INTRODUCTION

Transjugular intrahepatic portosystemic shunt (TIPS) stent insertion is an established procedure with efficacy demonstrated in randomized-controlled trials of cirrhotic patients for recurrent ascites, and recurrent and acute variceal bleeding amongst other indications. The traditional technique involves right internal jugular vein access and selection of an hepatic vein (commonly right) with a TIPS cannula (Rösch-Uchida Transjugular Liver Access Set, Cook Medical, Bloomington, Indiana, USA), then transhepatic puncture into a portal vein branch, placement of a TIPS stent, and variceal embolisation where indicated. This reported technical success rate is 95%, however, failure occurs, typically at the intrahepatic puncture step, which is relatively blind in the traditional technique. Knowledge of alternative techniques may increase the success rate, particularly in the setting of challenging anatomy or limited resources.

Techniques to guide the intrahepatic needle pass can be broadly classified into wedge portal venography, ultrasound needle guidance (intravascular or transhepatic), and portal vein targeting (insertion of a wire, snare, or balloon), with published series demonstrating a decreased number of needle passes with use of these adjuncts. Direct intrahepatic portocaval shunt (DIPS) has gained popularity over recent years and can be performed as a salvage or primary technique, however, may contraindicate certain liver transplant techniques.

A gun-sight approach was first described for transscaval portosystemic shunt (DIPS) in a patient with recurrent varices and hepatic vein stenosis after conventional portohepatic TIPS, involving fluoroscopic percutaneous transhepatic puncture through snares in the portal vein and inferior vena cava (IVC), snaring of a wire to establish through-and-through access, balloon dilatation of the parenchymal tract, and stent placement.
At our centre, a modified gun-sight technique of portohepatic TIPS was adopted firstly as a salvage technique after unsuccessful conventional attempt, and subsequently as a primary technique. This technical note will focus on experience of the modified gun-sight TIPS technique at a low-volume centre.

**METHODS AND MATERIALS**

**Ethical approval**

Approval was granted for retrospective review of modified gun-sight TIPS cases by the local institutional review board.

**Patient identification**

All patients who underwent modified gun-sight TIPS in a 1-year period from September 2020 to September 2021 were identified using the electronic medical records system, and patient demographics, procedural technique and outcomes reviewed.

**Modified gun-sight TIPS procedure technique**

After clinical consultation and anaesthetic assessment, a suitable hepatic vein segment superior and posterior to the target portal vein branch were identified on CT imaging. The skin of the right neck and abdomen was prepared with chlorhexidine wash. Under general anaesthesia, a left portal vein branch was punctured under ultrasound guidance using a Neff Set (Cook Medical), and an 0.035” 180 cm glidewire (Terumo, Tokyo, Japan) and 5 Fr 65 cm Berenstein catheter (Angiodynamics, Latham, New York, USA) were passed into the target right portal vein branch under fluoroscopy (Figure 1). A Bright Tip 23 cm 7 Fr sheath (Cordis, Santa Clara, California, USA) was exchanged over a 260 cm Amplatz extrastiff wire (Cook Medical).

Next, the right internal jugular vein was punctured under ultrasound guidance using a micropuncture kit (Angiodynamics) and an 0.035” 180 cm glidewire (Terumo) and 5 Fr 65 cm Berenstein catheter (Angiodynamics) were passed into the target right hepatic vein segment with transabdominal ultrasound assistance where necessary (Figure 1). A 10 Fr 30 cm Dry Seal sheath (Gore, Flagstaff, Arizona, USA) was passed into the right atrium, and the right atrial and portal venous pressures measured. Fashioned snares were created using fixed-core 0.018” 260 cm wires (Cook Medical) looped-back through the hepatic and portal venous catheters. After transabdominal ultrasound screening of the superficial needle path, a percutaneous gun-sight puncture was performed with an 18 or 20 g 15-cm trocar needle (Cook Medical) under fluoroscopic guidance from an anterolateral approach with slight craniocaudal uptilt, with the needle held by forceps to avoid radiation exposure to the operator’s hand. A fixed core 0.018” 260 cm wire (Cook Medical) was passed through the trocar needle and snared on both the portal vein and hepatic vein sides to establish through-and-through access (Figures 2–3). After 5-mm balloon dilatation of the parenchymal tract, a 5 Fr 100-cm Hinck catheter (Terumo) was used to exchange the 0.018” wire for a 260 cm Amplatz extra stiff wire (Cook Medical), and the 10 Fr sheath advanced into the portal vein (Figure 4).

To measure stent length, a 100 cm 5 Fr measuring pigtail catheter (Cook Medical) was passed into the portal vein, and a TIPS stent (Gore VIATORR) deployed with the 2 cm uncovered portion at...
Figure 4. 10 Fr sheath access via the right hepatic vein segment into the right portal vein.

Figure 5. TIPS stent in place.

the portal vein parenchymal margin and covered portion in the hepatic vein toward the IVC (Figure 5). The stent was dilated to 8, 9 or 10 mm, with a target pressure gradient of 7 to 10 mmHg. Finally, haemostasis was achieved by embolization of the transhepatic portal venous puncture tract with 6 mm x 7 cm 0.035” Nester coils (Cook Medical) and manual pressure to the right internal jugular vein jugular puncture site.

Technique alterations

In one case, right-side-portal vein thrombosis precluded right-sided TIPS. To overcome this, a gun-sight fluoroscopic puncture was performed from a left portal vein branch to left hepatic vein segment. In another case, small-calibre portal vein branches precluded safe percutaneous transhepatic puncture, so transsplenic puncture was performed to access the portal vein and 6 mm x 7 cm 0.035” Nester coils (Cook Medical) deployed at conclusion for haemostasis. Lastly, just one patient had significant varices suitable for simultaneous endovascular embolisation, which performed via the newly created TIPS.

RESULTS

Patient demographics

Six patients were identified, of median age 56 years, with 5 males and one female, and all had Child-Pugh B alcoholic cirrhosis...
(Table 1). The indication for TIPS was refractory ascites in 4 patients and recurrent variceal bleeding in 2 patients. Other significant past medical history included ischaemic heart disease and type two diabetes mellitus in two patients, and chronic kidney disease in two patients. No patient had previously undergone TIPS.

**Technical outcomes**

All 6 patients had a technically successful TIPS with a single fluoroscopic-guided transhepatic portohepatic needle pass and portosystemic pressure gradient of 7 to 10 mmHg, without immediate complication. In five procedures, the modified gunsight technique was used primarily, and in one procedure after failed conventional attempt. Each procedure was performed by two operators, from a group of five interventional radiologists with varying experience in TIPS procedures from 1 to 12 years. Of note, the fluoroscopic gunsight needle puncture was performed successfully in all cases by the most junior member of the team under supervision. Total procedure duration (wheel in/wheel out time) ranged from 2 to 5.75 h (mean 3.8 h), fluoroscopic screening time ranged from 37 to 98 min (mean 67 min), and dose area product (DAP) ranged from 121 to 971 Gy·cm² (mean 502 Gy·cm²). There was a noticeable learning-curve effect, with initial procedure duration of over 4.5 h for the first two cases in the series, and procedure duration of under 2.5 h for the final two cases.

**Clinical outcomes**

All TIPS stents were patent on ultrasound at 2 weeks postoperatively with appropriate haemodynamic flow. One patient (Patient 2) was admitted four months later with pneumonia and decompensated hepatorenal failure, and palliated. The five other patients had patent TIPS stents at 6 months and fewer hospital admissions for paracentesis or variceal bleeding over a 6 month follow-up period, commensurate with expectations.

**DISCUSSION**

The described technique in this manuscript is a modification of the gun-sight TIPS method to create a portohepatic shunt rather than portocaval. Whilst the direct intrahepatic portocaval shunt (DIPS) procedure, involving transhepatic puncture between the IVC and main portal vein through the caudate lobe, is highly successful and suitable for many patients, it may contraindicate certain liver transplant techniques that spare the native IVC. Use of intravascular ultrasound has been described by several authors to increase the success rate of TIPS and decrease the number of needle passes required, with one series reporting a median of 2 passes (range: 1–12) utilising intravascular ultrasound compared with a median of 6 passes (range: 1–35 passes) with the conventional technique. Another retrospective series examining several adjunct techniques for transhepatic needle puncture reported a median of 4 passes (IQR: 1–7) utilising fluoroscopy guided wedged hepatic portography, median of 2 passes (IQR: 1–4) utilising transabdominal ultrasound guidance for portal vein access, and median of 2 passes (IQR: 1–7.25) utilising percutaneous ultrasound-guided portal vein guidewire placement for fluoroscopic targeting. A significant advantage of the ultrasound-guided intrahepatic needle puncture techniques is that they do not require additional fluoroscopic screening and radiation dose, however intravascular ultrasound may be unavailable in many centres and transabdominal ultrasound can be challenging in patients with large body habitus.

The presented modified gun-sight technique of portohepatic TIPS has several technical advantages. Firstly, the transhepatic puncture is fluoroscopically image-guided and well-suited to single-plane angiographic machines, likely decreasing the number of intrahepatic needle passes required as just a single pass was required in all cases in the present series. Secondly, the technique does not require a designated TIPS kit or intravascular ultrasound, utilising typically on-shelf low-cost equipment and a
10 Fr sheath for stent deployment. Lastly, the technique is adaptable in cases with challenging anatomy, allowing for left-sided TIPS and trans-splenic access.

There are disadvantages to acknowledge. Firstly, the percutaneous hepatic punctures, not required in successful conventional TIPS, may have a risk of major bleeding of 2%14 based on percutaneous liver biopsy data; however, this must be balanced against the risks of multiple intrahepatic needle punctures with conventional TIPS.15 Secondly, the fluoroscopic-guided transhepatic puncture may expose the operator’s hand to radiation, which can be mitigated by using needle forceps. Thirdly, total fluoroscopic screening times and DAP were relatively high in this series, however were comparable to previously published reference levels,16 particularly when considering the additional fluoroscopic steps involved and likely learning curve effect. Lastly, this technical note presents data from a single small-volume patient series.

CONCLUSION
The presented modified gun-sight portohepatic TIPS technique is an alternative approach that does not require a dedicated TIPS set or endovascular ultrasound, utilising typically on-shelf and low-cost equipment for a targeted fluoroscopic-guided parenchymal puncture. The technique is adaptable in challenging anatomy and was technically successful with a single porto-systemic transhepatic needle pass in all patients in this series.

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ETHICS APPROVAL
The study was approved by the local institutional review board.

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