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Ultrasound-Guided Portosystemic Cannulation During Transjugular Intrahepatic Portosystemic Shunt Placement: An Experience of 23 Cases

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Keywords:

Transjugular intrahepatic portosystemic shunt; Portal hypertension; Portal vein access; Ultrasound guidance

Abbreviations:

TIPS: Transjugular intrahepatic portosystemic shunt; GEVE: gastro-esophageal variceal embolization; PH: Portal hypertension; PVA: portal vein access; US: Ultrasound; PTA: percutaneous transluminal angioplasty

1. Abstract

1.1. Aims: The purpose of this study was to describe Portosystemic Cannulation (PSC) Under Ultrasound (US) guidance to perform a Transjugular Intrahepatic Portosystemic Shunt (TIPS) placement.

1.2. Methods: Medical records of 23 patients who underwent TIPS procedure with US-guided PSC at our institute between October 2018 to December 2021 were reviewed, including for a first TIPS placement (n=21) and revision of the shunt (n=2). The indications for shunt creation were variceal bleeding in 19 cases and refractory ascites in 4 cases. Among them, salvage TIPS was performed in 11 patients with prior percutaneous gastro-esophageal variceal embolization (GEVE). Transabdominal US-guided PSC techniques included: transjugular intrahepatic PSC, direct intrahepatic portosystemic shunt (DIPS), and percutaneous puncture of the dysfunction shunt.

1.3. Results: Technical success was achieved in 21 patients (91.30%), except for 2 cases with salvage TIPS failed, including 1 patient died during the procedure due to massive variceal bleeding, and the other case with cranial porta hepatisa failed because of a acute angle shunt. In patients with successful procedure, the cumulative Fluoroscopic Time (FT) ranged 26 to 46 minutes (mean, 35.38±4.46 minutes), the cumulative Air Kerma (AK) ranged 410 to 606 mGy (mean, 462.95±53.18 mGy), the operation time (OP) ranged 90 to 170 minutes (mean, 110.24±19.40 minutes), and the contrast usage ranged 80 to 170 mL (mean, 106.19±21.56 mL). Portal venous pressure before TIPS was 24-33 mm Hg (mean, 28.14±2.53 mm Hg) and after TIPS was 10-19 mm Hg (mean, 16.38±2.01 mm Hg). No immediate complications related to the procedure were encountered in all the patients.

1.4. Conclusions: US-guided PSC could provide a safe, effective, and universally applicable method for TIPS placement in patients with either a first creation or revision of the shunt.

Highlights:

- During transjugular intrahepatic portosystemic shunt placement, ultrasound-guided transjugular and percutaneous portosystemic cannulation could provide a safe, effective, and universally applicable method for TIPS placement in patients with either a first creation or revision of the shunt.
- This study helps interventional radiologists determine a safe and efficient way to perform portal vein access, a key stage during TIPS placement.

2. Introduction

Since applied clinically in 1982 [1], Transjugular Intrahepatic Portosystemic Shunt (TIPS) creation is widely accepted as an effective therapy for the complications of Portal Hypertension (PH). The most technically challenging step of the procedure is the so-called 'blind puncture' of the Portal Vein Access (PVA) following hepatic venous access, and associated with a low rate of complications, such as hepatic artery injury, biliary injuries, subcapsular or intraparenchymal hepatic hematomas, and hemoperitoneum, etc [2, 3]. Furthermore, because of its complexity, the procedure includes exposure to high levels of radiation for patients and operators, which is undesirable as corresponding radiation risks.

To remove the step requiring blind puncture of PVA, several approaches have has been described in the recent literature, including superior mesenteric artery arterial portography, wedged hepatic venography, percutaneous placement of a metallic wire within the portal vein, etc [4-6]. Despite targeting the portal vein by using the techniques just mentioned, PVA under fluoroscopic guidance is still considered to be the most difficult step in the creation of TIPS. Direct visualization with intravascular sonogram has been described in assisting PVA [7, 8], however, the expertise or equipment for which may not be readily available in many radiology departments.

Multiple published technique about the ultrasound (US) guidance has been described [6, 9-11], but not widely adopted as still be lacking in the literature. To address these deficiencies, this study described our technique of PVA and Portosystemic Cannulation (PSC) under US guidance to place a TIPS.

3. Material and Methods

3.1. Patients

A total of 57 patients were referred to our institute for the TIPS creation from October 2018 to December 2021. The indications for TIPS in these patients were primary or recurrent variceal bleeding being unresponsiveness to endoscopic and drug therapy, and refractory ascites. Patients were excluded when different techniques of PVA, such as blinding puncture, superior mesenteric artery arterial portography, and percutaneous placement of a metallic wire or balloon within the portal vein, was utilized for PSC. Only patients with transabdominal US-guidance PVA were included, whether it is a first TIPS creation or the revision of the shunt.

Approval for this retrospective study was granted by the institutional review board. The study was conducted in accordance with the Declaration of Helsinki.

3.2. Therapeutic Procedure

After gave written informed consent for the TIPS procedure, all the patients were placed in a supine position and the procedure was performed under local anesthesia.

At the beginning, an initial screening sonogram was performed to evaluate the anatomy of portal and hepatic veins (Figure 1). Because transabdominal US-guided accessing the right portal vein is the most common way for entry of the portal venous system, the right antero-lateral abdomen has to be adequately disinfected alongside with the right jugular region at the start of the procedure.

To reduce the contrast usage and avoid the interference related to the contrast agent on sonogram, injection of a small amount of agitated saline to confirm the intravenous (IV) placement was adopted routinely. During the procedure, once the needle tip advanced into the vein under US guidance, following aspiration of blood as recommended, a small amount of agitated saline was injected, as shown as a cloud of echoes by sonogram, to confirm the successful IV entry. And then, contrast agent was injected to reconfirm the IV placement and outline the targeting vein (Figure 2).

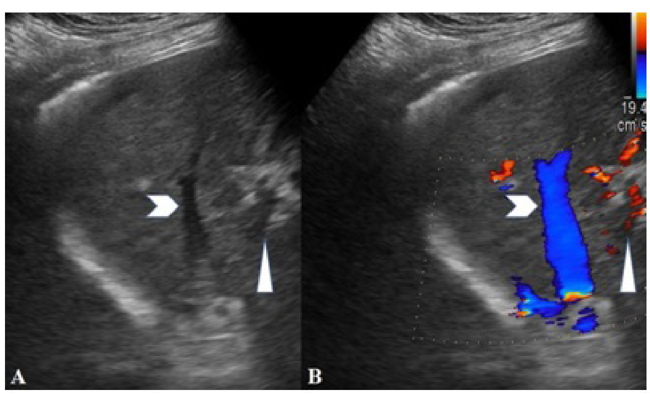

Figure 1: Display of portal and hepatic vein on sonogram. Real-time dual color Doppler sonogram shows the right portal vein (white triangle) near its bifurcation from main portal vein and middle hepatic vein (white arrowhead). (A) Gray scale US imaging. (B) Color Doppler US imaging.

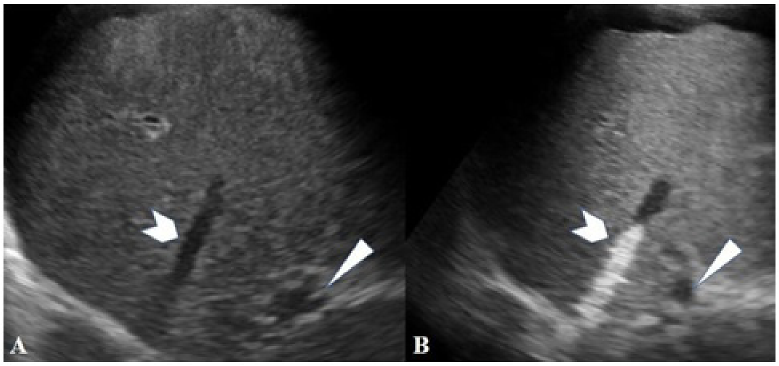

Figure 2: Display of hepatic vein before and after injection of saline on sonogram. (A) Sonogram shows the right portal vein (white triangle) and middle hepatic vein (white arrowhead). (B) As shown as a cloud of echoes by sonogram (white arrowhead), a small amount of agitated saline is injected to confirm IV placement when the catheter is localized in the hepatic vein.

3.3. Gastro-Esophageal Variceal Embolization (GEVE)

Considering TIPS alone without embolization may not be the optimal solution [12], GEVE would be performed if varices displayed on the venography, especially for patients with variceal bleeding. Moreover, for patients with massive variceal bleeding and hemodynamically unstable, salvage TIPS procedure, during which the percutaneous PVA and GEVE were started prior to the shunt creation, was recommended. Otherwise, conventional TIPS procedure was performed, which indicated that GEVE was performed following the TIPS creation typically.

Except for the salvage TIPS, if massive ascites was present, it was drained using a 7-French drainage catheter under US guidance routinely at the beginning of the procedure.

3.4. Transjugular PVA under US guidance

This procedure needed two operators working together. An operator positioned at the head of the patient could advance the needle, while description of sonogram for accessing into the portal vein provided by an US scanner.

Briefly, following the transjugular Rösch-Uchida PVA set (Cook, Bloomington, Indiana, USA) introduced into the hepatic vein, saline and contrast was injected to confirm the localization subsequently. When the needle was advanced toward the portal vein by the operator, real-time sonogram was given to monitor the PVA by the US scanner, describing the needle movement. When entry into the the portal vein was achieved, saline and contrast was injected to confirm and outline the vessel (Figure 3). Subsequently, portal venography was performed, and initial portal pressure measured. The remainder procedure of TIPS was completed as conventional transjugular approach [13, 14].

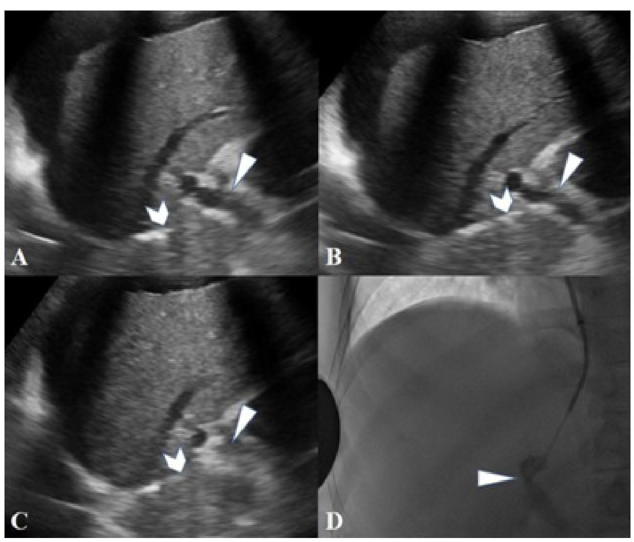

Figure 3: Ultrasound (US)-guided portal vein access and injection of saline to confirm the IV placement. (A) Needle (white arrowhead) targeting toward the right portal vein (white triangle) under US guidance. (B) US-guided advancement of needle (white arrowhead) into right portal vein (white triangle). (C) Agitated saline is injected to confirm the portal entry, shown as a cloud of echoes by sonogram (white triangle). (D) Injection of contrast agent to re-confirm the portal entry (white triangle).

3.5. Direct Intrahepatic Portosystemic Shunt (DIPS) under US guidance

If the procedure of transjugular PVA failed, percutaneous transhepatic puncture of portal and hepatic veins was recommended. As previously described [10], if a suitable window is available in which the right portal vein and the hepatic veins can be aligned within an US field (Figure 4), the patient is considered suitable for the 2-stage puncture technique.

Briefly, under US guidance, the right portal vein was punctured by using an 18-gauge Chiba needle (Hakko, Nagano, Japan) with the patient quietly breathing. After the portal entry was confirmed, the needle was adjusted slightly and advanced into the hepatic vein close to its junction with the inferior vena cava (IVC) as would be expected in a conventional TIPS procedure. Once the entry of hepatic vein was confirmed, a 0.018-inch guidewire (V-18, Boston Scientific, Heredia, Costa Rica) was advanced into the hepatic vein and IVC through the needle, and snared by using a Amplatz GooseNeck Snare Kit (ev3 Inc., Minnesota, USA) through the transjugular sheath, providing through-and-through access. Following a 4-F sheath (Cook, Bloomington, USA) introduced into the right portal vein over the transhepatic–transjugular wire, a 0.018-inch guidewire was advanced into the main portal vein through the transhepatic sheath, served as a safety guidewire for the percutaneous puncture approach and landmark for guiding the transjugular wire passes into the portal venous system.

Over the transhepatic–transjugular wire, a 4F angiographic catheter (VER, Cordis, Florida, USA) was advanced from the transjugular sheath to the portal vein, and another V-18 guidewire was advanced into the splenomesenteric veins through the transjugular VER catheter, served as a PSC guidwire. And then, the transhepatic–transjugular wire was withdrawn, and the catheter was advanced into the portal venous system over the PSC guidwire that was replaced by a 0.035-inch exchange guidewire (Amplatz, Cook, Bjaeverskov, Denmark) subsequently. Following dilation of the portosystemic trace by using an 6mm×80mm percutaneous transluminal angioplasty (PTA) balloon dilatation catheter (Mustang, Boston Scientific, Galway, Ireland) through the transjugular approach, the transjugular sheath was advanced into the the portal venous system through the shunt, and the remainder procedure was completed as conventional transjugular approach previously described (Figure 5).

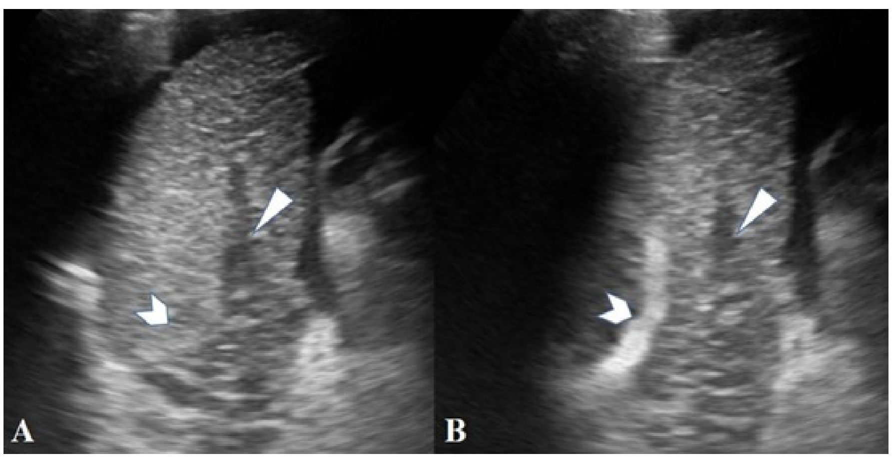

Figure 4: Display of hepatic vein before and after injection of saline in hepatic vein on sonogram. Initial sonogram showing proposed alignment of right portal vein (white triangle) with middle hepatic vein (white arrowhead) near its junction with IVC. (A) Sonogram before injection of saline. (B) Sonogram after injection of saline.

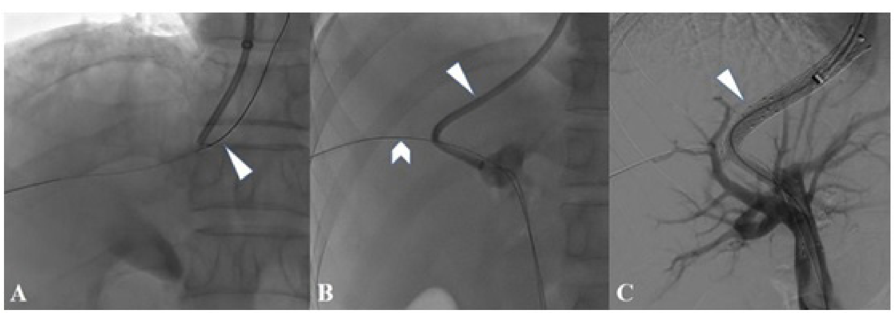

Figure 5: Direct intrahepatic portosystemic shunt (DIPS). (A) Following needle passed through the portal vein and hepatic vein sequentially, A 0.018-inch guidewire (white triangle) was advanced into the IVC through the needle. (B) With A 0.035-inch guidewire positioned in the main portal vein through the shunt, the transjugular sheath (white triangle) was advanced into the main portal vein. A 0.018-inch guidewire (white arrowhead) is localized in the main portal vein through the transhepatic sheath. (C) Fluoroscopic image of the shunt after deployment of metal stents (white triangle) across the portosystemic tract from transjugular approach.

3.6. Entry of Dysfuntion Shunt Under US Guidance

At the beginning, a Rösch-Uchida sheath was placed into IVC throuth the right internal jugular vein. With a 0.035-inch guidewire (Terumo, Tokyo, Japan) and 4-French angiographic catheter (VER / Cobra Cordis, Florida, USA), entry of the shunt was attempted from the proximal end of the stent under both US and fluoroscopic guidance. When attempts from the proximal approach failed, percutaneous US-guided PVA was performed.

Following puncture of the right portal vein and placement of a 4F transhepatic sheath, entry of the shunt was attempted from the distal end of the stent. Once guidewire could advance into the shunt and the right atrium, it would be snared through the transjugular sheath and replaced with a 0.035-inch exchange guidewire (Amplatz), providing the through-and-through access.

The transjugular sheath was advanced into the proximal shunt over the transhepatic–transjugular wire until resistance was met. An 6mm×80mm PTA balloon dilatation catheter (Mustang) was advanced over the wire, and the portosystemic tract was dilated (Figures 6). By advancing of the the sheath into the portal venous system, the following procedure was completed as previously described.

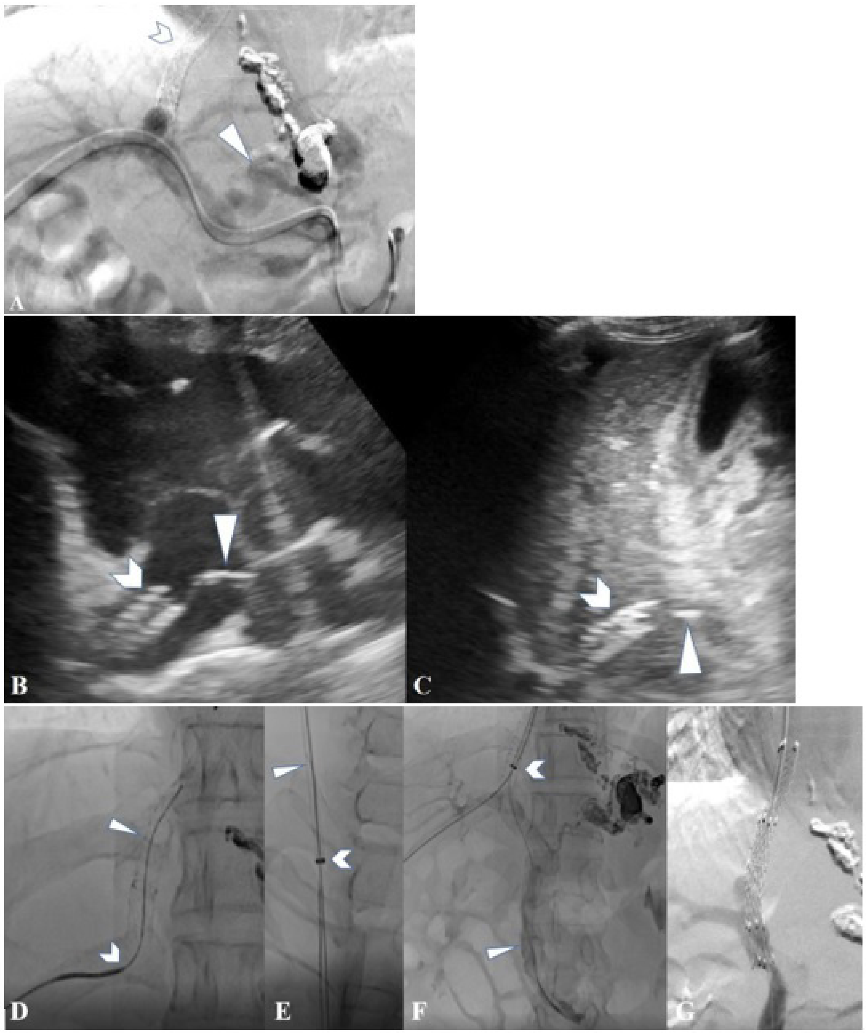

Figure 6: Entry of dysfuntion shunt and revison. (A) Initail percutaneous splenoportography shows the stent displacement and the shunt occlusion (white arrowhead) with recurrent gastric varies (white triangle). (B) Sonogram shows stent displacement (white arrowhead) into the right ventricle, and shunt entry was attempted from the transjugular approach under ultrasound (US) guidance with a VER catheter (white triangle). (C) Sonogram shows attempt of transhepatic access into the shunt under US guidance with a VER catheter (white triangle). (D) Transhepatic guidewire (white triangle) was maneuvered through the shunt (white arrowhead) into the right ventricle. (E) Transhepatic guidewire (white triangle) was maneuvered through the transjugular sheath (white arrowhead), thus creating transhepatic-transjugular guidewire. (F) Transjugular sheath (white arrowhead) was advanced into the shunt over the transhepatic-transjugular guidewire, and hydrophilic guidewire was maneuvered through transjugular sheath into superior mesenteric vein, followed by mesentericoportography (white triangle). (G) Fluoroscopic image of the shunt after deployment of metal stents across tract between hepatic and portal vein from transjugular approach.

3.7. Percutaneous Puncture of Dysfuntion Shunt

Despite of methods described above, if the entry of the dysfunction shunt failed, percutaneous puncture of the portosystemic shunt was performed.

Under US guidance, the shunt was accessed by using a 21-gauge Chiba needle (Cook, Bloomington, USA) with the patient quietly breathing. When the tip of the needle approached and advanced into the stent both on the sonogram and fluoroscopic image, a V-18 guidewire was passed through the needle and the shunt into the right atrium. Then, a 2.7-French catheter (Progreat, Terumo, Tokyo, Japan) was advanced into the IVC over the wire, and the position of the catheter was confirmed by the aspiration of blood. Subsequently, following snared through the transjugular sheath, the transhepatic–transjugular wire was replaced with a 0.035-inch exchange guidewire (Amplatz). The transjugular sheath was advanced into the proximal shunt over the through-and-through wire until resistance was met, and entry of the portal venous system was attempted with a 0.035-inch guidewire and 4-French VER catheter from the transjugular approach.

Once portal venous access was obtained, the 0.035-inch guidewire was replaced by a 0.035-inch exchange guidewire (Amplatz), served as a portosystemic access guidwire, and the transhepatic–transjugular wire was withdrawn subsequently. Then, the portosystemic trace was dilated, and the transjugular sheath was advanced into the the portal venous system through the shunt. The remainder procedure was completed as conventional transjugular approach (Figures 7).

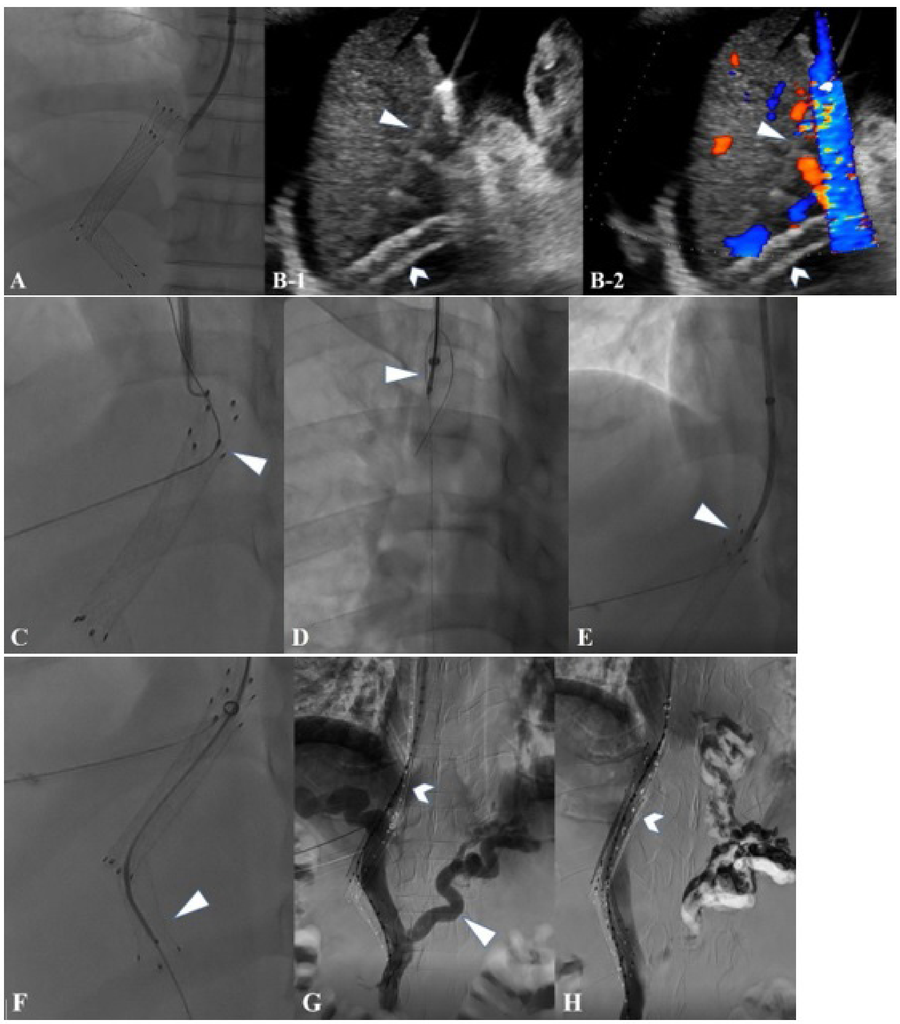

Figure 7: Percutaneous puncture of dysfuntion shunt and revison. (A) Initail fluoroscopic image showed the wreckage of stents, and transjugular attempt of shunt entry failed. (B) Transabdominal ultrasound (US) image shows the percutaneous transhepatic needle (white triangle) positioned towards the shunt (white arrowhead) for placement guidewire. B-1: gray scale ultrasound imaging. B-2: color Doppler ultrasound imaging. (C) Once the needle punctures the stent, a 0.018 guidewire (white triangle) was advanced into the IVC through the needle. (D) Transhepatic guidewire was snared (white triangle) through the transjugular sheath, providing through-and-through access. (E) Transjugular sheath (white triangle) was advanced into the shunt over the transhepatic–transjugular wire. (F) Transjugular guidewire (white triangle) was maneuvered through the shunt (white arrowhead) into the main portal vein with a VER catheter. (G) Portography shows shunt occlusion (white arrowhead) with recurrent gastric varies (white triangle). (H) Fluoroscopic image of the shunt after GEVE and deployment of metal stents (white arrowhead) across tract between hepatic and portal vein.

3.8. Embolization of the percutaneous needle trace

For the procedure with percutaneous PVA, the transhepatic approach should be embolized at the end of the procedure, and final sonogram should be performed.

As a sign of hemorrhage of the transhepatic trace, if a subcapsular outward blood flow shown on sonogram existed, the puncture point and transhepatic trace were accessed along the blood flow by a needle (16G, 5.25in, BD, Sandy, USA) under US guidance, and embolized through the needle if necessary (Figures 8).

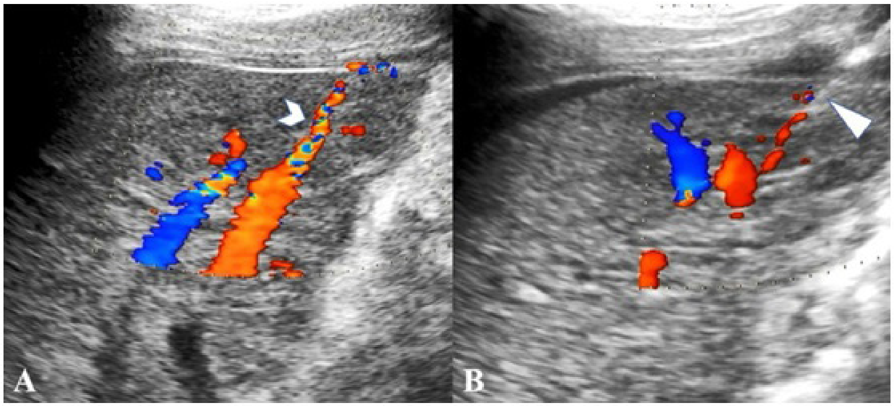

Figure 8: Hemorrhage and embolization of transhepatic trace under ultrasound (US) guidance. (A) Sonogram showed subcapsular outward blood flow (white arrowhead) as a sign of hemorrhage of the transhepatic trace. (B) Needle (white triangle) was accessed along the blood flow (white arrowhead) for compression hemostasis under US guidance.

3.9. Study Outcome Measures

Medical record was examined for each patient, and the procedural data, including cumulative fluoroscopy time (FT), cumulative Air Kerma (AK), operation time (OP), contrast usage were reviewed and evaluated. Technical success was defined as successful performance of TIPS creation. Given the study's aim to evaluate the safety and efficiency of US-guided PSC during the TIPS creation, the focus was placed on intraprocedural complications, which were evaluated for the first week after the procedure.

3.10. Statistical Analysis

The Statistical Package for Social Sciences (SPSS), version 13.0, (IBM Inc., Chicago, ILL., USA) was used for statistical analysis. Descriptive statistical data are shown as frequency (percentage), number and mean ± standard deviation (SD). Normality of distribution was evaluated by the Kolmogorov-Smirnov test. Comparisons of continuous variables between the groups were performed using independent samples t test. P values <0.05 were considered statistically significant.

4. Results

23 patients (20 men, 3 woman; age range, 43-82 years; mean age, 61.43±9.05 years) who underwent TIPS procedures from October 2018 through December 2021 at our institution were reviewed and analyzed retrospectively. Among them, 22 patients was diagnosed as cirrhosis and complications of PH, due to hepatitis B virus infection in 20 patients, and hepatitis C virus infection in 2 patient. Tumor thrombus of mai portal vein occurred in one patient with hepatitis B virus infection. 21 patients underwent the procedure for a first TIPS, including 11 cases of salvage TIPS and 20 cases of selective operation, while the other two patients underwent revision of dysfunction shunt because of thrombosis.

4.1. Technical Successful Rate

In one case with massive variceal bleeding, due to the progressive decrease in heart rate and blood pressure, the TIPS creation was terminated after successful GEVE, and the patient died on the fluoroscopy table finally. In other patient with cranial porta hepatis, because the portosystemic trace was too flexuous to be eligible for the shunt creation on portography, and the patient was irritable and difficult to tolerate the operation, TIPS creation failed following GEVE.

Technical success was achieved in 21 patients (91.30%), including 19 cases of first TIPS creation and tow cases of shunt revision.

In 19 cases with successful procedure for a first TIPS creation, the shunt was between the middle hepatic vein and the right portal vein in 15 patients. The other had portosystemic shunts with connection of middle hepatic vein and the main portal vein in 4 patients. Totally, 19 covered-stent (Viattor, Gore, Arizona, USA) were used during procedures, while 3 covered-stent (Fluency, Bard, Karlsruhe, Germany) and 2 bare-stent (E·luminexx, Bard, Karlsruhe, Germany) were used for prolonging of the portosystemic trace.

In patients with dysfunction TIPS, including one case with shunt thrombsis and the other with wreckage stents shown on the fluoroscopy, dysfunction shunts were recanalized by the placement of a coverd-stent (Fluency, Bard, Karlsruhe, Germany) and a bare-stent (E·luminexx, Bard, Karlsruhe, Germany), respectively.

4.2. Measurements of the Procedure

In patients with successful procedure, cumulative FT ranged 26 to 46 minutes (mean, 35.38±4.46 minutes), cumulative AK ranged 410 to 606 mGy (mean, 462.95±53.18 mGy), the OP ranged 90 to 170 minutes (mean, 110.24±19.40 minutes), and the contrast usage ranged 80 to 170 mL (mean, 106.19±21.56 mL). Portal venous pressure before

TIPS was 24-33 mm Hg (mean, 28.14±2.53 mm Hg) and after TIPS was 10-19 mm Hg (mean, 16.38±2.01 mm Hg).

In addition, there was no statistical difference in FT, AK, OP and contrast volume between the patients of salvage TIPS with prior GEVE and the patients underwent conventional TIPS with prior TIPS (Table 1).

Table 1: Comparison between salvage TIPS and conventional TIPS

	FT (minutes)	AK (mGy)	OP (minutes)	CU (mL)
Salvage TIPS (n=9)	35.11±2.52	448.89±37.23	106.67±12.24	105.56±12.36
Conventional TIPS (n=12)	35.58±5.60	473.50±62.06	112.92±23.59	106.67±27.08
p value	0.054	0.131	0.182	0.132

*FT, Cumulative fluoroscopy time; AK, Cumulative Air Kerma; OP, Operation time; CU, contrast usage

4.3. Complications

Among the patients with successful TIPS procedure (n = 21), one patient (male, aged 82 years with pre-hospital massive variceal bleeding) died of multiple organ failure 2 days after the procedure. Otherwise, none of the patients had clinical evidence of internal hemorrhage during ICU monitoring, and there were no immediate complications related to the procedure were encountered during hospitalization.

5. Discussion

PH is the major mechanism leading to complications responsible for morbidity and mortality of cirrhotic patients. The introduction of TIPS in clinical practice has been one of the most relevant improvements in the management of complications of PH.

Be thought of as the number of individual x-ray photons per unit area, Air kerma represents the kinetic energy released per unit mass when an x-ray beam is traveling through air, and it is how the intensity of the x-ray beam is characterized [15]. Consistent with prior researches [6, 16-18], this study demonstrated that US-guided

PSC was safe and efficient with shorter cumulative FT and lower cumulative AK, which can be used as an indirect measure of procedure complexity. In addition, prior work has shown that as the number of needle passes increases, the incidence of non-target organ injury also increases [19]. US guidance could contribute for inducing the number of needle passes to achieve portal access. After all, the fewer passes combined with the safer the procedure.

In acutely bleeding patients, TIPS is recommended at an early time point, within 72 h (ideally ≦ 24 hr) in patients at high risk of treatment failure [20, 21]. However, the rationale for a decompression alone may not be given and TIPS alone without embolization may not be the optimal solution [12]. Considering persistent bleeding during the procedure, GEVE should be performed prior to TIPS during the procedure. As shown in our stduy, compared with conventional TIPS, shunt creation with prior GEVE would not lead to longer FT and higher AK.

Studies suggested that the paracentesis should be started at the begin of the TIPS procedure if any ascites was present [6, 22]. Massive ascites forces the liver more cephalad, and the extra density caused by the ascites degrades the fluoroscopic image. Furthermore, the patient is more difficult to control breathing, and the respiratory movement would make the shunt venography be worsening. These effects can compromise the measurement of the shunt, and make the procedure more difficult [22]. However, US real-time observation could minimize these interferences. In most cases of our study, the measurement of the shunt and the choice of the stent were depended on by both US and fluoroscopy routinely (Figure 9). In addition, a small amount of ascites could force the lung more cephalad, and push the intestines surrounding the live away, which was beneficial for monitoring the procedure in sonogram. Moreover, for the pateint with salvage TIPS, hemostasis should be the first and most important stage during the treatment, and paracentesis should be started at less after the successful GEVE. In our study, one patients died on the the fluoroscopy table, even with successful GEVE.

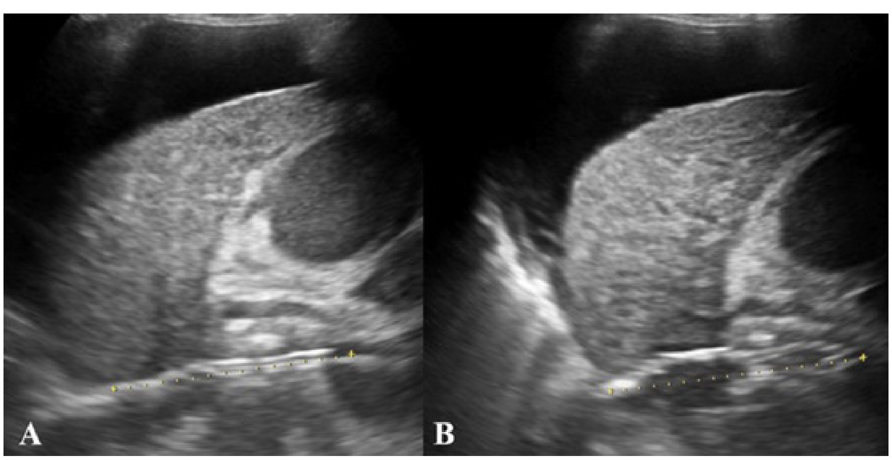

Figure 9: Measurement of the shunt by both sonogram. (A) Measurement of the shunt before the placement of metal stent on sonogram. (B) Measurement of the portosystemic stent after placement on sonogram.

Hepatorenal Syndrome (HRS), the extreme manifestation of renal impairment in patients with cirrhosis, is characterized by reduction in renal blood flow and glomerular filtration rate. Beside pre-procedural contrast CT, the use of contrast agent during the TIPS procedure will aggravate the damage of renal function, too. Prior works has shown that less contrast agent was used with US-guided TIPS, and analysis of factors that affect the efficiency of the procedure and minimize complications are valuable [6, 18]. By producing a cloud of echoes in vessels, injection of agitated saline into a patient's bloodstream for echocardiography was reported since 1969 by Gramiak et al, and adopted widespreadly [23]. In our study, the method was used to confirm the localization of the needle after hepatic and portal access, and reduce the contrast agent dosage in the procedure as possible.

Previous studies have suggested that the successful PVA should be confirmed by aspiration of blood, but in case of tumor thrombus within the portal vein, it is difficult to realized. Furthermore, once the initial punctures in attempts at transjugular access to the portal vein failed, the confidence of the operator may be slowly eroded by repeated failures. With real-time targeting and advancing into the portal vein under US guidance, once PVA was confirmed by sonogram, injection of saline or contrast agent through the needle into the portal vein could confirm the portal entry mostly (Figure 10).

For patients with cirrhosis, severe shrinking of the liver could lead to a cranial porta hepatis and produce an acute angle between the hepatic veins and the level of the portal bifurcation, which makes it difficult to perform PSC by the transjugular approach. Raza et al. proposed a technique of serial transhepatic puncture of the portal and hepatic veins under US guidance in a single needle pass [10]. In one case of our study, following attempts for conventional transjugular PSC failed, the serial percutaneous transhepatic portohepatic puncture in a single needle pass, was performed under US guidance. On top of that, serial percutaneous portocaval puncture would be an alternative [11].

Furthermore, to minimize complications related to the procedure, embolization of the transhepatic needle tract should be considered [10]. It was performed routinely in all patients of our study. Even so, subcapsular bleeding was observed in one case, shown as an outward blood flow on sonogram. Where available, an post-operative US scan should be performed at the end of the whole procedure.

US-guided TIPS allows a 3-dimensional description of the hepatic vascular structure, and a real-time targeting puncture, as opposed to any fluoroscopic guidance that could not satisfy. Nonetheless, US-guided PVA requires assisting staff who performs US to target the hepatic and portal vein. The procedural efficiency depends on operators ability and, will be affected by patient BMI, which could interfere with US visualization [6, 13]. In addition, how to cooperate of guidance with both fluoroscopy and US in tandem is considered another factor in the PVA procedure. Anyhow, US -guided TIPS was performed with a high success rate, low radiation exposure and low complication rate in our study, suggesting perhaps these factors can be overcome.

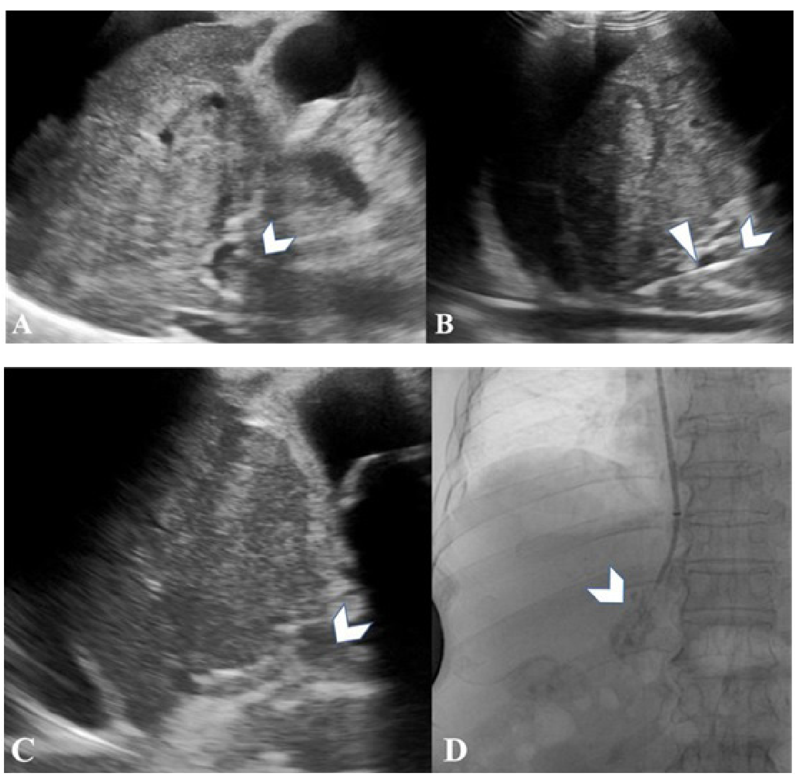

Figure 10: Ultrasound (US)-guided portal vein access in patient with tumor thrombus in portal vein. (A) Sonogram showed that the portal vein was filled with isoechoic mass (white arrowhead). (B) Advancement of needle (white triangle) under US guidance into right portal vein (white arrowhead). (C) Agitated saline is injected to confirm the portal entry, shown as a cloud of echoes by sonogram (white arrowhead). (D) Contrast agent is injected to re-confirm and outline the portal entry (white arrowhead).

6. Conclusions

In conclusion, US-guided PSC, whether from conventional transjugular or percutaneous transhepatic access, is a safe and effective technique during the TIPS placement, by providing fewer radiation exposure, less contrast usage, and minimizing the risk of complications.

7. Limitations

This study has a number of limitations, including its retrospective nature and a single center experiences. Firstly, this study had a limited number of subject's despite being the largest regional medical center. Secondly, outcomes may also have been affected by variation in operator technique, experience, and the learning curve associated with US-guided PCS. Furthermore, our experience may not be widely adopted given differences in operator experience, patient demographics, and choice of techniques employed, however, these data may provide some additional information to aid decisions in the treatment. Prospective studies are therefore needed to investigate this aspect of TIPS technique and provide further insight.

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