

Image guided portal vein access techniques in TIPS creation and considerations regarding their use

Aung Zaw Win

Notre Dame de Namur University, Belmont, CA, USA

Correspondence to: Aung Zaw Win, MD, MA, MPH. Notre Dame de Namur University, 1500 Ralston Avenue, Belmont, CA 94002, USA.

Email: aungzwin@gmail.com.

Abstract: Transjugular intrahepatic portosystemic shunt (TIPS) is a difficult procedure to perform and accessing the portal vein is a very challenging step. There are three broad categories of image guided TIPS creation techniques. Each technique has its advantages and disadvantages. TIPS procedure carries some risk of complications regardless of the guidance technique employed. The technology for TIPS has evolved in parallel with the expanding indications for TIPS. Ultrasound guidance technique offers a safe option, particularly for patients with challenging anatomy. Patient safety should always come first and the US guided technique should be more routinely used. Experience is the main factor in the success of TIPS. Other factors to consider in reducing the all-cause morbidity and mortality are patient selection, patient management and the clinical setting.

Keywords: Transjugular intrahepatic portosystemic shunt (TIPS); technique; ultrasound; fluoroscopy; complications

Submitted May 12, 2016. Accepted for publication May 17, 2016.

doi: 10.21037/atm.2016.05.43

View this article at: <http://dx.doi.org/10.21037/atm.2016.05.43>

Transjugular intrahepatic portosystemic shunt (TIPS) is a difficult procedure to perform in interventional radiology and it carries some risks of morbidity and mortality. TIPS creates a new connection between the portal vein and the hepatic vein. This procedure lowers portal venous pressure by shunting blood from the portal to the systemic circulation. It is less invasive than surgical shunting. Technical success in TIPS is defined as the successful creation of a shunt between the right hepatic vein and intrahepatic branch of the right portal vein. However, locating and accessing the portal vein is very challenging and it is considered the rate-limiting step of the procedure. Multiple attempts are sometimes required to access the portal vein. Portal venous bifurcation is extra-hepatic in some patients. Puncture of the right portal vein at least 1–2 cm distal to the portal venous bifurcation should guarantee an intra-hepatic puncture. Indications for TIPS include acute variceal hemorrhage, refractory ascites, gastric antral vascular ectasia, hepatic hydrothorax, hepatorenal syndrome, Budd-Chiari syndrome, hepatopulmonary syndrome, and portal vein thrombosis.

Gipson *et al.* described three broad categories of image guided techniques: (I) fluoroscopic guidance with portography [contrast medium or carbon dioxide (CO₂)]; (II) marker wire guidance; and (III) ultrasound (US) guidance (1). Each technique has its advantages and disadvantages. Fluoroscopic guidance with portography is currently the most widely used technique (1). X-ray machines for fluoroscopy are available internationally and most physicians who perform TIPS are familiar with this technique. Yet, this technique has more radiation exposure to the physician and the patient, compared to other techniques. A study from Sweden found that patient skin doses usually exceed the threshold values for erythema (2 Gy) with the fluoroscopically guided technique (2). The use of iodinated contrast medium can be nephrotoxic and this presents a problem in patients with renal insufficiency. In the United States, the number of patients with chronic renal failure is increasing. Iodinated contrast can also cause an allergic reaction. The hepatic vein and the portal vein are separated by the liver parenchyma, and the contrast agent cannot flow through to the portal venous

system. The portal vein is therefore not visible when the needle is advanced through the liver. CO₂, on the other hand, causes no allergic reaction or renal toxicity. Wedged venography can only offer a 2-dimensional view and in challenging cases, information on the 3-dimensional relationship between the hepatic vein and the portal vein is required. Due to low viscosity, CO₂ can diffuse to the surrounding areas, not to the portal vein branches, resulting in low resolution images. More than one CO₂ injection may be required to obtain a good portogram. In addition, with manual injection of CO₂, it is possible to deliver excessive volumes of CO₂. Forceful injection of the iodinated contrast or explosive delivery of CO₂ can cause liver laceration, subcapsular hematoma, and intra-abdominal bleeding.

The marker wire guidance technique is useful in patients with ascites (3). But, placement of a marker is invasive and vessel trauma can sometimes occur. Gipson *et al.* found that fluoroscopy time, cumulative radiation dose or air kerma, contrast volume and total procedural time were reduced with US guidance compared to fluoroscopic guidance (1). In addition, fluoroscopy time and contrast agent volume were reduced with US guidance compared to marker wire guidance (1). US allows for real-time localization of the needle tip in relation to the portal vein. In one study, using sonography as a guiding tool has reduced the complication rate from 17% to 3% (4). This technique can ensure a single needle pass to access the portal vein (5). One disadvantage of this technique is that a second clinician is needed to perform the US. It also exposes the sonographer to radiation. Moreover, sonographic imaging can be obscured by obesity, ascites and bowel gas in the peritoneal cavity. Similar to wedged venography, US can only provide 2-dimensional images. Another disadvantage of intravascular US is that femoral vein puncture is needed to insert the transducer and this causes additional discomfort to the patient. When an intravascular US probe is used, there is an increased cost of \$1,365 per procedure (6).

TIPS procedure carries some risk of complications regardless of the guidance technique employed. Technique-related complications can include short term (within 30 days of the procedure) and long term (after 30 days), and fatal and non-fatal complications. When TIPS was first used, complication rates were higher due to blind puncture of the portal vein, without any image guidance. As the number of needle passes for portal vein increases, the incidence of nontarget organ injury also increases. Technique-

related short term complications result from injury to the surrounding structures such as hepatic artery, gallbladder, and biliary ducts. Some of these complications can be fatal. Hepatic artery puncture can result in a life-threatening hemorrhage. Injury to the hepatic artery can also contribute to liver ischemia and infarction. Puncture of the gallbladder can result in cholecystitis, hemobilia and biliary peritonitis. Furthermore, fistulas can develop between the biliary or arterial system and portal vein. Intrahepatic hematomas or subcapsular hematomas can also occur days after the procedure, especially in patients who are on anticoagulation medication. Transcapsular puncture can lead to hemoperitoneum and laceration of the liver capsule is possible in patients with small livers from cirrhosis. As mentioned above, portal venous bifurcation can be extrahepatic and dissection of the portal vein in its extrahepatic part can lead to rapid bleeding. Hepatic encephalopathy and shunt occlusion are two long term complications and they are rarely fatal if detected and treated early. Hepatic encephalopathy after TIPS is common and it can be seen with any guidance technique. In contrast, shunt occlusion can depend on the technique because multiple needle passes can cause bile leakage into the stent and lead to shunt dysfunction. Polytetrafluoroethylene (PTFE) covered stents can decrease the incidence of shunt occlusion (7). Radiation dermatitis is another non-fatal complication related to technique. Radiation is less of a concern today due to the fact that modern imaging rooms offer improved protection from radiation.

There are three principal scoring systems to predict mortality from TIPS: APACHE II, Child-Pugh and MELD. Although these scoring systems are not perfect, they are commonly used to estimate risks and to select patients for the procedure. Patients with an APACHE II score higher than 20 have a greater risk for early mortality. Tzeng *et al.* reported that APACHE II score is not useful for Asian patients (8). Child-Pugh score of greater than 12 is associated with high risk of postprocedural death. For Asian patients, the score cut-off is 11 (8). Additionally, the Child-Pugh classification cannot discriminate among class C patients because it uses parameters such as ascites and encephalopathy which are based on subjective interpretation (9). The MELD score is superior to Child-Pugh score in predicting the 3-month post TIPS mortality (9). Casadaban *et al.* found that MELD is also useful for the emergency setting, besides the elective setting (10). It has been validated in Korea, United States and Europe (9,11). Mortality is higher in patients with a MELD score of 18 or above but in Asian patients, the

score cut-off is 20 (8). The accuracy of the model decreases for long-term (after 3 months) predictions of mortality (9).

Mortality from TIPS also depends on the specific clinical setting. Gipson *et al.* found no differences in outcome between the elective, emergent and urgent settings, but their results were based on a retrospective study within a single institution and using a small sample size (1). In the emergency setting, there are many cases of uncontrolled variceal hemorrhage and they have a higher risk of mortality. In cases of active variceal bleeding unresponsive to endoscopic and pharmacotherapy, early TIPS placement must be done (within 72 h after admission) (12). Russo *et al.* reported that urgent TIPS placement was associated with shunt stenosis (13). Elective TIPS have decreased mortality rates (14). Patient selection also influences outcome after TIPS. Patients with pre-existing comorbid conditions have increased risk for an unfavorable outcome following TIPS (15). Likewise, periprocedural management plays a role in patient survival. Ordering labs, imaging tests and draining ascites must be done before TIPS. Patients should receive IV hydration before contrast injection and must be followed-up with Doppler US. Lastly, according to Trivedi *et al.*, post-TIPS outcome is a function of patient demographic and socioeconomic factors (16).

There are papers that state that technical success of TIPS is related to the experience level of the interventional radiologist. Technical success rates improved in parallel with experience at a medical center in China (17). Similarly, in an Israeli medical center, experience is the main factor in determining the success of TIPS (18). Keller *et al.* found that technical failure rates were higher in institutions that have performed less than 100 TIPS procedures (19). An experienced, skillful team is necessary to ensure the high technical success of TIPS and to avoid its potential procedural complications (20). Therefore, patients should be transferred to a center with TIPS placement experience. In the United States, teaching or academic hospitals performed 78.7% of TIPS in 2012 (14). Moreover, academic centers have the expertise for dealing with complications associated with TIPS and imaging equipment is readily available. In Japan, some hospitals rarely perform TIPS and it is a challenge to maintain the necessary skills in those hospitals (3). Diverse experience levels may explain the difference in survival rates from Japan, United States, Canada, France, Germany, Italy and Spain (21). For residents to gain experience, there is a potential role for TIPS simulation training.

The technology for TIPS has evolved in parallel with

the expanding indications for TIPS. TIPS is also indicated for some pediatric patients. There are reports of using cone-beam CT or MRI in combination with fluoroscopy to guide TIPS (22,23). These new technologies are still in experimental stages and they are costly and not widely available. They require special software, hardware and work stations. There is a lack of multicenter prospective randomized studies for TIPS. Future studies can explore the overall feasibility, including cost effectiveness and quality of life, between the image guidance techniques. Most of the time, the decision on guidance technique is not criteria or indication based, but rather a result of operator preference (1). Rössle reported that in medical centers using sonography during the puncture process, TIPS complications were almost abolished (21). As reported by Gipson *et al.*, US guidance technique offers a safe option, particularly for patients with challenging anatomy such as Budd-Chiari syndrome (1). Patient safety should always come first and the US guided technique should be more routinely used. Gipson *et al.* stressed the importance of radiation exposure in choosing a guidance technique in TIPS. However, radiation dose should not be the only priority as there are other more serious life-threatening complications and the amount of exposure is so small that it is almost impossible to cause cancers. Finally, technique is only one part of the procedure and there are other things to consider. Experience is the main factor in the success of TIPS. Other factors to consider in reducing the all-cause morbidity and mortality are patient selection, patient management and the clinical setting.

Acknowledgements

None.

Footnote

Provenance: This is a Guest Perspective commissioned by Section Editor Fengzhan Hu, Master of Medicine (Department of Interventional Medicine, First Hospital of Lanzhou University, Lanzhou, China).

Conflicts of Interest: The author has no conflicts of interest to declare.

Comment on: Gipson MG, Smith MT, Durham JD, *et al.* Intravascular US-guided portal vein access: improved procedural metrics during TIPS creation. *J Vasc Interv Radiol* 2016. [Epub ahead of print].

References

- Gipson MG, Smith MT, Durham JD, et al. Intravascular US-guided portal vein access: improved procedural metrics during TIPS creation. *J Vasc Interv Radiol* 2016. [Epub ahead of print].
- Persliden J. Patient and staff doses in interventional X-ray procedures in Sweden. *Radiat Prot Dosimetry* 2005;114:150-7.
- Yamagami T, Tanaka O, Yoshimatsu R, et al. Hepatic artery-targeting guidewire technique during transjugular intrahepatic portosystemic shunt. *Br J Radiol* 2011;84:315-8.
- Hidajat N, Kreuschner M, Röttgen R, et al. Placement of transjugular intrahepatic portosystemic shunt via the left hepatic vein under sonographic guidance in a patient with right hemihepatectomy. *Acta Radiol* 2003;44:363-5.
- Leong S, Kok HK, Govender P, et al. Reducing risk of transjugular intrahepatic portosystemic shunt using ultrasound guided single needle pass. *World J Gastroenterol* 2013;19:3528-30.
- Farsad K, Fuss C, Kolbeck KJ, et al. Transjugular intrahepatic portosystemic shunt creation using intravascular ultrasound guidance. *J Vasc Interv Radiol* 2012;23:1594-602.
- Boyvat F, Harman A, Ozyer U, et al. Percutaneous sonographic guidance for TIPS in Budd-Chiari syndrome: direct simultaneous puncture of the portal vein and inferior vena cava. *AJR Am J Roentgenol* 2008;191:560-4.
- Tzeng WS, Wu RH, Lin CY, et al. Prediction of mortality after emergent transjugular intrahepatic portosystemic shunt placement: use of APACHE II, Child-Pugh and MELD scores in Asian patients with refractory variceal hemorrhage. *Korean J Radiol* 2009;10:481-9.
- Rosado B, Kamath PS. Transjugular intrahepatic portosystemic shunts: an update. *Liver Transpl* 2003;9:207-17.
- Casadaban LC, Parvinian A, Zivin SP, et al. MELD score for prediction of survival after emergent TIPS for acute variceal hemorrhage: derivation and validation in a 101-patient cohort. *Ann Hepatol* 2015;14:380-8.
- Kim HK, Kim YJ, Chung WJ, et al. Clinical outcomes of transjugular intrahepatic portosystemic shunt for portal hypertension: Korean multicenter real-practice data. *Clin Mol Hepatol* 2014;20:18-27.
- de Franchis R, Baveno V Faculty. Revising consensus in portal hypertension: report of the Baveno V consensus workshop on methodology of diagnosis and therapy in portal hypertension. *J Hepatol* 2010;53:762-8.
- Russo MW, Jacques PF, Mauro M, et al. Predictors of mortality and stenosis after transjugular intrahepatic portosystemic shunt. *Liver Transpl* 2002;8:271-7.
- Perry BC, Kwan SW. Portosystemic shunts: stable utilization and improved outcomes, two decades after the transjugular intrahepatic portosystemic shunt. *J Am Coll Radiol* 2015;12:1427-33
- Copelan A, Kapoor B, Sands M. Transjugular intrahepatic portosystemic shunt: indications, contraindications, and patient work-up. *Semin Intervent Radiol* 2014;31:235-42.
- Trivedi PS, Rochon PJ, Durham JD, et al. National trends and outcomes of transjugular intrahepatic portosystemic shunt creation using the nationwide inpatient sample. *J Vasc Interv Radiol* 2016. [Epub ahead of print].
- Qi X, He C, Guo W, et al. Transjugular intrahepatic portosystemic shunt for portal vein thrombosis with variceal bleeding in liver cirrhosis: outcomes and predictors in a prospective cohort study. *Liver Int* 2016;36:667-76.
- Goykhman Y, Ben-Haim M, Rosen G, et al. Transjugular intrahepatic portosystemic shunt: current indications, patient selection and results. *Isr Med Assoc J* 2010;12:687-91.
- Keller FS, Farsad K, Rösch J. The transjugular intrahepatic portosystemic shunt: technique and instruments. *Tech Vasc Interv Radiol* 2016;19:2-9.
- Rösch J, Keller FS. Transjugular intrahepatic portosystemic shunt: present status, comparison with endoscopic therapy and shunt surgery, and future prospectives. *World J Surg* 2001;25:337-45;
- Rössle M. TIPS: 25 years later. *J Hepatol* 2013;59:1081-93.
- Bell BM Jr, Cura M, Shaw CJ, et al. Transjugular intrahepatic portosystemic shunt creation using a three-dimensional fluoroscopy guidance system in patients with the Budd-Chiari syndrome. *Proc (Bayl Univ Med Cent)* 2015;28:484-7.
- Gaba RC, Khiatani VL, Knuttinen MG, et al. Comprehensive review of TIPS technical complications and how to avoid them. *AJR Am J Roentgenol* 2011;196:675-85.

Cite this article as: Win AZ. Image guided portal vein access techniques in TIPS creation and considerations regarding their use. *Ann Transl Med*, 2016;4(11):226. doi: 10.21037/atm.2016.05.43