patients who have undergone stent-graft placement and who have not been successfully treated by conventional means.

**Further Information and Scheduling**

For further information on IVUS-guided shunt placement at Mass General including scheduling information, please contact Zubin Irani, MD, Interventional Radiology Division, Department of Radiology, Massachusetts General Hospital, at 617-726-8315. IVUS-guided DIPS and TIPS procedures are not widely available, and have only been introduced recently at Mass General.

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**References**


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